UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 50-400-LA
CAROLINA POWER & LIGHT	)	
COMPANY	)	ASLBP No. 99-762-02-LA
	)	
(Shearon Harris Nuclear Plant)	)	
	)	

AFFIDAVIT OF JAMES A. DAVIS IN SUPPORT OF
NRC STAFF BRIEF AND SUMMARY OF RELEVANT FACTS, DATA
AND ARGUMENTS UPON WHICH THE STAFF PROPOSES TO RELY
AT ORAL ARGUMENT ON TECHNICAL CONTENTION 3

I, James A. Davis, being duly sworn, state as follows:

1. My name is James A. Davis. My position is Materials Engineer in the Non-Destructive Evaluation & Metallurgy Section, Materials and Chemical Engineering Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission. I received a Bachelor of Metallurgical Engineering Degree, Master of Science Degree in Metallurgical Engineering, and a Doctor of Philosophy Degree in Metallurgical Engineering from the Ohio State University. I also attended Canusius College in Buffalo where I took business management courses. I began to examine degradation mechanisms for welds in 1962 as a technician in the Fontana Corrosion Center during summers while in college. I continued to examine degradation mechanisms for welds after graduation from college in 1968 until the present. My resume is attached hereto. (Attachment 1). I am responsible for the NRC staff review and the oversight of reviews to determine the presence and extent of age-related degradation, if any, of the piping, including welds, for previously completed portions of the Harris Nuclear Plant Unit 2 Fuel Pool Cooling and Cleanup

System under 10 C.F.R. Part 50. To establish the presence and extent of degradation of the piping and welds, it is necessary to determine the condition of the piping and welds after initial construction.

2. The purpose of this affidavit is to address the Atomic Safety and Licensing Board (Board) concerning Technical Contention 3, as set forth in the Board's Memorandum & Order of July 12, 1999. (*Carolina Power and Light Co.* (Shearon Harris Nuclear Plant) LBP-99-25, 50 NRC 25 (1999)).

TECHNICAL CONTENTION 3:

> CP&L's proposal to provide cooling of pools C & D by relying upon the use of previously completed portions of the Unit 2 Fuel Pool Cooling and Cleanup System and the Unit 2 Component Cooling Water System fails to satisfy the quality assurance criteria of 10 C.F.R. Part 50, Appendix B, specifically Criterion XIII (failure to show that the piping and equipment have been stored and preserved in a manner that prevents damage or deterioration), Criterion XVI (failure to institute measures to correct any damage or deterioration), and Criterion XVII (failure to maintain necessary records to show that all quality assurance requirements are satisfied).
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> Moreover, the Alternative Plan submitted by Applicant fails to satisfy the requirements of 10 C.F.R. § 50.55a for an exception to the quality assurance criteria because it does not describe any program for maintaining the idle piping in good condition over the intervening years between construction [and] implementation of the proposed license amendment, nor does it describe a program for identifying and remediating potential corrosion and fouling.
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> The Alternative Plan submitted by Applicant is also deficient because fifteen welds for which certain quality assurance records are missing are embedded in concrete and inspection of the welds to demonstrate weld quality cannot be adequately accomplished with a remote camera.

Finally, the Alternative Plan submitted by Applicant is deficient because not all other welds embedded in concrete will be inspected by the remote camera, and the weld quality cannot be demonstrated adequately by circumstantial evidence.

3. By letter of December 23, 1998, the Carolina Power & Light (CP&L or Applicant) requested an amendment to Facility Operating License NPF-63 for the Shearon Harris Nuclear Power Plant (HNP) to place spent fuel pools 'C' and 'D' in service. Specifically, HNP proposes to revise TS 5.6 "Fuel Storage" to increase the spent fuel storage capacity by adding rack modules to pools 'C' and 'D'. *See* Letter from James Scarola to the United States Nuclear Regulatory Commission, "Shearon Harris Nuclear Power Plant, Docket No. 50-400/License No. NPF-63, Request for License Amendment, Spent Fuel Storage," December 23, 1998 (Amendment Request). (Davis Exhibit 1).[1]

4. As stated in the Amendment Request, CP&L originally planned the HNP as a four nuclear unit site (Harris 1, 2, 3, and 4). (Davis Exhibit 1, page 1). Four separate spent fuel pools (SFPs) were designed to be built in the Fuel Handling Building (FHB). SFPs 'A' and 'B' were intended to support Harris Units 1 and 4 and SFPs 'C' and 'D' to support Units 2 and 3. Harris Units 3 and 4 were canceled in late 1981 and Harris Unit 2 was canceled in late 1983. All four of the SFPs, including liners, and the 'A' and 'B' cooling and cleanup system were completed and turned over[2] as part of the construction and licensing of Harris Unit 1. The plant was designed and constructed to the requirements of Section III-Division 1, "Rules for Construction of Nuclear Power Plant

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[1] The license amendment request was submitted under oath pursuant to 10 CFR § 50.90.

[2] A plant is "turned over" when all of the inspections and testing required in Section III of the Code are completed. After the plant is turned over, it falls under the rules of Section XI of the Code, "Rules for Inservice Inspection of Nuclear Power Plant Components."

Components," of the 1974 American Society of Mechanical Engineers (ASME) Code (the Code) with the 1976 Addenda (Davis Exhibit 2). The construction of the 'C' and 'D' cooling and cleanup system was discontinued after Unit 2 was canceled. The 'C' and 'D' cooling and cleanup was approximately 80 % completed during original construction. (Davis Exhibit 1, page 4) Some other major system components, such as the SFP cooling heat exchangers and pumps, were installed before construction was discontinued. (Davis Exhibit 1, page 4).

5. HNP has been authorized to receive spent fuel from the Brunswick 1 and 2 and Robinson since the issuance of its operating license in 1987. (Davis Exhibit 1, page 1). The activation of SFPs 'C' and 'D' will provide storage capacity for all four CP&L nuclear units (HNP, Brunswick 1 and 2, and Robinson) through the end of their current licenses. The spent fuel pool cooling system for pools 'C' and 'D' is nuclear safety related with two fully redundant 100% capacity trains. (Davis Exhibit 1, page 5 of 6).

6. Technical Contention 3 states that "The Alternative Plan submitted by Applicant is also deficient because fifteen welds for which certain quality assurance records are missing are embedded in concrete and inspection of the welds to demonstrate weld quality cannot be adequately accomplished with a remote camera." The following paragraphs discuss this aspect of the Contention.

7. The ASME Code of Record for the HNP is the 1974 Edition with the 1976 Addenda. (Davis Exhibit 2). The HNP Final Safety Analysis Report (FSAR) commits CP&L to design, construct, and inspect the class 3 piping according to Section III, Subsection ND (Davis Exhibit 3, NUREG-1038, Safety Evaluation Report related to the operation of Shearon Harris Nuclear Power Plant, Units 1 and 2, November, 1983, pages 3-2 and 3-3 and SHNPP FSAR, Vol. 7, pages 3.2-1-1

and 3.2.1-19) and (Davis Exhibit 2). The method for inspecting the cooling and cleanup system piping, which is class 3 piping, is given in Paragraph ND-5212, which states, "Longitudinal weld joints in piping, pumps, and valves greater that 4 in. nominal pipe size shall be examined by either the magnetic particle, liquid penetrant, or radiographic methods. Acceptance standards shall be those stated in ND-5300," and Paragraph ND-5222, which states, "The requirements for circumferential weld joints shall be the same as given in ND-5212." (Davis Exhibit 2). The acceptance standards for liquid penetrant examinations are given in Paragraph ND-5352, which states:

> (a) Unless otherwise specified in this Subsection, the following relevant indications are unacceptable.
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> (1) Any cracks or linear indications;
> (2) Rounded indications with dimensions greater than 3/16 inch;
> (3) Four or more rounded indications in a line separated by 1/16 inch or less edge to edge;
> (4) Ten or more rounded indications in any 6 sq. in. of surface with the major dimension of this area not to exceed 6 in. with the area taken in the most unfavorable location relative to the indications being evaluated.
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> (b) Indications with major dimensions greater than 1/16 in. shall be considered relevant.

An indication is defined as the response or evidence from the application of a nondestructive examination. (Davis Exhibit 2)

8. All of the stainless steel piping, including the embedded piping, in the cooling and cleanup system for HNP fuel pools C and D is constructed using materials specified in Section II, Part A of the ASME Code, SA-358/SA-358M, "Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Alloy Steel Pipe for High-Temperature Service," (Davis Exhibit 4) using AISI Type 304 stainless steel that is 0.375 inch thick by 12 inches in nominal diameter (Davis Exhibit 1,

Enclosure 8, pages 5 and 6 of 13). CP&L examined the accessible welds using PT as discussed in Don Naujock's affidavit. CP&L proposed to inspect the embedded welds from the interior of the pipe since the exterior of the pipe is inaccessible. (Davis Exhibit 5, Letter from Donna B. Alexander to the United States Nuclear Regulatory Commission, "Shearon Harris Nuclear Power Plant, Docket No. 50-400/License No. NPF-63, Supplemental Information Regarding the License Amendment Request to Place HNP Spent Fuel Pools 'C' and 'D' in Service," October 15, 1999). While external surface examinations are customary, it is the utility's prerogative to do the examination internally. Paragraph ND-5212 does not specify whether the surface examination is external or internal. (Davis Exhibit 2, Paragraph ND-5212). CP&L also proposed that an enhanced visual inspection be used in place of the liquid penetrant examination for the internal inspections. (Davis Exhibit 5). Enhanced visual inspection is inspection using a high resolution video camera that has the capability of detecting a one mil diameter wire. The NRC staff has previously approved the use of an enhanced visual examination in place of a surface examination for reactor vessel internals. The method was approved by the staff in: NRC Letter to Carl Terry from Jack R. Strosnider, "Final Safety Evaluation of 'BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03) Revision 1, July 15, 1999 (Davis Exhibit 6), at the Brunswick Steam Plant, Units 1 and 2; NRC Letter to Mr. R. A. Anderson from David C. Trimble, "Examination of Feedwater Spargers and N4D Feedwater Nozzle, Brunswick Steam Electric Plant, Units 1 & 2, March 16, 1995.(Davis Exhibit 7); and for Prairie Island in an NRC Letter to Mr. Roger O. Anderson from Cynthia A. Carpenter, "Prairie Island Nuclear Generating Plant-Evaluation of Request for Approval of an Alternative to the ASME Code on Surface Examination and Weld Overlay of Canopy Seal Welds for Control Rod Drive Mechanism," January 22, 1999 (Davis Exhibit 7).

9. The recently retired Authorized Nuclear Inspector (ANI)[3] and the current ANI for HNP were interviewed during the November 15-19, 1999, onsite NRC staff inspection concerning their involvement with the remote visual inspection of the 15 embedded welds (NRC Inspection Report No. 50-400/99-12, December 28, 1999). Both observed a demonstration by CP&L of the equipment and reviewed the qualifications of the three remote visual examiners. They also observed a demonstration of the equipment on a mockup containing intentional flaws representative of those in ND-5352, "Acceptance Criteria" (Davis Exhibit 2). According to the ANIs, all three examiners were able to find and characterize the intentional flaws using the remote visual examination. The three examiners were certified by HNP and verified by the ANIs. Both ANIs signed off on the qualifications of the three examiners on June 30, 1999. I observed that the camera can be manipulated to look straight down at the pipe, to look along the pipe length, and to rotate 360° around the circumference of the pipe. The camera can pass a weld and look back at the weld. The camera has a self contained light source that can be made brighter and darker for optimum contrast. The camera can magnify from 1X to about 10X. Based on the above information, I conclude that the remote visual inspection used by HNP is capable of detecting flaws that are larger than the maximum allowable flaw sizes specified in ND-5352, (Davis Exhibit 1) and that the three examiners are qualified to conduct the remote visual inspections of the embedded welds. I also conclude that

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[3] An ANI is hired by a State or municipality, or an insurance company authorized to write, and actively writing, boiler and pressure vessel insurance in that jurisdiction. The ANI's basic responsibility is to provide an independent verification that the systems, structures, and components in a nuclear power plant are constructed and inspected in accordance with the appropriate codes and standards. One of the duties of the ANI is to take appropriate action to advise the Owner of the need to correct non-conforming activities reported by the ANI.

the remote visual inspections are an acceptable alternative to the code required surface inspections. As stated above, intentional flaws were detected using the remote visual inspections.

10. To assess both the original condition of the welds and the present condition of the welds and pipe surfaces of the embedded piping, I reviewed the following video tapes, supplied to the NRC staff by CP&L, of the enhanced visual examination of the embedded welds:

1) CP&L Tape 1 for welds 2-SF-143-FW-513 (FW-513), 2-SF-143-FW-514 (FW-514), and 2-SF-144-FW-517 (FW-517);

2) CP&L Tape 2 for welds 2-SF-1-FW-3 (FW-3), 2-SF-1-FW-4 (FW-4), 2-SF-159-FW-518 (FW-518), 2-SF-1-FW-2 (FW-2), 2-SF-1-FW-4 (FW-4), and 2-SF-159-FW-519 (FW-519);

3) The tape of welds 2-SF-8-FW-66 (FW-66), and 2-SF-8-FW-65 (FW-65);

4) Tape WR/JO 99-ADUP1 for welds 2-SF-143-FW-408 (FW-408), 2-SF-143-FW-515 (FW-515), and 2-SF-143-FW-516 FW-516); and,

5) The tape of weld 2-SF-143-FW-512 (FW-512).

The weld identification, my observations about the condition of the weld and surrounding area, and my opinion of what additional action is required follows:

Weld Identification	Comments	Appendix B Corrective Action Resolution
FW-513	I reviewed the video tape of this weld on November 15, 1999. The HNP qualified examiners examined this weld on September 14, 1999. The pipe surface and longitudinal weld were clearly visible. The surface of the pipe and the longitudinal seam weld were clean with no evidence of microbiologically influenced corrosion (MIC). The bottom of the pipe was covered with white crystals that may be boron crystals. I did not see any obvious weld defects or evidence of biofouling on the circumferential weld, heat affected zone (HAZ), or base metal.	None required.
FW-514	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on September 14, 1999. A small amount of water remained on the bottom of the pipe. There was no evidence of boric acid crystals in this video. No weld defects were identified on the circumferential weld. There was no evidence of deposits or biofouling on the circumferential weld, the HAZ, or the base metal.	None required.
FW-517	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on September 14, 1999. There was evidence of deposits on this weld in three locations that may have been caused by MIC. There were no obvious weld defects. There was no evidence of biofouling on the longitudinal weld or on the walls of the pipe. This weld was thereafter evaluated using HNP licensee's Appendix B Corrective Action Program.	The deposits were sampled and tested for bio-activity. None was observed. CP&L observed no pitting or pin holes under the deposits. (See discussion in following paragraphs)

Weld Identification	Comments	Appendix B Corrective Action Resolution
FW-3	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on September 14, 1999. There was no evidence of weld defects on the circumferential weld. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld.	None required.
FW-4	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on September 14, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld.	None required.
FW-518	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on September 14, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld. There were some small linear indications that may be incomplete fusion at the root of the weld. This weld was thereafter evaluated using HNP licensee's Appendix B Corrective Action Program.	Prior to pouring concrete, this weld passed a system system hydrostatic test at 150% of the design pressure of 150 psi with a 10 minute hold with no leakage. This indicates that the minimum wall thickness has been achieved. See discussion in following paragraphs)

Weld Identification	Comments	Appendix B Corrective Action Resolution
FW-2	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on September 14, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld.	None required.
FW-1	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on September 14, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld.	None required.
FW-519	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on September 14, 1999. A deposit that extended in both directions from the weld for some distance covered the circumferential weld and the bottom of the pipe. This made the circumferential weld difficult to examine. However, is accessible areas, there was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld.	None required.

Weld Identification	Comments	Appendix B Corrective Action Resolution
FW-65	I reviewed this video tape of this weld on November 15, 1999. The HNP examiners examined this weld on July 6, 1999. This weld was originally covered with a green slime making it difficult to inspect. The slime was removed by hydrolazing (cleaning with a high pressure spray). After removal of the slime, there was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld. There were some small linear indications which may be incomplete fusion. This weld was subsequently evaluated using HNP licensee's Appendix B Corrective Action Program.	Prior to pouring concrete, this weld passed a system system hydrostatic test at 150% of the design pressure of 150 psi with a 10 minute hold with no leakage. This indicates that the minimum wall thickness has been achieved. (See discussion in the following paragraphs)
FW-66	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on July 6, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld.	None required.
FW-408	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on July 6, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld. One small area of the weld had a concave root. There was some minor porosity in the root. There were some small, stained spots.	None required.

Weld Identification	Comments	Appendix B Corrective Action Resolution
FW-515	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on July 7, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld. There were two small stained areas on the circumferential weld. There was a crack like indication next to the longitudinal weld near where the longitudinal weld and the circumferential weld meet. There were some small linear indications that may have been incomplete fusion. This weld was subsequently evaluated using HNP licensee's Appendix B Corrective Action Program.	Prior to pouring concrete, this weld passed a system system hydrostatic test at 150% of the design pressure of 150 psi with a 10 minute hold with no leakage. This indicates that the minimum wall thickness has been achieved. The crack like indication was examined and dispositioned as follows. It appears that the indication was a manufacturing artifact. The ferrite number indicated that there was sufficient ferrite to avoid cracking. Furthermore, even if a crack were present, the critical flaw size before the crack would become unstable was calculated to be a 102 inch long and completely through wall crack. (Seen discussion in the following paragraphs)

Weld Identification	Comments	Appendix B Corrective Action Resolution
FW-516	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on July 7, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld. This weld was the poorest quality of any of the welds examined. There were many small pieces of the weld insert that were not melted. There was one fairly large piece of insert that still had the stencil, 308L, visible. This weld was subsequently evaluated using HNP licensee's Appendix B Corrective Action Program.	Prior to pouring concrete, this weld passed a system system hydrostatic test at 150% of the design pressure of 150 psi with a 10 minute hold with no leakage. This indicates that the minimum wall thickness has been achieved. (See discussion in following paragraphs)
FW-512	I reviewed the video tape of this weld on November 15, 1999. The HNP examiners examined this weld on July 8, 1999. There was no evidence of biofouling or degradation of the circumferential weld, HAZ, or base metal. There was no evidence of biofouling or degradation of the longitudinal weld.	None required.

11. CP&L had the results of the enhanced video inspections of the embedded welds reviewed by Structural Integrity Associates (SIA) as an independent reviewer. CP&L also requested that SIA determine the suitability for service of the embedded welds. I received a copy of the SIA report on December 9, 1999 (Davis Exhibit 12). As part of it's evaluation (at page 5-2), the SIA reviewed the adequacy of the piping as designed. The report states that Ebasco Services performed the calculation for minimum wall thickness for the nominal operating pressure of 25 psi. SIA verified these

calculations. For the 12 inch pipe with an 80% joint efficiency,[4] the minimum wall thickness for the nominal operating pressure of 25 psi is 0.011 inches. The nominal thickness of the pipes is 0.375 inches which is over 30 times the required minimum thickness for the nominal operating pressure. This piping has a design pressure of 150 psi. Subparagraph ND-6221 states (Davis Exhibit 2) that this piping shall be subjected to a system hydrostatic test of 150% of the design pressure. Ebasco Services calculated that the minimum wall thickness required to pass the system hydrostatic test at 80% weld-joint efficiency, and 150% of design pressure, is 0.10 inches, which is less than the nominal thickness of the pipes (0.375 inches). SIA states (page 5-2) that this value is conservative since the presence of the concrete around the pipe reinforces the pipe. I reviewed the SIA data and analysis and agree the piping and welds are conservatively designed and are several times thicker than required in the code.

12. I reviewed the videotapes and concluded that the piping, longitudinal welds, and piping surfaces were in generally good condition. The video camera passed several shop welds during the inspection. The shop welds were not inspected in as much detail as the field welds. However, the video camera did not record any unusual protrusions, blockages, or abnormal indications as it passed these welds. There were some minor defects identified as noted in Paragraph 10 above that were analyzed using the licensee's corrective action program. Since the piping in question passed a 360° examination for leakage at a pressure in excess of 125% of the design pressure, I concluded that

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[4] The 80% joint efficiency accounts for the fact that the joints are examined using PT and the joints may contain minor defects. The weld-joint efficiency for a single butt weld is given in Table ND-3613.4-1 (Davis Exhibit 2, page 95).

there were no major defects present in the welds or piping. The system hydrostatic test procedure included a review of all weld data records and a sign-off that those records were complete. The system hydrostatic test procedure also required that all welded joints be visible for inspection, that the piping be pressurized to a minimum of 150% of the design pressure, held at that pressure for a minimum of ten minutes, and that the piping be examined for leakage during the system hydrostatic test at all joints and at all regions of stress while the piping was at pressure (Davis Exhibit 2, pages 222 to 224). The examination was witnessed by the independent authorized nuclear inspector (ANI). Copies of these hydrostatic test reports are included in the inspection report for the November 15-19, 1999 Inspection Report. The staff's position is that the system hydrostatic test results indicate that the piping has leak tight integrity and does not have any major structural defects. The minor defects observed would not make the piping unsafe for its intended function. The SIA report also states (page 5-2) that, in general, the piping and welds in the embedded piping were in good condition. The SIA report states that there were some areas where they observed linear indications (e.g., FW-65, FW-515, FW-517, FW-518) that may be related to incomplete fusion. The SIA report states that no areas were visible from the inside diameter that would suggest that the reduction in thickness approached the minimum thickness (Davis Exhibit 12, page 5-2). The SIA report concludes that since the piping in question passed a 360° examination for leakage at a pressure in excess of 150% of the design pressure, this verifies the initial quality and structural integrity of the welds. I agree with the SIA report's conclusion that the welds were inspected during construction because the piping passed the system hydrostatic test and the data records for the hydrostatic test indicates that all of the weld data records were complete.

[4] A consumable insert is a solid ring of material placed at the root of the weld. The ring is melted (consumed) during welding and becomes part of the weld.

13. I observed evidence around FW-516 where the consumable insert[5] was not completely consumed. However, FW-516 had complete fusion at the interface between the consumable insert and the pipe wall. Based on the discussion in paragraph 12 and my review of the videotapes, I concluded that welds containing these types of minor indications will be able to perform their intended function and that these welds will provide an acceptable level of quality and safety. The SIA report also states that there was evidence that in some weld areas, generally scattered around the circumference, where the consumable insert was not completely consumed (Davis Exhibit 12, page 5-3). The SIA report concluded that with the nature of the indications and the fact that these welds were subjected to the system hydrostatic test and passed, that the minimum wall thickness exists.

14. During my review of the videotape of FW-515, I observed a linear indication near the longitudinal seam shop weld in an adjacent pipe near FW-515. I noted that indication in the heat affected zone of the longitudinal weld had more of a crack-like appearance than shallow linear indications. I requested that CP&L provide further analysis of this weld. The SIA report states (page 5-3) that FW-515 contained apparently shallow linear indications in the weld and in the heat affected zone of the longitudinal seam of one of the adjacent pipes. The report states that the longitudinal seam had passed a visual examination and liquid penetrant examination as part of its inspection following shop fabrication. CP&L provided a copy of this report to the NRC staff (Davis Exhibit 16, page 4). The report also stated that there was no evidence of pitting or crevice corrosion in the shallow linear indications in either the longitudinal seam or in FW-515. CP&L reevaluated the apparent linear indication (Davis Exhibit 15, page 4) since it exceeds the acceptance criteria in ND-

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[5] A consumable insert is a solid ring of material placed at the root of the weld. The ring is melted (consumed) during welding and becomes part of the weld.

5352(1) of Section III of the ASME Code (Davis Exhibit 2). They concluded that the indication is a manufacturing artifact such as an inclusion. CP&L provided the QA records for this weld (Davis Exhibit 14, page 8) that show this weld was radiographed and no indications were noted and the pipe passed a hydrostatic test at 1324 psi. In addition, CP&L concluded there are no viable mechanisms for a linear indication to be created during lay-up. The temperature and the concentration of impurities are too low for intergranular stress corrosion cracking or transgranular stress corrosion cracking. Corrosion fatigue is not possible because this area is embedded in concrete and can not be subjected to cyclic loading. A crack could form in the weld if the Ferrite Number were too low. The Ferrite Number is an indication of the amount of delta ferrite in the weld. Subparagraph ND-2433.2 of Section III of the code states that the Ferrite Number should be a minimum of 5FN (Davis Exhibit 2). In this case, the ferrite number was high enough to preclude that a crack like indication could form as indicated in the CP&L Metallurgical Report (Davis Exhibit 15, page 9). Based on my review of CP&L's data and analysis, SIA's data and analysis, and my engineering experience, I concluded that there is no viable mechanism for a crack to develop at this location.

15. Code Case N-560 provides a listing of all possible degradation mechanisms and attributes that can occur in this piping (Davis Exhibit 17, pages 4-3 to 4-7). The only potentially viable operative corrosion mechanisms include transgranular stress corrosion cracking (TGSCC), intergranular stress corrosion cracking (IGSCC), localized corrosion, and microbiologically influenced corrosion (MIC). TGSCC occurs when a susceptible material comes into contact with a specific corrosive media. In areas that have high tensile stress, cracks develop that propagate across grains of the stainless steel (Mars G. Fontana and Norbert D. Greene, "Corrosion Engineering," McGraw-Hill Book Company. 1967, Library of Congress Catalog Card Number 67-

19901, Davis Exhibit 10, pages 91 to 109). IGSCC occurs when a susceptible material is exposed to a specific corrosive media. In areas that have high tensile stress, cracks develop and propagate between grains (Davis Exhibit 10). This mechanism requires that the material be sensitized by being heated in the temperature range of 950 to 1450 °F. During sensitization, chromium rich carbides form at the grain boundaries producing a chromium depleted zone next to the grain boundary. The cracks propagate along the chromium depleted zone. Sensitization is commonly caused by welding and occurs in the weld and heat affected zone. (This is discussed in detail in Davis Exhibit 10, pages 58 to 67.) Water sample tests conducted by CP&L indicate low concentrations of chlorides, fluorides, and sulfates and conductivity consistent with the specifications for spent fuel pool chemistry. Copies of the water sample tests are included in the November 15-19, 1999, inspection report. Samples were taken by CP&L to check for the presence of active MIC bacteria (Davis Exhibit 12). Sulfate reducing bacteria levels were between the lower detection limit of 1000 cells/ml and 100,000 cells/ml. No slime formers, iron bacteria, or heterotrophic aerobes were detected in any of the samples taken by the licensee. The SIA report states (page 5-5) that these results are in dramatic contrast to typical bacterial counts for raw waters, providing verification that the water is typical of controlled chemistry water. These results indicate that there is no viable mechanism for the degradation of this piping.

16. Based on my knowledge of corrosion mechanisms and my review of the CP&L data discussed above, I concluded that the only viable mechanism for corrosion of the 'C' and 'D' cooling and cleanup system piping is MIC. The lack of aggressive species and the low temperature of the water eliminate TGSCC or IGSCC as viable degradation mechanisms. The SIA report also presents a discussion on the viability of potential corrosion mechanisms occurring in the 'C' and 'D'

cooling and cleanup system piping (Davis Exhibit 12, pages 5-6 to 5-11). The SIA report also states that, due to the lack of aggressive species in the water and the low temperature of the water, the only likely mechanism of corrosion is MIC. This is in accordance with my conclusions. The SIA report states that while very low counts of microbial species associated with MIC were observed, water samples are not the best method for verifying that there is no biofilm on piping surfaces (Davis Exhibit 12, page 5-8). The report states that results of the water samples and the visual inspection provide a reliable indicator that MIC has not produced any accelerated corrosion in the piping. I agree that water samples have limited use. Visual inspection provides a more reliable indicator about the presence of MIC as stated in Davis Exhibit 11, page 4-54.

17. If MIC were present, it would be expected to occur at the weld or heat affected zone. Experience at the Watts Bar Nuclear Plant has shown that leakage caused by MIC is small, localized pin-hole type leaks at welds and heat affected zones in austenitic stainless steels and that such leakage would not compromise the functionality of the system (NRC Inspection Report Nos. 50-390/93-67 and 50-391/93-67). (Davis Exhibit 14). MIC attack has been observed at the Watts Bar Nuclear Plant on stainless steel butt welds in an essentially raw service water line (NRC Inspection Report Nos.: 50-390/93-09 and 50-391/93-09,Davis Exhibit 13)[6]. The morphology of MIC in stainless steel restricts MIC attack to sensitized portions of the materials such as welds and weld heat affected zones (Davis Exhibit 14, page 3). The SIA report reaches the same conclusion that if MIC were present, it would likely occur at welds or in the weld heat affected zone (Davis Exhibit 12, page 5.5). The SAI report also states that MIC on stainless steel produces small leaks that do not

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[6] Note, I was one of the inspectors for the Watts Bar inspections, Davis Exhibits 13 and 14.

compromise the structural integrity of the welds (Davis Exhibit 11, page 5.5). Based on statements in the SIA report, in the NRC Inspection Reports, and my knowledge of MIC, I conclude that, if MIC were present, it could result in small leaks that do not compromise the functionality of the system but, as discussed below, I found no evidence of MIC.[5]

18. During my inspection of FW-517, I noticed 3 deposits on the welds that had the appearance of sulfate-reducing bacteria nodules. The typical characteristics of sulfate-reducing bacteria nodules on stainless steel are a black deposit of iron sulfide, a rounded gouge or pit, and black FeS at the center, surrounded by a dark outer ring and a bluish inner ring with shiny metal beneath (Davis Exhibit 12, page 4-54). The SIA report states (page 5-9) that there were reddish-brown deposits and apparent entrance holes in the weld metal of FW-517 that could have been caused by MIC, or could come from another source. CP&L decided to take samples of the deposits for bio-activity analysis, and to remove the deposits to determine if any damage was apparent under the deposits. Sampling of the deposits is a more positive method of determining if MIC is present. The samples confirmed the absence of sulfate reducing bacteria or other types of MIC (Davis Exhibit 12). The licensee did not detect any bio-activity in the samples of deposits and concluded that the deposits were not associated with MIC (Davis Exhibit 16). I reviewed the report of MIC analysis of the samples. The results are consistent with the discussion in Davis Exhibit 16. I also reviewed the video tapes of the licensee removing the deposits and the reinspection of FW-517 after the removal of the deposits. I did not observe any damage under the deposits.

19. My experience at other nuclear plants (e.g., Watts Barr) indicates that if MIC is present in the HNP C and D piping, leaks would have been observed in the exposed piping during the period of lay-up (Davis Exhibits 13 and 14). The SIA report reaches the same conclusion, stating that SIA

does not believe that MIC has occurred on the welds, including embedded welds, because if MIC had occurred, there would have been leaks observed in the exposed piping (Davis Exhibit 11, page 5-10). All of the exposed welds have been examined, both visually and by liquid penetrant testing. These welds are exposed to the same water as the embedded welds. No leaks have been identified for any of these welds. The report states that it is likely that MIC induced leaks would have occurred during the 10 year period that the piping was exposed to water. I have reviewed the experience at other nuclear power plants and the absence of leaks in the exposed welds at CP&L and have concluded that MIC is not actively occurring as evidenced by the lack of leaks.

20. On pages 219 and 220 of David A. Lochbaum's Deposition dated October 14, 1999 (Davis Exhibit 18), he raised questions about corrosion of the piping as a result of some type of leakage into the concrete. As a general rule, stainless steel does not significantly corrode when in contact with concrete and water. If borated water were to leak out of the cooling and cleanup system piping, the boric acid would not cause the stainless steel to corrode. What has been shown to corrode significantly while embedded in concrete is rebar in the presence of high concentrations of sodium chloride in the concrete. The presence of chloride ions results in the loss of passivity on the rebar surfaces. Oxide films as a result of corrosion of the rebar cause the concrete to fracture and may result in spalling of the concrete. In general, this type of rebar corrosion is observed in northern climates on bridges and in parking garages as a result of heavy use of salt for deicing of roads, bridges, and parking garages. This type of corrosion is not applicable to spent fuel pools. There is a detailed discussion of corrosion of rebar in contact with Portland cement in Davis Exhibit 15, pages 5-13.

21. In summary, I conclude that remote, enhanced visual inspection can be used to detect flaws representative of those in the ASME Code, Section III, Paragraph ND-5352 (Davis Exhibit 2). I also conclude that the three examiners are qualified to conduct the remote visual inspections. I viewed the videotapes of the 15 embedded welds and identified 5 welds for further evaluation. These were evaluated using HNP's Appendix B Corrective Action Program. These welds were 2-FS-144-FW-515, -516, -517, -518, and 2-SF-8-FW-65. No areas were visible from the interior of the pipe that would suggest that the reduction in thickness approached the minimum thickness. The piping in question passed a 360° examination for leakage at a pressure in excess of 150% of the design pressure during initial construction, which verifies the welds were leak tight and that there were not areas where major degradation had occurred. I observed some areas where the consumable insert was not completely consumed. However, there was complete fusion at the edges of the consumable insert producing a leak tight seal. The SIA report stated that the minimum wall thickness exists based on the visual observations and the fact that these welds passed the system hydrostatic test. I agreed with this conclusion. I observed a linear indication in the heat affected zone near the longitudinal weld in the pipe adjacent to FW-515. CP&L was requested to conduct additional investigations concerning this weld to determine the disposition of this weld. The licensee provided information to demonstrate that this weld had been radiographed and hydrostatically tested following manufacture (Davis Exhibit 14). In addition, no viable mechanism exists to induce a crack during lay-up. CP&L concluded that the indication is a manufacturing defect such as an inclusion. Based on my review of the videotapes and my review of the original QA report for this weld, I agree with this conclusion. All possible degradation mechanisms for the spent fuel pool piping are listed in Code Case N-560 (Davis Exhibit 17). Due to the low temperature of the water and the low

concentration of aggressive species in the water, MIC is the only viable degradation mechanism for this piping. I identified deposits in FW-517 that could have been caused by MIC. CP&L took samples of these deposits and is conducting bio-activity tests on the deposits. There has been no indication of the presence of bio-activity in the deposits. I have concluded that there are no viable mechanism for degradation of the 'C' and 'D' cooling and cleanup system piping. Therefore, I conclude that a sufficient basis exists to state with reasonable assurance that the subject piping including welds were completed with an acceptable level of quality and safety in accordance with 10 CFR 50.55a(3)(i) and that no degradation of this piping including welds has occurred during the period of lay-up. Therefore, the 'C' and 'D' cooling and cleanup system piping is suitable for it's intended service.

22. The attached Exhibits are true and correct copies of the documents relied upon in this affidavit.

23. The foregoing statements made by me are true and correct to the best of my information, knowledge, and belief.

James A. Davis
Materials Engineer
Metallurgy and Nondestructive
Examination Section

Sworn and Subscribed before me

This 4 day of January, 2000

Notary Public

CIRCE E. MARTIN NOTARY PUBLIC MONTGOMERY CO., MD.

My commission expires March 1, 2003

Exhibits

1) Letter from James Scarola to the United States Nuclear Regulatory Commission dated December 23, 1998, "Shearon Harris Nuclear Power Plant, Docket No. 50-400/License No. NPF-63, Request for License Amendment, Spent Fuel Storage,"

2) Section III-Division 1, "Rules for Construction of Nuclear Power Plant Components," of the 1974 American Society of Mechanical Engineers (ASME) Code with the 1976 Addenda

3) NUREG-1038, Safety Evaluation Report related to the operation of Shearon Harris Nuclear Power Plant, Units 1 and 2, November, 1983, pages 3-2 and 3-3 and SHNPP FSAR, Vol. 7, pages 3.2-1-1 and 3.2.1-19

4) Section II, Part A of the ASME Code, SA-358/SA-358M, "Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Alloy Steel Pipe for High-Temperature Service,"

5) Letter from Donna B. Alexander to the United States Nuclear Regulatory Commission dated October 15, 1999, "Shearon Harris Nuclear Power Plant, Docket No. 50-400/License No. NPF-

63, Supplemental Information Regarding the License Amendment Request to Place HNP Spent Fuel Pools 'C' and 'D' in Service."

6) NRC Letter to Carl Terry from Jack R. Strosnider, "Final Safety Evaluation of 'BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines" (BWRVIP-03) Revision 1, July 15, 1999.

7) NRC Letter to Mr. R. A. Anderson from David C. Trimble, "Examination of Feedwater spargers and N4D Feedwater Nozzle, Brunswick Steam Electric Plant, Units 1 & 2, March 16, 1995.

8) NRC Letter to Mr. Roger O. Anderson from Cynthia A. Carpenter, "Prairie Island Nuclear Generating Plant-Evaluation of Request for Approval of an Alternative to the ASME Code on Surface Examination and Weld Overlay of Canopy Seal Welds for Control Rod Drive Mechanism," January 22, 1999.

9) NRC Inspection Report No. 50-400/99-12, December 28, 1999.

10) Mars G. Fontana and Norbert D. Greene, "Corrosion Engineering," McGraw-Hill Book Company. 1967, Library of Congress Catalog Card Number 67-19901.

11) "Microbially Influenced Corrosion and Biodeterioration," Editors, Nicholas J. Dowling, Marc W. Mittleman, and Joseph Danko, The University of Tennessee, Knoxville, Institute for Applied Microbiology, Center for Materials Processing, American Welding Society, Material Properties Council, and the National Association of Corrosion Engineers, October 7-12, 1990, ISBN: 0-9629856-0-0.

12) G. J. Licina, "Evaluation of Embedded Welds in Spent Fuel Piping at Harris Nuclear Plant," Structural Integrity Associates, Inc., San Jose, CA, Report No. SIR-99-127, December 1999.

13) NRC Inspection Report Nos.: 50-390/93-09 and 50-391/93-09, March 26, 1993.

14) NRC Inspection Report Nos.: 50-390/93-67 and 50-391/93-67, November 1, 1993.

15) "Corrosion Effect of Stray Currents and Techniques for Evaluation Corrosion of Rebars in Concrete," Victor Chaker, Editor, ASTM STP 906, 1985, Library of Congress Catalog Card Number 85-30618, pp5-13.

16) Carolina Power & Light Company, Material Services Section, Metallurgy Services, Technical Report, Project Nol 99-179, "Harris Nuclear Plant - Bacteria Detection in a Deposit Sample and Chemical Analysis of Reddish-Brown Material from the C&D Spent Fuel Pool Cooling Lines," December 16, 1999.

17) Case N-560. "Alternative Examination Requirements for Class 1, Category B-J Piping Welds, Section XI, Division 1, August 9, 1996.

18) Deposition of David A. Lochbaum at the offices of Shaw Pittman, October 14, 1999.

Davis Exhibit 1

CP&L

Carolina Power & Light Company
PO Box 165
New Hill NC 27562

James Scarola
Vice President
Harris Nuclear Plant

DEC 23 1998

SERIAL: HNP-98-188
10CFR50.90
10CFR50.59(c)
10CFR50.55(a)

United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

SHEARON HARRIS NUCLEAR POWER PLANT
DOCKET NO. 50-400/LICENSE NO. NPF-63
REQUEST FOR LICENSE AMENDMENT
SPENT FUEL STORAGE

Dear Sir or Madam:

In accordance with the Code of Federal Regulations, Title 10, Part 50.90, Carolina Power & Light Company (CP&L) requests a license amendment to place spent fuel pools 'C' and 'D' in service. Specifically, Harris Nuclear Plant (HNP) proposes to revise TS 5.6 "Fuel Storage" to increase the spent fuel storage capacity by adding rack modules to pools 'C' and 'D'. The enclosures to this letter support the proposed license amendment.

Enclosure 1 provides background information, a description of the proposed changes, and the basis for the changes.

Enclosure 2 details, in accordance with 10 CFR 50.91(a), the basis for the CP&L's determination that the proposed changes do not involve a significant hazards consideration.

Enclosure 3 provides an environmental evaluation which demonstrates that the proposed amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental assessment is required for approval of this amendment request.

Enclosure 4 provides page change instructions for incorporating the proposed revisions.

Enclosure 5 provides the proposed Technical Specification pages.

Enclosure 6 provides a report entitled "Licensing Report for Expanding Storage Capacity in Harris Spent Fuel Pools 'C' and 'D'" which contains supporting technical documentation. Please note that Enclosure 6 contains information which is considered proprietary pursuant to 10 CFR 2.790. In this regard, CP&L requests Enclosure 6 be withheld from public viewing.

Enclosure 7 is identical to Enclosure 6, except that the proprietary information has been removed and replaced by highlighting and/or a note of explanation at each location where the information has been omitted. CP&L provides this additional version for the purposes of public review.

Enclosure 8 provides a detailed description of the proposed alternatives to demonstrate compliance with ASME B&PV Code requirements for the cooling and cleanup system piping in accordance with 10 CFR 50.55a(a)(3)(i).

Enclosure 9 provides results of the thermal hydraulic analysis of the cooling water systems that support placing pools 'C' and 'D' in service. The analysis resulted in changes to previously reviewed and approved cooling water flow requirements. These changes have been identified as an unreviewed safety question and are being submitted for NRC review and approval pursuant to the requirements of 10 CFR 50.59(c) and 10 CFR 50.90.

CP&L requests the issuance date for this amendment be no later than December 31, 1999. This issuance date is necessary to support loading of spent fuel in pool 'C' starting in early 2000. CP&L also requests the proposed amendment be issued such that implementation will occur within 60 days of issuance to allow time for procedure revision and orderly incorporation into copies of the Technical Specifications.

Please refer any questions regarding this submittal to Mr. Steven Edwards at (919) 362-2498.

Sincerely,

James Scarola

RSE/KWS/kws

Enclosures:
1. Basis for Change Request
2. 10 CFR 50.92 Evaluation
3. Environmental Considerations
4. Page Change Instructions
5. Technical Specification Pages
6. Licensing Report for Expanding Storage Capacity in Harris Spent Fuel Pools 'C' and 'D' (proprietary version)
7. Licensing Report for Expanding Storage Capacity in Harris Spent Fuel Pools 'C' and 'D' (non-proprietary version)
8. 10 CFR 50.55a(a)(3) Alternative Plan
9. Unreviewed Safety Question Analysis

James Scarola, having been first duly sworn, did depose and say that the information contained herein is true and correct to the best of his information, knowledge and belief, and the sources of his information are employees, contractors, and agents of Carolina Power & Light Company.

Lisa M. Randall
Notary (Seal)

My commission expires: 6-7-2003

LISA M. RANDALL NOTARY PUBLIC WAKE COUNTY, N.C.

c: Mr. J. B. Brady, NRC Sr. Resident Inspector
Mr. S. C. Flanders, NRC Project Manager
Mr. Mel Fry, Director, N.C. DRP
Mr. L. A. Reyes, NRC Regional Administrator

bc:
Ms. D. B. Alexander
Mr. K. B. Altman
Mr. G. E. Attarian
Mr. H. K. Chernoff (RNP)
Mr. B. H. Clark
Mr. W. F. Conway
Mr. G. W. Davis
Mr. R. S. Edwards
Mr. R. J. Field
Mr. K. N. Harris
Ms. L. N. Hartz
Mr. W. J. Hindman
Mr. C. S. Hinnant
Mr. G. J. Kline
Ms. W. C. Langston (PE&RAS File)
Mr. R. D. Martin
Mr. J. W. McKay
Mr. P. M. Odom (RNP)
Mr. W. S. Orser
Mr. P. M. Sawyer (BNP)
Mr. J. M. Taylor
Nuclear Records
Licensing File
File: H-X-0512
File: H-X-0642

Enclosure 1 to Serial: HNP-98-188

SHEARON HARRIS NUCLEAR POWER PLANT
DOCKET NO. 50-400/LICENSE NO. NPF-63
REQUEST FOR LICENSE AMENDMENT
SPENT FUEL STORAGE

BASIS FOR CHANGE REQUEST

BASIS FOR CHANGE REQUEST

Background:

The Harris Plant was originally planned as a four nuclear unit site (Harris 1, 2, 3 and 4). In order to accommodate four units at Harris, the Fuel Handling Building (FHB) was designed and constructed with four separate pools capable of storing spent fuel. The two pools at the south end of the FHB, now known as Spent Fuel Pools (SFPs) 'A' and 'B', were to support Harris Units 1 and 4. The two pools at the north end of the FHB, now known as Spent Fuel Pools 'C' and 'D', were to support Harris Units 2 and 3. The multi-unit design included a spent fuel pool cooling and cleanup system to service SFPs 'A' and 'B' and a separate cooling and cleanup system to support SFPs 'C' and 'D'.

Harris Units 3 and 4 were canceled in late 1981. Harris Unit 2 was canceled in late 1983. The FHB, all four pools (including liners), and the cooling and cleanup system to support SFPs 'A' and 'B' were completed and turned over. However, construction on the spent fuel pool cooling and cleanup system for SFPs 'C' and 'D' was discontinued after Unit 2 was canceled and the system was not completed. Harris Unit 1 began operation in 1987 with SFPs 'A' and 'B' in service. The need to eventually activate SFPs 'C' and 'D' (depending on the availability of a permanent DOE spent fuel storage facility) was anticipated at the time the operating license for Harris Unit 1 was issued. The spent fuel storage capacity currently identified in Section 5.6.3 of the Harris Plant Technical Specifications (1832 PWR assemblies and 48 interchangeable (7 x 7 cell) PWR or (11 x 11 cell) BWR racks) assumes installation of racks in all four of the spent fuel pools.

Since the time that construction of the spent fuel pool cooling and cleanup system for SFPs 'C' and 'D' was halted, CP&L has implemented a spent fuel shipping program because DOE spent fuel storage facilities are not available and are not expected to be available for the foreseeable future. Spent fuel from Brunswick (2 BWR units) and Robinson (1 PWR unit) is shipped to Harris for storage in the Harris SFPs. Shipment of spent fuel to Harris is necessary in order to maintain full core offload capability at Brunswick and Robinson. As a result of the operation of the Harris Plant, shipping program requirements, and the unavailability of DOE storage, it will be necessary to activate SFPs 'C' and 'D' and the associated cooling and cleanup system by early in the year 2000. Activation of these two pools will provide storage capacity for all four CP&L nuclear units (Harris, Brunswick 1 and 2, and Robinson) through the end of their current licenses.

SFP 'A' now contains six Region 1 flux trap style (6 x 10 cell) PWR racks and three (11 x 11 cell) BWR racks for a total storage capacity of 723 assemblies. SFP 'A' has been, and will continue to be, used to store fresh (unburned) and recently discharged Harris fuel.

SFP 'B' now contains six (7 x 10 cell), five (6 x 10 cell), and one (6 x 8 cell) PWR Region 1 style racks. SFP 'B' also currently contains seventeen (11 x 11 cell) BWR racks. SFP 'B' is licensed to store one more (11 x 11 cell) BWR rack, which would increase the total pool storage capacity to 2946 assemblies. Harris is postponing installation of the last BWR rack and prefers to reserve the pool open area for fuel examination and repair. Therefore, the total installed capacity in SFP 'B' will temporarily remain as 768 PWR cells and 2,057 BWR cells for a total of 2,825 storage cell locations.

Proposed Changes:

The proposed changes will allow CP&L to increase the spent fuel storage capacity at the Harris plant by placing SFPs 'C' and 'D' in service. In order to activate the pools, CP&L requests that the NRC review and approve the following changes:

1. Revised Technical Specification 5.6 to identify PWR burnup restrictions, BWR enrichment limits, pool capacities, heat load limitations and nominal center-to-center distances between fuel assemblies in the racks to be installed in SFPs 'C' and 'D'.

   The use of the high density region 2 racks has been shown to be acceptable based on the analysis performed by Holtec International.

2. 10CFR50.55a Alternative Plan to demonstrate acceptable level of quality and safety in the completion of the component cooling water (CCW) and SFP 'C' and 'D' cooling and cleanup system piping.

   The cooling system for SFPs 'C' and 'D' cannot be N stamped in accordance with ASME Section III since some installation records are not available, a partial turnover was not performed when construction was halted following the cancellation of Unit 2 and CP&L's N certificate program was discontinued following completion of Unit 1. The Alternative Plan demonstrates that the originally installed equipment is acceptable for use and that the design and construction on the remaining portion of the cooling system piping (estimated at about 20%) maintains the same level of quality and safety through the use of the CP&L Appendix B QA program supplemented by additional QA requirements integrated into the plant modification package which completes the system

3. Unreviewed safety question for additional heat load on the component cooling water (CCW) system.

   The acceptability of the 1.0 MBtu/hr heat load from SFPs 'C' and 'D' was demonstrated by the use of thermal-hydraulic analyses of the CCW system under various operating scenarios. The dynamic modeling used in the thermal-hydraulic analyses identified a decrease in the minimum required CCW system flow rate to the RHR heat exchangers. This change has not been previously reviewed by the NRC and is deemed to constitute an unreviewed safety question.

Basis for Change

Installation of spent fuel storage racks in SFPs 'C' and 'D':

The FHB and SFPs 'C' and 'D' (including pool liners) were fully constructed and turned over as part of the construction and licensing of Harris Unit 1. However, the decision was made to not place SFPs 'C' and 'D' in service until needed (depending on the availability of DOE spent fuel storage). SFPs 'C' and 'D' are flooded but have not been previously used for spent fuel storage. CP&L proposes to expand the storage capacity at Harris by installing Region 2 (non-flux trap style) rack modules in Pools 'C' and 'D' in incremental phases (campaigns), on an as needed basis. SFP 'C' will provide the initial storage expansion for both PWR and BWR fuel. In its fully implemented storage configuration, SFP 'C' can accommodate 927 PWR and 2763 BWR assemblies. Expansion of storage capacity by installing racks in SFP 'D' will occur once SFP 'C' is substantially filled. SFP 'D' will contain only PWR fuel and can accommodate 1025 maximum density storage cells.

Following this proposed change, Spent Fuel Pool capacities will be as follows:

Pool	PWR spaces	BWR spaces	Total
'A'	360	363	723
'B'	768	2178	2946
'C'	927	2763	3690
'D'	1025	0	1025
Total	3080	5304	8384

Racks in SFP 'C' and 'D' will be installed in the following phases:

SFP 'C' - 1st Campaign - install by early 2000
4 PWR racks → 360 PWR spaces
10 BWR racks → 1320 BWR spaces

SFP 'C' - 2nd Campaign - install approximately 2005
4 PWR racks → 324 PWR spaces
6 BWR racks → 936 BWR spaces

SFP 'C' - 3rd Campaign - install approximately 2014
3 PWR racks → 243 PWR spaces
3 BWR racks → 507 BWR spaces

SFP 'D' - 1st Campaign - install approximately 2016
6 PWR racks → 500 PWR spaces

SFP 'D' - 2nd Campaign - installation date to be determined
6 PWR racks → 525 PWR spaces

(Note: The projected rack installation dates listed above are based on the current spent fuel shipping schedule. These dates may change as the shipping schedule is revised).

This configuration represents the mixture of PWR and BWR storage which will accommodate future storage requirements based on currently identified needs. Within SFP 'C', eighteen (18) of the racks are sized to allow interchangeability between BWR and PWR storage if required in the future. The dimensions of the (9 x 9 cell) PWR rack and the (13 x 13 cell) BWR rack are virtually identical. Therefore, rack configurations other than those identified above are possible.

Enclosure 6 of this license amendment request provides a report developed in conjunction with Holtec International which describes the evaluations performed to show the acceptability of the proposed change to install the racks in pools 'C' and 'D'. (Enclosure 7 is a non-proprietary version of enclosure 6). The report includes listings of the applicable regulations, codes and standards, descriptions of the evaluation methodology, acceptance criteria, and evaluation results. The licensing report also includes discussions on the need for the proposed change and considerations of other alternatives. Technical Specification Section 5.6, Fuel Storage, will be revised to identify PWR burnup restrictions, BWR enrichment limits, pool capacities, heat load limitations and nominal center-to-center distances between fuel assemblies in the racks to be installed in SFPs 'C' and 'D' (See Enclosure 5).

Completion of Cooling and Cleanup System for SFPs 'C' and 'D':

In order to activate Spent Fuel Pools 'C' and 'D', it is necessary to complete construction of the cooling and cleanup system for these pools and to install tie-ins to the existing Harris Unit 1 component cooling water system to provide heat removal capabilities. Approximately 80% of the SFP cooling and cleanup system piping and the majority of the CCW piping was installed during the original plant construction. In addition, other major system components such as the SFP cooling heat exchangers and pumps were also installed before original construction was discontinued. The cooling and cleanup system for pools 'C' and 'D' will be completed such that system design and operation is consistent with the design and operation of the cooling and cleanup system for pools 'A' and 'B'. The spent fuel pool cooling system for pools 'C' and 'D' is nuclear safety related with two fully redundant 100% capacity trains.

