APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-206/94-23

License: DPR-13

Licensee: Southern California Edison Co.
Irvine Operations Center
23 Parker Street
Irvine, California

Facility Name: San Onofre Nuclear Generating Station (SONGS), Unit 1

Inspection At: SONGS site, San Diego, California

Inspection Conducted: October 3-6, 1994

Team Leader: G. Michael Vasquez 12/2/94
G. M. Vasquez, Senior Health Physicist Date
Fuel Cycle and Decommissioning Branch

Inspectors: Louis Carson, II
Health Physicist, Region IV

Jack D. Parrott
Project Manager, NMSS

Lee H. Thonus
Project Manager, NRR

Michael K. Webb
Project Manager, NRR

Approved: Charles L. Cain 12/2/94
Charles L. Cain, Chief Date
Fuel Cycle and Decommissioning Branch

Inspection Summary

Areas Inspected: Special, announced team inspection of the licensee's safety review program, management oversight, self assessment program, auditing program, fuel storage and spent fuel pool, siphon potential, freeze potential, emergency preparedness program, radiation protection program, unit material condition, maintenance program, licensee organization, training program, radiological effluent/environmental monitoring, and records important to decommissioning.

Results:

- The licensee's management controls, safety review processes and self-assessment programs were functioning and adequately implemented for the shutdown condition of the plant.

- The licensee's spent fuel accountability (inventory) program effectively accounted for Unit 1's spent fuel, some of which was located in the spent fuel pools (SFPs) of Units 2 and 3.

- The Unit 1 SFP water chemistry was within technical specifications and water clarity was excellent.

- The team concluded that there was no credible potential for existing plant piping to drain the SFP to a level that would expose spent fuel.

- The team concluded that the licensee's emergency preparedness program for Unit 1 adequately met requirements and was appropriate to Unit 1's defueled status.

- The team concluded that the licensee's radiation protection program met or exceeded requirements.

- The licensee's maintenance program was sufficient to assure operability of those systems supporting the safe storage of Unit 1's spent fuel. Further, the team noted that Unit 1 was in good material condition.

- The licensee's organization and lines of responsibility complied with its Permanently Defueled Technical Specifications. The organization and staffing were appropriate to Unit 1's shut down and defueled condition.

- The licensee's training for certified fuel handlers and spent fuel bridge crane operators was strong.

- The licensee has been complying with NRC requirements regarding changes to the Offsite Dose Calculation Manual, the radwaste treatment systems, and reviews of uncontrolled or unplanned releases.

- The team found that the licensee program for decommissioning recordkeeping was weak.

Summary of Inspection Findings:

- IFI 50-206/9423-01 was opened, involving the long-term degradation potential to the spent fuel pool's stainless steel liner from poor quality water contacting it.

Attachments:

- Persons Contacted and Exit Meeting

TABLE OF CONTENTS

EXECUTIVE SUMMARY v

DETAILS 1

1 SAFETY REVIEW PROGRAM 1

2 MANAGEMENT OVERSIGHT, SELF ASSESSMENT, AND AUDITING 2

3 FUEL STORAGE AND SPENT FUEL POOL 3

4 SIPHON POTENTIAL 6

5 FREEZE POTENTIAL 6

6 EMERGENCY PREPAREDNESS PROGRAM 7

7 RADIATION PROTECTION PROGRAM 8

8 UNIT MATERIAL CONDITION AND MAINTENANCE PROGRAM 9

9 ORGANIZATION 10

10 TRAINING PROGRAM 11

11 RADIOLOGICAL EFFLUENT/ENVIRONMENTAL MONITORING 12

12 RECORDS IMPORTANT TO DECOMMISSIONING 13

ATTACHMENT 1

EXECUTIVE SUMMARY

On April 14, 1994, NRC issued NRC Bulletin 94-01, "Potential Fuel Pool Draindown Caused By Inadequate Maintenance Practices at Dresden Unit 1," to inform licensees of the potential for draindown of the spent fuel pool below the active fuel assemblies. Numerous concerns were identified that attributed the event at Dresden to management neglect of the facility, poor or nonexistent 10 CFR 50.59 reviews, lack of a dedicated and knowledgeable staff, and deviations from the Decommissioning Plan and license commitments. Based on a review of these issues, NRC decided to conduct a series of team inspections at shutdown reactor facilities, including the San Onofre Nuclear Generating Station (SONGS) Unit 1 facility.

The team's objectives were to verify that the licensee was safely storing spent fuel, to verify the adequacy of the licensee's actions and commitments in response to Bulletin 94-01, and to verify that licensee programs provide mechanisms to prevent degradation of various plant systems that ensure the safety of the spent fuel.

The team concluded that licensee programs were effectively implemented to ensure the safety of spent fuel. The licensee's management controls, safety review process, quality assurance, and self-assessment programs were functional and effective. Staffing levels appeared good to maintain the shutdown and defueled condition of the plant. The spent fuel pool was clean and orderly. Bulletin 94-01 responses were appropriate. With one potential exception, discussed below, the licensee had programs to prevent degradation of various plant support systems related to the storage of spent fuel.

