Operational Service Life Evaluation for the United States Forest Service P-3 Aircraft

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AVENGER Aircraft and Services

Outline

- *Background*
- *Program Objectives*
  - *Phase 1 – Baseline FAA DTA Evaluation*
  - *Phase 2 – Airtanker FAA DTA Evaluation*
  - *Phase 3 – USFS Economic Operational Service Goal*
  - *Phase 4 – Continued Tracking / Fleet Management*
- *Conclusions*

AVENGER Aircraft and Services

Background

- *C-130A Walker Crash Investigation Spurred Review of Airtanker Fleet*
- *USFS is the FAA Type Certificate Holder for the P3A TCDS A32NM*
- *NTSB Provided Numerous Recommendations for Entire Airtanker Fleet including the P3A as a Result of the Accident Investigation*
- *FAA Provided Similar Comments Including DTA and WFD Evaluations*
- *USFS Made Commitment to Develop the Necessary Engineering Capabilities to Fully Support all of the FAA Type Certificates*
- *USFS Funded FAA DTA and WFD Evaluations for Both of the Type Certificates they own, P2V-5 and P3A respectively.*

Background (contd.):

P3A Successfully employed as airtankers for over 15 years

P3A Aircraft Currently Account for 50% of USFS Large Airtanker Fleet and are vital to operations

Program Objectives

Phase 1 – Baseline Evaluation

- *Baseline Fatigue/DTA Evaluation to FAA Criteria*
- *FAA Approved Airworthiness Limitations (ALS)*

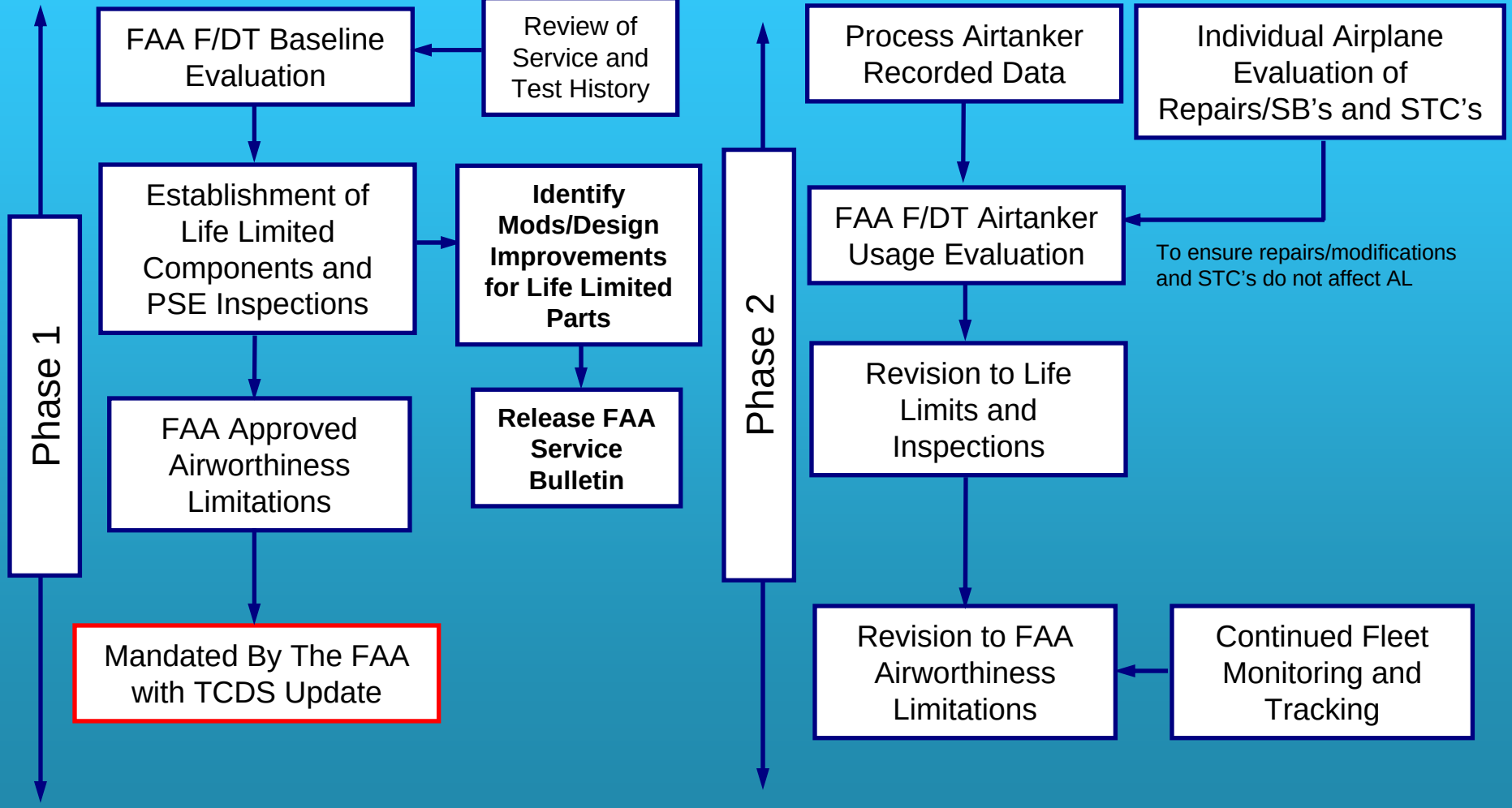
Phase 2 – Airtanker Evaluation

- *USFS Airtanker Usage Evaluation*
- *Revised FAA F/DTA and Airworthiness Limitations*

Phase 3 – USFS P-3 Operational Service Goal

Phase 4 – Continued Fleet Management

- *Entire Fleet to be Instrumented*
- *Continued Tracking and Recording of Fleet*


Phase 1
FAA F/DT Baseline Evaluation
Review of Service and Test History
Establishment of Life Limited Components and PSE Inspections
Identify Mods/Design Improvements for Life Limited Parts
FAA Approved Airworthiness Limitations
Release FAA Service Bulletin
Mandated By The FAA with TCDS Update
Phase 2
Process Airtanker Recorded Data
Individual Airplane Evaluation of Repairs/SB's and STC's
FAA F/DT Airtanker Usage Evaluation
To ensure repairs/modifications and STC's do not affect AL
Revision to Life Limits and Inspections
Revision to FAA Airworthiness Limitations
Continued Fleet Monitoring and Tracking

Phase 1 - Baseline Evaluation

Review of Test and Service History

- *Military Usage and Airtanker Operator Records*
- *Relevant Full Scale and Component Testing*

F/DT Evaluation

- *Analysis Performed to Current FAA FAR 25.571*
- *Full Development of External & Internal Loads*
- *DTA performed at all PSE for local and acreage areas*
- *Fatigue analysis performed to address WFD*
- *Results utilized in the development of FAA Airworthiness Limitations*

Relevant Test and Service History

Large Database of Available Information on Fatigue Cracking Reviewed:

- ***P-3A and Relevant P-3C Full Scale Fatigue Test***
- ***Relevant L188 Fatigue Testing***
- ***In-Service Data from P-3 and L188 Fleet***

Test and Service History Utilized for the Following:

- ***Correlation of Analytical Methods***
- ***Identification of WFD Susceptible Areas***
- ***Establishment of FAA Mandatory Replacements/Modifications***

Structural Components Requiring FAA Mandatory Action as a Result of Service and Test History

- ***Front Spar and Plank 1 Assembly at Wing to Fuselage Joint***
- ***Lower Wing Planks***
- ***Horizontal and Vertical Tail Attachments to Fuselage***

F/DT Baseline Evaluation – FAA Criteria

Criteria for Fatigue:

- ***Minimum Scatter Factor of 2.0 Must be Employed***
- ***Airframe Evaluated for Susceptibility to WFD***
- ***Life Limitations for all Demonstrated WFD Susceptible Structure***

Criteria for DTA:

- ***Repeat Intervals Based on Time from Detectable to Critical***
- ***All Inspection Methods meet Reliability (90/95 POD) Requirements***
- ***All Structure Classified as PSE's are Evaluated***

Criteria for Continued Airworthiness:

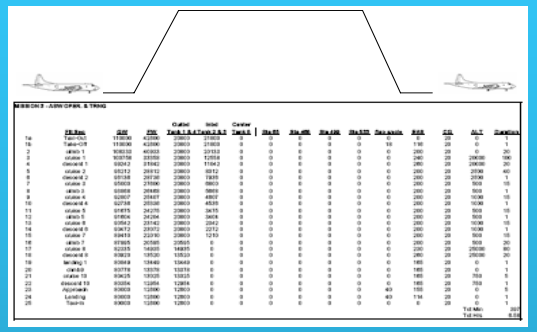
- ***Damage Tolerance Based Inspection Requirements and WFD Limitations***
- ***Terminating Action Modifications for WFD Susceptible Structure***