At the time that construction on the SFP cooling system was discontinued following cancellation of Harris Unit 2, a formal turnover of the partial system was not performed and CP&L has since discontinued its N certificate program. Also, some of the field installation records for the completed piping are no longer available. As a result, the system when completed will not satisfy ASME Section III code requirements (i.e. will not be N stamped). Therefore, an Alternative Plan in accordance with 10CFR50.55a(a)(3) is provided as Enclosure 8 to demonstrate that the completed system will provide an acceptable level of quality and safety. The majority of the ASME Section III piping was already installed when original construction was discontinued. As identified in the Alternative Plan, that piping to the extent that it was completed, was designed, constructed and inspected to Section III requirements. The remainder of the system will also be designed, constructed, inspected and tested to Section III requirements to the extent practical considering CP&L no longer has an N certificate program. Work will be performed in accordance with CP&L's 10CFR50 Appendix B QA program with any differences between Section III requirements and Appendix B requirements conservatively dispositioned. Supplemental QA requirements will be integrated into the modification package(s) as appropriate.

Calculations have been performed to verify that the existing CCW system is adequate to provide heat removal for near-term pool operation. The Spent Fuel Pool 'C' and 'D' heat loads will be limited to 1.0 MBtu/hr for near-term operation. Technical Specification section 5.6.3 will be revised to identify this heat load limit (Enclosure 5). This heat load limit is being established since additional CCW heat loads resulting from the power uprate project (potential to increase post-accident containment temperature resulting in an increased containment sump temperatures and increased load on RHR during long term recirculation phase) are not quantified at this time. Therefore, it has been determined that the most prudent action is to establish limiting heat loads based on current system loads. Additional heat load analysis will be performed concurrent with the power uprate project to establish the maximum heat loads on the CCW system that will exist at the end of plant licensed life when all spent fuel pools are expected to be full. Any CCW modifications necessary to increase system heat removal capability will be identified and implemented at that time. As part of the licensing required to support the power uprate project (currently planned for implementation concurrent with the steam generator replacement in late 2001), the technical specification heat load limit will either be revised or removed completely.

The plant design change package and supporting analyses for the CCW tie-in demonstrated that adequate capacity exists on the CCW system to add the 1.0 MBtu/hr for the near-term operation of SFPs 'C' and 'D'. The thermal-hydraulic analysis performed in support of this plant design change package modeled the dynamic RHR heat exchanger performance based on fluid property changes. Previous analyses evaluated RHR heat exchanger performance at a fixed data sheet value. This results in a reduction in the required CCW flow to the RHR heat exchanger. While technically valid, the lower required flow rate has not been previously reviewed by the NRC and, therefore, is deemed to constitute an unreviewed safety question. Included in Enclosure 9 are the results of the 10CFR50.59 evaluation for the unreviewed safety question identified by the tie-in to Unit 1 CCW.

Conclusion:

CP&L has concluded that placing SFPs 'C' and 'D' in service at this time to provide spent fuel storage is the safe and prudent alternative for increasing spent fuel storage capacity in the nuclear generating system. This option has been shown to be safe and in conformance with the appropriate regulations, codes and standards. Expansion of storage capacity by using Pools 'C' and 'D' will support continued operation of the Harris, Brunswick and Robinson facilities until the end of their current operating licenses.

Enclosure 8 to Serial: HNP-98-188

SHEARON HARRIS NUCLEAR POWER PLANT
DOCKET NO. 50-400/LICENSE NO. NPF-63
REQUEST FOR LICENSE AMENDMENT
SPENT FUEL STORAGE

10CFR50.55a ALTERNATIVE PLAN

10CFR50.55a ALTERNATIVE PLAN

I. Introduction

Regulatory Background

10CFR50.55a (Codes and Standards) requires that nuclear power facilities be subject to the licensing condition that (1) structures, systems and components are designed, fabricated, erected, constructed and inspected to quality standards commensurate with the importance of the safety function to be performed, and (2) that certain systems and components of nuclear power reactors must meet the requirements of the ASME Boiler and Pressure Vessel Code. 10CFR50.55a(a)(3) allows alternatives to these requirements with the permission of the Office of Nuclear Reactor Regulation if it can be demonstrated that the proposed alternative would provide an acceptable level of quality and safety, or if compliance with the requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The following is an outline of a "10CFR50.55a Alternative Plan" for licensing plant systems originally intended for use in cooling and storage of Harris Units 2 and 3 spent fuel. This portion of the plant was only partially completed under the Harris Plant construction program at the time that Unit 1 was completed and was never turned over as a part of the licensed and operating facility. The completion of this spent fuel storage capacity is now needed for long term storage of spent fuel from the Harris, Brunswick and Robinson Nuclear Plants in support of continued operation of these CP&L facilities. However, continuing its construction on the basis of the original site construction program is not viable since (1) CP&L has discontinued its N certificate holder program, and (2) certain code required construction records associated with the field installation of this piping are no longer available. This 10CFR50.55a Alternative Plan is intended to provide the basis for construction requirements for the completion of this portion of the Harris Plant and to justify the acceptability of previously constructed equipment in light of missing documentation.

Construction History / Chronology

Carolina Power & Light filed an application with the Atomic Energy Commission in 1971 for licenses to construct and operate its proposed Shearon Harris Nuclear Power Plant Units 1, 2, 3 and 4, in Wake County, NC. After completion of preconstruction reviews and hearings, the AEC issued Construction Permit Nos. CPPR-158, CPPR-159, CPPR-160 and CPPR-161 on January, 1978. Construction proceeded on the four unit site until December 1981, when CP&L informed the NRC that Units 3 and 4 had been canceled, and requested that Units 1 and 2 be considered concurrently for operating licenses. NUREG-1038 was issued in November 1983 for Unit 1, and reflected ongoing construction and eventual completion of Unit 2. However, Unit 2 was canceled soon afterward in December 1983, leaving Unit 1 as the only Unit to be completed and licensed. The Unit 1 Full Power Operating License was issued in January 1987, with commercial operation beginning in May 1987.

The original design of the four unit Harris Nuclear Plant located Units 1 and 4 at the south end of the plant, and Units 2 and 3 on the north end. These four units were to share a common fuel handling building to serve the purposes of loading and offloading fuel, as well as storage of spent fuel. Two sets of fuel storage pools were located in the fuel handling building, each set containing a spent fuel pool and a new fuel pool. The spent fuel pools were intended to function primarily as spent fuel storage capacity, while the new fuel pools were provided for staging new fuel and offloading spent fuel from the reactor. In the initial design, Units 1 and 4 shared the south ('A' and 'B') fuel pools, while the north ('C' and 'D') fuel pools were intended to service Unit 2 and 3.

The Fuel Handling Building was a common feature to all units, and completion of the building itself was requisite for operation of the first unit placed into service. Logical progression of the Fuel Handling Building construction dictated that major pieces of equipment be installed early in the schedule. As a result, the full complement of Spent Fuel Pool Cooling pools, heat exchangers and pumps initially associated with four unit construction was installed. Many of the smaller pumps, filters, strainers and lesser pieces of equipment were installed as well. Fuel Handling Building construction also dictated that all of the piping to be embedded in concrete be installed at the logical interval as the building was erected. Since the pools were encased in concrete, the adjoining portions of piping providing cooling connections and auxiliaries were necessarily constructed, inspected and tested prior to the encasement concrete being poured.

Subsequent to the cancellation of Units 3 and 4, work on the 'C' and 'D' Spent Fuel Pools continued in support of the planned completion of Unit 2. By the time that Unit 2 was canceled, the majority of the mechanical piping and equipment associated with operation of the 'C' and 'D' end pools was already installed, including all of the embedded and most of the exposed portions of ASME Section III piping associated with these fuel pools' cooling system. Work on the remaining equipment associated with the 'C' and 'D' pools in the Fuel Handling Building was suspended when Unit 2 was canceled. Plant documents from that time describe plans to eventually complete the 'C' and 'D' spent fuel pools and place them into service.

Construction Records Issue

The completed portion of the Unit 2 Fuel Pool Cooling and Cleanup System (FPCCS) and supporting facilities were constructed to the same codes and standards and using the same procedures and personnel as was Unit 1, which was fully completed and licensed. Appropriate records documenting field activities were generated at the time of construction as required by the construction codes and plant procedures, and maintained in storage under the control of the construction Quality Assurance (QA) program pending system completion and turnover. When construction on Unit 2 was halted, these records were transferred to temporary storage facilities maintained by the Harris Nuclear Plant Document Control. They were not microfilmed since they were associated with systems which were not fully completed and accepted under the site's N Certificate Program, and later were inadvertently discarded during a document control records cleanup effort.

Notably, these discarded records include the piping isometric packages for field installation of the completed portion of Unit 2 Fuel Pool Cooling and Cleanup System and Component Cooling Water System (CCWS) piping within Code boundaries. As a result, Code required records are no longer available for approximately 40 of the nearly 200 large bore welds in the completed ASME Section III portions of the Unit 2 FPCCS and CCWS.

II. Alternative Plan for Missing Construction Records (Piping Pedigree Plan)

The plan for addressing the missing construction documentation associated with the portion of the piping initially installed during plant construction and intended for the 'C' and 'D' Spent Fuel Pools' cooling systems consists of four elements. These are: (1) scoping, (2) records retrieval and review, (3) examination and testing, and (4) reconciliation. The intent of this plan is to develop the body of evidence which supports the quality of the previously completed constructed piping. Consistent with 10CFR50.55a, any deficiencies identified will be evaluated to determine whether a acceptable level of quality and safety can be provided through alternate methods, or if not, whether attaining full compliance would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

(1) The scoping portion of the Piping Pedigree Plan defines the boundaries of piping within the plan, and basically consists of a review of the extent of existing construction vs. that required for completion of the system. The extent of previously completed construction is determined by conducting and documenting detailed field walkdowns. Identification markings such as spoolpiece numbers, welder identification numbers, heat numbers, etc. are recorded at this time for use later in the records review and retrieval phase. Accessibility (both external and internal) are assessed for planning the examination / testing phase.

(2) The records review and retrieval phase of the project is an investigation of construction era documents to compile the archived body of evidence which substantiates the quality of the Unit 2 Spent Fuel Cooling piping. Specific sources of this information are discussed as follows:

A) Procurement documents for piping spool pieces. Requirements to which these spool pieces were fabricated were delineated on Purchase Order NY 435035, which invoked piping spec CAR-SH-M-30. Vendor Data Packages were supplied to the requirements of the pipe spool vendor's NPT program, and include records of material certification, welding activities and Nondestructive Examination (NDE) and hydrotesting. These records were retained by the Harris Nuclear Plant Document Control Program and are available on microfilm.

B) Construction era documents which defined requirements associated with the procurement, storage, handling and installation of the piping. Work procedures fall into this category, and include those for welding, weld material control, piping installation, concrete placement, hydrotesting, etc. Development of the sequence of installation through controlling procedures establishes the activities related to quality (tests, inspections, reviews, etc.) which by procedure would have to be satisfactorily completed in order to meet specific documented construction milestones, such as concrete placement and hydrotest.

C) Review of records which are available through the Harris Nuclear Plant Document Control System relating to construction of the Spent Fuel Pools and related equipment. Record types which fall into this category include, hydrotest records, concrete placement tickets, records relating to pipe spool modifications, etc. In many cases records may be found which do not directly establish quality, but rather serve to demonstrate that the construction of this piping was subject to the same level of scrutiny as was comparable Unit 1 piping, for which the appropriate quality records do exist.

D) Review of construction era records which are not quality assurance records, but which do serve to substantiate the quality of construction. This category would include documents such as engineering files, or quality control inspector log books which note specific inspections or records review.

(3) An examination and test phase will recreate, to the extent possible, any inspections or records which would have originally been required by plant procedures and the construction code and for which documentation is no longer available. The primary focus of this phase will consist of inspection and NDE of field welds for which weld data records are not available. Accessible ASME Section III welds will be subject to 100% surface examination, and ANSI B31.1 welds will receive a visual examination. Where feasible, internal weld inspections will be performed to verify fitup and adequacy of shielding gas purge. Notably, this will include an internal remote camera inspection of a substantial portion of the embedded FPCCS piping. Alternate methods of attaining comparable assurance will be developed whenever code required inspections cannot be performed, or deficiency in code required records cannot be otherwise addressed. For example, since filler material traceability cannot be established by weld data records, examination and testing of weld filler material will be performed to verify the composition of filler material is consistent with weld requirements. Finally, system hydrotesting will be performed upon completion of the piping systems using ASME Section III hydrotest criteria.

(4) The reconciliation phase of the Piping Pedigree Plan is a review of the data collected in previous phases and assessment of the level to which original construction documentation requirements were met. This is accomplished by compiling the body of records retrieved from document control and those generated by the examination / testing effort, then reviewing this record set against code documentation requirements to determine the extent to which code requirements are met. For instances wherein deficiencies are identified, the body of evidence (alternate tests or inspections, construction procedures, etc) which substantiates the quality of the component would be evaluated to determine if comparable assurance of quality and safety exists.

Piping Pedigree Plan - Implementation

ASME Section III Piping:

The elements of the Piping Pedigree Plan as described above are essentially complete for the ASME Section III piping associated with the 'C' and 'D' pools' FPCCS.
The following is a summary of the results of this effort to date:

Scope Definition - The ASME Section III piping associated with the 'C' and 'D' SPF Cooling System has been walked down by CP&L engineering and Harris Nuclear Plant Quality Control personnel to compare the plant configuration with construction isometric drawings and ensure that all welds, both vendor and field constructed, have been identified. Pipe spool identification numbers and welder symbols were inspected and recorded for review and comparison against vendor data packages. The scope of the ASME Section III piping within the plan has been defined based on field walkdowns, a review of modification design and results of the records retrieval effort. Basically, the plan will cover the large bore ASME Section III piping in the FPCCS and CCWS, leaving the small bore pipe welds (vents, drains, etc.) to be cut out and redone as part of the modification effort. A total of 40 large bore piping field welds and 12 pipe hanger attachment welds are being addressed within this portion of the Alternative Plan scope. Of this total, 37 are FPCCS piping welds (15 of which are embedded in concrete) and 3 are CCWS piping welds. All 12 hanger attachment welds are in the FPCCS piping.

Vendor Data Package review - All of the 44 vendor data packages associated with the ASME Section III portions of the 'C' and 'D' FPCCS have been retrieved and reviewed to ensure that the requisite paperwork is in hand. These packages account for approximately 80% of the large bore piping welds in the previously constructed portions of this system . Of the nearly 200 existing large bore (12" and 16") ASME Section III FPCCS piping welds, approximately 160 are vendor welds for which all required records exist. As noted above, these vendor data packages also account for all but 12 of the hanger attachments welds existing in the FPCCS piping. Only 2 vendor data packages are associated with the portion of the previously installed Unit 2

CCW System which will be used in the design to tie in Unit 1 CCW to the 'C' and 'D' Spent Fuel Pool Cooling Heat Exchangers. These packages account for all but 3 of the existing large bore piping welds in this piping.

Review of other documentation - A review of other Construction Quality Control (QC) documentation in the document control system has identified that some construction information does exist for the piping in question. Notably, hydrotest records were located which show that all of the embedded piping was in fact subject to hydrotest. Completion of weldments within the hydrotest boundary and review of Weld Data Reports (WDRs) was a procedural prerequisite for conducting these hydrotests. Of these 15 embedded field welds, hydrotest records contain specific signoffs attesting to satisfactory review of completed WDRs for 9. An additional 4 embedded welds are specifically identified as being within the hydrotest boundary with a general signoff attesting to satisfactory review of weld records, while the remaining 2 can be shown to be within a hydrotest boundary with a signoff for review of welding documentation, although not specifically identified by name.

Additional information pertaining to the quality of the 15 embedded field welds can be found in QC reports (ie., nonconformance reports or deficiency disposition reports*) associated with construction of this piping. Notably, several of these records contain WDR and repair WDRs for embedded welds, providing information pertaining to welder id, filler material and / or NDE for those welds. Pipe Spool Modification packages were located on microfilm; these have been reviewed to determine if any field changes had been made to the pipe spools as supplied from the vendor. Construction era procedures and specifications have been reviewed to identify programmatic requirements pertinent to construction quality.

(* Note - These QC records address routine construction issues which were satisfactorily resolved, and do not have any adverse implications on overall construction quality. On the contrary, the existence of such records serves to strengthen the position that construction was subject to the appropriate level of QC scrutiny.)

Field inspections - Reinspection and NDE of the 37 piping field welds and 12 hanger attachment field welds within the ASME Section III SFP Cooling System portion of the plan scope has been completed. WDRs were generated to document the inspection results; these will be reviewed by both Harris Nuclear Plant Quality Control personnel and the site Authorized Nuclear Inspector (ANI). These inspections also located and recorded weld symbols from each field weld to verify which welds were performed by the pipe spool vendor and to identify the specific welder responsible for field welds. This information was reviewed against pipe spool modification records and vendor data packages to determine that the original vendor welds were intact (had not been replaced or altered by field work), and to ensure that all welds had been identified and their origin accounted for. A total of 4 externally accessible field welds were also subject to internal examination by engineering and welding craft supervisory personnel, with no anomalies being identified which might indicate substandard weld quality.

The internal examination of externally inaccessible field welds is an integral component of the Piping Pedigree Plan These inspections will be completed prior to post-modification acceptance testing. CP&L has contracted with a specialty vendor to provide remote camera inspections of a substantial portion of the embedded piping and field welds. An inspection procedure will be developed specifically for this activity and will include detailed inspection and acceptance criteria. Based on a feasibility walkdown with the vendor, it is anticipated that greater than one third of the embedded field welds will be subject to an internal inspection in this manner. These inspections will take place at the appropriate interval in the modification process, when pool levels are lowered and the welded piping blanks are removed. Any discrepancies will be appropriately dispositioned at that time, including any necessary supplemental submittals to this 10CFR50.55a Alternative Plan.

Filler Material Analysis - All of the accessible large bore FPCCS piping field welds were subject to examination and/or testing to ascertain the composition of filler material. Generally, this was done using a nondestructive x-ray diffraction "alloy analyzer". In addition, chip samples were taken from three welds at random to support the validity of the alloy analyzer results. The results of this effort support that filler material alloy used in these field welds is consistent with that required by site specifications and welding procedures. The carbon steel CCWS piping welds do not lend themselves to conclusive identification using an x-ray diffraction analyzer, so the three field welds in this piping will either be subject to chemical analysis of chip samples, or as an alternative, cut out and replaced.

B31.1 Piping:

The non-safety related piping and equipment providing skimmer, purification and other support functions for the 'C' and 'D' spent fuel pools was very nearly completed at the time of original construction. All of this piping which will be retained in the final design is considered in the scope of the piping pedigree plan. As with the ASME Section III piping, vendor records can be located for this piping, but not the construction records associated with field installation. Under B31.1 and plant welding procedures, this piping would have been subject to external visual inspection at the time of construction. Reinspections have been performed on a large number of these field welds, with none being rejected. A complete reinspection of this piping will be accomplished as part of the modification effort, and a full system hydrotest to original construction requirements will be completed as part of post-modification acceptance testing.

Piping Pedigree Plan Conclusion - an acceptable level of quality and safety

10CFR50.55a(a)(3) allows for the development of an alternative plan with the permission of the Office of Nuclear Reactor Regulation if it can be demonstrated that the proposed alternative would provide an acceptable level of quality and safety, or if compliance with the requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. In the case of unavailable Unit 2 construction records, a great deal of evidence can be compiled to demonstrate that this piping was indeed constructed to the quality requirements consistent with the construction codes. These are summarized as follows:

Design - CP&L held the N certificate over the ASME Section III portion of Harris Nuclear Plant Construction. A single N Certificate program was developed and implemented uniformly to ensure code compliance for the entire site. All materials were specified to a common program using the same procurement specifications. The same welder qualification program and weld procedures, weld engineering, NDE program, and QC program were common to the site.

Work and Document Control - The Harris Nuclear Plant was designed and constructed (to the extent that it was completed) under a single construction program. Common work control procedures, document control, warehousing and storage facilities were used throughout the site. Generally, the same pool of craft and supervisory personnel, QC personnel and engineering staff was available for construction of all four units.

Welder Qualification - Welder identification symbols have been identified at each of the externally accessible field welds, and can be traced to welders qualified to perform that weld. The chronology of precisely when a welder was qualified vs. when the weld was made is difficult to establish since the precise time the weld was performed cannot be determined, but the work control procedures ensure that the appropriate qualifications were established prior to performing weld, particularly with regard to welds within ASME Section III boundaries.

Obviously, welder identification symbols cannot be inspected and recorded for the 15 embedded welds, but again, the same program and procedures would have applied. Work procedures specifically directed the creation of WDR packages for all welds within code boundaries and required that the supervisor ensure that welders were appropriately qualified. Besides the craft supervisor, welder qualification would have been subject to scrutiny by QC and the ANI upon review of the weld records. Of the 15 embedded field welds, QC construction reports provide the identification of welders associated with at least 3 of these welds. No direct records of welder identification have yet been located for the remaining 12 embedded field welds, but hydrostatic test records have been located which attest to the existence of completed WDR packages for these welds at the time of construction. These records contain signatures individually attesting to satisfactory review of completed WDRs for 9 of the 15 embedded field welds, with an additional 4 welds being specifically identified as being within the test boundary with a general signoff attesting to satisfactory review of weld records. The remaining 2 embedded field welds were also shown to be within a hydrotest boundary, although not specifically identified by name.

Generally, the same pool of welders was available for work on Unit 2 as was for the completed Unit 1 at any point during construction. A programmatic lack of appropriate welder qualification would have represented a quality assurance breakdown in the welder qualification program for the site, not just for a given unit. Thus, the satisfactory completion and subsequent operation of Unit 1 using a common craft pool qualified under a single welder qualification program provides strong assurance that the Unit 2 welders were also appropriately qualified.

Filler Material Identification - The WDR package generated for each field weld contained the heat number of weld filler metal which provided the traceability for this material. Since the WDRs are typically the only historical source of this information, material certification cannot be directly established for field welds without these records. However, assurance that the filler material was procured to ASME Section III requirements and supplied with traceability records is provided in Site Specification SS-021 (Purchasing Welding Materials for Permanent Plant Construction). Per this procedure, austenetic stainless steel weld filler material procured for permanent plant welding (such as would have been used in the embedded FPCCS piping) was purchased to ASME Section III requirements, including those requirements associated with traceability and certification.

Issuance and control of weld filler material was strictly controlled through the site materials control program. This program and its implementing procedures were common to all Harris units under construction. The site materials control program was regularly subject to QC audit to ensure compliance with the site ASME Section III Program Manual.

An examination and testing program has been completed for the accessible large bore piping welds in the ASME Section III portion of the 'C' and 'D' pools' FPCCS, as well as 12 hanger welds on this piping. Each of these welds was tested either by use of a non-destructive alloy analyzer or by removing chip samples for chemical assay. In each case, the results supported that the filler material alloy was consistent with that required by site specifications and welding procedures. Such inspections cannot be performed for the inaccessible welds, but the quality of filler metal in these welds is supported by the existence of hydrotest records as discussed above, the existence of QC records for several of these welds which do provide certification and traceability information, the procurement requirements of Site Specification SS-021, as well as satisfactory test results from the 22 accessible welds. The 3 carbon steel CCW field welds in the Piping Pedigree Plan will also be subject to chemical analysis of chip samples to verify composition.

NDE - The WDR package generated for each field weld contained the record of code required inspections and non-destructive examination. The specification of required NDE was a line item on the WDR, and completion of these examinations was affirmed by signature on the WDRs and supported by NDE records included in the respective piping isometric package. Site work control procedures required that these examinations be performed and appropriately documented, and it is clear from interviewing plant personnel that these piping isometric packages were generated and did exist until recently discarded. Since the WDRs are again the only source of this information, the completion of original construction NDE cannot be directly established for the field welds in question.

To address the issue of NDE records, each of the accessible field welds identified as being in the Piping Pedigree Plan scope has been subjected to reinspection and NDE consistent with that which would have been originally performed and found to be acceptable. Obviously, this level of NDE cannot be reperformed on the field welds embedded in concrete, but the existence of hydrotest records attesting to review of completed WDR, QC records for several of these welds which do contain the appropriate NDE records, and the satisfactory NDE of accessible field welds with no rejections provides assurance that the NDE was satisfactorily completed for the embedded welds as well.

The internal camera inspection of a large percentage of embedded field welds will also be performed against inspection criteria developed to provide both subjective examination of weld quality and, to the extent feasible, objective compliance with code and procedural requirements. While an inspection of this nature is not a Code requirement, it is significant in that it will provide direct physical evidence of quality for the embedded field welds. These inspections will take place at the appropriate interval in the modification process, when pool levels are lowered and the welded piping caps are removed. Any discrepancies will be appropriately dispositioned at that time, including any necessary supplemental submittals to this 10CFR50.55a Alternative Plan.

In summary, the portion of the 'C' and 'D' FPCCS which were installed at the time of original plant construction were constructed under CP&L's N Certificate program, using sitewide programs and controls for quality assurance and a common pool of craft, quality control and engineering resources. There is no evidence to support that the level of quality in this portion of Harris plant construction is any less than that of Unit 1, and indeed, it would be difficult to conceive of an unacceptable deficiency which might exist in the partially completed Spent Fuel Cooling facilities without implicating the possibility of its existence in Unit 1 as well. That Unit 1 was completed, licensed and has been in commercial operation for approximately 12 years without cause to suspect construction quality provides strong assurance of that the quality assurance programs for the site were suitably comprehensive and fully implemented. It follows that a comparable level of quality exists in the partially completed Unit 2 facilities, including those for spent fuel storage.

Beyond programmatic assurances, a large body of evidence has been compiled which directly attest to quality of construction. Vendor data packages, hydrostatic test records, QC records and other construction era documentation has been retrieved which constitute substantial proof of compliance with site programs and procedures. An examination effort has been completed in which code required external NDE of accessible welds has been reperformed with no rejectable indications, and material examinations provide proof that the filler metal used in field welds was appropriate for the weldment. These results provide direct evidence of the quality of accessible field welds, and by extension, the smaller group of welds which are embedded. Internal examination of a significant percentage of these embedded field welds provides an additional measure of quality assurance beyond that required by the Code.

There is no evidence that supports that the missing records were never generated, and to the contrary, document control records indexes indicate that these piping isometric packages were transferred to QA storage and maintained there until they were inadvertently discarded in a document control "cleanup effort". Adverse Condition Report 93-354 was generated at that time which specifically identifies that installation documentation for the 'C' and 'D' FPCCS, including installation verification data and field weld records, was inadvertently discarded during Sept. 1993.

It is concluded that the Piping Pedigree Plan outlined above provides ample evidence exists to support that the portion of the Harris plant associated with the 'C' and 'D' Spent Fuel Pools which was completed during the original site construction effort was indeed constructed to the appropriate level of quality and safety and in compliance with construction code requirements. It follows that the issue of missing code documentation is simply that, a documentation issue, and does not infer a physical lack of quality in the field.

III. Alternative Plan for Continuance of Design and Construction

The original construction of the Harris Nuclear Plant was subject to the full requirements of ASME Section III of the ASME Boiler and Pressure Vessel Code under the authorization of a single N Certificate program maintained by CP&L. This site ASME Section III QA program was discontinued shortly after completion and turnover of Unit 1, and a corporate QA program meeting 10CFR50 Appendix B requirements was implemented as required to address plant operation, including Section XI requirements regarding inspection, repair and replacement activities. Thus, the original construction program no longer exists and it is not possible to complete construction of the 'C' and

'D' FPCCS as a continuance of this program. Further, since a Code data report was not prepared by CP&L for this partially completed piping and equipment under its N certificate holder program at the time it was constructed, responsibility for its construction cannot be now assumed by another N certificate holder under a current program. It follows that it is not possible to N stamp the previously completed portion plant associated with the 'C' and 'D' Spent Fuel Pools. Given this, and considering that the majority of construction has been completed, it is the opinion of CP&L and code authorities within the Hartford Steam Boiler Inspection and Insurance Co. and Bechtel Power Corporation that there is no benefit with invoking an N certificate program to govern the completion of the relatively small outstanding portion of construction vs. using another suitable quality assurance program of comparable rigor.

Since this portion of the plant was never turned over at the time of construction, it is not considered part of the operating facility from the perspective of the ASME code and its completion could not be interpreted as a replacement activity as defined in Section XI. However, the site Section XI Repair and Replacement Program as implemented under the Corporate 10CFR50, Appendix B QA Program does contain many elements of quality control (ie., welder qualification, weld procedures, inspections, documentation, etc.) consistent with the original construction program. Therefore, CP&L proposes to complete the design of this portion of the plant to appropriate ASME Section III requirements, but utilize the Corporate 10CFR50, Appendix B QA Program and site procedures for those elements of quality assurance for which it is appropriate to provide. Generally, any conflicts between the ASME Section III requirements and that of the Corporate 10CFR50, Appendix B QA Program (and the corporate and site procedures which invoke it) would be conservatively dispositioned, such as the use of ASME Section III hydrotest requirements vs. those requirements found in Section XI.

A set of supplemental quality assurance requirements has also been developed to augment the Corporate 10CFR50, Appendix B QA Program in completion of the Code portions of the plant associated with the 'C' and 'D' Spent Fuel Pools. These requirements were obtained by a close review of the requirements in the approved ASME Section III Construction QA Program Manual as it existed at the time of completion of construction vs. those of the currently existing Corporate 10CFR50, Appendix B QA Program, and are specifically intended to identify and conservatively reconcile deficiencies in the corporate program with ASME Section III requirements. For instance, the supplemental requirements specify a level of ANI involvement commensurate with ASME Section III requirements, including review of work packages prior to field issuance, integration of ANI involvement into the work control process, and final review and approval of documentation subsequent to work completion. Other highlights of the supplemental quality assurance requirements include integration of comparable requirements for design specifications and a process for system documentation review and turnover similar to that of N Stamping. These supplemental quality assurance requirements will be implemented by integration into the modification package, or when necessary, by procedure revision.

Since the current Corporate 10CFR50, Appendix B QA Program is sufficient to govern ongoing operation of the Harris Plant (including Section XI repair and replacement activities), it follows that it is of sufficient rigor for the construction effort to complete and activate the portion of the plant associated with the 'C' and 'D' spent fuel pools. There are instances wherein the Corporate 10CFR50, Appendix B QA Program does not address specific ASME Section III quality assurance requirements, and a set of supplemental quality assurance requirements has been developed specifically for the purpose of addressing these items. This approach for continuance of construction is both technically acceptable and commercially viable, and will ensure the requisite level of quality and safety in the completed systems as discussed in 10CFR50.55a(a)(3)(i).

Davis Exhibit 2

ASME BOILER AND PRESSURE VESSEL CODE

An American National Standard

SECTION III—DIVISION 1

Rules for Construction of Nuclear Power Plant Components

SUBSECTION ND

Class 3 Components

1974 EDITION

July 1, 1974

ASME BOILER AND PRESSURE VESSEL COMMITTEE
SUBCOMMITTEE ON NUCLEAR POWER

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
UNITED ENGINEERING CENTER
345 EAST FORTY-SEVENTH STREET, NEW YORK, N.Y. 10017

1974 ASME BOILER AND PRESSURE VESSEL CODE

An American National Standard

Sections*

I	Power Boilers
	Material Specifications
II	. . . Part A – Ferrous
II	. . . Part B – Nonferrous
II	. . . Part C – Welding Rods, Electrodes, and Filler Metals
	Nuclear Power Plant Components, Division 1
III	. . . Subsection NA – General Requirements (Includes All Appendices)
III	. . . Subsection NB – Class 1 Components
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VIII	. . . Division 1
VIII	. . . Division 2 – Alternative Rules
IX	Welding and Brazing Qualifications
X	Fiberglass-Reinforced Plastic Pressure Vessels
XI	Rules for Inservice Inspection of Nuclear Power Plant Components

*Available in bound and loose-leaf versions. The bound version is necessary for ASME Certification.

Code Cases

The Boiler and Pressure Vessel Committee meets regularly to consider requests for interpretations of the Code and to consider rulings for conditions encountered requiring special provisions. Those which have been adopted are in the 1974 Case Book. Modifications will be sent automatically to the purchasers of the Case Book up to the publication of the 1977 Edition.

Addenda

Colored-sheet Addenda, which include additions and revisions to individual Sections of the Code, are published twice a year and will be sent automatically to purchasers of the applicable Sections up to the publication of the 1977 Code. Purchasers of the bound versions of the Sections will receive bound Addenda. Purchasers of the loose-leaf versions of the Sections will receive replacement pages approximately 3 months after the bound version is published.

Addenda Color Legend

Pink	Summer 1974	Blue	Winter 1975
Green	Winter 1974	Salmon	Summer 1976
Yellow	Summer 1975	Gray	Winter 1976

formed on a weld deposit of the material or combination of materials being certified. The removal of chemical analysis samples shall be from an undiluted weld deposit made in accordance with (c). As an alternate, the deposit shall be made in accordance with (d) for material that will be used for corrosion resistant overlay cladding. Where the welding procedure specification or the welding material specification specifies percentage composition limits for analysis, it shall state that the specified limits apply for filler metal and undiluted weld deposit analysis or for *in situ* cladding deposit analysis in conformance with the above required certification testing.

(c) The preparation of samples for chemical analysis of undiluted weld deposits shall comply with the method given in the applicable SFA specification. Where a weld deposit method is not provided by the SFA specification, the sample shall be removed from a weld pad, groove, or other test weld[1] made using the welding process that will be followed when the welding material or combination of welding materials being certified is consumed. The weld for A-No. 8 material to be used with the GMAW or EGW process shall be made using the shielding gas composition specified in the welding procedure specifications that will be followed when the material is consumed.

(d) The alternate method provided in (b) above for the preparation of samples for chemical analysis of welding material to be used for corrosion resistant overlay cladding shall require a test weld made in accordance with the essential variables of the welding procedure specification that will be followed when the welding material is consumed. The test weld shall be made in conformance with the requirements of Section IX, QW-214.1. The removal of chemical analysis samples shall conform with QW-214.3 for the minimum thickness for which the welding procedure specification is qualified.

ND-2432.2 Requirements for Chemical Analysis. The chemical elements to be determined, the composition requirements of the weld metal, and the recording of results of the chemical analysis shall be in accordance with (a), (b), and (c) below.

(a) A-No. 8 welding material (QW-442, Section IX) shall be analyzed for the elements listed in Table ND-2432.2-1 and any other elements specified in the Welding Material Specification referenced by the Welding Procedure Specification.

(b) The chemical composition of the weld metal for filler metal shall conform to the welding material specification for elements having specified percentage composition limits. Where the welding procedure specification contains a modification of the composition limits of SFA or other referenced welding material specifications, or provides limits for additional elements, these composition limits of the welding procedure specification shall apply for acceptability.

(c) The results of the chemical analysis shall be reported in accordance with NA-3767. Elements listed in Table ND-2432.2-1 but not specified in the welding material specification or welding procedure specification shall be reported for information only.

TABLE ND-2432.2-1
WELDING MATERIAL CHEMICAL ANALYSIS

Cr-Ni Stainless Materials	C, Cr, Mo, Ni, Mn, Si, Cb

ND-2433 Delta Ferrite W76

A determination of delta ferrite shall be performed on A-No. 8 weld material (QW-442, Section IX) backing filler metal (consumable inserts); bare electrode, rod, or wire filler metal; or weld metal, except that delta ferrite determinations are not required for SFA-5.4, Type 16-8-2, nor A-No. 8 weld filler metal to be used for weld metal cladding.

ND-2433.1 Method. Delta ferrite determinations of welding material, including consumable insert material, shall be made using a magnetic measuring instrument and weld deposits made in accordance with (b) below. Alternatively, the delta ferrite determinations for welding materials may be performed by the use of the chemical analysis of ND-2432 in conjunction with Fig. ND-2433.1-1.

(a) Calibration of magnetic instruments shall conform to AWS-A4.2-74.

(b) The weld deposit for magnetic delta ferrite determination shall be made in accordance with ND-2432.1(c).

(c) A minimum of six ferrite readings shall be taken on the surface of the weld deposit. The readings obtained shall be averaged to a single Ferrite Number.

ND-2433.2 Acceptance Standards. The minimum acceptable delta ferrite shall be 5FN (Ferrite Number). The results of the delta ferrite determination shall be included in the Certified Material Test Report of ND-2130 or ND-4120.

[1]The methods given in the Appendix of SFA 5.9, "Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes," shall be used to establish a welding and sampling method for the pad, groove, or other test weld to ensure that the weld deposit being sampled will be substantially free of base metal dilution.

ARTICLE ND-5000
EXAMINATION

ND-5100 GENERAL REQUIREMENTS FOR EXAMINATION

ND-5110 PROCEDURES, QUALIFICATIONS, AND EVALUATION

ND-5111 General Requirements

Nondestructive examination of components, except radiography of vessels and tanks, shall be in accordance with the examination procedures of Section V unless otherwise modified by the requirements of this Article. Radiography shall be in accordance with the procedures of Article 2 of Section V except that radiography of vessels and tanks shall be in accordance with the procedures of Appendix X. The extent of radiography shall meet the requirements of ND-3352 for the joint efficiency used in the design. Nondestructive examination requirements for tanks are given in ND-5280. The examination shall be performed by personnel who have been qualified as required in this Article. The results of the examinations shall be evaluated in accordance with the acceptance standards of this Article.

ND-5112 Nondestructive Examination Procedures

All nondestructive examinations performed under this Subsection shall be executed in accordance with detailed written procedures which have been proven by actual demonstration, to the satisfaction of the Inspector. The procedure shall comply with the appropriate Article of Section V or Appendix X as applicable for the particular examination method. Written procedures and records of demonstration of procedure capability and personnel qualification shall be made available to the Inspector on request. At least one copy of the procedure shall be readily available to all applicable nondestructive examination personnel for reference and use.

ND-5113 Postexamination Cleaning

Following any nondestructive examination in which examination materials are applied to the piece, the piece shall be thoroughly cleaned in accordance with applicable materials or procedure specifications.

ND-5120 TIME OF EXAMINATION OF WELDS

Acceptance examinations of welds shall be performed at the times stipulated in (a), (b), and (c) below during fabrication and installation, except as otherwise specified in ND-5200.

(a) Radiographic examination of all welds in vessels and tanks constructed of P-1 material may be performed prior to any required postweld heat treatment. For welds in other vessels and tanks and for welds in piping, pumps and valves greater than 6 in. thick, radiographic examination, when required, shall be performed after any intermediate or required final postweld heat treatment. Radiographic examination of welds in piping, pumps and valves 6 in. or less in thickness may be performed prior to any required postweld heat treatment.

(b) Magnetic particle or liquid penetrant examinations shall be performed after any required postweld heat treatment except that welds in P-Number 1 materials may be examined either before or after postweld heat treatment. Weld surfaces that are covered with weld metal cladding shall be examined before the weld metal cladding is applied. Weld surfaces which are not accessible after a postweld heat treatment shall be examined prior to the operation which caused this inaccessibility.

(c) All dissimilar metal weld joints such as in austenitic or high-nickel to ferritic material or using austenitic or high-nickel alloy filler metal to join ferritic materials which penetrate the vessel wall shall be examined after final postweld heat treatment.

ND-5200 EXAMINATION OF WELDS

ND-5210 CATEGORY A VESSEL WELD JOINTS IN VESSELS AND SIMILAR WELD JOINTS IN PIPE, PUMPS, AND VALVES

ND-5211 Vessels

ND-5211.1 General Requirements

(a) Category A weld joints (ND-3351.1) shall be fully radiographed when:

(1) The thickness exceeds the limits of ND-5211.2 or ND-5211.3.

(2) The welds are based on a joint efficiency permitted by ND-3352.1(a)

(3) The butt welds in nozzles or communicating chambers are attached to vessel sections or heads which are required to be fully radiographed by (1) or (2) above.

(b) Welds not required to be fully radiographed by (a) shall be examined by spot radiography except as permitted by (c). Spot radiography is required when a joint efficiency described in ND-3352.1(b) is used.

(c) No radiography is required when the vessel or part is designed for external pressure only or when the design complies with ND-3352.1(c).

ND-5211.2 Ferritic Materials. Complete radiography shall be performed at each butt welded joint at which the thinner of the plate or vessel wall thickness at the welded joint exceeds the thickness limit above which full radiography is required in Table ND-5211.2-1.

ND-5211.3 Nonferrous Materials

(a) Vessels or parts of vessels constructed of nonferrous materials shall be radiographed in accordance with the requirements of ND-3352.

TABLE ND-5211.2-1
THICKNESS ABOVE WHICH FULL RADIOGRAPHIC EXAMINATION OF BUTT WELDED JOINT IS MANDATORY

P-Number Classification of Material	Nominal Thickness Above Which Butt Welded Joints Shall Be Fully Radiographed, in.
1	1 $^1/_2$
3	$^3/_4$
4	$^5/_8$
5	0
7	$^5/_8$
11	$^5/_8$

(b) Welded butt joints in vessels constructed of materials covered by specifications SB-163 (Alloy 800 only), SB-333, SB-334, SB-335, SB-336, SB-407, SB-408, SB-409, SB-443, SB-444 and SB-446 shall be examined radiographically for their full length when the thinner of the plate or vessel wall thicknesses at the welded joint exceeds $^3/_8$ in.

(c) Vessels constructed of unalloyed titanium shall have all weld joints of Categories A and B fully radiographed.

(d) All welds, both groove and fillet, in components constructed with materials SB-333, SB-334, SB-335, and SB-336 shall be examined for the detection of cracks by the liquid penetrant method.

(e) All weld joints in vessels constructed of unalloyed titanium shall be examined by the liquid penetrant method.

(f) All weld joints in components or parts constructed with materials SB-163 (Alloy 800 only), SB-407, SB-408, SB-409, SB-443, SB-444, and SB-446 not required to be radiographed shall be examined by the liquid penetrant method.

ND-5212 Piping, Pumps, and Valves

Longitudinal weld joints in piping, pumps and valves greater than 4 in. nominal pipe size shall be examined by either the magnetic particle, liquid penetrant, or radiographic methods. Acceptance standards shall be those stated in ND-5300.

ND-5220 CATEGORY B VESSEL WELD JOINTS AND CIRCUMFERENTIAL WELD JOINTS IN PIPING, PUMPS, AND VALVES

ND-5221 Vessels

(a) Weld joint (ND-3351.2) shall be fully radiographed when:

(1) The thickness exceeds the limits of ND-5211.1(a)(1).

(2) The welds are based on a joint efficiency permitted by ND-3352.1(a) except as permitted in (b) below.

(3) Butt welds in nozzles or communicating chambers attached to vessel sections or heads that are required to be fully radiographed under (1) or (2) above, but not including Category B and similar butt welds in nozzles and communicating chambers that neither exceed 10 in. nominal pipe size nor 1$^1/_8$ in. wall thickness.

(b) Any Category B and similar type welds not required to be fully radiographed by thickness or

location as in (a) above shall as a minimum be partially radiographed. This shall consist of a radiographic examination at least 6 in. long of any section of the weld picked at random plus a similar examination of any intersection of the weld with all Category A and similar welds in either of the sections being connected. Acceptance standards for partially examined welds shall be as set forth in ND-5320 for full radiography.

(c) The welds not required to be fully radiographed by (a) or (b) above. shall be examined by spot radiography except as permitted by (d). Spot radiography is required when a joint efficiency described in ND-3352.1(b) is used.

(d) No radiography is required when a vessel or part is designed for external pressure only or when a design complies with ND-3352.1(c).

(e) The requirements of ND-5211.2 and ND-5211.3 shall be met.

ND-5222 Piping, Pumps, and Valves

The requirements for circumferential weld joints shall be the same as given in ND-5212.

ND-5230 CATEGORY C VESSEL WELD JOINTS AND SIMILAR WELD JOINTS IN PIPING, PUMPS, AND VALVES

ND-5231 Vessels

(a) Type 1 and Type 2 full penetration butt welds shall be fully radiographed when:

(1) The thickness exceeds the requirements of ND-5211.2 or ND-5211.3.

(2) Category C welds in nozzles or communicating chambers are attached to vessel sections or heads which are required to be fully radiographed because of thickness or design with the exception that butt welds in nozzles and communicating chambers that neither exceed 10 in. nominal pipe size nor 1⅛ in. wall thickness need not be radiographed.

(b) Any Category C butt weld not required to be fully radiographed by thickness or location using the joint efficiency of ND-3352.1(a) shall meet the requirements of ND-5221(b).

(c) The welds not required to be fully radiographed by (a) above shall be examined by spot radiography except as permitted by (d) below. Spot radiography is required when the butt welds are designed with a joint efficiency as described in ND-3352.1(b).

(d) No radiography is required when the vessel or part is designed for external pressure only, when the design complies with ND-3352.1(c) or when the joint is not a butt welded joint.

ND-5232 Piping, Pumps, and Valves

The requirements for weld joints similar to Category C shall be the same as given in ND-5212.

ND-5240 CATEGORY D VESSEL WELD JOINTS AND SIMILAR JOINTS IN PIPING, PUMPS, AND VALVES

ND-5241 Vessels

(a) Full penetration butt welds of Category D (ND-3351.4) shall be fully radiographed when:

(1) The vessel or part is designed with a joint efficiency as permitted by ND-3352.1(a).

(2) Butt welds in nozzles or communicating chambers attached to vessel sections or heads that are required to be fully radiographed.

(b) Butt welds not required to be fully radiographed by (a) above shall be examined by spot radiographed except as permitted by (c).

(c) No radiography is required for butt welded joints when the vessel or part is designed for external pressure only or when the design complies with ND-3352.1(c). Radiography is not required for non butt welded joints.

ND-5242 Piping, Pumps, and Valves

The requirements for weld joints similar to Category D weld joints shall be as given in ND-5212.

ND-5260 WELDED STAYED CONSTRUCTION

Welded staybolts need not be radiographed. When welded stays are used to stay jacketed vessels, the inside weld shall be visually examined before closing plates are attached.

ND-5270 SPECIAL WELDS

ND-5272 Weld Metal Cladding

Weld metal cladding shall be examined by the liquid penetrant method.

ND-5273 Hard Surfacing

Hard surfacing shall be examined by the liquid penetrant method in accordance with ND-2546 and the acceptance standards applicable to materials less than ⅝ in. thick shall apply. Penetrant examination is not required for hard surfacing on valves with inlet connections 4 in. nominal pipe size or less.

ND-5274 Tube To Tube Sheet Welds

Tube to tube sheet welds shall be examined by the liquid penetrant method.

ND-5275 Brazed Joints

Flux and flux residue shall be removed from all surfaces prior to examination. Joints shall be visually examined on all accessible surfaces to determine whether there has been adequate flow of brazing metal through the joint. Optical aids may be employed for indirect visual examination of joints which cannot be directly examined.

ND-5276 Stud Welds

Stud welds shall be visually examined.

ND-5277 Special Exceptions

When the joint detail does not permit radiographic examination of joints attaching penetration assemblies, which are fabricated as appurtenances, or the closing seam within an electrical penetration assembly which is not fabricated as an appurtenance, ultrasonic examination plus liquid penetrant or magnetic particle examination of the completed weld may be substituted for the radiographic examination. The absence of suitable radiographic equipment shall not be justification for such substitution. The substitution of ultrasonic examination can be made provided the examination is performed using a detailed written procedure which has been proven by actual demonstration to the satisfaction of the Inspector as capable of detecting and locating discontinuities described in this Subsection. The nondestructive examination shall be in accordance with Section V and meet the acceptance standards of ND-5300.

ND-5280 EXAMINATION OF WELDS IN STORAGE TANKS

ND-5281 Examination Procedures

Nondestructive examinations of welds in storage tanks shall be in accordance with the examination procedures of Appendix X for radiography and of Section V for other types of examination.

ND-5282 Atmospheric Storage Tanks

ND-5282.1 Sidewall Joints. Sidewall joints shall be examined in accordance with ND-5211 and ND-5221.

ND-5282.2 Roof Joints. Roof joints and roof to sidewall joints shall be visually examined.

ND-5282.3 Bottom Joints. Bottom joints shall be examined by the vacuum box method from the inside of the tank by applying soapsuds to the joints and pulling a partial vacuum of at least 3 psi by means of a vacuum box with transparent top.

ND-5282.4 Bottom to Sidewall Joints. Bottom to sidewall joints shall be examined by the vacuum box method from the inside of the tank by applying soapsuds to the joints and pulling a partial vacuum of at least 3 psi by means of a vacuum box with transparent top.

ND-5282.5 Nozzle to Tank Joints. Nozzle to tank joints shall be examined by either the magnetic particle or liquid penetrant method.

ND-5282.6 Joints in Nozzles. Joints in nozzles shall be examined by either the magnetic particle or the liquid penetrant method.

ND-5282.7 Other Joints. Joints not specifically covered by ND-5282 shall be examined in the same manner as similar weld joints in vessels as required by this subarticle.

ND-5283 Welds In 0-15 PSI Storage Tanks

ND-5283.1 Sidewall Joints. Sidewall joints shall be examined in accordance with ND-5211 and ND-5221.

ND-5283.2 Roof Joints. Roof joints and roof to sidewall joints shall be examined in accordance with ND-5211.

ND-5283.3 Bottom Joints. Bottom joints shall be examined by the vacuum box method from the inside of the tank and pulling a partial vacuum of at least 3 psi by means of a vacuum box with transparent top.

ND-5283.4 Bottom to Sidewall Joints. Bottom to sidewall joints shall be examined by the vacuum box method from the inside of the tank and pulling a partial vacuum of at least 3 psi by means of a vacuum box with transparent top.

ND-5283.5 Nozzle to Tank Joints. Nozzle to tank joints shall be examined by either the magnetic particle or the liquid penetrant method.

ND-5283.6 Joints in Nozzles. Joints in nozzles shall be examined by either the magnetic particle or the liquid penetrant method.

ND-5283.7 Other Joints. Joints not specifically covered by ND-5283 shall be examined in the same manner as similar weld joints in vessels as required by this subarticle.

ND-5300 ACCEPTANCE STANDARDS

ND-5310 GENERAL REQUIREMENTS

Unacceptable weld defects shall be removed or reduced to an acceptable limit and when required, the weld shall be repaired and reexamined in accordance with ND-4400. Acceptance standards for welds shall be as stated in this Subarticle while acceptance standards for base material adjacent to the welds shall be as stated in ND-2500.

ND-5320 RADIOGRAPHIC ACCEPTANCE STANDARDS

ND-5321 Evaluation of Indications (100% Radiography)

Welds that are shown by radiography to have any of the following types of discontinuities are unacceptable:

(a) Any type of crack or zone of incomplete fusion or penetration;

(b) Any other elongated indication which has a length greater than:

(1) ¼ in. for t up to ¾ in., inclusive;

(2) $\frac{1}{3}t$ for t from ¾ in. to 2¼ in., inclusive;

(3) ¾ in. for t over 2¼ in. where t is the thickness of the thinner portion of the weld;

(c) Any group of indications in line that have an aggregate length greater than t in a length of $12t$ except where the distance between the successive indication exceeds $6L$ where L is the longest indication in the group;

(d) Porosity in excess of that shown as accepatable in Appendix VI.

ND-5322 Evaluation of Indications (Spot Radiography)

The acceptability of welds examined by spot radiography shall be determined by (a), (b), and (c).

(a) Welds in which the radiograph shows any type of crack or zone of incomplete fusion or penetration shall be unacceptable.

(b) Welds in which the radiographs show slag inclusions or cavities shall be unacceptable if the length of any such imperfection is greater than $\frac{2}{3}T$ where T is the thickness of the thinner plate welded. If several imperfections within the above limitations exist in line, the welds shall be judged acceptable if the sum of the longest dimensions of all such imperfections is not more than T in a length of $6T$ or proportionately for radiographs shorter than $6T$and if the longest imperfections considered are separated by at least $3L$ of acceptable weld metal, where L is the length of the longest imperfection. The maximum length of acceptable imperfections shall be ¾ in. Any such imperfections shorter than ¼ in. shall be accetable for any plate thickness.

(c) Porosity is not a factor in the acceptability of welds not required to be fully radiographed.

ND-5330 ULTRASONIC ACCEPTANCE STANDARDS

All indications which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity and location of all such reflectors and evaluate them in terms of the acceptance-rejection standards as follows:

(a) Discontinuities are unacceptable, if the amplitude exceeds the reference level and discontinuities have lengths which exceed:

(1) ¼ in. for t up to ¾ in., inclusive

(2) $\frac{1}{3}t$ for t from ¾ in. to 2¼ in., inclusive;

(3) ¾ in. for t over 2¼ in.

where t is the thickness of the weld being examined; if a weld joins two members having different thicknesses at the weld, t is the thinner of these two thicknesses;

(b) Where discontinuities are interpreted to be cracks or incomplete penetration, they are unacceptable regardless of discontinuity or signal amplitude.

ND-5340 MAGNETIC PARTICLE ACCEPTANCE STANDARDS

ND-5341 Evaluation of Indications

(a) Mechanical discontinuities at the surface will be indicated by the retention of the examination medium. All indications are not necessarily defects, however, since certain metallurgical discontinuities and magnetic permeability variations may produce similar indications which are not relevant to the detection of unacceptable discontinuities.

(b) Any indication which is believed to be nonrelevant shall be regarded as a defect and shall be reexamined to verify whether or not actual defects are present. Surface conditioning may precede the reexamination. Nonrelevant indications which would mask indications of defects are unacceptable.