The team developed one concern related to the long-term integrity of the spent fuel pool liner. The team noted that because of the design of the spent fuel pool leak detection well and the way licensee procedures were written, poor quality water (perhaps from groundwater or as a result of leaching from the concrete) could contact the outside of the stainless steel spent fuel pool liner. The team was concerned that the licensee had not evaluated the long-term metallurgical effects to the stainless steel from long-term contact with poor quality water. As a result of the team's concern, the licensee committed to taking immediate action by modifying its procedures to prevent water from contacting the liner until the condition could be evaluated, to performing chemical analysis of water samples from the leak detection well, and to evaluating the potential degradation that could occur. The licensee also committed to providing the NRC Region IV office with a copy of the results of its evaluation within 90 days of issuance of the inspection report.

DETAILS

1 SAFETY REVIEW PROGRAM

The team reviewed the licensee's administrative procedure associated with the 10 CFR 50.59 safety review process. San Onofre Administrative Procedure SO123-VI-1.3, "Unreviewed Safety Question Screening Criteria and Environmental Evaluation for Orders, Procedures, and Instructions," contained, in part, the Southern California Edison (SCE) requirements and guidance for performing evaluations as required by 10 CFR 50.59. This procedure, coupled with other San Onofre procedures (including Engineering Design Quality Procedures and checklists), provided acceptable formal procedural guidance for the following: 1) implementing the requirements of 50.59 for proposed changes, tests, and experiments, 2) assessing and documenting whether a change to the Permanently Defueled Technical Specifications (PDTSs) or an unreviewed safety question is involved, and 3) records retention. SO123-VI-1.3 and the numerous other procedures and checklists were found to be comprehensive and provided detailed guidance on complying with the requirements of the regulation.

The inspector reviewed each of the two 10 CFR 50.59 reviews performed at San Onofre Nuclear Generating Station (SONGS), Unit 1, since January 1, 1993. Both reviews were found to be in compliance with SO123-VI-1.3 and NRC regulations.

The inspector also reviewed the Facility Change Report for San Onofre Nuclear Generating Station, Units 1, 2, and 3, dated July 11, 1994, and compared the entries in the report to the actual file copies of the evaluations. A sample of descriptions and the narratives of the evaluation in the Annual Report accurately described the evaluations on file.

In addition, the inspector reviewed three facility changes made at Unit 1 in which equipment no longer required for operation was modified or taken out of service but did not require a 10 CFR 50.59 evaluation. Licensee representatives indicated that these activities had been conducted using Engineering Design Quality Procedure, SO1-XXIV-10.10, "Unit 1 Post Shutdown Configuration Control." This procedure provided guidance to control configuration changes to systems not required for operation. If the affected systems or components had been identified as required for operation by the Decommissioning Plan Task Force, a more extensive procedure, SO123-XXIV-10.9, "Design Process Flow and Controls SONGS Units 1, 2 & 3," was required to be followed.

The site training lesson plan for "Operator Safety Assessments per 10 CFR 50.59" was reviewed. The training plan stated that the duration of the training is four hours. The 10 CFR 50.59 training program was thorough. SO123-VI-1.3 required that the cognizant functional division managers designate the personnel within their organization authorized to approve 10 CFR 50.59 screening criteria. A review of licensee records indicated that all personnel assigned to Unit 1 authorized to approve the screening criteria had indeed received 10 CFR 50.59 training within the past two years.

The team concluded that the licensee's 10 CFR 50.59 Safety Review program was thorough and well-designed, that implementation of the program appeared to be in accordance with licensee procedures, and that the program met NRC requirements.

2 MANAGEMENT OVERSIGHT, SELF ASSESSMENT, AND AUDITING

The team reviewed the licensee's self assessment and audit programs to verify that these programs were adequate to self-identify developing problems and implement timely corrective actions. The inspection consisted of selected interviews with plant personnel, reviews of audits, selected reviews of the Onsite Review Committee meeting minutes, and independent verification of related plant activities.

PDTSs Section D6.5.3 requires that the Nuclear Safety Group provide independent review of designated activities and that reports of reviews and audits be distributed monthly. An inspector reviewed QA Procedure N2.21, "Nuclear Safety Group Functions and Responsibilities," and the monthly reports produced by the Nuclear Safety Group in 1994. The Nuclear Safety Group met and reported on their activities on a monthly basis as required by the PDTS. The scope of its audits covered all of the critical activities required by the PDTS such that the Nuclear Safety Group audit program was adequately implemented.

The team reviewed two Operations Division self-monitoring procedures and the resultant reports for the past year. SO-123-0-33, "Operations Internal Audits," provided a means to identify Operations records to receive periodic internal auditing. The audits were conducted on a schedule in compliance with the audit frequency specified by SO123-0-33. SO-123-0-35, "Operations Division Experience Report," established a method to identify, evaluate, and document significant operational occurrences. One Operations Division Experience Report, ODER-1-94-1, had been generated in Unit 1 this calendar year. The root cause determination and recommended corrective actions appeared adequate.

The team also reviewed the Onsite Review Committee meeting minutes. At the time of the inspection, the meeting minutes for 1994 existed in the form of the secretary's hand-written notes and audio recordings. Sufficient documentation existed for the team to conclude that the meetings had occurred as required. Meeting minutes appeared to indicate that substantive discussions were occasionally held. However, documentation was weak and difficult to understand. Licensee representatives stated that the meeting minutes would be appropriately documented in the future.

