STEAM TURBINE INLET SLEEVE INSPECTOR

By Dr. Don McCann

Inlet sleeves can develop cracks at the trepan radius in service due to high transient stresses (thermal and bending). If the cracks propagate through the wall, then inlet steam can leak out and it is possible that the sleeve will separate into two pieces, which would cause the turbine to be shut down. Therefore, cracks need to be detected and removed when they are small so that the turbine can continue to operate.

Summary of joint paper presented by WesDyne and ReGENco at 9th EPRI NDE & Condition Assessment Workshop in Denver CO, August 22-24, 2005 titled "Nondestructive Examination and Analysis of Inlet Sleeves". The phased array ultrasonic technique used to inspect the inlet sleeves on the HP outer cylinder enhances flaw characterization and can size indications down to 0.060" deep while detecting flaws as small as 0.015" deep. The sizing of these flaws can help determine if repairs are a suitable fix or if sleeve replacement is necessary.

Unlike traditional methods of inspecting the inlet sleeves, the phased array inspection requires no blasting operations or surface preparation. The entire set of inlet features, including the main steam inlet sleeves and the nozzle chamber welds, can be inspected in less than one shift – saving 3 to 4 days over magnetic rubber, conventional UT, radiography, and visual examinations.

A metallurgical examination was conducted on a condemned BB22 inlet sleeve that was removed from service. This sleeve was inspected by phase array. The location and size of cracks was recorded. Cross sections were made through the cracks to verify their size and determine the type of crack (fatigue and/or creep). It was found that fatigue cracks initiated at tool marks in the trepan radius but were relatively small. Material samples were removed and creep ratedata were obtained to determine the influence of creep. It was concluded that crack propagation was primarily by fatigue, and that the inlet sleeve was condemned prematurely.

In order to estimate the amount of remaining life of a BB44 inlet sleeve, finite element stress analysis (FEA) and fatigue/creep crack growth techniques have been developed. Sensitivity studies were conducted using linear FEA to determine the magnitude of the various stresses. The studies included pressure, thermal gradient and relative displacements (bending stress) of the sleeve due to misalignment and differential thermal expansion of inner and outer casings. A time dependent creep-fatigue crack growth analysis was performed for the inlet sleeve. Customary creepfatigue crack growth relationships were employed to evaluate crack growth. As a sensitivity study a preexisting flaw was allowed to grow from 0.06" deep to 0.125" deep under a given stress for given load block consisting of one start followed by number of operating hours. The results showed that high bending and thermal stresses, rather than creep, are the primary contributors to crack growth. This means that the sleeves are repairable if the cracks are not too deep. Hence, inspection and analysis can save condemned sleeves.