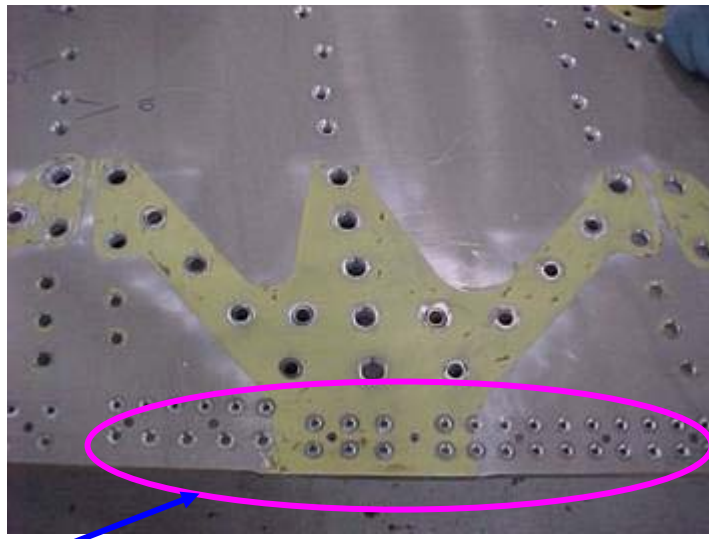
TukLoc as a repair fastener

Great ideas”
competition

October 2004

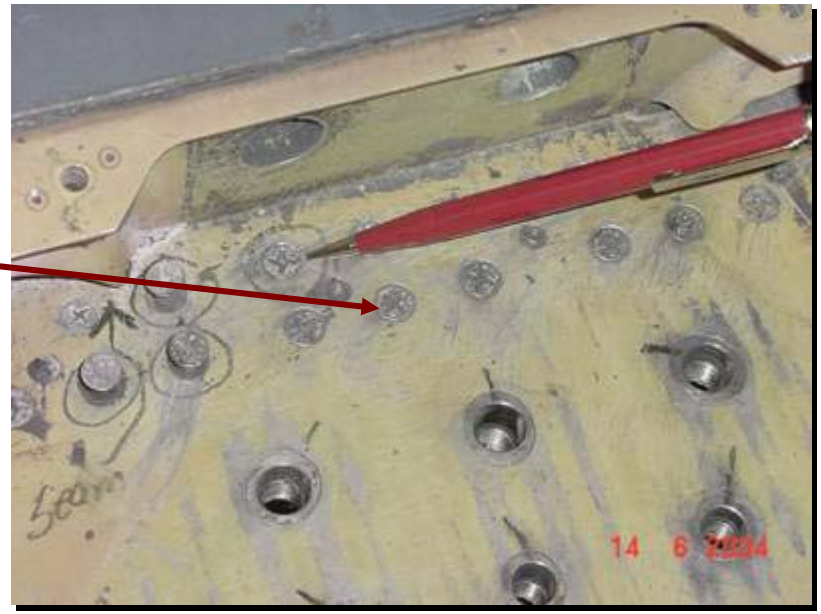
Statement of the problem

- In June 2004, a fatigue cracking problem was identified to the USAF from a foreign operator of the F-16 Falcon aircraft.
- This premature fatigue cracking is occurring in the upper wing skin-to-rib attachment bolt holes.