(c) Relevant indications are those which result from unacceptable mechanical discontinuities. Linear indications are those indications in which the length is more than 3 times the width. Rounded indications are indications which are circular or elliptical with the length less than 3 times the width.

ND-5342 Acceptance Standards

Unless otherwise specified in this Section the following relevant indications are unacceptable:

(a) Any cracks and linear indications;

(b) Rounded indications with dimensions greater than $^3/_{16}$ in.;

(c) Four or more rounded indications in a line separated by $^1/_{16}$ in. or less edge to edge;

(d) Ten or more rounded indications in any 6 sq in. of surface with the major dimension of this area not to exceed 6 in. with the area taken in the most unfavorable location relative to the indications being evaluated.

ND-5350 LIQUID PENETRANT ACCEPTANCE STANDARDS

ND-5351 Evaluation of Indications

(a) Mechanical discontinuities at the surface will be indicated by bleeding out of the penetrant; however, localized surface imperfections such as may occur from machining marks or surface conditions may produce similar indications which are nonrelevant to the detection of unacceptable discontinuities.

(b) Any indication which is believed to be nonrelevant shall be regarded as a defect and shall be reexamined to verify whether or not actual defects are present. Surface conditioning may precede the reexamination. Nonrelevant indications and broad areas of pigmentation which would mask indications of defects are unacceptable.

(c) Relevant indications are those which result from mechanical discontinuities. Linear indications are those indications in which the length is more than 3 times the width. Rounded indications are indications which are circular or elliptical with the length less than 3 times the width.

ND-5352 Acceptance Standards

(a) Unless otherwise specified in this Subsection, the following relevant indications are unacceptable.

(1) Any cracks or linear indications;

(2) Rounded indications with dimensions greater than $^3/_{16}$ in.;

(3) Four or more rounded indications in a line separated by $^1/_{16}$ in. or less edge to edge;

(4) Ten or more rounded indications in any 6 sq in. of surface with the major dimension of this area not to exceed 6 in. with the area taken in the most unfavorable location relative to the indications being evaluated.

(b) Indications with major dimensions greater than $^1/_{16}$ in. shall be considered relevant.

ND-5360 VISUAL ACCEPTANCE STANDARDS FOR BRAZED JOINTS

Braze metal shall give evidence of having flowed uniformly through a joint by the appearance of an uninterrupted, narrow visible line of brazing alloy at the joint.

ND-5380 ACCEPTANCE STANDARD FOR SOAP BUBBLE TEST

Welded joints shall give no indication of leakage, while under pressure for a mininum of 5 minutes, by the formation of bubbles during a soap bubble or vacuum box test. Any indication of leaking, by the formation of bubbles or the breaking of the continuous soap film by large leaks, shall be evidence of an unacceptable condition.

ND-5500 QUALIFICATIONS OF NONDESTRUCTIVE EXAMINATION PERSONNEL

ND-5510 GENERAL REQUIREMENTS

It shall be the responsibility of the Manufacturer or Installer to assure that all personnel performing nondestructive examination operations under this Subsection are competent and knowledgeable of the applicable examination requirements to the degree specified in ND-5520. All nondestructive examinations required by this Subsection shall be performed and the results evaluated by qualified nondestructive examination personnel. The assignment of responsibilities to individual personnel will be at the discretion of the Manufacturer or Installer.

ND-5520 PERSONNEL QUALIFICATION

ND-5521 Qualification Procedure

(a) Personnel performing nondestructive examination shall be qualified in accordance with SNT-TC-1A,[1] Supplements and Appendices as applicable for the technique and methods used. For nondestructive examination methods not covered by SNT-TC-IA documents, personnel shall be qualified by the Manufacturer or Installer to comparable levels of competency by subjection to comparable examinations on the particular method involved; for example, leak testing. The practical portion of the qualification shall be performed using the Manufacturer's or Installer's procedure on part representative of the Manufacturer's or Installer's product.

(b) The emphasis shall be on the individual's ability to perform the nondestructive examination in accordance with the applicable procedure for the intended application.

(c) For nondestructive examination methods that consist of more than one operation or type, it is permissible to use personnel qualified to perform one or more operations. As an example, one person may be used who is qualified to conduct the examination and another may be used who is qualified to interpret and evaulate the examination results.

ND-5522 Verification By Inspector

The Inspector has the duty to verify the Manufacturer's or Installer's certification of an operator in accordance with SNT-TC-1A and has the prerogative to audit the program and require requalification of any operator when the Inspector has reason to question the performance of that operator.

ND-5530 RECORDS

Personnel qualification records shall be retained in accordance with NA-4900.

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[1]SNT-TC-1A and Supplements is a *Recommended Practice for Nondestructive Testing Personnel Qualification and Certification* published by the American Society for Nondestructive Testing, 914 Chicago Avenue, Evanston, Ill. 60202.

ND-5700 EXAMINATION REQUIREMENTS FOR EXPANSION JOINTS

ND-5720 BELLOWS EXPANSION JOINTS

The examinations stipulated in (a) through (f) below are required to verify the integrity of bellows expansion joints for installation in piping systems.

(a) The formed bellows shall be determined to be free of injurious defects such as notches, crevices, material buildup or upsetting, weld spatter, etc., which may serve as points of local stress concentration by visual examination. Suspect surface areas shall be further examined by liquid penetrant examination in accordance with Article 6 of Section V.

(b) The longitudinal seam weld in the bellows shall be examined by the liquid penetrant method in accordance with Article 6 of Section V. When the individual ply thickness excees 1/8 in., the weld shall also be radiographed in accordance with Article 2 of Section V. These examinations may be performed either before or after the bellows is formed.

(c) The circumferential attachment weld between the bellows and pipe or flange shall be liquid penetrant examined in accordance with Article 5 of Section V when the total bellows thickness is 1/4 in. or less. When the total thickness exceeds this limit, the weld shall be radiographed in accordance with Article 2 of Section V except where radiography is not meaningful, for example when the weld thickness constitutes less than 20% of the total thickness being radiographed, liquid penetrant examination may be substituted.

(d) In the case of liquid penetrant examination of bellows welds, unacceptable indications when there are four or more such indications and the separation between each is less than 1/16 in. Up to five randomly distributed porosity indications, each not exceeding the lesser of 1/2 the bellows thickness or 1/16 in. diameter, are permitted in any 6 in. length of weld.

(e) The examination of all other welds in the expansion joint shall comply with ND-5000.

(f) The variation of the cylindrical end thickness of the formed bellows from the nominal or specified thickness shall not exceed the values given in Table 2 of SA-480. Thinning of the bellows material during forming shall be considered in the design and selection of material thickness but need not be limited to the values specified in Table 2 of SA-480.

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ARTICLE ND-6000
TESTING

ND-6100 GENERAL REQUIREMENTS

ND-6110 TESTING OF COMPONENTS, APPURTENANCES, AND SYSTEMS

ND-6111 Components and Appurtenances

ND-6111.1 Hydrostatic Testing

(a) All components and appurtenances constructed or installed under the rules of this Subsection shall be hydrostatically tested, in the presence of the Inspector. Nuts, bolts, studs and gaskets are exempt from hydrostatic testing.

(b) The hydrostatic test of each line valve and pump with inlet connections over 4 in. nominal pipe size shall be witnessed by the authorized Inspector and a Data Report completed for each valve (NA-8400). The hydrostatic test pressure for valves designed to ND-3511 shall be in accordance with the requirements of ANSI B16.5 or MSS SP-66, respectively.

(c) A hydrostatic test of each line valve and pump with inlet piping connections of 4 in. nominal pipe size and less shall be performed by the Manufacturer and so noted on the Data Report Form (NA-8400). However, this hydrostatic test need not be witnessed by the Inspector. The Inspector's review of the Manufacturer's test records will be his authority to sign the report. This takes precedence over NA-5280.

(d) The requirements for testing atmospheric and 0-15 psi storage tanks designed to ND-3800 shall be those stipulated in ND-6500.

ND-6111.2 Pneumatic Testing. When a hydrostatic test is not practical (ND-6112), a pneumatic test in accordance with ND-6300 may be substituted.

ND-6112 When Pneumatic Testing May Be Used

(a) Pneumatic tests may be used in lieu of the hydrostatic test required by ND-6111.1 and ND-6113 except as permitted in (b) below only when the following conditions exist:

(1) When components, appurtenances or systems are so designed or supported that they cannot be safely filled with water;[1]

(2) When components, appurtenances or systems, which are not readily dried, are to be used in services where traces of the testing medium cannot be tolerated and, whenever possible, the parts of the components, appurtenances or systems have been previously hydrostatically tested to the pressure required in ND-6220.

(b) A pneumatic test at a pressure not to exceed 25 psi may be applied, preliminary to either a hydrostatic or a pneumatic test, as a means of locating major leaks. If used, the preliminary pneumatic test shall be carried out in accordance with the requirements of ND-6300.

ND-6112.1 Precautions To Be Employed in Pneumatic Testing. Compressed gas is hazardous when used as a testing medium. It is therefore recommended that special precautions for protection of personnel be taken when a gas under pressure is used as a test medium.

ND-6113 Testing of Systems

ND-6113.1 Hydrostatic Testing. Prior to initial operation, the installed system shall be hydrostatically tested except as permitted in ND-6113.2 in the presence of the Inspector. The test shall be conducted in accordance with the requirements of ND-6200.

ND-6113.2 Pneumatic Testing. When a hydrostatic test (ND-6112) is not practical, a pneumatic test, in accordance with ND-6300, may be substituted.

[1]These tests may be made with the item being tested partially filled with water, if desired.

ND-6114 Time of Hydrostatic Tests of Parts, Piping Subassemblies and Materials

(a) The component or appurtenance hydrostatic test when conducted in accordance with the requirements of ND-6221(a) shall be acceptable as a test for parts and piping subassemblies.

(b) The component or appurtenance hydrostatic test when conducted in accordance with the requirements of ND-6221 may be used in lieu of any such test required by the material specification for a part or material used in the component or appurtenance provided:

(1) Nondestructive examinations, if required by the material specification, can be performed subsequent to the component or appurtenance hydrostatic test;

(2) Repairs by welding, if required as a result of the hydrostatic test, can be performed in accordance with rules of ND-2500;

(3) Postweld heat treatment, when required after repairs, can be performed in accordance with the rules of ND-4620.

ND-6115 Time of Hydrostatic Tests of Components and Appurtenances

The hydrostatic tests of components and appurtenances required by ND-6111 shall be performed prior to initial operation of a system as specified in ND-6113. The Data Report Form shall not be completed nor signed by the Inspector and the components shall not be stamped until the component Manufacturer has conducted the hydrostatic pressure test. Appurtenances containing brazed joints and pumps and valves shall always be hydrostatically tested prior to installation in a system because of the required higher test pressure.

ND-6120 PREPARATION FOR TESTING

ND-6121 Exposure of Joints

All joints including welds shall be left uninsulated and exposed for examination during the test.

ND-6122 Addition of Temporary Supports

Components designed for vapor or gas may be provided with additional temporary supports, if necessary, to support the weight of the test liquid.

ND-6123 Restraint or Isolation of Expansion Joints

Expansion joints shall be provided with temporary restraint, if required for the additional pressure load under test or they shall be isolated from the test.

ND-6124 Isolation of Equipment Not Subjected To Pressure Test

Equipment that is not to be subject to the pressure test shall be either disconnected from the component or system or isolated by a blank flange or similar means. Valves may be used if the valve with its closure is suitable for the proposed test pressure.

ND-6125 Treatment of Flanged Joints Containing Blinds

Flanged joints at which blinds are inserted to blank off other equipment during the test need not be tested until the blinds are removed.

ND-6126 Precautions Against Test Medium Expansion

If a pressure test is to be maintained for a period of time and the test medium in the system is subject to thermal expansion, precautions shall be taken to avoid excessive pressure. A relief valve set to $1\frac{1}{3}$ times the test pressure is recommended during the pressure test.

ND-6200 HYDROSTATIC TESTS

ND-6210 HYDROSTATIC TESTING PROCEDURE

ND-6211 Provision of Air Vents at High Points

Vents shall be provided at all high points of the component or system in the position in which the test is to be conducted to purge air pockets while the component or system is filling.

ND-6212 Test Medium and Test Temperature

(a) Water shall be used for a hydrostatic test.

(b) It is recommended that the test be made at a temperature that will minimize the possibility of brittle fracture (ND-2330). The test pressure shall not be applied until the component, appurtenance or system and the pressurizing medium are approximately at the same temperature.

ND-6213 Check of Test Equipment Before Applying Pressure

The test equipment shall be examined before pressure is applied to ensure that it is tight and that all low-pressure filling lines and other appurtenances that should not be subjected to the test pressures have been disconnected or isolated by valves or other suitable means.

ND-6215 Examination For Leakage After Application of Pressure

Following the application of the hydrostatic test pressure for a minimum of 10 minutes (ND-6224), examination for leakage shall be made of all joints, connections and of all regions of high stress such as regions around openings and thickness-transition section. Except in the case of pumps and valves, which shall be examined while at test pressure, this examination shall be made at a pressure equal to the greater of the design pressure or three-fourths of the test pressure and it shall be witnessed by the Inspector. Leakage of temporary gaskets and seals, installed for the purpose of conducting the hydrostatic test and which will be replaced later, may be permitted unless the leakage exceeds the capacity to maintain system test pressure for the required amount of time. Other leaks, such as from permanent seals, seats and gasketed joints in components, may be permitted when specifically allowed by the Design Specifications. Leakage from temporary seals or leakage permitted by the Design Specifications shall be directed away from the surface of the component to avoid masking leaks from other joints.

ND-6220 HYDROSTATIC TEST PRESSURE REQUIREMENTS

ND-6221 Minimum Required System Hydrostatic Test Pressure

(a) Except as may be otherwise required by this Article (ND-6111.1) or the material specifications (see ND-6114), completed components and appurtenances shall be subjected to a hydrostatic test at a pressure not less than 1.5 times the system design pressure prior to installation in the nuclear power system. The system design pressure shall be established in accordance with the rules of ND-7411.

(b) All pressure retaining components of the completed nuclear power system that are within the boundary protected by the overpressure protection devices which satisfy the requirements of ND-7000 shall be subjected to a system hydrostatic test at a pressure not less than 1.5 times the system design pressure. The system design pressure for the protected boundary shall be established in accordance with the rules of ND-7411.

(c) The system hydrostatic test of ND-6221(b) may be substituted for a component hydrostatic test of ND-6221(a) provided:

(1) the component can be repaired by welding, if required as a result of the system hydrostatic test, in accordance with the rules of ND-2500;

(2) the component repair can be postweld heat treated (if required) and nondestructively examined in accordance with rules of ND-2500 and ND-5100 as applicable, subsequent to the system hydrostatic test, and

(3) the component is subjected to minimum required system hydrostatic test following the completion of repair and examination.

ND-6222 Maximum Permissible Hydrostatic Test Pressure

(a) If the minimum test pressure defined in ND-6221 is to be exceeded at any point in a component, appurtenance or system by more than 6%, the upper limit shall be established by the designer using an analysis which includes all loadings which may exist during the test.

(b) When hydrostatically testing a system, the test pressure shall not exceed the maximum test pressure of any component in the system.

ND-6224 Hydrostatic Test Pressure Holding Time

The hydrostatic test pressure shall be maintained for a minimum total time of 10 minutes and for such additional time as may be necessary to conduct the examination for leakage required by ND-6215. When testing pumps and valves, the pressure shall be maintained a minimum of 15 minutes for each inch of design minimum wall thickness but for not less than 10 minutes.

ND-6230 BELLOWS EXPANSION JOINTS

The hydrostatic test requirements for bellows expansion joints shall be as required in (a) through (c) below.

(a) The completed expansion joint shall be subject to a hydrostatic test in accordance with the applicable provisions of ND-6000 as supplemented by the Design Specifications.

(b) This test may be performed with the bellows fixed in the straight position, at its neutral length, when the design has been shown to comply with ND-3649.4(e)(1) or (e)(2). If the design is to comply with ND-3649.4(e)(3), this test shall be performed with the bellows fixed at the maximum design rotation angle or offset movement.

(c) In addition to inspecting the expansion joint for leaks and general structural integrity during the test, the Inspector shall also visually inspect the bellows for evidence of meridional yielding as defined in ND-3649.4(b) and for evidence of squirm as defined in ND-3649.4(c). If the design is to comply with ND-3649.4(e)(3), actual measurements shall be made before, during and after the pressure test in accordance with ND-3649.4(b) and (c).

ND-6300 PNEUMATIC TEST

ND-6310 PNEUMATIC TESTING PROCEDURES

ND-6311 General Requirements

When a pneumatic test is performed, it shall be conducted in accordance with the requirements of this Subarticle and ND-6112.

ND-6312 Test Medium and Test Temperature

(a) The gas used as the test medium shall be nonflammable.

(b) It is recommended that the test be made at a temperature that will minimize the possibility of brittle fracture (ND-2330). The test pressure shall not be applied until the component, appurtenance or system and the pressurizing medium are approximately the same temperature.

ND-6313 Check of Test Equipment Before Applying Pressure

The test equipment shall be examined before pressure is applied to ensure that it is tight and that all appurtenances that should not be subjected to the test pressure have been disconnected or isolated by valves or other suitable means.

ND-6314 Procedure For Applying Pressure

The pressure in the system shall gradually be increased to not more than one-half of the test pressure, after which the pressure shall be increased in steps of approximately one-tenth of the test pressure until the required test pressure has been reached.

ND-6315 Examination For Leakage After Application of Pressure

Following the application of pressure for the time specified in ND-6324, examination for leakage in accordance with ND-6215 shall be made.

ND-6320 PNEUMATIC TEST PRESSURE REQUIREMENTS

ND-6321 Minimum Required Pneumatic Test Pressure

(a) The pneumatic test pressure for components or appurtenances except storage tanks shall be not less than 1.2 times the system design pressure of the system in which the component or appurtenance is to be installed.

(b) The pneumatic test pressure of portions of the system as permitted by the rules of ND-6112 (such as components except tanks partially filled with water) shall be not less than 1.25 times the system design pressure as determined in ND-6221(b).

ND-6322 Maximum Permissible Pneumatic Test Pressure

If the minimum test pressure defined in ND-6321 is to be exceeded at any point in a component, appurtenance or system by more than 6%, the upper limit shall be established by the designer using an analysis which includes all loadings which may exist during the test.

ND-6324 Pneumatic Test Pressure Holding Time

The pneumatic test shall be maintained for a minimum total time of 10 minutes. The pressure shall then be reduced to a value equal to the greater of the design pressure or three-fourths of the test pressure and held for a sufficient time to permit examination of the system.

ND-6330 BELLOWS EXPANSION JOINTS

The pneumatic test for bellows expansion joints shall be as stipulated in ND-6230 for the hydrostatic test of bellows expansion joints except that the provisions of ND-6320 shall apply instead of those of ND-6220.

ND-6400 PRESSURE TEST GAGES

ND-6410 REQUIREMENTS FOR PRESSURE TEST GAGES

ND-6411 Types of Gages To Be Used and Their Location

Pressure test gages used in pressure testing shall be indicating pressure gages and shall be connected directly to the component. If the indicating gage is not readily visible to the operator controlling the pressure applied, an additional indicating gage shall be provided where it will be visible to the operator throughout the duration of the test. For systems with a large volumetric content, it is recommended that a recording gage be used in addition to the indicating gage.

ND-6412 Range of Indicating Pressure Gages

Indicating pressure gages used in testing shall preferably have dials graduated over a range of about double the intended maximum test pressure but in no case shall the range be less than 1½ nor more than four times that pressure.

ND-6413 Calibration of Pressure Gages

All gages shall be calibrated against a standard dead-weight tester or a calibrated master gage prior to each test or series of tests. Gages shall be recalibrated at least every 6 months.

ND-6500 ATMOSPHERIC AND 0-15 PSIG STORAGE TANKS

ND-6510 TESTING OF ATMOSPHERIC STORAGE TANKS

ND-6511 Testing of Reinforcement Pads

Following the examination specified in ND-5282.5 and before filling the tank with test water, the reinforcement pads shall be tested by applying up to 15 psi pneumatic pressure between the tank shell and the reinforcement plate, on each opening, using the telltale hole; and, while each such space is subject to such pressure soapsuds, linseed oil or other suitable material for detection of leaks shall be applied to all attachment welding around reinforcement, both inside and outside the tank.

ND-6512 Preparation For Testing

Preparation for testing of storage tanks shall conform to the requirements of ND-6120 as applicable.

ND-6513 Hydrostatic Testing of Tank Shell

Upon completion of the entire tank, and before any external piping has been connected to the tank, the shell shall be tested. For tanks with supported cone, self supported cone, self supported dome and self supported umbrella roofs the tank shall be filled with water and inspected frequently during the filling operation. The filling height shall be 2 in. above the top leg of the angle. For tanks with flat roofs the filling height shall be the liquid level for which the tank was designed or the bottom of any overflow which limits the filling height.

ND-6520 TESTING OF 0-15 PSIG STORAGE TANKS

ND-6521 Testing of Reinforcement Pads

Following the examination specified in ND-5283.5 and before performing the preliminary pneumatic testing the reinforcement pads shall be tested by using the same procedure as given in ND-6511.

ND-6522 Preparation For Testing

Preparation for testing of storage tanks shall conform to the requirements of ND-6120 as applicable.

ND-6523 Preliminary Pneumatic Testing

Prior to the application of the hydrostatic or combination hydrostatic-pneumatic test, the tank shall be filled with air to a pressure of 2 psi or one-half the pressure, P_G, for which the vapor space at the top of the tank is designed, whichever pressure is the smaller. Soapsuds shall be applied to all joints in the tank wall above the high liquid design level. If any leaks appear, the defects shall be removed and rewelded and the applicable preliminary tightness test shall be repeated. In the case of a tank whose bottom rests directly on the tank grade without having anchor bolts provided near the boundary of contact to hold it down, if the bottom at this boundary rises slightly off the foundation during the tightness test with air pressure in the tank, sand shall be tamped firmly under the bottom, while the tank is under pressure, to fill the gap so formed.

ND-6524 Combination Hydrostatic—Pneumatic Tests

The following requirements apply to tanks which have not been designed to be filled with liquid to a test level higher than their specified capacity level.

ND-6524.1 Pressurizing. After the preliminary tests specified in ND-6523 have been completed, the pressure-relief valve or valves shall be blanked off; and, with the top of the tank vented to atmosphere to prevent accumulation of pressure, the tank shall be filled with water to its high liquid level. The vents at the top of the tank shall then be closed and air shall be injected slowly into the top of the tank until the pressure in the vapor space is about one-half the pressure, P_G, for which this space is designed. Thereafter the test pressure shall be increased in steps of approximately 2 psi or one-fourth of the intended test pressure, whichever is the smaller, until the pressure in the vapor space is 1.25 times the pressure, P_G, for which this space is designed.

ND-6524.2 Time at Pressure and Relief Valve Check. The pressure in the tank shall be held stationary for a reasonable time after the application of each increment of pressure as specified so as to provide an opportunity to examine the tank carefully for signs of distress. The maximum test pressure of 1.25 times the vapor space design pressure shall be held for at least one hour, after which the pressure shall be released slowly, the blanks removed from relief valves, and the operation of the relief valves checked by injecting air into the top of the tank until the pressure in the vapor space equals the pressure, P_G, at which time the relief valves shall start to release air.

ND-6524.3 Soap Bubble Test. The pressure, P_G, specified in ND-6524.2 shall be held for a sufficient time to permit a close visual examination of all joints in the walls of the tank and of all welding around manways, nozzles, and other connections. In this examination, soapsuds shall be applied to all of the welding involved above the high liquid design level for which the tank is designed including the roof to sidewall joint. This examination is not required for welds examined by radiography.

ND-6524.4 Precautions To Be Employed in Pneumatic Testing. An air test as specified in ND-6523 and in ND-6524 introduces some hazard. In view of the large amount of air which will be present during such a test, it is recommended that no one be permitted to go near the tank while the pressure is being applied for the first time in this test. While the pressure in the tank exceeds the pressure for which the vapor space is designed, the inspections should be made from a reasonable distance from the tank using optical aids, if necessary, for observations of particular areas.

ND-6525 Hydrostatic Test

The requirements apply to tanks which have been so designed and constructed that they may be filled with liquid to the top of the roof.

ND-6525.1 Filling. Following the preliminary tests specified in ND-6523 the pressure-relief valve or valves shall be blanked off. With the top of the tank vented to atmosphere, the tank shall be filled with water to the top of the roof, while allowing all air to escape in order to prevent accumulation of pressure. The vents on the tank shall be closed and the pressure in the tank shall be increased slowly until the hydrostatic pressure under the topmost point in the roof is 1.25 times the pressure, P_G, for which the vapor space is designed to withstand when in operation with the tank filled to its specified high liquid level.

ND-6525.2 Pressurizing. Test pressure may be developed either by (a) or (b) below.

(a) Pumping water into the tank with all vents closed;

(b) Superimposing a vertical pipe, not less than 6-in. nominal pipe size, above the top of the tank with an overflow located at such a height as to give the desired test pressure by static head alone and then filling the pipe to the level of said overflow.

ND-6523.3 Time at Pressure. Test pressure shall be held at least one hour. The hydrostatic pressure under the roof shall then be reduced to the pressure, P_G, and shall be held at this level for a sufficient time to permit close visual examination of all joints in the walls of the tank and of all welding around manways, nozzles, and other connections.

ND-6525.4 Testing Relief Valves. The tank shall be vented to atmosphere, following the examinations specified in ND-6525.3 the water level lowered below the inlets to the pressure relief valves, the blanks removed from the relief valves and the operation of the relief valves shall then be checked by injecting air into the top of the tank until the pressure in the vapor space equals the pressure, P_G, for which the space is designed and at which time the relief valves shall start to release air.

ND-6526 Partial Vacuum Testing Procedure

ND-6526.1 Development of Partial Vacuum For Which Tank Was Designed. Following the tests

ARTICLE ND-3000
DESIGN

ND-3100 GENERAL DESIGN

ND-3110 LOADING CRITERIA

ND-3111 Loading Conditions

The loadings that shall be taken into account in designing a component shall include, but are not limited to, the following:

(a) Internal and external pressure;

(b) Impact loads, including rapidly fluctuating pressures;

(c) Weight of the component and normal contents under operating or test conditions, including additional pressure due to static and dynamic head of liquids;

(d) Superimposed loads such as other components, operating equipment, insulation, corrosion resistant or erosion resistant linings and piping;

(e) Wind loads, snow loads, vibrations and earthquake loads where specified;

(f) Reactions of supporting lugs, rings, saddles, or other types of supports;

(g) Temperature effects.

ND-3112 Design Conditions

The components shall be designed in accordance with the Owner's Design Specifications (NA-3250).

ND-3112.1 Design Pressure.[1] Components shall be designed for at least the most severe condition of coincident pressure and temperature expected in normal operation. For this condition, the maximum difference in pressure between the inside and outside of a component or between any two chambers of a combination unit shall be considered.

[1]It is recommended that a suitable margin be provided above the pressure at which the vessel will be normally operated to allow for probable pressure surges in the vessel up to the setting of the pressure-relieving devices (ND-7500).

ND-3112.2 Design Temperature

(a) The temperature used in design shall be not less than the mean metal temperature through the thickness expected under operating conditions for the part considered. If necessary, the metal temperature shall be determined by computation using accepted heat transfer procedures or by measurement from equipment in service under equivalent operating conditions. In no case shall the temperature at the surface of the metal exceed the maximum temperature listed in Tables I-7.0 and I-8.0 of Appendix I nor exceed the temperature limitations specified elsewhere in this Subsection.

(b) When the occurrence of different metal temperatures during operation can be definitely predicted for different zones of a component the design of the different zones may be based on their predicted temperatures. When sudden cyclic changes in temperature are expected to occur in normal operation with only minor pressure fluctuations, the design shall be governed by the highest or lowest probable operating metal temperature and the corresponding pressure.

ND-3112.3 Design Mechanical Loads The specific combinations and values of mechanical loads which must be considered in conjunction with the design pressure and design temperature shall be those identified in the Design Specifications and designated as the Design Mechanical Loads. The requirements of (a), (b), and (c) below shall also apply.

(a) Impact forces caused by either external or internal conditions shall be considered.

(b) The effects of earthquake shall be considered in the design of components, component supports, and restraints. The stresses resulting from these earthquake effects shall be included with pressure or other applied loads.

(c) Components shall be arranged and supported so that vibration will be minimized.

pressure-relief devices, safety valves and relief piping shall be at least equal to the maximum capacity of the larger of the two valves.

(c) Exhaust and pump suction lines for any service and pressure shall have relieved valves of a suitable size unless the lines and attached equipment are designed for the maximum pressure and temperature to which they may be accidentally or otherwise subjected.

(d) The effluent from relief devices may be discharged outside the containment only if provisions are made for the disposal of the effluent.

(e) Drip lines from steam headers, mains, separators or other equipment operating at different pressures shall not discharge through the same trap. Where several traps discharge into a single header that is or may be under pressure, a stop valve and a check valve shall be provided in the discharge line from each trap. The design pressure of trap discharge piping shall not be less than the maximum discharge pressure to which it may be subjected. Trap discharxe piping shall be designed for the same pressure as the trap inlet piping unless the discharge piping is vented to a system operated under lower pressure and has no intervening stop valves.

(f) Blowdown, dump and drain piping from water spaces of a steam generation system shall be designed for saturated steam at the pressures and temperatures given below.

Vessel Pressure (psi)	Design Pressure (psi)	Design Temperature (F)
600 and below	250	410
601 to 900	400	450
901 to 1500	600	490
1501 and above	900	535

These requirements for blowdown, dump and drain piping apply to the entire system beyond the blowdown valves to the blowdown tank or other points where the pressure is reduced to approximately atmospheric and cannot be increased by closing a valve. Where pressures can be increased because of calculated pressure drop or otherwise, this shall be taken into account in the design. Such piping shall be designed for the maximum pressure to which it may be subjected.

(g) Pump discharge piping shall be designed for the maximum pressure exerted by the pump at any load and for the highest corresponding temperature actually existing.

(h) When a fluid passes through heat exchangers in series, the design temperature of the piping in each section of the system shall conform to the most severe temperature condition expected to be produced by heat exchangers in that section.

ND-3613 Allowances

ND-3613.1 Corrosion or Erosion. When corrosion or erosion is expected, the wall thickness of the piping shall be increased over that required by other design requirements. This allowance shall be consistent with the specified design life of the piping.

ND-3613.2 Threading and Grooving. The calculated minimum thickness of piping that is to be threaded or grooved shall be increased by an allowance equal to the depth of the cut.

ND-3613.3 Mechanical Strength. When necessary to prevent damage, collapse, or buckling of pipe due to superimposed loads from supports or other causes, the wall thickness of the pipe shall be increased or, if this is impractical or would cause excessive local stresses, the superimposed loads or other causes shall be reduced or eliminated by other design methods.

ND-3613.4 Longitudinal Weld Joint Efficiency Factors. Longitudinal weld joint efficiency factors are required. The following factors shall be applied to the allowable stress values given in Tables I-7.0 and I-8.0:

ND-3613.5 Steel Casting Quality Factors. The quality factors for castings required in Tables I-7.0 and I-8.0 apply to castings which are designed using the stresses contained in this Subsection. The minimum examination required for these castings are those stipulated in the applicable material spec-

TABLE ND-3613.4-1

Type of Longitudinal Joint	Weld-Joint Efficiency Factor *E*
Arc weld	
Single butt weld	0.80
Double butt weld	0.90
Single or double butt weld with 100 % radiography per ND-2560 for joints welded with filler metal or otherwise examined per ND-2550 for joints welded without filler metal, as applicable	1.00
Electric resistance weld	0.85

Davis Exhibit 3

NUREG-1038

Safety Evaluation Report
related to the operation of Shearon Harris Nuclear Power Plant, Units 1 and 2

Docket Nos. STN 50-400 and STN 50-401

Carolina Power and Light Company
North Carolina Eastern Municipal Power Agency

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

November 1983

items in conformance with RG 1.29, Revision 3, and constitute an acceptable basis for satisfying, in part, the requirements of GDC 2.

In its review of FSAR Section 3.9, the staff confirmed that acceptable design interfaces exist between seismic Category I and nonseismic portions of piping systems. All other structures, systems, and components that may be required for operation of the facility are not required to be designed to seismic Category I requirements, including those portions of Category I systems such as vent lines, fill lines, drain lines, and test lines on the downstream side of isolation valves and portions of these systems that are not required to perform a safety function.

3.2.2 System Quality Group Classification

GDC 1 requires that nuclear power plant systems and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. These pressure-retaining components of fluid systems are part of the reactor coolant pressure boundary (RCPB) and other fluid systems important to safety, where reliance is placed on these systems: (1) to prevent or mitigate the consequences of accidents and malfunctions originating within the RCPB, (2) to permit shutdown of the reactor and maintain it in a safe shutdown condition, and (3) to retain radioactive material. RG 1.26 is the principal document used in the staff's review for identifying on a functional basis the components of those systems important to safety as NRC Quality Groups A, B, C, or D. 10 CFR 50.55a identifies those American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Section III, Class 1 components that are part of the RCPB.

Conformance of these RCPB components with 10 CFR 50.55a is addressed in Section 5.2.1.1 of this report. These RCPB components are designated in RG 1.26 as Quality Group A. Certain other RCPB components that meet the exclusion requirement of footnote 2 of the rule are classified Quality Group B in accordance with RG 1.26. Shearon Harris Units 1 and 2 were reviewed in accordance with SRP 3.2.2.

The applicant used the American Nuclear Society (ANS) Safety Classes 1, 2, 3 and nonnuclear safety (NNS) as defined in ANSI N18.2a-1975, "American National Standard Revision and Addendum to Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants," in the classification of system components as an alternate acceptable method of meeting the guidance of RG 1.26. Safety Classes 1, 2, 3 and NNS correspond to the Commission's Quality Groups A, B, C, and D in RG 1.26.

The relationship of the NRC Quality Groups and ANS Safety Classes can be summarized as follows:

NRC Quality Group	Shearon Harris PWR Safety Class
A	1
B	2
C	3
D	NNS

The staff has reviewed the applicant's use of ANS safety classes in FSAR Table 3.2.1-1 and finds the classification of components acceptable. Quality Group A (Safety Class 1) components of the RCPB are constructed* in accordance with ASME Code Section III, Division 1, Class 1. Components in fluid systems that are classified Quality Group B (Safety Class 2) are constructed in accordance with the ASME Code, Section III, Division 1, Class 2. Components in fluid systems that are classified Quality Group C (Safety Class 3) are constructed in accordance with ASME Code, Section III, Division 1, Class 3. Components in fluid systems that are classified Quality Group D (Safety Class NNS) are constructed to the following codes as appropriate: ASME Code, Section VIII, Division 1; ANSI B31.1.0, Power Piping; and storage tank codes such as American Water Works Association (AWWA) D100. The codes and standards used in the construction of Quality Group A, B, C, or D components are identified in FSAR Table 3.2.1-1. The staff finds the codes and standards used in the construction of components acceptable.

The safety-related systems and components that are important to safety have been identified in an acceptable manner in FSAR Table 3.2.1-1. As noted above, this table, in part, identifies major components in fluid systems---such as pressure vessels, heat exchangers, storage tanks, pumps, piping, and valves--and in mechanical systems--such as cranes, refueling platforms, and other miscellaneous handling equipment. In addition, piping and instrumentation diagrams in the FSAR identify the classification boundaries of interconnecting piping and valves. The staff has reviewed FSAR Table 3.2.1-1** and the fluid system piping and instrumentation diagrams and concludes that pressure-retaining components have been properly classified in conformance with RG 1.26, Revision 3.

The staff concludes that construction of components in fluid systems identified in FSAR Table 3.2.1-1 is in conformance with the ASME Code and industry standards, the Commission's regulations, and RG 1.26. This provides assurance that component quality is commensurate with the importance of the safety function of these systems and constitutes an acceptable basis for satisfying the requirements of GDC 1.

3.3 Wind and Tornado Criteria and Loadings

3.3.1 Wind Design Criteria

All seismic Category I structures exposed to wind forces are designed to withstand the effect of the design-basis wind. The design wind specified has a velocity of 179 mph at 30 ft above plant grade, with a recurrence interval of 1000 years.

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*Constructed, as used herein, is an all-inclusive term comprising materials design, fabrication, examination, testing, inspection, and certification required in the manufacture and installation of components.

**Staff acceptance is contingent on the applicant's incorporating into the FSAR the proposed revisions to Table 3.2.1-1 relating to classification of pressure-retaining components.

3.2 CLASSIFICATION OF STRUCTURES, COMPONENTS AND SYSTEMS

3.2.1 SEISMIC CLASSIFICATION

3.2.1.1 Balance of Plant Scope

Plant structures, systems and components important to safety are designed to withstand the effects of a safe shutdown earthquake (SSE) and remain functional if they are necessary to assure:

a) The integrity of the reactor coolant pressure boundary (RCPB),

b) The capability to safely shutdown the reactor and maintain it in a safe condition, or

c) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of 10 CFR Part 100.

Plant structures, systems and components, including their foundations and supports, that are designed to remain functional in the event of a safe shutdown earthquake are designated Seismic Category I and are listed in Table 3.2.1-1. These seismic classifications are consistent with the requirements of Regulatory Guide 1.29 (see Section 1.8).

For systems which are partially Seismic Category I, the Seismic Category I portion includes all components within the seismic boundary and extends to the first seismic restraint beyond the boundary.

The seismic design of Seismic Category I structures, systems and components is described in the following Sections:

Mechanical	Sections 3.7 and 3.9
Electrical	Section 3.10
Structures	Sections 3.7 and 3.8
Instrumentation and Controls	Section 3.10

All Seismic Category I structures, systems and components are analyzed under the loading conditions discussed in Section 3.7 which include safe shutdown earthquake (SSE) and operating basis earthquake (OBE) loads.

Non-seismic structures, systems and components are those whose failure would not result in the release of significant amounts of radioactivity and would not prevent reactor shutdown or degrade the operation of Engineered Safety Features System. Their failure may, however, interrupt power generation.

The occurrence of adverse interaction between safety and non-safety related components during SSE events has been eliminated by adherence to the following:

TABLE 3.2.1-1 (Continued)

Design Information

Systems and Components	Safety Class[1]	Code	Code Class	Seismic Category[2]	Quality Class[23]	Remarks
Fuel Pool Skimmer Filters	NNS	ASME VIII	-	-	E	
Fuel Pool Skimmer Pumps	NNS	-	-	-	E	
Fuel Pool and Refueling Water Purification Pump	NNS	-	-	-	E	
Fuel Pool Skimmers	NNS	-	-	-	E	
Fuel Pool Liner	NNS	-	-	I	A	See Note (21)
Fuel Pool Nozzles	NNS	-	-	I	A	See Note (21) and (21A)
System Piping and Valves						
a) Required for cooling and makeup to the fuel pools	3	ASME III	3	I	A	
b) Makeup from RWST	3	ASME III	3	I	A	
c) Required for fuel pool cleanup and normally isolated from a)	NNS	ANSI B31.1	-	-	E	
Instrumentation	IE	-	-	I	A	
<u>Fuel Handling System</u>						
Manipulator Crane	NNS	-	-	-	B	
Reactor Vessel Internals Lifting Device	NNS	-	-	-	E	
Rod Cluster Control Changing Fixture	NNS	-	-	-	E	
Reactor Vessel Stud Tensioner	NNS	-	-	-	E	
Spent Fuel Handling Tool	3	-	-	I	A	See Note (10)
Fuel Transfer System						
a) Fuel Transfer Tube and Flange	2	ASME III	2	I	A	See Note (11)
b) Portions of Conveyor System and Controls in Fuel Handling Building	3	-	-	I	A	See Note (12)
c) Remainder of System	NNS	-	-	-	E	

Davis Exhibit 4

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Summer 1975 Addenda

Date of Issue: June 30, 1975

ASME BOILER AND PRESSURE VESSEL CODE
An American National Standard

SECTION II
Material Specifications
Part C
Welding Rods, Electrodes and Filler Metals

1974 Edition

This is the first Addenda to be published to the 1974 Edition of Section II, Part C.

CIFICATION SFA-5.4

itle *Revise to read:*

(Identical with AWS A 5.4 – Addendum 1-1975)

tem 1 – *In* Table 2 (Chemical Requirements for ll-Weld Metal), *add a maximum of* 0.5 percent *for* olybdenum *for the following grades:*

E308	E310	E347
E308L	E310Cb	E410
E309	E312	E430
E309Cb	E330	

tem 2 – *In the same* Table 2, *add a new column* Copper, percent" *and show a maximum of* 0.5 per- nt *for all grades except for* E320 *which now shows range for* Copper *of* 3.0 to 4.0 percent *per* otnote e.

em 3 – *In the same* Table 2, *revise* Note 1 *to read as* llows:

ote 1. – Analysis shall be made for the elements for which ic values are shown in the table. If, however, the presence her elements is indicated in the course of routine analysis, er analysis shall be made to determine that the total of other elements, except iron, is not present in excess of ercent.

SPECIFICATION SFA-5.9

Subtitle *Revise to read:*

(Identical with AWS A 5.9 – Addendum 1-1975)

A. **Item 1** – *In* Table 1 (Chemical Requirements), *add a maximum of* 0.5 percent *for* Molybdenum *for the following classifications:*

ER308	ER310	ER348
ER308L	ER312	ER420
ER309	ER347	ER430

B. **Item 2** – *In the same* Table 1, *add a new column* "Copper, percent" *and show a maximum of* 0.5 percent *for all classifications except for* ER320 *which now shows a range for* Copper *of* 3.0 to 4.0 percent *per footnote* e.

C. **Item 3** – *In the same* Table 1, *revise* Note 1 *to read as follows:*

Note 1. – Analysis shall be made for the elements for which specific values are shown in the table. If, however, the presence of other elements is indicated in the routine analysis, further analysis shall be made to determine that the total of these other elements, except iron, is not present in excess of 0.5 percent.

SPECIFICATION FOR CORROSION-RESISTING CHROMIUM AND CHROMIUM-NICKEL STEEL WELDING RODS AND BARE ELECTRODES

SFA-5.9

(Identical with AWS Specification A 5.9-69)

1. Scope

1.1 This specification covers corrosion-resisting chromium and chromium-nickel steel welding rods for use with the atomic hydrogen and gas-tungsten-arc welding processes and bare electrodes for use with the submerged arc and gas metal-arc welding processes. These welding rods and electrodes include those alloy steels designated as corrosion- or heat-resisting chromium and chromium-nickel steels, in which chromium exceeds 4 per cent and nickel does not exceed 50 per cent.

NOTE — No attempt has been made to classify all grades of filler metals within the limits of the above scope; only the more commonly used have been included.

2. Classification

2.1 The filler metals are classified on the basis of their chemical composition.

3. Manufacture

3.1 The filler metal may be made by any method that will yield a product conforming to the requirements of this specification.

4. Acceptability

4.1 At the option and expense of the purchaser any or all of the tests required by this specification may be used as a basis for acceptance of electrodes.

5. Chemical Composition

5.1 The chemical composition requirements for the electrodes and welding rods are given in Table 1.

5.1.1 For solid electrodes and solid welding rods the requirements are based on chemical analysis of the as-manufactured filler metal.

5.1.2 For composite electrodes and composite welding rods the requirements are based on the chemical analysis of a fused sample made in accordance with paragraph 6.2.1, or on the analysis of a sample obtained by any suitable method agreed upon by the purchaser and supplier.

5.2 The details of this test are stipulated in 6. Chemical Analysis.

6. Chemical Analysis

6.1 When testing solid electrodes and solid welding rods an adequate sample of as-manufactured filler metal, sufficient for retest if necessary, shall be acquired to perform the prescribed chemical analysis.

6.2 When testing composite electrodes and composite welding rods, samples for chemical analysis may be obtained either by the method specified in paragraph 6.2.1, or by any suitable method agreed upon by the purchaser and the supplier. In case of dispute, samples for chemical analysis shall be obtained by the method specified in paragraph 6.2.1.

6.2.1 The sample of composite welding rod or composite electrode shall be melted in the flat position using gas tungsten arc welding with argon as the shielding gas. The sample obtained by this method shall represent undiluted fused filler metal.

6.3 Chemical analysis may be made by any suitable method agreed upon by the supplier and the purchaser. In case of dispute, referee methods of analysis shall be according to the appropriate technique set

Table 1 — Chemical Requirements

AWS Classification	Carbon, per cent	Chromium, per cent	Nickel, per cent	Molybdenum, per cent	Columbium plus Tantalum, per cent	Manganese, per cent	Silicon, per cent	Phos-phorus, per cent	Sulfur, per cent	Tungsten, per cent
ER308[a,f]	0.08	19.5 to 22.0	9.0 to 11.0	...	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER308L[a,f]	0.03	19.5 to 22.0	9.0 to 11.0	...	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER309[f]	0.12	23.0 to 25.0	12.0 to 14.0	...	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER310	0.08 to 0.15	25.0 to 28.0	20.0 to 22.5	...	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER312	0.15	28.0 to 32.0	8.0 to 10.5	...	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER316[f]	0.08	18.0 to 20.0	11.0 to 14.0	2.0 to 3.0	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER316L[f]	0.03	18.0 to 20.0	11.0 to 14.0	2.0 to 3.0	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER317	0.08	18.5 to 20.5	13.0 to 15.0	3.0 to 4.0	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER318	0.08	18.0 to 20.0	11.0 to 14.0	2.0 to 3.0	8 × C, min to 1.0, max	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER320[e]	0.07	19.0 to 21.0	32.0 to 36.0	2.0 to 3.0	8 × C, min to 1.0, max	2.5	0.60	0.04	0.03	...
ER321[c]	0.08	18.5 to 20.5	9.0 to 10.5	0.5 max	...	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER347[a,f]	0.08	19.0 to 21.5	9.0 to 11.0	...	10 × C, min to 1.0, max	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER348[a]	0.08	19.0 to 21.5	9.0 to 11.0	...	10 × C, min to 1.0, max[b]	1.0 to 2.5	0.25 to 0.60	0.03	0.03	...
ER349[d]	0.07 to 0.13	19.0 to 21.5	8.0 to 9.5	0.35 to 0.65	1.0 to 1.4	1.0 to 2.5	0.25 to 0.60	0.03	0.03	1.25 to 1.75
ER410	0.12	11.5 to 13.5	0.6	0.6	...	0.6	0.50	0.03	0.03	...
ER420	0.25 to 0.40	12.0 to 14.0	0.6	...	...	0.6	0.50	0.03	0.03	...
ER430	0.10	15.5 to 17.0	0.6	...	...	0.6	0.50	0.03	0.03	...
ER502	0.10	4.5 to 6.0	0.6	0.45 to 0.65	...	0.6	0.25 to 0.60	0.03	0.03	...

NOTE 1.—Analysis shall be made for the elements for which specific values are shown in this table. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made to determine that the total of these other elements, except iron, is not present in excess of 0.70 per cent.

NOTE 2.—Single values shown are maximum percentages except where otherwise specified.

a Chromium, min = 1.9 × Nickel, when so specified.

b Tantalum, max = 0.10 per cent.

c Titanium = 9 × C, min to 1.0, max.

d Titanium = 0.10 to 0.30.

e Copper = 3.0 to 4.0.

f These grades are available in high silicon classifications which shall have the same chemical composition requirements as given above with the exception that the silicon content shall be 0.50 to 1.0 per cent. These high silicon classifications shall be designated by the addition of "Si" to the standard classification designations listed above. The fabrication should consider carefully the use of high silicon filler metals in highly restrained or fully austenitic welds. A discussion of this problem is presented in paragraphs A1.11, A1.32 and A1.33 in the Appendix to this specification.

SPECIFICATION FOR ELECTRIC FUSION-WELDED AUSTENITIC CHROMIUM-NICKEL ALLOY STEEL PIPE FOR HIGH-TEMPERATURE SERVICE

SA-358

(Identical with ASTM Specification A 358-72a except that the following requirements apply)

All products furnished under this SA specification are intended for application under the rules of some section of the ASME Boiler and Pressure Vessel Code. Furnishing of such products is limited to manufacturers who hold the appropriate ASME Certificate of Authorization and Code Symbol Stamp. In addition to conforming to this specification, the manufacturer shall meet all applicable requirements of whichever Section of the Code is designated in the order. *The plate used to fabricate the pipe shall conform to SA-240.* The joints shall be full penetration butt welds as obtained by double welding or by other means which will obtain the same quality of deposited weld metal on the inside and outside. Welds using metal backing strips which remain in place are excluded. The product is subject to all requirements of the designated Section of the Code including welding, heat treatment, nondestructive examination, authorized inspection at the point of manufacture, and application of the Code Symbol Stamp.

The applicable ASME partial data report form, signed by an authorized inspector, and a certified mill test report shall be furnished for each lot of pipe. The term "lot" applies to all pipe of the same mill heat of material and wall thickness which is heat treated in one furnace charge. For pipe which is not heat treated or which is heat treated in a continuous furnace, a lot shall consist of each 200 ft. (61 m.) or fraction thereof of all pipe of the same mill heat of material and wall thickness, subjected to the same heat treatment. For pipe which is heat treated in a batch-type furnace which is automatically controlled with a 50° F range and is equipped with recording pyrometer so that the heating records are available, a lot may be defined the same as for continuous furnaces. Each length of pipe shall be marked in such a manner as to identify each piece with the "lot" and the representative certified mill test report.

1. Scope

1.1 This specification covers electric-fusion-welded austenitic chromium-nickel alloy steel pipe suitable for corrosive or high-temperature service, or both. (Although no restrictions are placed on the sizes of pipe which may be furnished under this specification, commercial practice is commonly limited to sizes not less than 8-in. (203-mm) nominal diameter.)

1.2 This specification covers seven grades of alloy steel as indicated in Table 1. The selection of the proper alloy and requirements for heat treatment shall be at the discretion of the purchaser, dependent on the service conditions to be encountered.

1.3 Two classes of pipe are covered as follows:

1.3.1 *Class 1*—All welded joints to be completely examined by radiography.

1.3.2 *Class 2*—No radiographic examination required.

1.4 Optional requirements of a supplementary nature are provided for pipe where a greater degree of examination is desired. These supplementary requirements call for additional tests to be made and, when desired, one or more of these may be specified in the order.

2. General Requirements

2.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of the ASTM Specification A 530, General Requirements for Specialized Carbon Steel and Alloy Steel Pipe,[2] unless otherwise provided herein.

3. Basis of Purchase

3.1 Orders for material under this specification shall include the following, as required, to describe the desired material adequately:

3.1.1 Quantity (feet, centimeters,[3] or number of lengths),

3.1.2 Name of material (electric-fusion-welded pipe),

3.1.3 Grade (Table 1),

3.1.4 Class (see 1.3),

3.1.5 Size (outside diameter and minimum wall thickness),

3.1.6 Length (specific or random),

3.1.7 End finish (16. Ends, Specification A 530),

TABLE 1.—PLATE SPECIFICATIONS.

Grade	Material	ASTM Specification Number and Grade
304	Type 304	A 240, Type 304
316	Type 316	A 240, Type 316
347	Type 347	A 240, Type 347
321	Type 321	A 240, Type 321
309	Type 309	A 240, Type 309S
310	Type 310	A 240, Type 310S
348	Type 348	A 240, Type 348

3.1.8 Optional requirements (supplementary requirements S1 to S3; 16.3 and 16.4),

3.1.9 ASTM designation, and

3.1.10 Special requirements or exceptions to this specification.

[2] *Annual Book of ASTM Standards*, Part 1.

[3] For referee purposes, U.S. customary units shall be used throughout this specification.

[4] *Annual Book of ASTM Standards*, Part 4.

4. Materials and Manufacture

4.1 *Materials:*

4.1.1 The steel plate material shall conform to the requirements of one of the grades of ASTM Specification A 240, Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels,[4] as listed in Table 1.

4.2 *Welding:*

4.2.1 The joints shall be double-welded, full-penetration welds made in accordance with procedures and by operators qualified in accordance with the *ASME Boiler and Pressure Vessel Code*, Section IX.

4.2.2 The welds shall be made either manually or automatically by an electric process involving the deposition of filler metal.

4.2.3 The joints shall be reinforced at the center of the weld on each side of the plate by at least 1/16 in. (1.6 mm) but not more than 1/8 in. (3.2 mm). This reinforcement may be removed at the manufacturer's option or by agreement between the manufacturer and purchaser. The contour of the reinforcement should be reasonably smooth and free from irregularities. The deposited metal shall be fused uniformly into the plate surface. No concavity of contour is permitted unless the resulting thickness of weld metal is equal to or greater than the minimum thickness of the adjacent base metal.

4.2.4 Weld defects shall be repaired by removal to sound metal and rewelding. Subsequent heat treatment and examination (that is, visual, radiographic, and dye penetrant) shall be as required on the original welds.

