The Locomotive

When Failure Analysis of Broken Parts is Not Enough

Costly Turbine Damage
Hartford Steam Boiler paid $600,000 as part of steam turbine claim because the inspections and investigative work after a failure did not find all of the broken parts. In this particular incident, the last blade stage of the low-pressure turbine encountered a water induction incident as a result of a high condenser hotwell level. The turbine blades were fastened by tie wires and some of the blades and tie wires were damaged during the incident.

A Second Blade Failure
As part of the post failure investigation, the failed blades were examined for the root cause of the failure. These blades were replaced with new blades. Undamaged blades were subjected to thorough non-destructive examinations (NDE) and reinstalled in the machine. New brazed tie wires were installed for both the new and old blades. The unit was reassembled and within a short time of running, encountered a second failure of blades in the same turbine stage. Several of the reused blades failed.

What Was the Lesson Learned?
While it is normal to conduct failure analyses of broken parts, it is also necessary to conduct analyses of parts which do not appear to be broken. Physical condition, even after NDE, can be misleading. In this particular case, braze alloy in the blade tie wires holes did not allow for finding microcracks in the blade holes by either magnetic particle or liquid penetrant inspections. This contributed to a second turbine failure as a result of undetected microcracks in the "non damaged" blades.

When several blades in a row fail, metallurgical examination of some "good blades" should be included to verify that blades planned for reuse are free of material defects and cracks. These additional analyses apply to gas turbine blades as well as steam turbine blades where the true metallurgical assessment may require destructive testing of blades to insure the parts are satisfactory for continued operation.