January 4, 1996

Mr. E. E. Fitzpatrick, Vice President
Indiana Michigan Power Company
c/o American Electric Power Service Corporation
1 Riverside Plaza
Columbus, OH 43215

SUBJECT: DONALD C. COOK NUCLEAR PLANT, UNIT NO. 1 - ISSUANCE OF AMENDMENT RE: USE OF LASER-WELDED STEAM GENERATOR TUBE SLEEVES (TAC NO. M92193)

Dear Mr. Fitzpatrick:

The Commission has issued the enclosed Amendment No. 205 to Facility Operating License No. DPR-58 for the Donald C. Cook Nuclear Plant, Unit No. 1. The amendment consists of changes to the Technical Specifications (TS) in response to your application dated April 13, 1995, as supplemented August 28 and October 27, 1995.

The amendment modifies the TS to allow use of laser-welded sleeves to repair defective steam generator tubes. The staff is aware that some issues will only become evident when the actual installation process is underway and therefore recommends that if large scale sleeving is necessary, pre-production demonstration programs be used as has been done in other plants with great success in identifying potential problems. A potentially significant issue that should be identified prior to execution of a sleeving campaign is determining whether or not tubes are locked in the tube support plates and evaluating the consequences this has for post weld heat treatment (PWHT) procedures. Additionally, the desirability of performing a PWHT of the upper hydraulic expansion transition is presently unclear and is the subject of ongoing staff review. You should revisit this issue for technical resolution prior to implementing a sleeving campaign.

A copy of our related Safety Evaluation is also enclosed. Notice of Issuance will be included in the Commission's biweekly Federal Register notice.

Sincerely,

Original Signed By:

John B. Hickman, Project Manager
Project Directorate III-1
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-315

Enclosures: 1. Amendment No. 205 to DPR-58
2. Safety Evaluation

cc w/encl: See next page

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

January 4, 1996

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Indiana Michigan Power Company
c/o American Electric Power Service Corporation
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2. Safety Evaluation

cc w/encl: See next page

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

INDIANA MICHIGAN POWER COMPANY

DOCKET NO. 50-315

DONALD C. COOK NUCLEAR PLANT, UNIT NO. 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 205
License No. DPR-58

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Indiana Michigan Power Company (the licensee) dated April 13, 1995 and supplemented August 28 and October 27, 1995, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. DPR-58 is hereby amended to read as follows:

   Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 205 , are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of issuance, with full implementation within 45 days.

FOR THE NUCLEAR REGULATORY COMMISSION

John B. Hickman, Project Manager
Project Directorate III-1
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: January 4, 1996

ATTACHMENT TO LICENSE AMENDMENT NO. 205

TO FACILITY OPERATING LICENSE NO. DPR-58

DOCKET NO. 50-315

Revise Appendix A Technical Specifications by removing the pages identified below and inserting the attached pages. The revised pages are identified by amendment number and contain vertical lines indicating the area of change.

REMOVE	INSERT
3/4 4-7	3/4 4-7
3/4 4-8	3/4 4-8
3/4 4-9	3/4 4-9
3/4 4-10	3/4 4-10
3/4 4-11	3/4 4-11
3/4 4-12	3/4 4-12
B 3/4 4-2b	B 3/4 4-2b

STEAM GENERATORS

LIMITING CONDITION FOR OPERATION

3.4.5 Each steam generator shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3 and 4.*

ACTION:

With one or more steam generators inoperable, restore the inoperable generator(s) to OPERABLE status prior to increasing T_{avg} above 200°F.

SURVEILLANCE REQUIREMENTS

4.4.5.0 Each steam generator shall be demonstrated OPERABLE by performance of the following augmented inservice inspection program and the requirement of Specification 4.0.5.

4.4.5.1 Steam Generator Sample Selection and Inspection - Each steam generator shall be determined OPERABLE during shutdown by selecting and inspecting at least the minimum number of steam generators specified in Table 4.4-1.

4.4.5.2 Steam Generator Tube Sample Selection and Inspection - The steam generator tube minimum sample size, inspection result classification, and the corresponding action required shall be as specified in Table 4.4-2. The inservice inspection of steam generator tubes shall be performed at the frequencies specified in Specification 4.4.5.3 and the inspected tubes shall be verified acceptable per the acceptance criteria of Specification 4.4.5.4. When applying the exceptions of 4.4.5.2.a through 4.4.5.2.e, previous defects or imperfections in the area repaired by sleeving are not considered an area requiring reinspection. The tubes selected for each inservice inspection shall include at least 3% of the total number of tubes in all steam generators; the tubes selected for these inspections shall be selected on a random basis except:

a. Where experience in similar plants with similar water chemistry indicates critical areas to be inspected, then at least 50% of the tubes inspected shall be from these critical areas.

b. The first sample of tubes selected for each inservice inspection (subsequent to the preservice inspection) of each steam generator shall include:

1. All tubes that previously had detectable wall penetrations (greater than or equal to 20%) that have not been plugged or repaired by sleeving in the affected area.