4.3 *Heat Treatment:*

4.3.1 All pipe shall be furnished in the heat treated condition. The heat treatment procedure shall consist of heating the material to a minimum temperature of 1900 F (1038 C) and quenching in water or rapidly cooling by other means.

4.3.2 Controlled structural or special service characteristics shall be specified as a guide for the most suitable heat treatment. If the final heat treatment is at a temperature under 1900 F (1038 C) and is so specified on the order, each pipe shall be stenciled with the final heat treatment temperature in degrees Fahrenheit (Celsius) after the suffix "HT." If no final heat treatment is applied and is so specified on the order each pipe shall be stenciled "HT-O."

5. Chemical Composition

5.1 The chemical composition of the plate shall conform to the requirements of the applicable specification and grade listed in Table I of Specification A 240.

5.2 The alloy content (chromium, nickel, molybdenum and columbium) of the deposited weld metal shall conform to that required for the plate or the welding electrodes as shown in Table II of Specification AWS A5.4[5] or in Table I of Specification AWS A5.9,[5] except that when welding on Type 321 base metal, the deposited weld metal may correspond to Type 347.

6. Ladle Analysis

6.1 An analysis of each heat of steel shall be made by the plate manufacture to determine the percentages of the elements prescribed in Table I of Specification A 240. This analysis shall be made from a test ingot taken during the pouring of the heat. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements prescribed in Table I of Specification A 240.

7. Check Analysis

7.1 For each lot of 500 ft (152 m) of pipe or fraction thereof, analysis shall be made by the manufacturer from the finished pipe of the plate and of the weld deposit. Drillings for analysis may be taken from the mechanical test specimens. The results of these analyses shall be reported to the purchaser or his representative, and shall conform to the requirements of 5. Chemical Composition.

7.2 If the analysis of one of the tests specified in 7.1 does not conform to the requirements specified in 5. Chemical Composition, analyses shall be made on additional pipe of double the original number from the same lot, each of which shall conform to the requirements specified.

7.3 For referee purposes ASTM Methods E 30, Chemical Analysis of Steel Cast Iron, Open-Hearth Iron, and Wrought Iron[6] shall be used.

8. Tensile Properties

8.1 The plate used in making the pipe shall conform to the requirements as to tensile properties of the applicable specifications listed in Table 1. Tension tests made by the plate manufacturer shall qualify the plate material.

8.2 Transverse tensile tests taken across the welded joint shall meet the same minimum tensile strength requirements as the plate.

9. Transverse Guided-Bend Weld Tests

9.1 Two bend test specimens shall be taken transversely from the pipe. One shall be subject to a face guided-bend test and the second to a root guided-bend test. One specimen shall be bent with the inside surface of the pipe against the plunger, and the other with the outside surface against the plunger.

9.2 The bend test shall be acceptable if no cracks or other defects exceeding ⅛ in. (3.17 mm) in any direction be present in the weld metal or between the weld and the pipe metal after bending. Cracks which originate along the edges of the specimen during testing, and that are less than ¼ in. (6.35 mm) measured in any direction shall not be considered.

10. Test Specimens and Methods of Testing

10.1 Transverse tension and bend test specimens shall be taken from the end of the finished pipe; the transverse tension and bend test specimens shall be flattened cold before final machining to size.

10.2 As an alternate to the requirements of 10.1, the test specimens may be taken from a test plate of the same material as the pipe, which is attached to the end of the cylinder and welded as a prolongation of the pipe longitudinal seam.

10.3 Tension test specimens shall be made in accordance with Section IX, Part A, Paragraph Q6 of the ASME Boiler and Pressure Vessel Code and shall be one of the types shown in Figs. Q6(b) or Q6(c) of that code.

10.3.1 Reduced-section specimens conforming to the requirements given in Fig.

[5] Available from American Welding Society, 345 E. 47th St., New York, N. Y. 10017.

[6] *Annual Book of ASTM Standards*, Part 32.

Q6(b) may be used for tension tests on all thicknesses of pipe having outside diameter greater than 3 in. (76.2 mm).

10.3.2 Turned specimens conforming to the requirements of Fig. Q6(c) may be used for tension tests.

10.3.2.1 If turned specimens are used as given in 10.3.2.2 and 10.3.2.3, one complete set shall be made for each required tension test.

10.3.2.2 For thicknesses to and including $1\frac{1}{4}$ in. (31.8 mm), a single turned specimen may be used.

10.3.2.3 For thicknesses over $1\frac{1}{4}$ in., multiple specimens shall be cut through the full thickness of the weld with their centers parallel to the material surface and not over 1 in. (25.4 mm) apart. The centers of the specimens adjacent to material surfaces shall not exceed $\frac{5}{8}$ in. (15.9 mm) from the surface.

10.4 The test specimens shall not be cut from the pipe or test plate until after final heat treatment.

11. Mechanical Tests Required

11.1 *Transverse Tension Test*—One test shall be made to represent each lot[7] of finished pipe.

11.2 *Transverse Guided-Bend Weld Test*—Two tests shall be made to represent each lot[7] of finished pipe.

11.3 *Hydrostatic Test*—Each length of pipe shall be subjected to a hydrostatic test by the manufacturer to a pressure which will produce in the pipe wall a stress of 75 per cent of the minimum specified yield strength of the plate. Pressure shall be held for sufficient time to permit the inspector to examine entire length of welded seam.

11.4 The purchaser, with the agreement of the manufacturer, may complete the hydrostatic test requirement with the system pressure test, which may be lower or higher than the specification test pressure, but in no case shall the test pressure be lower than the system design pressure. Each length of pipe furnished without the completed manufacturer's hydrostatic test shall include with the mandatory marking the letters "NH."

12. Radiographic Examination

12.1 For Class 1 welded joint quality, all welded joints shall be completely examined by radiography.

12.2 Radiographic examination shall be in accordance with the requirements of the *ASME Boiler and Pressure Vessel Code*, Section I, latest edition, Paragraph PW51.

12.3 Radiographic examination may be performed prior to heat treatment.

13. Thickness and Weights

13.1 The wall thickness and weights for welded pipe furnished under this specification shall be governed by the requirements of the specification to which the manufacturer ordered the plate.

14. Permissible Variations in Dimensions

14.1 *Permissible Variations*—The dimensions at any point in a length of pipe shall not exceed the following:

14.1.1 *Outside Diameter*—Based on circumferential measurement, ±0.5 per cent of the specified outside diameter.

14.1.2 *Out-of-Roundness*—Difference between major and minor outside diameters, 1 per cent.

14.1.3 *Alignment*—Using a 10-ft (305 cm) straightedge placed so that both ends are in contact with the pipe, $\frac{1}{8}$ in. (3.17 mm).

14.1.4 *Thickness*—The minimum wall thickness at any point in the pipe shall not be more than 0.01 in. (0.254 mm) under the nominal thickness.

15. Lengths

15.1 Circumferentially welded joints of the same quality as the longitudinal joints shall be permitted by agreement between the manufacturer and the purchaser.

16. Finish

16.1 The finished pipe shall be free from injurious defects, and shall have a workmanlike finish.

16.2 *Repair of Plate Defects by Machining or Grinding*—Pipe showing moderate slivers may be machined or ground inside or outside to a depth which shall ensure the removal of all included scale and slivers, providing the wall thickness is not reduced below the specified minimum wall thickness. Machining or grinding shall follow inspection of the pipe as rolled, and shall be followed by supplementary visual inspection.

16.3 *Repair of Plate Defects by Welding*—Repair of injurious defects shall be permitted only subject to the approval of the purchaser. Defects shall be thoroughly chipped out before welding. The repairs shall be radiographed and if the pipe itself has already been heat treated, it shall then be heat treated again except in the case of small welds that, in the estimation of the purchaser's inspector, do not require heat treatment. Each length of repaired pipe shall be subjected to the hydrostatic test.

16.4 When required by the purchaser in the contract or order, the inside surface of the pipe shall be sandblasted or pickled and then passivated.

17. Marking

17.1 In addition to the marking prescribed in Specification A 530, the markings on each length of pipe shall include the plate material designation as shown in Table 1 and the marking requirements prescribed in 4.3 and 11.3.

SUPPLEMENTARY REQUIREMENTS FOR PIPE REQUIRING SPECIAL CONSIDERATION

These requirements shall not be considered unless specified in the order, in which event the specified tests shall be made by the manufacturer and witnessed by the purchaser or his representatives before shipment of the pipe.

S1. Check Analysis

S1.1 Check analysis may be made on any length of pipe. Individual lengths failing to conform to the chemical requirements prescribed in Table 1 shall be rejected.

S2. Tension and Bend Tests

S2.1 Tension tests (8. Tensile Properties) and bend tests (9. Transverse Guided Weld Bend Tests) shall be made on specimens to represent each length of pipe. Failure of any test specimen to

[7] The term "lot" applies to all pipe of the same nominal size and wall thickness (or Schedule) which is produced from the same heat of steel and is subjected to the same finishing treatment:

1. In a continuous heat treatment furnace, or
2. In a batch type heat treatment furnace, in which case the lot shall include only that pipe heat treated in the same batch furnace charge, or
3. When not heat-treated, a lot shall consist of the material from one heat of steel, or the same nominal size and wall thickness (or Schedule).

meet the requirements shall be cause for the rejection of the pipe length represented.

S3. Penetrant Oil and Powder Examination

S3.1 All welded joints shall be subjected to examination by a penetrant oil and powder method. The details of the method and the disposition of flaws detected shall be a matter for agreement between the purchaser and the manuacturer.

S4. Ferrite Control in Weld Deposits

S4.1 The ferrite content of the deposited weld metal in any length of pipe may be determined. The procedural details pertaining to this subject (that is, welding; plate and weld deposit chemistry; testing equipment and method; number and location of test sites; and ferrite control limits) shall be a matter for agreement between the purchaser and the manufacturer.

Davis Exhibit 5

CP&L

OCT 15 1999

Carolina Power & Light Company
Harris Nuclear Plant
PO Box 165
New Hill NC 27562

SERIAL: HNP-99-156

United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

SHEARON HARRIS NUCLEAR POWER PLANT
DOCKET NO. 50-400/LICENSE NO. NPF-63
SUPPLEMENTAL INFORMATION REGARDING THE LICENSE AMENDMENT REQUEST TO PLACE HNP SPENT FUEL POOLS 'C' AND 'D' IN SERVICE

Dear Sir or Madam:

Enclosure 8 of the HNP license amendment request (ref. SERIAL: HNP-98-188, dated December 23, 1998) provided a detailed Alternative Plan for demonstrating compliance with ASME Boiler & Pressure Vessel Code requirements for spent fuel pool cooling and cleanup system piping in accordance with 10 CFR 50.55a(a)(3)(i). By letter dated March 24, 1999, the NRC issued a request for additional information (RAI) related to the Harris Nuclear Plant (HNP) license amendment request to place spent fuel pools C and D in service. The March 24, 1999 RAI included a request to identify each of the embedded field welds within the scope of the Alternative Plan. The HNP response (ref. SERIAL: HNP-99-069, dated April 30, 1999) provided a field weld matrix which identified the field welds to be inspected by using a high resolution remote video camera. The sample size was selected based on a feasibility walkdown with the camera vendor. CP&L has continued, however, to investigate alternative inspection methods with other vendors. Through these efforts with another vendor, CP&L has successfully performed a remote camera inspection of all 15 embedded field welds included within the scope of the Alternative Plan. In the course of the inspection, two field welds (2-SF-1-FW-3 and 2-SF-1-FW-6) which were not embedded in concrete, but within the scope of the Alternative Plan, were cut out to facilitate removal of piping to provide access for the camera inspections. An updated field weld matrix will be provided to reflect the removal of these two welds and the inspection of all 15 embedded field welds.

In addition, by letter dated April 29, 1999, the NRC issued an RAI related to the criticality control provisions in the HNP license amendment request. Item 1 of this RAI requested information regarding a postulated fresh fuel assembly misloading event. As a supplement to our June 14, 1999 response (ref. SERIAL: HNP-99-094) to requested item 1 of the RAI, we had our vendor, Holtec International, perform additional fuel assembly misloading analyses. The results of these analyses are included as an Enclosure to this letter. These analyses demonstrate that criticality will not occur as a result of the postulated misloading of a fresh fuel assembly in the spent fuel storage racks for HNP pools C and D.

This information is provided as a supplement to our December 23, 1998 license amendment request and does not change our initial determination that the proposed license amendment represents a no significant hazards consideration.

Please refer any questions regarding the enclosed information to Mr. Steven Edwards at (919) 362-2498.

Sincerely,

J.H. Eads for DBA

Donna B. Alexander
Manager, Regulatory Affairs
Harris Nuclear Plant

KWS/kws

Enclosure:

c: (all w/ Enclosure)

Mr. J. B. Brady, NRC Senior Resident Inspector
Mr. Mel Fry, N.C. DEHNR
Mr. R. J. Laufer, NRC Project Manager
Mr. L. A. Reyes, NRC Regional Administrator - Region II

bc: (all w/ Enclosure)

Mr. K. B. Altman
Mr. G. E. Attarian
Mr. R. H. Bazemore
Mr. C. L. Burton
Mr. S. R. Carr
Mr. J. R. Caves
Mr. H. K. Chernoff (RNP)
Mr. B. H. Clark
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Mr. W. J. Dorman (BNP)
Mr. R. S. Edwards
Mr. R. J. Field
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Mr. C. S. Hinnant
Mr. W. D. Johnson
Mr. G. J. Kline
Mr. B. A, Kruse
Ms. T. A. Head (PE&RAS File)
Mr. R. D. Martin
Mr. T. C. Morton
Mr. J. H. O'Neill, Jr.
Mr. J. S. Scarola
Mr. J. M. Taylor
Nuclear Records
Harris Licensing File
Files: H-X-0511
H-X-0642

HOLTEC INTERNATIONAL

Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (609) 797-0900
Fax (609) 797-0909

October 11, 1999

Mr. Steven Edwards
Manager of Projects
Carolina Power & Light Company
Harris Nuclear Plant
P.O. Box 165
New Hill, NC 27562

References: Holtec Project 70324
CP&L Contract XTA7000024

Subject: Additional Criticality Analysis Results

Dear Mr. Edwards,

Per your request, and in support of the recent NRC RAIs pertaining to the criticality evaluations performed for fuel storage in pools C and D, we have performed additional analyses.

RAI #1 from the NRC stated that an evaluation of a fuel assembly misloading event should be analyzed. Holtec's previous response drew upon earlier spent fuel rack evaluations and stated that the k_{eff} would remain below 0.95 with a minimum of 400 ppm soluble boron in the pool.

As a supplement to this response, Holtec International has performed additional analyses for the Harris Spent Fuel Pools C and D to determine the amount of soluble boron required to maintain k_{inf} below 0.95 with a misloaded fresh PWR fuel assembly. The results of this analysis are summarized here.

The inadvertent misloading of a fresh PWR fuel assembly into Harris Pools C and D was analyzed using MCNP-4A and CASMO-3. A delta-k_{inf} for the misloading event was calculated using MCNP and this delta-k_{inf} was applied to the maximum k_{inf} in the licensing amendment report (LAR) to determine the maximum k_{inf} under the misloading scenario. This accident scenario consisted of a single 5 wt.% ^{235}U PWR fresh fuel assembly misloaded into the PWR racks surrounded by fuel of maximum reactivity as determined by the burnup and enrichment curve in the LAR. The k_{inf} for the PWR racks with the misloaded fresh assembly, without taking credit for soluble boron, was determined to be 0.9916 with a 95%/95% confidence level.

HOLTEC INTERNATIONAL

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Mr. Steven Edwards
Carolina Power & Light Company
Page 2

A second scenario was also analyzed in which the fresh 5 wt.% ^{235}U PWR fuel assembly was placed in a PWR storage cell adjacent to the BWR storage racks. The PWR and BWR racks were filled with fuel of maximum permissible reactivity. The k_{inf} for this scenario with the misloaded fresh 5 wt.% ^{235}U PWR fuel assembly, without taking credit for soluble boron, was 0.9932 with a 95%/95% confidence level.

These results clearly demonstrate that the spent fuel pool will remain subcritical even with a fresh 5 wt.% ^{235}U PWR fuel assembly misloaded in the PWR racks.

The April 1978 NRC letter to All Power Reactor Licensees states that "The double contingency principle of ANSI N-16.1-1975 shall be applied. It shall require two unlikely, independent, concurrent events to produce a criticality accident." Consistent with this approach, credit for soluble boron, which is normally in the spent fuel pool, was taken when the misloaded fresh 5 wt.% ^{235}U PWR fuel was analyzed. It was determined that the maximum k_{inf} for the misloading accident is 0.9352 with 400 ppm soluble boron in the spent fuel pool water. Therefore, the minimum amount of soluble boron required to maintain k_{inf} less than the regulatory limit of 0.95 under all postulated abnormal and accident conditions is 400 ppm.

Additional calculations were also performed to determine the k_{inf} for the misloading accident with 1000 and 2000 ppm soluble boron in the spent fuel pool water. The maximum k_{inf} was calculated to be 0.8671 and 0.7783 for the 1000 and 2000 ppm respectively. These results demonstrate that there is considerable un-credited margin in the criticality analysis of Harris Spent Fuel Pools C and D.

If you have any questions please feel free to contact me.

Sincerely,

Scott H. Pellet
Scott H. Pellet
Project Manager

cc: Holtec Engineering File 80964
Holtec Contracts file

Document ID: 80964SP1

Davis Exhibit 6

(2

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

July 15, 1999

Carl Terry, BWRVIP Chairman
Niagara Mohawk Power Company
Post Office Box 63
Lycoming, NY 13093

SUBJECT: FINAL SAFETY EVALUATION OF "BWR VESSEL AND INTERNALS PROJECT, REACTOR PRESSURE VESSEL AND INTERNALS EXAMINATION GUIDELINES (BWRVIP-03) REVISION 1" (TAC NO. M95369)

Dear Mr. Terry,

The NRC staff has completed its review of the Electric Power Research Institute (EPRI) Report TR-105696-R1, "BWR Vessel and Internals Project: Reactor Pressure Vessel [RPV] and Internals Examinations Guidelines (BWRVIP-03) Revision 1," dated March 30, 1999. This report was submitted in response to the NRC staff's initial safety evaluation dated June 8, 1998, regarding your initial submittal of the BWRVIP-03 report dated November 10, 1995, as supplemented by letters dated April 16, 1996, and March 12 and July 7, 1997. The BWRVIP-03 report, as revised, proposed guidelines for NDE techniques and inspection standards intended for voluntary implementation by BWR licensees in order to effectively examine and ensure the integrity of safety-related RPV internal components.

The NRC staff has reviewed the revised BWRVIP-03 report and finds, in the enclosed Safety Evaluation (SE), that the guidance of the BWRVIP-03 report is acceptable for inspection of the subject safety-related RPV internal components. This finding is based on information submitted by the above letters. The staff has concluded that licensee implementation of the guidelines in BWRVIP-03, Revision 1, will provide an acceptable level of quality for examination of the safety-related components addressed in the BWRVIP-03, Revision 1, document. This letter also closes the open items on the BWRVIP-03 report in the staff's SE's for the following BWRVIP reports:

BWRVIP-18, "BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines," SE dated June 8, 1998;

BWRVIP-26, "BWR Vessel and Internals Project, BWR Top Guide Inspection and Flaw Evaluation Guidelines," SE dated May 18, 1999;

BWRVIP-42, BWRVIP Vessel and Internals Project, "BWR Vessel and Internals Project, LPCI Coupling Inspection and Flaw Evaluation Guidelines," SE dated June 14, 1999

BWRVIP-47, "BWR Vessel and Internals Project, BWR Lower Plenum Inspection and Flaw Evaluation Guidelines," SE dated April 7, 1999; and,

BWRVIP-48, "BWR Vessel and Internals Project, Vessel [Inner Diameter] ID Attachment Weld Inspection and Flaw Evaluation Guidelines," SE dated March 21, 1999.

Please contact C. E. (Gene) Carpenter, Jr., of my staff at (301) 415-2169, if you have any further questions regarding this subject.

Sincerely,

Jack R. Strosnider, Director
Division of Engineering
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc: See next page

Please contact C. E. (Gene) Carpenter, Jr., of my staff at (301) 415-2169, if you have any further questions regarding this subject.

Sincerely,

Jack R. Strosnider, Director
Division of Engineering
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc: See next page

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U.S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION SAFETY EVALUATION OF "BWR VESSEL AND INTERNALS PROJECT, REACTOR PRESSURE VESSEL AND INTERNALS EXAMINATION GUIDELINES (BWRVIP-03) REVISION 1

1.0 INTRODUCTION

1.1 Background

By letters dated November 22, 1994, and April 21, 1995 (References 1 and 2), the Boiling Water Reactor Vessel and Internals Project (BWRVIP) submitted the reports, "BWR Core Shroud Inspection and Evaluation Guidelines, Revision 1," and the "BWRVIP Core Shroud NDE Uncertainty and Procedure Standard," respectively, for NRC staff review. The staff, with technical assistance from Brookhaven National Laboratory (BNL), assessed these reports in its safety evaluation (SE), dated June 16, 1995, (Reference 3). The BWRVIP then submitted the EPRI proprietary report TR-105696, "BWR Vessel and Internals Project, Reactor Pressure Vessel [RPV] and Internals Examinations Guidelines (BWRVIP-03)," by letter dated November 10, 1995, (Reference 4). The BWRVIP-03 report superseded References 1 and 2. It contained sections not in the original document, including Section 5, "Shroud Support," and Section 6A, "Standards for Visual Inspection of Core Spray Piping, Spargers, and Associated Components." The BWRVIP-03 report was supplemented by letters dated April 16, 1996, and March 12 and July 7, 1997, (References 6, 13, and 15, respectively).

The BWRVIP-03 report proposed guidelines for NDE techniques and inspection standards intended for voluntary implementation by BWR licensees in order to effectively examine and ensure the integrity of safety-related RPV internal components. The BWRVIP-03 report was structured to eventually address the examination of all components under the charter of the BWRVIP. The BWRVIP plans to update the BWRVIP-03 report twice a year to incorporate the results of ongoing NDE demonstrations and the inspection of the remaining internal components. The BWRVIP intended, in submitting the BWRVIP-03 report, to provide proven, documented NDE techniques and inspection standards to effectively examine susceptible BWR internal components to ensure their structural integrity.

By letter dated June 8, 1998, (Reference 17), the Staff forwarded its initial SE of the BWRVIP-03 report to the BWRVIP. This SE had several open items, repeated below, and requested that the BWRVIP address these issues in a timely manner. In response, the BWRVIP submitted EPRI Report TR-105696-R1, "BWR Vessel and Internals Project: Reactor Pressure Vessel and Internals Examinations Guidelines (BWRVIP-03) Revision 1," dated March 30, 1999, (Reference 18), which addressed the open items in the staff's June 8, 1998, SE.

1.2 Purpose

The staff reviewed the BWRVIP-03, Revision 1, report to determine whether its amended guidance would provide adequate NDE techniques and inspection standards to effectively examine susceptible BWR internal components to ensure their structural integrity.

1.3 Organization of this Report

The BWRVIP-03, Revision 1, report is proprietary; therefore, this SE was written to ensure that proprietary information was not compromised. Because of proprietary information concerns, this SE does not discuss in any detail the provisions of the guidelines nor the parts of the guidelines that the staff finds acceptable.

This SE gives a brief summary of the general contents of the report in Section 2.0 and the detailed evaluation in Section 3.0, below. In Section 3.0, the staff evaluates relevant parts of the BWRVIP-03, Revision 1, report, and associated documentation, to determine if items documented in the staff's June 18, 1998, SE (Ref. 17) have been satisfactorily addressed. It then compares the BWRVIP-03, Revision 1, report (Ref. 18) to the original BWRVIP-03 report (Ref. 4), to determine whether new material had been added that had not been previously evaluated or differed from the information upon which the Ref. 17 SE was based. The staff's conclusions are summarized in Section 4.0.

2.0 SUMMARY OF BWRVIP-03, REVISION 1

The BWRVIP-03, Revision 1, report addresses the following topics in the following order:

- General Procedures: defines the process for BWRVIP member utilities and their vendors to use mockups developed by the BWRVIP. Details a consistent and formal manner that demonstrations of inspection tooling and NDE techniques on realistic mockups are performed, documented and reported.

- Visual Examination Accuracy Demonstration: describes the protocol for determining uncertainties in visual inspections, including NDE uncertainty measurements and evaluation factors, and standards for visual examinations (VT).

- Inspection Considerations and Technique Demonstrations: details the inspection considerations that are to be used in examining the various BWR internals. Describes applicable mockups, delivery systems for the inspection tooling, and the technique demonstrations to be used for the various examination methods (e.g., ultrasonic (UT), eddy current (ET), and VT) for the core shroud, shroud support, core spray piping and sparger, top guide, core plate, low pressure coolant injection (LPCI) coupling, jet pump assemblies, standby liquid control, vessel attachments, components located in the lower plenum, and instrument penetrations.

3.0 NRC STAFF EVALUATION

3.1 Evaluation of the BWRVIP-03 Report and Associated Documentation to Determine If Staff Concerns Documented in the SE Dated June 16, 1995, Have Been Satisfactorily Addressed.

The staff's June 8, 1998, SE, provided a list of nine items that were the subject of the staff's June 16, 1995, SE. The BWRVIP, in its letters of May 17 and June 6, 1996, (Ref. 7 and 8) addressed the majority of these items, except for Item 6, which expressed the staff's concern regarding the completion and evaluation of full size mockups for assessing the performance of NDE techniques for core shroud evaluations. The BWRVIP responded that two mockups of ring segment welds have been fabricated (BWRVIP-G and BWRVIP-H) and were being evaluated by NDE. A report for these evaluations was planned for summer of 1996; however, at the time the staff provided its initial SE (Ref. 17), the BWRVIP had not provided the results of these evaluations for staff review. The BWRVIP-03, Revision 1, report addressed this item. The staff reviewed the subject information and finds that the BWRVIP activities adequately addressed this item.

3.2 <u>Evaluation of the BWRVIP-03 Report with Respect to New Material and Differences from Original Documents.</u>

The staff compared the original BWRVIP-03 report (Reference 4) to the original documents (References 1 and 2) to determine whether new material had been added that had not been previously evaluated or differed from the information upon which the staff's June 16, 1995, SE was based. The staff issued a request for information dated March 12, 1997, (Ref. 13), to which the BWRVIP responded in its letter of June 30, 1997, (Ref. 14). Having evaluated the BWRVIP's response, the staff identified several items for resolution. These are repeated below, along with the BWRVIP's response to the items as provided in Reference 18, dated March 30, 1999, and the staff's disposition of the BWRVIP's responses.

Item 3.2-1 Paragraph 4.1 specifies that personnel evaluating inspection data be certified in the VT-1 method (as required by the American Society of Mechanical Engineers (ASME) Code, Section XI) only. The staff believes that this certification is not sufficient to show the competence of the personnel evaluating inspection data with enhanced visual testing (EVT-1) and the visual inspection of core spray components (CS-VT-1). EVT-1 and CS-VT-1 are more demanding examinations; i.e., they are performed underwater, in radiation environments, and require more specialized equipment. The personnel must also be able to resolve finer targets, 1/2- and 1-mil, underwater, versus the 1/32-inch, in air, required by VT-1. Therefore, the staff concludes that the personnel also need to be certified in (1) EVT-1 and (2) CS-VT-1.

Response: The BWRVIP agrees that there is a need for the additional training and/or experience and has prepared the required guidance to assess the qualifications of those inspection personnel. The "Generic Standards for Visual Examination of Reactor Pressure Vessel Internals, Components, and Associated Repairs" is included in Revision 1 to BWRVIP-03. This Generic Standard combines the previous Shroud and Core Spray Visual Standards and provides the minimum requirements and recommendations for the performance of underwater in-vessel visual inspections (IVVI) of reactor pressure vessel (RPV) internals. The standard establishes additional training and experience requirements for those individuals performing the inspections. Utilities review personnel certifications and training documentation to assure the additional BWRVIP training and experience requirements are met.

NDE industry practice calls for a single certification for each NDE method (e.g. magnetic particle, penetrant, and ultrasound) as specified in ASNT-TC-1A. There may be additional training and *qualifications* required for personnel performing various techniques within a method – such as solvent removable, post-emulsified, visible, or fluorescent techniques within the dye penetrant method – but there is only one *certification*. Since VT-1 allows both the direct and remote application, the EVT-1 is just an extension of remote visual. The remote and direct visual techniques are different in application, however ASME Section XI does not require an additional certification. The BWRVIP feels that the different visual techniques are analogous to the different techniques for other NDE methods, and thus, only additional training and experience are required, but not additional certifications. Although the BWRVIP may recommend additional training or experience for specific activities, certification of nondestructive testing personnel is the domain of the ASME Boiler and Pressure Vessel Code and the ASNT. BWRVIP does not believe it should alter the present consensus process for certification of NDE personnel in the nuclear industry, and feels that the certification, experience, and training recommendations contained in the Generic Standard provide adequate assurance of EVT-1 personnel capability.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

Item 3.2-2 Paragraph 4.3 addresses personnel training. The staff questioned the amount of facility specific training for performing the inspections recommended by the BWRVIP. The BWRVIP responded that it has no recommendation for site-specific training. This answer is inadequate. There needs to be some minimum amount of site-specific training required of even the most easily inspected plants since each plant is unique and has certain characteristics that could affect the validity of an inspection.

Response: The BWRVIP originally intended that the training in Paragraph 4.3 be given prior to the inspections for each refueling outage. However, this was not clear as written in this document, and as submitted to the NRC. This is clarified in Revision 1 to BWRVIP-03. The obvious advantage of this is that the inspections will be performed shortly after a refresher orientation covering the plant-specific configuration, equipment, and procedures.

The mix of visual examination data evaluators at a particular refueling outage can range from the use of only utility personnel to the use of only contractor personnel, or it could be a combination of both. The evaluators could be the same people that have been there for many refueling outages, or it could be their first time at that plant. It can be seen then, that the previous plant-specific experience has a large effect on the amount of training necessary to meet this requirement.

Additionally, the scope of inspections will vary from outage to outage. The components to be inspected and the complexity of those inspections, along with previous inspection results, may vary widely. A specific plant may have many components scheduled for inspection, whereas another plant may only have a few components. It can also be seen that as inspection history grows, the amount of necessary training may increase.

As stated in the NRC concern, each plant is unique and the amount of plant-specific training will vary. This is not only because of the uniqueness of the plant, but it is also affected by the outage scope, previous experience of evaluation personnel with the plant, and previous inspection results. To accommodate this wide array of scenarios, the BWRVIP does not believe that specifying a minimum amount of time is appropriate. If a minimum amount of time were to be specified, it may be inadequate for plants with large scopes of work and inspection personnel without previous plant-specific experience, regardless of plant configuration complexity. *A minimum specified time may not require the utility to make a realistic assessment of the amount of training hours actually needed.* In light of this clarified interpretation of Paragraph 4.3 as it relates to a pre-inspection orientation rather than a one-time training function, it can be seen why the BWRVIP recommends additional site-specific training, but lets the utility determine at their discretion the duration of the training. The BWRVIP clarified Paragraph 4.3 to state that this orientation training will be conducted prior to inspections at each refueling outage, and the length of the training will be based on the outage inspection scope, the inspection history, and the familiarity of data evaluators with the plant.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

Item 3.2-3 Subsection 8 of Section 4B concerns the documentation of results. The staff questioned whether the amount of training time in the use of equipment used for visual inspection and in aspects of inspection specific to a given site was specified and documented. The BWRVIP responded that training time and other details of personnel qualification and certification are not considered a necessary part of the documentation of an examination. This answer is inadequate for the following reasons:

- Visual inspection is relied upon as a primary method of inspection of internals.
- The qualification of personnel performing visual inspections is important as discussed in Item 3.2-1.
- To the staff's knowledge, this information would not be documented elsewhere.
- This information would be important for possible future evaluations.

Response: The BWRVIP agrees that the amount of training time and experience is important to the examination. Therefore, "Generic Standards for Visual Examination of Reactor Pressure Vessel Internals, Components, and Associated Repairs" requires documentation of all specified experience and training.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

Item 3.3-1 Paragraph 4.1 specifies the certification of personnel evaluating inspection data. See discussion under Item 3.2-1.

Response: See Response to 3.2-1.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

Item 3.3-2 Paragraph 4.3 addresses personnel training. See discussion under Item 3.2-2.

Response: See Response to 3.2-2.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

Item 3.3-3 Subsection 9 concerns the documentation of results. See discussion under Item 3.2-3.

Response: See Response to 3.2-3.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

Item 3.3-4 Upon cross-referencing the recommendations of Reference 10 to the BWRVIP-03 report, the staff finds that the scope of Section 6A is limited to EVT-1. The scope needs to cover standards for all the types of visual examinations specified in Reference 10. These include CS-VT-1, VT-1 and VT-3. (In contrast, the staff found no such limitation of scope in Section 4B).

Response: The BWRVIP has consolidated its visual inspection guidance into one standard (as previously noted in Response 3.2-1), "Generic Standards for Visual Examination of Reactor Pressure Vessel Internals, Components and Associated Repairs." This standard addresses all types of visual examination techniques employed by the BWRVIP program. This change is documented in Revision 1 of BWRVIP-03.

Integral to the change is the elimination of the CS-VT-1 and MVT-1 methods. Thus the remaining visual examination methods will be the EVT-1, VT-1 and VT-3.

The definition of and requirements for VT-1 and VT-3 will continue to be the same as that in ASME Section XI. Members will perform the examinations that use these methods in accordance with their current written practice using each plant's existing procedures for these methods. This will eliminate confusion and contradictions between procedures implementing the BWRVIP inspections and existing procedures for code and other examinations.

As noted above, CS-VT-1 and MVT-1 are eliminated. BWRVIP through its assessment of the efficacy of the various methods concluded that there was not a meaningful difference between the EVT-1 and the MVT-1 (CS-VT-1 in BWRVIP-18). Examinations that previously were to be conducted using those methods will be performed using the EVT-1, VT-1 or VT-3 methods in the future. The EVT-1 method will be specified as the primary technique to be used when fine, tight IGSCC is a primary concern. In other locations, VT-1 or VT-3 will be used as appropriate.

The only real difference in the two methods was the resolution check (1/2 mil wire for EVT-1 vs. 1 mil wire for MVT-1) performed prior to the examination starting. This resolution check is used to demonstrate the resolution capabilities of the system in the environment and does not provide the complete means to determine the techniques detection capabilities. Rather, the detection capability of a particular visual technique is determined by important factors such as the surface condition, camera to object distance (or field of view for zoom type cameras) and camera lighting angles. These attributes are not controlled by the equipment/system resolution check. The more important aspects of the examination are those things that an examiner does after the simple system resolution check. BWRVIP members have complied with the existing BWRVIP recommendations, which already address these important factors.

As described in the previous paragraph, the resolution check of the system is essentially a quality assurance verification for the system. As such, the resolution check of a ½ mil wire vs. a 1 mil wire provides little difference to the overall sensitivity of the examination. Adequacy of the examination is controlled by the efforts of the examiner. Industry experience has shown that inspection personnel typically verify surface texture identifiers such as grinding and machining marks, weld beads and ripples, etc., before performing examinations to assure that proper visual resolution is attained. This leads one to conclude there is in fact little, if any, real difference between the examinations performed using EVT-1 versus the MVT-1 methods. Therefore, reassessment of previously performed examinations for the purpose of quality assurance verification is not required and the examinations previously performed using MVT-1 are deemed acceptable.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

Item 3.3-5 Unlike Subsection 6 of Section 4B, Subsection 6 of Section 6A does not require that the effectiveness of cleaning be demonstrated. The effectiveness of surface cleaning needs to be demonstrated for all visual examinations, not just for those affecting the core shroud.

Response: The NRC is correct in pointing out that the visual technique for the core spray should be consistent with the one for the shroud. The BWRVIP recognized this and incorporated this change into Revision 1 to BWRVIP-03. In Revision 1, the Core Shroud Visual Inspection Standard was replaced by the "Generic Standards for Visual Examination of Reactor Pressure Vessel Internals, Components, and Associated Repairs." The Generic Standard will be used when the BWRVIP Inspection and Evaluation Guidelines specify visual inspection.

A cleaning assessment will still be required by the Generic Standard prior to performing an EVT-1 inspection whether the area is inspected in the "as found" or cleaned state. The Generic Standard will provide guidance with objective criteria that has been obtained from industry experience on determining when the surface is suitable for inspection. The objective criteria for the cleaning assessment includes surface texture identifiers such as grinding and machining marks, weld beads, ripples, etc. As an example, if a cleaning was performed in the previous outage, or components are in a high flow region, pre-inspection cleaning may not be necessary. However, the guideline provides means to assess this in all cases and does not provide for automatic exemption from cleaning when an EVT-1 inspection is to be performed. These changes will enhance the visual inspections currently being performed by the BWRVIP.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

Item 3.4 Concerning the guidance presented, this section [Section 5] appears to be incomplete. Mockups were made for just 3 of the shroud support welds, demonstrations were applicable to only one of those welds, and those demonstrations were for UT only. Qualification of UT and VT inspection methods for specific shroud support weld configuration remains to be completed. This item will be addressed in the staff's review of BWRVIP-38, "Shroud Support and Flaw Evaluation Guidelines," dated September 15, 1997.

Response: Revision 1 to BWRVIP-03 includes additional demonstrations that have been completed, including additional mockups of the shroud support welds. The demonstrations for several techniques, including UT, VT and eddy current (ET), have been conducted satisfactorily. As future demonstrations are completed they will be added under subsequent revisions. As a note, demonstrations become valid as soon as they are documented by EPRI.

Evaluation: The staff finds that the BWRVIP's response adequately addressed this item.

3.3 Evaluation of Section 5, "Shroud Support"

The staff previously found in its June 8, 1998, SE (Ref. 17) that this section appeared to be incomplete. As described in the original BWRVIP-03 report (Ref. 4), mockups were made for just 3 of the shroud support welds, demonstrations were applicable to only one of those welds, and those demonstrations were for UT only. The qualification of UT and VT inspection methods for specific shroud support weld configurations remain incomplete.

The BWRVIP has significantly expanded this section of the BWRVIP-03, Revision 1, report. In addition, the staff is completing its review of BWRVIP-38, "Shroud Support and Flaw Evaluation Guidelines," dated September 15, 1997. As such, the staff finds that the BWRVIP has adequately addressed this item.

4.0 CONCLUSIONS

The staff has completed its review of the BWRVIP-03, Revision 1, report and finds that the licensee implementation of the guidelines in BWRVIP-03, Revision 1, will provide an acceptable level of quality for examination of the safety-related components addressed in the BWRVIP-03, Revision 1, document.

5.0 REFERENCES

1. BWRVIP letter to NRC dated November 22, 1994, submitting the "BWR-VIP Core Shroud NDE Uncertainty and Procedure Standard."

2. BWRVIP letter to NRC dated April 21, 1995, submitting the "BWR Core Shroud Inspection and Evaluation Guidelines, Revision 1."

3. NRC letter to the BWRVIP dated June 16, 1995, providing safety evaluation titled, "Evaluation of BWR Core Shroud Inspection and Evaluation Guidelines, GENE-523-113-0894, Revision 1, dated March 1995, and BWRVIP Core Shroud NDE Uncertainty and Procedure Standard, dated November 22, 1994."

4. BWRVIP letter to NRC dated November 10, 1995, transmitting EPRI Report TR-105696, "BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examinations Guidelines (BWRVIP-03)."

5. BWRVIP letter to NRC dated February 2, 1996, "Electric Power Research Institute (EPRI) EPRI Topical Report TR-105747, BWR Vessel and Internals Project, Guidelines for Reinspection of BWR Core Shrouds (BWRVIP-07)."

6. BWRVIP letter to NRC dated April 16, 1996

7. BWRVIP letter to NRC dated May 17, 1996, titled "BWRVIP Response to NRC staff Concerns and Unresolved Items."

8. BWRVIP letter to NRC dated June 6, 1996, "Additional Response to NRC Staff Concerns and Unresolved Items."

9. BWRVIP letter to NRC dated July 17, 1996, titled "Clarifications to Core Shroud Reinspection Guidelines."

10. BWRVIP letter to NRC dated July 26, 1996, transmitting "BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines (BWRVIP-18)," EPRI Report TR-106740, July 1996.

11. BWRVIP letter to NRC dated October 21, 1996, titled "BWRVIP Response to Request for Additional Information Regarding Proprietary Topical Report EPRI TR-105747."

12. BWRVIP letter to NRC dated January 8, 1997 titled "Modification to BWRVIP Response to NRC Request for Additional Information on BWRVIP-07."

13. NRC letter to the BWRVIP dated March 12, 1997, "Proprietary Request for Additional Information - Review of BWR Vessel and Internals Project Reports, BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines."

14. BWRVIP letter to NRC dated June 30, 1997, titled "BWRVIP Response to NRC Request for Additional Information on BWRVIP-03."

15. BWRVIP letter to NRC dated July 7, 1997

16. NRC letter to the BWRVIP dated September 15, 1997, providing the NRC Staff's Safety Evaluation of EPRI Topical Report TR-105747 "BWR Vessel and Internals Project, Guidelines for Reinspection of BWR Core Shrouds (BWRVIP-07)."

17. NRC letter to the BWRVIP dated June 8, 1998, providing the Staff's initial safety evaluation of the BWRVIP-03 report.

18. BWRVIP letter to NRC dated March 30, 1999, EPRI Report TR-105696-R1, "BWR Vessel and Internals Project: Reactor Pressure Vessel and Internals Examinations Guidelines (BWRVIP-03) Revision 1."

Davis Exhibit 7

50-325/32

(3)

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

March 16, 1995

Mr. R. A. Anderson
Vice President
Carolina Power & Light Company
Brunswick Steam Electric Plant
Post Office Box 10429
Southport, North Carolina 28461

SUBJECT: EXAMINATION OF FEEDWATER SPARGERS AND N4D FEEDWATER NOZZLE, BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 & 2 (TAC NO. M85922)

Dear Mr. Anderson:

In a letter dated October 28, 1994, Carolina Power & Light Company (CP&L) notified the U.S. Nuclear Regulatory Commission (NRC) that its plan to replace the Brunswick Steam Electric Plant (BSEP), Unit 1, feedwater spargers during refueling outage 9 (B110R1) had been modified. Based on the results of previous inspections and its commitment to perform future inspections, the licensee stated that replacement of the BSEP, Unit 1, spargers does not warrant the radiation exposure or the resource commitment needed to perform the work. Rather than replace the feedwater spargers, CP&L will continue the examinations in accordance with NUREG-0619, "BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking." Furthermore, since the spargers will not be replaced, the feedwater nozzle N4D will also not be replaced, as previously committed to. A previous non-destructive examination (NDE) confirmed that an earlier identified indication in the weldment for this nozzle was not connected to the inside surface and did not have intergranular stress corrosion cracking (IGSCC) characteristics. The indication was considered to be a mid-wall discontinuity associated with an original fabrication weld repair. On May 20, 1993, the NRC concurred with the CP&L reclassification of the weldment as Category D, pursuant to NUREG-0313, and no longer required further examinations because of the planned nozzle replacement.

On February 3, 1995, the licensee requested NRC concurrence with CP&L plans to perform visual (VT) examinations during future inspections of the Unit 1 and Unit 2 feedwater spargers in lieu of liquid penetrant (LP) examinations. The VT examinations will utilize an underwater, high resolution, remote-operated camera and be performed in accordance with the minimum requirements for VT-1 examinations specified in the 1980 Edition/Winter 1981 Addenda of the American Society of Mechanical Engineers (ASME) Code, Section XI, IWA-2211. LP examination of the feedwater spargers was initiated after VT examination identified cracking emanating from the side of drilled flow holes. In a letter dated June 6, 1991, the NRC stated that CP&L should continue to perform LP examinations of the spargers to ensure that the cracks have not progressed to a stage requiring complete sparger replacement. LP examination of the spargers requires that the reactor vessel be deflooded which exposes personnel conducting the examination to increased radiation fields. The VT examination

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is expected to save approximately 8 person-rem during each refueling outage. In a letter dated June 24, 1993, the NRC previously approved an outage-specific request to perform VT in lieu of LP examination of the feedwater spargers on Unit 2.

On August 1, 1994, CP&L submitted the results of the NDE of the feedwater spargers that was performed during the BSEP, Unit 1, refueling outage 8 (B109R1). The NDE encompassed the inspection of the 8 circumferential welds joining the sparger arms to the tees, the 4 circumferential welds joining the thermal sleeves to the tees, and 56 pre-selected holes of the 144 sparger arm flow holes. The NDE results indicate continued slow growth of the cracking emanating from the flow holes. No segments of the spargers have separated from around the holes because of the cracks. While there were no liquid penetrant (LP) indications noted on the thermal sleeve to tee welds, the LP examination found that 6 of the 8 sparger arm-to-tee circumferential welds had circumferentially oriented indications on the outside diameter (OD). Subsequent ultrasonic testing (UT) of these welds found that the crack extended approximately 0.25 - 0.30 inch beyond the length of the observed LP indication at the inside diameter (ID). The longest indication in the tee to arm welds was a 2.5 inch crack ID on the left weld at the 135° azimuth tee. The cracks start from the flow holes and, upon reaching the heat-affected zone (HAZ) of a circumferential weld, grow downward through the HAZ.

On December 21, 1994, CP&L submitted the results of the NDE of the feedwater spargers that was performed during the BSEP, Unit 2, spring 94 refueling outage 10 (B211R1). The NDE encompassed VT of the 8 circumferential welds joining the sparger arms to the tees and all the flow holes to the extent possible using an underwater, high resolution, remote-operated camera. The examination determined that the circumferential weld cracks were in the same condition as in the previous Unit 2 examination, i.e., all of the cracks were on the flow hole side of the spargers. The cracks extend downward following the HAZ of the circumferential welds. There was no appreciable change in the length or number of cracks. The flow holes continued to show slow crack growth. Some new cracking was seen around the flow holes; however, the new cracks were not as long as existing cracks, and the licensee concluded their size and orientation did not represent an increase in the probability of loose sparger pieces in the vessel. The longest existing crack found in Unit 2 was on the 135° sparger and measured 2 inches at the OD. Previous UT examination on Unit 2 of the circumferential welds confirmed that no crack extended beyond the length of the observed LP indication.

In the February 3, 1995, request described above, CP&L noted that LP examinations of both Units' feedwater spargers during previous plant outages have shown that the crack growth rate at the circumferential welds is negligible. The NRC staff previously reviewed the General Electric Company (GE) analysis for both units which showed that the maximum predicted crack length before structural failure is 14.1 inches and the maximum predicted crack growth rate is 3.16 inches per operating cycle. Based upon this maximum crack growth rate, the longest Unit 1 and Unit 2 cracks at the end of their present operating cycles would be 5.7 and 5.16 inches respectively.

In its October 28, 1994, letter, CP&L submitted the feedwater nozzle fracture mechanics analysis for the limiting location prepared by GE to show compliance with NUREG-0619 and NRC Generic Letter 81-11. The analysis showed, by using the 1989 American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, fatigue crack growth curves, that the postulated 0.25 inch crack becomes 0.56 inch deep after the 40-year plant design life. The results also show that stress cycling from actual temperature and flow profiles results in the growth of an initial 0.25 inch crack to less than 1 inch during the remaining plant life. Also, CP&L stated that no cracking in the blend radius of the N4D nozzle has been found by UT from the OD or by LP testing from the ID.

After reviewing the information provided with the August 1, 1994, October 28, 1994, December 21, 1994, and February 3, 1995 letters, the NRC staff finds your decision to not replace the BSEP, Unit 1, feedwater spargers and the N4D feedwater nozzle to be acceptable. This is based on the last NDE results and your commitment to resume the inspections of the feedwater nozzle and continue inspection of the spargers in accordance with NUREG-0313 and NUREG-0619. Although having concurred in the May 20, 1993, letter with the discontinuation of the crack arrest verification system autoclave; due in part to the decision to replace this nozzle, the NRC will not require the resumption of this testing because the indication is not on the ID and is not IGSCC. Additionally, the NRC staff finds your decision to perform visual (VT) examinations during future inspections of the Unit 1 and Unit 2 feedwater spargers in lieu of liquid penetrant (LP) examinations acceptable based upon the sensitivity of the VT examination technique, the present crack length as compared with the maximum allowable, and the observed and maximum calculated crack growth rates. However, CP&L is requested to continue to provide the NRC staff with a summary of the results of the inspections of the feedwater nozzle and spargers and any contingency repairs made based on examination findings.

If you have any questions, please contact me.

Sincerely,

David C. Trimble

David C. Trimble, Project Manager
Project Directorate II-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket Nos. 50-325 and 50-324

cc: See next page

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Davis Exhibit 8

January 22, 1999

7D4

Mr. Roger O. Anderson, Director
Nuclear Energy Engineering
Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

SUBJECT: PRAIRIE ISLAND NUCLEAR GENERATING PLANT - EVALUATION OF REQUEST FOR APPROVAL OF AN ALTERNATIVE TO THE ASME CODE ON SURFACE EXAMINATION AND WELD OVERLAY OF CANOPY SEAL WELDS FOR CONTROL ROD DRIVE MECHANISM (TAC NOS. MA4254 AND MA4255)

Dear Mr. Anderson:

By letter dated November 30, 1998, Northern States Power Company (NSP) proposed an alternative to the surface examination requirements of paragraph N-518.4 of the 1968 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code for control rod drive mechanism canopy seal welds. In lieu of the liquid penetrant surface examination required by the ASME Boiler and Pressure Vessel Code, the proposed alternative is to make weld repair/overlays using an automatic welding process with visual examinations of the weld area with a remote video camera and a post-outage system leakage test inspection. The proposed alternative would be used in the examination of one canopy seal weld repair and in the examinations of weld overlays applied on other non-repaired canopy seal welds.

The staff has reviewed the NSP's proposed alternative and concludes that the proposed alternative provides an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the use of the proposed alternative. The detailed results of the staff review are provided in the enclosed safety evaluation. If you have any questions concerning this action please call T. J. Kim of my staff at (301) 415-1392.

Sincerely,
ORIGINAL SIGNED BY

Cynthia A. Carpenter, Director
Project Directorate III-1
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Docket Nos. 50-282 and 50-306
Enclosure: Safety Evaluation
cc w/encl: See next page

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Mr. Roger O. Anderson, Director
Northern States Power Company

Prairie Island Nuclear Generating
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Prairie Island Indian Community
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REVIEW OF PROPOSED ALTERNATIVE TO THE ASME CODE

ON SURFACE EXAMINATION OF WELD REPAIRS AND OVERLAYS

TO NON-STRUCTURAL CANOPY SEAL WELDS

PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2

NORTHERN STATES POWER COMPANY

DOCKET NOS.: 50-282 AND 50-306

1.0 INTRODUCTION

Pursuant to 10 CFR 50.55a(a)(2), systems and components of boiling and pressurized water-cooled nuclear power reactors must meet the requirements of ASME Boiler and Pressure Vessel Code specified in paragraphs (b), (c), (d), (e), (f), and (g) of this section. 10 CFR 50.55a(a)(3) proposed alternatives to the requirements of paragraphs (c) through (h) of this section or portions thereof may be used when authorized by the NRC. The applicant shall demonstrate that (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

By letter dated November 30, 1998, Northern States Power Company (the licensee) proposed an alternative to the surface examination requirements of paragraph N-518.4 of the 1968 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (the code of record for Prairie Island) for control rod drive mechanism (CRDM) canopy seal welds. In place of the liquid penetrant (PT) surface examination required by the ASME Boiler and Pressure Vessel Code, the licensee-proposed alternative is to make weld repair/overlays using an automatic welding process, to perform visual examinations of the weld area with a remote 8x video camera, and to perform a post-outage system leakage test inspection. The proposed alternative would be used in the examination of one canopy seal weld repair and in the examinations of weld overlays applied on non-repaired canopy seal welds. The seal weld repair is at location E11 on the lower canopy seal weld. The weld overlays will be performed as a preemptive measure on the lower and intermediate canopy seal welds during the upcoming refueling outages.

The seal welds are used to ensure leak tightness of threaded joints holding the rod travel housing to the CRDM housing. Each seal weld is a small groove weld applied to a small protrusion ("canopy") over the end of the threads. Since the threads constitute the pressure boundary, the seal weld is non-structural. The presence of the canopy protrusion provides a weld surface that avoids fusion of the ends of the threads and allows the seal weld to be more readily removed when necessary. The weld repair/overlays will increase the wall thickness of the protrusion at the seal weld.

2.0 DESCRIPTION

2.1 Request for Relief

The licensee requested relief from the PT testing requirements in N-518.4 of the 1968 Edition of Section III of the ASME Code for weld repair/ overlays of CRDM canopy seal welds.

2.2 Basis for Relief

Paragraph N-518.4 of the 1968 Edition of Section III of the ASME Code requires that attachments welded to the pressure boundary be inspected by means of a PT. However, PT weld examinations of the canopy seal welds are difficult. Surface preparation (grinding) of the welds, PT examination, and subsequent cleanup would have to be performed around obstacles, would be time consuming, and would incur substantial personnel radiation exposure. Access between CRDMs is limited with a separation of approximately 7.2 inches, and canopy seal welds are in a high radiation field of approximately 400 mr/hr.

