

# IP-2 SG Tube Rupture

Technical Specification Limit

.3 gpm approximately 432 gpd

The morning of, reading indicated 3gpd approximately .002gpm

10% of tubes plugged

One tube went, not plugged, 1/8 in thick. Area degraded - u bend; leak in excess of 75gpm, leak not gradual, but a step increase

June 1999 got an amendment to test tubes, which added an extra 2 mos. onto the 24mos requirement by TS.

They were well within the administrative, TS, and industry limits. We depend on inspection and evaluation during outages. To monitor otherwise, we have operating limits.

Basis

Well within limits

Administrative limits .1gpm shutdown (110 gpd)

TS . >.3gpm shutdown

Industry 20 gpd log, record actual leak rate

30 - 40 gpd record hourly

60 gpd shutdown

Questions: Is it a leak or a rupture (flowrate of leak exceed the capacity of available of all charging pumps)? Industry experience, Ft Calhoun had a leak of 112 gpm and North Anna 167gpm

J/89

## Indian Point Unit 2

- W 4-loop plant with Model 44 SGs, Alloy 600 Tubes
  - Replacement SGs with Alloy 600 tubes are on site.
- Received OL in Sept 73
- SG Tube Degradation Summary
  - denting (severe, including hourglassing)
  - pitting
  - ODSCC at support plate intersections
  - ODSCC in sludge pile
  - ODSCC in TS crevice
  - PWSCC at roll transitions
  - PWSCC in U-bends
  - Broken plugs (explosive type)
- SGs last inspected in Spring 1997
  - 100% of tubes inspected full length
  - insitu pressure testing of 6 tubes, including axial indication above TS
  - 173 tubes plugged
- Total plugging to date:
  - SG 21 - 313 tubes (9.6%)
  - SG 22 - 405 tubes (12.4%)
  - SG 23 - 301 tubes (9.2%)
  - SG 24 - 306 tubes (9.4%)
- IP-2 restart from refueling/inspection outage on June 13, 1997
- Oct 27, 1997 to August 5, 1998: maintenance outage
- Tech Specs require inspections every 24 calendar months. Thus, reinspection of the Sgs was required by June 1999.

**B. ACCEPTANCE CRITERIA AND CORRECTIVE ACTION**

1. Tubes shall be considered acceptable for continued service if:
  - a. depth of degradation is less than:
    - 40% of the tube wall thickness, or
    - 23% of the sleeve wall thickness

AND

- b. the tube will permit passage of a 0.540" diameter probe and the strain in the tube wall (if measured) is less than the tensile strain criterion as specified in the approved examination program, or the tube will permit passage of a 0.610" diameter probe in the absence of strain measurement.
    - c. the tube is an F\* tube and meets a. and b. above the F\* region.
2. Tubes or sleeves that are not considered acceptable for continued service shall be plugged or repaired.

**C. REPORTS AND REVIEW OF RESULTS**

1. The proposed steam generator examination program shall be submitted for NRC staff review at least 60 days prior to each scheduled examination.
2. The results of each steam generator examination shall be submitted to NRC within 45 days after the completion of the examination. A significant increase in the rate of denting or significant change in steam generator condition shall be reportable immediately.
3. An evaluation which addresses the long term integrity of small radius U-bends beyond row 1 shall be submitted within 60 days of any finding of significant hour-glassing (closure) of the upper support plate flow slots.
4. Restart after the scheduled steam generator examination need not be subject to NRC approval.

## Basis

Inservice examination of steam generator tubing is essential if there is evidence of mechanical damage or progressive deterioration in order to assure continued integrity of the tubing. Inservice examination of steam generator tubing also provides a means of characterizing the nature and cause of any tube degradation so that corrective measures can be taken.

An essentially 100% tube examination was performed on each tube in each steam generator by eddy current techniques prior to service in order to establish a baseline condition for the tubing. No significant baseline imperfections were identified. In addition, prior to the discontinuance of phosphate treatment and the institution of all-volatile treatment (AVT), a baseline inspection was conducted in March, 1975 before the resumption of power operation.

Wastage-type defects are unlikely with the all-volatile treatment (AVT) of secondary coolant; however, even if this type of defect occurs, the steam generator tube examination will identify tubes with significant degradation from this effect.

The results of steam generator tube burst and collapse tests have demonstrated that tubes having wall thickness of not less than 0.025 inch have adequate margins of safety against failure due to loads imposed by normal plant operation and design basis accidents. An allowance of 10% for tube degradation that may occur between inservice tube examinations added to the 40% degradation depth provided in the acceptance criteria provides an adequate margin to assure that tubes considered acceptable for continued operation will not have a minimum tube wall thickness of less than the acceptable 50% of normal tube wall thickness (i.e. 0.025 inch) during the service life-time of the tubes. Steam generator tube examinations of other operating plants have demonstrated the capability to reliably detect wastage type defects that have penetrated 20% of the original 0.050 inch wall thickness.

Examination of samples of tubes and support plates removed from steam generators have revealed that "denting" is caused by the accretion of steel corrosion products in the tube/support plate annuli. As these corrosion products are more voluminous than the support plate material from which they are derived, a compressive force is exerted on the tubes in the plane of the support plates, resulting in deformation of the tubes. If the deformation results in an ovalization of the tubes, the resulting strain is low and there is no risk of development of stress corrosion cracking in the tubes. However, if the deformation results in an irregular tube shape, the resulting strain may be high enough for the tube to become susceptible to stress corrosion cracking inservice, and it should be preventively repaired. Beginning with the steam generator examination to be conducted during the Cycle 5/6 Refueling Outage, the tensile strain criterion for profilometry shall be 25%. The 25% strain criterion is based on a review of data currently available from operating steam generators, and will be revised as necessary as more experience is gained with the evaluation of this measurement. In the future, this criterion

- Licensee requested and staff approved extension of the required inspection interval to June 2, 2000.
  - By June 2, 2000, IP-2 will have accumulated 26 calendar operating months or 21.5 EFPM
  - Basis:
    - layup conditions were maintained during maintenance outage consistent with the EPRI guidelines.
    - During operation, secondary water chemistry was maintained in accordance with EPRI guidelines with no significant chemistry transients reported.
    - Operational assessment was performed by licensee for each degradation mechanism. The results indicated that tube integrity would be maintained through the end of the current fuel-cycle (June 2, 2000).
    - Multiple methods available for the early detection of SG leakage, including N-16 monitors. Administrative leakage limits in place which are more restrictive than TS LCO limits.
- IP-2 has had a very low level of primary to secondary leakage (slightly above 1 gpd total, all SGs) in three of the four SGs since October 1999. N-16 monitor indicated that leakage in SG 24 increased slightly to 1.5 gpd on Feb 6, 2000. *No information currently available beyond that date.*
- SGTR history summary is attached.