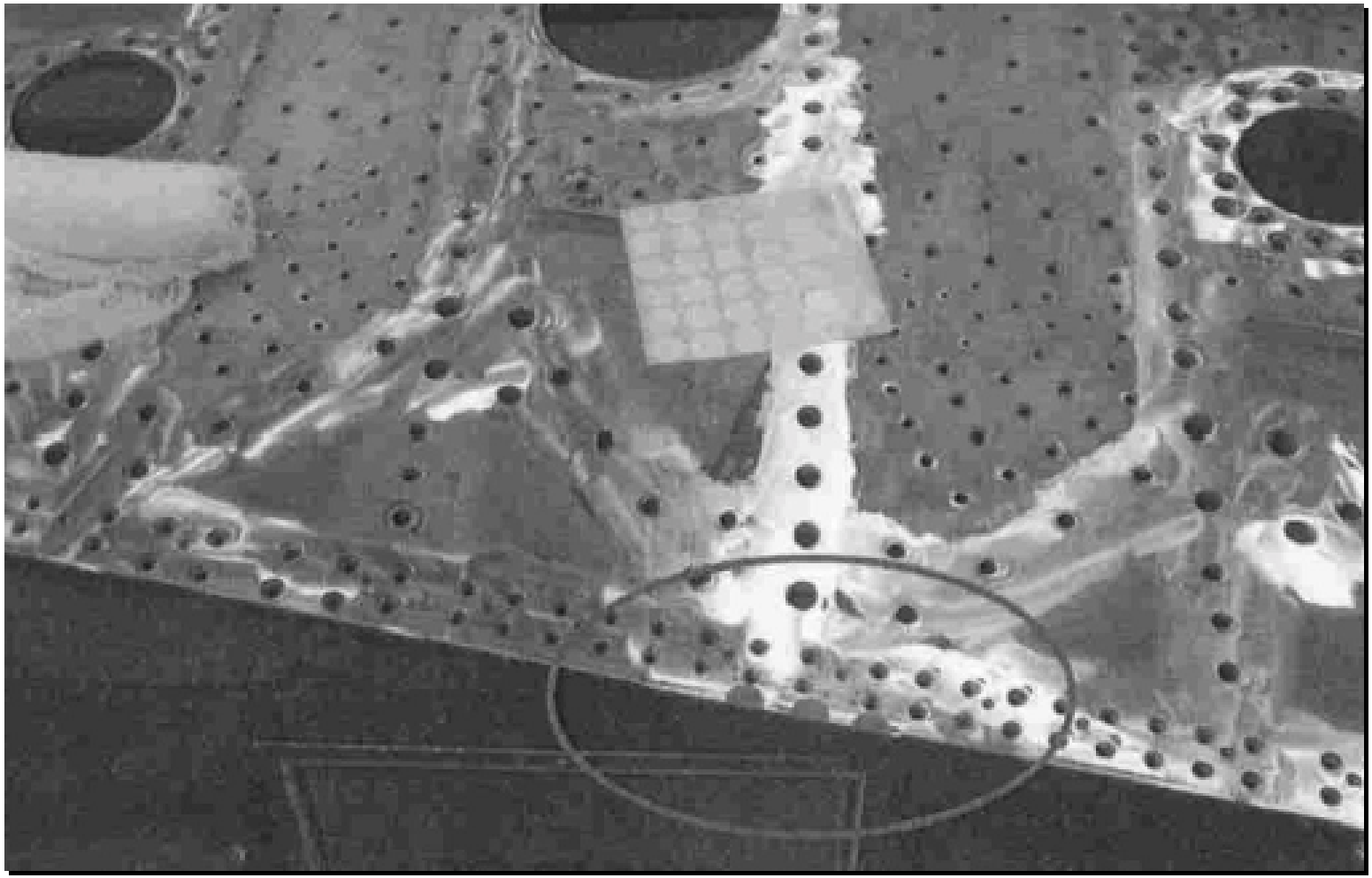


Background

- Location is the inboard end of the wing
- Fastener holes under the Wing Attach Fittings (upper)
- Cracks are in the skin
- Joint is skin-to-rib fastener
  - Standard screw into a NAS-1734 Davis press nut