2.3 Proposed Alternative

The licensee proposed the following alternative to the liquid penetrant testing requirements for the weld repair/overlays described above:

- The use of a controlled automatic welding process.
- The observation of the weld puddle/deposit via a 8x camera during the welding process.
- A final visual examination of the weld surface using the same 8x camera.
- The performance of a VT-2 inspection of the canopy seal weld area for leakage during the post-outage system leakage test inspection.
- The authorized nuclear inservice inspector approval of alternative testing and NIS-2 acceptance.

3.0 EVALUATION

The 1968 Edition of Section III of the ASME Code specifies that a surface examination be performed on weld repaired areas (para. N-514.2) or welded attachments (para. N-518.4). These paragraphs require PT examination be performed in accordance with N-627. In paragraph N-627, the most stringent acceptance criteria is the requirement for "no linear indications." For the proposed alternative, a no linear indication criteria is unrealistic. Instead, the licensee calculated the critical flaw (crack) size with fracture mechanics and limit load analysis, then demonstrated a video camera system that had the capability of finding flaws smaller than the critical flaw size.

The licensee submitted a test report giving the results of a resolution test for the camera equipment that will be used by the welding contractor during the weld repair/overlays. In the test, a 0.0005-inch diameter by 0.4-inch long wire was used to simulate a crack. The wire was taped to the surface next to a mock-up production weld. A review of the video recording made during the demonstration showed that the camera system was capable of recording the image of the test wire.

Since the camera demonstration was with a simulated crack, the licensee performed a bounding analysis using limit load (net section collapse) and linear elastic fracture mechanics (LEFM) analyses to determine critical crack size. Using the limit load method, the critical longitudinal and circumferential through-wall crack lengths were 4.3 inches and 8.1 inches, respectively. Using LEFM, the critical longitudinal and circumferential through-wall crack lengths were 5 inches and 7.8 inches, respectively. The limit load analyses provide the most realistic calculation of the maximum tolerable crack length. Although known to be less accurate for the high toughness materials used, the LEFM results provide an independent verification of the limit load analyses.

Both sets of analyses give critical crack sizes 10 times larger then the length of wire detected in the weld head video camera performance demonstration. In the staff's opinion, the initiation and growth of a crack larger than the bounding critical length of 4.3 inches in and near a weld joining stainless steel-to-Inconel 600 material without being detected is unrealistic. Because of weld shrinkage, a crack, if present, would exhibit significant opening in the width dimension, thereby, enhancing detectability.

As part of the license's process control during welding, the video camera will be employed to monitor the weld puddle during performance of the production welds. The monitoring enables the welding operator to verify the welding process, take corrective actions during the course of welding, and to identify potential problem locations prior to weld completion. The licensee will also perform a VT-2 inspection of the canopy seal weld area for leakage during the post-outage system leakage test inspection. With this additional process monitoring capability, the licensee can provide reasonable assurance that any crack formed in or near the canopy seal weld will be detected. This technique is now commonly employed in the industry with positive results.

4.0 CONCLUSION

Based on the submittal and above discussion, the staff concludes that pursuant to 10 CFR 50.55a(a)(3)(i), the licensee's proposed alternative will provide an acceptable level of quality and safety.

Prinicpal Contributor: D. Naujock

Date: January 22, 1999

Davis Exhibit 9

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, SW. SUITE 23T85
ATLANTA, GEORGIA 30303-8931

December 28, 1999

Carolina Power & Light Company
ATTN: Mr. James Scarola
Vice President - Harris Plant
Shearon Harris Nuclear Power Plant
P. O. Box 165, Mail Code: Zone 1
New Hill, NC 27562-0165

SUBJECT: NRC INSPECTION REPORT NO. 50-400/99-12

Dear Mr. Scarola:

This refers to the inspection conducted on November 15 - 19, 1999, at your Harris facility. This was a special team inspection covering activities related to the planned expansion of the Shearon Harris spent fuel pool. The objectives of this inspection were to assess the implementation of the construction quality assurance program in construction of the C and D spent fuel pools, evaluate the alternate weld inspection program, and evaluate the plans for commissioning of the equipment for the C and D spent fuel pools (SFP).

The inspection found that CP&L had a comprehensive program to control, inspect, and document welding at the time of original plant construction in accordance with Section III of the ASME Boiler and Pressure Vessel Code, and NRC requirements. The inspection also found that the alternate weld inspection program was adequate to provide assurance that the welds for which documentation was missing, met design requirements. The program for commissioning of the C and D SFP equipment will be examined in an inspection tentatively planned for January 24 - 28, 2000. No violations of NRC requirements were identified during the inspection.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be placed in the NRC Public Document Room.

Sincerely,

Kerry D. Landis, Chief
Engineering Branch
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Docket No. 50-400
License No. NPF-63

Enclosure: NRC Inspection Report

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U. S. NUCLEAR REGULATORY COMMISSION

REGION II

Docket Nos.: 50-400

License Nos.: NPF-63

Report Nos.: 50-400/99-12

Licensee: Carolina Power & Light Company (CP&L)

Facility: Shearon Harris Nuclear Power Plant, Unit 1

Location: 5413 Shearon Harris Road
New Hill, NC 27562

Dates: November 15 - 19, 1999

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SUMMARY OF FINDINGS

Shearon Harris Nuclear Power Plant
NRC Inspection Report 50-400/99-12

The fuel pool cooling systems are described in Section 9.1.3 of the licensee's Updated Final Safety Analysis Report (UFSAR). The design basis for pools A and B, which support the operation of Unit 1, is identical to that for pools C and D. Because these pools are located in a single building and major system components needed to be installed during the early phase of construction, procurement and installation of the major system components for all four spent fuel pools was performed concurrently, in the late 1970s and early 1980s. In a letter dated December 23, 1998, the licensee requested an amendment to the Shearon Harris facility operating licensee to place spent fuel pools (SFP) C and D in service to increase the onsite spent fuel storage capacity. The licensee is currently operating and storing fuel in the A and B SFP. The majority of the C and D SFP were completed prior to 1982 during plant construction.

During preparation of the plans for completion of the C and D SPF, the licensee discovered that documentation for 52 welds on ASME Class III piping had been inadvertently destroyed. The 52 welds were 40 piping welds and 12 welded attachments for pipe hangers (lugs). The 40 piping welds included 15 spent fuel system welds which are embedded in concrete, 22 accessible spent fuel system welds, and 3 accessible component cooling system welds. Three of the accessible spent fuel system welds were subsequently removed and replaced with new welds, resulting in 37 piping welds with missing records. The most significant missing documents were the weld data reports (WDRs) for each of the welds. In order to demonstrate the weld quality for the welds with missing documentation, the licensee developed and implemented an alternative inspection program.

This special inspection included a review of the construction quality assurance (QA) and quality control (QC) program; the original construction QA/QC records; the licensee's alternative inspection program for welds with missing QA/QC records; the engineering service requests prepared to complete the C and D SFP; a walkdown inspection of the accessible C and D SPF components; and the licensee's program for commissioning of the C and D SFP. The inspectors used Temporary Instruction (TI) 2515/143 for guidance during this inspection.

The inspection found that the licensee had a comprehensive program to control, inspect, and document welding at the time of original construction in accordance with Section III of the ASME Boiler and Pressure Vessel Code, and NRC requirements. The inspection also found that the licensee's alternative weld inspection program was adequate to provide assurance that the welds for which documentation was missing, met design requirements. The licensee's program for commissioning of the C and D SFP equipment should ensure that existing equipment meets design requirements and will perform its design function. An Inspector Followup Item (IFI) was opened to inspect implementation of the equipment commissioning process. No violations were identified.

REPORT DETAILS

1. REVIEW OF THE LICENSEE'S CONSTRUCTION QUALITY ASSURANCE PROGRAM

1.1 Review of Quality Assurance and Quality Control Procedures

Inspection Scope

The inspectors reviewed Quality Assurance (QA) and Quality Control (QC) procedures that implemented the QA program requirements during construction.

Observations and Findings

The inspectors reviewed the licensee's ASME Quality Assurance Manual for the Construction of the Shearon Harris Nuclear Power Plant transmitted to NRC by letter dated dated April 30, 1999. This Manual described the quality assurance program that implemented the quality assurance requirements of ASME Boiler and Pressure Vessel Code, Section III, Division 1, Nuclear Power Plant Components, and applicable Federal, State and local regulations and codes. The Manual was applicable to fabrication and construction of ASME components which include the A, B, C and D spent fuel pools.

The inspectors reviewed the implementing QA and QC procedures listed below which controlled activities relating to weld quality. The procedures revisions were applicable to the time during 1979-1981 when the major weld activity for construction of the spent fuel pools occurred. Procedures reviewed were as follows:

Number, Revision	Title
CQA-1, Rev. 5	Personnel Training and Qualification
CQA-2, Rev. 0	QA Document Control
CQA-4, Rev. 5	QA Records
CQA-8, Rev. 3	Material Issue Surveillance
CQA-12, Rev. 0	Mechanical Equipment Installation Monitoring
CQA-14, Rev. 0	Application and Control of "N" Type Symbol Stamps
CQA-15, Rev. 0	Assignment and Control of National Board Serial Numbers
CQA-16, Rev. 0	Preparation and Submittal of ASME Code Data Reports
CQA-18, Rev. 0	Control of Site Fabrication/Modification of Piping Subassemblies
CQA-20, Rev. 0	Surveillance of Contractor Welding and Related Activities
CQA-22, Rev. 0	Welding Activity Monitoring
CQA-24, Rev. 0	Procurement Control
CQA-28, Rev. 0	QA Surveillance
CQA Appendix A	Quality Assurance Forms
CQC-2, Rev. 3	Nonconformance Control
CQC-4, Rev. 3	Procurement Control

CQC-6, Rev. 0Receiving Inspection
CQC-8, Rev. 3Storage Control
CQC-10, Rev. 0 Cleanness Control
CQC-12, Rev. 0 Mechanical Equipment Installation Control
CQC-13, Rev. 0 Concrete Control
CQC-19, Rev. 0 Weld Control
CQC-20, Rev. 0 Post-Weld Heat Treatment Control
CQC-22, Rev. 3 Hydrostatic Test Inspection
CQC-23, Rev. 0 Systems Turnover

The procedures were consistent with the CP&L QA program, established by the ASME QA Manual and NRC requirements, and defined specific process requirements in sufficient detail to provide for QA/QC control of welding activities.

A detailed review was performed for procedures CQC-19, Weld Control; CQC-22, Hydrostatic Test Requirements; and CQC-13, Concrete Control. This review was directed toward determining an alternate method to ascertain the quality of the field welds for which certain records were missing. These procedures are described below.

Weld Control

CQC-19 assigned the Welding QA/QC Specialist the responsibility for: review and verification of data and designated hold points in the Weld Data Reports (WDRs); ensuring completed WDRs for code welds were forwarded to the Authorized Nuclear Inspector (ANI) for review; supervising the QC Inspectors in the performance of weld inspections; and monitoring activities related to welding. QC inspection personnel were trained and qualified in accordance with CQA-1. The SFP field welds, which were ASME Code Class 3 welds, were documented on a WDR , reviewed and approved by the Welding QA/QC Specialist, and reviewed for acceptance by the ANI. The ANI performed an independent third party review. The responsibilities of the Welding QA/QC Specialist and QA inspection personnel were sufficiently defined to provide reasonable assurance that the quality of the completed field welds were in compliance with applicable ASME Code requirements. After the documentation of a field weld was determined to be acceptable, pertinent documents were assembled and the package was transmitted to QA Records in accordance with CQA-4.

Hydrostatic Test Inspection

CQC-22 established the requirements for performing hydrostatic test inspections to ensure that hydrostatic tests were performed in accordance with approved procedures and specifications. The Mechanical QA Specialist was responsible for verifying that the documentation for the piping was completed prior to performance of the hydrostatic test. This included verification that field welds within the scope of a hydrostatic test had been satisfactorily completed, inspected, and accepted. The Mechanical QA Specialist was also responsible for performance of the leak inspection during hydrostatic testing. QC inspection personnel also witnessed the test. The responsibilities of the Mechanical QA Specialist and QC inspection personnel were sufficiently defined to provide assurance that the quality of hydrostatic testing was in compliance with applicable procedures and specifications. After the documentation for a hydrostatic test had been accepted by the ANI, the pertinent documents were assembled and reviewed by the Mechanical QA Specialist, who verified that manufacturing/fabrication records for components within the boundaries of the test had been received and accepted and that there were no open nonconformances on any of the components.

Concrete Placement

CQC-13 and Construction Procedure WP-05, Concrete Placement, established the requirements for assuring all work activities in the area affected by a concrete pour were completed prior to placement of concrete. A prerequisite to placement of concrete was the completion of a Concrete Placement Report, which signified that all activities in the affected area had been satisfactorily completed such that access to the area to be covered with concrete was no longer required. When specific crafts completed their work, the appropriate Craft Superintendent signed off the Concrete Placement Report, signifying that a particular activity, such as mechanical, electrical, cadwelds, nondestructive examination, or cleanup, was complete and ready for the concrete pour. This sign-off was required by all Craft Superintendents, whether or not they had work in the particular placement, as a safeguard against omissions. After sign-off by the Craft Superintendents, Field Engineering signed the Concrete Placement Report, verifying that required design attributes, such as the correct location and anchoring of embedded conduit, grounding, inserts, sleeves, piping, and plumbing, were complete and correct. When all the crafts had completed their work, the Construction Inspector signed the report, signifying that all work had been inspected and approved. Subsequently, Quality Control and Quality Assurance signed the report signifying that all of their oversight activities were completed and that the items to be embedded in the concrete were in compliance with applicable requirements. Finally, after all required disciplines, QA, Construction Inspector and design approval sign-offs were completed, the Area Superintendent authorized concrete placement activities to proceed. The completed Concrete Placement Report was transmitted to QA Records in accordance with CQA-4.

Conclusions

The QA/QC procedures in effect at the time of construction of the SFP provided comprehensive control of welding and other construction activities. The procedures provided holdpoints to assure welding was completed in accordance with ASME and NRC requirements prior to proceeding beyond a point wherein any nonconformances could be resolved. These included a detailed review of weld documentation to assure the welds were completed in accordance with technical requirements, and that the welds were inspected and tested prior to being subjected to a hydostatic pressure test. For welds which were to be embedded in concrete, completion of the Concrete Placement Report provided an additional holdpoint to assure the welds were satisfactory prior to placement of concrete. The ANI provided an independent third party review of the ASME welding program.

1.2 Review of Welding Process Control Procedures

Inspection Scope

The inspectors reviewed original construction welding process control procedures, which were in effect at the time the existing Fuel Pools "C" and "D" equipment and piping were installed, as detailed below.

Observations and Findings

The welding control procedures listed below were reviewed to verify that a quality assurance program was in place at the time of installation of Fuel Pools "C" and "D" piping to ensure that pipe welding was accomplished in accordance with applicable Code requirements. The procedure revisions were those applicable when the welding activities for the fuel pools were in progress. Procedures reviewed were as follows:

MP-01, Revisions 3, 5, 6, and 7, Qualifying of Welding Procedures

MP-02, Revision 4, Procedure for Qualifying Welders and Welding Operators

MP-03, Revisions 1, 3, and 4, Welding Material Control

MP-06, Revisions 3, 4, and 5, General Welding Procedure for Carbon Steel Weldments

MP-07, Revisions 3 and 4, General Welding Procedure for Stainless Steel Nickel Base and Nonferrous Weldments

MP-09, Revisions 1, 9, and 10, Welding Equipment Control

MP-10, Revisions 2 and 3, Repair of Base Materials and Weldments

MP-11, Revisions 3, 4, and 5, Training and Qualification of Metallurgical/Welding Engineering and Support Personnel

MP-12, Revisions 1, 2, and 3, Control of Special Welding Materials for BOP and Welding Material for Non-Permanent Plant

MP-13, Revisions 1 and 2, Welder Qualification for Areas of Limited Accessibility

The procedures provided detailed control for all aspects of the welding process, including qualification of procedures and welders, control of welding materials, control of welding variables, and quality documentation for each weld.

Conclusions

At the time of original construction of the existing fuel pool cooling system piping, a comprehensive welding program was in place to control and document pipe welding in accordance with Section III of the ASME Boiler and Pressure Vessel Code.

2. REVIEW OF CONSTRUCTION QA/QC RECORDS

2.1 Review of Hydrostatic Test Reports

Inspection Scope

The inspectors reviewed the records documenting the results of hydrostatic testing performed on the piping welds embedded in the C and D fuel pool concrete.

Observations and Findings

The inspectors reviewed the records which documented completion of hydrostatic testing in accordance with WP-115 and the licensee's quality assurance program. Records examined were for the following C and D fuel pool embedded piping welds numbers : 2-SF-1-FW-1, -2, -4, & -5; 2-SF-149-408; 2-SF-143-512, 513, & -514; 2-SF-144-FW-515, -516, & -517; and 2-SF-159-FW-518 & -519. These records were documented on CP&L form QA-26, pages one and two of two, Hydrostatic Test Records. Information on the data sheets included the hydrostatic test boundaries (welds tested), the piping design pressure, test pressure, the test medium and test temperature, test data, and the test results. The test prerequisites required that the mechanical QA specialist verify that all required piping documentation was completed, and that all required weld documentation was completed. The inspectors verified that the hydrostatic test records specified that all weld records were completed, and that the welds were accepted by the quality assurance group prior to start of the hydrostatic test. The inspectors also verified that the records had been signed by the ANI. The hydrostatic test records for the above welds showed that all welds were tested to a minimum of 25 percent above design pressure and that all welds met the test acceptance criteria. The licensee did not retain copies of the form QA-26 for embedded weld numbers 2-SF-8-FW-65 & -66. However, in response to questions during construction regarding hydrostatic testing of the welds attaching the liner plate to the piping spool pieces, the licensee initiated Deficiency and Disposition Report (DDR) 794. Resolution of this DDR included documentation of the dates various welds were hydrostatically tested. The dates the welds for piping spool pieces were hydrostatically tested (July 19, 1979 and July 24, 1979) were listed in the DDR response. These included weld numbers 2-SF-8-FW-65 & 66. The inspectors concluded that the documentation for DDR-794 provided evidence that weld numbers 2-SF-8-FW-65 & 66 were subjected to hydrostatic testing in accordance with WP-115 and the licensee's quality assurance program.

Conclusions

The hydrostatic test records documented that the embedded welds were subjected to hydrostatic testing, and met the test acceptance criteria. The records also provided evidence that the welds were completed, inspected and documented in accordance with the licensee's quality assurance program. The hydrostatic test records provide evidence that the WDRs were reviewed prior to performance of the hydrostatic tests.

2.2 Review of Concrete Placement Reports

Inspection Scope

The Inspectors reviewed the concrete placement records for spent fuel pools C and D which documented that all work and preparations for the concrete placements were completed and that all required inspections had been completed prior to placement of concrete.

Observation and Findings

Prior to placement of concrete, a concrete placement report was completed to document that all work activities have been completed in a particular area (slab, column, wall, etc) and that the concrete placement could proceed. The inspectors reviewed drawing numbers SK A-G-0126, South Fuel Pool Area of FHB Isometric, and SK A-G-0125, FHB Isometric North Fuel Pool Units 2 & 3, to determine the concrete placement numbers which contained the embedded piping for the C and D fuel pool cooling system. This review showed that the piping had been installed in the following C & D fuel pool placement numbers: wall placements W-255-7, W-261-7, -7A, -9, -10, and -11, W-281-10, -16, -17, and -18, and slab placements SL-246-3 and SL-246-4. The inspectors reviewed the placement report for the above listed placement numbers and verified that the placement reports had been properly completed and signed prior to placement of concrete. The inspectors verified that the mechanical embed/piping had been signed in accordance with CP&L procedure WP-05. The acceptance criteria noted on the placement reports for mechanical embed/piping was CP&L procedure WP-102, Installation of Piping. Procedure WP-102 required that a verification be performed to assure that all piping was installed as per the design drawings. Additional requirements referenced by procedure WP-102 were that hydrostatic testing of piping to be embedded in concrete was to be completed in accordance with CP&L procedure WP-115, Hydrostatic Testing of Buried or Embedded Piping.

Conclusions

The concrete placement reports provide evidence that the piping embedded in the concrete was inspected and tested in accordance with the requirements of the licensee's construction quality assurance program prior to concrete placement. These requirements included verification that the welding was completed in accordance with applicable procedures, and that documentation such as WDRs were completed and reviewed prior to the concrete placement.

2.3 Review of ASME Documentation

Inspection Scope

The inspectors reviewed completed documentation required by the ASME Boiler and Pressure Vessel Code for the fuel pool cooling systems.

Observation and Findings

10 CFR 50.55, "Codes and standards," requires that systems and components of pressurized water-cooled nuclear reactors meet certain requirements of the ASME Boiler and Pressure Vessel Code. The fuel pool cooling systems for for SFP A, B, C, and D are classified as ASME Code Section III, Division 1, Class 3 systems. The applicable edition of the ASME code is Section III, 1974, Winter 1976 Addenda.

Subsection NA of Section III addresses "General Requirements"; Subsection ND addresses requirements for "Class 3 Components". Subsection NA-8420, "Report Form for Field Installation," required that installation welds be verified on Data Form N-5, which includes attestation of the quality of the weld process and specification data for the weld filler material. The weld process was witnessed at several specified check points by a Quality Assurance inspector; the Authorized Nuclear Inspector had the option to witness any check point and verified the completed weld data report prior to closure.

The licensee's amendment request, submitted by letter dated December 23, 1998, states that certain records, notably piping isometric packages for field installation of the completion portion of SFP C and D, were inadvertently discarded. Subsection NA-8416, "Piping Systems" of the Code requires completion of N-5 forms for each piping system, which includes weld data records attesting to the quality of the weld process and weld material certification. Because these records have been lost, the SPF C and D cannot be certified as an N-stamp system.

Since piping welds for SFP A and B were completed during the same time frame as those for SFP C and D, and by the same group of welders, it is reasonable to expect similar quality of the N-5 data packages for both units. Therefore, the N-5 package for Pools A and B were examined. The N-5 forms were included as part of the N-3 package, which was submitted upon completion of Unit 1 to the ASME National Board, the enforcement authority having jurisdiction. The N-3 form listed the components including interconnecting welds and the data reports for a facility. The summary N-3 package for Unit 1 was examined by the inspectors.

Subsection NA-8400 identifies the reporting requirements for various components, including valves and pumps, parts and appurtenances, pipe subassemblies, and piping systems. Only the reporting requirements for 49 field welds cannot be met. The inspectors randomly selected data packages for two C and D SFP components: a pump (2B-SB) and a strainer (3-SF-53-5A-2). The data package for the pump included a Certificate of Compliance, a Manufacturer's Data Report (NPV-1), material certification, hydrostatic test reports, performance test reports, welding ticket records, dimensional inspection records, a cross-sectional drawing, and an as-built drawing. The data package for the strainer included an ASME Code data report, a Certificate of

Conformance, liquid penetrate reports, a product quality control check list, material test reports, an inspection and test report, dimensional inspection records, and sequence traveler.

Conclusions

The ASME N-3 and N-5 data packages for Unit 1 and the ASME data packages for two SPF C and D components reviewed by the inspectors were determined to be complete and satisfactory and provided an indication that the licensee documented construction of the SFP in accordance with ASME requirements.

2.4 Review of Audits of ASME QA Program Implementation

Inspection Scope

The inspectors randomly selected an audit of ASME QA program implementation for review.

Observations and Findings

CP&L corporate audits were conducted of the ASME QA Program implemented at Shearon Harris. The inspectors retrieved a listing of these audits from the licensee's data base and noted that eight such audits had been conducted during the period from March 19, 1979 through February 19, 1982. From these audits, the inspectors randomly selected audit QAA/170-6 for review. QAA/170-6 was conducted at the Shearon Harris site on September 21-29, 1981. The inspectors reviewed the audit checklist, the audit report containing the findings and concerns, the memoranda describing the corrective actions for each identified deficiency, and the QA closure documentation. The audit report concluded that the Shearon Harris Construction, Nuclear Plant Engineering, and QA Program adequately met ASME code requirements except for eleven findings and sixteen concerns. The identified deficiencies were typically associated with procedural and training requirements and indicative of careful review by the auditors. The inspectors reviewed the corrective actions and found them reasonable and appropriate. All corrective actions were implemented and determined to be satisfactory by the licensee'sQuality Assurance organization within four months following the audit.

Conclusions

The audit report showed that the licensee's QA program implemented the ASME program and NRC requirements during construction.

2.5 Review of Vendor ASME QA Program Implementation

Inspection Scope

The inspectors reviewed an audit of a vendor supplying Code equipment for compliance with ASME requirements.

Observations and Findings

The inspectors reviewed CP&L corporate audit QAA/702-1, conducted at the fabrication facility of Southwest Fabricating & Welding Company, Inc., a supplier of piping spool pieces for the four spent fuel pools at Shearon Harris. The audit was conducted on May 22-23, 1974, in order to appraise the the manufacturing facility and quality assurance program to adherence to purchase order requirements, including applicable Articles of Section III of the ASME Boiler and Pressure Vessel Code and the requirements of 10 CFR 50, Appendix B, "Quality Assurance for Nuclear Power Plants." The audit report concluded that the vendor's quality system, as defined in its QA Manual was adequate to meet the intent of the requirements imposed by the purchase order. The audit report identified six findings requiring corrective action. The inspectors reviewed the audit checklist and the audit report containing the findings. The inspector also reviewed the corrective actions taken by the vendor and the QA closure documentation. Based on this review, the inspectors determined that the deficiencies were relatively minor and administrative in nature and that the corrective actions were appropriate. All actions were determined to be satisfactory by the CP&L Quality Assurance organization within three months of the audit with exception of an issue related to training and qualification of audit personnel. This issue was held open pending resolution of a related draft ANSI standard and closed satisfactorily in December, 1974.

Conclusions

The vendor audit report showed that the licensee's QA program implemented the ASME program and NRC requirements for performance of vendors during construction.

2.6 Review of QA/QC Related Reports

Inspection Scope

The inspectors reviewed a random sample of QA/QC related reports to assess the effectiveness of the site QA/QC program in identifying and resolving problems associated with SFP welding activities.

Observations and Findings

Reports documenting results of QA/QC activities were reviewed by the inspectors to assess the effectiveness of the QA/QC program. The reports selected for review covered the period when welding activities were in progress on the piping from 1979 to 1982. The records reviewed include Deficiency and Disposition Reports (DDRs), Nonconformance Reports (NCRs), and QA/QC monitoring and surveillance reports. DDRs for ASME Code components required the ANI to review, approve and sign the final disposition as acceptable. The following DDRs, which are listed in general categories assigned by the inspectors, were reviewed:

Category	DDR

Arc Strike	869, 877, 895, 945
Stamping	888, 889, 914, 945
Holdpoint	829, 1009
Hydrostatic Test	783, 794

The identified deficiencies were clearly identified on the DDR and disposition of the deficiencies were appropriate. Concurrence with the disposition by the ANI and report closure by Quality Assurance was completed for all DDRs reviewed.

Nonconformances (NCRs) were less significant infractions of the QA program requirements (i.e., were less serious than DDRs). The following NCRs were reviewed and listed in general categories assigned by the inspectors.

Category	NCR
Arc Strike	WP-206
Stamping	W-027, W-096, W-103
Holdpoint	W-207
Welder Requirement	WP-111, W-028
Weld Status Report	WP-278

Documentation of the nonconforming condition was clear and corrective actions were appropriate. The final disposition for each NCR was verified by the responsible QA Specialist.

For completeness of review, the inspectors arbitrarily selected a sample of QA/QC reports which documented monitoring and surveillance of weld activities. These covered areas which included material control, welding equipment, welder training and qualification, review of WDRs for accuracy and completeness, and compliance with weld procedures. The following QA/QC activity reports were reviewed and determined to be typical and expected for oversight of welding activities.

WP62, WS79, WP56, W29, W86, W116, W124, W143, W199, W200, W285, W297, W322, W361, W365, W402, W429, W434, W456, W461, W462, W469, W475, QA8, QA81, WS80, QA146, QA150, QA169, QA215, QA294, QA359, QA424, QA368, QA376, QA509, QA548, QASRC83116, QA550, QA551, QA586, QA587, QA588, QA703, QA777, W509, W507, W506, W503, W767, W756, W750, QA16, QA254, QASRC187, QASRC822660, QA199, W630, W560, W554, W544, W519, W518, QA385, W8257, W225.

Conclusions

Based on review of the above DDRs, NCRs, and reports documenting QC/QA activities, the inspectors concluded that inspection personnel actively monitored welding activities and processes for compliance with ASME Code and QA Program requirements. Deficiencies were accurately reported, corrective actions promptly taken, and appropriately resolved. All corrective action documents reviewed were in compliance with the licensee's QA program and NRC requirements.

3. SFP C AND D DESIGN CHANGES

Inspection Scope

The inspectors reviewed the design changes prepared by licensee engineers to complete the C and D spent fuel pools.

Observations and Findings

The licensee implements design changes in accordance with CP&L procedure EGR-NGGC-0005, Engineering Service Requests (ESR). This procedure implements the design control program required by 10 CFR 50, Appendix B. The licensee prepared the following ESRs to complete the C and D spent fuel pools:

- ESR 95-00425, Study Effort to Support Fuel Pool in Service Date.

- ESR 99-00218, CCW Tie In to Heat Exchangers for North Pools

The inspectors reviewed the ESRs. ESR 99-00218 was prepared for connecting the C and D spent fuel pool heat exchangers to the Unit 1 component cooling water system. During the inspection, the licensee was in the process of installing piping and pipe supports required for the tie-in of the CCW system to the SFP C and D heat exchangers. The final tie in will not be completed unless NRC approval is received for the fuel pool expansion. ESR 95-00425 was prepared to complete the C and D SFP piping, complete installation of equipment (pump motors, strainers, etc.), perform system pre-operational and startup testing, and revise existing plant procedures to incorporate the C and D SFP into the Unit 1 operating plant.

The inspectors reviewed the 10 CFR 50.59 safety evaluation, design inputs, design evaluations, assumptions, and references, design verification documentation, and installation drawings and instructions. The inspectors noted that the details for commissioning of the existing equipment were incomplete. The licensee initiated ESR 99-00416 to control the commissioning process. This is discussed in the Section below. The requirements and procedures for preoperational and startup testing were also incomplete. Discussions with licensee engineers disclosed that these procedures will be developed following those used for startup of Unit 1 (SFP A and B). The 10 CFR 50.59 evaluation concluded that this project involved an unreviewed safety question which required NRC approval prior to completion and startup.

Conclusions

The ESRs were technically adequate and generally met regulatory requirements.

4. EQUIPMENT COMMISSIONING

Inspection Scope

The inspectors examined the licensee's maintenance and lay-up actions for the installed Fuel Pool "C" and "D" piping and equipment. In addition, plans for additional activities to ensure that equipment will meet all applicable requirements and be capable of performing its intended function were reviewed.

Observations and Findings

A significant portion of the Fuel Pool Cooling System and Component Cooling Water System piping and components for Fuel Pools "C" and "D" were installed during original construction in the late 1970s and early 1980s. As documented in section 26.5.0 of Engineering Service Request (ESR) Design Specification 95-00425, Revision 0, the equipment was never incorporated into the operating unit and has not been formally maintained under controlled storage since that time. The equipment was procured and installed to applicable quality assurance requirements. However, since the installed equipment has been stored in-place without a formal storage and lay-up program, the licensee plans to implement an equipment commissioning or dedication process to ensure that the equipment will meet the applicable requirements and is capable of performing its intended function in the completed design. In accordance with ESR 95-00425, which had not been approved and issued at the time of the inspection, a Matrix of Commissioning Requirements is to be developed, which will define the requirements, including any additional inspections and testing, for each component. At the time of the inspection, a preliminary matrix had been developed as part of ESR 95-00425 and ESR 99-00416 had been initiated to further detail and manage the commissioning process. Although plans and some of the details for the process were included in ESR 95-00425, most of the details for each individual component were still being developed to be included in ESR 99-00416. Based on discussions with responsible licensee personnel and review of ESR 95-00425, the commissioning process will consist of the following activities:

Scope Development

To develop the scope for the commissioning process, a field walkdown of the installed equipment (mechanical, civil, instrumentation and control, and electrical) will be performed to compare the installed equipment with the completed modification design and each item in scope will be identified and individually dispositioned as part of ESR 99-00416.

Document Review

Quality documentation will be retrieved and reviewed to ensure that required quality assurance information is available, complete and acceptable. The verified records will include original procurement and field installation records. The equipment installation records will be compared with field conditions to ensure that the installation as accepted has not been altered. If records are missing or deficient, an assessment will be performed to determine what can be accepted by virtue of retest or re-inspection, or by use of alternate methods of verification.

Test and Acceptance Criteria

The Equipment Commissioning Matrix will specify additional activities needed to ensure the required level of quality assurance because of the lack of formal storage and lay-up program since original equipment installation. These activities will include:

Field verification of equipment identification against procurement documentation with establishment of traceability to Code Data Reports for code related equipment.

Physical inspections and testing as required to verify that lack of controlled storage conditions and regular maintenance has not caused any condition (corrosion, aging, etc.) adverse to quality.

Physical inspections and considerations necessary to ensure that plant activities since construction have not resulted in any conditions adverse to quality (scavenging of parts, introduction of foreign material, damage from personnel and equipment traffic, etc.).

Although the equipment commissioning details for individual equipment had not been finalized, some work had already been accomplished. The inspectors reviewed the following work requests (WRs) that had been issued:

WR 98-AGAR1 - Disassemble and Inspect Valve 1CC-512
WR 98-AFJA1 - Inspect Train A Spent Fuel Cooling Heat Exchanger
WR 98-AFJE1 - Inspect Train B Spent Fuel Cooling Heat Exchanger
WR 98-AFJF1- Disassemble and Inspect Train A Spent Fuel Cooling System Strainer
WR 98-AFJH1- Disassemble and Inspect Train B Spent Fuel Cooling System Strainer
WR 98-AFIY1- Disassemble and Inspect Spent Fuel Pool Cooling Pump 2A
WR 98-AFIZ1- Disassemble and Inspect Spent Fuel Pool Cooling Pump 2B

Disassembly and inspection had been completed for WRs 98-AGAR1, 98-AFJA1, 98-AFJE1, 98-AFJH1. The other 3 WR's had not yet been worked. For inspection of the Heat Exchangers, the WRs only covered removing the end covers and inspecting the tube side of the Heat Exchangers. The WRs indicated that a nitrogen purge had been maintained on the shell side of the heat exchangers. However, further investigation revealed that the use of the nitrogen purge had not been implemented until late 1991. In May of 1988, WRs 88-AMYH1 (Train A) and 88-AMYI1 (Train B) were issued to provide a nitrogen purge on the shell side of the Heat Exchangers. The WRs documented that the shell side of the Heat Exchangers had been open to the Fuel Building atmosphere. There was no indication how long the heat exchangers had been open. The 1988 WRs installing the purge were not worked until December 1991. Also, additional WRs documented a number of problems with low nitrogen purge on Train B Heat Exchanger in 1993. Based on the documented history of lack of control of the atmosphere on the shell side of the Heat Exchangers, the inspectors questioned whether additional evaluations of the Heat Exchangers were needed. In response, the licensee indicated that further evaluations of the shell side of the Heat Exchangers will be performed as part of the commissioning process under ESR 99-00416.

The inspectors walked down and observed the general condition of the installed piping and equipment. Even though the equipment had not been maintained under a formal program, the equipment and piping appeared to be well preserved. The inspectors also examined spent fuel pool cooling pump motors "A" and "B", which have been stored and maintained in the warehouse since procurement at the time of construction. These were found to be in good condition with the motor space heaters energized. Evidence of control of storage of the pumps, including records of periodic pump shaft rotation, maintenance of heat on motors, and megger testing, were reviewed. Preventative maintenance of these parameters had been maintained in accordance with licensee Material Evaluation Procedure ME 000261.03.

The inspectors inspected three welds, weld numbers 2-CC-3-FW-207, 2-CC-3-FW-208, and 2-CC-3-FW-209 for misalignment and concluded that there was no noticeable misalignment.

The inspectors reviewed the re-inspection records for installed welds and piping as discussed below.

Based on the above reviews, the inspectors concluded that the planned equipment commissioning process should ensure that existing equipment will meet requirements and will perform its design function. However, since the details of tests and inspections to be performed for individual equipment items had not been completed, Inspector Followup Item (IFI) 50-400/99-12-01, Review of Final Equipment Commissioning Details, was opened to track further inspection after more details are available.

Conclusions

Although details of the commissioning inspections had not been finalized for each individual piece of equipment, a detailed plan had been drafted and if properly implemented should ensure that existing equipment meets requirements and will perform its intended function. An IFI was opened to track further inspection of the equipment commissioning process after more details of the tests and inspections to be performed for individual equipment items are available. The equipment commissioning WRs reviewed were considered appropriate to ensure that equipment is acceptable to place in service. Based on the documented history of lack of control of the atmosphere on the shell side of the Spent Fuel Pool Cooling Heat Exchangers, the inspectors concluded that additional evaluations of the heat exchangers were needed.

5. ALTERNATE INSPECTION PROGRAM

5.1 Review of Weld Records

Inspection Scope

The inspectors reviewed the Spent Fuel Cooling System and Component Cooling System weld and weld inspection records as detailed below.

Observations and Conclusions

The licensee re-inspected all existing accessible Fuel Pool "C" and "D" Spent Fuel Pool Cooling System (SFPCS) and supporting Component Cooling Water System (CCWS) pipe and pipe attachment field welds. The welds were visually (VT) and liquid penetrant (PT) inspected. In addition, vibro-tooled welder symbol identifications were taken from each weld surface and welder qualification verified by review of records. The re-inspections and the welder symbols were documented on new Weld Data Reports (WDRs). The inspectors reviewed the new WDRs, the NDE qualification records for the current re-inspections and the original construction welder qualification records for these welds. All records were retrievable and found to be in order.

In addition to review of the re-inspection records for the accessible welds, records consisting of WDRs, welder qualification records, weld QC inspector records, NDE examiner qualification records, welding procedure specifications (WPSs), and procedure qualification records (PQRs) were reviewed for the below listed Unit 1 SFPCS piping welds. These Unit 1 (SFP A and B) welds were constructed using the same welding QC program at approximately the some time period as that used for the cooling system piping welds for Fuel Pools "C" and "D".

F1-236-1-SF-10-FW-60
F1-236-1-SF-2-FW-9
F1-236-1-SF-10-FW-58
F1-236-1-SF-2-FW-8
F1-236-1-SF-10-FW-59
F1-236-1-SF-2-FW-6
F1-236-1-SF-2-FW-7

These original Unit 1 (SFP A and B) construction records were retrievable, legible, and complete. The records provided objective evidence that a detailed welding quality control program was in place and followed during original construction.

Conclusions

All records reviewed were retrievable and in order. The original Unit 1 construction records provided good assurance that the SFP C and D welding was accomplished and documented in accordance with the approved welding quality assurance program in effect at that time.

5.2 Welding Material

Inspection Scope

The inspectors reviewed the welding procedure specifications and the records for the filler metal (materials) used for welding the SFPCS and CCWS piping.

Observations and Findings

SFP A & B Filler Metal

The inspectors randomly selected embedded SFPCS welds from isometrics drawings, 1-SF-2 and 1-SF-10 from SFP A and B for review. The WDRs for these welds were reviewed by the inspectors. From the WDRs, the inspectors randomly selected the certified material test reports (CMTRs) for filler and insert metals and reviewed the chemical test records. Based on the records reviewed, the inspectors concluded that the materials used for the embedded welds were type 308 filler metal, type 308 consumable inserts, and type 304 base material (piping materials).

The inspectors reviewed Weld Procedure Specification (WPS)1BA3 for the material used for welding the pipes in the component cooling water system. The WPS listed the pipe material as P-1, Grade 1 (Appendix D to Section XI of the ASME Code) and weld filler metals as E70S-6 and E7018. For procedure qualification, WPS 1BA3 referenced Procedure Qualification Report (PQR) 15. The inspectors reviewed PQR 15 and CMTRs of the material used for the qualifications.

Product Check Chemistries

The inspectors compared the chemistries from CMTRs with the stainless steel product check chemistries submitted to NRC in a letter dated April 30, 1999, Subject: Response to NRC Request for Additional Information Regarding The Alternative Plan for SFPCS Piping, and the chemical analyses from PQR 15 that were used for qualifying the carbon steel weld procedure specification 1BA3 with product check chemistries submitted to NRC in a letter dated June 14, 1999. The comparisons showed carbon analyses for the product checked consistently above the filler metal values for SFP A & B and values recorded in the PQR. The inspectors questioned the licensee regarding possible carbon contamination with the product check chemistries.

In search of the contamination, the inspectors examined the sampled surface on weld 2-CC-3-209. The sample had been removed from the center of the weld crown. The weld and surrounding pipe were clean and free of foreign matter. Next, the inspectors reviewed the technique used for sampling. The sampling technique is in Appendix A to Procedure NW-16, Revision 1, "Identification of Base Metals for Welding Applications," dated January 6, 1998. The sampling technique uses a rotary carbide deburring tool which removes material with a grinding action. Licensee engineers suspected that the deburring tool was a possible source of the carbon contamination. The licensee made test samples by taking known material and seeding it with metal flakes broken from the teeth of the deburring tool. The tests showed that for samples seeded with 5 and 10 weight percent from the deburring tool, the carbon analyses increased by .03 and .08 weigh percent, respectively. The tests showed that the carbide deburring tool was a possible source of carbon contamination.

Alloy Comparator

During the inspection, the inspectors witnessed a demonstration of the test method used to develop the acceptance criteria for the test data submitted to NRC in the April 30, 1999 letter. For the testing, the licensee utilized the Metorex X-Met 880 electronic unit, CP&L Control No. MLCE-132 which was operated by CP&L's plant metallurgist. The inspectors reviewed the following: Operating Instruction Manual 3881 432-4VE; and operating procedure: MCP-NGGC-0101, Revision 1, Test Method 4, dated March 26, 1999. For developing an acceptance criteria, the metallurgist setup the X-Met using the same calibration and reference standards that were used for the previous testing. For calibration, pure standards for Fe, Cr, Ni, Cu, Mo, and a backscatter sample were run and stored in the X-Met. For reference alloys, stainless steel standards for type 304, 309, 310, 316, and NIST C1154a were run and stored in the X-Met reference library.

For the development of the acceptance criteria, 12 different standards were used. Each standard was run 10 times producing an average set of chemical values. In the comparison mode, the X-Met compared each test against the standards stored in the reference library. If the test matched or was close to a match with a reference standard, the X-Met displayed the reference standard followed by the term: good, possible, or good/possible. If a test did not come close to any reference standard, the X-Met displayed "no good match." The reference standards, test standards, type of match displayed for that standard, and the Cr, Ni, Mo, Mn, and Cu from the certified analysis reports for the standards are shown in Table 1 in the Appendix. The data showed that the X-Met comparison mode can discriminate stainless steel types and chemical extremes within a stainless steel type. Based on the testing performed on the accessible field welds and Table 1, the licensee's metallurgist tentatively established the acceptance criteria for field welds as two test displays showing a good or possible match and no test displays showing no good match.

Conclusions

The SFPCS piping and CCW piping was welded using the correct materials. The X-Met and chemical analysis provided identification of stainless steel and carbon steel materials.

5.3 Water Quality

Inspection scope

The inspectors reviewed the C & D SFP pipe welds exposed internally to hydrostatic pressure test water and/or the spent fuel pool water.

Observations and Findings

The inspectors reviewed drawings and hydrostatic test records to identify the C & D SFP welds that were exposed internally to hydrostatic pressure test water or spent fuel pool water, to determine the length of time that these welds were exposed to that water. Of the 52 welds identified in CP&L's letter dated April 30, 1999, pipe welds 2-SF-1-FW-3, 2-SF-1-FW-6, and 2-SF-36-FW-448 were replaced by new welds, and 12 are hanger-to-pipe welds. Of the remaining 37 pipe welds with missing documentation, the inspectors identified 15 welds exposed to hydrostatic test water, 22 welds exposed to the fuel pool liner leak test water, and the same 22 welds exposed to the current fuel pool water conditions.

Hydrostatic test water quality was specified in CP&L Procedure WP-115, Revision 0, "Hydrostatic Testing of Buried or Embedded Pressure Piping," dated September 19, 1979. WP-115 specified that potable or lake water was to be used for hydrostatic testing. After testing, the procedure required that the pipes must be drained. However, the procedure did not specify a time limit for draining of the piping/system. The inspectors were unable to determine from documentation when the piping was drained. However, logic dictates that the pipes were drained before the licensee performed the fuel pool liner leak testing (hydrostatic test).

Hydrostatic test water quality for fuel pool liners was identified in CP&L Procedure TP-57, "Hydrostatic Test of Fuel Pool Liners," dated May 17, 1983. TP-57 required that that the fuel pool be leak tested for a 24 hour period using unchlorinated site water. The procedure defined unchlorinated water as site water with a chloride content not exceeding 100 parts per million (ppm). After the test, the procedure required that the test water was pumped out of the SFP and that the pool was rinsed with demineralized or distilled water. Attachment A to TP-57 for SFP D showed that the pool was filled June 11, 1985 with water containing less than 1 ppm chlorides and that the rinse was completed on November 1, 1985. For SFP C, the records showed that the pool was filled May 7, 1985 with water containing less than 1.5 ppm chlorides and that the rinse was completed on November 4, 1985.

Discussions with licensee engineers disclosed that SFPs C & D were filled with SFP quality water around 1989 and have been full ever since. The gates between SPF A and B and C and D were opened at various times which resulted in the water mixing between the pools. During April 1999, the licensee obtained water samples from the low points in seven of eight pipe lines connected to SFP C & D. These samples were analyzed for impurities. The results are tabulated in Table 2 in the Appendix. The inspectors compared the sample results to the administrative limits for A & B SFP and data for a primary system cold shut down that is published in NUREG CR-5116, Survey of PWR Water Chemistry, February 1989. Based on the data reviewed, the water quality in SFP C & D was similar to the water quality in SFP A and B.

The pipe welds exposed to the potentially poorest water quality were the embedded welds. If corrosion or fouling were to occur, they would occur in the embedded welds first. The presence of corrosion or fouling would be visible from the interior of the piping. The visual inspection of the embedded welds performed by the licensee to examine the interior of the embedded piping is discussed below.

Conclusions

The pipe welds exposed to the potentially poorest water quality were the 15 embedded welds. The pipe welds remaining were exposed to treated water with very low impurities and similar to the water quality in SFP A and B. If corrosion or fouling were present in the SFP C and D piping, they would occur in the embedded welds first because of the type of water the embedded piping was exposed to.

5.4 Review of the Procedure for Remote Visual Inspection of Welds and Piping

Inspection Scope

The procedure used for remote visual inspection of embedded welds was examined for compliance with the CP&L Quality Assurance Program and NRC requirements.

Observations and Findings

The inspectors reviewed Temporary Procedure SPP-0312T, Temporary Procedure For Remote Visual Examination of Interior Welds and Surfaces of Embedded Unit 2 Spent Fuel Pool Cooling Piping for C and D Pools. The procedure provided instructions for performing remote visual examinations of interior welds and surfaces of embedded piping for the SFP C and D piping. The results of these examinations were used to determine whether the weld quality and interior surface conditions meet the acceptance criteria established in Paragraph 6.0 of the procedure. The acceptance criteria specified that welds were to be free of the following defects: cracks, lack of fusion, lack of penetration, oxidation ("sugaring"), undercut greater than 1/32 inch, reinforcement ("push through") exceeding 1/16 inch, concavity ("suck back") exceeding 1/32 inch, porosity greater than 1/16 inch, or inclusions. Any recordable indications of these defects were recorded on Attachment 1 of the procedure. Other indications such as arc strikes, foreign material, mishandling, pipe mismatch, pitting and microbiologically induced corrosion were also recorded on the attachment and were required to be evaluated by licensee engineers.

In addition to reviewing SPP-0312T, the following referenced documents were examined by the inspectors with respect to applicable requirements: (1) ASME Section III, 1974, Subsection ND-4424, Surfaces of Welds; NDEP-0606, Rev. 4, Remote Visual Examination; NDEP-601,Rev. 13, VT Visual Examination of Piping System and Component Welds at Nuclear Power Plants; and NDEP-A, Rev. 13, Nuclear NDE Procedures and Personnel Processes.

Both Revision 0 (approved 5/17/99) and Revision 1 (approved 9/9/99) of procedure SPP-0312T were reviewed. Revision 1 contained no change in the technical content or scope of work, but was made to reflect a new vendor and contract number. Based on review of the procedure and applicable references, the inspectors determined that the procedure prescribed prerequisites, precautions and limitations, and detail on special tools and equipment to adequately control the scope of the visual inspection activities. Technical, process-related, and administrative references were adequate and complete. The acceptance criteria were appropriately detailed such that conclusions as to the weld quality and interior surface conditions could be made by qualified inspection personnel. The remote inspection procedure was reviewed for adequacy prior to its use by a licensee NDE Level III inspector. The licensee's Level III NDE inspector was interviewed by the inspectors. The Level III certification records and training for this individual were also reviewed.

Conclusions

The procedure which specified the method for visual inspection of the embedded welds provided detailed instructions and acceptance criteria for inspecting and evaluating the embedded welds. The procedure complied with the licensee's QA program and NRC requirements.

5.5 Remote Visual Examination

Inspection Scope

The inspectors reviewed the videotape that recorded the remote visual examination and the analysis of the remote visual examination of embedded welds. The review included piping and other welds captured on videotape. The inspectors also reviewed the licensee's evaluations of the welds documented on Attachment 1 to SPP-0312T.

Observation and Findings

The licensee performed a remote enhanced visual examination of 15 embedded field welds from inside the stainless steel SFP C and D piping. Prior to performance of the remote video examinations of the embedded piping, three Level II NDE personnel were trained in the use of procedure SPP-0312T. These individuals demonstrated their proficiency with the use of this procedure to the ANI and the Level III NDE inspector. Attestations to the satisfactory completion of these activities were reviewed by the inspectors and determined to be satisfactory.

The visual examination was performed by sending a mobile video camera with focusing and magnifying capabilities through the piping to examine each embedded field weld. The video camera sent images of the weld to a television monitor and video recorder. The images on the monitor were viewed by the licensee's Level II qualified remote visual inspectors. The Level II's observations were documented on Attachment 1 to SPP-0312T, "Remote Visual Examination Data Sheets." Attachment 1 contained a check list for recordable condition of the weld. These recordable conditions are described in the acceptance criteria of SPP-0312T. Weld acceptability was determined by the qualified Level II visual examiner in accordance with the acceptance criteria specified in procedure SPP-0312T and approved by a qualified Level III NDE inspector and the ANI.

The inspectors reviewed eight videotapes recorded during the remote visual inspection and the completed SPP-0312T Attachment 1 for each embedded field weld. The videotapes reviewed were as follows: weld 2-SF-8-FW-65 prior to cleaning; the in-process cleaning of 2-SF-144-FW-516; and the 15 embedded field welds after cleaning. The videotapes also captured images of accessible welds 2-SF-150-412 and 2-SF-148-FW-382.

In the videotape made prior to cleaning, the inspectors observed laced material particles inside the pipes and on the field welds. These particles looked like a dusting of snow flakes. They were flat, very thin, interconnected, and conformed to the contour of the pipes, pipe seams, and field welds. The inspectors viewed the videotape showing removal of the particles from welds 2-

SF-144-FW-516. The particles were removed with a pressurized water flow directed toward the pipes, interior surfaces. When the particles were hit by the water stream, they were readily dispersed. After dispersing, the particles appeared to be suspended in the water.

Based on the videotapes of the cleaned field welds, the inspectors concurred with the observations of the licensee's NDE inspectors recorded on the Attachment 1 to SPP-0321T for each weld. The inspectors observed the images of vendor fabricated welds, pipe seam welds, and the piping itself as the video camera traveled to the different embedded field weld locations. These images showed no misalignment, unusual protrusions, blockages, or indentations in the pipe walls, pipe seams, vendor fabricated welds, and the two accessible field welds examined. In the videotapes made of the cleaned welds, the inspectors identified conditions in three welds that require further evaluations. These conditions were: (1) an insert segment with the letters 308L still visible on weld 2-SF-144-FW-516; (2) brown spots that were out of focus with the surface of the pipe on weld 2-SF-144-FW-517, and (3) heavy stains, oxides, and deposits on weld 2-SF-159-FW-519. Although not part of the weld inspection, the inspectors also observed and requested an evaluation of a condition adjacent to the longitudinal seam in the pipe just beyond weld 2-SF-144-FW-515. The condition appears to be a fine saw tooth line located parallel to the pipe seam and about half the seam thickness away. The length of the line was not determined. The licensee stated that they were evaluating these conditions which were identified on the SPP-0312T, Attachment 1.