The team found that the SONGS Quality Assurance (QA) department had reviewed and modified its program to consider the defueled status of Unit 1. The licensee had developed a procedure in its QA Plan, Chapter 8-C, "Unit 1 Permanently Defueled Quality Assurance Program Requirements." The team reviewed revision 1 of this procedure and found that it described the variance in the QA program for those systems that were designated as Safety Related. The procedure also described systems, parts and components that were designated as "Required to be Operational" in the Q-List. The licensee's modifications to the QA program appeared reasonable.

The QA department had performed three audits of the Unit 1 PDTS in 1994. These were in the areas of training and qualification, emergency plan implementation, and chemistry/radiochemistry monitoring program. Also, the QA department had performed several surveillances of activities associated with Unit 1. Other performance based observations were also performed related to spent fuel pool (SFP) activities (which included Unit 1), foreign material exclusions around the SFPs, Unit 1 maintenance activities, and Unit 1 material condition and housekeeping.

QA representatives also stated the licensee's intent to perform systematic audits of line items of the Unit 1 PDTSs beginning in 1995, on a 5 year cycle.

The team concluded that the licensee was generally complying with its PDTSs and that management oversight, through the self-assessment activities, was evident. The team's review of the QA activities indicated that the licensee had been performing some self-assessment functions for activities specific to Unit 1, and that the licensee planned to begin line item audits of the Unit 1 PDTSs beginning in 1995.

3 FUEL STORAGE AND SPENT FUEL POOL

SONGS Unit 1 shut down in November 1992 and completed defueling the reactor in about March 1993. During defueling activities, SONGS placed some of its Unit 1 fuel in the spent fuel pools of Units 2 and 3, due to the lack of space in the Unit 1 SFP.

The team reviewed the licensee's most recent special nuclear materials inventory conducted between March 7 and 21, 1994. The inventory was conducted to satisfy the requirements of 10 CFR 70.51 and the licensee's Nuclear Engineering, Safety, and Licensing procedural requirements. The licensee had 207 Unit 1 fuel assemblies stored in the Unit 1 SFP, 70 Unit 1 fuel assemblies stored in the Unit 2 SFP, and 118 SONGS 1 fuel assemblies stored in the Unit 3 SFP. The inventories included serial number verification of each stored fuel assembly. In addition to independent serial number verification, the licensee kept a video tape backup of the inventory which could be used to resolve any questions which might arise. The team found that the use of independent verification with video tape backup was a strength in the licensee's fuel storage program. No discrepancies were identified by the licensee's inventory or by the team.

The team conducted a visual inspection of the Unit 1 SFP and the surrounding areas and found that they were neat, orderly and that water clarity was excellent. In addition to the 207 fuel assemblies, the SFP had four fuel assembly positions which were occupied by containers of irradiated and radioactive components. No items were hung from the wall of the SFP, and no items were stored at a level higher than the fuel assemblies. This assures that maintaining shield water above the fuel assemblies also provides adequate shielding for the stored irradiated and radioactive components.

The team observed that the licensee maintained a clearly demarcated foreign materials exclusion area around the SFP.

During the inspection, the water level in the SFP was at 40 ft. 8.75 in. (i.e. above the PDTS minimum level of 40 ft. 3 inches). The water temperature was 74°F, well below the PDTS maximum allowed temperature of 150°F. These parameters were observed and logged at least once per shift by the SONGS 1 operations staff.

The auxiliary feedwater storage tank (AFWST) was used as an emergency supply of makeup water to the SPF. The team verified the AFWST level was above the PDTS minimum requirement of 50 ft. 9 in. plant elevation. The operators verified and logged AFWST water level readings at least once per shift. Both the SFP and the AFWST have low level alarms which annunciate in the control room.

The team reviewed records of chemistry analyses of the water in the SFP from the period July through September 1994. The licensee is required to verify that the concentrations of chlorides and fluorides in the SFP are each less than 0.15 ppm. The licensee's test results indicated that these parameters were an order of magnitude below the PDTS limits. The licensee also performed analyses for pH, sulfates, boron, and gamma emitting radioactivity. The results indicated that pH was in the normal expected range for a borated SFP, sulfates were an order of magnitude below the PDTS limits for chlorides and fluorides (the PDTS do not impose a limit on sulfates), boron was in excess of 2000 ppm (the licensee took no credit for the presence of the boron as a neutron absorber), and gamma emitters were in the expected range (10^{-2} - $10^{-3}\mu Ci/ml$) for a plant with known minor fuel pin leakage. No significant adverse trends were observed.

The team observed that the licensee used National Institute of Standards and Technology analytical chemical standards for the calibration of their ion chromatograph. The master standards and diluted standards for daily/weekly calibration were all within their shelf life and expiration dates.

The SFP was a seismically qualified reinforced concrete structure with a stainless steel liner. There is a small gap between the liner and the concrete and a collection system to collect any liner leakage in a well. The sampling well for this leak detection system was a vertical right circular cylinder with the drain collection at the bottom and a cap at the top. The fuel transfer tube had a similar leakage collection system and sampling well. In accordance with its procedural requirements, the licensee had been monitoring the water level in each well on a weekly basis.

The team's review of the licensee's response to Bulletin 94-01 indicated that the response was reasonable. No problems were identified.

Until 1986, the SFP liner had not experienced any significant leakage and the leakage collection system and well remained dry. However, in 1986, spent fuel pool water leaked through the liner and filled the leakage collection system and well. The SFP water apparently penetrated through the concrete structure around the SFP because water eventually exuded from a concrete slab (outdoors) adjacent to the fuel handling building. The licensee subsequently identified the leak, isolated that portion of the SFP, drained down and repaired the leak.