F/DT Baseline Evaluation – Loads and Spectrum Development

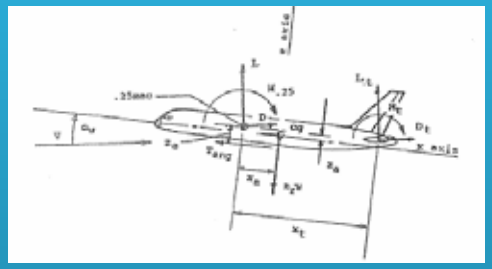
- *External and Internal Loads Development Utilizes FAA Approved Methods*
- *Mission Profiles and Flight Conditions based on Aircraft Logbook Data*
- *Balanced External Loads Developed for All Flight Segments in Mission Profiles such as: 1-G, 2-G, 1G+Gust, Taxi, Landing*
- *Loads Histories include Gust, Maneuver, Taxi and Landing*
- *Internal Loads Developed Using a Combination of Methods such as BoxBeam as well as Finite Element Models for Complex Structural Interfaces*
- *Fatigue Spectra Developed using SpecGen which develops Fully Sequenced Flight-By-Flight Spectra*

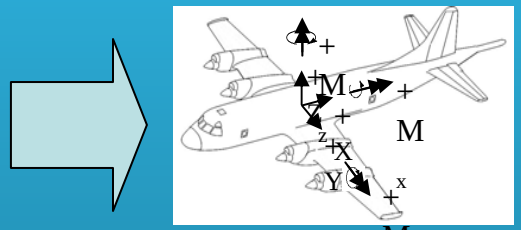
F/DT Baseline Evaluation – Loads and Spectrum Development

Mission Profiles

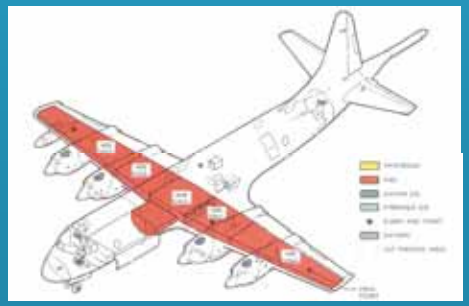


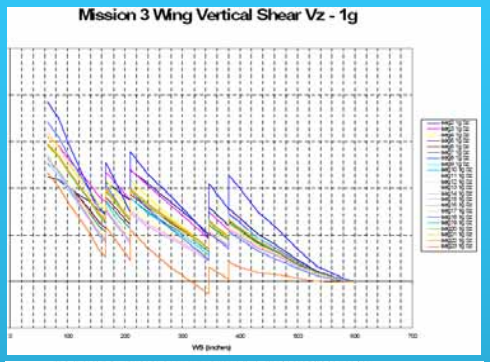
Aerodynamic Loading

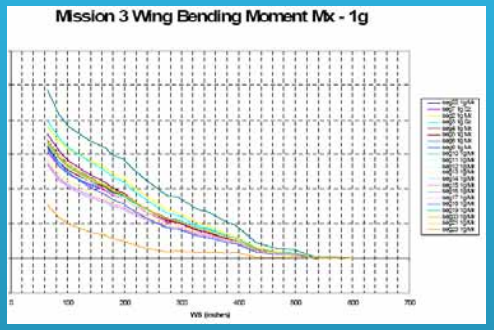


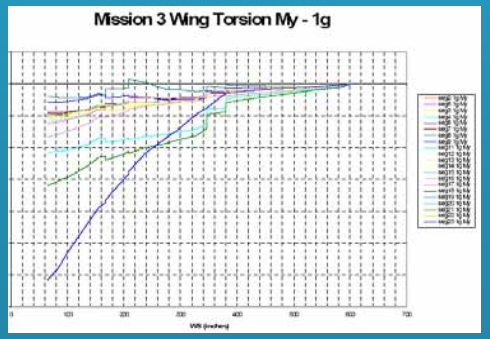


Weight and Balance









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F/DT Baseline Evaluation – Loads and Spectrum Development

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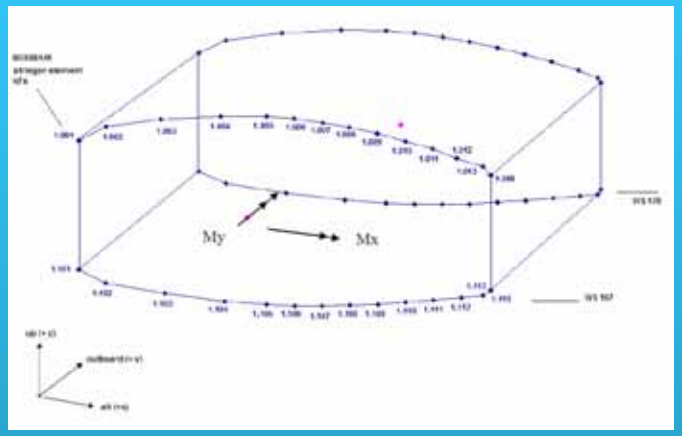
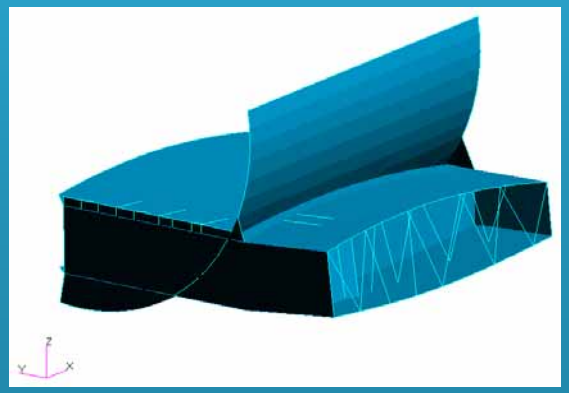


BoxBeam for Wing Box General Load Distribution



FEMs for Internal Load Redistribution Effects

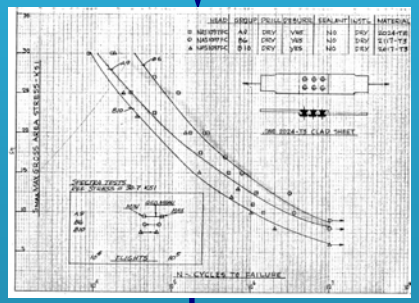
INTERNAL LOADS

F/DT Baseline Evaluation - Fatigue Analysis Method

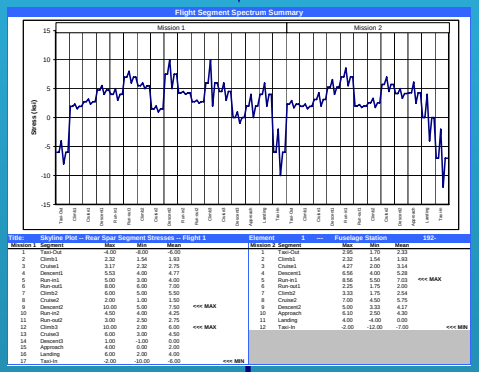
Fatigue Analysis

(Sequence Accountable Method)

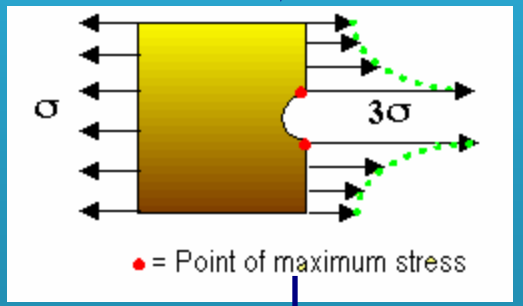
Material Database
(Joint data for various Kt)



Stress Spectrum



Stress Severity Factor (SSF)