The inspectors reviewed and found satisfactory work requests associated with preparation for remote video inspection, and the system closure following completion of the visual inspection. These were WR/JO 99-ADUN2, ADUP1, AEHH2, and AFEY1. Results of the visual examinations were recorded on a data sheet, marked as a QA Record, which was included in SSP-0312T as Attachment 1. The data sheet was reviewed by the inspectors and determined to provide adequate detail of the examination to determine whether the acceptance criteria had been met and to record any recordable conditions noted by the licensee's NDE inspector. Completed data sheets documenting examination of 15 interior welds and piping surfaces were examined and determined to contain sufficient detail as to the results of the inspection. The signature of the NDE Level II examiner on Attachment 1 was determined to be one of the three personnel who were trained and qualified in the use of this procedure.

The recordable conditions documented on the data sheet are required to be reviewed and approved by licensee engineers and subsequently be approved by an ANI. The licensee initiated ESR 99-00266 to evaluate the recordable conditions. The evaluations were being performed by an independent engineering consultant. At the time of the inspection, evaluation of the recordable conditions had not been completed.

The inspectors reviewed and discussed the videotape examination of weld 2-SF-144-FW-516 with a CP&L welding supervisor that worked as a welding engineer during the construction of the SFP. The videotape showed the section of a consumable insert in the weld with the lettering 308L still visible on the consumable insert. The welding supervisor stated that the type of consumable insert for this application is shaped like the cross section of an inverted mushroom. The stem of the insert forms the base of the joint between the pipes. The joint is hand welded using a gas shielded tungsten arc welding process. The process should consume the insert and adjacent pipe during the first weld pass. The supervisor stated that insufficient heat input may fuse the insert (mushroom) head to the weld puddle instead of melting the insert completely. After the first pass, subsequent passes were made with filler metal to form weld layers. The supervisor estimated that 5 layers of filler metal were necessary to weld 3/8-inch thick piping.

The inspectors requested that the licensee provide chemical analysis on the particulate that were dispersed during the pipe/weld cleaning process. This particulate appeared reddish brown in color, is easily disturbed, and is believed by the licensee to be the source of the pipe stain. The inspectors questioned the ANI regarding the particulate. The ANI stated that there he observed abundant amounts of reddish brown color on the video equipment, piping interior, and at the video equipment entry point during the inspection. The licensee radiologically analyzed by chemical elements the particulate in 1990 and again in 1996. They provided the analyses to the inspectors for review. The particulate is radioactive with the most abundant element by two orders of magnitude being iron, followed by one order of magnitude cobalt, and zero order of magnitude nickel.

Conclusions

The condition of the embedded welds and associated piping inside the C and D SFP piping are free of abnormal obstructions and deposits. However, the inspectors identified four conditions requiring further evaluations. The licensee is in the process of evaluating the data shown on SSP-312T, Attachment 1 that include these four conditions.

5.6 QA Programs for Special Inspections Associated with the Alternate Inspection Program

Inspection Scope

The inspectors reviewed the alternate inspection activities for compliance with quality assurance requirements.

Observations and Findings

Ongoing activities associated with the alternate inspection program for resolution of issues concerning activation of Pools "C" and "D" were reviewed. These activities include remote inspection of the inner surfaces and field welds for embedded piping, determination of water chemistry during the period of layup, and examination of weld material taken from accessible field welds.

Oversight and examination of the embedded piping was performed by qualified NDE Level II examiners, who demonstrated proficiency in the use of the procedure used for the inspection (SPP-0312T) to the satisfaction of a NDE Level III examiner. The demonstration was witnessed and an Authorized Nuclear Inspector concurred with the demonstration of this proficiency.

Water chemistry analysis was performed by the CP&L chemistry organization, in accordance with site and corporate quality assurance program requirements. Material analysis of the weld samples was performed by NSL Analytic Services, identified on the CP&L Approved Supplier List with Supplier Control No. 16; manual dated 6/30/99; reviewed by CP&L 11/4/99. The supplier was audited for compliance under the CP&L Commercial Grade Survey program on February 1-2, 1999.

Conclusions

Activities associated with special inspections related to activation of fuel pools C and D were performed in compliance with applicable quality assurance requirements.

6. AUTHORIZED NUCLEAR INSPECTOR

Inspection Scope

The inspectors interviewed the authorized nuclear inspector (ANI) to determine the involvement of the ANI with the WDR, hydrostatic tests, and remote visual examinations.

Observations and Findings

The inspectors interviewed the recently retired ANI (July 1, 1999) and current ANI. The retired ANI was involved in plant construction and reviewed WDRs during plant construction. The verification was performed in two stages. The first stage was the verification of field weld fabrication at randomly selected predetermined hold points and ASME Code required inspection points. When satisfied that ASME requirements were met, the ANI initialed the associated line entry on the WDR. The second stage was verification of the entire WDR. When satisfied that all the necessary entries for the specified field weld were complete, the ANI signed off the WDR.

When questioned by the Inspectors regarding the significance of the ANI signature on the hydrostatic test document, both ANIs stated that the signature meant that the hydrostatic test satisfied ASME Code requirements, and the signature on the hydrostatic test was independent of any ANI signatures on the WDRs.

The ANIs were questioned regarding the extent of their involvement with the remote visual examinations of the 15 embedded welds in the C & D SFPs. They stated they both observed the equipment demonstration and qualifications of the remote visual examiners. For the equipment demonstration, a video camera was mounted on a transporting device that moved through a mockup of the SFP piping. The mockup contained flaws similar to those described in the acceptance criteria of Procedure SSP-0312T. In the mockup demonstration, the video camera transmitted images to a television monitor as it was moved. By viewing the monitor, the licensee's remote visual examiner directed the equipment operator to the areas of interest. These images were analyzed by the examiner. The examiner had to determine if the images of interest were a flaw, the type of flaw, and the acceptability of the flaw. The successful detection of flaws in the mockup demonstrated the equipment and remote visual examiner's skills. Upon a successful demonstration, the remote visual examiner qualification was certified by the licensee and verified by the ANI. On June 30, 1999, both ANIs signed off on the qualifications of the three remote visual examiners.

The inspectors questioned the current ANI regarding his involvement with the reinspection of the accessible welds and remote video examination of the embedded welds. The ANI stated that he observed the reinspection of accessible welds, 2-SF-36-FW-450 and 2-SF-38-FW-451, and that he observed the remote video inspections of at least two of the embedded welds. The actual examinations of the other embedded welds were less extensively viewed. At the time of the inspection, the ANI was in the process of reviewing the videotapes and verifying the data recorded on the remote visual examination data sheets.

Conclusions

The ANIs performed an independent verification of ASME Code requirements on the WDR and hydrostatic test documentation. The verification is part of their duties that are required by the 1974 Edition (and later) of ANSI/ASME Code N626.0, "Qualifications and Duties for Authorized Nuclear Inspection," and the referenced edition and addenda of Section III of the ASME Code. The ANIs were actively involved with the demonstration of the remote visual examination equipment and the qualification of the personnel. The current ANI was actively involved with examination and videotaping of the embedded welds

7. NRC INSPECTIONS DURING THE CONSTRUCTION PHASE

The Inspectors reviewed NRC Inspection Reports which documented inspection of construction activities by NRC Region II Inspectors between 1978 and 1983. This was the period when the A, B, C, and D spent fuel pools were under construction. The inspection reports document more than 50 separate inspections for this period for items related to the welding program and/or piping installation. The majority of these inspections were performed by eight Region II Welding Specialist inspectors. Several violations dealing with the general subject of welding were identified in these reports. Most of these violations were relatively minor (Severity Level V and VI) and would not be cited under the current NRC reactor inspection program. These violations would typically be resolved through the licensee's corrective action program. The violations were typical of what one would expect for oversight of a large construction project and are not indicative of any programmatic weakness in the licensee's welding program.

MANAGEMENT MEETINGS

The Team Leader discussed the progress of the inspection with licensee representatives on a daily basis and presented the results to members of licensee management and staff at the conclusion of the inspection on November 19, 1999. The licensee acknowledged the findings presented.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

D. Alexander, Manager, Regulatory Affairs
B. Altman, Manager, Major Projects Section
E. Black, Level III NDE Examiner

G. Brovette, ANI
B. Clark, General Manager, Harris Plant
E. Dayton, ANI (Retired)
J. Eads, Supervisor, Licensing and Regulatory Programs
S. Edwards, SFP Activation Project Manager
G. Kline, Manager, Harris Engineering Support Services
J. Scarola, Vice President, Harris Plant
K. Shaw, Licensing Engineer, Major Projects Section
M. Wallace, Senior Analyst, Licensing
Daniel W. Brinkey III, CP&L Metallurgist
Charlie Griffith, CP&L Welding Supervisor

Other licensee employees contacted included engineering, maintenance and administrative personnel.

NRC:

R. Hagar, Resident Inspector
K. Landis, Chief, Engineering Branch, Division of Reactor Safety

INSPECTION PROCEDURE USED

TI 2515/143, Shearon Harris Spent Fuel Pool ("C" and "D") Expansion

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

50-400/99-12-01	IFI	Review of Final Equipment Commissioning Details

Closed

None

Discussed

None

APPENDIX 1

TABLES

Table 1

X-Met 880 Alloy Analyzer Data for Developing an Acceptance Criteria

Standard	Cr	Ni	Mo	Mn	Cu	Good/Possible Match: Alloy	No Good Match	Overall Rating
Type 304	18.28	8.13	0.17	1.48	0.19	7 / 3: Type304	----	Good
Type 309	22.60	13.81	---	1.63	---	9 / 1: Type309	----	Good
Type310	24.87	19.72	0.16	1.94	0.11	5 / 5: Type310	----	Good
Type 316	16.74	10.07	2.06	1.44	0.11	Not Analyzed	----	----
NIST C1154a	19.31	13.08	0.068	1.44	0.44	10 / 0: C1154a	----	Good
Standards Used to Check the Alloy Analyzer								
NIST 1267	24.14	0.29	---	0.315	---	0 / 0	10	No Match
NBS 1219	15.64	2.16	0.164	0.42	0.162	0 / 0	10	No Match
NBS C1289	12.12	4.13	0.82	0.35	0.205	0 / 0	10	No Match
BCS 331	15.20	6.26	---	0.78	---	0 / 0	10	No Match
NIST C1151a	22.59	7.25	0.79	2.37	0.385	0 / 0	10	No Match
NIST C1153a	16.70	8.76	0.24	0.544	0.226	0 / 9: Type304	1	Possible
NIST C1152a	17.76	10.86	0.44	0.95	0.097	0 / 4: Type304	6	No Match

NIST 1155	18.45	12.18	2.38	1.63	0.169	0 / 8: Type316	2	Possible
NIST C1287	23.98	21.16	0.46	1.66	0.58	0 / 8: Type310	2	Possible
NBS 1230	14.80	24.20	1.18	0.64	0.14	0 / 0	10	No Match
NBS C1288	19.55	29.30	2.83	0.83	3.72	0 / 0	10	No Match
NBS 1246	20.10	30.80	0.36	0.91	0.49	0 / 0	10	No Match

Table 2

Current Water Assay for C & D SFP Piping Systems, Administrative limits for A & B SFP, and NUREG CR-5116 Data for Primary Water in Cold Shut Down (ppb = parts per billion)

Identification	F (ppb)	Cl (ppb)	SO_4 (ppb)	pH
2-SF-75	57	29.5	1027	6.33
2-SF-74	29.3	62.7	682	5.82
2-SF-49	166	48	632	5.60
2-SF-215	11.7	26	321	5.55
2-SF-214	14.2	31.5	430	5.40
2-SF-212	120	70.5	676	6.74
2-SF-213	13.1	28.2	424	5.33
A & B SFP Admin. Limits (1)	<150	<150	----	----
Primary Water(2) Shut Down	<150	<150	----	----

(1) HNP Plant operating manual, Volume 5, Part 3, "SHNPP Environmental and Chemistry Sampling and Analysis Program," January 20, 1999.
(2) Shut down values above those indicated should be corrected before reaching full power operations.

NIST 1155	18.45	12.18	2.38	1.63	0.169	0 / 8: Type316	2	Possible
NIST C1287	23.98	21.16	0.46	1.66	0.58	0 / 8: Type310	2	Possible
NBS 1230	14.80	24.20	1.18	0.64	0.14	0 / 0	10	No Match
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(2) Shut down values above those indicated should be corrected before reaching full power operations.

Davis Exhibit 10

Davis Exhibit 11

Davis Exhibit 12

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Evaluation of Embedded Welds in Spent Fuel Piping at Harris Nuclear Plant

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Structural Integrity Associates, Inc.

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Section	Pages	Revision	Date	Comments
1.0	1-1 – 1-2	0	12/7/99	Initial Issue
2.0	2-1 – 2-3			
3.0	3-1			
4.0	4-1 – 4-7			
5.0	5-1 – 5-11			
6.0	6-1 – 6-3			
7.0	7-1			

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1.0 INTRODUCTION

Carolina Power & Light Company (CP&L) requested Structural Integrity Associates, Inc. (SI) to evaluate the structural integrity and suitability for service of the embedded stainless steel piping, including 15 field welds, in the Spent Fuel Pool Cooling and Cleanup System for Harris Nuclear Plant (HNP) spent fuel pools C and D. The Spent Fuel Pool Piping (SFP Piping) was constructed in the early 1980s, but was never installed and has not been operational. CP&L is now commissioning C and D SFP Piping in support of activating the C and D spent fuel pools.

This report provides a review of all of the materials transmitted to SI (Table 1-1) to provide an independent, expert opinion regarding the quality of construction and suitability for purpose of the SFP Piping. This review was primarily focused on the 15 embedded field welds, described on CP&L isometric drawings 2-SF-149, -144, -143, -151, -159, -1, and –8, but also considered the overall condition of the balance of the piping.

The quality of construction assessment was focused on the as-installed structural integrity of the SFP Piping, as described by the quality records provided for this review and from the videotapes of the remote visual inspections performed during 1999. The suitability for service included an assessment of the structural integrity of the SFP Piping in its present condition, including any potential degradation that the SFP Piping has experienced since initial installation, and projections of any further degradation that stainless steel piping in that condition would possibly experience for the duration of the SFP Piping's service life.

Table 1-1

Materials Provided by CP&L

1. Vendor Data Packages for the following segments:

2-SF-149	2-SF-151	2-SF-30
2-SF-144	2-SF-1	2-SF-34
2-SF-143	2-SF-8	2-SF-159

2. Requested sections of the RAI submittal labeled "Enclosure 6 to Serial HNP-99-069" (includes CP&L weld procedures and PQRs, and DDRs).

3. Videotapes:
   "Weld Hydrolasing"
   "1999 CTS Power Services 1st Visit, 6/99 – Non Clear "C" Pipe"
   "Weld Cleaning 2-SF-8-FW-65 & 66"
   "Visual Inspections of Welds: WR/JO 99, ADUP1, 2-SF-149-FW-408, 2-SF-144-FW-515, 2-SF-144-FW-516, July 7, 1999"
   "6-24-99, 99-ADUNZ WR/JO, Weld 2-SF-8-FW-66 I.D "
   "Visual Inspection of Weld: 2-SF-143-FW-512, July 8, 1999"
   "Visual Inspection of Weld: 2-SF-8-FW-66, 2-SF-8-FW-65, CTS Power Services"
   "CP&L Tape 1" (2-SF-143-FW-513, FW-514; 2-SF-144-FW-517)
   "CP&L Tape 2" (2-SF-1-FW-5, FW-4, FW-1, FW-2; 2-SF-159-FW-518, FW-519)

4. Hydrostatic Test Records for the following segments:

2-SF-143	2-SF-159	2-SF-143
2-SF-149	2-SF-34	2-SF-1
2-SF-151	2-SF-144	2-SF-30

5. "Harris Nuclear Plant – Bacteria Detection in Water from the C and D Spent Fuel Pool Cooling Lines", Metallurgy Services Technical Report 99-90.

6. Isometric Drawings:

2-SF-149	2-SF-159	2-SF-1
2-SF-144	2-SF-151	2-SF-30
2-SF-143	2-SF-8	2-SF-34
2-SF-159		

7. Chemistry Sample Data Sheets –Spent Fuel Pool Drains (7), 4-27-99

2.0 BACKGROUND

Initial communications with CP&L indicated that the SFP Piping in question is embedded in concrete and is therefore not accessible for external examination or radiographic examination. However, the majority of the piping in the Spent Fuel Pool Cooling and Cleanup System is exposed and is accessible. Per CP&L, all of the stainless steel piping, embedded or exposed, was installed under the CP&L ASME N Certificate construction program which existed at the time of construction, and was spared in place when construction of HNP Units 2 & 3 was canceled.

The stainless steel SFP Piping consists of 150 psi class piping spools, 12" or 16" STD (0.375") wall, welded Type 304 stainless steel pipe, with both seamless and welded fittings, prefabricated by an authorized supplier. Vendor data records (Table 1-1, Item 1) for those spools were reviewed. Those records show that the longitudinal seam welds for the pipe itself were made by the gas tungsten arc welding (GTAW) and submerged arc welding (SAW) processes, and were radiographed and examined by liquid penetrant techniques. Pipe spool welds done by the fabricator were examined visually and by liquid penetrant testing (PT). These spools were joined by field welds made by CP&L or its contractors or assembled by flanged connections. Consistent with the piping's Code of Construction (designed to Section III, Class 3, 1971-73; constructed to 1974-76), volumetric inspection was not required for the field welds. All of the embedded field welds are in 12" lines.

Some of the records associated with the installation and field welding of the piping were discarded, including the weld data reports for the embedded field welds. All of the SFP Piping received a hydrostatic test. The hydrostatic test procedure included a review of all weld data records and a sign-off that those records were complete. The hydrostatic test procedure also required that all welded joints be visible for inspection, that the piping be pressurized to a minimum of 1.25 times the design pressure, held at that pressure for a minimum of ten minutes, and that the piping be examined for leakage over 360° at all joints and at all regions of stress while the piping was at pressure. The examination was also witnessed by the independent authorized nuclear inspector (ANI).

Service conditions for this embedded SFP Piping will be, and have been, very mild. The design pressure of the stainless steel SFP Piping is 150 psi; however, as noted by CP&L, the maximum service pressure is only about 25 psi. The maximum service pressure is so low because the Cooling and Cleanup System takes its suction on, and discharges into, the spent fuel pool, which is open to atmospheric pressure in the Spent Fuel Handling Building. Typical operating pressure will be less than 10 psi (limited by the static head at the lowest point); design temperature is less than 200°F; and service stresses from either pressure or supports are very low. The SFP Piping experiences no high fluid velocities, and the service environment is a well controlled, benign water chemistry (borated demineralized spent fuel pool water).

Following hydrostatic testing in late 1979 (Field Welds 2-SF-1-FW-1, -2, -4, and -5) or 1981/1982 (all of the other embedded Field Welds), CP&L indicated that the SFP Piping was drained and vented, but there are no records to indicate that the piping was either rinsed or dried. No water has been introduced into the SFP Piping by in-leakage from other systems, because none of the embedded piping is connected to any other systems. Per CP&L, piping was left unconnected to other systems (e.g., Closed Cooling Water, CCW) and openings were covered with Foreign Material Exclusion covers (plywood covers prior to1989; welded-on metal covers after spent fuel pools A and B were filled). The first filling of any of the "A" and "B" spent fuel pools occurred in 1989. Later, spent fuel pools C and D were also filled to ensure that there was no drain-down event from interconnected pools A and B. Over the years, this SFP Piping has filled with water from spent fuel pools C and D, that has leaked past "plumbers plugs" installed at the pool nozzles. This leakage from the spent fuel pools to the spared-in-place SFP Piping could have begun as early as 1989 or 1990. For the purposes of this analysis, the maximum time of flooding, approximately 10 years, will be assumed for conservatism. Although the piping has been filled for a number of years with spent fuel pool borated demineralized water, no formal lay-up program has ever been implemented for the embedded SFP Piping connected to spent fuel pools C and D. The phrase "wet lay-up" will be used to describe the flooded conditions that the piping has experienced since 1989, at the earliest.

Remote visual examination of fifteen embedded field welds (2-SF-8-FW-65 and –66; 2-SF-144-FW-515, -516, and –517; 2-SF-149-FW-408; 2-SF-143-FW-512, –513, and –514; 2-SF-159-FW-518, and –519; 2-SF-1-FW-1, –2, -4, and -5) and the piping in six of the eight lines was done by a CP&L contractor using a high resolution camera mounted to a pipe crawler following draining of those lines. Those videotapes were reviewed as a part of this project. In addition, CP&L has collected and analyzed water samples from seven of the lines for water chemistry and from seven lines to characterize the microbiological nature of the water.

3.0 OBJECTIVES

The primary objective of this project was to provide an independent, expert opinion on the structural integrity and suitability for purpose of the subject SFP Piping.

This assessment includes:

- A determination of the structural integrity of the welds as installed,
- An assessment of the present condition of the SFP Piping based upon any damage that has ensued during the roughly 10 years of wet lay-up,
- Suitability for service of the SFP Piping in the benign spent fuel pool water environment, and
- Specific recommendations on any other actions that should be performed to substantiate the quality of the SFP Piping.

4.0 APPROACH

4.1 Initial Quality

The first step in this assessment involved a detailed review of the available data, listed in Table 1-1. Materials that were reviewed included:

- Piping layout information
- Specified materials of construction, including weld metals
- Actual materials of construction (or verification that the specified materials were used throughout)
- Welding procedure specification(s) for shop and field welds
- Procedure Qualification Records for shop and field welds
- Visual and PT inspection records for shop welds
- Hydrotest results
- Videotapes of the remote visual examinations of fifteen field welds in the installed SFP Piping.

4.2 Degradation Since Construction

All potentially applicable degradation mechanisms were considered. The probability for each of those mechanisms to have degraded the piping during the extended wet lay-up was evaluated against the best estimate of the conditions to which the piping was actually exposed, considering:

- All loadings
- Nominal temperature, pressure, and water chemistry conditions
- Hydrotest water chemistry, and draining or drying procedures that might have been implemented following hydrotest
- Time of immersion since initial flooding (conservatively assumed to be approximately 10 years, the time between the initial fill of spent fuel pools and the drying done for the remote visual examination)
- Verification of the exposure conditions based upon temperature, pressure, and water chemistry data from monitoring or other surveillance of the lines (water chemistry, microbiological characterization)

- Detailed review of the videotapes from the remote visual examination of fifteen of the field welds performed in 1999.

All potentially operative degradation mechanisms were considered for the SFP Piping by comparing the degradation mechanisms and the operating conditions that are associated with them to the normal operating conditions for the piping (low flow or stagnant controlled purity water at ambient temperature) plus off-normal conditions, which for the SFP Piping are no different. Those degradation mechanisms are listed in Tables 4-1 and 4-2. Both tables are from compilations of all of the potentially operative degradation mechanisms for nuclear power plant components used in either ASME Code Case N-560 [1] evaluations or the EPRI Methodology for Risk-Informed Inservice Inspection [2]. This assessment has conservatively assumed that piping residual stresses were tensile stresses at the piping inside diameter and equal to the material's yield strength. Fit up and welding can produce residual stresses that can reach the yield strength before plastic deformation relaxes them.

Table 4-1

Degradation Mechanisms and Attributes in Code Case N-560 [1]

	Mechanism	Attributes	Susceptible Regions
1	Thermal Fatigue i. Thermal Shock ii. Stratification iii. Striping	Intermittent Cold Water Injection (i, ii, iii) Low Flow, Little Fluid Mixing (ii. Iii) Notch-Like Stress Risers (ii, iii) Very Frequent Cycling (ii, iii) Unstable Turbulence Penetration into Stagnant Lines (ii, iii) Bypass leakage in valves with large ΔTs (ii, iii)	Nozzles, branch pipe connections, safe ends, welds, HAZ, and base metal regions of high stress concentration
2	Flow Accelerated Corrosion	Turbulent Flow at Sharp Radius Elbows and Tees Proximity to Pumps, Valves and Orifices Material Chromium Content Fluid pH Oxygen Temperature	
3	Erosion-Cavitation	Severe Discontinuities in Flow Path Proximity to Pump, Throttle Valve, Reducing Valve or Flow Orifice	Fittings, welds, and HAZ
4	Corrosion i. General Corrosion ii. Crevice Corrosion iii. Pitting iv. MIC	Aggressive Environment (i, iii) Oxidizing Environment (ii, iii) Material (i, iv) Temperature (i, iv) Contaminants (sulfur species, chlorides, etc.) (ii) Crevice Condition (ii) Stagnant Region (ii) Low Flow (iii) Lay up (iv)	Base metal, welds, and HAZ
5	Stress Corrosion Cracking i. IGSCC ii. TGSCC iii. PWSCC	Susceptible Material (i) Oxidizing Environment (i, ii) Stress (residual, applied) (i, ii) Initiating Contaminants (sulfur species, chlorides, etc.) (I) (aqueous halides or concentrated caustic) (ii) Temperature (i, ii) Strain Rate (environmentally assisted cracking) (i, ii) Fabrication Practice (e.g., weld ID grinding, cold work (i) Notch-like Stress Risers	Austenitic stainless steel welds and HAZ (i) Mill-annealed Alloy 600 nozzle welds and HAZ without stress relief (iii)
6	Water Hammer [Note (1)]	Potential for Fluid Voiding and Relief Valve Discharge	

NOTE:

(1) Water hammer is a rare, severe loading condition as opposed to a degradation mechanism, but its potential at a location, in conjunction with one or more of the listed degradation mechanisms, could be cause for a higher examination zone ranking.

Table 4-2

Degradation Mechanism Criteria and Susceptible Regions (from [2])

Degradation Mechanism		Criteria	Susceptible Regions
TF	TASCS	–NPS > 1 inch, and –pipe segment has a slope < 45° from horizontal (includes elbow or tee into a vertical pipe), and –potential exists for low flow in a pipe section connected to a component allowing mixing of hot and cold fluids, or potential exists for leakage flow past a valve (i.e., in-leakage, out-leakage, cross-leakage) allowing mixing of hot and cold fluids, or potential exists for convection heating in dead-ended pipe sections connected to a source of hot fluid, or potential exists for two phase (steam/water) flow, or potential exists for turbulent penetration into a relatively colder branch pipe connected to header piping containing hot fluid with turbulent flow, and –calculated or measured ΔT > 50°F, and –Richardson number > 4.0	Nozzles, branch pipe connections, safe ends, welds, heat affected zones (HAZs), base metal, and regions of stress concentration
	TT	–operating temperature > 270°F for stainless steel, or operating temperature > 220°F for carbon steel, and –potential for relatively rapid temperature changes including cold fluid injection into hot pipe segment, or hot fluid injection into cold pipe segment, and – |ΔT| > 200°F for stainless steel, or |ΔT| > 150°F for carbon steel, or |ΔT| > ΔT allowable (applicable to both stainless and carbon)	

Table 4-2. Degradation Mechanism Criteria and Susceptible Regions (Cont.)

Degradation Mechanism		Criteria	Susceptible Regions
SCC	IGSCC (BWR)	–evaluated in accordance with existing plant IGSCC program per NRC Generic Letter 88-01	Welds and HAZs
	IGSCC (PWR)	– austenitic stainless steel (carbon content ≥ 0.035%), and –operating temperature > 200°F, and –tensile stress (including residual stress) is present, and –oxygen or oxidizing species are present <u>OR</u> –operating temperature < 200°F, the attributes above apply, and –initiating contaminants (e.g., thiosulfate, fluoride or chloride) are also required to be present	
	TGSCC	– austenitic stainless steel, and –operating temperature > 150°F, and –tensile stress (including residual stress) is present, and –halides (e.g., fluoride or chloride) are present, and –oxygen or oxidizing species are present	Base metal, welds, and HAZs

Table 4-2. Degradation Mechanism Criteria and Susceptible Regions (Cont.)

Degradation Mechanism		Criteria	Susceptible Regions
SCC (cont.)	ECSCC	– austenitic stainless steel, and –operating temperature > 150°F, and –tensile stress is present, and –an outside piping surface is within five diameters of a probable leak path (e.g., valve stems) and is covered with non-metallic insulation that is not in compliance with Reg. Guide 1.36, or –an outside piping surface is exposed to wetting from concentrated chloride-bearing environments (i.e., sea water, brackish water, or brine)	Base metal, welds, and HAZs
	PWSCC	–piping material is Inconel (Alloy 600), and –exposed to primary water at T > 560°F, and –the material is mill-annealed and cold worked, or cold worked and welded without stress relief	Nozzles, welds, and HAZs without stress relief
LC	MIC	–operating temperature < 150°F, and –low or intermittent flow, and –pH < 10, and –presence/intrusion of organic material (e.g., Raw Water System), or –water source is not treated with biocides	Fittings, welds, HAZs, base metal, dissimilar metal joints (for example, welds and flanges), and regions containing crevices
	PIT	–potential exists for low flow, and –oxygen or oxidizing species are present, and –initiating contaminants (e.g., fluoride or chloride) are present	
	CC	–crevice condition exists (i.e., thermal sleeves), and –operating temperature > 150°F, and –oxygen or oxidizing species are present	

Table 4-2. Degradation Mechanism Criteria and Susceptible Regions (Concluded)

Degradation Mechanism		Criteria	Susceptible Regions
FS	E-C	–cavitation source, and –operating temperature < 250°F, and –flow present > 100 hrs./yr., and –velocity > 30 ft./sec., and –$(P_d - P_v) / \Delta P < 5$	Fittings, welds, HAZs, and base metal within 5D of source
	FAC	–evaluated In accordance with existing plant FAC program	per plant FAC program

5.0 RESULTS

5.1 Initial Quality

This piping was constructed (to the extent that construction was completed) under the HNP ASME QA program. All procedures and plant construction were subject to frequent internal and external audits. This same QA program was used to successfully complete and license HNP Unit 1. While much of the documentation for the fifteen embedded field welds was unavailable, the QA program did require procedures for material controls, material handling and welding procedures and qualifications, completion of weld data reports (note that hydrotest procedures required a sign-off of the completion of all weld data reports), specific QC inspections, and ANI third party review. Construction of the subject SFP Piping without those controls would have required a total breakdown of that QA program.

The presence of Deficiency Disposition Reports (DDRs) pertaining to embedded field welds (Table 1-1; Item 2.) provides a clear indication that the QA program was indeed applied to the field welds. For example, Field Weld FW-408 required a DDR since an ANI hold point was bypassed on final inspection. Similarly, a DDR was written for FW-517 (arc strikes found).

In the absence of weld documentation packages for the field welds, the signed-off hydrotest records provide the only formal documentation that "all weld data records (are) complete". Those packages were provided for field welds FW-408, -512, -513, -514, -515, -516, -517, -518, and –519. No hydrotest packages were supplied for field welds FW-65 and –66.

The weld procedures that were reviewed as a part of this project were CP&L procedures that were in place at the time the field welds in the SFP Piping were made. Those procedures included welds in the variety of P-8 materials (per ASME Code Section IX) that would be used in nuclear construction, including the Type 304 stainless steel used for the SFP Piping. The controls on welding processes (GTAW and Shielded Metal Arc Welding, SMAW), heat inputs, purge and shielding gas, and other parameters required to make high quality welds in nuclear construction were typical of those that have been reviewed by Structural Integrity Associates for other plants, including welds for Class 1 systems. The weld procedure packages that were reviewed (Table 1-1, Item 2) also included Procedure Qualification Records that demonstrated that the weld procedures produced sounds welds with satisfactory mechanical properties.

Ebasco Services performed a calculation on the minimum piping wall thickness, t_{min}, that was required to retain the design pressures in the Spent Fuel Pool Cooling and Cleanup System, assuming a maximum allowable stress, SE, of 17,800 psi due to internal pressure [3]. That calculation, verified by Structural Integrity Associates showed that for 16" stainless steel pipe, t_{min} = 0.011" for a design service pressure of 25 psi (joint efficiency = 100%). For 12" pipe and a joint efficiency of 80%, the maximum for butt welds not subjected to volumetric examination, the calculated t_{min} was also equal to 0.011" for a design service pressure of 25 psi. The pipe's 0.375" nominal thickness is therefore approximately 30 times the required minimum thickness for the design service pressure.

The minimum wall thickness was also calculated for 150% of the 150 psi design rating of the 12" stainless steel piping, or 225 psi. The calculated t_{min} for that pressure (nine times the 25 psi design service pressure) was 0.080"; about one-fifth of the actual pipe thickness of 0.375". At a joint efficiency of 80% and pressure of 225 psi, t_{min} = 0.100". Those calculations apply to the exposed pipe. The results will be conservative for the SFP Piping embedded in concrete since the presence of the concrete effectively reinforces the pipe.

Although the fabrication requirements for the SFP Piping field welds did not require examination of the ID of pipe welds by visual or enhanced methods (such as PT), detailed visual examination results of the fifteen embedded field welds were provided by CP&L, from remote visual inspections performed during the Summer and Fall of 1999, to assess the present condition of those welds.

These visual examinations demonstrated that, in general, the piping and welds in the embedded SFP Piping were in good condition. However, there were some areas on some welds where the consumable insert was not completely consumed and some areas on most of the welds where the profile was less than ideal. The condition of a non-consumed insert was most pronounced on

FW-516. Some small linear indications were observed (e.g., FW-65, FW-515, FW-517, FW-518) which appeared to be related to incomplete fusion. No areas were visible from the ID that would suggest that the reduction in thickness approached t_{min}. The fact that all welds passed a hydrostatic test (i.e., no visible leakage from a 360° examination) at a pressure in excess of 125% of the design pressure, for a minimum of ten minutes, provides a further verification of the initial quality and structural integrity of the welds.

At the ID, the appearance of the tie-in at the edges of all of the Field Welds that were examined is good to excellent. There are some weld areas, generally scattered around the circumference, where the consumable insert was not completely consumed or where the weld profile was less than ideal; not surprising for closure welds. FW-516, the worst weld in this regard, had the largest intermittent areas of incomplete consumption of its consumable insert but still exhibited complete fusion at the edges. Since there has been no volumetric examination of these welds, the evaluation of the overall structural integrity of the weld, where the subsurface condition resulting from small areas of the consumable insert not having been completely consumed, must revert to the calculation of the required minimum thickness for the design or operating pressure (including a reduced joint efficiency; which is precisely why a joint efficiency less than 100% is employed). The successful hydrotest results provide a verification that thickness exceeded t_{min} throughout FW-516 and the other welds at the time of the hydrotest, despite the non-consumed areas.

Several broad and apparently shallow linear indications were noted for FW-515. Those indications were always at the edge of the consumable insert. Similar indications were also apparent in the longitudinal seam of one of the adjacent pipes. That longitudinal seam had passed visual examination and PT as a part of its inspection following shop fabrication. No pitting or crevice corrosion were observed in the shallow linear indications in either the longitudinal seam or in FW-515.

No evidence of overheating or excessive heat tint was detected.

5.2 Degradation Since Construction

A review of all of the potentially operative degradation mechanisms listed in Table 4-1 and 4-2 identified that the only potentially operative degradation mechanisms for the SFP Piping are associated with corrosion. The flows, vibrations, and thermal conditions associated with the operation of the SFP piping, including up to ten years of wet lay-up, are far less than the conditions that can produce flow accelerated corrosion, or vibrational or thermal fatigue.

The potentially operative corrosion mechanisms include transgranular stress corrosion cracking (TGSCC), intergranular stress corrosion cracking (IGSCC), localized corrosion, and microbiologically influenced corrosion (MIC). No other corrosion mechanisms were considered to have been potentially operative for the extended lay-up conditions experienced by this piping. Other corrosion mechanisms, such as flow accelerated corrosion (FAC), are not considered operative due to the materials of construction (stainless steel), operating conditions (little or no flow; no temperatures in excess of typical ambient), and nominal environment (no caustic, raw water, or other damaging chemical species have been introduced to this piping).

The spent fuel pool cooling heat exchangers are cooled by the high purity component cooling water (CCW) system, which operates at a higher pressure than the SFP cooling water. Hence, any leakage would be from the CCW system into the SFP cooling water. Even this design condition is of no consequence for the embedded SFP Piping, since construction did not progress to the extent that any of the embedded piping was ever connected to the heat exchangers.

The SFP Piping has in effect been exposed to an extended wet lay-up with high purity water (albeit an inadvertent lay-up since no formal lay-up program was ever implemented for the lines connected to the spent fuel pools). As noted previously, over time, the piping has filled with water from the spent fuel pools which leaked past "plumbers plugs" installed at the pool nozzles, possibly beginning as early as 1989 when the "A" and "B" pools were first filled. No water has been introduced by in-leakage from other systems, because none of the embedded piping is connected to any other systems.

No regular sampling has been performed of the water in the SFP Piping. However, chemistry samples were collected from each of seven lines associated with the embedded piping (2-SF-74, -75, -212, -213, -214, -215, and –49) on 4-27-99 (Table 1-1, Item 7). Those results showed that chloride, fluoride, sulfate, and conductivity levels were very low (maximum values: chloride = 70.5 ppb; fluoride = 166 ppb; sulfate = 1027 ppb; conductivity = 103 μS/cm). Those chloride and fluoride concentrations are consistent with the specifications for spent fuel pool chemistry. Sulfate and conductivity levels are also consistent with those of a high purity water. The water samples also showed low levels of tritium; at a concentration similar to that of Spent Fuel Pool "C". The visual examinations also revealed a white crystalline substance near the bottom of some lines. That material looked very similar to boric acid crystals that form when borated water, as from the fuel pool, dries out on surfaces.

Seven water samples, from the "C" and "D" SFP Piping drains were also collected and evaluated by CP&L to provide some insight regarding the presence of active MIC bacteria in the lines (Table 1-1, Item 5). The water samples were analyzed using RapidChek™ II kits for sulfate reducing bacteria (SRB) and Hach Corporation BART™ kits for slime formers, iron related bacteria, and heterotrophic bacteria. The RapidChek tests indicated that the number of SRB was somewhere between the lower detection limit of 1000 cells/ml and 100,000 cells/ml. No slime formers, iron bacteria, or heterotrophic aerobes were detected with the BART kits. Those results are in dramatic contrast to typical bacterial counts for raw waters, providing further verification that the water in the lines was water of controlled chemistry; not untreated cooling water.

In low energy piping, the potentially operative degradation mechanisms will produce either tight cracks (TGSCC or IGSCC) or pinhole leaks (localized corrosion and MIC). For these low pressure lines, the only manifestations of those degradations will be very small leaks, of the order of a few drops per minute. In the absence of significant pressure loadings, which are absent in these lines, or significant seismic loadings, even the cracks produced by TGSCC or IGSCC would have no effect on structural integrity of the lines. Even significant pitting (i.e., over a large fraction of the circumference) confined to a narrow band, as can occur with severe MIC degradation of a weld, does not degrade the structural integrity of stainless steel weldments due to the very high toughness of those welds.

5.2.1 *IGSCC*

There is an extremely low probability of occurrence of IGSCC in stainless steel in the conditions and environment of the SFP Piping. While the very conservative assumption that residual stress is equal to the yield strength produces stresses sufficient to initiate and grow cracks, the controlled purity environment is not sufficiently aggressive to initiate or propagate cracks. For IGSCC driven by oxidizing conditions, the spent fuel pool temperature is far too low to produce IGSCC. Other aggressive and potential IGSCC-inducing species like thiosulfate are not present in the controlled purity environment nor is there a path that would introduce such species to the spent fuel pool environment. For example, IGSCC requires the presence of a significantly higher operating temperature (minimum of 200°F) or the presence of very aggressive chemical species such as caustic or thiosulfate.

5.2.2 *TGSCC*

Similarly, there is an extremely low probability of occurrence of TGSCC. As for IGSCC, the controlled purity environment is not sufficiently aggressive for either initiation or growth, even with the conservative assumption of residual stresses equal to the yield strength; a stress that would be sufficient to initiate and grow cracks if an appropriate environment were present. Chlorides are very low, limited to the levels permitted in the spent fuel pool environment (<100 ppb) or from chlorides that may have been introduced during the hydrotest (of the order of 50 to 100 ppm), with the residual chlorides subsequently diluted from the system by the spent fuel pool water.

Further, the spent fuel piping does not have any connection to coolers or other piping that can cause raw water to leak into the spent fuel pool environment.

5.2.3 *Localized Corrosion*

Pitting or crevice corrosion are also unlikely degradation mechanisms. The only environmental source over the long term is the very innocuous, controlled purity, spent fuel pool water. While the environment in this piping is not monitored, the spent fuel pool environment is checked by periodic water samples. All samples that have been collected from this piping, seven sample locations at one time point, as much as 10 years after initial wet-out, have confirmed that the environment inside the piping is consistent with the spent fuel pool water. The visual examinations also suggested that boric acid crystals were present in some of the lines

The chemical influence of the hydrotest water is limited by the total amount of chlorides, fluorides, and other potentially aggressive species in that water. Subsequent filling of the lines with high purity water would eliminate virtually all of those effects. The 1999 water samples have confirmed that no additional sources of water-borne chemical impurities were introduced. Dry-out and subsequent re-flooding or nearly complete dry-out of low spots would produce the most aggressive chemistry. Those locations would be expected at drains, precisely where samples were collected.

5.2.4 MIC

MIC is more likely than the other forms of localized corrosion since a minuscule population of microorganisms can grow to a diverse population of millions of microorganisms, limited only by the available nutrients. Source terms for microorganisms are hydrotest water, the spent fuel pool water, and potential intrusions of raw water from coolers. The latter item is not considered to be viable since the SFP Piping has effectively been isolated from all the coolers (more correctly, it was never connected).

Most often, MIC will produce closed, "ink bottle" shaped pits (Figure 5-1), characterized by tiny entrance holes and exit holes (if the pit goes through-wall) with a much larger area of metal loss beneath the surface. Because of the very small openings to the pit at the ID and OD, leak rates are extremely small. In stainless steels, MIC pits are far more common at weldments, either in the weld metal itself, in the heat affected zone, or beneath the heat tint. In a worst case scenario, pits in a single weld could produce a significant area of metal loss along the length of the weld such that the effective length of the flaw is large.

CP&L Test Procedure TP-30 [4] required all hydrotest water to meet Westinghouse spec PS292722. Procedure WP-115 [5] permitted hydrotests using lake water or potable water (but still water per Westinghouse spec PS292722 for piping in Westinghouse's scope of supply). The majority of the hydrotest results that were received for the embedded piping evaluated in this report were performed in accordance with WP-115.

The monitoring of the water that has been done (one data point, consisting of seven samples collected in 1999) has shown very low counts of microbial species associated with MIC. While water samples are not the best method for verifying that there is no biofilm on piping surfaces, the water sampling plus visual inspection (both ID and OD) provides a reliable indicator that MIC has not produced any leakage or accelerated corrosion in the piping

It is recognized that MIC can occur in high purity waters, in nuclear plants in systems that are nominally high purity, but that have been contaminated during initial hydrotest or during operation [8, 9]. It is also well known that water samples provide a poor representation of the biofilms on surfaces that cause MIC. The water samples that have been collected and analyzed for bacteria associated with MIC do show that the purity of the water is still very good. More importantly, no evidence of large mounds of organic materials that are typically associated with MIC was present in any of the lines that were examined in the as-found condition. All of those welds and the surrounding pipe work that were examined by the remote visual examination have been very clean, even prior to hydrolasing.

No corrosion nodules or other indications that a localized corrosion phenomenon such as MIC has occurred during the wet lay-up were revealed by the detailed remote visual inspections for all but one of the welds. A few welds exhibited some evidence of minor corrosion; limited to minor staining on those welds, except for FW-517. A very few minor discolored areas, indicative of small pits that may or may not be active any longer, were observed on those welds that exhibited evidence of corrosion. None of those indications suggests the presence of any defects that would compromise the structural integrity of these lines. No crack-like defects were noted in any of the weldments.

The remote visual examination of FW-517 revealed three apparent pits, each defined by a reddish-brown deposit. Two of those indications were located in one short section near the bottom of the pipe; the other near the top.

The reddish-brown deposits and apparent entrance holes in the weld metal of FW-517 could be due to MIC, or could be from another source. In either case, the depth and morphology of the metal loss through the thickness cannot be determined from the remote visual examination of the as-found pipe. The visual examination also cannot provide a determination of whether pitting is active or not, or provide information on the source of the pitting. A definitive determination of the root cause for these small pits would require careful microbiological and chemical sampling of the deposits and the pit interior to augment the visual examination of the as-found condition, then a similarly detailed examination of the area following removal of the deposits to better characterize the pit morphology.

CP&L may choose to attempt to collect the additional information described above in order to define the root cause. However, the location of these small indications and the material's exposure history (numerous unknowns regarding time of first wet-out and possible contamination during remote visual examination and reflooding) will make sample collection and its interpretation difficult at best. The additional sampling and visual inspection may clearly define the depth and extent of the pits (both axially or circumferentially) and provide conclusive evidence of the source of the pitting. The sampling effort may show that the present chemical and microbiological nature of the deposits is inconclusive, a possible result of the difficulties of sampling or because of the age of the pits.

Corrosion pits, even the closed, tunneling pits in weld metal that are often associated with MIC of stainless steel, would have no consequence on structural integrity. MIC can produce pinhole leaks, however, even a severe MIC condition does not impact the structural integrity of stainless steel welds, as demonstrated both by calculation [6] and confirmed by experiment [7]. As demonstrated in References 6 and 7, a distribution of much larger pits in a more severely stressed stainless steel weld had no effect on load carrying capability.

The presence of the reddish-brown deposits and apparent small pits in FW-517 is not considered to be a condition that jeopardizes the structural integrity of the SFP Piping at all.

The most powerful evidence that all welds, including the embedded welds, are structurally sound is that there have been no pinhole leaks reported for any of the exposed piping. If MIC or other localized corrosion mechanisms were operative now or had produced a problem during the 10 year period that these lines have been wet, one or more pinhole leaks might be anticipated. All of the exposed piping has been subject to external visual examination by both CP&L engineering and QC. All of the exposed field welds have been satisfactorily reexamined, both visually and by liquid penetrant testing (PT). No leakage has ever been seen in any of the exposed piping. It is noted that not all of the exposed SFP piping is connected to the embedded piping, but a significant portion of it is. CP&L has estimated that a comparable volume of exposed piping is actually connected to and communicates with the embedded piping, and has been subject to the same flooded conditions.

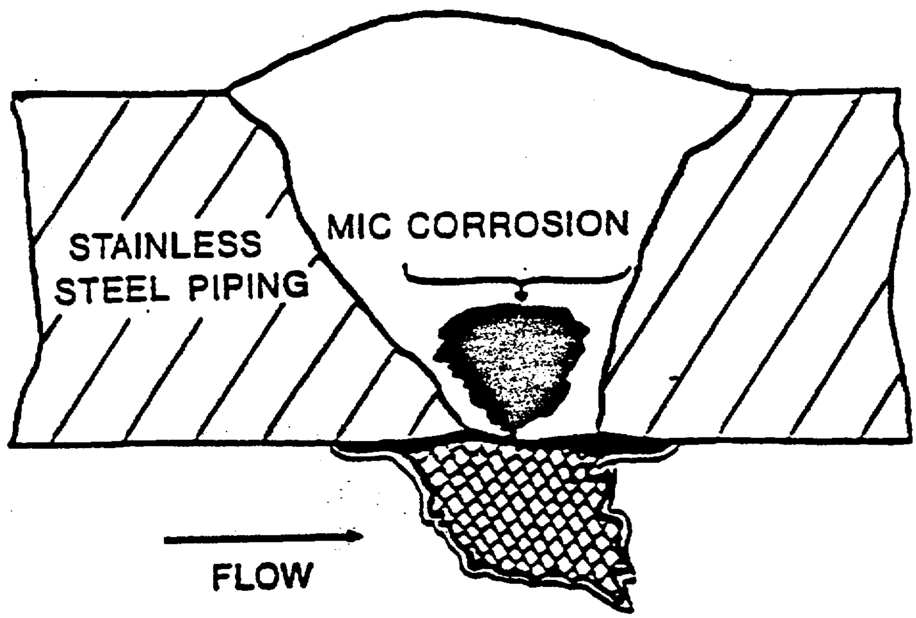

Figure 5-1. Closed Pit, Typical of MIC in Stainless Steel Piping Welds (from [7])

6.0 CONCLUSIONS

6.1 Initial Quality

The fabrication records for all of the spools in this scope were reviewed. Objective evidence was located to confirm that all components and all shop welds were of good quality.

This piping was constructed under the plant's ASME QA program; a program that was used to successfully complete and license HNP Unit 1, and which definitely appeared to have been solidly in place during the construction of all of the SFP Piping, as evidenced by QA records from that era.

No documentation was provided on the as-installed condition of field welds, except for those field welds for which hydrotest records are in hand (i.e., 2-SF-149-FW-408; 2-SF-143-FW-512, -513, and –514; 2-SF-159-FW–518, and -519; 2-SF-144-FW-515, -516, and-517; 2-SF-1-FW-1, -2, -4, and -5). For each of those welds, the hydrotest record did contain a sign-off that the weld data reports were complete, along with the successful results of the hydrotest itself, including the 360 degree visual inspection of each weld under pressure, done while the now embedded welds were still accessible.

Detailed visual examination results of embedded field welds were provided by CP&L from remote visual inspections performed for the utility during the Summer and Fall of 1999. Those inspections were used as a part of this evaluation.

The as-installed structural integrity of all of the field welds evaluated in this project (i.e., 2-SF-149-FW-408; 2-SF-143-FW-512, -513, and –514; 2-SF-159-FW–518, and -519; 2-SF-144-FW-515, -516, and-517; 2-SF-1-FW-1, -2, -4, and -5 ; 2-SF-8-FW-65 and, -66) was considered acceptable based upon the materials provided. The successful completion of the hydrostatic test and the detailed remote visual examination (following 10 years of exposure to a wet lay-up with high purity water) provided a conclusive demonstration of the quality of the initial welds.

6.2 Present Condition

The review of the detailed visual examinations for 2-SF-8-FW-65 and –66; 2-SF-144-FW-515, –516, and –517; 2-SF-149-FW-408; 2-SF-143-FW-512, -513, and –514; 2-SF-1-FW-1, -2, -4, and –5; and 2-SF-159-FW-518 and -519 also demonstrated that those welds were in a condition that would be very comparable to that of as-installed piping. The 10 years of wet lay-up does not appear to have degraded the structural integrity of the welds at all.

6.3 Suitability for Service as Spent Fuel Pool Piping.

The assessment of the suitability for service of this SFP Piping was based upon all of the items listed above – records review and remote visual inspection.

The SFP Piping is exposed to very benign conditions. Localized corrosion, which could produce pinhole leaks, is the most likely form of degradation. None of the forms of localized corrosion, including MIC, is considered very likely at all.

No pinhole leaks have been detected in any of the exposed piping to date.

Pinholes will have no effect on structural integrity in any event.

The videotapes from the detailed remote visual examination are for six lines in a total population of eight (which include the fifteen field welds). Conclusions drawn from them assume that they are representative of the population. Per CP&L, there are no field welds in the remaining two lines.

The overall condition of the welds, including the appearance of the tie-in at the edges of the consumable insert, is good to excellent. There are some areas, generally scattered around the circumference, where the consumable insert was not completely consumed (e.g., FW-516) or where the weld profile was less than ideal. The very small thickness required to withstand design service pressure and the successful hydrotest results provide a verification that these welds are suitable for the SFP Piping's service conditions despite the non-consumed areas or imperfect profile.

The plant's best method to control degradation is to continue to keep these lines isolated from potential sources of contaminants and to assure that the only environment that the lines experience is controlled purity water. Periodic visual examination of exposed piping for the presence leaks can provide continued additional assurance of the integrity of the SFP Piping population.

7.0 REFERENCES

1. "Alternative Examination Requirements for Class 1, Category B-J Piping Welds, Section XI, Division 1," ASME Code Case N-560, August 9, 1996.

2. "Revised Risk-Informed Inservice Inspection Evaluation Procedure," EPRI Report No. TR-112657 Final Report, April 1999.

3. "Minimum Wall Thickness Calculation for Spent Fuel Pool Cooling and Clean-up," Ebasco Services Incorporated Calculation CAR-6418-312, Rev. 0, 2-13-84.

4. "Hydrostatic Testing of Buried or Embedded Pressure Piping (Nuclear Safety Related)," Carolina Power & Light Company, Shearon Harris Nuclear Power Plant, Technical Procedure TP-30, Rev. 0, 1978.

5. "Hydrostatic Testing of Buried or Embedded Pressure Piping (Nuclear Safety Related)," Carolina Power & Light Company, Shearon Harris Nuclear Power Plant, Work Procedure WP-115, Rev. 3, 1982.

6. A. F. Deardorff, J.F. Copeland, A.B. Poole, L.C. Rinaca, "Evaluation of Structural Stability and Leakage From Pits Produced By MIC In Stainless Steel Service Water Lines," CORROSION/89, Paper No. 514, NACE, 1989.

