



AF Life Cycle Management Center



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AFGROW WORKSHOP **Assessment of Fatigue Crack** **Growth Rate (FCGR) Properties of** **Ti-6AL-4V BA** **19-20 September 2017**

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Outline



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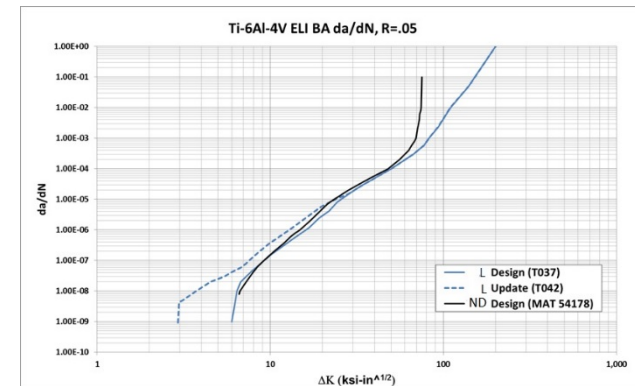
- **Background**
- **Analysis**
- **Conclusions**
- **Recommendations**



Background

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- **Legacy (L) aircraft developed updated FCGR properties for Ti-6AL-4V BA**
 - Results presented during an ASIP Conference
- **Shift of new data raised concerns on possible impacts to a new development (ND) aircraft**
- **OEM presentation “Ti-6AL-4V BA Crack Growth Assessment” compared “L” Design, “L” Update, and “ND” Design**
 - Did not include “ND” with updated “L” data
- **EZFS performed independent analysis using AFGROW to determine potential impacts to “ND”**





Analysis



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- **Compare “ND Design” to “L Update”**
 - **Two different spectrums, Wing and HT Bending Moment**
 - **Open hole corner crack**
 - **W=1.0”, Dia.=.25”, t=.25”**
 - **Generalized Willenborg Retardation Model**
 - **Shutoff Overload Ratio (SOLR) of 2.5, 2.8, and 5.0**
 - **Two different sets of FCGR data**
 - **Data used in ND design (labeled “ND Design”)**
 - **Data used in L Update (labeled “L Update”)**
 - **Assess both Durability and DT Life**
 - **$a_i = c_i = .01$ ” and $.05$ ”**



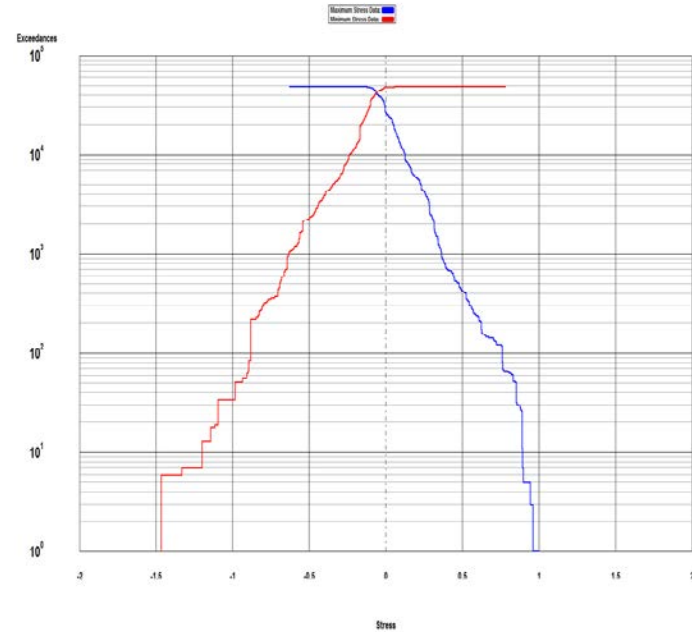
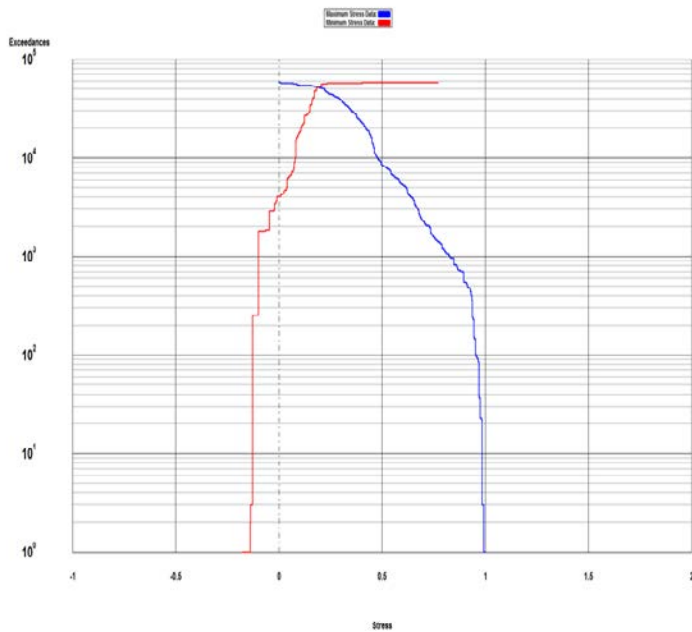
Assessment Spectra