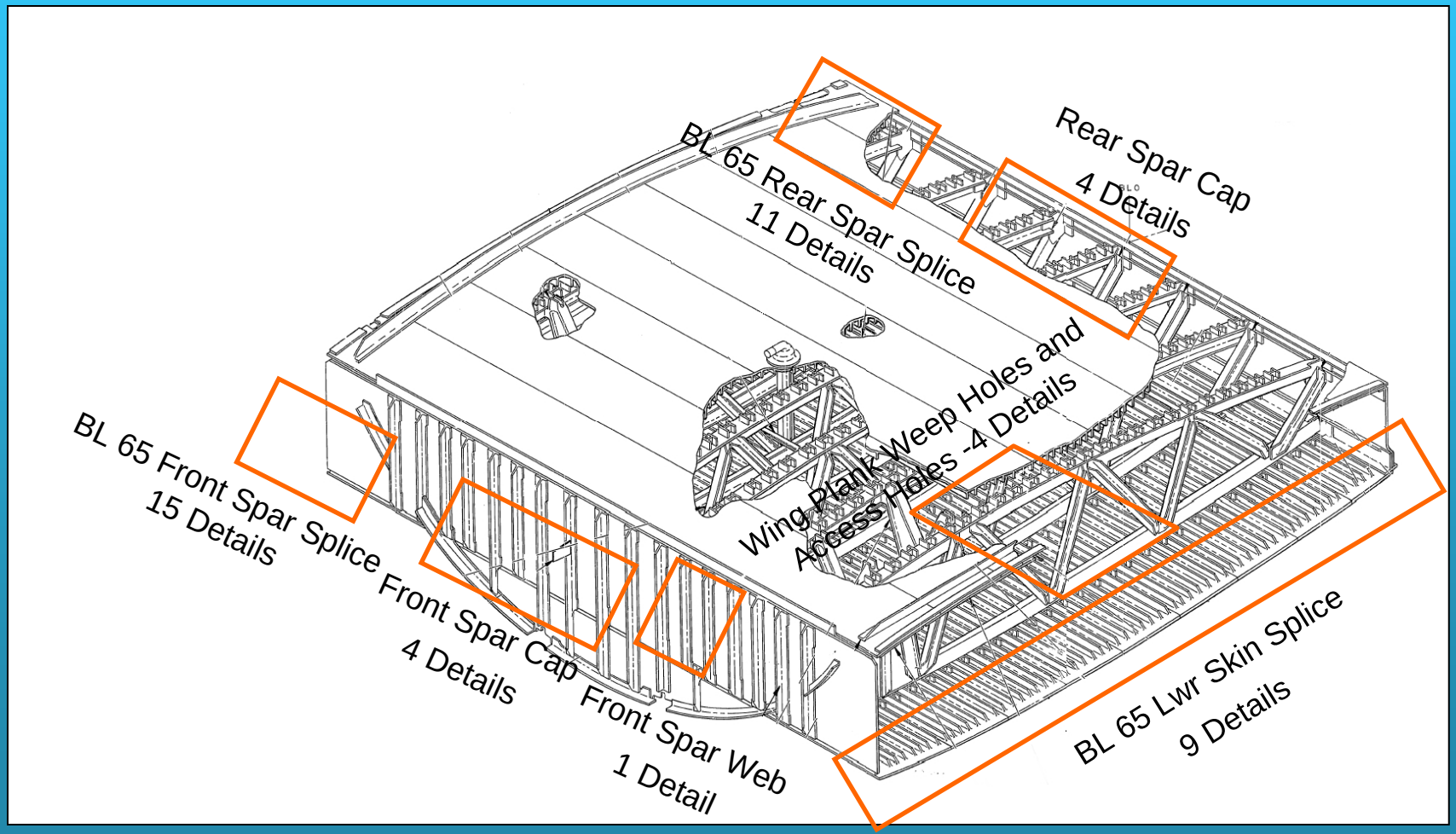


Fatigue Life/SF

F/DT Baseline Evaluation – Wing Fatigue Analysis Summary

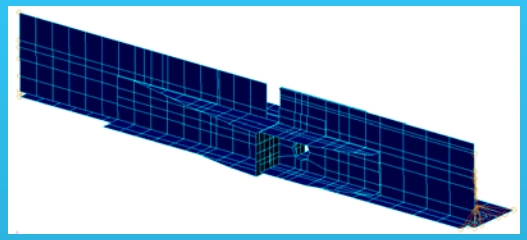
- ***Analysis Utilizes FAA Approved Methods with an FAA SF = 2***
- ***Analysis Results Correlate (without SF) with Known Fatigue Test and In-Service Fleet Cracking Accounting for both Hours and Flight Cycles***
- ***Large blueprint tolerances and on-aircraft conditions were found to have significant effects on fatigue life and correlated with service history:***
    - ***Edge Distance***
    - ***Inconsistent Fastener Fit***
    - ***Surface Finish***
- ***Several Structural Components Found to be WFD Susceptible***
- ***WFD Results were Used to Set FAA Component Life Limits and USFS Economic Service Goal***

F/DT Baseline Evaluation – Wing Center Section



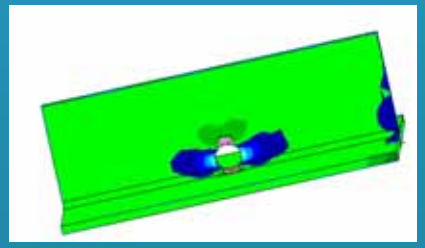
F/DT Baseline Evaluation – Wing Center Section

- *Over 40 Structural Details Analyzed*
- *Analyses included Tanker 25 USN Logbook Based Usage*
- *FEMs developed to analyze detailed joints (i.e. BL65 splice)*

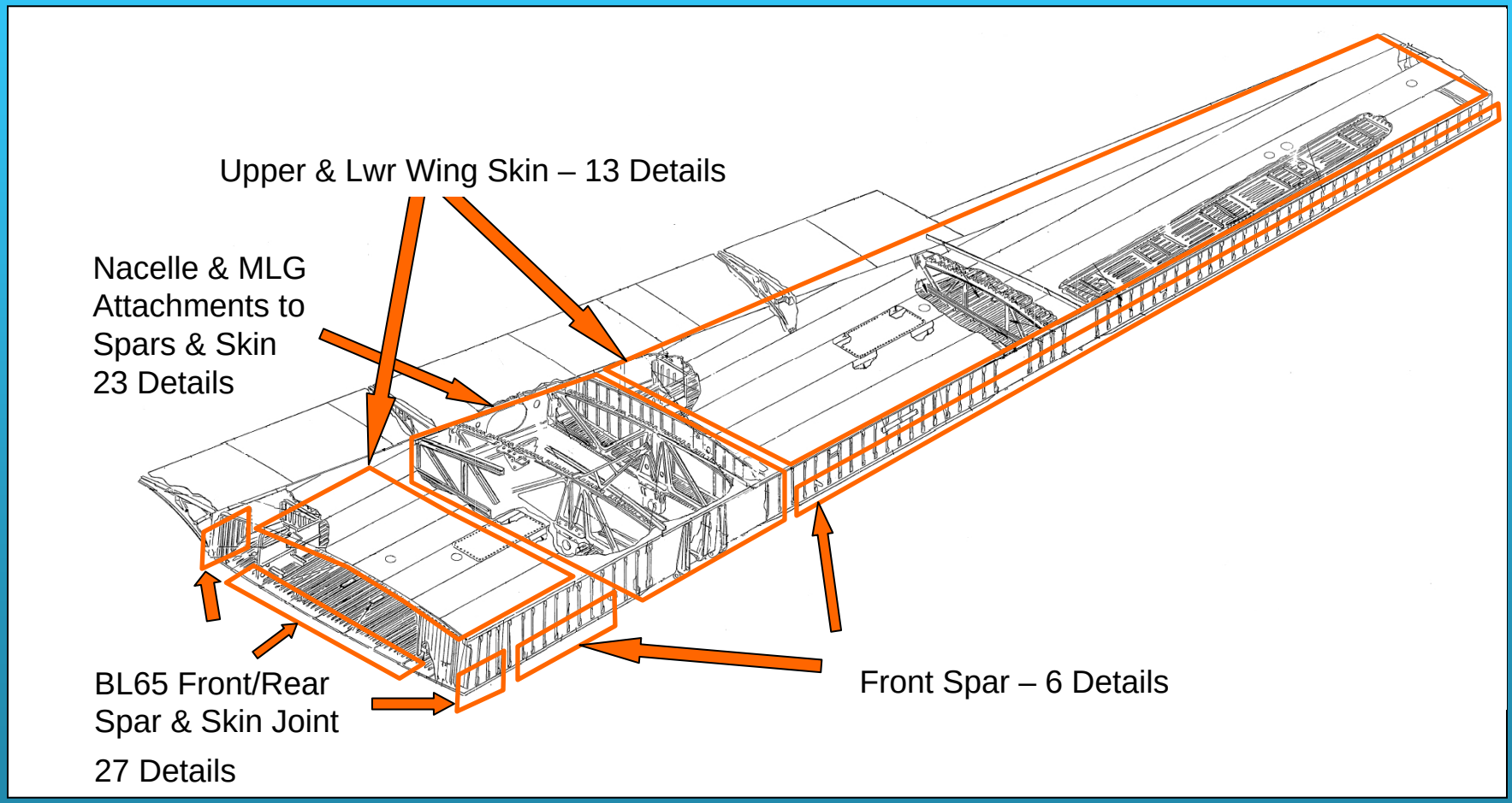


- *Effects of blueprint tolerances and on-aircraft conditions taken into account for several details*
  - *Example: Center Wing Plank Weepholes:*
  - *Existing drawing callout for tolerance between weephole edge and plank could result in weepholes being +0.020 to -0.020 from plank*
  - *This results in a large impact to the fatigue life of this location*

Clearance	*Flight Hours*	*Flights*
+0.020	*24,900*	*5,770*
0.0	*21,200*	*4,900*
-0.020	*13,000*	*3,020*



F/DT Baseline Evaluation – Outer Wing Section



F/DT Baseline Evaluation – Outer Wing Section

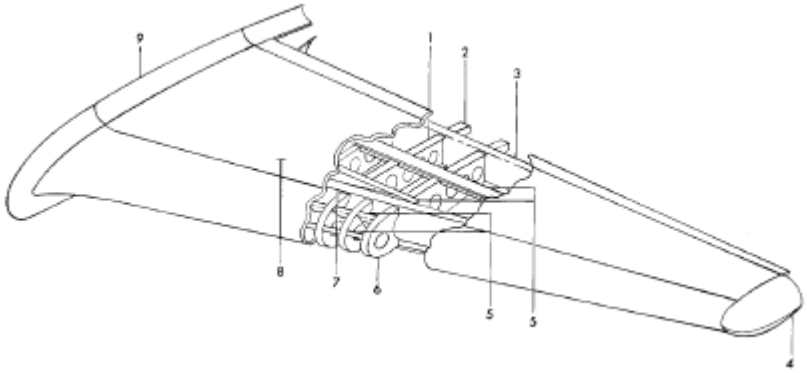
- *Over 50 Structural Details Analyzed*
- *All major structural components and major attachments analyzed*
- *Numerous FEMs and joint analyses performed*
- *Zoning of widespread repeated details performed in order to obtain more accurate analyses and avoid conservative "blanketing" of results*
  - *Examples: Upper & Lwr Spanwise Splices Separated into WS Zones*
- *Trends in P3A vs P3C fatigue lives for the outboard upper and lower wing skins match previous findings*
  - *P3A wing skins are approx. 10~20% thinner*
  - *Differences in skin thickness result in a few areas having different critical locations for the P3A vs P3C.*