7. W.A. Pavinich, L.C. Rinaca, P.V. Guthrie, D.M. Hewette, "Four-Point Bend Testing of MIC-Damaged Piping," Proceedings: EPRI Service Water System Reliability Improvement Seminar, EPRI, 1988.

8. G.J. Licina, "Sourcebook for Microbiologically Influenced Corrosion," EPRI NP-5580, 1988.

9. G.J. Licina, "Detection and Control of Microbiologically Influenced Corrosion – An Extension of the Sourcebook for Microbiologically Influenced Corrosion," EPRI NP-6518-D, 1990.

Davis Exhibit 13

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

Report Nos.: 50-390/93-09 and 50-391/93-09

Licensee: Tennessee Valley Authority
6N 38A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Docket Nos.: 50-390 and 50-391 License Nos.: CPPR-91 and CPPR-92

Facility Name: Watts Bar 1 and 2

Inspection Conducted: February 22 through February 26, 1993

Inspectors: ______________________ 3/26/93
G. A. Walton, Senior Resident Inspector Date Signed
Construction

Lead Inspector: P. G. Humphrey, Resident Inspector, Watts Bar

Inspectors: J. Davis, Materials Engineer, NRR
W. Kleinsorge, RII Inspector
J. Medoff, Chemical Engineer, NRR

Approved by: ______________________ 3/26/93
P. E. Fredrickson, Section Chief Date Signed
Division of Reactor Projects

SUMMARY

Scope:

This inspection was conducted to evaluate the microbiologically induced corrosion special program for the raw water systems. The evaluation included implementation of corrosion controls, and the evaluation of the suitability of the existing piping and equipment to perform its intended function during future plant operation.

Results:

The program as inspected at the 75% implementation stage met requirements to evaluate, monitor, and control MIC damage in the raw water systems. The new MIC control process which began injecting chemicals in October 1992 did not provide enough operating experience at the time of the inspection to make an adequate evaluation of its effectiveness.

Four Inspector Follow-up Items were identified that will require resolution and are as follows: (1) the use of an ASME Section XI Code Case for evaluating piping systems with MIC damage; (2) inspection requirements for raw

water piping in containment penetrations; (3) instruction deficiencies noted in the non-destructive examination program; and (4) utilization of heat exchanger efficiency data to monitor MIC.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*T. Arney, Senior Quality Project Manager
K. Boyd, Site Licensing Program Manager
M. Bellamy, Startup Manager
*R. Briggs, Materials Engineer
*E. Camp, Mechanical Engineer
J. Chardos, Manager of Projects
*C. Crews, QA Specialist
*J. Christensen, Site Quality Manager
S. Crowe, Site Quality Assurance Manager
*J. Cruise, Licensing Engineer
*T. Dean, Licensing Engineer
*W. Elliott, Engineering Manager, Nuclear Engineering
*T. Hale, NDE Specialist
*J. Hawkins, QC Manager
R. Johnson, Modifications Manager
N. Kazanas, Vice President Completion Assurance
*D. Koehl, Technical Support Manager
*F. Koontz, Design Engineering Manager
A. McLemore, Modifications Engineering Manager
*R. McIntosh, Project Management
L. Maillet, Site Support Manager
*R. Milhiser, Vice President/Project Director, Ebasco
D. Moody, Plant Manager
W. Museler, Site Vice President
C. Nelson, Maintenance Support Superintendent
*P. Pace, Compliance Licensing Supervisor
*G. Pannell, Site Licensing Manager
R. Purcell, Startup and Test Manager
*J. Riggle, Chemical Engineer
K. Stinson, TVA Project Manager
S. Tanner, Special Projects Manager
*D. Voeller, Chemistry Program Manager
J. Vorees, Regulatory Licensing Manager
*C. Webber, ET Level III
*U. White, Task Manager
C. Whitehead, Project Engineer

Other licensee employees contacted included chemists, engineers, operators, technicians, and construction supervisors.

NRC Personnel

*G. Walton, Senior Resident Inspector, WBN
*B. Crowley, RII Inspector
*J. Davis, Materials Engineer

*W. Kleinsorge, RII Inspector
*J. Medoff, Chemical Engineer

*Attended exit interview

Acronyms and initialisms used throughout this report are listed in the last paragraph.

2. MIC Special Program

a. Introduction

MIC was discovered at WBN in 1986 when a leak in a stainless steel pipe occurred and a metallurgical analysis was performed as part of a root cause analysis. Since that time, leaks and various other material damage have been noted in both carbon and stainless steel piping materials associated with the raw water systems. This damage affects the flow rates and the structural integrity of the piping and equipment systems.

This inspection was a special effort to evaluate the licensee's program, at the 75% completion level, to control corrosion in raw water systems derived from the colonization of bacteria on the metal surfaces in contact with aqueous environments. The inspection included areas selected from those identified by the NRC as necessary for the program evaluation and closure based on code requirements and compliance with the SSERs, the programs committed to by the licensee to monitor and preserve the piping and equipment, and open items identified by the NRC and TVA.

The licensee prepared a closure report which addressed the NRC issues of concern. The report provided detail in each area and was utilized extensively by the inspectors during the inspection. However, areas which the licensee determined to be not applicable or to have no outstanding issues associated with the MIC program were not reviewed as part of the 75% inspection.

b. Applicable NRC Documents

Issues have been identified by the NRC pertaining to corrosion problems associated with nuclear power plants. The licensee's response to the documents applicable to the WBN MIC program were reviewed by the inspectors as follows:

- Generic Letter 89-13, Service Water System Problems Affecting Safety-Related Equipment

  The purpose of this generic letter was to address problems experienced with raw service water systems in relation to compliance with NRC regulations and the capability of meeting their intended functions. The letter recommended a program that includes: (1) examination of the intake structure for macroscopic biological fouling organisms; (2) treatment of the service water system to control macroscopic biological fouling species; (3) flushing of cooling loops and flow tests to ensure that they are not fouled or clogged; (4) addition of biocides to sections of the service water system that are to be put in lay-up status; and (5) periodic sampling for Asiatic clams.

In response to the applicable sections on GL 89-13, the licensee committed to use divers to examine the intake structure once-per-refueling cycle for Asiatic clams that have been identified in the WBN area; use a biocide to control Asiatic clams when the temperature of the Tennessee River temperature is above 60°F; and flush cooling loops and add biocide on the portions of systems that are to be placed in a lay-up status.

The inspectors noted that one area discussed in the generic letter which suggests performance data from heat exchanger tests should be utilized as input for evaluating the MIC problems had not been included in the MIC program. However, the licensee indicated during the inspection that heat exchanger test data will be used to evaluate the efficiency of the MIC program to dissolve the biofilm and corrosion deposits. Review of the implementation of this effort is identified as Inspector Follow-up Item, IFI 390/93-09-01, Utilization of Heat Exchanger Efficiencies For MIC Program Evaluations.

- Generic Letter 90-05

Generic Letter 90-05 is discussed in paragraph 2.c, ASME Code Section.

- Safety Evaluation Report Reviews

The applicable safety evaluation reports were reviewed by the inspectors to determine the licensee's compliance in the areas evaluated. SSER Nos. 8 and 10, Appendix Q, addressed the MIC issues and were reviewed during the inspection. The following documents the result of this area of the inspection.

1) SSER No. 8, Appendix Q

This SSER addresses the MIC program at WBN. It describes the replacement of some of the carbon steel piping with stair' ss steel in the ERCW system during the early 1980s because of corrosion product build-up. It also describes the first observation of MIC in

August 1986 in a 316 ss butt weld. The SSER describes the program that the licensee established as a result of MIC and in response to GL 89-13, Service Water System Problems Affecting Safety-Related Equipment, as described in site TI-36. This SSER concludes that the WBN MIC program for detection, assessment, and control of MIC in the ERCW system, if properly implemented, and if commitments in the licensee's February 2, 1991 submittal to NRC were met, would provide reasonable assurance that this system will not lose its capability to perform its safety function due to MIC damage. It also concluded that the biocide treatment may not be as effective if slime, scale, and other material were not removed mechanically or chemically prior to the implementation of the MIC program.

2) SSER Supplement No. 10, Appendix Q

This SSER supplemented SSER No. 8, Appendix Q, and included clarifying information. The safety-related portion of the fire protection system was added to the MIC monitoring program. The staff provided clarifying information on GL 90-05 concerning continued operation after detection of a leaking pipe. The staff acknowledged that WBN had installed a bromine/chlorine biocide injection system for treatment of the new water system, including the ERCW and safety-related portions of the fire-protection system.

c. Commitments and Implementing Programs

The licensee's program to evaluate, monitor, and control MIC corrosion has been implemented through the corporate and plant upper tier documents as follows:

- ASME Code

The applicable construction code stated in the FSAR is ASME Section III, 1971 Summer 1973 Addenda. The inspectors reviewed the licensee's program for compliance with the ASME code and determined that some discrepancies exist in that the raw water systems may not be in compliance based on areas of the piping that have experienced wall thinning as a result of corrosion.

The licensee had proposed to use the ASME Code Case N-480 to analyze MIC damage and evaluate the structural integrity of the ERCW and RCW systems for service suitability. Generic Letter 90-05, Guidance For Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping, refers to the

Code Case which establishes criteria for temporary non-code repairs to moderate and low energy Class III systems. The NRC staff has determined that GL 90-05 can only be used after a full power operating license has 'een issued and is not acceptable for evaluation of WBN Class III components. The use of Code Cases requires NRC staff approval, and the use of Code Case N-480 has not been endorsed by the NRC staff. The licensee has not requested NRC staff approval for the use of Code Case N-480 to analyze MIC damage in the ERCW, RCW or safety related portions of the fire protection systems. NRC evaluation of Code Case N-480 is identified as an Inspector Follow-up Item, IFI 390/93-09-03, 391/93-09-01, Utilization of Code Case N-480 of ASME Program for MIC Damage Analyses.

- Nuclear Performance Plan, Volume 4

The Nuclear Performance Plan, Volume 4, included a commitment to develop and implement a program that would determine the extent of MIC, monitor, and implement recurrence control measures to mitigate further corrosion. The plan was reviewed by the NRC and a determination was made that if properly implemented the program should be acceptable.

The plan and its implementation through the following specifications, procedures, and instructions was reviewed during the inspection.

- General Engineering Specification G-97C

The corporate program for MIC control at TVA nuclear plants is described in General Engineering Specification G-97C, Corrosion Control, Part C, Microbiologically Induced Corrosion. The scope of G-97C, Part C, defines the general basis for detecting, evaluating, monitoring, and controlling MIC in all TVA nuclear plants. G-97C, Part C, requires each TVA nuclear plant to plan, prepare, and implement the necessary details and strategies to control MIC at their respective sites. G-97C, Part C, is a corporate QA controlled document.

The inspector reviewed G-97C. The contents were as follows:

1) General Criteria

Planning MIC control program activities at TVA nuclear sites

Housekeeping requirements of records and documents

2) Technical Criteria

Identification of potential MIC problem areas

Assessment of potential MIC problem areas

Means of detecting MIC

Monitoring of systems and components determined to be susceptible to MIC

Means of assessing damage induced by MIC causing bacteria

Means of achieving water spray protection of safety related systems, structures and components in the vicinity of leaking components

Chemical treatment control of MIC

Flow monitoring requirements in relation to MIC degraded systems

The acceptability of G-97C will be determined by the NRC as part of the evaluation of IFI 390/93-09-03, 391/93-09-01, previously discussed in paragraph 2.c

- Technical Instruction TI-36

Implementation of the requirements of General Engineering Specification G-97C, Part C, at the Watts Bar Nuclear Plant is achieved through implementation of site TI-36, Control of Microbiologically Induced Corrosion at Watts Bar Nuclear Plant. The program described in this instruction covers activities, including delineating staff responsibilities, for specifying acceptance criteria for microbiological activity levels for the structural integrity of ferritic and austenitic stainless steel systems and specifying appropriate measures to be taken for maintaining QA and non-QA records and documents.

The inspector reviewed TI-36 and determined that it provided sufficient specificity for implementation of the MIC control program at WBN. TI-36 requires evaluations by nuclear engineering whenever microbiological activity levels of grab water samples exceed 10,000 counts/ml and provides acceptance criteria for system minimum wall requirements.

TI-36 and PM-1-PIPE-067-C, Files 01 and 02, require semiannual walkdowns and visual examination of all welds in the stainless steel portions of each train of the ERCW system. However, the licensee has not provided procedural guidance to ensure that all welds will be examined. During the inspection the licensee indicated that a list of applicable weld map drawings had been inadvertently deleted from PM-1-PIPE-067-C, File 01 and 02, and would be replaced. With this list used to select all the applicable weld map drawings and the use of the weld maps as check lists, adequate assurance would be provided that all applicable welds are examined. Resolution of the deleted weld map issue is identified as example 1 of IFI 390/93-09-02, Technical Instruction Deficiencies. In addition utilizing the structural acceptance criteria in TI-36 is dependent on the resolution of IFI 390/93-09-03, 391/93-09-01, previously discussed in paragraph 2.c.

TI-36 and PM-1-PIPE-067-C, File 05, require annual radiography of 15 selected welds in the stainless steel portion of the ERCW system to monitor the change in MIC indication cumulative length over time. In order to correlate the results of successive radiographic examinations and to prevent indication length variations due to setup variations, it is essential that the radiographic technique (including source to film distance, increment marker locations, the relationship of source to increment markers, pipe and film) remain constant from one examination to the next. The instruction does not specify the radiographic technique to be followed. The licensee stated that the TI would be revised to address this issue. Review of this revision is identified as example 2 of IFI 390/93-09-02, Technical Instruction Deficiencies.

- Technical Instruction, TI-31.13, Wall Thinning Monitoring Program For Cavitation, Microbiologically Induced Corrosion, and Dual Phase Erosion/Corrosion, Revision 9

  This instruction provides the detailed steps for ultrasonic testing on localized areas to monitor for wall thinning resulting from cavitation, dual phase erosion/corrosion, microbiologically induced corrosion in carbon steel piping, and generalized corrosion. One area of concern to the inspector was the ultrasonic scanning scheme mandated in TI-31.13, paragraph 6.3 [4] (scan each 2-inch grid section and record the low reading) that was not consistent with the ultrasonic examination procedure N-UT-26, which requires scanning of the entire area or taking spot readings at grid intersections. The licensee stated that the instruction will be revised to correct this inconsistency. Review of this revision is identified as example 3 of IFI 390/93-09-02, Technical Instruction Deficiencies.

- Chemistry Manual Chapters

The chemical treatment for the control of MIC at the WBN is governed by a series of chemistry manual chapters. Review of these manual chapters by the inspectors is documented below.

1) Chapter 4.0, Corrosion Control, Revision 0, describes the raw water treatment program implemented at WBN to control corrosion and fouling, and defines program goals and objectives.

2) Chapter 4.01, Visual Inspections and Corrosion Monitoring, Revision 0, describes the requirements for visual inspections and corrosion monitoring of raw water systems, and defines, instructs, and documents actions necessary to meet the requirements in relation to these activities.

3) Chapter 4.02, Startup and Normal Operation of the Pyrophosphate, Zinc, and Copolymer Equipment, Revision 0, defines and describes the actions to be taken for the operation of the pyrophosphate, zinc sulfate, and copolymer portions of the raw water treatment skid, including instructions for the receipt of these chemicals from BI.

4) Chapter 4.04, BCDMH Injection for Control of Clams, Slime, and MIC, Revision 0, defines and describes group responsibilities and actions necessary for controlling MIC, mollusc, and slime in systems containing raw water, including instructions for injecting BCDMH into the plant's raw water systems.

5) Chapter 6.02, MIC Sampling, Revision 0, provides a method of sampling solids and liquids to test for MIC infestation.

Within the areas inspected, no deviations or violations were identified.

3. Hardware and System Reviews

a. Chemical Injection System

Chemical control of MIC at the WBN is achieved by the station's chemical injection system. This system injects five different chemicals into the raw water and essential raw water systems at the intake pumping station. These chemicals and their uses were reviewed by the inspectors and are listed as follows:

1) Pyrophosphate - Injected continuously and acts as a sequestering agent of iron in existing MIC nodules and tubercles.

2) Zinc sulfate - Injected continuously and acts as a cationic corrosion inhibitor of carbon steel systems.

3) BI co-polymer dispersant - Injected continuously and acts to keep solids in suspension to reduce the amount of silt and particle deposition in areas of low system flow.

4) Butyl benzotriazole (Copper-trol) - Injected periodically to reduce corrosion resulting from aqueous solutions of copper cations.

5) Bromo chloro dimethyl hydantoin (BCDMH) - Injected on a periodic basis (continuous for 4 hrs each day) and acts as an oxidizing biocide for control of MIC causing bacteria. This compound also serves to control Asiatic clam, and Zebra mussel populations.

The first three chemicals are stored in separate tanks located on a skid adjacent to the raw water control monitoring building. The latter two chemicals are stored in tanks located in side rooms contained in the IPS. Three flow controllers located in the IPS indicate which raw water system pumps are in service (one controller for the RCW pumps, and two controllers for the respective ERCW system pumps in the A and B intake pits) and give indication of total flow in the respective systems. The respective transmitters send the data to Pacesetter computer controllers that automatically adjust the addition of pyrophosphate, zinc sulfate, and co-polymer into the raw water systems that are in service at that time. The BCDMH biocide and Copper-trol are injected, on a periodic basis.

Operation, service, and maintenance of the injection system falls under the responsibility of the WBN Chemistry Department. The department's manager and lead chemical engineer serve as the primary staff members responsible for implementation of the chemical injection aspects of the station's MIC control program. The chemical injection system is not a plant safety-related system, although many of the forms and records, listed as appendices to the chemistry manual chapters governing implementation of the chemical injection system, have been designated as QA documents for conservatism in the review process.

BI has been contracted to assist the WBN chemistry department in its efforts to control MIC at the station. This involves supplying the chemicals for use in the injection system and providing technicians to maintain and operate the computerized injection controller system. BI conducts raw water sampling and biological assays; provides side stream corrosion test specimens and the evaluation of those specimens after exposure; and provides periodic reports of test results and evaluations. The licensee indicated that they have not audited the BI testing and laboratory procedures or the BI QA program, but as part of the agreement with

BI, an independent contractor will be provided to semiannually evaluate the BI records of work performed for the licensee.

The corrosion rate project involves the use of BI Cosmos portable corrosion monitors, weight loss coupon racks, a total residual oxidant analyzer, visual observation of test spool pieces, and sessile bacteria bead monitors. However, the program was in the beginning stages and insufficient data existed to draw any conclusions with the exception of the Cosmos corrosion monitors which appeared to provide acceptable monitoring. The licensee at WBN has committed to a maximum corrosion rate allowance of 0.005 inches per year surface removal for carbon steel and 0.0005 inches per year for yellow metals such as copper-nickel and brass alloys.

b. Piping And Equipment

The licensee's program for monitoring MIC degradation in piping and equipment includes semiannual walkdowns and visual examination of all welds in the stainless steel portions of each train of the ERCW system, annual radiographic examination of fifteen selected stainless steel welds with identified MIC, semiannual ultrasonic examination of seventeen selected MIC areas in carbon steel ERCW piping and visual examination inside the carbon steel piping after each breach of raw water systems. In addition the chemical treatment of raw water is monitored by test equipment and specimens that are monitored and evaluated by BI as previously described.

To evaluate the licensee's piping and equipment MIC monitoring program the inspectors conducted interviews with licensee and contractor personnel; performed a walkthrough inspection of the raw water treatment facility at the intake pumping station, the sample facility at the cooling tower basin, and the chemical laboratories; reviewed weld radiographs; viewed video tapes of remote internal inspections of various piping systems and test assemblies conducted over the past two years; and examined associated records. The records and weld radiographs that were reviewed are listed as follows:

Procedures Reviewed

Identification	Revision	Title
TI-106	(R1)	Nondestructive Examination of Stainless Steel and Stainless Steel to Carbon Steel Butt Welds to Assess Damage From MIC

PM-1-PIPE-067-C File 01	(R2)	Monitoring of ERCW System By Visual Examination for Damage in Stainless Steel to Stainless Steel & Stainless Steel To Carbon Steel Butt Welds Resulting From MIC, Train A
PM-1-PIPE-067-C File 02	(R2)	Monitoring of ERCW System By Visual Examination for Damage in Stainless Steel to Stainless Steel & Stainless Steel To Carbon Steel Butt Welds Resulting From MIC, Train B
PM-1-PIPE-067-C File 03	(R2)	Weekly Inspection of Leaking ERCW Stainless Steel To Stainless Steel and Carbon Steel to Stainless Steel Butt Welds
PM-1-PIPE-067-C File 04	(R2)	Quarterly Radiographic Exam of Leaking ERCW Stainless Steel To Stainless Steel and Carbon Steel to Stainless Steel Butt Welds
PM-1-PIPE-067-C File 05	(R2)	Radiographic Exam of Selected Stainless Steel To Stainless Steel and Carbon Steel to Stainless Steel Butt Welds
N-RT-2	(R3)	Radiographic Examination of Structures, Systems, and Components (Nonmandatory)
N-UT-26	(R12)	Ultrasonic Examination for The Detection of ID Pitting, Erosion, and Corrosion

N-UT-18	(R3)	Ultrasonic Testing Supplements
QMP 102.4	(R6)	Qualification and Certification Requirements for Nuclear Power NDE Personnel

Radiographs Examined

Weld Identification

1-067J-T-524-19
1-067C-T-288-02
2-067G-T-048-15

The inspectors questioned why the ERCW piping in the containment penetrations was not included in the licensee's inspection program for MIC damage. The inspectors concern for MIC damage in the containment penetrations regards potential loss of containment integrity due to pipe failure. The licensee's position was that these sections of piping were in the areas considered low risk for MIC attack due to the higher flow rates. The inspectors questioned this position since the ERCW piping penetrations are part of the containment pressure boundary, and since another nuclear plant experienced problems in the penetration area. The licensee indicated that they will reevaluate their position. This is identified as Inspector Follow-up Item, IFI 390/93-09-04, Analysis of ERCW Piping In The Containment Penetrations.

c. Raw Water System Flush

The completed documentation for Cleanness Plan, CP-026-3A, Revision 1, High Pressure Fire Protection System; and Cleanness Verification of Turbine and Auxiliary Building Header Piping, was selected for review by the inspectors to evaluate the licensee's program to ensure that all areas of the system were included. The various flush paths were reviewed, and it was determined that all the system piping and associated equipment had been included and that the licensee sequenced the flushes to insure that cleaned portions of the system were not contaminated by future flushing activities.

One of the references in CP-026-3A is TOP-076-026, Temporary Operating Procedure For Temporary Diesel Driven Pumps. This procedure specifies in step 1.2.8 of the introduction that sodium hypochlorite would be added to the system for layup after flushing was completed, or as requested or directed by the startup or chemistry department. The inspector noted that the layup status was not documented in the flush data package nor was it documented in the test director's log. However, the licensee presented evidence that the chemicals were added and implemented a change, CPCN-04, to Cleanness Plan, CP-026-04, Revision 0, to require documentation for the chemicals added during the flush cycles.

The inspector determined that the flush program was properly implemented based on the system reviewed.

Within the areas inspected, no deviations or violations were identified.

4. Action On Previous Inspection Findings (92701)

The inspectors reviewed two NRC open items applicable to the MIC program which addressed deficient issues identified by the licensee. These are documented as follows.

a. (Closed) IFI 390/86-25-04, Follow-Up of Corrective Action for NCR W-471-P

This issue will be addressed in the MIC Special Program. This item is considered administratively closed, and the issue will be covered by the NRC closure inspection for this program.

b. (Closed) URI 390/90-20-06, High Pressure Fire Protection-Microbiologically Induced Corrosion

This issue will be addressed in the MIC Special Program. This item is considered administratively closed, and the issue will be covered by the NRC closure inspection for this program.

5. Exit Interview

The inspection scope and findings were summarized on February 26, 1993, with those persons indicated in Paragraph 1. The inspectors described the areas inspected and discussed in detail the inspection results. Dissenting comments were not received from the licensee. Proprietary information is not contained in this report.

Item Number	Status	Description and Reference
390/86-25-04	Closed	IFI - Follow-up for Corrective Action for NRC W-471-P (Paragraph 4.a)
390/90-20-06	Closed	URI - High Pressure Fire Protection-Microbiologically Induced Corrosion (Paragraph 4.b)
390/93-09-01	Open	IFI - Utilization of Heat Exchanger Efficiencies For MIC

		Program Evaluations (Paragraph 2.b)
390/93-09-02	Open	IFI - Technical Instruction Deficiencies (Paragraph 2.c)
390/93-09-03 391/93-09-01	Open	IFI - Utilization of Code Case N-480 of ASME Program for MIC Damage Analyses (Paragraph 2.c)
390/93-09-04	Open	IFI - Analysis of ERCW Piping in the Containment Penetrations (Paragraph 3.b)

13. List of Acronyms and Initialisms

ASME	American Society of Mechanical Engineers
BCDMH	Bromo Chloro Dimethyl Hydantoin
BI	Betz Industrial, a division of Betz Laboratories
B&PV	Boiler & Pressure Vessel
CATD	Corrective Action Tracking Document
ECSP	Employee Concerns Special Program
ERCW	Essential Raw Cooling Water
ET	Eddy Current Test
FSAR	Final Safety Analysis Report
GL	Generic Letter
ID	Inside Diameter
IFI	Inspector Follow-up Item
IPS	Intake Pumping Station
IVP	Independent Verification Program
MIC	Microbiologically Induced Corrosion
NDE	Nondestructive Examination
NRC	Nuclear Regulatory Commission
QA	Quality Assurance
QC	Quality Control
RCW	Raw Cooling Water
SS	Stainless Steel
SSER	Supplemental Safety Evaluation Report
TI	Technical Instruction
TVA	Tennessee Valley Authority
URI	Unresolved Item
WBN	Watts Bar Nuclear

Davis Exhibit 14

O-Official ... (6)

NOV 1993

Docket Nos. 50-390 and 50-391
License Nos. CPPR-91 and CPPR-92

Tennessee Valley Authority
ATTN: Dr. Mark O. Medford
Vice President, Technical Support
3B Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Gentlemen:

SUBJECT: NRC INSPECTION REPORT NOS. 50-390/93-67 AND 50-391/93-67

This refers to the inspection conducted by P. G. Humphrey on September 27 through October 1, 1993. The inspection included a review of activities authorized for your Watts Bar facility. At the conclusion of the inspection, the findings were discussed with those members of your staff identified in the enclosed report.

Areas examined during the inspection are identified in the report. Within these areas, the inspection consisted of selective examinations of procedures and representative records, interviews with personnel, and observation of activities in progress.

The enclosed inspection report documents the NRC conclusions regarding the TVA implementation of the Microbiological Induced Corrosion Special Program at the 100 percent implementation phase. Based on this inspection and others referenced in this report, the NRC concurs with TVA's closure report dated August 31, 1993, that the Microbiologically Induced Corrosion Special Program is adequately implemented. This program is closed.

Within the scope of the inspection, no violations or deviations were identified.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be placed in the NRC Public Document Room.

Should you have any questions concerning this letter, please contact us.

Sincerely,

(Original signed by E. Merschoff)

Ellis W. Merschoff, Director
Division of Reactor Projects

Enclosure: (See page 2)

Enclosure:
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Report Nos.: 50-390/93-67 and 50-391/93-67

Licensee: Tennessee Valley Authority
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Docket Nos.: 50-390 and 50-391 License Nos.: CPPR-91 and CPPR-92

Facility Name: Watts Bar 1 and 2

Inspection Conducted: September 27 through October 1, 1993

Team Leader: P. G. Humphrey, Resident Inspector, WBN — 10/28/93 Date Signed

Inspectors: J. Davis, Materials Engineer, NRR
W. Kleinsorge, Reactor Inspector, RII
N. McNeill, Reactor Inspector, RII

Approved by: P. E. Fredrickson, Section Chief
Division of Reactor Projects — 10/28/93 Date Signed

SUMMARY

Scope:

The scope of this inspection was to evaluate the licensee's full implementation of the Microbiologically Induced Corrosion (MIC) Special Program at Watts Bar Nuclear Plant. The inspection concentrated on the raw water systems that were safety-related and those important to safety, which consisted of the Emergency Raw Cooling Water and the High Pressure Fire Protection systems.

This was a follow-up inspection of the 75 percent implementation inspection conducted in February 1993, documented in Inspection Report 50-390, 391/93-09. This inspection evaluates and examines the remaining documentation packages and areas identified in a letter dated November 12, 1992, from NRC to TVA titled, "Documentation Packages to Support Inspections of Corrective Action Plans and Special Programs." The inspection also addresses those items that were identified as open issues from the 75 percent inspection. The early results achieved from the MIC Special Program were reviewed to determine their effectiveness.

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Results:

The inspectors determined that the licensee had successfully implemented the MIC Special Program with noted exceptions (Inspector Follow-up Items 93-09-01 and 04, paragraphs 7.a and 7.c) and, therefore, the Special Program was closed. The injection of chemicals into the raw water systems to control or eliminate microbiologically induced corrosion at Watts Bar Nuclear Plant showed positive results for those areas with a continuous flow of at least 3 feet per second. For the stagnant or low flow areas of those systems, a chemical treatment of once per calendar quarter as required per the surveillance program may offer no benefits toward the elimination of the existing microbiologically induced corrosion problems. However, the treatment would appear to prevent new growth in the low flow areas with the possibility of reducing or removing the existing growth. For areas of systems that have stagnant or low flow, the structural integrity is monitored by the nondestructive test programs.

Although the licensee has experienced five leaks to date attributed to MIC, the possibility exists that more leaks will occur in the future. However, the MIC monitoring program was established to identify leaks in their early stages and make repairs to assure that the systems will continue to serve their safety function.

A strength was identified in the chemistry area for the control of microbiologically induced corrosion. The proper utilization of the chemical injection system and the associated specific procedures should mitigate microbiologically induced corrosion in the plant during its future operations.

Within the areas inspected, violations or deviations were not identified.

2. Introduction (TI 2512/39)

MIC was discovered at WBN in 1986 as a result of a metallurgical analysis performed when a leak in a stainless steel pipe was discovered. Since that time, MIC has been responsible for leaks and various other material damage noted in both carbon and stainless steel piping materials associated with the raw water systems. This damage potentially affects the flow rates and the structural integrity of the piping and equipment systems.

This inspection was a follow-up of the 75 percent implementation phase inspection documented in NRC IR 50-390, 391/93-09. The purpose was to evaluate the full implementation (100 percent) of the licensee's MIC program to control and evaluate MIC damage in the ERCW and High Pressure Fire Protection systems and to address the issues identified by the licensee and previous NRC inspections. Only the two systems referenced were addressed in the inspection because of their safety significance.

Based on the letter to TVA from the NRC, dated November 12, 1992, the licensee prepared a MIC Special Program closure report. This report was utilized extensively by the inspectors during the inspection.

3. FSAR/Code Requirements (TI 2512/39)

The inspectors completed a review of the MIC program to determine if the requirements of the FSAR and applicable codes were properly implemented. The FSAR, Section 9.2.1.6, Corrosion, Organic Fouling, and Environmental Qualification, describes the MIC program for raw water systems at WBN. Zinc sulfate was used to control corrosion of carbon steel, and Butyl benzotriazole was used for control of corrosion of yellow metals. Chemicals, 1-bromo, 3-chloro, 5-5 dimethylhydantoin were used to introduce hypobromous and hypochlorous acid to control MIC and clams in the raw water piping systems. Design allowances were made for corrosion effects on the structural integrity of system pressure boundaries including pipes, heat exchangers, and other system pressure retaining components. All 2-inch and smaller piping lines in the ERCW system are stainless steel and essentially all raw water piping in the reactor building is stainless steel.

Strainers were installed in the supply headers to aid in the control of Asiatic clams. These strainers remove particles larger than 1/32-inch diameter and chemicals are injected into the systems to kill those small enough to pass through the strainer. No flow and low flow areas of piping are periodically flushed in the fire protection system and a quarterly light flush of similar areas in the ERCW system are performed to ensure the presence of the MIC treatment chemicals.

Section 9.2.1.7 of the FSAR stated that ERCW system components were designed to codes listed in FSAR Table 3.2-2a. This table referred to ASMF Section III, Classes I, II, and III, 1971 Edition with Summer 1973 Addenda and ANSI B31.1, 1967. However, the licensee reported that the wall thinning calculations were conducted in accordance with later editions of ASME Section III, paragraph ND-3652, Equations 8, 9, 10, and 11. These later editions of the code were defined in paragraph 3.7.3.8.1 of the FSAR. Experience has shown that leakage would be small localized pin-hole type and calculations confirm that these small leaks would not compromise the functionality of the system. The licensee's program, TI-31.12, Wall Thinning Monitoring Program, Appendix D.2 through D.4 implements the ASME code for leaks discovered prior to plant start-up.

The inspectors concluded that the licensee was in compliance with the applicable codes and sections referenced in the FSAR.

Within the areas inspected, no deviations or violations were identified.

4. MIC Control and Monitoring (TI 2512/39)

The inspectors reviewed those areas not completed at the 75 percent implementation phase for MIC damage associated with the ERCW and Fire Protection Systems. Although Section III of the ASME Code did not provide detailed rules for corrosion or other service-induced degradation, analytical methodology based on stress margins inherent in ASME Sections III and XI were applied to demonstrate compliance and qualification of the piping systems with MIC damage.

The licensee's program for assuring the structural integrity of these raw water piping systems included: semi-annual walkdown inspections of 100 percent of stainless steel systems; observations by auxiliary unit operators on routine plant rounds; annual radiographic examination of a sample of stainless steel piping butt welds; semi-annual ultrasonic examinations of a sample of carbon steel piping; and evaluations of sampling manifolds that have been installed to simulate various conditions that exist in the plant.

The licensee indicated that the basis for the monitoring plan was as follows:

- The morphology of MIC in stainless steel restricts MIC attack to sensitized portions of the material (welds and weld HAZs). When leaks occur, the leak rate should be quite low and characterized as weeps or drips. As a result, the licensee has chosen to perform a semi-annual walkdown inspection of all butt welds in safety-related piping systems in the plant wetted by raw water, both inside and outside of containment.

- The morphology of MIC in carbon steel is such that the attack can occur anywhere in the piping system. When leaks occur, the leak rate is greater than that found in stainless steel and characterized as a stream or spray. The licensee considered that leaks of this nature would be obvious to observant plant personnel; therefore, they depend on the observations made by AUOs during their routine rounds through the plant.

- The licensee's selection of 15 stainless steel butt weld joints were from the population of: (1) 32 weld radiographs examined and documented in NRC IR 390, 391/90-15; (2) a subsequent 182 radiographs re-examined by the licensee as part of the follow-up actions associated with NRC IR 390, 391/90-15; and (3) one 3-inch weld evaluated to have high stress levels. The 15 welds were selected on the basis of those welds determined most susceptible for MIC damage and constitute a representative sample to evaluate the effectiveness of the biocide addition program.

- The licensee's selection for UT examination of 19 carbon steel pipe grid locations was based on previous leak locations and engineering judgment. By monitoring the change in wall thickness in the grid locations, the licensee can evaluate the effectiveness of the biocide addition program.

To evaluate the implementation of the licensee's actions, the inspectors reviewed procedures, drawings, and records, and conducted interviews with licensee personnel as indicated below.

Documents Examined

ID	Revision	Title
TI-106	3	Non-Destructive Examination of Stainless Steel to Stainless Steel and Stainless Steel to Carbon Steel Butt Welds to Assess Damage From MIC
G-29C Part 3	0	Microbiologically Induced Corrosion
TI-36	4	Control of Microbiologically Induced Corrosion at Watts Bar Nuclear Plant
TI-31.13	10	Wall Thickness Monitoring Program for Cavitation, Microbiologically Induced Corrosion, and Generalized Corrosion
SSP-3.04	10	Corrective Action Program
PM-1-PIPE-067-C File 01	5	Monitoring of ERCW System by Visual Examination for Damage in Stainless Steel to Carbon Steel Butt Welds resulting from MIC Train A 1,2,3,4
PM-1-PIPE-067-C File 02	5	Monitoring of ERCW System by Visual Examination for Damage in Stainless Steel to Carbon Steel Butt Welds resulting from MIC Train B 1,2,3
SSP-3.06	11	Problem Evaluation Reports

Note: Relative to PM-1-PIPE-067-C, Files 01 and 02, the licensee plans to implement an evaluation to enhance and better define the type of visual examination (direct, indirect, remote); distance of the observer from the object examined; angle of observation; examination equipment (flashlight, mirror, telescope, etc); and the acceptable lighting level and how that level was verified.

Drawings Examined

ID	Revision	Title
1-47W850-2	9	Flow Diagram Fire Protection, Raw Service Water
1-47W832-2	9	Flow Diagram Raw Service Water & Fire Protection Systems
1-47W845-1	18	Mechanical Flow Diagram-Essential Raw Cooling Water System
1-47W845-2	15	Mechanical Flow Diagram-Essential Raw Cooling Water System
1-47W845-3	9	Mechanical Flow Diagram-Essential Raw Cooling Water System
1-47W845-4	8	Mechanical Flow Diagram-Essential Raw Cooling Water System
1-47W845-5	11	Mechanical Flow Diagram-Essential Raw Cooling Water System
1-47W845-7	8	Mechanical Flow Diagram-Essential Raw Cooling Water System

The inspectors reviewed the marked-up drawings listed above indicating the flow path of the various flushes to ensure that the entire systems, ERCW and Fire Protection, had been included in the flush program. Some areas, including instrument lines and some short pipe headers on the fire protection system, were not included in the flush plan. Although the licensee had failed to include those areas, SCAR WBSCA920028, Revision 0, had been initiated by the licensee which required that all piping and instrument lines be flushed as a prerequisite for closing the document.

In addition, the inspectors reviewed the requirement for performing surveillances identified by the MIC program and found that several had not been performed as required. The inspectors questioned the omission of these surveillances and found that the licensee had previously identified these deficiencies and corrective actions had been implemented as documented in the surveillance program.

Within the areas reviewed. no violations or deviations were identified.

5. Closure Package Matrix Review (TI 2512/39)

All items, as requested in the letter dated November 12, 1992, to TVA from the NRC, were in the MIC Special Program package. These various interface items were reviewed by the inspectors to assure they were either resolved or did not affect the closure of the Special Program. The items listed below were inspected for applicability to the MIC Special Program and, as stated in the program package, were verified to have no association with the MIC program and therefore are considered resolved.

- Vertical Slice Review

  A listing of items identified by the Sargent & Lundy Vertical Slice Review was examined by the inspectors during the inspection period. There were no items identified that pertained to the MIC program at WBN.

- CATD Program Review

  There were no CATDs identified that were applicable to the MIC program.

- CDR Program Review

  There were no related CDRs associated with the MIC program at WBN. This was confirmed by a search through the NRC Open and Closed Items Listing for WBN.

- Employee Concerns Special Program

  There were no MIC related issues identified from the ECSP reviews.

- Issues Identified During NRR Audits

  There were no outstanding NRR inspection issues.

- Evaluation of TVA letter, Employee Concerns Status Update dated March 30, 1987

  There were no issues identified in the concerns update letter that pertained to the MIC program.

- All Other TVA Open Items Reviewed (CAQs, etc.)

  The licensee's OILs were reviewed by the inspectors and there were no additional items identified that had not been addressed in the program.

- Review of PACR Items

  The inspectors reviewed "Watts Bar Nuclear Plant (WBN) - Program for Assurance of Quality (PAC/QA) Project - Technical Adequacy

Review of Special Program (SP) T-107, Microbiologically Induced Corrosion (MIC)," Phase III report. There were no program concerns identified.

To verify that all MIC special program commitments had been identified in the closure report, the inspectors performed a word search for MIC-related issues in the licensee's computer program, Folio Views INFOBASE. As a result, no additional existing commitments were identified that had not been included in the closure report.

Within the areas inspected, no deviations or violations were identified.

6. Commitment Summary and Implementation

a. Special Program Corrective Action Issues

Corrective actions taken by the licensee as a result of deficiencies identified that were associated with the MIC program have included various corrective measures. These measures were taken by the licensee to correct the deficiency and prevent recurrence of the problem and resulted in enhancements to the program. The following nonconformance reports were a selected sample reviewed to verify that the corrective measures have been fully implemented and to determine if there were additional actions or measures that have not been included in the licensee's program.

- NC0910050001, Analytical Methodology and the MIC Abatement Program

  This has been incorporated in a revision to the licensee's Class 3 Piping Design Specifications in accordance with paragraph NP-2160 of Section III of the ASME code. This report was closed by the licensee on January 10, 1992.

- NC0910050002, Acceptability of Degraded Carbon Steel Piping

  The most susceptible MIC areas were identified based on the flow velocity of the raw water. Analyses that identify maximum loads in the locations at each pipe geometry for all pipe diameters were reviewed. Minimum acceptable wall thickness was calculated using ASME Code Section III Criteria. UT measurements were made at the highest stress locations and compared to the acceptance criteria. Either the minimum wall thickness was verified or the piping was repaired per Section III of the ASME code. This report was closed by the licensee on October 23, 1991.

- NC0910050003, Structural Integrity of MIC Degraded Stainless Steel

  Stainless steel was evaluated to demonstrate ASME Section III acceptability. This report was closed by the licensee on October 23, 1991.

- NC0910050005, Dispersant/Corrosion Inhibitor Chemical Treatment System

  This system was installed and began operation during the second quarter of 1991. This report was closed by the licensee on October 26, 1992.

- NC0910050006, Corrosion Monitoring Program

  This program was established to monitor the effectiveness of the biocide and dispersant/corrosion inhibitor treatments. This report was closed by the licensee on April 2, 1991.

- NC0910050007, Comprehensive MIC Management Program

  This involved the development of TIs and preventive maintenance procedures to provide analytical data to assess treatment effectiveness and system piping structural integrity. This report was closed by the licensee on January 6, 1992.

- NC0910050008, Identification of Additional MIC Locations

  Locations distinguished primarily by flow rate were identified, and NDE evaluations were performed and analyzed to demonstrate compliance with Section III of the ASME code. This report was closed by the licensee on October 18, 1992.

- NC0910050009, Fire Protection System High Velocity Flush

  The licensee's program required a high velocity flush on the safety-related portion of the FPS on a quarterly basis. These surveillances were to be implemented on October 1, 1993. This report was closed by the licensee on August 10, 1993.

- NC08901123035, Identification of MIC Affected Locations

  MIC affected locations were identified using water samples, visual inspections, review of design and operating documents, and review of NDE results. This issue was verified to be closed on October 14, 1992.

- NC08901123036, Revision on Specs, DCNs, and Procedures

  DCN 26454 was issued and partially implemented to install quick disconnect fittings at the flood mode spool piece flanges. This report remained open pending completion of the work effort.

The inspectors reviewed the items referenced above and determined the licensee's actions were appropriate.

b. Review of NRC Bulletins, Technical Instructions, and Information Notices applicable to the MIC program at WBN

NRC IN 89-76, Biofouling Agent: Zebra Mussels, pertained to corrosion and biofouling problems associated with nuclear power plants. It specifically addressed potential problems that may result from biofouling of raw water and cooling water systems that may result from infestation by a new mussel introduced into the United States in 1988. In addition, the NRC issued GL 89-13, Service Water System Problems Affecting Safety-Related Equipment, which required licensees to adopt either the specific recommended surveillance and control procedures delineated in the letter or an equally effective course of action for prevention of biofouling of their nuclear service water systems by previously identified species. The licensee's actions in response to IN 89-76 as applicable to the WBN MIC program and its integration with GL 89-13 were reviewed by the inspectors.

A description of the licensee's program to detect biofouling agents was included in NRC IR 390, 391/93-09. The program required the divers to examine the intake structure during each refueling cycle for Asiatic clams and Zebra mussels. Samples were taken from the Tennessee River at the WBN intake on a weekly basis during the spawning season. A Zebra mussel trap has been installed near the intake and is monitored weekly.

To date, seven Zebra mussel adults were found in the lock at the Watts Bar Dam (July 12, 1993) but no larval stage specimens have been found in the traps provided. Although Asiatic clams were detected in the WBN intake structure, Zebra mussels were not detected. TVA Corporate Resources Group has theorized that since Zebra mussels have only been found in the locks at the Watts Bar Dam and at other sites along the Tennessee River, these adults were dislodged from barge traffic using the locks. The fact that larval stage specimens were not identified would support that contention.

The inspectors noted that the licensee was monitoring potential macro biofouling agents in accordance with guidelines as outlined in both GL 89-13 as well as IN 89-76.

c. Prior NPP Volume 4 Assessments Concerning the Chemistry Program at WBN Relative to the MIC Program

The inspectors reviewed the assessments implemented prior to issuance of the NPP Volume 4. During this review, it was identified that INPO had issued a finding in 1985 which questioned corporate management oversight of chemistry activities to achieve optimum protection for plant systems and materials as addressed in ONP Directive Manual 5.8 (Chemistry).

Discussions with the licensee indicated that since the 1985 assessment, the chemistry program as outlined in procedure SSP-13.01 (Watts Bar Site) and STD-13.1 (Corporate), had changed the managerial approach to the chemistry program. An in-depth analysis of the chemistry program was not performed, but a management review and quality assurance aspects of the program were included in the outlines and would be the focus for the direction of the procedures.

This was an on-going effort that required continued assessments and changes as necessary to the chemistry program to ensure its effectiveness.

d. Independent Verification Program

The inspectors reviewed the licensee's QA assessment of the MIC program. This review consisted of WBN Assessment Report No. NA-WB-93-0076, "Assessment of Microbiologically Induced Corrosion (MIC) Special Program Closure Verifications" dated August 30, 1993. The associated PER (WBPER930207) and FIRs (WBFIR920219 and WBFIR930140) were included as part of that review. The inspectors determined that the licensee had conducted a comprehensive review, identified discrepancies, and taken appropriate actions to assure corrective actions and recurrence controls were implemented to resolve the issues.

e. Issues that Could Affect Program Closure

- The potential problem of MIC resistance to stagnant and/or low flow lines was reviewed by the inspectors which included data received from TVA personnel and the system vendor. While the expectation was that the existing chemical treatment system and procedures were adequate for areas of high flow, the question remains as to the effectiveness of the chemical injection program in low flow (less than 3.0 fps) areas. In these areas of stagnant or low flow, the structural integrity is monitored by the nondestructive test programs.

  Reviews of the licensee's data and a review of the vendor's chemical injection system descriptions confirm that MIC growth and nodules/tubercles formation were arrested and reduced in high flow areas. While indications were that it was possible to arrest future growth and formation of nodule/tubercles, the effect on existing colonies was not shown. In both cases (high and low flow areas) it appears that the best solution was thorough cleaning followed by application and continued use of biocides.

- The status and condition of equipment at the injection skid was reviewed by the inspectors. This equipment consisted of the chemical feed system which delivers polyphosphate, zinc, and copolymer dispersant to the IPS for treatment of all raw water systems; and a review of the dry halogen feed tank to add BCDMH, an oxidizing biocide, into the IPS suction pits. This review also included the procedures to periodically inject a non-oxidizing biocide (Clam-Trol).

The inspector reviewed the operation records of the chemical injection system as well as the Chemistry Manual, Chapter 4.04, BCDMH Injection for Control of Clams, Slime, and MIC, Revision 0. It was noted that injection of polyphosphate, zinc sulfate, and dispersant had proceeded continuously since October 1992. Continuous (4 hours per day) injection of BCDMH had occurred since December 1990. However, injection of BCDMH was tracked with bivalve larval stages as found in the river traps and the program required an increase to 24 hours per day for three weeks during peak reproductive periods. Clam-Trol injection began in September 1993 and was to follow a 12-hour per quarter cycle. Copper-Trol addition began in June 1993.

The inspectors reviewed an incident relative to this system's operation, recorded on August 19, 1993, when one thousand pounds of granular form BCDMH was added to the bromination system tank. Apparently, either not all of the BCDMH was covered with water or voids formed in the tank. Decomposition of the uncovered BCDMH began and released gaseous bromine and water from the tank. Upon discovery of the gas and venting problem, the system was inactivated for four days according to the BCDMH Usage Log. The system vendor confirmed that this gas generation at the wet/dry interface was likely, and corrective actions were implemented based on that reasoning. The system was then placed in operation with higher flow rates. Decomposition products were removed from the drum and dike areas and deposited in the lined pond. Appropriate authorities were notified of the potential bromine release at or near reporting levels. Other activities were performed to properly repair the system and return to use. The system was out of service for a minimum amount of time and a more stable form of BCDMH, a tablet form, was substituted for future operation. The incident was handled in accordance with the chemistry operating procedures and applicable state and federal regulations.

A strength was identified in this area for control of microbiologically induced corrosion. The proper utilization of the chemical injection system and the associated specific procedures should mitigate microbiologically induced corrosion in the plant during future operations.

f. Employee Concerns (post ECSP)

One concern applicable to the MIC program was reviewed.

Within the areas inspected, no deviations or violations were identified.

7. NRC Open Issue Review (TI 2512/39)

The inspectors reviewed the remaining NRC open items pertaining to the MIC program at WBN. Open items 390/93-09-03 and 391/93-09-01 were previously closed in IR 50-390, 391/93-29. The following are the results of that review:

a. (Open) IFI 390/93-09-01, Heat Exchanger Performance Testing

This issue addressed the licensee's intent to not include heat exchanger performance testing for evaluating MIC in the raw water systems as recommended in NRC GL 89-13. To resolve the issue, the licensee initiated TI-79 to include the performance efficiency of the heat exchangers to determine the effectiveness of the MIC mitigation program. However, completion of the instruction was put on administrative hold on February 3, 1988. The rationale for not completing the TI was that there was no heat load on the heat exchangers prior to startup, and heat exchanger performance testing could not be performed.

The inspectors deemed it essential to evaluate the completed instruction for adequacy prior to closing the issue. The licensee plans to include in TI-79 the number of heat exchangers in the program, the frequency of testing, and how the data would be utilized in the MIC program.

Based on the fact that this TI is not complete or issued, this issue remains open.

b. (Closed) IFI 50-390/93-09-02, Technical Instruction Deficiencies

This item concerned the following TI deficiencies: (1) the list of the applicable weld map drawings had been inadvertently deleted from PM-1-PIPE-067-C, Files 01 and 02; (2) instruction N-RT-2 did not specify the radiographic technique to be followed; and (3) the UT examination area of interest in the program procedure TI-31.13 was not consistent with that indicated in the examination procedure N-UT-26. After these deficiencies were identified, the licensee issued Revision 5 to PM-1-PIPE-067-C, Files 01 and 02, Temporary Change No 93-12 to N-RT-2, and Revision 13 to N-UT-26. These TI amendments adequately addressed the inspectors' concerns.

c. (Open) IFI 50-390/93-09-04, Analysis of ERCW Piping in the Containment

This item concerns potential damage to the CPV penetrations and potential loss of the CPV integrity due to pipe failure.

There are sixteen ERCW penetrations in the CPV (eight 6-inch and eight 2-inch penetrations). At the 6-inch penetrations, there was less than 3 feet of carbon steel pipe between the inside and outside CPV isolation valves. At the 2-inch penetrations, the distance between the inside and outside isolation valves was in excess of 50 feet. These 2-inch pipe runs were socket-welded stainless steel with the exception of approximately two feet of carbon steel at the penetration. Socket-welded and fillet-welded lug joints exist in each of the eight 2-inch pipe runs between the penetration and the inside isolation valve. These provide a potential for MIC attack and through-wall leaks in the HAZ of each of these welds.

The licensee visually examined two of the 2-inch penetrations and two of the 6-inch penetrations that were outboard of the CPV. The licensee noted a heavy uniform corrosion product buildup accompanied by an approximately 0.030-inch wall loss in the 2-inch carbon steel penetration. A number of tubercles were noted in the 6-inch penetrations which were indicative of MIC attack.

As a result of this item, the licensee added two areas to the UT program which were: (1) the outer CPV segment of one of the 2-inch penetrations, and (2) one carbon steel pipe spool piece between the 6-inch CPV penetration and the outboard isolation valve. Since discovery of MIC in the raw water systems at WBN, the licensee has not visually examined the 2-inch pipe runs between the penetration and the inboard containment isolation valves. This was because the MIC program only required butt welds to be examined visually on a semi-annual basis and those were socket welded.

Although the licensee indicated that they had never experienced a leak attributed to MIC at a socket weld, they did concede that a MIC leak had been identified associated with a fillet-welded lug. The possibility exists that a leak caused by MIC in piping located between the inboard and outboard isolation valves of the CPV could result in loss of CPV integrity. As a result, the licensee indicated that they would re-evaluate this issue. This item remains open.

Within the areas examined, no violations or deviations were identified.

8. Exit Interview

The inspection scope and findings were summarized on October 1, 1993, with those persons indicated in Paragraph 1. The inspectors described the areas inspected and discussed in detail the inspection results. Dissenting comments were not received from the licensee. Proprietary information is not contained in this report.