The team deduced that during this episode the outer surface of the liner was exposed to the borated water from the SFP plus any chemical contaminants which leached from the concrete or existed in the leak detection well. The concentration and composition of the contaminants from this episode was unknown because the licensee had not sampled the water prior to the inspection.

Subsequent to the liner repair, the SFP leak detection system and well were dry. However, in March 1994 the level in the leakage detection well began to increase slowly, indicating the likely presence of a small leak from either the spent fuel pool or groundwater intrusion. The licensee suspected that the leak was from the SFP rather than groundwater intrusion because the leak was observed after its heat-up test. But, the licensee had not sampled the water, and did not know for certain.

Because of the design of the SFP leak detection system and well, when the level in the leak detection well exceeds approximately one-half foot from the bottom, the outer side of the bottom surface of the SFP liner becomes immersed in the water contained in the leakage collection system. As the level rises, the lower portion of the sides of the SFP also become immersed. The water level in the leak detection well exceeded 6 ft. in 1994 before it was pumped out, so the bottom 5 1/2 ft. were in contact with the water in the well. During the well pumpout, the licensee obtained a sample for chemical analysis but it was representative of the pump priming water rather than the leak detection well water. The team was concerned that the well water could contain solutes which could be deleterious to the stainless steel liner when in solution, or when left as a film as water levels changed.

Immediately prior to the inspection, the licensee had modified Procedure SO1-12.9-11, "Miscellaneous Surveillances," Revision 4, to require that the SFP liner and Transfer Tube leak detectors be pumped if the level in the leak detector was above the -16 ft. level (as measured from the top of the well cap, this would correspond to about 16 ft. down into the well) or if the level had increased more than 2 ft. since the last inspection. Licensee representatives stated that the change was implemented to keep the level in the leak detection system and well below the groundwater table so that any SFP leaks would not escape into the groundwater. If the level were below the groundwater table, groundwater would tend to leak into the system.

At levels above the -19.5 ft. mark (19.5 ft. down into the well), water would be in contact with the outside of the SFP stainless steel liner. The team noted that the licensee's procedures would not require pumping water out of the well until water reached the -16 ft. level. At that level, the waters would be in contact with the bottom 3 1/2 ft. of the stainless steel SFP liner. Since groundwater probably has a very high chloride level (and since chlorides, under certain conditions, can damage stainless steel), the team also noted that groundwater intrusion could pose a long term challenge to the SFP stainless steel liner.

As a result of the team's concerns, a sample from the heel of the SFP well taken during the inspection indicated chloride concentrations of 26 ppm and sulfate concentrations of 168 ppm. The team conc uded that any damage to the liner would occur slowly due to the relatively low temperature of the SFP ($\leq$80°F) and that even if leakage developed it would do so very slowly. Thus, there was no immediate safety concern. However, the licensee had not analyzed the potential for long-term metallurgical effects to the stainless steel SFP liner to pitting and intergranular attack. As a result, the licensee agreed to review the situation and to report the results to the NRC within 90 days of the issuance of the inspection report. Review of the licensee's analysis was designated as an Inspector Followup Item (IFI) 50-206/9423-01.

4 SIPHON POTENTIAL

The tops of the fuel assemblies stored in the SONGS 1 SFP are at the 15 ft. 1 in. elevation. None of the pipes shown in the licensees drawings of the SFP extend below elevation 28 ft. and, therefore, could not serve as a siphon path below that elevation. Visual inspection by the team did not disclose any piping not shown on the licensee drawings nor any temporary hoses which could serve as potential siphon paths. There were two temporary hoses stored on the wall separating the upender area from the cask area. In their configuration they could only serve as a pathway between the cask area and the upender area which communicate and were at equal level; this would not affect pool level.

The team reviewed the licensee's administrative control system for plant modifications and procedure changes. Several procedures were reviewed including S01-14-24, "Operations Procedures Group," Revision 1; S0123-XXIV-10.21, "Field Change Notice (FCN) and Field Interim Design Change Notice," Revision 4; S0123-XXIV-10.9, "Design Process Flow and Controls," Revision 1; S0123-VI-1.3, "Unreviewed Safety Question Screening Criteria and Environmental Evaluation for Orders, Procedures and Instructions," Revision 2; and S0123-VI-0.9, "Authors Guide for the Preparation of Orders, Procedures, and Instructions," Revision 3. The team determined that the licensee's system included adequate checks, independent reviews, and precautions to enable the engineering and operating staffs to capture potential siphon paths of the SFP prior to the change being implemented.

The team concluded that there was no credible potential for existing plant piping to drain the SFP to a level which would expose spent fuel. The team further determined that it was unlikely that any future modifications would create a configuration which would allow a siphon path which could drain the SFP to a level which could expose spent fuel.

5 FREEZE POTENTIAL

The climate in Southern California, where SONGS is located is quite mild. Freezing temperatures have never been recorded at the site. Since a prolonged hard freeze was not deemed possible at the site, the team determined that no freeze protection was necessary.

