

Air Force Life Cycle Management Center



U.S. AIR FORCE



SOUTHWEST RESEARCH INSTITUTE

A-10

DTA Update – Enhanced Wing Assembly

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Overview



- **A-10 DTA Report**
- **A-10 DTA update REV-F Overview**
- **2021 DTA Ground rules refinement study**
- **2022 SOLR re-correlation**
- **A-10 DTA update REV-F – EWA**





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A-10 DTA Report



- **A-10 DTA Report**
 - DTA repository for fatigue critical locations
 - Over 30 years of DTA
 - Multi Volume Report
 - Volumes 2 and 3 detailed analysis of control points





A-10 DTA Report



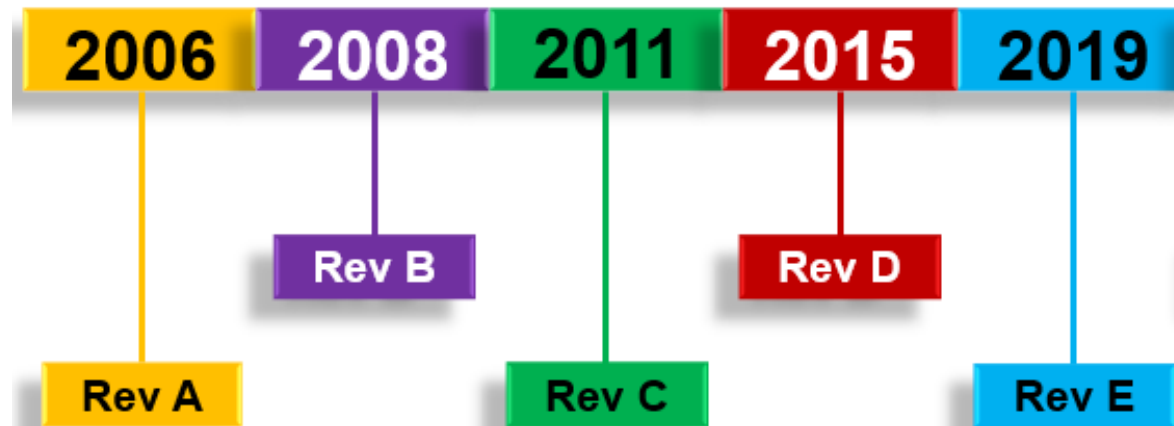
- **A-10 DTA Report Importance**
 - Recertification requirement
 - Allows A-10 program office to provide organic structural support
 - Main driver for Force Structural Maintenance Plan
 - Determines inspection intervals





A-10 DTA Report

- **A-10 DTA Report Updates**
 - MIL-STD-1530 requires DTA to be updated periodically
 - Incorporate changes that affect DTA
 - New revision every 2 to 4 years
- **REV E latest revision – published in 2019**





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A-10 DTA Update REV-F Overview



- **Kicked off in January 2022**
- **Updated report format**
- **Updated DTA ground rules**
- **Updated fit of material rate curves**
- **Re-correlated SOLR values**
- **Added new volume for Enhanced Wing Assembly (EWA)**





A-10 DTA Ground Rules Refinement Study



- **2021 ground rules refinement study**
 - **Advanced model**
 - **Varying corner crack aspect ratios**
 - **Yield zone adjustment option for Willenborg model**
 - **Net section yield failure criteria**





A-10 DTA Ground Rules Refinement Study



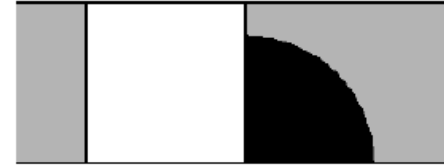
- **Compared Classic Model and Advanced Model**
 - Classic Model (Newman and Raju in 1986)
 - Advanced Model (Fawaz and Anderson in 2004)
- **Classic and advanced models**
 - All Corner Crack CP's put a through Component Object Modeler (COM)
 - Median increase in life 2.4%
 - Recommended to switch to advanced model for next DTA update





- **Aspect Ratios**

- Investigated allowing AFGROW to vary the aspect ratio
- REV E ground rules call for using constant aspect ratios
- Overall showed a decrease in life
- Recommended to allow AFGROW to vary aspect ratios with next DTA update