Affected holes



Historical option

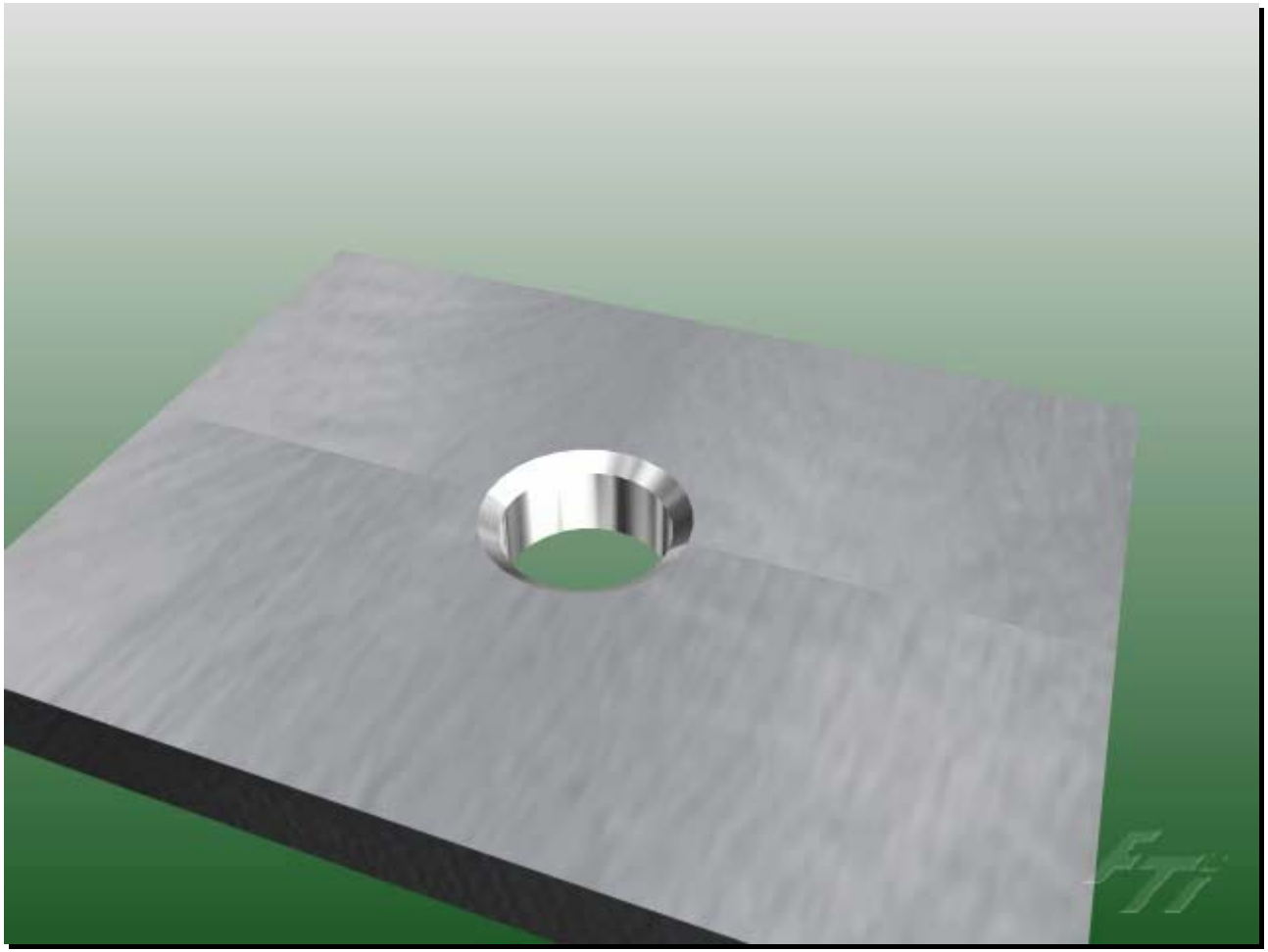
- Repairing these skins requires the removal and replacement of the wing skin, a costly and cumbersome repair.

New TukLoc fastener developed

- A new technology has been developed that will remove small cracks (up to 0.035” in length) and reinforce the wing skin without removing the skin.
- This technology can be implemented as a preventative modification before the onset of fatigue cracks.
- This technology can be applied to any metallic or composite structure, especially where traditional maintenance practices are not feasible.