* This Specification does not apply in Mode 4 while performing crevice flushing as long as Limiting Conditions for Operation for Specification 3.4.1.3 are maintained.

SURVEILLANCE REQUIREMENTS (continued)

2. Tubes in those areas where experience has indicated potential problems.

3. A tube inspection (pursuant to Specification 4.4.5.4.a.8) shall be performed on each selected tube. If any selected tube does not permit the passage of the eddy current probe for a tube inspection, this shall be recorded and an adjacent tube shall be selected and subjected to a tube inspection.

4. Tubes left in service as a result of application of the tube support plate plugging criteria shall be inspected by bobbin coil probe during all future refueling outages.

c. In addition to the sample required in 4.4.5.2.b.1 through 3, all tubes which have had the F* criteria applied will be inspected in the roll expanded region. The roll expanded region of these tubes may be excluded from the requirements of 4.4.5.2.b.1.

d. The tubes selected as the second and third samples (if required by Table 4.4-2) during each inservice inspection may be subjected to a partial tube inspection provided:

1. The tubes selected for the samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found.

2. The inspections include those portions of the tubes where imperfections were previously found.

e. Implementation of the steam generator tube/tube support plate plugging criteria for one fuel cycle (Cycle 15) requires a 100 percent bobbin coil inspection for hot-leg tube support plate intersections and cold-leg intersections down to the lowest cold-leg tube support plate with known outside diameter stress corrosion cracking (ODSCC) indications. The determination of tube support plate intersections having ODSCC indications shall be based on the performance of at least a 20 percent random sampling of tubes inspected over their full length.

f. Inspection of sleeves will follow the initial sample selection (1st sample) and sample expansion requirements of Table 4.4-2.

The results of each sample inspection shall be classified into one of the following three categories:

Category	Inspection Results
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.
C-2	One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.
C-3	More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

SURVEILLANCE REQUIREMENTS (continued)

Note: In all inspections, previously degraded tubes or sleeves must exhibit significant (greater than or equal to 10%) further wall penetrations to be included in the above percentage calculations.

4.4.5.3 Inspection Frequencies - The above required inservice inspections of steam generator tubes shall be performed at the following frequencies:

a. The first inservice inspection shall be performed after 6 Effective Full Power Months but within 24 calendar months of initial criticality. Subsequent inservice inspections shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection. If two consecutive inspections following service under AVT conditions, not including the preservice inspection, result in all inspection results falling into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval may be extended to a maximum of once per 40 months.

b. If the results of inservice inspection of a steam generator conducted in accordance with Table 4.4-2 at 40 month intervals fall in Category C-3, the inspection frequency shall be increased to at least once per 20 months. The increase in inspection frequency shall apply until the subsequent inspections satisfy the criteria of Specification 4.4.5.3.a; the interval may then be extended to a maximum of once per 40 months.

c. Additional, unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.4-2 during the shutdown subsequent to any of the following conditions:

1. Primary-to-secondary tubes leaks (not including leaks originating from tube-to-tube sheet welds) in excess of the limits of Specification 3.4.6.2.

2. A seismic occurrence greater than the Operating Basis Earthquake.

3. A loss-of-coolant accident requiring actuation of the engineered safeguards.

4. A main steam line or feedwater line break.

SURVEILLANCE REQUIREMENTS (continued)

4.4.5.4 Acceptance Criteria

a. As used in this Specification:

1. Imperfection means an exception to the dimensions, finish or contour of a tube or sleeve from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections.

2. Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube or sleeve.

3. Degraded Tube or Sleeve means an imperfection greater than or equal to 20% of the nominal wall thickness caused by degradation.

4. Percent Degradation means the amount of the tube wall thickness affected or removed by degradation.

5. Defect means an imperfection of such severity that it exceeds the repair limit.

6. Repair/Plugging Limit means the imperfection depth at or beyond which the tube or sleeved tube shall be repaired or removed from service. Any tube which, upon inspection, exhibits tube wall degradation of 40 percent or more of the nominal tube wall thickness shall be plugged or repaired prior to returning the steam generator to service. This definition does not apply to the portion of the tube in the tubesheet below the F* distance for F* tubes. Any sleeve, except laser welded sleeves, which upon inspection exhibits wall degradation of 29 percent or more of the nominal wall thickness, shall be plugged prior to returning the steam generator to service. In addition, any sleeve, except laser welded sleeves, exhibiting any measurable wall loss in sleeve expansion transition or weld zones shall be plugged. This definition does not apply to tube support plate intersections for which the voltage-based plugging criteria are being applied. Refer to 4.4.5.4.a.10 for the plugging limit applicable to these intersections. For a tube that has been sleeved with a laser welded sleeve, through wall penetration of greater than or equal to 23% of sleeve nominal wall thickness requires the tube to be removed from service by plugging.

7. Unserviceable describes the condition of a tube or sleeve if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in 4.4.5.3.c, above.

8. Inspection determines the condition of the steam generator tube or sleeve from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg. For a tube in which the tube support plate elevation interim plugging limit has been applied, the inspection will include all the hot leg intersections and all cold leg intersections down to, at least, the level of the last crack indication.

SURVEILLANCE REQUIREMENTS (continued)

9. Sleeving a tube is permitted with tube support plate sleeves and with tubesheet sleeves. Tube support plate sleeves are centered about the tube support plate intersection. Tubesheet sleeves start at the primary fluid tubesheet face and extend to the free span region of tube above the tubesheet.

10. Tube Support Plate Repair Limit is used for the disposition of a steam generator tube for continued service that is experiencing outside diameter stress corrosion cracking (ODSCC) confined within the thickness of the tube support plates. At tube support plate intersections, the repair limit is based on maintaining steam generator tube serviceability as described below:

    a. Degradation attributed to ODSCC within the bounds of the tube support plate with bobbin voltage less than or equal to 2.0 volts will be allowed to remain in service.

    b. Degradation attributed to ODSCC within the bounds of the tube support plate with a bobbin voltage greater than 2.0 volts will be repaired or plugged except as noted in 4.4.5.4.a.10.c below.

    c. Indications of potential degradation attributed to ODSCC within the bounds of the tube support plate with a bobbin voltage greater than 2.0 volts but less than or equal to 5.6 volts may remain in service if a rotating pancake coil inspection does not detect degradation. Indications of ODSCC degradation with a bobbin voltage greater than 5.6 volts will be plugged or repaired.

11. F* Distance is the distance from the bottom of the hardroll transition toward the bottom of the tubesheet that has been conservatively determined to be 1.11 inches (not including eddy current uncertainty).

12. F* Tube is a tube with degradation, below the F* distance, equal to or greater than 40%, and not degraded (i.e., no indications of cracking) within the F* distance.

13. Tube Repair refers to sleeving as described by the reports listed in 4.4.5.4.c which are used to maintain a tube in service or return a tube to service. Tubes with degradation indications of less than the plugging limit may be preventively sleeved at the Owner's discretion. This includes removal of plugs that were installed as a corrective or preventive measure. A tube inspection per 4.4.5.4.a.8 is required prior to returning previously plugged tubes to service. Further restrictions regarding identified indications and their proximity to the joint areas of various sleeving processes may be applicable.

b. The steam generator shall be determined OPERABLE after completing the corresponding actions (plugging or sleeving all tubes exceeding the repair limit and all tubes containing through-wall cracks) required by Table 4.4-2.

c. Steam generator tube repairs may be made in accordance with the methods described in either WCAP-12623, WCAP-13088 (Rev. 3), or CEN-313-P.

SURVEILLANCE REQUIREMENTS (continued)

4.4.5.5 Reports

a. Following each inservice inspection of steam generator tubes, if there are any tubes requiring plugging or sleeving, the number of tubes plugged or sleeved in each steam generator shall be reported to the Commission within 15 days.

b. The complete results of the steam generator tube inservice inspection shall be included in the Annual Operating Report for the period in which this inspection was completed. This report shall include:

   1. Number and extent of tubes and sleeves inspected.

   2. Location and percent of wall-thickness penetration for each indication of an imperfection.

   3. Identification of tubes plugged or sleeved.

c. Results of steam generator tube inspections which fall into Category C-3 and require prompt notification of the Commission shall be reported pursuant to Specification 6.9.1 prior to resumption of plant operation. The written followup of this report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

d. For implementation of the voltage-based repair criteria to tube support plate intersections, notify the staff prior to returning the steam generators to service should any of the following conditions arise:

   1. If estimated leakage based on the actual measured end-of-cycle voltage distribution would have exceeded the leak limit (for the postulated main steam line break utilizing "Standard Review Plan - NUREG-0800" assumptions) during the previous operating cycle.

   2. If circumferential crack-like indications are detected at the tube support plate intersections.

   3. If significant indications are identified that extend beyond the confines of the tube support plate.

   4. If the calculated conditional burst probability, as calculated per WCAP-14277, exceeds 1×10^{-2}, notify the NRC and provide an assessment of the safety significance of the occurrence.

3/4.4.5 STEAM GENERATORS TUBE INTEGRITY (Continued)

Whenever the results of any steam generator tubing inservice inspection fall into Category C-3, these results will be promptly reported to the Commission pursuant to Specification 6.9.1 prior to resumption of plant operation. Such cases will be considered by the Commission on a case-by-case basis and may result in a requirement for analysis, laboratory examinations, tests, additional eddy-current inspection, and revision of the Technical Specifications, if necessary.

Degraded steam generator tubes may be repaired by the installation of sleeves which span the section of degraded steam generator tubing. A steam generator tube with a sleeve installed meets the structural requirements of tubes which are not degraded.

To determine the basis for the sleeve plugging limit, the minimum sleeve wall thickness was calculated in accordance with Draft Regulatory Guide 1.121 (August 1976). In addition, a combined allowance of 20 percent of wall thickness is assumed for eddy current testing inaccuracies and continued operational degradation per Draft Regulatory Guide 1.121 (August 1976).

The following sleeve designs have been found acceptable by the NRC staff:

1. Westinghouse Mechanical Sleeves (WCAP-12623)
2. Combustion Engineering Leak Tight Sleeves (CEN-313-P)
3. Westinghouse Laser Welded Sleeves (WCAP-13088, Rev. 3)

Descriptions of other future sleeve designs shall be submitted to the NRC for review and approval in accordance with 10 CFR 50.90 prior to their use in the repair of degraded steam generator tubes. The submittals related to other sleeve designs shall be made at least 90 days prior to use.

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 205 TO FACILITY OPERATING LICENSE NO. DPR-58

INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK NUCLEAR PLANT, UNIT NO. 1

DOCKET NO. 50-315

1.0 INTRODUCTION

By letter dated April 13, 1995, as supplemented August 28 and October 27, 1995, the Indiana Michigan Power Company (the licensee) requested an amendment to the Technical Specifications (TS) appended to Facility Operating License No. DPR-58 for the Donald C. Cook Nuclear Plant, Unit No. 1. The proposed amendment would allow for the installation of steam generator tube repair sleeves at the D. C. Cook Nuclear Plant, Unit 1. The proposal is for the use of laser-welded sleeves designed by Westinghouse.

The technical justification supporting the Westinghouse laser-welded sleeve process is given in WCAP-13088, Revision 3, "Westinghouse Series 44 and 51 Steam Generators Generic Sleeving Report Laser Welded Sleeves (Proprietary), and WCAP-13089, Revision 3, "Westinghouse Series 44 and 51 Steam Generators Generic Sleeving Report Laser Welded Sleeves (Non-Proprietary).

WCAP-13088, Revision 3, (1.0 Introduction, p. 1-1) states that this report serves as a reference design basis for laser-welded sleeve installation in plants with Model 51 steam generators (SGs) and further states that changes in plant operating parameters can occur as a result of system or operating modifications. It further states that prior to installation, a supplementary plant-specific review of the applicable operating parameters at the time of sleeve installation relative to the design-basis parameters will be performed to form the plant-specific design basis for the laser-welded sleeves. In Attachment 1 to the letter dated April 13, 1995 (NRC Accession NBR:9504260146), the licensee provides an evaluation of plant-specific parameters. The staff found that the licensee's technical justification for using laser-welded sleeves is within the D. C. Cook licensing basis. The D. C. Cook, Unit 1 licensing basis as it relates to sleeving repairs of defective SG tubes is provided in the attachment to this safety evaluation.

The August 28 and October 27, 1995, supplements provided clarifying information and updated TS pages that incorporated changes made by previously issued amendments. These submittals did not change the staff's initial proposed no significant hazards considerations determination.

2.0 DISCUSSION

2.1 Background

Tubes in an operating pressurized water reactor SG can be degraded by mechanisms such as primary water stress corrosion cracking, outer diameter stress corrosion cracking, intergranular attack, pitting, or by other phenomena such as denting and vibration-induced wear. Tubes that become excessively degraded reduce the integrity of the primary-to-secondary pressure boundary and must be removed from service or repaired. Degradation of SG tubes has typically been monitored using eddy current testing (ECT) techniques. Plant TS have historically required that SG tubes be plugged at both the inlet and outlet ends of the tubes, when tubes are determined to have degraded below a calculated minimum wall thickness value (termed the "plugging limit"). However, installing plugs in an SG tube reduces the heat transfer surface area available for reactor core cooling. For this reason, design restrictions limit the total number of SG tubes which may be plugged in any one SG during the lifetime of a plant.

Alternatively, SG tubes experiencing localized degradation can be fitted with sleeves over the degraded area to re-establish the integrity of the reactor coolant pressure boundary (RCPB). The sleeves are expanded and sealed inside the tubes to provide an acceptable leak-resistant load-carrying path. The reductions in heat transfer area and primary flow resulting from sleeving are slight in comparison to that resulting from tube plugging. ECT methods have been developed for monitoring any degradation in the sleeve and the underlying parent tube. However, because the sleeve becomes part of the RCPB, licensees are required to submit amendments to their TS for review and approval before the NRC will authorize a given sleeving technique as an acceptable SG tube repair method. Licensees typically implement the TS amendment by referencing the generic or plant-specific sleeving topical report(s) in the appropriate SG Limiting Condition for Operation or Surveillance Requirement.

In this case, where a licensee has amended its TS to allow for sleeving of SG tubes, the licensee may use either plugging or sleeving as an SG tube repair method. Should subsequent ECT measurements of installed sleeves indicate that a sleeved tube has degraded beyond the plugging limit for its design, the TS would then require that the defective SG tube be plugged and removed from service. The tube and sleeve plugging limits conservatively account for the uncertainties in ECT measurements and contain additional margins for expected or postulated degradation which may occur between inspections.

2.1 Sleeve Design

Sleeves are of two basic designs: tubesheet sleeve and tube support sleeve. The tubesheet sleeve spans from the end of the tube, at the bottom surface of the tubesheet, to a point above the secondary-side surface of the tubesheet. The tube support sleeve may be installed centered approximately on a tube support intersection or in a free span section of the tube. Tubesheet sleeves are secured by first hydraulically expanding the upper and lower portions of the sleeve. The hydraulic expansion brings the sleeve into contact with the parent tube to optimize weld performance and minimize tube deformation. A continuous circumferential laser weld is applied in the area of the hydraulically expanded region of the upper joint and stress relieved with a post-weld heat treatment (PWHT). This weld structurally supports the sleeve and at the same time forms a seal.

At the lower hydraulically expanded joint, a mechanical hard roll expansion is performed. The lower joint provides structural integrity under all plant conditions. Because it is a mechanical seal, it has not historically been considered leak-tight, although the test data indicate that the joint will be essentially leak-tight at operating and accident temperatures and pressures. An optional continuous circumferential laser seal weld without PWHT can be applied between the sleeve and the cladding to provide additional leak tightness. Leak testing, as discussed below, has qualified the joints without the seal weld.

2.1.1 Tube Lock-up

The licensee has discussed the issue of tubes under certain conditions becoming locked to the support plate structure of the SG. Normally this will cause tensile loads in the tube upon cool down because of the differential thermal expansion rates between the sleeve and the SG structure. This issue was the subject of additional testing and analysis related to the use of laser-welded sleeves at the Maine Yankee facility recently. The licensee will have the benefit of this experience and the staff recommends that the issue of tube lock-up and bowing be examined for plant-specific concerns at D. C. Cook.

2.2 Licensee Commitments

Recent experience at operating plants has emphasized the sensitivity of the Alloy 600 parent SG tube material to stress corrosion cracking when unfavorable residual stresses are introduced by processes such as sleeving. For this reason, the staff position on sleeving considers sleeving unable to assure an unlimited service life for a repaired tube. The conservative view is that sleeving potentially creates new locations in the parent tube which may be susceptible to cracking after new incubation times are expended. Incubation times have been observed to vary between individual SGs and for the various conditions of tubes within them. According to the licensee, about 18,000 laser-welded sleeves have been in service in Japan for several years and approximately 800 have been in service at Farley Nuclear Plant, some since 1992, and to date no laser-welded sleeved tube failures have been reported. Earlier in 1995, a sample inspection of laser-welded tubes at Farley using the Cecco-5 probe indicated no instances of sleeve or parent tube cracking.

The sleeves are manufactured from thermally treated, American Society of Mechanical Engineers (ASME) SB-163, Alloy 690. This material, also known as Alloy 690 TT (thermally treated), has been demonstrated to be highly resistant to intergranular stress corrosion cracking (IGSCC) under SG conditions. The resistance of the laser-welded sleeve joint to in-service cracking depends primarily on the resistance of the parent Alloy 600 tubing to IGSCC. As mentioned previously, stresses in the tubing, either service operating stresses or residual stresses, can potentially cause cracking. Two sources of residual stresses are related to hydraulic expansion during sleeve placement and to stresses introduced as a result of welding.

A testing program was conducted under conditions which accelerate corrosion in SG materials to simulate long-term SG service. Each test contained a rolled tube transition which served as a control sample. The stress levels in the control sample were representative of the residual stress conditions in the hard rolled transitions found at the top of the tubesheets in operating SG and are considered a bounding stress level.

The accelerated corrosion testing was performed in high temperature-high pressure autoclaves. A doped steam environment was utilized to accelerate crack initiation and propagation. Results of the accelerated corrosion tests indicate that laser-welded sleeve joints with post-weld heat treatment have a corrosion resistance greater than 10 times that of the as-welded joint. The licensee has committed to the use of a minimum tube outer diameter (OD) wall temperature of 1400 degrees F as the post-weld stress relief heat treatment for the laser-welded sleeving method in accordance with staff positions.

In response to the staff request for further information regarding confirmatory testing to establish the design life of the sleeves, the licensee stated that the results of long-term corrosion testing that Westinghouse is performing as part of the Maine Yankee 3/4-inch sleeve program will be available for use in establishing the design life for the sleeves installed at Cook. The licensee staff further stated that they would continue to consider corrosion test results and apply findings from industry inservice test programs to verify the long-term suitability of the sleeves placed in service in Cook.

The licensee has committed to use enhanced and improved eddy current inspection techniques as they are developed and verified for use by vendors in accordance with Electric Power Research Institute (EPRI) NP-6201, "PWR Steam Generator Examination Guidelines," for appropriate inservice inspection for tubes containing laser-welded sleeves.

In response to the staff request for a commitment regarding primary-to-secondary leakage limits to account for the installation of the sleeves into the SG, the licensee stated that it follows the leakage and monitoring guidelines outlined in EPRI PR-104788, "PWR Primary-to-Secondary Leak Guidelines." The licensee's TS was previously amended to provide reduced primary-to secondary leak rate limits of 150 gallons per day through any one SG.

3.0 EVALUATION

3.1 Sleeve Design and Analysis and Testing

The laser-welded sleeves (both tubesheet and tube support plate sleeves) have been analyzed to ensure they will maintain SG tube and leak integrity during all plant conditions. The sleeve joint designs have been qualified through laboratory testing and analysis. Analytical verification has been performed using design and operating transient parameters which have been determined to apply to D. C. Cook conditions.

The function of the sleeve is to restore the integrity of the RCPB in the region between the sleeve joints to a level which is consistent with the original tube. The sleeve has been designed according to Section III of the ASME Boiler and Pressure Vessel Code. Fatigue and stress analyses of sleeved tube assemblies have been completed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III. The analyses include a primary stress intensity evaluation, primary plus secondary stress intensity range evaluation, and a fatigue evaluation for mechanical and thermal conditions which envelop the loading conditions for the D. C. Cook SGs. For all analyzed conditions, the calculated stress levels and fatigue usage factors for both the sleeve and weld were found to be bounded by the ASME Code allowable values.

3.2 Sleeve Plugging Limits

The sleeve minimum acceptable wall thickness is determined using the criteria of Regulatory Guide 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes," the ASME Code Section III allowable stress values, and the pressure stress equation in NB-3324.1 of Section III of the ASME Code. According to Regulatory Guide 1.121 criteria, an allowance for non-destructive evaluation (NDE) uncertainty and postulated operational growth of tube wall degradation within the sleeve must be accounted for when using NDE to determine sleeve plugging limits. Therefore, a conservative tube wall combined allowance for postulated degradation growth and eddy current uncertainty of 20% through-wall per cycle have been assumed for the purpose of determining the sleeve plugging limit. The sleeve plugging limit, which was calculated based on the most limiting of normal, upset, or faulted conditions for D. C. Cook was determined to be 23% of the sleeve nominal wall thickness based on ASME Code minimum material properties in accordance with staff positions. Removal of tubes and/or sleeves from service when degradation reaches the plugging limit provides assurance that the minimum acceptable wall thickness will not be violated during the next subsequent cycle of operation.

3.3 Leakage

While the laser weld should be inherently leak-tight, in practice, the lower joint of a tubesheet sleeve may be installed with or without a seal weld; therefore, the leakage characteristics must be considered. The licensee has analyzed the effects of an abnormal tubesheet sleeve lower joint seal weld because of the inability of the ultrasonic testing (UT) inspection process to confirm the width of the fusion zone. The analysis shows that even under extreme postulated conditions, it will have satisfactory leakage integrity.

3.4 Non-Destructive Examination

The welding parameters are computer controlled. The essential variables, in accordance with the ASME Code, are monitored and documented to produce repeatability of the weld process. In addition, the non-destructive qualification examination of the laser-welded sleeves utilizes two techniques. UT is performed after welding to confirm that the laser welds are consistent with critical process dimensions and are of acceptable weld quality and that there is a metallurgical bond between the sleeve and the tube and to verify that no leak path exists across the weld. The licensee has stated that the minimum acceptable weld width as determined by ultrasonic examination is approximately 50% wider than the minimum weld width which satisfies the stress conditions of the ASME Code (Attachment 1 p. 7, letter dated April 13, 1995). It is the staff's understanding that this margin over code minimum requirements may be difficult to achieve in the field. The staff believes that the margins involved in the laser weld acceptance requirements should be determined and established prior to production welding.

ECT is used to establish baseline inspection data for every installed sleeve/tube to be utilized during subsequent inservice inspections. Furthermore, in accordance with the criteria in Regulatory Guide 1.83, Revision 1, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes," the licensee has presented data which demonstrates that structural integrity of sleeved tubes can be monitored by performing periodic ECT examinations. The ECT technique presently qualified utilizes a double crosswound eddy current coil, which minimizes the effects of geometry and weld zone changes. However, for future inservice inspections, the licensee has committed to utilize enhanced and improved inspection techniques as they are developed and verified for use. The licensee described a number of proprietary advanced inspection techniques that are currently under development, and stated that alternate inspection techniques may be applied as they become available, as long as they can be demonstrated to provide the same or a greater degree of inspection accuracy as the method described in the reports submitted to and accepted by the NRC staff.

It should be noted that inspections of installed sleeves necessitate the use of an eddy current bobbin probe which is of sufficiently small OD to allow the probe to pass through the sleeve inner diameter (ID). This probe diameter, however, is not optimized for the span between the sleeves (reduced "fill-factor"). The licensee has committed that for any tube indication in this area, a further inspection will be performed by an alternate technique, such as a surface riding probe, in order to determine the acceptability of the sleeved tube for further service. In addition, the licensee has committed that, for any change in the eddy current signature of the sleeve or sleeve/tube joint region, a further inspection will also be performed by an alternate eddy current technique in order to determine the acceptability of the sleeved tube for continued service.

3.5 Sleeving of Previously Plugged Tubes

In the event that previously plugged tubes are unplugged and returned to service by using the sleeving process, the TS would require that the sleeving requirements be applied to the tubes designated for sleeving. This includes provisions to ensure that the new sleeve joints are located a minimum acceptable distance apart from the degraded tube area. Following installation, a new "baseline" inspection of the tube and sleeve would then be required for any sleeved tube placed back in service.

4.0 CHANGES TO THE TECHNICAL SPECIFICATIONS

TS Section 4.4.5.2 specifies requirements for steam generator tube inspection size and selection as well as results classification and corresponding actions. These requirements include exemptions to the generic inspection requirements that provide inspection criteria which focus inspections on specific areas of concern. The licensee's first proposed change would add to this specification: "When applying the exceptions of 4.4.5.2.a through 4.4.5.2.e, previous defects or imperfections in the area repaired by sleeving are not considered an area requiring reinspection." Since the installation of the sleeve constitutes a redefinition of the RCPB, the reinspection of the defects in the parent tube is not necessary. Therefore, the staff finds the proposed change acceptable.

The next proposed change would add to TS Section 4.4.5.2 an additional inspection criteria which states: "Inspection of sleeves will follow the initial sample selection (1st sample) and sample expansion requirements of Table 4.4-2." Since the sleeves become the RCPB, inspection of the sleeves, consistent with the existing requirements for the tubes, is appropriate, and, therefore, the staff finds the proposed change acceptable.

The third proposed change to TS 4.4.5.2, adds to the note pertaining to results classification that previously degraded sleeves as well as previously degraded tubes must exhibit significant further wall penetrations to be included in the results calculations. Since the sleeves are now part of the RCPB, inclusion of them as part of the results calculations, subject to the same limitations, is appropriate. Therefore, the staff finds this change acceptable.

The fourth proposed change affects TS Section 4.4.5.4 which provides acceptance criteria for tube inspections. Specifically, Section 4.4.5.4.a.6., which details the repair/plugging limits, is revised to state: "For a tube that has been sleeved with a laser welded sleeve, through wall penetration of greater than or equal to 23% of sleeve nominal wall thickness requires the tube to be removed from service by plugging." This criterion is acceptable as stated in Section 3.2 of this safety evaluation.

The next change would revise TS 4.4.5.4.a.9. to allow sleeving a tube with both tube support plate sleeves and with tubesheet sleeves. This allowance is needed to use both laser welded sleeves, approved elsewhere in this safety evaluation, as well as the hardrolled sleeves previously approved. This change is therefore acceptable.

The sixth change would add TS Section 4.4.5.4.a.13. This section defines tube repair by referencing the sleeving reports listed elsewhere in the TS. The section also discusses repair options and inspection requirements. These repair requirements are consistent with the repair process approved previously in this safety evaluation and are therefore acceptable.

The next change to the TS would modify TS Section 4.4.5.4.c. which lists the reports that describe acceptable tube repair methods. The WCAP report which describes the laser welded sleeving option previously discussed in this safety evaluation is added. The staff finds this change acceptable.

The final change to the TS would add to Section 4.4.5.5.b., which details reporting requirements for steam generator tube inspections, the statement that sleeves inspected must also be included. This is consistent with the sleeves use as the RCPB and is acceptable.

The licensee also made appropriate and consistent changes to the TS Bases.

5.0 SUMMARY

Based on the preceding analysis, the staff concludes that at D. C. Cook, the repair of SG tubes using laser-welded sleeves in accordance with the proposed amendment is acceptable, as supplemented by additional licensee commitments to (1) using enhanced and improved ECT inspection techniques as they are developed and verified for use, (2) performing post-weld heat treatment of installed laser-welded sleeves at a 1400 degree F minimum wall OD temperature, (3) using the results of long-term corrosion testing to establish the design life of the sleeves, (4) maintaining requirements to provide for appropriate inservice inspection for any SG tubes containing sleeves and (5) continuing TS license requirements for primary-to-secondary leakage limits to account for any installation of sleeves into the SGs.

6.0 STATE CONSULTATION

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

7.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes surveillance requirements. The staff has determined that the amendment involves 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 amendment involves no significant hazards consideration and there has been no public comment on such finding (60 FR 29877). Accordingly, the amendment meets 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 amendment.

8.0 CONCLUSION

The staff 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 amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributors: H. Conrad
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Date: January 4, 1996

Attachment: Licensing Basis

LICENSING BASIS

1. 10 CFR 50.55a

   10 CFR 50.55a, "Codes and Standards," requires that components which are a part of the reactor coolant pressure boundary be built to the requirements of Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. 10 CFR 50.55a also requires that throughout the service life of the plant, licensees meet the inservice inspection requirements of the ASME Code Section XI for ASME Code Class 1, 2, or 3 components.

   Section 5.2.1.1 of the Standard Review Plan, entitled "Compliance with the Codes and Standards Rule, 10 CFR 50.55a," provides an outline of the standards used for evaluation by the NRC staff. Any modification, repair, or replacement of these components must also meet the requirements of the ASME Code to assure that the basis on which the unit was originally evaluated is unchanged.

2. ASME Code Requirements

   The design of the sleeves is predicated on the requirements of the ASME Code Section III, Subarticles NB-3200, "Analysis" and NB-3300, "Wall Thickness." The ASME Boiler and Pressure Vessel Code provides criteria for evaluation of the stress levels in the tubes for design, normal operating, and postulated accident conditions. The margin of safety is provided, in part, by the inherent safety factors in the criteria and requirements of the ASME Code.

   Section IX of the ASME Code, Subsection QW, and Section III, including Code Case N-395, define the applicable essential variables for the welding procedure specification and welding procedure qualification test.

   Section XI, IWB-4334 of the ASME Code defines the extent of examination requirements for installation of laser-welded sleeves.

3. Regulatory Guide 1.121

   Regulatory Guide 1.121, issued for comment, entitled "Bases for Plugging Degraded PWR Steam Generator Tubes," addresses tubes with defects. The criteria of Regulatory Guide 1.121 are extended to the laser-welded sleeve in order to determine the level of degradation, which will require removal of the sleeve from service by plugging. ASME Code allowable strength values were used for this evaluation. By utilizing the requirements for sleeve design according to the ASME Code and Regulatory Guide 1.121 to define acceptance criteria, the sleeve meets the requirements of General Design Criterion (GDC) 14, "Reactor Coolant Pressure Boundary," GDC 15, "Reactor Coolant System Design," and GDC 31, "Fracture Prevention of Reactor Coolant Pressure Boundary."

4. Regulatory Guide 1.83

Regulatory Guide 1.83, "Inservice Inspection of Pressurizer Water Reactor Steam Generator Tubes" (and the D. C. Cook, Unit 1 Technical Specifications) is used as the basis to determine the inservice inspection requirements for the sleeve.

5. 10 CFR Part 100

Total plant allowable primary-to-secondary leakage rates, derived from the requirements of 10 CFR Part 100, are determined on a plant-specific basis. Offsite doses during either a main steam line break or tube rupture event are not to exceed a small fraction of the 10 CFR Part 100 limits per the Bases to the D. C. Cook, Unit 1 Technical Specifications.

DATED: January 4, 1996

AMENDMENT NO. 205 TO FACILITY OPERATING LICENSE NO. DPR-58-D. C. COOK-UNIT 1

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