Item Number	Status	Description and Reference
390/93-09-01	Open	IFI - Heat Exchanger Performance Testing (Paragraph 7.a)
390/93-09-02	Closed	IFI - Technical Instruction Deficiencies (Paragraph 7.b)
390/93-09-04	Open	IFI - Analysis of ERCW Piping in the Containment (Paragraph 7.c)

9. List of Acronyms and Initialisms

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
AUO	Auxiliary Unit Operator
BCDMH	bromochlorodimethylhydantoin
CAP	Corrective Action Program
CAQ	Condition Adverse to Quality
CATD	Corrective Action Tracking Document
CDR	Construction Deficiency Report
CPV	Containment Pressure Vessel
DCN	Design Change Notice
DR	Deficiency Report
ECSP	Employee Concerns Special Program
ERCW	Essential Raw Cooling Water
FIR	Finding Identification Report
FPS	Fire Protection System
fps	feet per second
FSAR	Final Safety Analysis Report
GL	Generic Letter
HAZ	Heat-Affected Zone
IFI	Inspector Follow-up Item
IN	Information Notice
INPO	Institute of Nuclear Power Operations
IPS	Intake Pumping Station
IR	Inspection Report
MIC	Microbiologically Induced Corrosion
NDE	Nondestructive Examination
NPP	Nuclear Performance Plan
NRC	Nuclear Regulatory Commission

OIL	Open Items List
ONP	Office of Nuclear Power
PACR	Potential Area of Concern Report
PER	Problem Evaluation Report
PM	Preventive Maintenance
QA	Quality Assurance
ROI	Regional Office Instruction
RT	Radiographic Test
SCAR	Significant Corrective Action Report
SER	Safety Evaluation Report
SP	Special Programs
SSP	Site Standard Practice
STD	Standard
TI	Technical Instruction
TVA	Tennessee Valley Authority
UT	Ultrasonic
WB	Watts Bar
WBN	Watts Bar Nuclear Plant

Davis Exhibit 15

Davis Exhibit 16

CAROLINA POWER & LIGHT COMPANY
MATERIAL SERVICES SECTION
METALLURGY SERVICES

TECHNICAL REPORT

To: Mr. Steve Edwards

Investigators:
Danny Brinkley
Ahmad Moccari

Distribution:
Mr. Robert Lane/HNP
File/Metallurgy Services

Project Number: 99-179
Date: December 16, 1999
Reviewed by: KEVIN E JOHNSTON
Approved by: 12/16/99
Supervisor, Metallurgy Services

SUBJECT: **Harris Nuclear Plant - Bacteria Detection in a Deposit Sample and Chemical Analysis of Reddish-Brown Material from the C&D Spent Fuel Pool Cooling Lines**

INTRODUCTION:

The objectives of this project were: (1) to determine if nuisance bacteria that could potentially cause microbiologically influenced corrosion (MIC) are present in the deposit sample from a field weld (2-SF-144-FW-517); (2) to perform chemical analysis of a sample of the reddish-brown material in the C&D spent fuel pool cooling lines, and (3) to provide a review of videotapes of the remote visual examination of the Harris Nuclear Plant (HNP) spent fuel pool cooling piping and field welds. Regarding these examinations, Field Welds 515, 516, 517, and 519 were particularly noted as being of interest to HNP engineering personnel and the NRC, and are specifically addressed herein.

LABORATORY EXAMINATION AND RESULTS:

1. Characterization of the Microbiological Nature of the Deposits

One smear pad containing some deposits scraped from Field Weld 517 from the C&D spent fuel pool cooling line was received for bacterial characterization. Review of the videotape of the remote visual inspection of Field Weld 517 showed the deposit sample being removed directly from the location(s) of interest.

The as-received pad was rinsed with nano-pure demineralized water. The majority of the deposit appeared to have been removed from the pad by this rinsing and resulted in about 100 milliliters of reddish-brown solution with some suspended particulate.

The presence/absence of sulfate-reducing bacteria (SRB) in about 10 milliliters of the rinsed water was then evaluated using a Rapidchek™ II Kit, a "sulfate-reducing bacteria kit". The bacterial counts were found to be less than 1000 cells per milliliter which is the lower detectable level of this kit. The Rapidchek II Kit for detecting SRB is a commonly used kit in the field and provides a qualitative result in a short time. This kit provides a simple "presence/absence" test capable of indicating the population size of the SRB bacteria present in a water sample but it does not provide any information on the activity/aggressivity of the bacteria.

In order to confirm the results obtained from using the Rapidchek II kit, the presence and aggressivity of sulfate-reducing bacteria were investigated using an Easicult™ S culture tube. The growth of sulfate-reducing bacteria in the Easicult S culture tube results in the formation of black iron sulfide. The blackening may begin at any location in the tube and, depending on the degree of aggressivity, eventually either a portion of or the entire culture tube may become black. No blackening was observed after culturing for 5 days (the culturing time per the manufacturer's recommendation) indicating that the rinsed water was not infected with sulfate-reducing bacteria.

In addition, the presence and aggressivity of slime-forming bacteria, iron-related bacteria, and heterotrophic aerobic bacteria were evaluated using appropriate BART™ kits. These evaluations involve culturing and observation for up to about two weeks to determine any bacterial activity and growth. The results of the BART kits' analyses indicated that no nuisance bacteria capable of causing material degradation due to microbiological influenced corrosion (MIC) were present in the deposit sample from the C&D spent fuel pool cooling lines. As a controlled test, one kit of each kind was used to characterize bacteria in the nano-pure demineralized water. The results of these tests were negative.

It should be noted that the presence of microbiologically influenced corrosion (MIC) and halogen associated localized corrosion are not considered likely in the Harris Nuclear Plant C&D spent fuel pool cooling lines given that the piping is filled with a relatively low conductivity borated demineralized water with very low measured concentrations of chloride, fluoride, and sulfate. Furthermore, since these lines have been reportedly flooded for an extended period of time (up to ten years), the existence of microbial activity in an aggressive form would be expected to have been evidenced by this time in the form of material degradation which most likely would be visible by external leakage in accessible piping. The outside diameter surfaces of the accessible piping that have been exposed to the same water for the same number of years have been inspected by plant personnel and no incidents of leaking/weeping have been reported.

2. Chemical Analysis of the Reddish-Brown Material in the Spent Fuel Cooling Lines

Two fluid samples were received by Health Physics/Dosimetry personnel at the Harris Energy & Environmental Center. The sample that was the most discolored of the two was shaken and a portion of this sample was filtered using a 0.45-micron Millipore filter membrane. The first filter clogged, so a second filter was used.

The two filter samples were visually examined. Portions of the most heavily loaded filter were selected, excised, and prepared for analyses using an energy dispersive x-ray spectrometer (EDS) attachment to a scanning electron microscope (SEM) for elemental identification and a x-ray diffractometer (XRD) for chemical compound identification.

The SEM/EDS system is capable of detecting and analyzing x-rays emitted from elements having atomic numbers greater than or equal to that of beryllium. Typically, this instrumentation can detect the higher atomic elements (sodium and above on the Periodic Table) when present in concentrations of about 0.1 weight percent or greater. The detection limits for lower atomic number elements, such as oxygen and carbon, are probably at least an order of magnitude larger (e.g., > 1 weight percent) depending upon the sample matrix. The samples were imaged using a combination of secondary and backscattered electron detectors. The secondary electron images are very sensitive to surface features and topography. The intensity of the backscattered electron images is proportional to the average atomic number of the area being excited by the electron beam (e.g., lead is brighter than iron, and iron is brighter than carbon). The x-ray diffraction (XRD) system provides information that permits the identification of the crystal structure of an unknown material.

The SEM imaging showed the samples to consist of a mixture of materials. Some of the particles had a higher average atomic number than did other portions of the particulate. The chemical composition of the bulk sample was found to be primarily iron and oxygen with lesser and varying concentrations of silicon, aluminum, carbon, calcium, chromium, nickel, sodium, magnesium, nickel, potassium, zinc, and chlorine. Some small metallic fragments were observed in the sample that had compositions consistent with austenitic stainless steel. Carbon-rich, aluminum-rich, silicon-oxygen-calcium-aluminum-rich, silicon-rich, and chromium-rich particles were present in the sample. Some rod-like fibers were also present in the sample.

XRD analysis of the filtered deposit on a Millipore filter membrane showed this sample to consist primarily of iron oxides (a mixture of hematite - α-Fe_2O_3 and lepidocrocite - FeOOH) and possibly graphite. The obtained XRD pattern did not match any of the published patterns for aluminum silicates or calcium-aluminum silicates.

In summary, the majority of the filtered deposits from the fluid samples were identified to consist of iron oxide in the form of hematite (α-Fe_2O_3) and lepidocrocite (FeOOH). Lesser amounts of graphite and other types of particulate were present in the sample.

3. Review of the Videotape of the Remote Visual Examination of Embedded Spent Fuel Pool Cooling Piping and Field Welds

Reviewing the videotapes of the remote visual inspection of the 15 field welds (reviewing was performed at several times for a period of 12 to 15 hours) of the embedded C&D spent fuel cooling and cleanup system piping after the water had been drained revealed that the camera work was very professional. High quality images were obtained of the inside of the spent fuel piping showing very clearly the longitudinal welds, circumferential welds, and the inside surfaces of the piping. Some halos/rust streaks were observed indicating minor corrosion at the weld(s) or adjacent to the welds. Some predominantly yellowish-white deposits were also observed in the line which are most likely boric acid crystals. These surface anomalies appear to be superficial with no discernable pin hole(s) or crack-like defect(s) associated with them and are very highly unlikely to be detrimental to the structural integrity of the piping. The following discussion will address the specific field welds of concern.

Field Weld 515 (2-SF-144-FW-515)

A small linear indication extending out of the circumferential seam weld on the piping of FW-515 was observed. This indication is not associated with the field weld and does not have the appearance of being corrosion related. The degradation mechanisms that potentially could cause cracking in the spent fuel line which is fabricated from Type 304 stainless steel are intergranular stress-corrosion cracking (IGSCC), trangranular stress-corrosion cracking (TGSCC), and corrosion fatigue. The piping is exposed to an environment consisting of borated demineralized water with very low impurities (such as chloride, fluoride, and sulfur) and relatively low conductivity. This environment is not sufficiently corrosive and the operating temperature is not high enough for either IGSCC or TGSCC to be possible. Corrosion fatigue is also not considered possible either because the line is embedded in 4 to 6 feet of concrete and can not be subjected to cyclic loading. The visible indication appears to be a manufacturing artifact in the longitudinal seam weld and not associated with the construction of the field weld itself.

Field Weld 516 (2-SF-144-FW-516)

Four locations with corrosion halos/rust streaks were noted on or adjacent to FW-516. In addition to this streaking, some small areas were also observed where the consumable insert had not completely fused. No pitting or pin holes were associated with these discolored/streaked areas and they do not appear to be of concern relative to the piping integrity. Closer inspection of the consumable insert revealed that the insert was fused on its edges.

Field Weld 517 (2-SF-144-FW-517)

During the initial videotape review of the remote visual inspection of this field weld, three small locations with some rust-colored deposit buildup were observed. One area was located at approximately the 3 o'clock position and two areas were observed adjacent to each other at the 9 o'clock positions. No pitting or pin holes were visible at either of these locations due to the presence of the deposits. After removing some of the deposits for bacteria characterization, no visible pitting, pin hole, or crack-like defects on the piping underneath the deposits at the 3 o'clock position and at one of the two spots at the 9 o'clock position were observed. Some loosely scattered deposits and some discoloration were, however, noted at these two locations. The scattered deposits were removed after further hydrolazing and the inside diameter surface of piping appeared free of surface discontinuities at those locations. Some of the deposits were still present at one of the spots at the 9 o'clock position. Consequently, a conclusion about whether or not surface discontinuity was present at this location could not be made. However, based on observation of the other two spots and the remainder of the piping and field welds, it is very highly unlikely that any surface discontinuities would be found at this spot which would be detrimental in any way to the piping integrity.

Field Weld 519 (2-SF-143-FW-519)

This field weld appears to have more rust streaks/stains and more yellowish-white deposits (most likely boric acid crystals) which have obscured a good portion of the weld root. One pit-like indication appeared to have been associated with one of the rust streaks. A halo (circular discoloration with a yellowish-brown, reddish-brown, and black stain) is also associated with the pit-like indication. However, upon close inspection from a number of different angles as the camera moved back and forth it was concluded that this did not appear to be a pit or similar defect, but rather the start and stop of the weld which has acted as a nucleation site for crud to accumulate.

2SF-44

Form NPP-1

FORM NPP-1 DATA REPORT FOR FABRICATED NUCLEAR PIPING SUBASSEMBLIES*

(As Required by the Provisions of the ASME Code Rules)

1. Fabricated by Southwest Fab. & Wld. Co. Inc. Houston, TX. (Name and Address of Fabricator) Order No. S.O.Q-3304-FH
2. Fabricated for Ebasco Services Inc., New York, N.Y. 10006 (Name and Address) Order No. P.O. NY-435035
3. Owner Carolina Power & Light Co. 4. Location of Plant Raleigh, North Carolina
5. Piping System Identification SPENT FUEL SERIAL NO. 27315 (Brief description of intended use, main coolant, etc.)
   (a) Drawing No. Q-3304-FH#7 Prepared by Southwest Fab. & Wld. Co. Inc.,
   (b) National Board No. 3907
6. The material, design, construction, and workmanship complies with ASME Code Section III, Class 3
   Edition 1971, Addenda Date Summer 1973, Case No. ----------------

Remarks: Manufacturers' Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of this report PIPE - SWEPCO TUBE CORP. (P1) SN-M3947-9-Pc.28; (Name of Part — item number, Manufacturer's name, and identifying stamp) (P2) SN-M3947-9-Pc. 10.

7. Shop Hydrostatic Test N/A psi.
8. Description of piping inspected MK: F3-261-2-SF-144-1: SA-358 TP-304 CL 1 WLD 12" (.375"W) 9'-6" & 4'-6" LENGTHS; SA-403 WP-304 SMLS 12" 90° STD LR ELL (include — mark no. — material spec. — nom. pipe size — schedule or thickness — length — flanges — fittings, etc.)

Q A RECORDS

RECEIVED APR 2 3 1980 SHNPP CONSTR. Q A UNIT

REVIEWED FOR CORRECTNESS AND COMPLETENESS BY BB EBASCO ENGINEERING REVIEW VERIFIED BY [signature] EBASCO VOA REP.

SECTION III

We certify that the statements made in this report are correct and that the fabrication of the described piping conforms with the requirements of SECTION III of the ASME BOILER AND PRESSURE VESSEL CODE.

Date 3/19/80 Signed SF & W Co. (Fabricator) By (lgr) [signature]

Certificate of Authorization Expires July 23, 1982 Certificate of Authorization No. N-1459

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of Texas and employed by H.S.B.I.&I.CO. Hartford, Conn. have inspected the piping described in this Data Report on 3/19 1980, and state that to the best of my knowledge and belief, the Manufacturer has constructed this piping in accordance with the applicable Subsections of ASME Code, Section III.

By signing this certificate, neither the Inspector nor his employer make any warranty, expressed or implied, concerning the piping in this Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 3-20 19 80 [signature] (Inspector) Commissions Nat'l Bd. 8758 (National Board, State, Province and No.)

*Supplemental sheets in form of lists, sketches or drawings may be used provided (1) size is 8½" x 11", (2) information in items 1, 2 and 5 on this data report is included on each sheet, and (3) each sheet is numbered and number of sheets is recorded in item 7, "Remarks".

3

3-2(435035)

1362 1 1 7

FORM NPP-1 (back)

9. Description of Field Fabrication

10. Field Hydrostatic Test ______________ psi.

We certify that the field fabrication of the described piping conforms with the requirements of SECTION III of the ASME BOILER AND PRESSURE VESSEL CODE, Class ______, Edition ______, Addenda Date ______ Case No. ______

Date ______, 19___ Signed ______ (Fabricator) By ______ (Representative)

Our Certification of Authorization to use the ______ Symbol Expires ______, 19___

Certificate of Authorization No. ______

CERTIFICATE OF FIELD FABRICATION INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the state or Province of ______ and employed by ______ of ______ have compared the statements in this Manufacturer's Data Report with the described piping and state that the parts referred to as data items ______, not included in the certificate of shop inspection have been inspected by me and that to the best of my knowledge and belief the manufacturer has constructed this piping in accordance with the applicable section of the ASME CODE SECTION III.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the piping described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

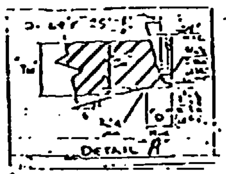
Date ______, 19___

______ Inspector Commissions ______ National Board, State, Province and No.

85271 / 1675A

NATL. BD. 3207 ✓
N/A
27315
3
1980

(1)
(2)

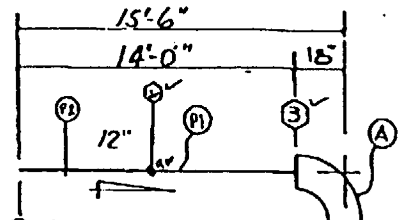


N PT 3

SOUTHWEST FABRICATING AND WELDING CO.
(Name of Manufacturer)
27315 ✓
(Manufacturer's Serial No.)
1920
(Year Built)

SHOP NOTE: CODE SYMBOL TO BE APPLIED TO N.B. TAG ONLY.

3-2(435035)-4



(4) NOTE GC
MBE PER DET'A'
C=12.053"
TM=.328"
D=.500"

(5) NOTE GC
MBE PER DET'A'
C=12.053"
TM=.328"
D=.250"

Q A RECORDS
RECEIVED APR 23 1980
CONSTR. Q A UNIT

CAT. 3 SYSTEM. SPENT FUEL UNIT # 2

ASME SECTION III

BBuhl 4/24

REV.	DATE	DESCRIPTION	BY	CHK
△	3/11/80	ADDED AS BUILT DATA		
○	1-25-79	ISSUED FOR FAB		

1-REQ'D MK: F3-261-2-SF-144-1 ✓

150°F @ 200°F

MK	QUAN	DESCRIPTION
		ALL BEV'S. 37½° (RAW).
		MATERIAL TO BE SOLUTION ANNEALED TO A TEMP. ABOVE 1900° F. RAPID COOL BY WATER QUENCH TO LESS THAN 800° F.
		SA403 WP304 SMLS.
A	1	12" 90° STD LR ELL W/MBE PER DET 'A' C=12.053" TM=.328 D=.250" HT# JNTK ✓

MK	QUAN	DESCRIPTION
		STD (.375W) SA358 CL I WLD TP304 (5% MIN FERRITE)
P1	1	12" 9'-6" 2BE. HT# F91051 ✓ ...
P2	1	12" 4'-6" 1 BE ... C=12.053 TM=.328 D=.500 HT-F91051 ✓ M3947-9-10 ✓

PREHEAT	50°F MIN
POST WELD HEAT TREAT	NONE
	NONE
	NOTE 3, 6A & 6B
FAB CODE	ASME SECT. III 1971 ED. W/ADD. THRU SUMMER '73
	SFEW 150° 2-SF-144
	SS-3

TOTAL 14 ...

SOUTHWEST FABRICATING & WELDING CO. P.O. BOX 9449 HOUSTON, TEXAS 77011

CUSTOMER CAROLINA POWER & LIGHT

ALL MAT'L. TP304/316 STN. ST'L.

SO-Q3304-FH SHT. 7

(65A) [illegible] 7-1-1666

79

SWEPCO TUBE CORPORATION

Swepco

ONE CLIFTON BOULEVARD • CLIFTON, NEW JERSEY 07015

(201) 779-0000
TWX NO 710-989-0051
TELEX NO. 133321

DATE: 10/23/79

GULFALLOY, INC.
P.O. Box 52518
HOUSTON, TEXAS
77052

T&F

Incoloy Stk
Line 5360-N-79
AT-E-27-04122
[illegible]

SWEPCO NUMBER	M-3947-9	DISTRIBUTOR P.O. NUMBER	22-27-13153	CUSTOMER P.O. NUMBER	[illegible]

PRODUCT DESCRIPTION: SWEPCO SP GRADE WELDED PIPE, T-304 TO ASME-SA-240, MANUFACTURED PER ASME-SA-358 CLASS 1 & ASME SECT. III CLASS 3, 1971 EDITION INCLUDING 1973 SUMMER ADDENDA, WELD X-RAYED 100% PER PARA PW-51, NPT-3 CODE STAMPED & INSPECTED, ANNEALED, WATER QUENCHED & PICKLED: 10 CFR PART 21 APPLIES. MATERIAL WAS MANUFACTURED IN ACCORDANCE SECT. III, SUBARTICLE NA-3700.

BASE METAL HEAT NO. [redacted]

WELD WIRE HEAT NO.
A. 05079
B.

HEAT TREATMENT
SOLUTION ANNEALED @ 1950 °F
FOR 25 MINUTES MINIMUM AND
RAPID AIR COOLED ☐
WATER QUENCHED [X]

SIZE: 12 3/4 O.D. x .375 W x 20 R/L

SWEPCO PC. NOS.
SN-M3947-9 - Pc 1-2-5-6-9-10-15
16-17-18-19-20-
23-24-27-28-33-34

CHEMICAL ANALYSIS

	C	Mn	P	S	Si	Ni	Cr	Mo	Co	Cu	N	Cb & Ta
CHEMICAL REQUIREMENTS - PLATE	.08	2.00	.045	.030	1.00	8.00-10.50	18.00-20.00				.10 max	
HEAT ANALYSIS	.044	1.69	.016	.005	.67	8.37	18.09		.14		.064	
PRODUCT ANALYSIS - BASE METAL	.042	1.65	.019	.009	.54	8.20	18.25					
PRODUCT ANALYSIS - WELD DEPOSIT	.042	1.63	.020	.011	.55	8.60	18.75					
CHEMICAL REQUIREMENTS (Spec. SFA 5.9 Weld Wire)	.08	1.0-2.5	.03	.03	.25-.60	9.0-11.0	19.5-22.0					
A. HEAT ANALYSIS - WELD WIRE	.05	1.71	.026	.016	.46	9.42	19.85	.21	Ti .01	.16 / .02		.02
B. HEAT ANALYSIS - WELD WIRE												
PRODUCT ANALYSIS-UNDILUTED WIRE												

MECHANICAL TESTS

	HARDNESS	YIELD P.S.I.	TENSILE P.S.I.	ELONG. IN 2"	FACE BEND	ROOT BEND	REV. BEND	FLAT
MECHANICAL TEST REQUIREMENTS	RB-88 / BHN-157	30000	75000	40.0				
BASE METAL	HB-157	42700	90700	56.0				
PIPE WELD-TRANSVERSE		46100	89600	53.0	ok	ok		
PIPE WELD-TRANSVERSE		47900	90600	49.0	ok	ok		
PIPE WELD-TRANSVERSE		49200	89400	49.0	ok	ok		
PIPE WELD-TRANSVERSE		49200	91800	50.0	ok	ok		
PIPE WELD-TRANSVERSE								
PIPE WELD-TRANSVERSE								
PIPE WELD-TRANSVERSE								

REVIEWED FOR CORRECTNESS AND COMPLETENESS BY: BB
EBASCO ENGINEERING
REVIEW NUMBER: [illegible]
BBrehl 4-1-80
EBASCO

Q. A. APPROVED
DATE 12/4/79 BY XTB

QA

6

FILM SUBMITTED UNDER SEPARATE COVER

EXAMINATION

	RADIOGRAPHY	ULTRASONIC	LIQUID PEN.	CORROSION	IMPACT	HYDRO.	P.S.I.
APPLICABLE PROCEDURES	ASME-SEC I PAR. PW-51		12/17/79			ASME-SA-358	1325
RESULTS	ACCEPTED						

REMARKS
PRODUCT WATER QUENCHED TO BELOW 800 °F WITHIN 3 MINUTES

THE FERRITE CONTENT OF THE DEPOSITED WELD WIRE AS DETERMINED BY THE SCHAEFFLER DIAGRAM= 8.07%

This certification affirms that above CMTR is correct and accurate including all test results and operations in compliance with the material specification and customer requirements.

SWEPCO TUBE CORPORATION

A. Olen - Q.C. Coord.

NOTARY PUBLIC OF NEW JERSEY
My Commission Expires [illegible]
Certification No. 11-2365
Expiration Date 10-29-80

Sworn to and subscribed to before me this 11th day of Dec. 1979
[illegible]

FORM 132 REV 1

SWEPCO TUBE CORPORATION

Swepco

ONE CLIFTON BOULEVARD • CLIFTON, NEW JERSEY 07015

FORM N-2 MANUFACTURERS DATA REPORT FOR NUCLEAR PART AND APPURTENANCES

1. (a) Manufactured by SWEPCO TUBE CORPORATION, 1 CLIFTON BLVD., CLIFTON, N.J.
   (b) Manufactured for Southwest Fab & Welding, Houston, TX (Gulfalloy Inc.Houston
   (Name and address of Manufacturer of completed nuclear component)
2. Identification-Manufacturer's Serial No. of Part N-3947-9 Nat'l Bd. No. N/A
   (a) Constructed According to Drawing No. -------------- Drawing Prepared by ----------------
   (b) Description of Part Inspected * 8 Pcs 12 3/4" OD x 3/8"W x 20'R/L (welded)
   (c) Applicable ASME Code:Section III, Edition 1971, Addenda date 1973-S Case No. --- Class 3
3. Remarks: SA-358 CL. 1 Sect. III Cl. 3 Mfg. (R/M SA-240 T-304 Ht. No. F-91051 welds x-rayed 100% per PW51 annealed and pickled Hydro tested @ 1324 P.S.. Min SWF No. 3302N-79. *Pc Nos. SNM-3947-9 Pcs 19-20-23-24-27-28-33-34

4. Shell: Material SA-240 304 (Kind & Spec. No) T.S. 75000 (Min. of Range Specified) Nominal Thickness 3/8 in. Corrosion Allowance 0 in. Dia. 1 Ft. 3/4 in. Length 20 R/L in.
5. Seams: Long Dbl welded H.T.[1] yes R.T. complete Efficiency 100 %
   Girth ________ H.T.[1] ________ R.T. ________ No. of Courses ________

We certify that the statements made in this report are correct and this vessel part or appurtenance as defined in the Code conforms to the rules of construction of the ASME Code Section III. (The applicable Design Specification and Stress Report are not the responsibility of the part manufacturer. An appurtenance manufacturer is responsible for furnishing a separate Design Specification and Stress Report if the appurtenance is not included in the vessel Design Specification and Stress Report.)

Date DEC. 6 1979 19__ Signed SWEPCO TUBE CORP. (Manufacturer) By J. Hendry, Eng. Coord.

Certificate of Authorization No. N-2365 Certificate of Authorization Expires 10/29/80

CERTIFICATION OF DESIGN FOR APPURTENANCE (when applicable)

Design information on file at

Stress analysis report on file at

Design specifications certified by Prof. Eng. State Reg. No.

Stress analysis report certified by Prof. Eng. State Reg. No.

REVIEWED FOR CERTIFICATION AND CONFORMANCE BY BB
EBASCO ENGINEERING
REVIEW VERIFIED BY
BBuhl 4-1-80

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of New Jersey and employed by COMMERCIAL UNION INSURANCE COMPANY of BOSTON, MA., have inspected the part of a pressure vessel described in this Manufacturer's Partial Data Report on DEC. 6 1979 19__, and state that to the best of my knowledge and belief, the Manufacturer has constructed this part in accordance with the ASME Code Section III.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the part described in this Manufacturer's Partial Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date DEC. 6 1979 19__

________ Inspector's Signature Commissions N.Y. 2555 N.J. 476 OHIO APP'D PA COMM W C ____ National Board, State, Province and No.

[1] If Postweld Heat-Treated.

8

79

NO-5

SOUTHWEST FABRICATING & WELDING CO INC

HOUSTON TEXAS 11-16-79

Test ~~ORDER NO~~ 61791

CUSTOMERS ORDER NO

AR-TECH LAB. REPORT NO. 79-5365

DETAILED ANALYSIS REPORT

DESCRIPTION	PHYSICALS OF MATERIALS FROM WHICH MADE					CHEMICAL ANALYSIS C	MN	P	S	SI	CR	NI	MO	Cu	HEAT OR LOT NO.	SPECIFICATION OF MATERIAL FROM WHICH MADE
3/32" (.094), 1/8" (.125)			Reported			.05	2.14	.022	.011	.35	21.41	9.76	.09	.09	~~05797~~	
Combustion Engr.						Ti	cb+ Ta	Co	Va							
T-308 Stainless						<.01	.02	.13	.01							
Steel Weld Wire.										Weld Deposit						
Specification: SFA-5.9						.033	2.50	.020	.012	.47	20.13	9.71	.06	.06	Chemical Analysis	
Class ER-308						Ti	cb+ Ta	Co	Va						For Information	
						.01	<.01	.05	.05						Purposes Only.	
70% 860 Flux Lot #73F						Ferrite % calculated from a chemical analysis										
30% ST-100 Flux Lot #66U						of weld deposit using Schaeffler Diagram.										
						FN 9 using ASME Section III Div. 1 Fig. NB-2433.1										
						Ferrite: Severn Gauge more than 7.5% less than 10%										
						FN more than 5 less than 10										
						Magnetic Readings per AWS 5.4-77										
Welded per 08.0P.005 R/4						more than 5 less than 10										

REVIEWED FOR CORRECTNESS AND COMPLETENESS BY [initials]
EBASCO ENGINEERING
REVIEWED BY [signature]
EBASCO VQA REP.

QA stamp

I HEREBY CERTIFY THIS REPORT TO BE TRUE AND CORRECT ACCORDING TO RECORDS IN THE POSSESSION OF THIS CORPORATION

David F. Hartmann

C-E POWER SYSTEMS
Combustion Engineering, Inc.
C-E Wire
4224 Shackleford Road
Norcross, Georgia 30093

MANUFACTURERS OF HIGH QUALITY NICKEL ALLOY, STAINLESS STEEL AND LOW ALLOY WIRE FOR WELDING, FORMING AND OTHER APPLICATIONS CERTIFIED TO ASTM, ASME, AWS, SECTION II AND SECTION III NUCLEAR SPECIFICATIONS

SHIP TO: Southwest Fabricating
7525 Sherman St.
Houston, Texas 77011

DATE SHIPPED: ~~XXX~~ 11-7-79
MARKED:

CERTIFICATE OF QUALITY CONFORMANCE TESTS

CUSTOMER PURCHASE ORDER NO. 79-2462
SHOP ORDER NO.: 4439
SPECIFICATIONS: SFA 5.9

ITEM	HEAT NUMBER	SIZE	TYPE	POUNDS SHIPPED	
1	05737	3/32" & 1/8" .094" Dia.	Weld ER308 S.S. Wire	43 #	1 Coil Shipped (Air Freight) Coil # 56
2					
3					
4					

CHEMICAL ANALYSIS

ITEM	C	Mn	Si	S	P	Cr	Ni	Cu	Al	Mo	N_2	Ti.	Cb+Ta	Co.	Va.
1	.05	2.14	.35	.011	.022	21.41	9.76	.09		.09	.065	.01	.02	.13	.01
2															
3															
4															

ITEM	TENSILE STRENGTH	YIELD STRENGTH	ELONGATION	ADDITIONAL TESTS
1	Welding			
2				
3				QA 6
4				

WE HEREBY CERTIFY THAT MATERIAL REFERRED TO ABOVE CONFORMS TO THE PHYSICAL AND CHEMICAL TESTS AND IS IN ACCORDANCE WITH SPECIFICATIONS

[illegible]
My Commission Expires [illegible]

[signature]
NOTARY

REVIEWED FOR CORRECTNESS AND COMPLETENESS BY BB
EBASCO ENGINEERING
REVIEW VERIFIED BY
B Buhl 4-1-90
EBASCO VOA REP.

Combustion Engineering, Inc.
[signature]
AUTHORIZED OFFICIAL

10

1 1 5 6 4

S.O. No: Q-3304-AH
Sheet No. 1

Southwest Fabricating & Welding Co., Inc.

LIQUID PENETRANT INSPECTION REPORT

Date 3-17-80
Page 1 of ___
Procedure No. PT-1 [illegible]

CLIENT: Carolina Power & Light
MATERIAL DESCRIPTION: 12" Pipe Spool
MATERIAL TYPE: S.S.

PENETRANT SYSTEM: Solvent Removable [✓] Water Washable [ ]
BRAND NAME: Spot Check
PENETRANT: SKL-S [✓] SKL-W [ ]
BATCH NO. 7/M023
REMOVER: SKC-S [✓] Water [ ]
BATCH NO. 79K031
DEVELOPER: SKD-S [✓]
BATCH NO. 79L085
SURFACE CONDITION: As welded

TEMPERATURE: 75 °F
PRECLEANER TYPE & BATCH NO.: SKC-S 79K031
CLEANER DRYING TIME: 5 Minutes
DWELL TIME: 10 Minutes
PENETRANT REMOVAL METHOD: Solvent Wiped [✓] Water Spray [ ]

REMOVER DRYING TIME: 5 Minutes
DEVELOPMENT TIME: 10 Minutes
POST CLEANER: Solvent [✓] Water [ ]
EVALUATED BY: C. B. Foster LEVEL II

PIECE OR WELD NO.	ACCEPT	REJECT	LINEAR	ROUNDED	DESCRIPTION OF INDICATIONS
W3	✓				NRI
W6	✓				"

REVIEWED FOR CORRECTNESS AND COMPLETENESS BY [BG]
EBASCO ENGINEERING
REVIEW REQUIRED BY [ ]
B [illegible] 4/18
EBASCO VOA IIF.

Davis Exhibit 17

Approval Date: August 9, 1996
See Numeric Index for expiration and any reaffirmation dates.

Case N-560
Alternative Examination Requirements for Class 1, Category B-J Piping Welds
Section XI, Division 1

Inquiry: What alternative requirements may be used for examination of Class 1 piping welds, excluding socket welds, in lieu of the requirements for Category B-J welds specified in Table IWB-2500-1?

Reply: It is the opinion of the Committee that the following examination requirements may be used for Class 1 piping welds, excluding socket welds, in lieu of those specified in Table IWB-2500-1.

(a) The inspection program shall be based on a total number of examination zones[1] consisting of not less than 10% of the Class 1 (Category B-J) piping welds in each system, excluding socket welds, to be examined during each inspection interval. The selection process shall consist of the following:

(1) Examination zones shall be selected based on a relative ranking process that identifies the more risk-important segments in the system with regard to probability and consequences of failure. Examination zones shall be selected from those pipe segments that fall into the highest risk group.

(2) The ranking process shall address relevant degradation mechanisms (e.g., corrosion, stress corrosion, thermal fatigue, thermal stratification, flow-accelerated corrosion) and industry failure experience with the systems and components.

(3) The consequences of failure at various locations in the system shall be based on the break size and operating mode that results in the highest impact on plant safety. Both direct and indirect effects shall be considered.

(4) The ranking shall be performed by an ISI Selection Team in accordance with Appendix I. The team shall consist of individuals with expertise in one or more of the disciplines related to the selection process, including the function and operation of the system, Probabilistic Safety Assessment (PSA), metallurgy, stress analysis, and knowledge of existing preservice and inservice examination results.

(5) Examination volumes for each examination zone shall be defined to include all areas potentially susceptible to the degradation mechanisms for the zone, such as ID counterbore discontinuities and high-stress locations in pipes or fittings. Sufficient circumferential length shall be examined to confirm the absence of the identified degradation mechanisms. The appropriate examination method (volumetric, surface, or visual) for detection of the degradation mechanisms shall be determined in accordance with Table 1 and Appendix I of this Case.

(6) This Case may be applied to all Class 1 piping systems or to individual systems subject to Category B-J examination requirements. When this Case is applied to more than one system, the selected examination zones may be distributed to concentrate examinations on higher-risk systems.

(7) The selected examination zones shall be reexamined during subsequent examination intervals. Modifications to the selected examination zones may be made based on relevant industry experience, changes in plant design or operation, new metallurgical knowledge, or prior examination results.

(b) The examination zone ranking, selection process, examination volumes, examination method, and the basis for each, shall be documented in the ISI program plan. Modifications shall be documented in revisions to the plan. Methods and procedures used for the examinations shall be qualified to reliably detect and size the relevant degradation mechanisms identified for each examination zone. Personnel performing the examinations shall be qualified to use these procedures. Examinations shall be conducted in accordance with IWA-2000. Use of this Case shall be documented on the applicable Data Report Form.

(c) If flaws exceeding the acceptance standards of IWB-3400 are detected, they shall be evaluated in accordance with IWB-3132, and additional examinations shall be performed in accordance with IWB-2430. If flaws are accepted by analytical evaluation, the requirements of IWB-2420(b) and (c) for successive examinations shall be applied.

[1] Examination zones are structural elements or portions of structural elements of the pinping system, such as welds, fittings, or pipe segments. Each examination zone contains an examination volume determined in accordance with the requiremnets of this Case.

TABLE 1 (CONT'D)
EXAMINATION CATEGORIES

EXAMINATION CATEGORY B-J — CLASS 1 PIPING

Item No.	Parts Examined [Note (1)]	Examination Requirement Fig. No. [Note (11)]	Examination Method	Acceptance Standard [Note (1)]	Extent and Frequency 1st	Extent and Frequency Successive [Note (6)]	Deferral to End of Interval
B9.17	Elements Subject to Microbiologically Influenced Corrosion (MIC)		Visual, VT-3 or Volumetric [Note (9)]	[Note (9)]	Element [Note (3), (4)]	Same as 1st	Not Permissible
B9.18	Elements Subject to Flow Accelerated Corrosion (FAC)	[Note (10)]	[Note (10)]	[Note (10)]	[Note (10)]	[Note (10)]	[Note (10)]

NOTES:
(1) Piping larger than NPS 1.
(2) The length of the examination volume shall be increased to include ½ in. beyond each side of the base metal thickness transition or counterbore.
(3) Includes examination locations identified in accordance with the risk-based selection procedures in Appendix I.
(4) Includes 100% of the examination location. When the required examination volume or area cannot be examined due to interference by another component or part geometry, limited examinations shall be evaluated by the ISI Selection Team for acceptability. Areas with acceptable limited examinations, and their bases, shall be documented.
(5) The examination shall include any longitudinal welds at the locations selected for examination in Note (3). The longitudinal weld examination requirements shall be met for both transverse and parallel flaws within the examination volume defined in Note (3).
(6) Initially selected examination locations are to be examined in the same sequence during successive examination intervals, to the extent practical.
(7) Applies to mill annealed Alloy 600 nozzle welds and heat affected zone (HAZ) without stress relief.
(8) The examination volume shall include the volume surrounding the weld, weld heat affected zone, and base metal, where applicable, in the crevice region. The examination should be concentrated on detection of cracks initiating and propagating from the inner surface.
(9) The examination volume shall include base metal, welds, and weld heat affected zones in the affected regions of carbon and low alloy steel, and within the welds and weld heat affected zones of austenitic stainless steel. The examination region shall be sufficient to characterize the extent of the MIC degradation. Examinations shall verify that the minimum wall thickness required by the Construction Code exists.
(10) In accordance with the Owner's existing FAC program.
(11) Paragraph and figure numbers refer to the 1989 Edition.

APPENDIX I
REQUIREMENTS FOR ISI SELECTION TEAMS AND EXAMINATION ZONE SELECTION

I-1.0 ISI SELECTION TEAM

The Owner shall assemble an ISI Selection Team comprised of individuals with expertise in one or more of the following disciplines. Experience in these disciplines shall be used to determine the expertise of the members.

(*a*) Probabilistic safety assessment;

(*b*) Inservice examination;

(*c*) Nondestructive examination;

(*d*) Stress and material considerations;

(*e*) Plant operations;

(*f*) Plant and industry maintenance, repair, and failure history;

(*g*) System design and operation.

The ISI Selection Team shall use this Appendix to select examination zones and specify examination volumes. Examination volumes of sufficient extent shall be specified to detect the presence, or confirm the absence, of the applicable degradation mechanisms in the examination zone. The team shall ensure that the selection process accounts for plant-specific and industry-wide service experience.

I-2.0 EXAMINATION ZONE SELECTION PROCESS

I-2.1 System Identification

The Owner shall define the Class 1 system boundaries to be addressed in accordance with this Case. This may include all Class 1 piping systems in the Owner's Inservice Inspection program, or individual systems, at the option of the Owner.

I-2.2 Segment Risk Assessment

Piping within a system shall be grouped into segments of common failure consequence and susceptibility to common degradation mechanisms. To accomplish this grouping for each pipe segment within the system, both the potential for failure (i.e., susceptibility to potential degradation mechanisms) and the consequence of failure, both direct and spatial effects, shall be assessed in accordance with I-2.3 and I-2.4.

I-2.3 Failure Potential Assessment

I-2.3.1 Identification of Degradation Mechanisms. Potentially active degradation mechanisms for each pipe segment within the Class 1 piping systems shall be identified. The following conditions shall be considered.

(*a*) Design characteristics, including material, pipe size and schedule, component type (e.g., fitting type or ANSI standard), and other attributes related to the system configuration.

(*b*) Fabrication practices, including welding and heat treatment.

(*c*) Operating conditions, including temperatures and pressures, fluid conditions (e.g., stagnant, laminar flow, turbulent flow), fluid quality (e.g., primary water, raw water, dry steam, chemical control), and service environment (e.g., humidity, radiation).[2]

(*d*) Industry-wide service experience with the systems being evaluated.

(*e*) Results of preservice, inservice, and augmented examinations and the presence of prior repairs in the system.

(*f*) Degradation mechanisms identified in Table I-1.

I-2.3.2 Degradation Mechanism Categories. Degradation mechanisms shall be categorized as de-

[2] Systems fabricated to nuclear standards, while resistant to degradation mechanisms addressed in the design process, have experienced degradation from phenomena unknown at the time of installation.

TABLE I-2
DEGRADATION MECHANISM CATEGORY

Large Pipe Break Potential	Conditions	Degradation Category	Degradation Mechanism
High	Degradation mechanism likely to cause a large break (> 50 GPM)	Large Break	Flow-Accelerated Corrosion
Medium	Degradation mechanism likely to cause a small K (≤ 50 GPM)	Small Leak	Thermal Fatigue, Erosion-Cavitation, Corrosion, Stress Corrosion Cracking
Small	No degradation mechanism present	None	n/a

scribed in Table I-2, in accordance with their probability of causing a large pipe break. Segments susceptible to FAC shall be classified in the large break category. Segments susceptible to any of the other degradation mechanisms shall be classified in the small leak category. Segments having degradation mechanisms listed in the small leak category shall be upgraded to the large break category, if the pipe segments also have the potential for water hammer loads.

I-2.4 Consequence Evaluation

I-2.4.1 Failure Modes and Effects Analysis (FMEA). Potential failure modes for each pipe segment shall be identified, and their effects shall be evaluated. The evaluation shall consider the following:

(a) Break Size. The consequence analysis shall be performed assuming a large break for most segments. The exceptions are piping for which a smaller leak is more conservative, or when a small leak can be justified through a leak-before-break analysis in accordance with the criteria specified in NUREG-1061, Volume 3, and 10CFR50, Appendix A, General Design Criteria 4.

(b) Isolability of the Break. A break can be automatically isolated by a check valve, a closed isolation valve, or an isolation valve that closes on a given signal or by operator action.

(c) Spatial Effects. These include the effects of flood, spray, and pipe whip.

(d) Initiating Events. These shall be identified using a plant-specific list of initiating events from the plant Probabilistic Safety Assessment/Individual Plant Examination (PSA/IPE) and the plant design basis.

(e) System Impact/Recovery. The means of detecting a failure, and the Technical Specifications associated with the system and other impacted systems shall be evaluated. Possible automatic and operator actions to prevent a loss of systems shall also be evaluated.

(f) System Redundancy. The existence of redundant flow paths for accident mitigation purposes shall be considered.

I-2.4.2 Impact Group Assessment. The FMEA impacts for each pipe segment shall be classified into one of three impact groups: initiating event, system, or combination. The consequence category (high, medium, or low) shall then be selected in accordance with (a) through (c) below.

(a) Initiating Event Impact Group Assessment. When a postulated break in a Class 1 pipe segment results in only an initiating event (e.g., loss of coolant accident, loss of feedwater, reactor trip), the consequence shall be classified into one of four categories: high, medium, low, or none. The initiating event categories shall be assigned according to the following:

(1) The initiating event shall be placed into one of the categories in Table I-3. These shall include all applicable design basis events previously analyzed in the Owners updated final safety analysis report PSA, or IPE.

(2) Breaks that cause an initiating event classified as routine operation (Category I) are not relevant to this analysis.

results in both an initiating event and the degradation or loss of a system shall be determined from Table I-6. The consequence category is a function of two factors:

(1) Use of the system as a mitigating function for the induced initiating event; and

(2) Number of unaffected backup systems or trains available to perform the same function.

I-2.5 Segment Risk Categorization

I-2.5.1 Risk Matrix. The risk of pipe segment failure shall be evaluated on the basis of the expected likelihood of the event and the expected consequence. The likelihood of failure is estimated based on the segment exposure to varying degradation mechanisms, and is represented by the degradation mechanism category assigned to the segment in accordance with I-2.3. Consequence is represented by the consequence category assigned to the segment in accordance with I-2.4. The structure used to document the results of this analysis is called a Risk Matrix and is illustrated in Table I-7. Each pipe segment shall be assigned to one of the risk categories in Table I-7, based on its degradation mechanism and consequence category.

I-2.5.2 Risk Categories. The three degradation mechanism categories and four consequence categories shall be combined into seven risk categories, as follows:

Risk Category	Risk Area
1	High Consequences and Large Break Degradation Category
2	High Consequences and Small Leak Degradation Category
3	Medium Consequences and Large Break Degradation Category
4	High Consequences and No Applicable Degradation Mechanisms
5	Medium Consequences and Small Leak Degradation Category, of Low Consequences and Large Break Degradation Category
6	Medium Consequences and No Applicable Degradation Mechanisms, or Low Consequences and Small Leak Degradation Category
7	Low Consequences and No Applicable Degradation Mechanisms, or No Consequences and Any Degradation Category

All pipe segments in the Class 1 systems addressed in accordance with this Case shall be classified, into one of the above seven risk categories, using the risk matrix.

I-2.6 Structural Elements and Examination Zone Selection

The selection team shall identify the structural elements such as welds, fittings, or pipe sections, within each pipe segment, based on susceptibility to the applicable damage mechanisms identified for that segment. For examination zone selection, each pipe segment shall be classified in accordance with I-2.5 in one of the following risk groups:

Risk Group	Segment Risk Category
High	1, 2, and 3
Medium	4 and 5
Low	6 and 7

Examination zones shall be selected starting with the structural elements in the HIGH risk group and working toward the LOW risk group, until a total number of structural elements equal to 10% of the Category B-J piping welds, excluding socket welds, has been selected.

Examinations may be concentrated on systems with more high-risk segments, such that a larger percentage of structural elements in the high-risk Categories 1, 2, and 3 are examined.

I-3.0 EXAMINATION VOLUMES AND METHODS

The selection of examination volumes and methods for each examination zone within a risk category will depend upon the degradation mechanism present, and access, radiation exposure, and cost considerations. Examination methods, volumes, and acceptance and evaluation criteria specifically designed for the active degradation mechanisms in the examination zone shall be used. The examination zones within each risk category shall be ranked by considering the following:

(a) Elements identified as susceptible to the specific degradation mechanisms in Table I-1.

(b) Plant-specific inservice cracking experience.

(c) Access. There shall be adequate access to the element to ensure that the examination method defined in this section for the relevant damage mechanism can be used effectively for the defined examination volumes.

TABLE I-7
RISK MATRIX FOR PIPE SEGMENTS

RISK CATEGORIES High-Cat. 1, 2, 3 Med.-Cat. 4, 5 Low-Cat. 6, 7		CONSEQUENCE CATEGORY			
		NONE	LOW	MEDIUM	HIGH
DEGRADATION MECH. CATEGORY	LARGE	Cat. 7	Cat. 5	Cat. 3	Cat. 1
	SMALL	Cat. 7	Cat. 6	Cat. 5	Cat. 2
	NONE	Cat. 7	Cat. 7	Cat. 6	Cat. 4

(d) Radiation Exposure. Elements shall be selected to minimize personnel radiation exposure during examination.

(e) Relative degradation severity for specific degradation mechanisms, when applicable (e.g., wear or erosion rates for flow-accelerated corrosion, Temperature Differential or Richardson number for thermal fatigue, NUREG-0313, Revision 2 weld categorization for IGSCC). Examinations for elements in Risk Category 4 segments shall be concentrated on any areas of significant stress concentration, geometric discontinuities, or terminal ends.

(f) Elements having break or consequence limiting devices e.g., pipe whip restraints, need not be examined, if these have not been credited in the consequence evaluation.

Examination programs developed in accordance with this Case shall use NDE techniques that are designed to be effective for specific degradation mechanisms and examination locations. The examination volumes and methods that are appropriate for each degradation mechanism are provided in Table 1 of this Case. The methods and procedures used for the examinations shall be qualified to reliably detect and size the relevant degradation mechanisms identified for each examination zone. Personnel performing the examinations shall be qualified to use these procedures. Examinations shall be conducted in accordance with IWA-2000.

I-4.0 RE-EVALUATION OF RISK-BASED SELECTIONS

The affected portions of the risk-based inservice inspection program shall be re-evaluated as new information affecting the selection and scope of the program becomes available. Examples include piping system design changes, industry-wide failure notifications, and prior examination results.

Davis Exhibit 18

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY & LICENSING BOARD

- - - - - - - - - - - - - - - - - - -x

In The Matter Of: :

CAROLINA POWER & LIGHT COMPANY, :

(Shearon Harris Nuclear Power :

Plant) :

- - - - - - - - - - - - - - - - - - -x

Washington, D.C.

Thursday, October 14, 1999

Deposition of DAVID A. LOCHBAUM, called for examination, pursuant to notice, at 10:10 a.m., at the offices of Shaw Pittman, 2300 N Street, NW, Third Floor, Washington, D.C., before Mario A. Rodriguez, a notary public in and for the District of Columbia, when were present on behalf of the respective parties:

APPEARANCES:

On behalf of Carolina Power & Light Company:

JOHN H. O'NEILL, JR., ESQ.
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On behalf of Nuclear Regulatory Commission:

SUSAN L. UTTAL, ESQ.
U.S. Nuclear Regulatory Commission
Washington, D.C 20444
(301) 415-1582

On Behalf of the Board of Orange County Commissioners:

DIANE CURRAN, ESQ.
Harmon, Curran, Spielberg & Eisenberg, LLP
1726 M Street, NW

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(202) 328-3500

ALSO PRESENT:

JAMES A. DAVIS, Materials Engineer
KENNETH C. HECK, Operations Engineer
U.S. Nuclear Regulatory COmmission

P R O C E E D I N G S

Whereupon,

DAVID LOCHBAUM,

a witness, was called for examination by counsel and, having been first duly sworn, was examined and testified as follows:

MR. O'NEILL: First instructions to the court reporter: To transcribe everything during the deposition except during breaks or mutual off-the-record discussions when nothing should be transcribed.

Interrupt when necessary to clear up any doubts about a question or an answer that you have since what you transcribe is what's important.

Please transcribe the attendances and the exists and entrances of any individual during the deposition.

And we've already introduced ourselves prior to going on the record and we note that you have all of the individuals for the record at the moment.

I'll ask you to mark all exhibits prior to embedded portions, and some evaluation, analysis or inspection of the exterior piping surfaces.

Q And, of course, the evaluation has been done of all of the accessible exterior piping surfaces.

A That's my understanding.

Q And what you're talking about is some evaluation of the exterior that is embedded in concrete?

A That is correct.

Q I want you to tell me what evaluation that you would propose as one that would satisfy your concerns, particularly since we've agreed, for this opinion, that we are going to eliminate ripping out all of the reinforced concrete, tearing up the spent fuel pool to get to the piping?

A If it had been me in charge and I had to answer that question and document that, some walkdown of, was there any history of spills or anything that would have gotten into the concrete or around where these pipes came through walls that could have been an external contaminant, an inspection of where it went into the pipe, into the walls and out of, things like that, that would have given me some basis for saying that there was not, or no apparent indications of an external contaminant source.

Or could have walked through areas where there was signs that water was collecting as if some kind of water from some unknown source was collecting in the building that could have contaminated the external surfaces. I would have tried to eliminate those potentials and documented that in some kind of evaluation.

Q Are you familiar with the second prong of the 50.55a(3) which allows for an exemption to ASME code requirements that you can make certain demonstrations?

There's two tests, alternate tests. One is you can demonstrate adequate quality and safety. That's the test we've been talking about; is it not?

A Right.

Q But there's a second test, isn't there? In fact, the board referred to it in its order.

CERTIFICATE OF DEPONENT

I, DAVID A. LOCHBAUM, do hereby certify that I have read the foregoing transcript of my deposition testimony and, with the exception of additions and corrections, if any, hereto, find it to be a true and accurate transcription thereof.

____

11-30-99

DATE

Sworn and subscribed to before me, this the __________ day of ________________, 19____.

____

NOTARY PUBLIC IN AND FOR

My commission expires: