Prevention of Turbine Rupture Disc Air Inleakage

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A common problem on low-pressure (LP) condensing steam turbines is air in-leakage through leaking turbine rupture discs. Turbines are equipped with rupture discs (Figure 1) to protect the turbine casings from deforming or rupturing due to an accidental increase of the internal steam pressure. They are an intentional weak spot meant to fail should the system get over-pressurized allowing it to vent out safely. During normal operation, the exhaust ends of LP turbines are under vacuum because they directly connect to condensers. Due to stress, corrosion, and other causes, the lead discs are susceptible to fatigue cracking and corrosion. Evaluation of several rupture discs by one nuclear plant found high cycle fatigue cracking at a location where the discs were being deformed by the rupture disc housing assembly. Cracks in the discs were causing the assemblies to no longer being air-tight, which resulted in a major path for air leakage into the vacuum part of a steam system.

EPRI and other industry guidelines and the Heat Exchange Institute recommendations allow air inleakage to be only 1 SCFM (standard cubic foot per minute) per 100 Megawatts of installed capacity. When a rupture disc is leaking, this requirement often cannot be met. Subsequently, water and steam chemistry and cycle corrosion protection goes out of control and, in a case of severe air in-leakage, condenser vacuum and cycle output and efficiency are reduced. When severe, this problem can result in unit shutdowns to disassemble the rupture disc assemblies and replace leaking diaphragms. For a large unit, the outage costs can be up to $100,000 per hour and over one million dollars per repair.

Figure 1- Typical Turbine Rupture Disc Housing

There are several preventative and corrective measures that are commonly used to improve the rupture disc reliability including ensuring the steel plate is centered in flange opening so that the disc is not exposed to an excessive gap, coating the disc with a sealant during installation, and reducing the torque on retaining ring fasteners. Even with these actions, rupture disc reliability is still rather poor.

During operation, the loss of rupture disc integrity is difficult to correct and severe air in-leakage can be a safety hazard for operators and maintenance personnel. When leakage through a rupture disc is suspected, attempts to stop the leak with sealants can reduce the leakage enough to get through to the next maintenance outage, however this method is not reliable and is not a long term solution. Because of the frequency of maintenance due to the failing rupture discs and the lack of a reliable temporary fix to the leaking discs during operation, a new solution was developed for preventing air inleakage. This solution was the installation of a Turbine Rupture Disc Cover.

These Covers are made from nylon reinforced rubber and neoprene and slide over the top of the rupture disc housing to form an air-tight seal. The Covers are custom designed to fit most rupture disc housing designs, installation takes approximately 20 minutes and does not require the unit to be shutdown. The material of the Rupture Disc Cover is highly resistant to the ambient environment for both indoor and outdoor turbine installations.

During operation of the turbine, if depressions appear on the top of the Cover, this is an indicator that the rupture disc is leaking. The rupture disc can either be replaced during the next outage, or the Cover can be left in place permanently. In addition to sealing the rupture disc to prevent air inleakage, the Covers protect the rupture disc from corrosive atmospheric contaminants.

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