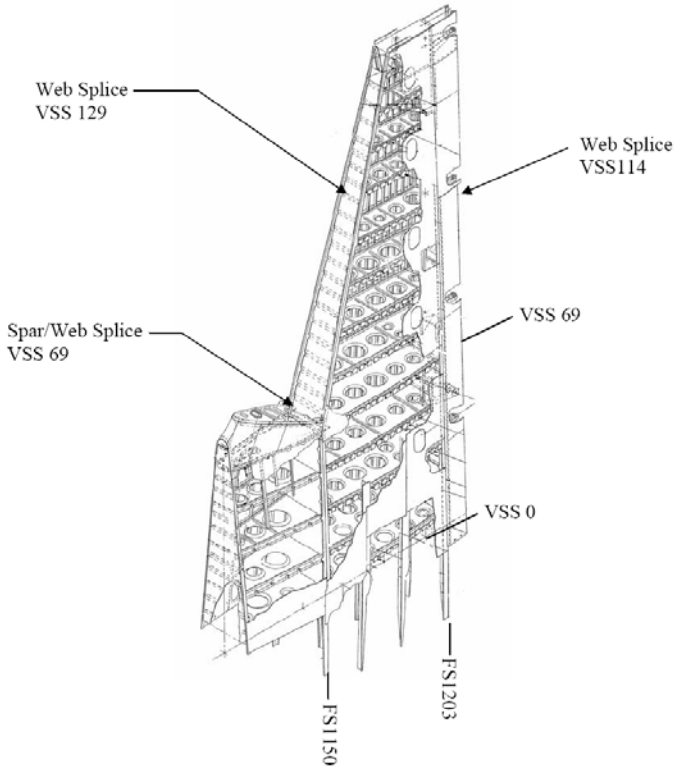
F/DT Baseline Evaluation – FAA Component Fatigue Life Limits

		FAA Mandatory Modification/Replacement Times for WFD		
Location	**Detailed Component**	**Flight Hours**	**Flights**	**Part Number**
Wing				
Center and Outboard Front Spar	BL 65 to WS 155 - Outboard - Lower Spar Cap, Web and Plank 1	7,150	1,650	Part No. 901054-1/-2, 925250-1/-2, 938321-101/-102, 919032-1/-2, 900601-1/-2
	BL 65 Splice - Outboard - Lower Forward Fitting	16,460	3,800	Part No. 904626-1/-2, 939193-101/-102
	BL 65 Splice - Outboard - Lower Aft Fitting	13,930	3,210	Part No. 807353-1/-2, 939192-101/-102
	BL 0 to BL 65 - Inboard - Lower Spar Cap, Web and Plank 1	11,930	2,750	Part No. 625251-101, 925251-1, 900581
	BL 65 Splice - Inboard - Lower Forward Fitting (Ring Frame)	10,870	2,510	Part No. 901721-1/-2
	BL 65 Splice - Inboard - Lower Aft Fitting	14,940	3,440	Part No. 903220-1/-2, 939195-101/-102, 905052
	BL 65 Splice - Main Tension Attachment Bolts and Barrel Nuts (see Note 1)	660	140	
Center Lower Wing Planks	Weep Holes Located on Riser > 0.02" from Plank Surface	24,990	5,770	Part No. 900621, 900622, 900623, 900624, 900625, 900626, 900627, 900628, 900629
	Weep Holes Located on Riser < 0.02" from Plank Surface	21,230	4,900	
	Weep Holes Located on Riser < 0.0" from Plank Surface	13,080	3,020	
Outboard Lower Wing Planks	Zone 1A - Spanwise Splice Attachments - WS 65 to WS 155 - Planks 3	8930	1950	Part No. 900602-1/-2, 900603-1/-2, 900604-1/-2
	Zone 1B - Spanwise Splice Attachments - WS 221 to WS 329 - Planks 2 and 3			
	Zone 2A - Spanwise Splice Attachments - WS 65 to WS 155 - Plank 2	13360	2930	Part No. 900601-1/-2, 900602-1/-2, 900603-1/-2
	Zone 2B - Spanwise Splice Attachments - WS 221 to WS 329 - Planks 1 and 2			
	Zone 3A - Spanwise Splice Attachments - WS 65 to WS 155 - Planks 4 to 9	40440	8860	Part No. 900603-1/-2, 900604-1/-2, 900605-1/-2, 900606-1/-2, 900607-1/-2, 900608-1/-2, 900609-1/-2
	Zone 3B - Spanwise Splice Attachments - WS 221 to WS 329 - Planks 4 to 9			
	Zone 4 - Spanwise Splice Attachments - WS 65 to WS 155 - Plank 1	7150	1650	Part No. 900601-1/-2
	Zone 5A - Spanwise Splice Attachments - WS 155 to WS 221 - All Planks	6740	1560	Part No. 900601-1/-2, 900602-1/-2, 900603-1/-2, 900604-1/-2, 900605-1/-2, 900606-1/-2, 900607-1/-2, 900608-1/-2, 900609-1/-2
	Zone 5B - Spanwise Splice Attachments - WS 329 to WS 380 - All Planks			
Outboard Upper Wing Planks	Spanwise Splice Attachment - WS 65 to WS 167 - Planks 4 to 8	15,960	3,500	Part No. 900594-1/-2, 900595-1/-2, 900596-1/-2, 900597-3/-4, 900598-3/-4

F/DT Baseline Evaluation – Horizontal and Vertical Tail

8 Horizontal Details





7 Vertical Details

F/DT Baseline Evaluation – Horizontal and Vertical Tail

- *15 Major Structural Details Analyzed*
- *All major structural components and major attachments analyzed*
- *Numerous joint analyses performed*
- *Two locations found to be WFD critical:*
  - *Horizontal Front and Rear and Splice Stringer Attachments to Fuselage*
  - *Vertical Spar Attachments to Fuselage Bulkheads*

		FAA Mandatory Modification/Replacement Times for WFD		
Location	**Detailed Component**	**Flight Hours**	**Flights**	**Part Number**
Horizontal Stabilizer				
Horizontal to Fuselage Attachments	Front and Rear Upper and Lower Spar Caps and Splice Stringers in Center Section Inboard of HS 42	13,270	2,900	See PSE 55-55-101 for detail part number listing
Vertical Stabilizer				
Vertical to Fuselage Attachments	Front Spar Attachments to Bulkhead FS 1150	18,860	--	See PSE 55-75-101 for detail part number listing

F/DT Baseline Evaluation – Wing Damage Tolerance

- *Details for Crack Growth Analysis Selected from Fatigue Critical Areas*
- *Over 40 Locations Analyzed*
- *Residual Strength Analyses performed to 100% of Limit Load*
- *Analysis takes advantage of retardation effects*
- *Crack Growth Analysis performed to complete part failure to obtain most representative failure mode and support least intrusive inspections*
- *FAA Prototyping of inspections required to determine best method and fit with existing maintenance access*

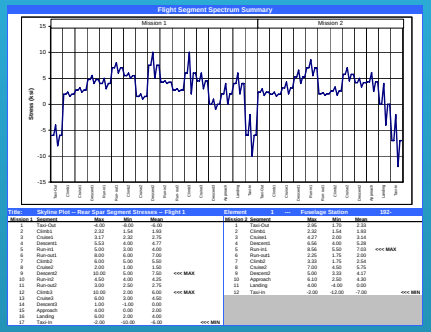
F/DT Baseline Evaluation – Crack Growth Analysis Method

Crack Growth Analysis

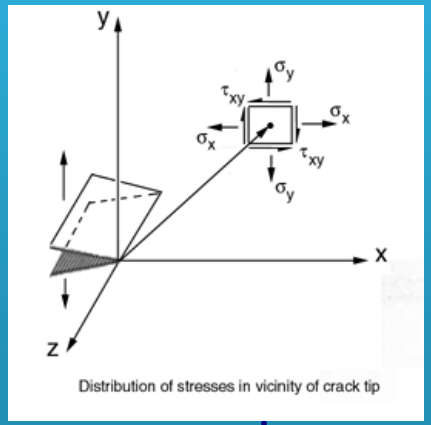
Material Data

- Crack Growth Rates (da/dN)
- Fracture Toughness (Kc and Kic)
- Fty

Stress Spectrum



Stress Intensity Solution (Beta)



Distribution of stresses in vicinity of crack tip

Residual Strength Analysis

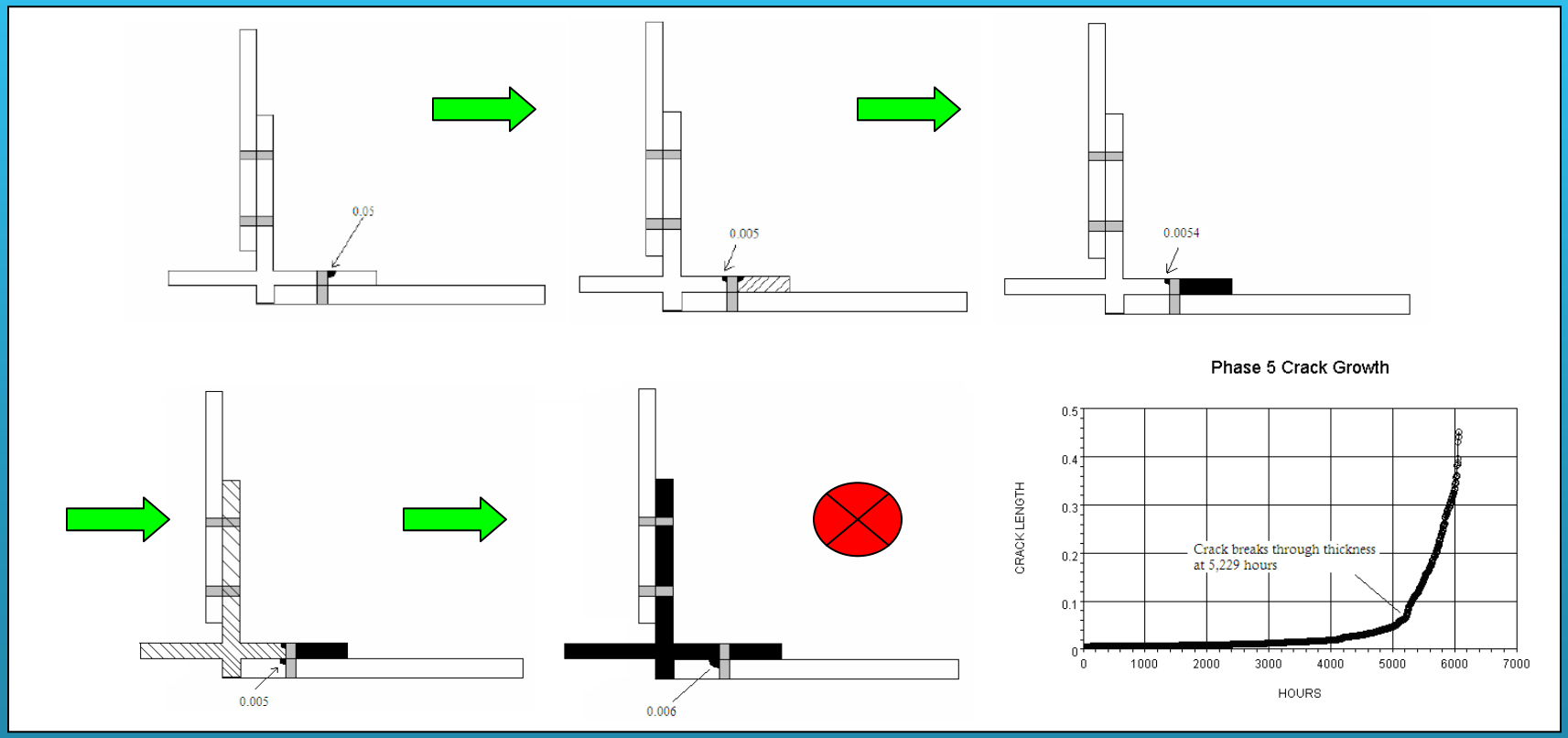
Determines at what point crack growth analysis must terminate.

Based upon damaged part's capability to carry limit load.

Crack Growth Life

F/DT Baseline Evaluation – Wing Damage Tolerance

WS 101 Outboard Front Lower Spar Cap Analysis



F/DT Baseline Evaluation – Wing Damage Tolerance

PSE Number	Principle Structural Element	Threshold Interval Hours	Threshold Interval Flights	Repeat Interval Hours	Repeat Interval Flights	Access	Type	* Inspection Covered by AFB 356 SSI
57-11-201	Center & Outer Wing Lower Skin Panel Weep Holes, ≥ 0.01	6,660	1,440	3,320	710	INT	NDT	Appendix F&G
57-11-202	Center & Outer Wing Lower Skin Panel Weep Holes, < 0.01	340	60	160	20	EXT	NDT	Appendix F&G
57-16-101	Center Wing Lower Skin Panel Access Holes	4,050	870	2,010	430	EXT	NDT	Appendix D
57-11-101	Center Wing Upper Plank Spanwise Splice	11,230	3,280	8,200	1,780	EXT	NDT	--
57-21-101	Center Wing Lower Plank Spanwise Splice	8,910	1,940	7,510	1,630	EXT	NDT	--
57-12-101A	Center Wing Front Spar Webs	6,260	1,360	1,470	310	EXT	VIZ	--
57-12-101B	Center Wing Front Spar Webs	6,260	1,360	1,470	310	EXT	NDT	--
57-12-102A	Center Wing Front Spar Caps and Skin	11,230	2,700	5,490	1,190	EXT	VIZ	--
57-12-102B	Center Wing Front Spar Caps and Skin	11,230	2,700	5,490	1,190	EXT	NDT	--
57-12-103	Center Wing Front Spar Penetration Holes	11,230	3,280	14,720	3,210	EXT	NDT	--
57-13-101A	Center Wing Rear Spar Webs	11,230	3,280	11,230	3,280	EXT	VIZ	--
57-13-101B	Center Wing Rear Spar Webs	11,230	3,280	11,230	3,280	EXT	NDT	--
57-13-102A	Center Wing Rear Spar Caps and Skin	11,230	3,280	11,230	3,280	EXT	VIZ	--
57-13-102B	Center Wing Rear Spar Caps and Skin	11,230	3,280	11,230	3,280	EXT	NDT	--
57-13-103	Center Wing Rear Spar Penetration Holes	11,230	3,280	11,230	3,280	EXT	NDT	--
57-48-201	WS 65 Front Spar Cap Splice							
	Outboard - Forward Fitting	11,230	3,280	2,440	520	INT	NDT	App K,L,M,N,O
	Outboard - Aft Fitting	11,230	3,200	2,440	520	INT	NDT	App K,L,M,N,O
	Outboard - Lower Spar Cap, Web & Skin	7,810	1,790	2,440	520	INT	NDT	App K,L,M,N,O
	Inboard - Forward Fitting (Ring Frame) (tweb=0.16")	10,860	2,490	2,440	520	INT	NDT	App K,L,M,N,O
	Inboard - Aft Fitting	11,230	3,280	2,440	520	INT	NDT	App K,L,M,N,O
	Inboard - Lower Spar Cap, Web & Skin	7,810	1,790	2,440	520	INT	NDT	App K,L,M,N,O
57-48-208	WS 65 Rear Spar Cap Splice							
	Outboard - Forward Fitting	11,230	3,280	2,440	520	INT	NDT	--
	Outboard - Aft Fitting	11,230	3,280	2,440	520	INT	NDT	--
	Outboard - Lower Spar Cap, Web & Skin	11,230	3,280	2,440	520	INT	NDT	--
	Inboard - Forward Fitting	11,230	3,280	2,440	520	INT	NDT	--
	Inboard - Aft Fitting (Ring Frame)	11,230	3,280	2,440	520	INT	NDT	--
	Inboard - Lower Spar Cap, Web & Skin	11,230	3,280	2,440	520	INT	NDT	--
57-29-201	WS 65 Lower Spar Attachment Bolts	2,630	640	2,630	640	INT	RR/NDT	--
57-21-201	WS 65 Lower Crown Splice	11,230	3,280	11,230	3,280	EXT	NDT	--

Table C.3 – P3A Wing Box PSE Inspection Requirements

F/DT Baseline Evaluation – Wing Damage Tolerance

PSE Number	Principle Structural Element	Threshold Interval Hours	Threshold Interval Flights	Repeat Interval Hours	Repeat Interval Flights	Access	Type	* Inspection Covered by AFB 356 SSI
57-42-101A	Outer Wing Front Spar Webs	11,230	3,280	7,570	1,640	EXT	VIZ	--
57-42-101B	Outer Wing Front Spar Webs	11,230	3,280	7,570	1,640	EXT	NDT	--
57-42-102A	Outer Wing Front Spar Caps and Skin	7,140	1,630	3,120	670	EXT	VIZ	--
57-42-102B	Outer Wing Front Spar Caps and Skin	7,140	1,630	3,120	670	EXT	NDT	--
57-42-301	Outer Wing Front Spar Cap at Nacelle Attachments	7,240	1,570	2,530	540	EXT	NDT	--
57-32-301	Outer Wing Front Spar Web at Nacelle Attachments	6,820	1,560	2,530	540	EXT	NDT	--
57-32-101	Outer Wing Front Spar Penetration Holes	11,230	3,280	8,750	1,900	EXT	NDT	--
57-42-103	Outer Wing Front Spar Caps With Short E.D.	4,370	940	950	190	EXT	NDT	--
57-43-101A	Outer Wing Rear Spar Webs	11,230	3,280	7,570	1,640	EXT	VIZ	--
57-43-101B	Outer Wing Rear Spar Webs	11,230	3,280	7,570	1,640	EXT	NDT	--
57-43-102A	Outer Wing Rear Spar Caps and Skin	8,440	1,840	3,120	670	EXT	VIZ	--
57-43-102B	Outer Wing Rear Spar Caps and Skin	8,440	1,840	3,120	670	EXT	NDT	--
57-33-302	Outer Wing Rear Spar Cap at Nacelle Attachments	7,240	1,570	2,530	540	EXT	NDT	--
57-33-301	Outer Wing Rear Spar Web at Nacelle Attachments	6,820	1,560	2,530	540	EXT	NDT	--
57-33-101	Outer Wing Rear Spar Penetration Holes	8,330	1,810	4,160	900	EXT	NDT	--
57-43-201	Outer Wing Rear Spar Skin Riser Runouts	11,230	3,280	11,230	3,280	INT	NDT	--
57-43-202	Outer Wing Rear Spar Lower Plank Splices	6,730	1,460	1,510	320	EXT	VIZ	--
57-36-101	Outer Upper Wing Plank Access Hole (Splice)	10,100	2,320	9,830	2,140	INT	NDT	--
57-36-102	Outer Upper Wing Plank Access Hole (Corner)	11,230	3,280	11,230	3,280	INT	NDT	--
57-31-101	Outer Upper Wing Plank Spanwise Splice	11,230	3,280	8,200	1,780	EXT	NDT	--
57-31-301	Outer Upper Wing Plank Riser Runout	4,910	1,060	1,620	340	INT	NDT	--
57-41-101	Outer Lower Wing Plank Spanwise Splice	8,910	1,940	7,510	1,630	EXT	NDT	--
57-46-101	Outer Lower Wing Plank Skin Cutout	4,050	870	2,010	430	INT	NDT	--
57-41-201	Outer Lower Wing Plank Riser Runout	4,170	900	2,070	440	INT	NDT	--
57-41-401	Lower Skin at MLG Attachment Fitting	11,230	3,280	13,670	2,980	EXT	NDT	Appendix U
57-41-402	Lower Skin at Nacelle Skate Angle Attachment, WS 209	3,080	660	1,530	320	EXT	NDT	Appendix B
57-41-301	Lower Skin at Nacelle Fairing Attachment, WS 167	11,230	3,280	8,860	1,930	EXT	NDT	Appendix A
57-44-201	WS 65 Rib Attachment To Front Spar	11,230	3,280	11,230	3,280	INT	NDT	--
57-44-301	Outer Upper Wing Skin at WS 167 Rib	10,060	2,330	5,020	1,150	EXT	NDT	--
57-44-401	Outer Upper Wing Skin at WS 209 Rib	10,060	2,330	5,020	1,150	EXT	NDT	--

Table C.3 – P3A Wing Box PSE Inspection Requirements

F/DT Baseline Evaluation – Empennage Damage Tolerance

- *Details for Crack Growth Analysis Selected from Fatigue Critical Areas*
- *15 Locations Analyzed*
- *Residual Strength Analyses performed to 100% of Limit Load*
- *Analysis takes advantage of retardation effects*
- *Prototyping of inspections required to determine best method and fit with existing maintenance access*
- *Horizontal Inspections Driven by both Flight Hours and Flight Cycles*
- *Vertical Tail Inspections Driven Primarily by Flight Hours*

F/DT Baseline Evaluation – Empennage Damage Tolerance

PSE Number	Principle Structural Element	Threshold Interval Hours	Threshold Interval Flights	Repeat Interval Hours	Repeat Interval Flights	Type
55-52-103	Horizontal Stabilizer Front Spar Splice at HSS 42	7,240	1,570	3,610	780	NDT
55-55-101	Horizontal Stabilizer to Fuselage Attachments	4,600	990	2,290	490	NDT
55-61-101B	Horizontal Upper and Lower Plank Spanwise Splices	11,750	2,560	1,890	400	NDT
55-61-101A	Horizontal Upper and Lower Plank Spanwise Splices	11,750	2,560	1,890	400	Visual
55-62-101	Horizontal Outer Section Front Spar Web	7,240	1,570	4,110	890	Visual
55-63-101	Horizontal Outer Section Rear Spar Web	7,240	1,570	4,110	890	Visual
55-66-101	Horizontal Lower Skin Access Holes	15,000	4,400	15,000	4,400	Visual
55-64-101	Horizontal Stabilizer Skin to Rib Attachment - Skin	6,510	1,410	2,300	490	NDT
55-64-102	Horizontal Stabilizer Skin to Rib Attachment - Rib	15,000	4,400	15,000	3,480	NDT

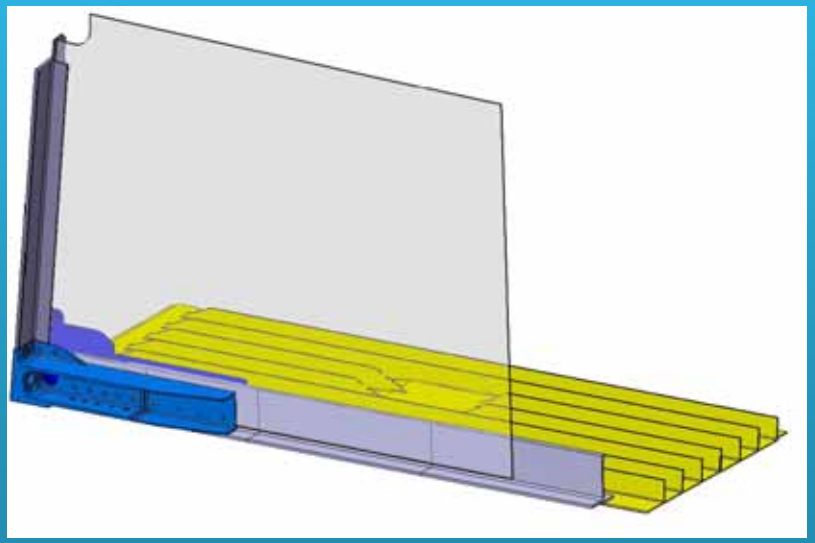
Table C.1 – P3A Horizontal Stabilizer Box PSE Inspection Requirements

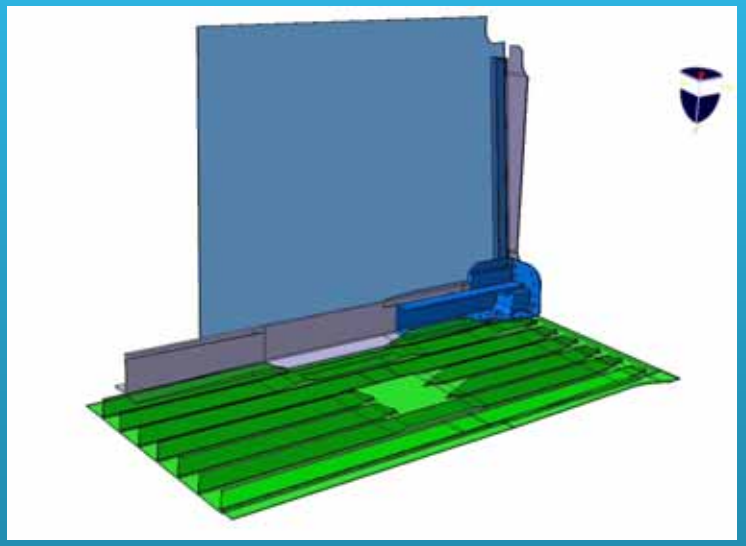
PSE Number	Principle Structural Element	Threshold Interval Hours	Repeat Interval Hours	Type
55-71-101A	Vertical Stabilizer Skin Splice	6,300	2,100	Visual
55-71-101B	Vertical Stabilizer Skin Splice	6,300	2,100	NDT
55-72-101A	Vertical Stabilizer Front Spar Web	3,560	3,040	Visual
55-72-101B	Vertical Stabilizer Front Spar Web	3,560	3,040	NDT
55-72-102A	Vertical Stabilizer Front Spar Cap	3,560	2,530	Visual
55-72-102B	Vertical Stabilizer Front Spar Cap	3,560	2,530	NDT
55-73-101A	Vertical Stabilizer Rear Spar Web	3,560	3,040	Visual
55-73-101B	Vertical Stabilizer Rear Spar Web	3,560	3,040	NDT
55-73-102A	Vertical Stabilizer Rear Spar Cap	3,560	2,530	Visual
55-73-102B	Vertical Stabilizer Rear Spar Cap	3,560	2,530	NDT
55-74-101	Vertical Stabilizer Ribs- Skin	6,510	2,300	NDT
55-74-102	Vertical Stabilizer Ribs- Ribs	19,000	15,970	NDT
55-75-101A	Vertical Stabilizer to Fuselage Attachment	10,830	5,410	Visual
55-75-101B	Vertical Stabilizer to Fuselage Attachment	10,830	5,410	NDT

Table C.2 – P3A Vertical Stabilizer Box PSE Inspection Requirements

Mandatory Modifications/Improvements for WFD Life Limits:

- *FAA Requires Terminating Action for Known Cracking*
- *Modifications and Redesign of Components via FAA Certification (FAA Service Bulletins and/or STC's)*





Current Efforts Include Redesigned Front Spar Caps, Plank and Fittings at BL65

Phase 3 – Airtanker Usage Evaluation

Instrumentation and Recorded Parameters

- ***Generic and Discrete Flight Parameters***
- ***Strain Gage Locations***
- ***Pilot Supplemental Data***

Evaluation of Recorded Data

Analysis Update

Revisions to ICA and OSL

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Instrumented P-3A Aircraft

Aero Union P-3A Tanker 21

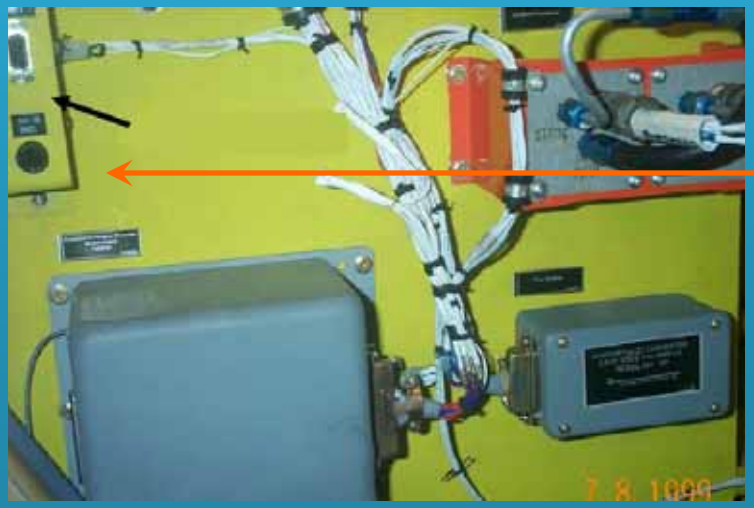
Ex-BUNO 151385

Aero Union P-3A Tanker 27

Ex-BUNO 151369

P3A Recorded Parameters

Parameter	Units	Range		Trigger Channel	Dead Band	Rise/Fall
		Low	High			
Centre-of-Gravity Vertical Acceleration (Nz_{cg})	g	-1.0	4.5	Yes	± 0.05	0.05
Roll Acceleration	rad/sec^2	-15	+15	Yes	± 0.3	0.3
Airspeed (CAS)	knots	0	450	No		
Altitude (ASL)	feet	-500	20,000	No		
Radar Altitude (If available) (AGL)	feet	0	2,000	No		
Retardant Tank Level	gallons	0	3,000	No		
Left Aileron Position	degrees	Max Down	Max Up	No		
Elevator position	degrees	Max Down	Max Up	No		
Flap Position	degrees	Max Down	Max Up	No		

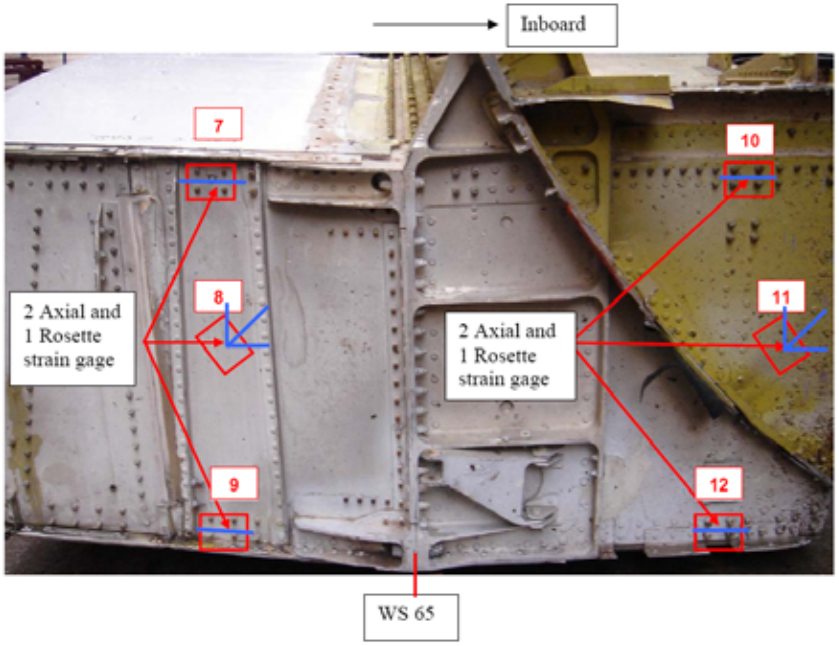


Parameter	Units	Minimum Sampling Rate (Samples/second)
Centre-of-Gravity Vertical Acceleration (Nz_{cg})	g	32
Roll Acceleration	rad/sec2	32
Airspeed (CAS)	knots	8
Altitude (AMSL)	feet	8
Left Aileron Position	degrees	8
Elevator Position	degrees	8
Flap Position	degrees	8
Retardant Tank Level	gallons	8
Strain Gauges	με	32

Gallons	Voltage DC
0	0.43
1,500	4.46
2,250	6.72
2,550	7.60
3,000	8.80

Strain Gage Locations – Total of 27 Locations on Wing

Strain Gage Number	Location
1	Plank 1,Top Panel Stiffener 6, WS49
2	Plank 1, Bottom Panel Stiffener 6, WS49
3	Plank 4, Top Panel Stiffener 23, WS49
4	Plank 4, Bottom Panel Stiffener 23, WS49
5	Plank 9, Top Panel Forward Most Stiffener, WS49
6	Plank 9, Bottom Panel Forward Most Stiffener, WS49
7	WS 65, Front Spar, Upper Outboard Cap Vertical Leg
8	WS 65, Front Spar, Shear Web, Middle of Upper and Lower Outboard Cap Vertical Leg
9	WS 65, Front Spar, Lower Outboard Cap Vertical Leg
10	WS 65, Front Spar, Upper Inboard Cap Vertical Leg
11	WS 65, Front Spar, Shear Web, Middle of Upper and Lower Inboard Cap Vertical Leg
12	WS 65, Front Spar, Lower Inboard Cap Vertical Leg
13	WS 65, Aft Spar, Upper Inboard Cap Vertical Leg
14	WS 65, Aft Spar, Shear Web, Middle of Upper and Lower Inboard Cap Vertical Leg
15	WS 65, Aft Spar, Lower Inboard Cap Vertical Leg
16	WS 65, Aft Spar, Upper Outboard Cap Vertical Leg
17	WS 65, Aft Spar, Shear Web, Middle of Upper and Lower Outboard Cap Vertical Leg
18	WS 65, Aft Spar, Lower Outboard Cap Vertical Leg
19	WS 221, Front Spar, Upper Cap Vertical Leg
20	WS 221, Front Spar, Shear Web, Middle of Upper and Lower Cap Vertical Leg
21	WS 221, Front Spar, Lower Cap Vertical Leg
22	WS 221, Aft Spar, Upper Cap Vertical Leg
23	WS 221, Aft Spar, Shear Web, Middle of Upper and Lower Cap Vertical Leg
24	WS 221, Aft Spar, Lower Cap Vertical Leg
25	Plank 1, WS 167 Lower Skin, MLG Support
26	Plank 4, WS 167 Lower Skin, MLG Support
27	Plank 7, WS 167 Lower Skin, MLG Support

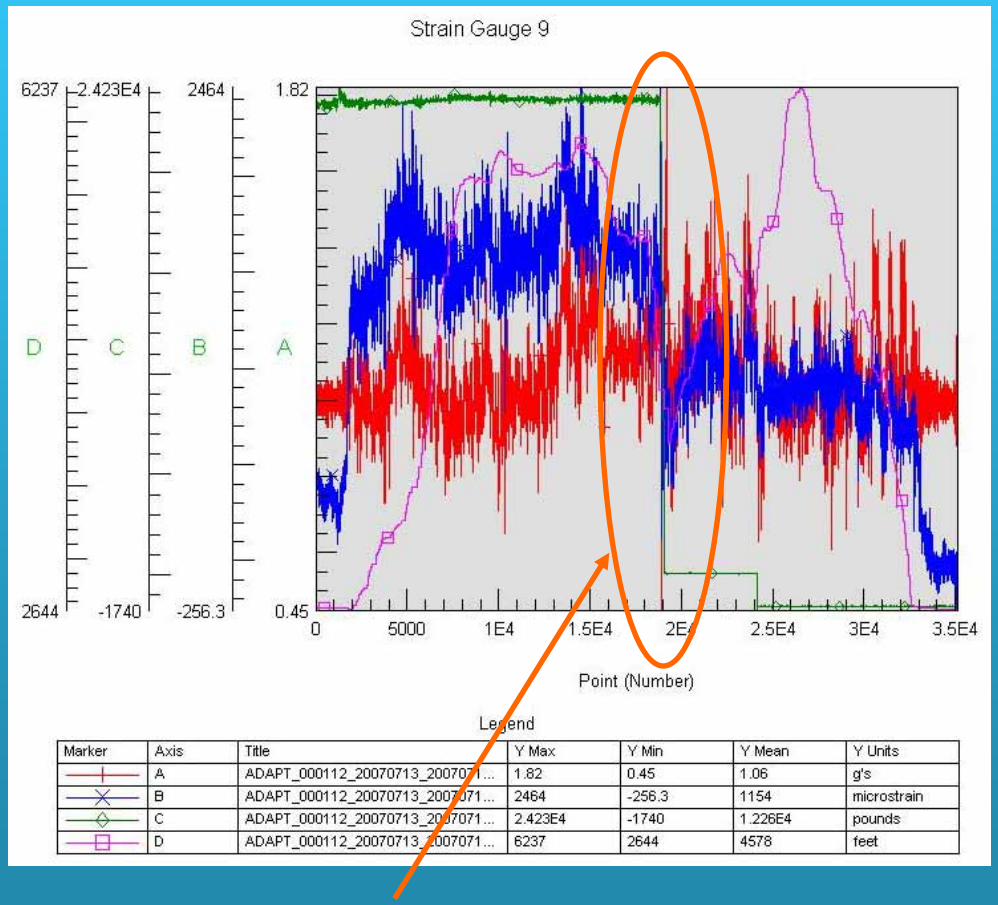


Gages #7, 8, 9 10, 11, 12

Pilot Supplemental Data

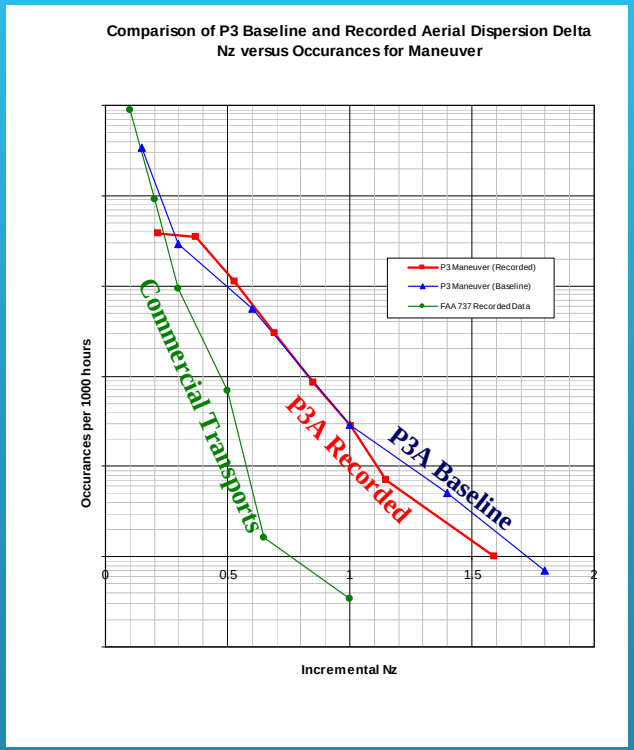
Parameter	Units
Date of Flight(s)	dd/mm/yyyy
Aircraft Tail Number	number
Duration of Flight(s)	hours
Location of Flight	text
Fuel Quantity at Start of Flight(s)	lbs
Retardant Quantities Loaded	gallons

Evaluation of 2007 Recorded Data

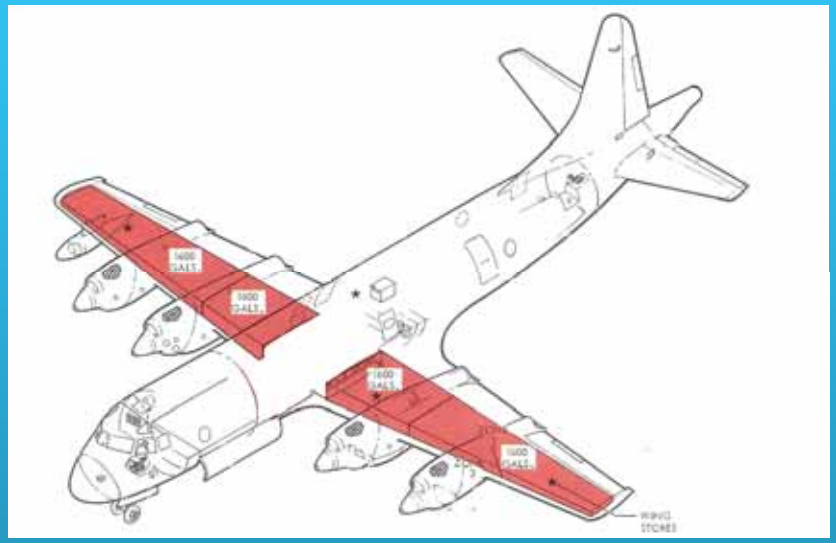


Nz and Max Strain spike noted during drop

Recorded Nz falls in range of Baseline Curve & Commercial Transport Data

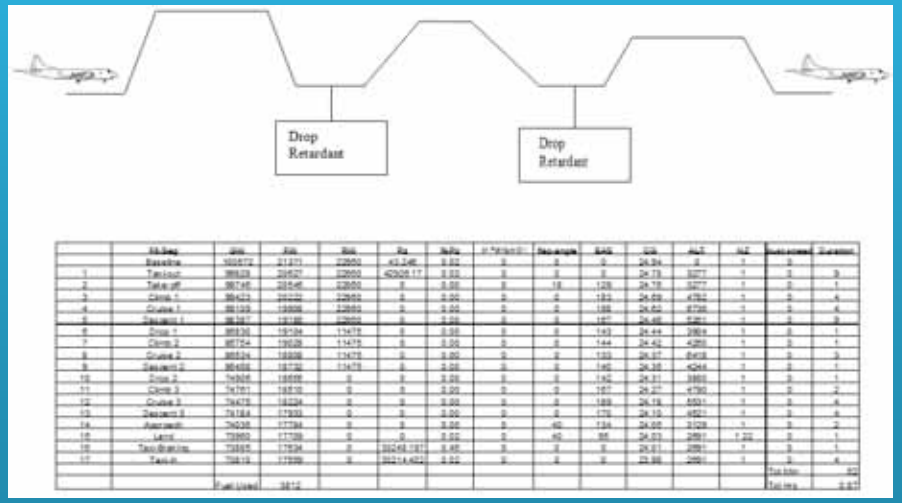


Analysis Update and Revision to ICA and OSL



P3A Airtanker Configuration

- •ASW Equipment Removed
- •No Center Wing Tank
- •Retardant Tank Weight



Mission Profiles

- •Based on 2007 Season Data
- •Incorporates Airtanker Wt Distr.
- •Accounts for different types of drops

Analysis Update and Revision to ICA – Usage Impact

Normal Air Tanker Usage:

- *Normal Air Tanker usage is over a 5 month period/season*
- *Average flight is 50 minutes in duration*
- *Daily utilization can average up to 8 flights a day*
- *Normal yearly utilization rate is approximately 450 flights*
- *Biggest Usage Impact is Damage Importance of Flight/GAG Cycles*

Projections with Baseline Demonstrates Impact:

- *Baseline (USN Logbook) Usage: 20,000 hours ~ 4,200 flights*
- *Average Airtanker Recorded Usage: 20,000 hours ~ 16,000 flights*

Significance of Findings:

- *USFS Evaluation Warranted due to Significant Change in Usage*
- *USFS Air Tankers May Well Exceed USN Known Fatigue Testing*

Phase 3 – USFS Operational Service Goal

- *Not an FAA Requirement*
- *Based on USFS Economics and Extent of Structural Evaluation*
- *Flights and Hours Based on Extent of WFD Evaluation and All FAA Mandatory Modifications Incorporated*

USFS OSG = 30,000 Hours / 16,000 Flights

- *Goal Represents Total Combined Avg Baseline Plus Airtanker Life*
- *Goal is not a Limit – Values can be extended thru Additional Evaluations and Mandatory Modifications*

Phase 4 – Continued P3 Fleet Management

- *Instrumentation of Remaining P-3A Fleet Aircraft*
- *Monitor and Accumulate P-3A Recorded Data*
- *Periodic Updates to P-3A Airtanker Usage Evaluation*
- *Complete Baseline Evaluation of Additional P-3B Heavyweight Configuration Aircraft*
- *Incorporate P-3B Baseline & Airtanker Usage*
- *Update FAA Continued Airworthiness as Required*

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Conclusions

- *USFS Possesses a Full FAA Structural Life Evaluation*
- *Program Fully Compliant with FAA Aging Safety Req.*
- *Approved Data Permits USFS to Support Type Certificate*
- *FAA P3A Type Certificate will be Updated to Reflect New Certification Levels*
- *Preliminary P3A Airtanker Usage Has Been Evaluated*
- *Remainder of P-3 Air Tanker Fleet to be Instrumented*
- *Continued Evaluation of Airtanker Usage beyond 2007*
- *Safe Continued Airworthiness Accounts for Unique Usage*
- *NTSB and FAA Recommendations Complied With*