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WBM

HTBM



Provided by PO

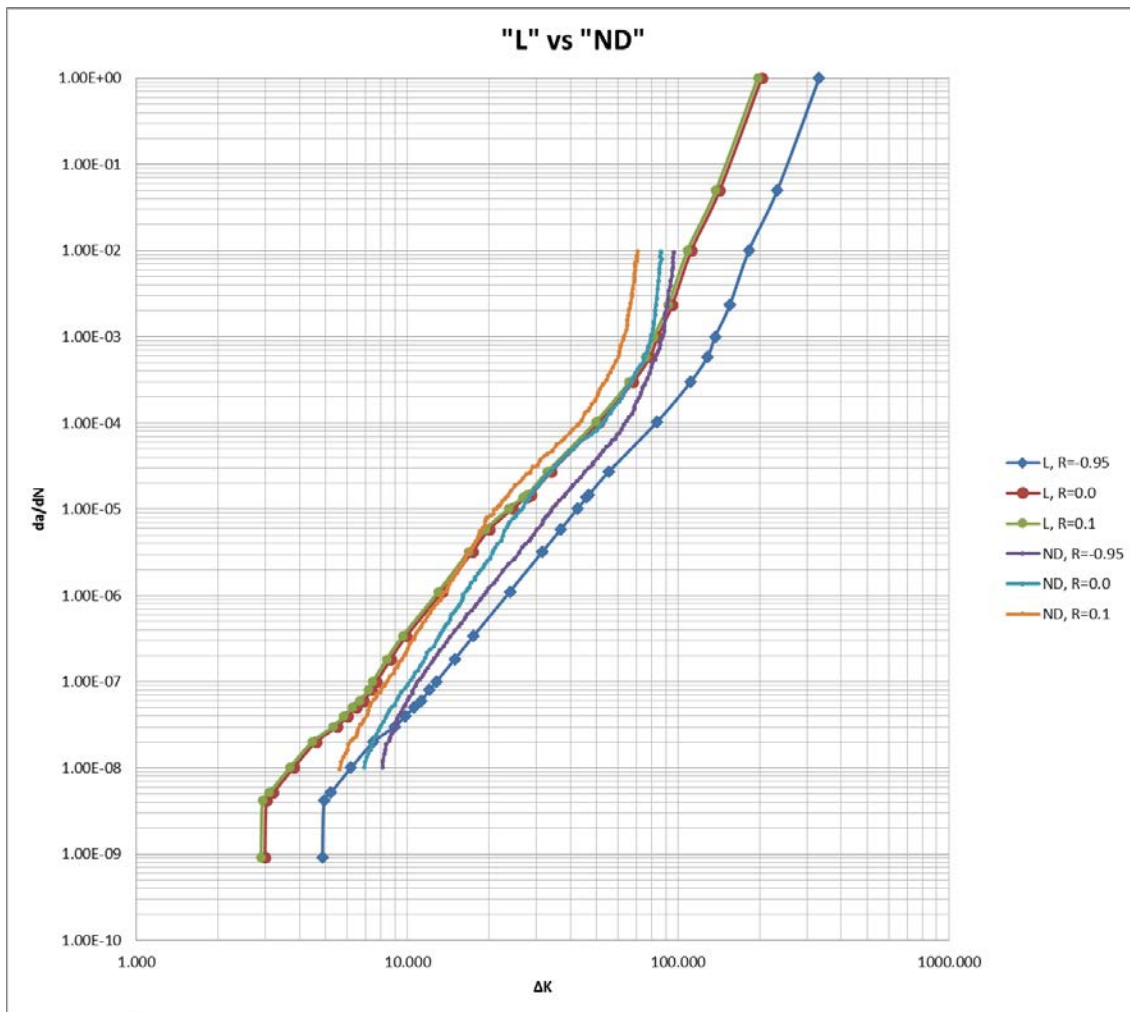
On file from TVT (2006-2007)



FCGR Data



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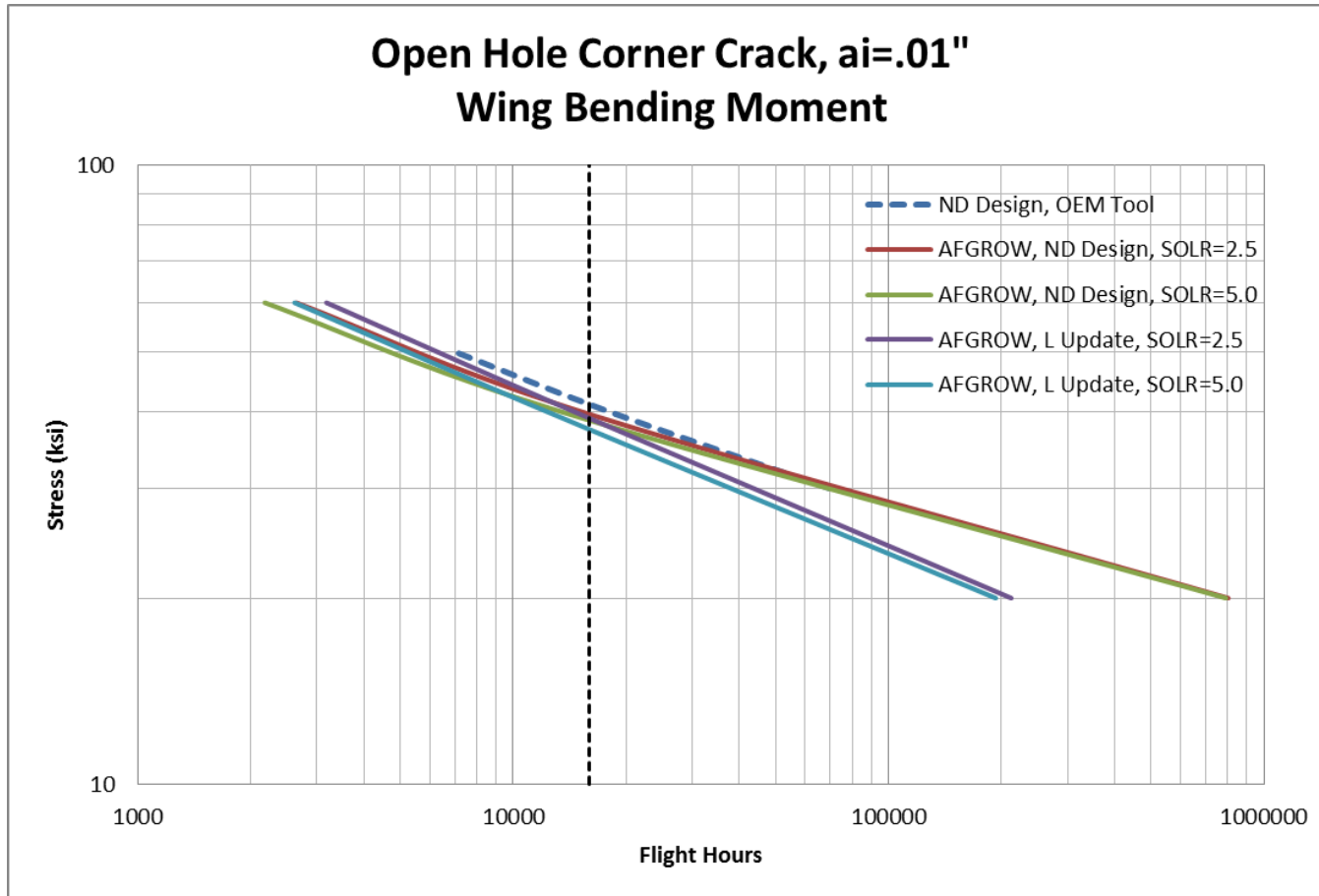
"L" more conservative at:

- $\sim \Delta K > 20$ at $R=0.1$
- $\sim \Delta K > 30$ at $R=0.0$
- $\sim \Delta K > 9$ at $R=-.95$



Durability Results

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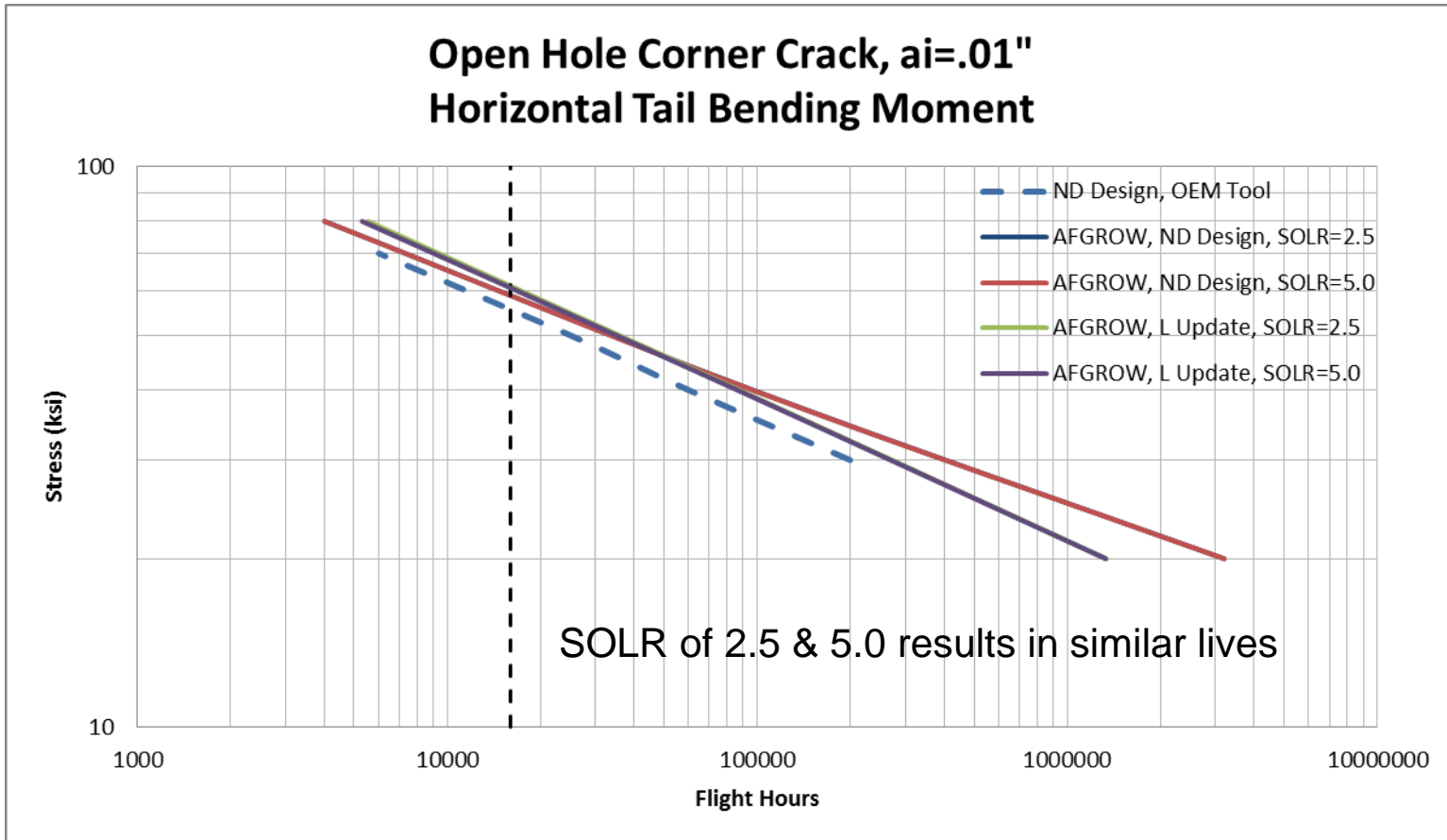
< ~10k, "ND Design" Results in Lower Life
> ~20k, "L Update" Results in Lower Life



Durability Results Cont.



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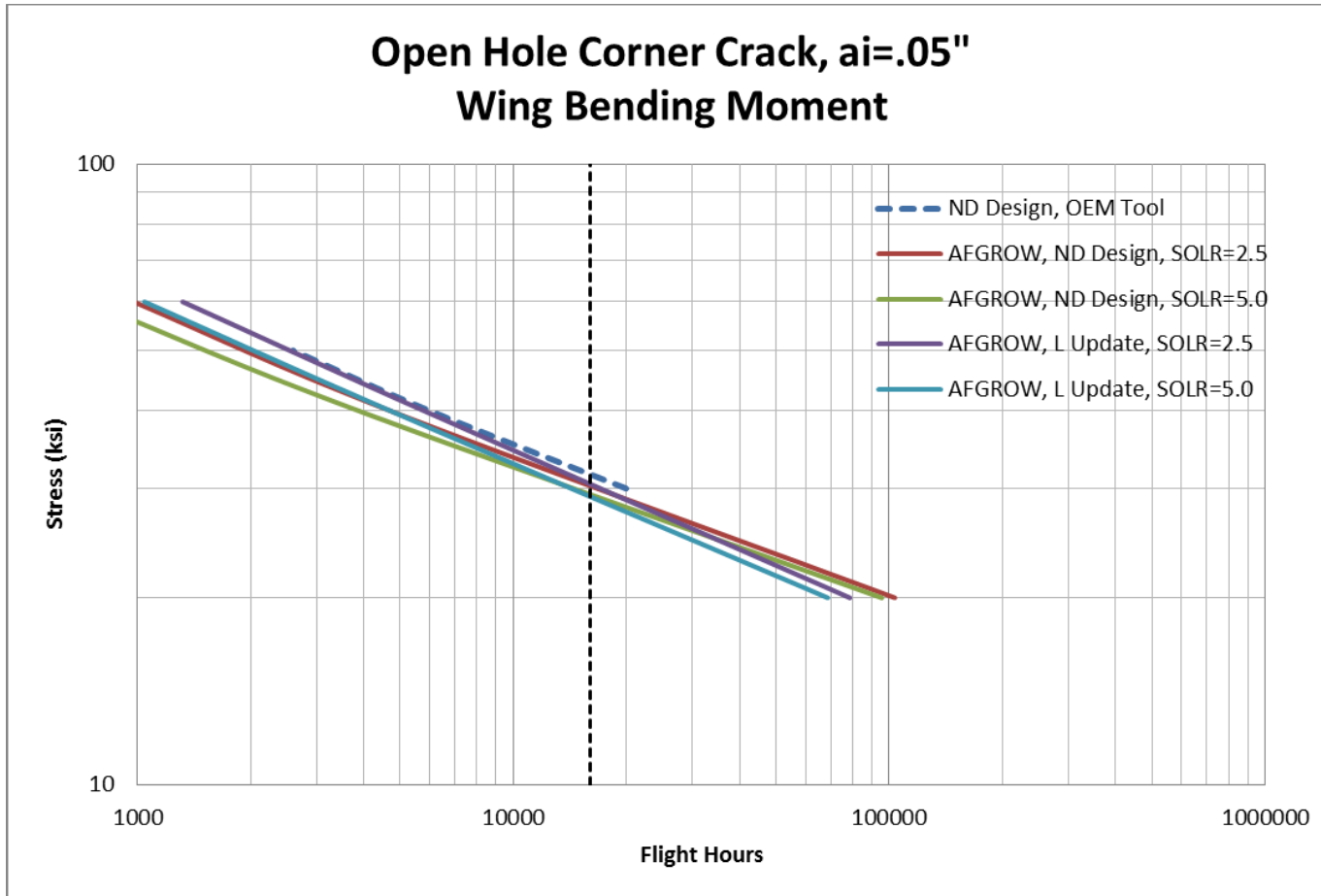
**< ~30k, "ND Design" Results in Lower Life
> ~70k, "L Update" Results in Lower Life**



Damage Tolerance Results



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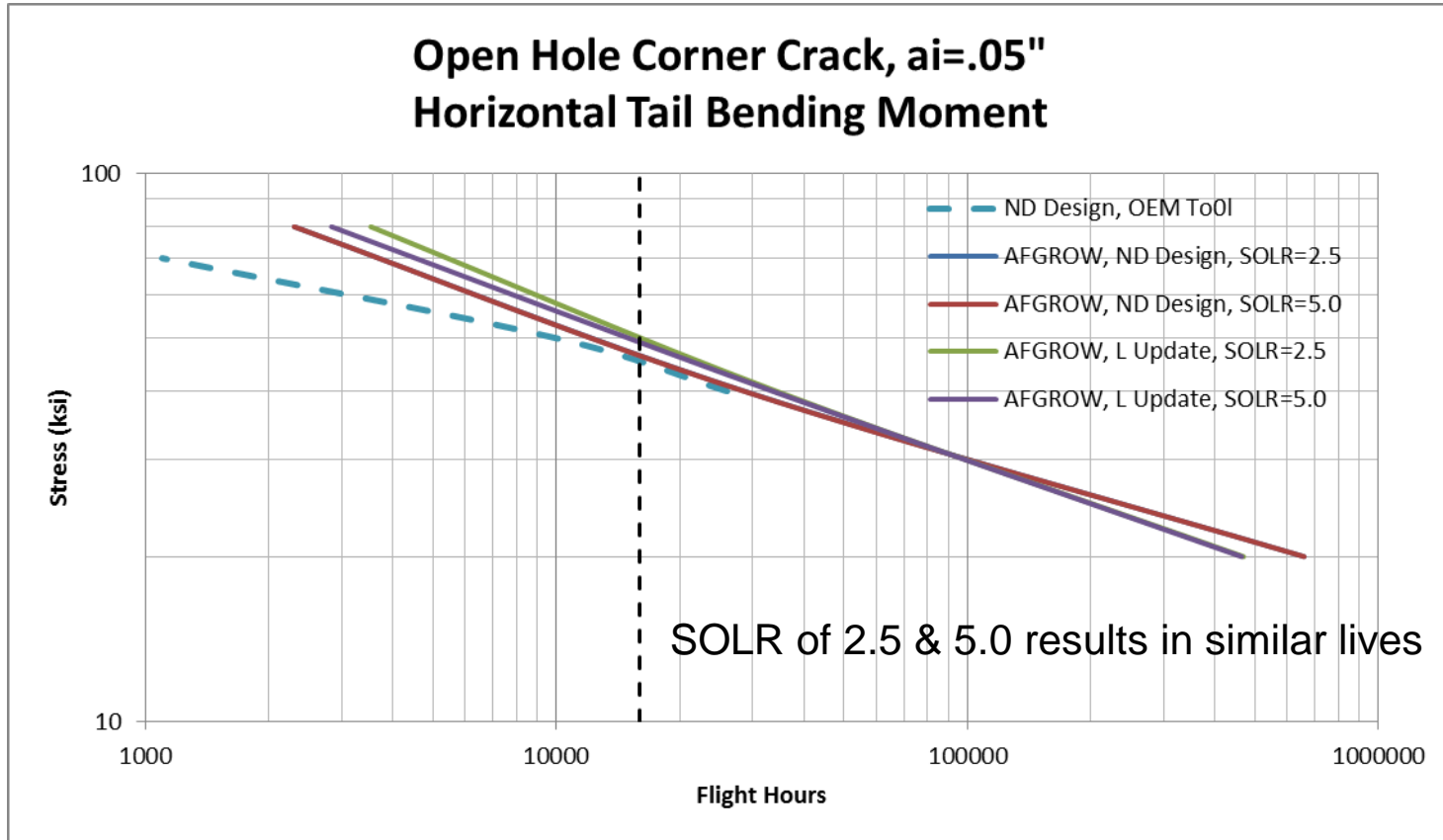
< ~10k, "ND Design" Results in Lower Life
> ~30k, "L Update" Results in Lower Life



Damage Tolerance Results Cont.



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< ~60k, "ND Design" Results in Lower Life
AFGROW & OEM Tool Not Close at Lives < ~10k



Conclusions

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- **OEM Tool and AFGROW show similar results**
- **More variation at long lives (lower stresses)**
 - Lower Delta K's
- **WBM Spectra more sensitive to SOLRs**
 - Tension dominated spectra
- **HTBM Spectra less sensitive to SOLRs**
 - More compression cycles
- **“L Update” produces shorter lives for WBM and longer lives for HTBM**
- **“L Update” does not impact “ND Design”**
- **“L Update” could help reduce predicted life short falls**



Recommendations



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- **Use both sets of FCGR data in the analysis correlation with all full scale test crack findings**
- **Determine which set of data or combination will be used in final design DADTA**



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Questions?