6 EMERGENCY PREPAREDNESS PROGRAM

The purpose of this part of the inspection effort was to determine if the licensee's Emergency Plan (E-Plan), Emergency Operating Procedures (EOPs), and Emergency Implementing Procedures (EPIPs) were adequate to respond with potential accidents for the permanently defueled condition of the plant. The scope of this inspection effort included a review of SONGS Unit 1's implementation of the E-Plan, EPIPs, EOPs, and the SONGS emergency preparedness program changes submitted as Revision 6 and discussed in NRC Inspection Report 50-206/93-41. Licensee emergency preparedness requirements for SONGS Unit 1 are specified in the PDTS Section D6.8.1(e) "Emergency Plan implementation." Additionally, the team reviewed the following licensee emergency implementation and abnormal operations procedures:

- SO1-VIII-30, "Unit 1 Operations Leader Duties," Revision 1
- SO123-VIII-1, "Recognition & Classification of Emergencies," Revision 1
- SO1-2.2-1, "Radiation Monitoring System High Radiation," Revision 4
- SO1.2.1-13, "Spent Fuel Pool Trouble," Revision 4

The team found that:

- On June 15, 1994, the licensee conducted an emergency site drill that featured a SONGS Unit 1 spent fuel pool failure as the initiating event. This emergency drill included 234 personnel.
- Based on the SONGS site emergency drill, the licensee identified substantial problems related to the licensee's response to the Unit 1 initiating event. Inspectors reviewed the licensee's findings regarding the emergency drill and the subsequent corrective actions. Corrective actions included reviews of pertinent EPIPs, EOPs, and retraining of site personnel. The team found that the licensee's corrective actions were adequate to provide a reasonable assurance that the licensee had corrected the deficiencies noted during the June 15, 1994, drill.
- When queried by the team about emergency response duties during a hypothetical SONGS Unit 1 emergency, the SONGS Unit 1 and Unit 2/3 Operations Shift Superintendents were knowledgeable on EPIPs and EOPs. Also, operations personnel had adequate familiarization with radiological hazards from a spent fuel accident as discussed in NRC Information Notice 90-08, "Kr-85 Hazards from Decayed Fuel."
- The team observed the licensee during the performance of the SONGS site annual emergency drill and determined that appropriate protective measures were taken for SONGS Unit 1 personnel.
- Process and effluent radiation monitors being used for measuring radioactivity during a spent fuel accident were being maintained calibrated and operational. Alarm setpoints and emergency responses

were appropriately identified in procedures SO123-VIII-1, and SO1-2.2-1 so that operations personnel could determine that an accident situation existed and if an event classification was necessary.

- The licensee had two event classifications for Unit 1 in a defueled condition: Unusual Event and Alert. Review of licensee procedures indicated that the licensee was not precluded from classifying an emergency situation higher if unexpected conditions arose (e.g., security intrusion or more severe damage to the spent fuel). The Alert is the highest credible emergency classification involving a Unit 1 spent fuel accident that the licensee analyzed. The specific accident that the licensee analyzed involved a fuel handling accident whereby one fuel assembly ruptured. The basis of this one fuel assembly rupture accident scenario was the SONGS Unit 1 operating plant Updated Final Safety Analysis Report (UFSAR) Chapter 15, "Design Basis Accident," for a refueling outage. The data and assumptions used for a SONGS Unit 1 spent fuel accident had been previously reviewed by the NRC. Further information is discussed in NRC Inspection Report 50-206/93-41 regarding the November 30, 1993, meeting between the NRC and the licensee concerning the SONGS emergency preparedness program changes (Revision 6), which evaluated the effects associated with Unit 1's defueled status.

The team concluded that the licensee's emergency preparedness program for Unit 1 adequately met requirements and was appropriate to Unit 1's defueled status.

7 RADIATION PROTECTION PROGRAM

The purpose of this portion of the inspection effort was to determine the adequacy of the licensee's radiation protection program for Unit 1's defueled condition during normal and accident conditions, and to determine whether the licensee was in compliance with the requirements of PDTS D6.11. The scope of this inspection effort included a review of the radiation protection organization; procedures; survey records; ALARA reviews; and NRC inspection reports 50-361/94-18, 50-206/94-06, and 50-206/93-37.

The team found that:

- SONGS operational health physics Units 2 and 3 staff, release group, radioactive material control group, and engineering group provided support for Unit 1 radiation protection activities. SONGS Unit 1's radiation protection support consisted of two senior health physics technicians who were considered dedicated to Unit 1. Additionally, 15 health physics personnel located at SONGS were allocated to SONGS Unit 1 on an as-needed basis. Three SONGS chemistry personnel were allocated to Unit 1 on an as-needed basis to analyze radiochemistry samples and monitor radiation effluent equipment.

- During the SONGS Unit 1 facility tour of the Containment and Fuel Handling Buildings, radiation exposure levels measured independently by an inspector using an NRC radiation survey meter were in agreement with licensee survey records and postings.

- Radioactive materials, radiation work activities, and radiation areas were being controlled in a manner that was consistent with the requirements of 10 CFR Part 20, PDTS D4.3, PDTS D6.8.1, PDTS D6.8.4, PDTS D6.11, and PDTS D6.12. A review of licensee records indicated that the licensee had conducted a Unit 1 radioactive source inventory and leak check as required by PDTS D4.3.

- The team reviewed updated survey log records, area plot plans, survey pre-job planning cards, and Unit 1 radiation trending data. Detailed periodic radiation and contamination surveys were being performed in accordance with licensee radiation survey procedures. The team compared the results of Unit 1 radiation trending data measured in the Containment Building for 1993 and 1994 and noted that radiation level were decreasing.