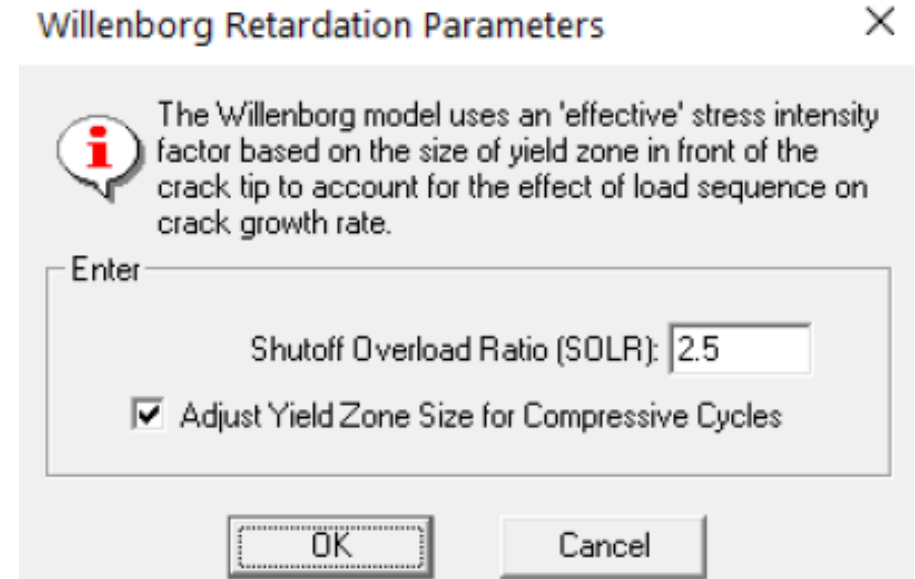
Keep 'A/C' constant



A-10 DTA Ground Rules Refinement Study



- **Yield Zones**
 - A-10 DTA uses the Willenborg model
 - AFGROW allows the user to adjust yield zone for compressive cycles
 - Rev E ground rules does not use this option
 - Investigated turning on yield zone adjustment option
 - Mixed results
 - Recommended not using Yield Zone adjustment option





A-10 DTA Ground Rules Refinement Study



- **Net section yield failure criteria**
 - Not used by A-10 due to redundancy in load paths
- **Ran all A-10 CPs through a COM**
 - 30 failed due to net section yield
 - 14 were due to inaccurate models
 - The 14 models updated
 - Recommended to verify accurate cross section area and stress if using net section yield failure criterion.

Stop Crack Propagation at: _____

- Crack Length
- Cycle Count
- 'Kmax' Failure Criteria
- User-Defined 'Kmax'
- 'Net Section Yield' Failure Criteria
- Part Through Crack Transition



A-10 SOLR Re-correlation



- **2021 crack growth rate material data updated**
 - **ASTM E-647 test standard used to determine crack growth rate**
 - **Needed to confidently predict crack growth in DTA**
 - **The retardation parameter SOLR (shut off overload ratio) is determined from the coupon test data for use in crack growth predictions**
 - **Updates to material crack growth rates required SOLR Re-correlation**



A-10 SOLR Re-correlation



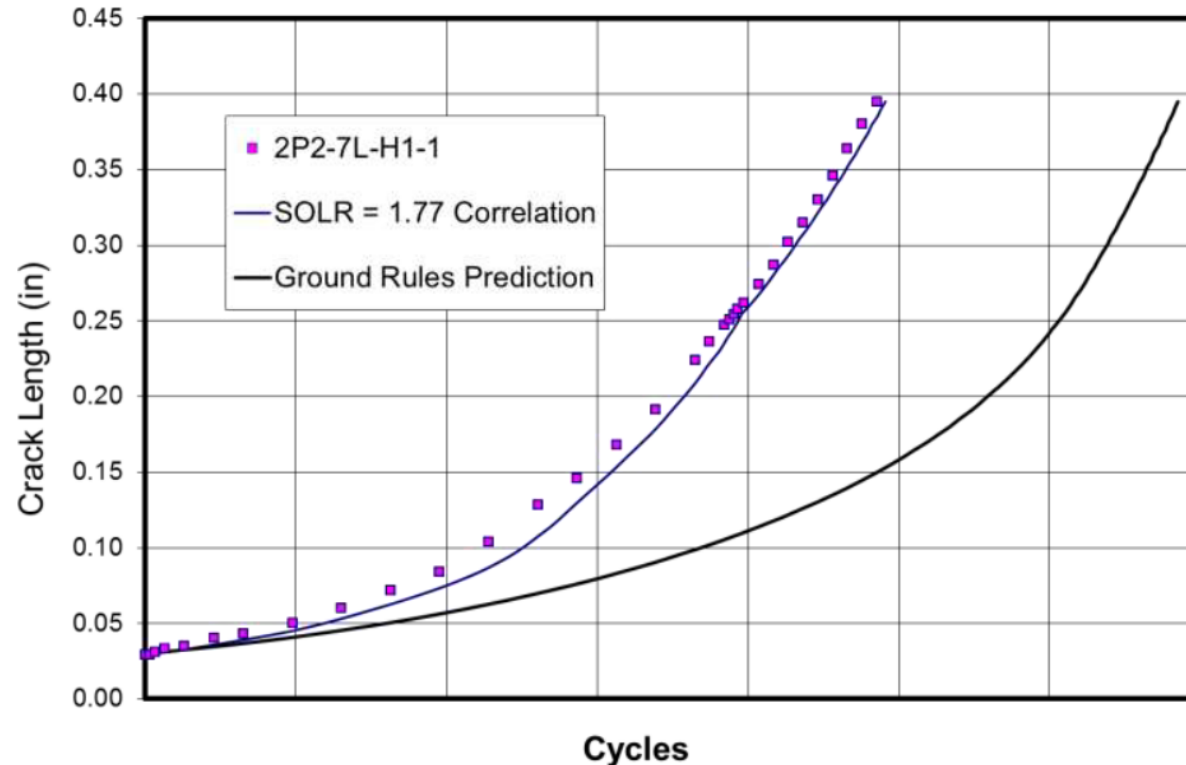
- **Correlation is accomplished with crack growth analysis that matches the test crack length and aspect ratio progression**
- **Previous correlation of crack growth analysis used user defined betas and allowed aspect ratios to vary to determine SOLR**
- **When the SOLR is used with REV E ground rules it resulted in unconservative life**



