RAS M-330

SUBJECT: OE20246 - Failure of Extraction Steam Bellows inside Condenser - Clinton Power Station

Abstract: CPS experienced a catastrophic failure of an Extraction Steam (ES) line bellows inside the condenser. Material from the bellows also caused a condenser tube failure.

Inspection of the ES lines and bellows in the condenser found significant FAC damage to the ES lines. The FAC damage was unexpected; the heat balance shows these ES lines carry superheated steam.
Reason for Message: CPS is submitting this NER to provide information on the ES line bellows failure. This message also provides information about FAC damage in lines previously thought to contain superheated steam.

Event Date:	February 17, 2005
Unit Name:	Clinton
NSSS/A-E:	General Electric / Sargent & Lundy
Turbine Manufacturer:	General Electric
Maintenance Rule Applicability:	Yes

Description: On 2-17-05 the CPS main control room (MCR) received high water level alarms for 4B feedwater heater. The 4B heater extraction steam (ES) line isolation valve closed in response to the high level. Subsequently, on 2-20-05 the MCR received an alarm for high condensate conductivity indicating a condenser tube leak. The plant initiated a down power to locate and repair the condenser tube leak.

An analysis of the heater condition identified the potential for a failed bellows in the ES line going to the 4B heater. The 4B ES line is a twelve (12) inch line. On 2-22-05, CPS commenced a reactor shutdown and began a forced outage to investigate the bellows condition and make any needed repairs.

An inspection of the condenser found severe damage to the 4B heater ES line bellows. Additionally, three thirty-inch (30) bellows adjacent to the 4B ES line had damage. These three bellows supply ES to the #3 heaters. CPS has six pairs of feedwater heaters with the #1 heaters being the lowest pressure/temperature heaters.

The 4B heater ES piping and bellows configuration consists of two 10-inch vertical sections of piping each with a single bellows that connects to the turbine exhaust. Downstream of the vertical bellows, both 10-inch lines connect into the 12-inch line through 45-degree elbows. The 12-inch line is a horizontal run that includes a double bellows with a segment of piping between these bellows. The bellows are stainless steel and the piping is carbon steel. The 3B ES lines are a similar configuration but have 20 and 30-inch piping. The heat balance shows these lines carry superheated steam.

The inspection of the 4B heater ES piping found holes in the horizontal portions of the piping and the connecting spool between the failed bellows. Examination of the inner piping and spool piece surfaces found evidence of significant FAC damage.

Causes: FAC caused a through-wall hole in an expansion joint. The resulting steam jet induced vibration of the expansion joint that led to high cycle fatigue failure.

Implate Seq-028

DS-03

U.S. NUCLEAR REGULATORY COMMISSION

In the Matter of Entergy Nuclear Vermont Yankee LLC

Docket No. 50-271 Official Exhibit No. E4-15-UY

OFFERED by: (Applicant/Licensee) Intervenor _____

NRC Staff Other _____

IDENTIFIED on 7/23/08 Witness/Panel NEC 4

Action Taken: (ADMITTED) REJECTED WITHDRAWN

Reporter/Clerk MAC

The FAC damage is the result of operating with saturated steam in the ES lines, rather than superheated steam. The saturated steam condition resulted from 1) condenser steam (120 F) cooling the top half of the horizontal portions of the ES piping such that the steam temperature inside the piping fell below superheated conditions and 2) operation with the MSR's out of service as well as reduced service.
Corrective Actions:

1. Include all extraction steam piping for the 3 A/B and 4 A/B feed water heaters into the FAC program.
2. Provide training to Operations and Engineering personal to explain the Root Cause results, FAC and program requirements to identify any changes in operations, chemistry or design whether due to procedure changes or equipment failure to the System Manager and the FAC engineer.
3. Propose a change to the Bellows PM templates to the peer group to review and clarify the "every outage" expectations.
4. Determine scope of extraction steam expansion joint and piping inspections/repairs for C1R10 and future refuel outages and submit scope adds.

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