- The Noble Gas/Contamination Logbook was being maintained by Unit 1 radiation protection personnel. An inspector reviewed Unit 1 personnel contamination events for 1994 and noted that 73 personnel contamination events had been identified. However, only five of those 73 contamination events required further investigation by the licensee's Personnel Contamination Investigation Report system as to the cause of the event. The team did not consider any of the personnel contaminations as radiologically significant.

- Radiation Exposure Permits (REPs) and ALARA evaluations were being adequately conducted by radiation protection staff. The team reviewed ALARA planning and REP development for three work activities conducted at SONGS Unit 1. The team determined that ALARA shielding, detailed work planning, and radiation protection pre-job briefings were adequate for the tasks being performed.

The team concluded that the licensee's radiation protection program, organization, and support structure met or exceeded requirements.

8 UNIT MATERIAL CONDITION AND MAINTENANCE PROGRAM

The team observed that SONGS Unit 1 was in good material condition during plant walkthroughs. No PDTS-required equipment was inoperable at the time of the inspection. Fire protection equipment was in service, orderly, and available; plant lighting was functional and in good repair. The overall physical plant was neat, clean, and orderly.

The team reviewed the licensee's maintenance practices and procedures, including procedure SO123-XX-1 ISS 2, Revision 0, with members of the operations and maintenance staffs. The prioritization system was appropriate with safety related and PDTS related items receiving the highest priority. The system used a computer tracking system and included preventative as well as corrective maintenance items. Preventative maintenance schedules were driven by due dates. The preventative maintenance program used techniques such as vibration analysis and trending as well as vendor-recommended frequencies to determine the scheduling of the periodic maintenance.

The team noted that there was no significant maintenance backlog and no work items long overdue. The team concluded that the maintenance program was sufficient to assure operability of those systems supporting the safe storage of spent fuel. The team further concluded that Unit 1 was in good material condition due to interdepartmental teamwork.

9 ORGANIZATION

San Onofre Nuclear Generating Station (SONGS) is a three unit site, of which one (Unit 1) had been permanently shut down. Licensee representatives stated that 104 full time equivalent individuals had been budgeted for Unit 1 for 1995. This figure included workers from the following departments: operations, maintenance, emergency preparedness, station technical, chemistry, health physics, security, training, site support, nuclear engineering and construction, nuclear oversight, nuclear regulatory affairs, and nuclear project management. Of this 104 budgeted individuals, 27 were totally dedicated to Unit 1. The other individuals also had responsibilities for the other two units (shared resources).

Because such a large number of individuals were shared resources, the team compared the licensee's actual organization with licensee procedures defining lines of authorities and responsibilities. A review of selected procedures indicated that the licensee had established an organization and had defined responsibilities that were consistent with the PDTSs. Interviews with selected managers indicated that the procedures were being implemented in a manner to ensure the safety of the Unit 1's spent fuel.

The team found that, as required by PDTSs, the Unit 1 superintendent had previously held a Senior Reactor Operator's license for Unit 1 and was a Certified Fuel Handler. Also, the team observed that at least one individual qualified to stand watch in the control room was in the control room area, in accordance with PDTSs.

The Unit 1 superintendent stated that he received an appropriate level of support from the other departments. The team noted that the superintendent was a member of the Onsite Review Committee (OSRC), which should also ensure that Unit 1 would receive the necessary support from other departments, and that he participated in the OSRC meeting during the previous year.

Interviews with licensee representatives indicated that SONGS still maintained much of its Unit 1 experience. Very few workers from the Unit 1 plant were laid off when it was shut down. Licensee personnel stated that, at the time Unit 1 was shut down, SONGS reduced its contract work force and placed its Unit 1 workers into positions which the workers were qualified to fill. Because of the union contract, Unit 1 workers with more seniority were able to be placed in Units 2/3. Also, licensee representatives stated that training was continuing on Unit 1 (for workers that had worked at Unit 1) to ensure a constant source of trained workers. As a result, SONGS would be able to maintain a large pool of Unit 1 expertise on each shift at Units 2 and 3, also.

The team concluded that the licensee's organization and lines of responsibility comnlied with its PDTSs. The organization and staffing were appropriate to Unit 1's shut down and defueled condition.

10 TRAINING PROGRAM

The purpose of this portion of the inspection effort was to determine if the licensee had implemented the training programs described in Section D6.4, "Training," of the PDTS. The scope of this inspection effort included a review of personnel training records, procedures, and NRC Inspection Reports 50-361/94-18 as they pertained to radiation protection, defueled operations, and emergency preparedness. Licensee procedure SO123-XXI-1.11.2, "Health Physics Personnel Training Program Description," Revision 2, was also reviewed. The team reviewed the licensee's compliance with the PDTS Section D6.2, SONGS Unit 1 PDTS Amendment Application No. 210, and procedure SO1-XXI-1.11.24, "Certified Fuel Handler/Shift Supervisor Training Program Description," Revision 3.

The team found that:

- All SONGS personnel associated with Unit 1 including health physics technicians and operations personnel were required to complete and pass computer based general employee requalification training.

- Qualification requirements for SONGS Unit 1 personnel were specified in PDTS Section D6.3, which committed the licensee to assuring that each Unit 1 staff member met the minimum qualification specified in ANSI N18.1-1971, "Selection and Training of Personnel for Power Plant Operation." Qualifications of SONGS radiation protection staff included 15 persons with graduate degrees, 26 with bachelor degrees, and 13 with associate degrees. Additionally, the radiation protection staff included 11 Certified Health Physicist and 30 persons listed by the National Registry of Radiation Protection Technologists (NRRPT).

