POWER TURBINE CRACKING AT THE ANNULUS MOUNTING FLANGE

By Robert Klova, PE

In 1998, RMS was contracted by a major US natural gas company to correct a chronic cracking problem on their Dresser-Clark DJ125 power turbine inlet ducts. The component, called an Inlet Annulus, directs flow from a GE LM1500 gas generator into the DJ125 aero derivative power turbine. Our customer experienced cracking at the Annulus mounting flange which required weld repair on a yearly basis.

To determine the cause of the cracking, RMS performed a finite element analysis (FEA) to determine peak stresses, which, it was determined, are caused by high transient thermal loading during start-up. These thermal stresses are caused by the rapid heating of flow-washed surfaces, being constrained by the relatively cool Annulus mounting flange. As shown in the stress contour plot, peak stresses were calculated to be 175,000 psi. Since the part is manufactured from AISI 304 stainless steel, which has a yield strength at temperature of under 30,000 psi, cracking at the peak stress location was predicted to occur with very few thermal cycles (start-up and shut-down).

Figure 1: Inlet Annulus Being Installed in the Field

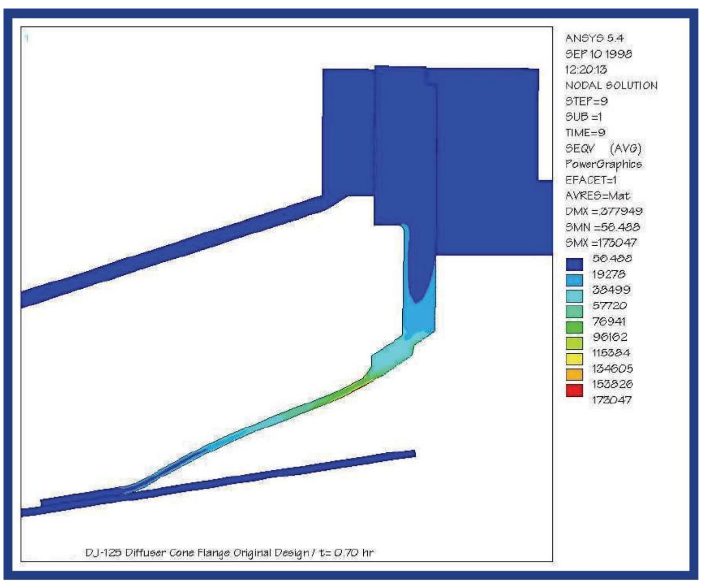


Figure 2: Original Design Showing Extreme Stresses in the Area Where Cracking Occurred

RMS's solution to the problem was to separate the hot flow-washed section of the annulus from the much cooler mounting flange. Axial expansion pins were employed to maintain concentricity of the duct. By doing so, thermal stresses were reduced to 20,000 psi. RMS provided three new Inlet Annuluses to our customer with the redesigned geometry. The design has been very successful, and completely eliminated the need for weld repair since the new ducts were placed in service.

After a number of years of operation, however, cracking began to occur in around the expansion pins that align the hot duct section to the mounting flange. This has been managed by stop-drilling these cracks when they

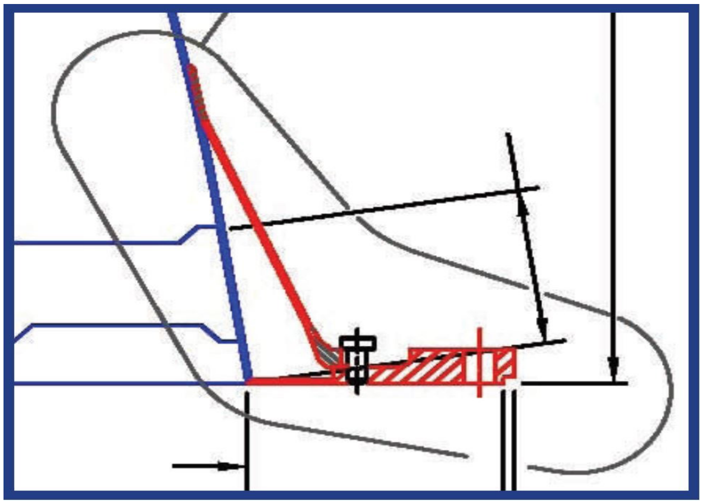
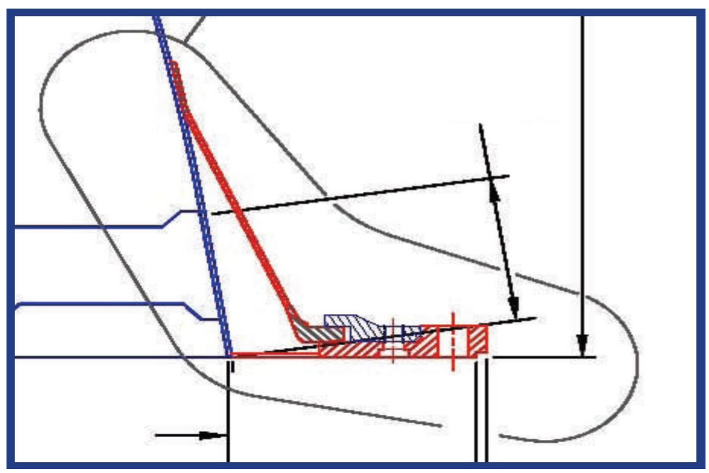


Figure 3: First Redesign Showing Expansion Pin

Figure 4:Expansion Pin During Routine Inspection

are found. RMS recently recommended a redesign of the mounting flange to our customer, to eliminate this cracking, since their turbines are now expected to continue in operation for another five to ten years.

The new design eliminates the expansion pins entirely and controls the position of the duct using a pilot fit that is loose when cold and tightens during operation. Since the duct has no critical clearances to other components, concentricity while shut-down is not important. The design challenge for RMS was to fit the new arrangement in the existing flange location, and also to allow the flange, which is relatively inexpensive, to be retrofitted to their existing Annuluses. Our final solution is shown in the following figure. This is one example of RMS' unique engineering and manufacturing capabilities helping our customers operate their older equipment reliably for much longer than their original design lives.



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