



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO. 173 TO FACILITY OPERATING LICENSE NO. DPR-39
AND AMENDMENT NO. 160 TO FACILITY OPERATING LICENSE NO. DPR-48

COMMONWEALTH EDISON COMPANY

ZION NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-295 AND 50-304

1.0 INTRODUCTION

By letter dated September 3, 1996, Commonwealth Edison Company (ComEd or the licensee), submitted a request to change the Technical Specifications (TS) at Zion Nuclear Power Station, Units 1 and 2. The proposed changes would incorporate revised installation procedures for steam generator tube sleeves designed by ABB Combustion Engineering (ABB/CE).

The proposed amendment would modify the TS by adding a footnote which references the cleaning and nondestructive examination (NDE) requirements as described in ABB/CE Topical Report CEN-629-P, Revision 00, "Repair of Westinghouse Series 44 and 51 Steam Generator Tubes Using Leak Tight Sleeves." The Zion TS would continue to specify the use of the existing approved topical report, CEN 331-P, Revision 1-P, but would also reference the recent revisions to the cleaning and inspection processes that are contained in CEN-629-P.

Topical Report CEN-629-P resulted from recent enhancements to the installation and inspection processes for the ABB/CE sleeve. The enhancements were specifically prompted by the issues that arose at Prairie Island earlier this year, associated with the upper welds of ABB/CE sleeves. These issues resulted from difficulties with the installation cleaning process.

2.0 BACKGROUND

ABB/CE sleeves are installed with an autogenous gas tungsten arc weld joining the sleeve to the parent tube at the upper (free span) end of the sleeve. This weld forms the pressure boundary transition between the sleeve and the tube. This upper weld joint is the subject of the subject modifications to the installation processes. The lower sleeve to tube joint (inside the steam generator tube sheet) is made by different means and is not pertinent to this evaluation.

Over 10 years of operating experience with ABB/CE sleeves has shown the technology to be highly reliable. No operationally induced degradation or leakage has occurred in any ABB/CE sleeves, with over 6300 installed to date.

Three or four instances of installation defects have occurred that resulted in inconsequential leaks. All were removed from service.

During the Spring 1996 refueling outage at Prairie Island, Unit 1, roughly 60 upper weld joints in ABB/CE sleeved tubes had eddy current testing (ET) indications. Discovery of most of the indications was the result of the licensee employing a new, more sensitive, ET probe for its routine, periodic inspection of steam generator tubes. Tube samples were removed from the steam generator for metallurgical examination and root cause determination. It was found that the ET indications were due to entrapped oxides and/or weld suckback within the sleeve to tube weld. The cause of these weld defects was traced to a previously revised tube cleaning procedure.

The parent tube inner surface is cleaned prior to welding the sleeve to the tube. Proper surface cleaning is necessary to ensure a good weld. The questionable cleaning procedure had been implemented two operating cycles before and, thus, only affected a limited number of sleeves. Although the defective welds failed to meet the required acceptance criteria, which included no leak path and a very conservatively specified minimum fusion width, they were all found to meet the design structural requirements (tensile strength) for a sleeve to tube weld.

As a result of the metallurgical examination, the tube cleaning procedure was revised and revised post cleaning visual inspections (VT) were adopted. The initial weld acceptance inspection, an ultrasonic test (UT), was revised to give greater sensitivity. As an added measure, the initial baseline ET, normally used only as reference for later periodic reinspections, was modified to supplement the UT as part of the initial weld acceptance inspection. All of these refinements to the sleeving procedure were confirmed using a large number of laboratory samples and field mock-ups. Finally, ABB/CE revised the generic topical report for sleeve installation.

3.0 EVALUATION

3.1 Cleaning

Prior to performing any weld, the surface of the metal(s) to be welded must be cleaned. For sleeve installation, the inner diameter of the parent tube at the desired weld location must be cleaned of service induced oxides. For the ABB/CE sleeving process, this is accomplished by using motorized wire brushes.