- Training records of the two health physics technicians and the supervisor who conducted most of the radiation protection activities at Unit 1 during 1994 were thorough and up to date. Some of the training courses taken by the health physics technicians in 1994 included health physics refresher training, NRRPT training, and Health Physics Advanced Practical Factors Training.

- Through records reviews and personnel interviews, the team verified that the objectives of the Certified Fuel Handlers Training Program were met. As of October 3, 1994, the licensee had 18 Certified Fuel Handlers and 31 Non-Certified Fuel Handlers.

- The licensee's training computer data base identified that operations and health physics personnel had successfully completed several emergency preparedness courses and had participated in a Unit 1 emergency response drill in June 1994.

- The team reviewed the licensee's training and retraining program for certified fuel handlers. Classroom topics were appropriate and included: Normal and abnormal operating procedures, Administrative procedures, accident analyses, design and operation of fuel handling equipment, PDTSs, E-Plan, supervisory skills, and applicable industry events and lessons learned. Initial training also included completion of an On-The-Job Training Manual.

- Recertification training for certified fuel handlers included such classroom topics as changes and modifications to plant equipment, industry events and plant operating experience, and selected topics from the initial training course. Recertification training also included completion of on-the-job training. Both programs included periodic evaluations and written examinations.

- The licensee used certified fuel handlers to supervise but not manipulate the handling of SONGS 1 fuel assemblies. The manipulation would be performed by spent fuel bridge crane (SFBC) operators, who undergo a separate training program. This separate training program also included a similar classroom phase followed by on-the-job training. The on-the-job training was progressive and included equipment maintenance and check-out followed by manipulation of simulated fuel assemblies.

The team found the overall program for training certified fuel handlers and SFBC operators to be very thorough, organized, and a programmatic strength. Inspectors concluded that the licensee had implemented the required training programs, and the qualifications of the SONGS Unit 1 staff and support personnel met or exceeded the requirements.

11 RADIOLOGICAL EFFLUENT/ENVIRONMENTAL MONITORING

The team reviewed the licensee's program for identifying occurrences of onsite environmental contamination. Generally it was determined that the Health Physics Division (HP) takes the lead on instances of onsite contamination or release events. If the event has, or has a potential to, release contamination to the environment, HP will request the assistance of the Chemistry Division. The Chemistry Division has responsibility for the monitoring of effluent release pathways to the environment.

The team reviewed the licensee's compliance with PDTS-related changes to the Offsite Dose Calculation Manual (ODCM), radwaste treatment systems, and licensee reviews of uncontrolled or unplanned releases. PDTSs D6.5.2.8 and D6.5.2.9 require that the Station Manager assure the performance of a review by a qualified individual/organization of every uncontrolled or unplanned release of radioactive material to the environs. The PDTS requirements also state that the Station Manager will assure the performance of a review by a qualified individual/organization and may designate the approval of changes to the Process Control Program (PCP), ODCM, and radwaste treatment systems. The PDTSs also require that documentation of uncontrolled or unplanned releases of radioactive material to the environs and changes to the PCP, ODCM, and radwaste treatment systems be provided to the Vice President and Site Manager, Nuclear Generation Site, and the Nuclear Safety Group Supervisor.

For this inspection, changes to the ODCM and the gaseous radwaste treatment system and two uncontrolled or unplanned releases at SONGS-1, that were reported in the 1993 Annual Effluent Release Report, were reviewed for compliance with the requirements of the PDTSs. The team verified that safety reviews or evaluations by qualified individual/organization were performed and that the performance of these reviews were assured by the Station Manager. In addition, the team verified that documentation of the reviews were forwarded to the Vice President/Site Manager and the Nuclear Safety Group Manager.

12. RECORDS IMPORTANT TO DECOMMISSIONING

The licensee's compliance with 10 CFR 50.75(g), and the related draft Regulatory Guide DG-1006, was reviewed for the maintenance of records of past spills, past and on-going leaks, and other such events which might be important for decommissioning.

Two specific instances of onsite contamination were reviewed to determine the response of the licensee to the potential for onsite environmental contamination. These instances were the discovery of a french drain in the bottom of the Unit 1 yard drain sump in 1992, and the Unit 1 spent fuel pool leak of 1986.

The discovery of the french drain by the Operations Division was referred for evaluation to the Chemistry Division. Before sealing the french drain, soil from it was sampled, and an analysis of the potential for movement of radioactive contamination off site was performed. It was determined that most of the contamination would remain on site with some contamination potentially migrating off site. The offsite dose from a potential ingestion pathway was estimated at 0.25 mrem. This response was adequate for the situation.

The 1986 spent fuel pool leak involved spent fuel pool water leaking through the concrete wall of the spent fuel pool, contacting the impermeable membrane surrounding the concrete wall of the spent fuel pool, and pushing up to the surface where seepage was discovered. The only thing separating the leaking spent fuel pool water from the unrestricted area environment (the soil and groundwater contacting the spent fuel pool wall) was the impermeable membrane. However, the licensee had no way to verify the integrity of the membrane and it did not appear that the membrane was sealed around the top of the concrete pad outdoors. Based on information provided by the licensee, the team noted that the licensee had not assessed the potential for contamination of the unrestricted environment from this event. However, licensee representatives stated they would review whether the event would be discussed in its decommissioning plan submittals.