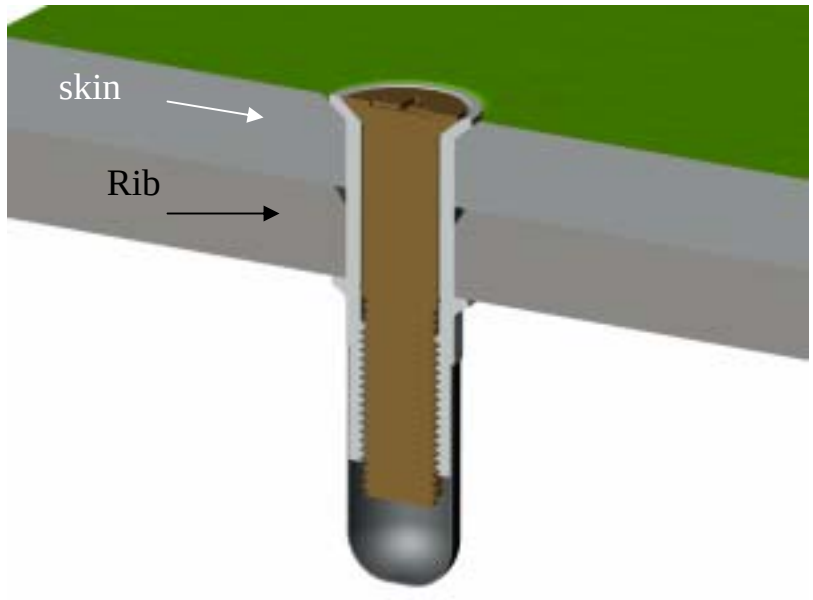
TukLoc™

Advanced Blind Fastening System

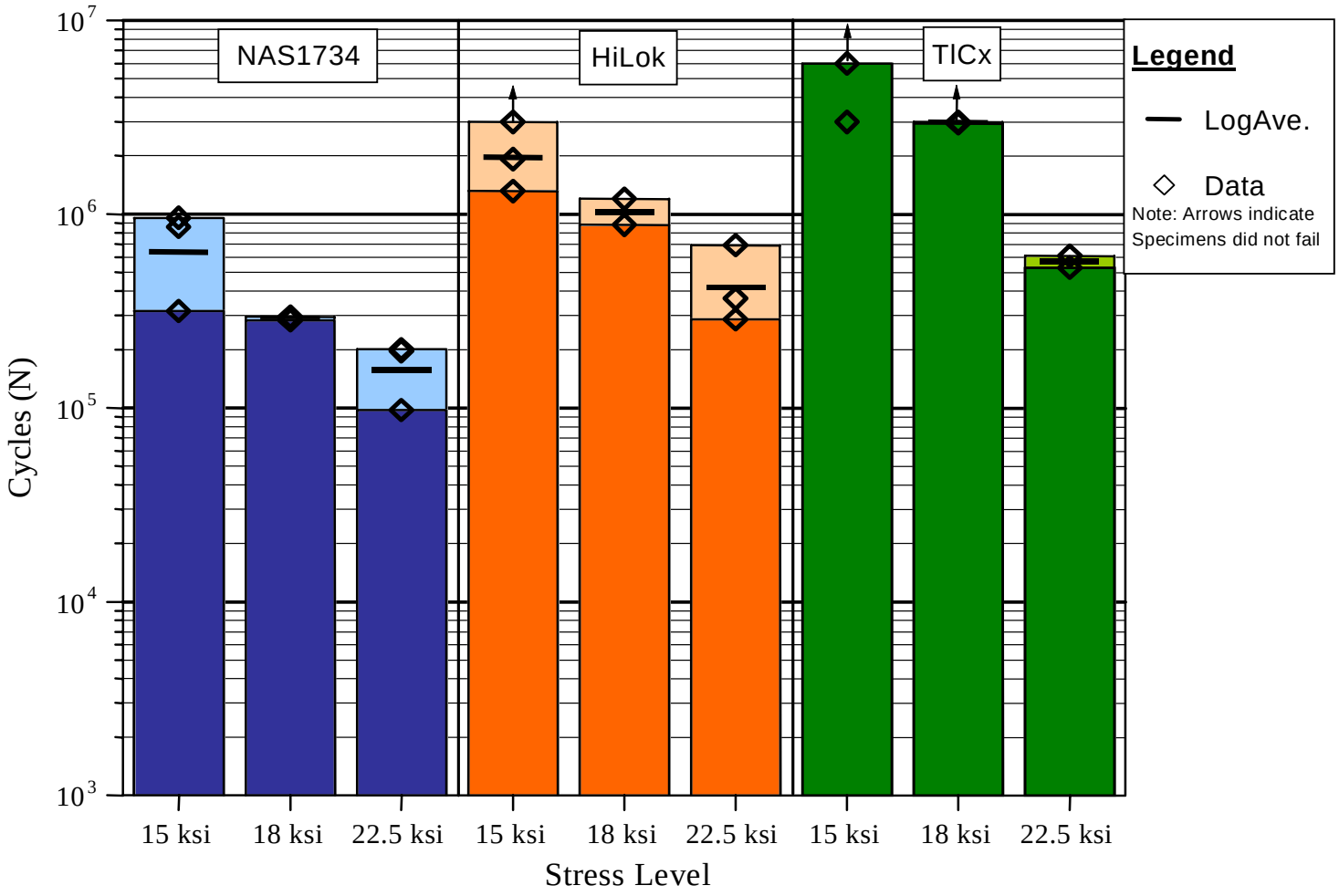


Why TukLoc works?

- Interference fit in skin and rib
- Stiffens the joint
- Does not require skin removal
- WAF's will be removed during planned maintenance
- Coldworking is an effective adjunct to the TukLoc installation
- Note the remnants of the old NAS fastener head remain in the hole

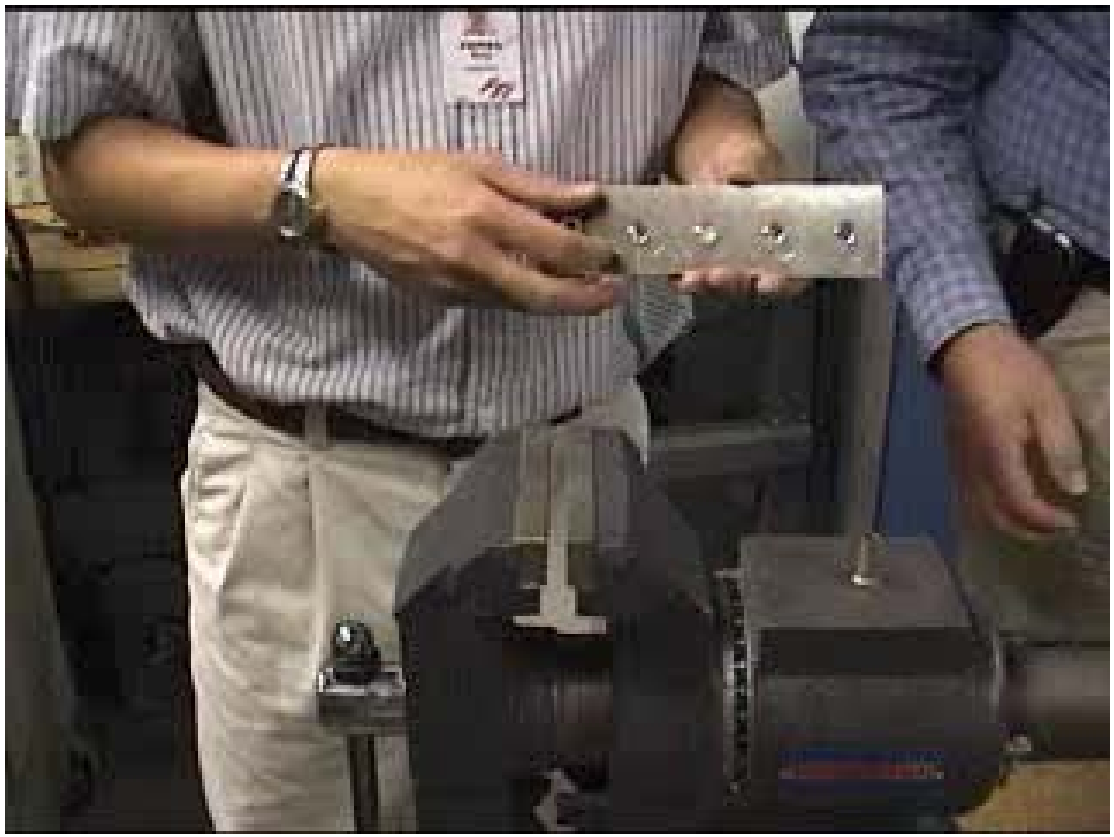


Low Load Transfer Fatigue Test Results

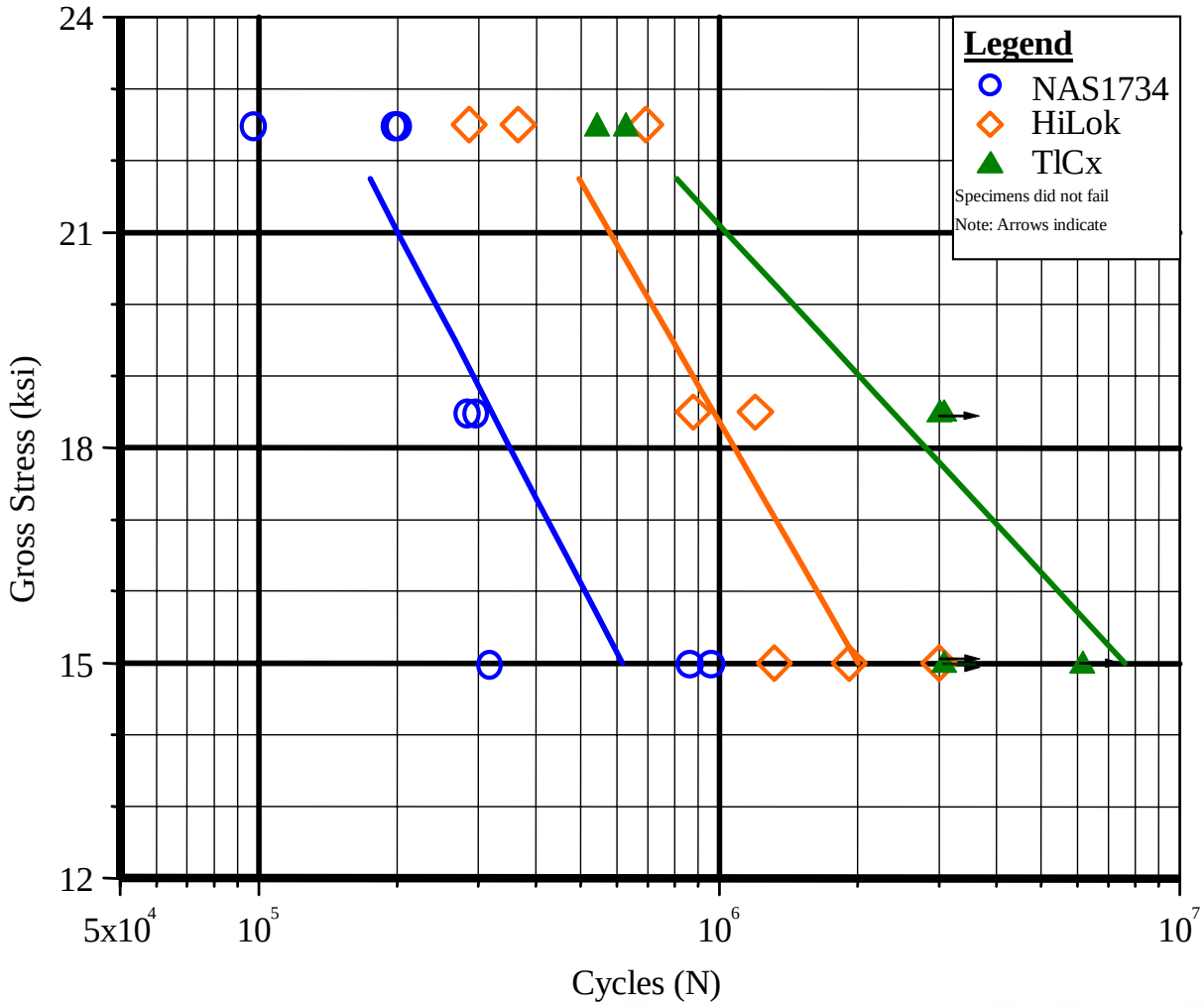


8% Effective load