Based upon the metallurgical findings, ABB/CE revised the cleaning method to ensure optimum removal of service induced oxides. The revised cleaning procedure entailed some equipment changes. More significantly, from the quality assurance standpoint, a 100 percent VT of the cleaning process was instituted. After the wire brush cleaning step, every tube is given a VT using a remote fiber optic camera system to confirm that adequate surface cleaning has been accomplished. ABB/CE advises that the 100 percent VT is an interim step until enough field experience is gained to consider adoption

of a statistical sampling plan in the future. The staff notes such a change would require a revision to the topical report.

3.2 Weld Acceptance Inspections

For compliance with the Code and regulatory requirements, initial and periodic examinations of steam generator tubes and sleeves are performed. Sleeve welds were historically accepted based on VT and UT examinations. Eddy current testing was used for an initial baseline inspection for comparison with later required periodic inspections. The reason for the different types of examinations being used for initial acceptance versus periodic reinspections is due to the differences between potential flaws from initial installation defects and service induced degradation. The different NDE techniques have normally been better suited for the respective types of anticipated flaws.

The Prairie Island event suggested that the current initial acceptance examinations (VT and UT) may not be sufficient in every circumstance. As a result, the weld acceptance NDE was modified to include:

- * 100 percent VT of all sleeves prior to welding
- * 100 percent UT with an enhanced digitized amplitude system
- * 100 percent ET using the Plus Point probe

The Prairie Island event indicated that cleaning the parent tube prior to welding is a critical step in forming a defect-free sleeve to tube weld. Thus, the new ABB/CE topical report requires a 100 percent VT of the parent tube after cleaning and prior to welding.

The original UT procedure was based upon the absence of a mid-wall reflection. In that procedure, the sleeve outside diameter wall reflection was readily apparent beyond the fusion zone of the weld, thus signifying lack of fusion with the parent tube. Where fusion existed, the mid-wall reflection (mid-wall of the fused sleeve and tube combination) would not appear since no interface would exist. The Prairie Island event led ABB/CE to discover that lack of fusion caused by axially oriented oxide inclusions from a poorly cleaned weld would not be detected since the oxides did not cause a large sound reflection.

In the enhanced UT procedure, the back wall signal from the outside of the parent tube is also monitored for presence in the fused area. Additionally, the back wall signal strength is examined for excessive attenuation. Attenuation beyond the normal amount can be interpreted, along with other signal artifacts, as either a weld that is too narrow or one with inclusions or patches of unfused material. The modified UT procedure was extensively tested on laboratory produced welds containing a variety of inclusion/lack of fusion defects. Samples were destructively examined and the metallurgical sections compared with the UT results. Comparison of results demonstrated that the revised UT procedure was highly reliable. No significant defects could remain undetected by the enhanced UT procedure.

Eddy current testing with the plus point probe is now part of the sleeve weld acceptance criteria. The Prairie Island event led ABB/CE to discover that weld suckback and circumferentially oriented oxide inclusions from a poorly cleaned weld would not be detected by UT. ABB/CE has shown the plus point probe reliably detects the various process-induced weld defects including blowholes, weld suckback and circumferentially oriented oxide inclusions. ABB/CE has also shown the ET technique can reliably locate the position of the defect with respect to the weld centerline which is considered the pressure boundary. Eddy current testing indications located above the weld centerline that meet UT requirements can be left in service. Any ET indication found below the weld centerline requires the tube to be plugged.

Based upon the review and evaluation of the information and data presented in the ABB/CE proprietary reports, the staff finds the TS amendment request to adopt the modified ABB/CE cleaning and initial weld acceptance inspections is acceptable for the future installation of ABB/CE steam generator tube sleeves and will provide reasonable assurance of sleeve integrity. Therefore, the proposed TS change is acceptable.

The staff notes that the adoption of limited sections of CEN-629-P rather than the entire topical report is a deviation from the normal handling of generic topical reports. The staff and the licensee agreed that adoption of the revised cleaning and inspection processes prior to the next scheduled outage at Zion was desirable. However, due to schedule constraints, review of the entire topical report was not feasible prior to the current Unit 2 refueling outage. The staff requested and the licensee agreed to submit an amendment that references the complete topical report, with noted exceptions, prior to the next scheduled refueling outage - currently scheduled in March 1997 for Unit 1.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Illinois State official was notified of the proposed issuance of the amendments. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change a surveillance requirement. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (61 FR 47966). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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