A-10 SOLR Re-correlation

- 2022 Kaylon Anderson SOLR re-correlation

2024-T351 Low Peak Stress (Thick Skin)



Ground Rules Model:

- 1) $A/C = 1$
- 2) AFGROW Classic corner crack at a hole model.
- 3) Coupon Geometry and Stress used
- 4) $SOLR = 1.77$

Correlation Model:

- 1) $A/C = \text{Variable}$
- 2) User Defined Betas from StressCheck
- 3) Coupon Geometry and Stress used
- 4) $SOLR = 1.77$



A-10 REV- F DTA Update Summary



- **Update to report format**
- **Updates to DTA ground rules**
- **Updates to material fit data**
- **Updated SOLR values**
- **Added new volume for the Enhanced Wing Assembly**



A-10 DTA Update REV-F – EWA



- **Enhanced Wing Assembly**
 - Introduced in a service life extension program
 - Same configuration as thick skin
 - Material changes to components
 - Geometry changes
- **DTA approach for EWA control points**
 - Reference thick skin control points
 - Established safety limit thresholds
 - Analysis required if life is considered low



- **Total of 82 Thick Skin Control Points**
- **16 EWA Control Points with high life**
 - Total life exceeds safety limit threshold
- **7 Control Points Analyzed**
 - Life considered low
- **4 New Control Points added**
 - Not applicable to thick skin
 - New geometry

Count Volume 3	
Total CPs	82
Needs Review	0
In-Review	0
Awaiting USAF Review	0
Awaiting SwRI Review	3
Total In the Review Process	3

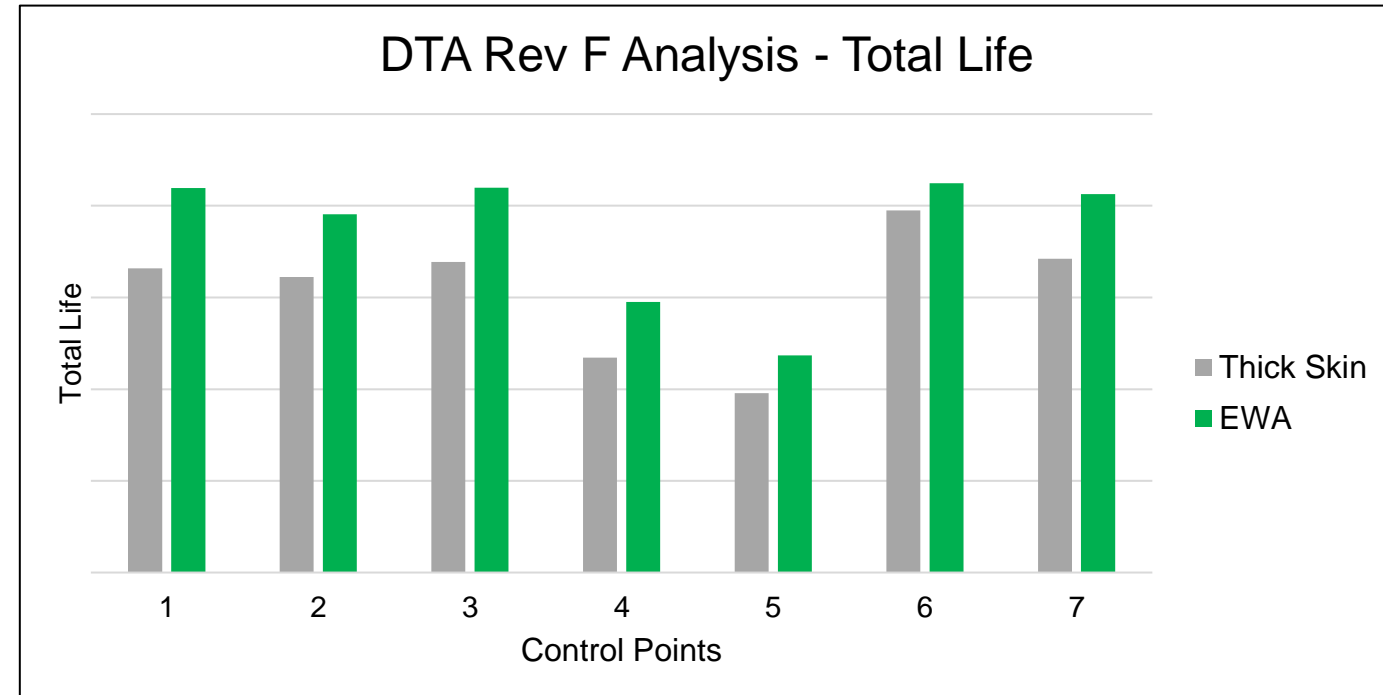


A-10 DTA Update REV-F – EWA

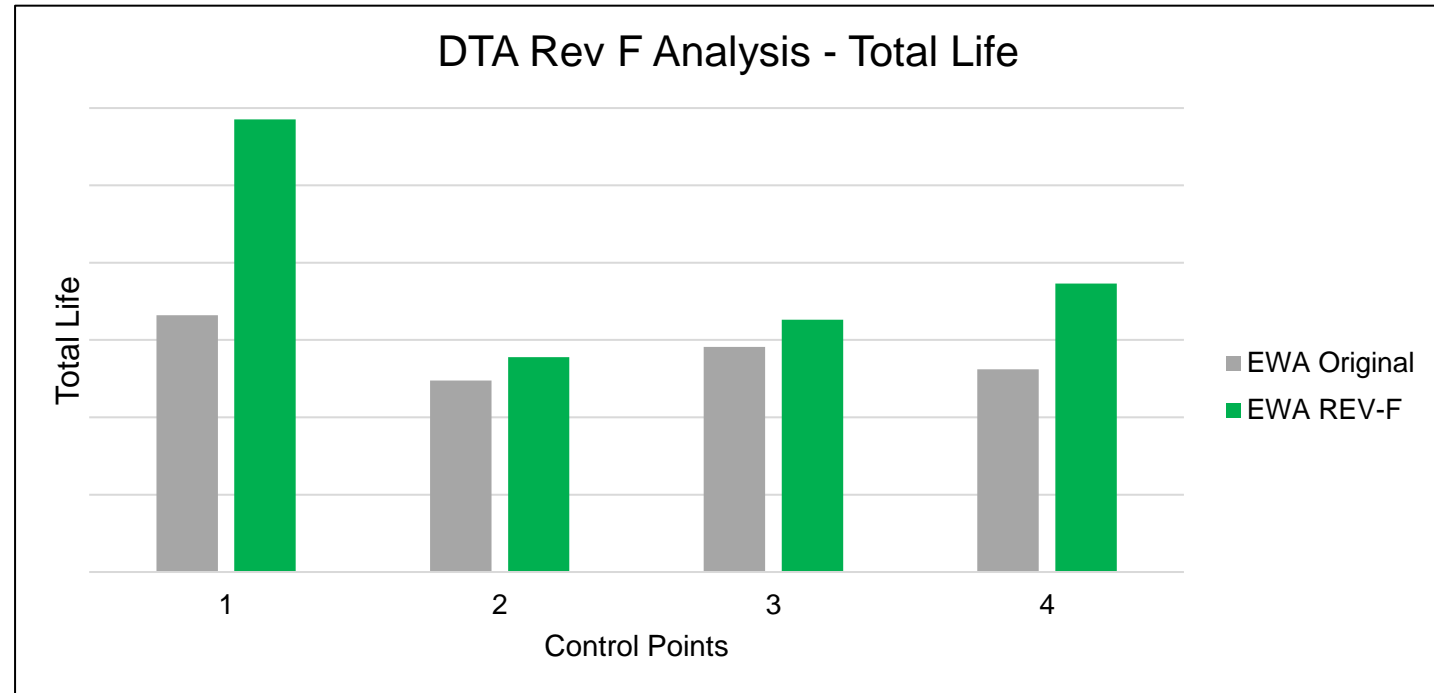


- **7 EWA Control Points Analyzed**

- CPs 1, 3, 6, and 7 were above life analysis requirement
- CP 1-5, and 7 had 20% increase in total life
 - Material change
- CP 6 increase in total life 8%
 - Geometry change



- **4 EWA Control Points Added**
 - Original EWA analysis performed under REV-B ground rules, material rate data ,and SOLR values
 - CP 1 had 76% increase in total life
 - CP 2 and 3 had 12% increase in total life
 - CP 4 had 42% increase in total life





Questions