Transfer dogbone specimen

Sample installation to assemble two pieces

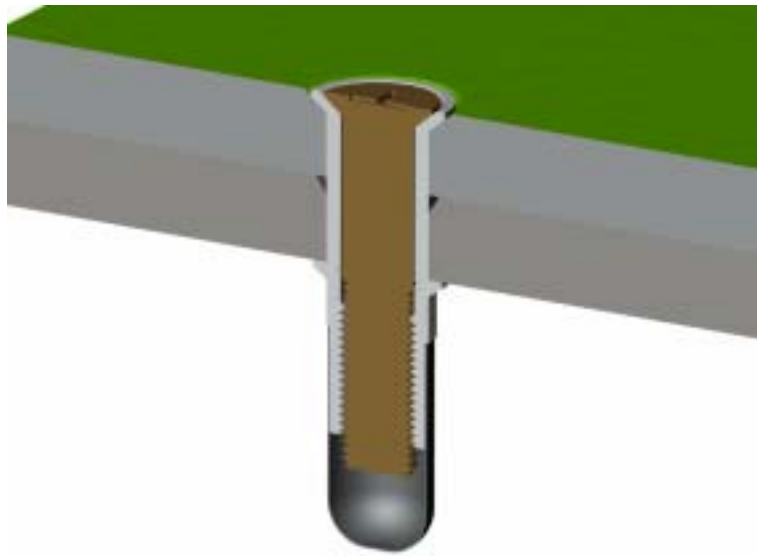


TukLoc™ – S-N Curves



2024-T3 Alum.

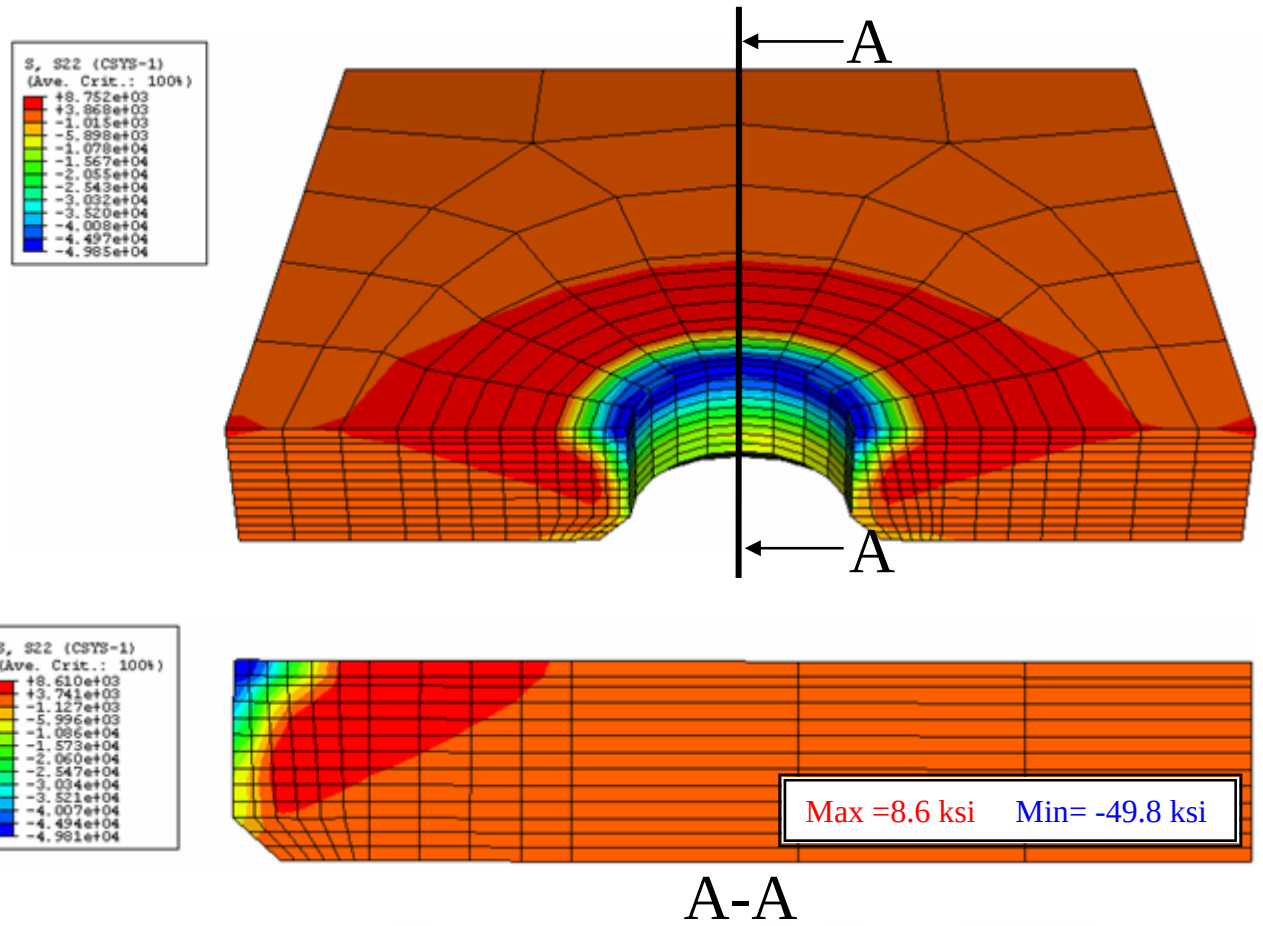
- The TukLoc fastener has been tested in fatigue, and finite element models have been created to show the residual stress effects in the skin and rib structure at rest, and under load.



Residual Stress State of Installed TukLoc Nut

Residual hoop stresses are due to expansion of the TukLoc with the mandrel and the collapse of the “bulge”

Hoop compressive stress and interference are higher on the “bulge” side but continue down the majority of the bore



Summary of TukLoc FEA

- Lower stress amplitude than NAS 1734 nuts is due to the interference fit at the hole edge
- Lower mean stress than HiLok fasteners due to the residual compressive stresses at the hole edge
- Peak stress was compressive in a significant portion of the bore at the hole edge. Crack retardation would be expected

Conclusions

- The combination of the interference fit and compressive residual stresses resulted in a significant life improvement for TukLoc nuts over NAS 1734 nuts at all stress levels
- The compressive stress in the parent material after the installation of a TukLoc nut resulted in life improvement over HiLok fasteners at all stress levels*. This may be contributed to a reduced mean stress and crack closure effects.
- Expanding TukLoc nuts in the wing skin and spar will eliminate the need for skin replacement. This will save the USAF $$ millions in the life of the F-16 fighter.

*Comparing minimum life to minimum life