The team found that the Control Document Management Division (CDM) had established a decommissioning file for Unit 1 and had identified it as the

"S/D sub-project directory." HP was directed to provide future Unit 1 records to CDM, and to designate certain past Unit 1 records, already in CDM, as records important to decommissioning. HP provided training to its staff on designating radiation/contamination surveys and waste shipping records as decommissioning records.

HP was also directed to identify and transmit records of historical events back to 1982. However, HP's review of past records so far have only covered approximately the 1990s. Therefore, HP records of the 1986 spent fuel pool leak, while sent to CDM, had not been captured into the Unit 1 decommissioning file. The team reviewed the "S/D sub-project directory" and found that the HP records that had been submitted were in bulk form so records of specific events could not be identified without searching through all the records from HP.

CDM was directed to locate records of historical events (before 1982) for technical review to support site characterization efforts. This had not been accomplished. Since site characterization will be put off until near the end of the SAFSTOR period, this record search had been given a lower priority.

While the Chemistry Division was required to send records of its involvement in spills and other events to CDM, it had not been directed to submit records to the decommissioning file. For example, the records of the evaluation of the yard drain sump french drain were sent to CDM but not specifically designated as records important to decommissioning.

Apparently, the licensee did not recognize that records generated by other divisions besides HP were also important to decommissioning and may be important to the Unit 1 decommissioning file. Time restrictions did not allow the team to review recordkeeping procedures, management requirements, and QA for decommissioning recordkeeping, but this may be done during a future inspection.

In summary, the team found that the licensee program for decommissioning recordkeeping was in its initial stages of implementation. Licensee representatives stated their opinion that decommissioning records were needed only to support site characterization, which was not planned until near the end of the SAFSTOR period. However, NRC may evaluate a summary of past events/spills during the decommissioning plan approval process, to allow for thorough review of the adequacy of planned environmental monitoring of any contaminated onsite areas during the SAFSTOR period and to ensure that the licensee has taken advantage of the institutional knowledge of past events that remains at the plant.

ATTACHMENT

1 PERSONS CONTACTED

1.1 Licensee Personnel

C. Anderson, Emergency Preparedness (EP) Supervisor
B. Ashe-Everest, Nuclear Fuel Services
H. Bentz
D. Breig, Manager, Technical
J. Childers
C. Coker
R. Corbett, Health Physics (HP) Supervisor
R. Giroux, Licensing Engineer
J. Habis, EP Engineer
D. Herbst, Manager, Site Quality Assurance (QA)
J. Joy, Sr. Engineer, Maintenance
M. Knowlton, QA Supervisor
P. Knapp, Manager, HP
R. Kratz, Shift Superintendent
T. Llorens, Licensing
W. Marsh, Manager, Nuclear Regulatory Affairs
S. Medling, Manager, Plant Licensing
J. Moore, Unit 1 Plant Superintendent
P. Penseyres, Engineer
J. Reilly, NEC&FS Manager
J. Rick, HP Engineer
C. Po, Effluent Supervisor
M. Short, Manager, STS
K. Slagle, NOD Manager
D. Spiker, Nuclear Construction Engineer
J. Stauss, Maintenance Superintendent
D. Rosenblum, Vice President, Eng./Tech. Services
R. Waldo, Manager, Operations

1.2 NRC Personnel

S. Bajwa, Section Leader, NRR
L. Carson, Health Physicist, RIV
J. Parrott, Project Manager, NMSS
L. Thonus, Project Manager, NMSS
M. Vasquez, Team Leader, RIV
M. Webb, Project Manager, NRR
S. Weiss, Project Director, NRR

The personnel listed above attended the exit briefing. In addition to the personnel listed above, the inspectors contacted other licensee personnel during the inspection.

2 EXIT INTERVIEW

An exit briefing was conducted on October 6, 1994. During the briefing, the team reviewed the scope and findings of the inspection. The licensee did not identify as proprietary any information provided to, or reviewed by, the team. In response to the team's concerns, licensee representatives stated that it had taken immediate action to modify its procedures to prevent water from contacting the liner until the condition could be evaluated, and to procedurally define the chemical analysis that would be performed on the liquid samples drawn from the leakage detection well. The licensee's Vice President of Engineering and Technical Services agreed to commit to evaluating the potential degradation that could occur to the spent fuel pool liner. The Vice President also committed to providing the NRC Region IV Office with a copy of the results of its evaluation within 90 days of issuance of this inspection report, including a discussion of any procedure changes or other actions it plans to take as a result of its assessment.

In response to a question from the NRC's Senior Resident Inspector, the licensee stated its intent to evaluate the issue on the Unit 2/3 side as well.

March 10, 1995

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D. C. 20555

Subject: NRC Inspection Report 50-206/94-23
San Onofre Nuclear Generating Station Unit 1

The subject report identified an NRC concern regarding the potential for negative long-term metallurgical effects to the Unit 1 spent fuel pool stainless steel liner from contact with poor quality water. During the exit interview conducted by the NRC inspection team, Edison agreed to perform an evaluation for potential degradation that could occur to the spent fuel pool stainless steel liner.

Attached is Edison's evaluation, "SONGS 1 Spent Fuel Pool Liner Plate Evaluation." This report indicates the long-term integrity of the spent fuel pool stainless steel liner was evaluated and concluded to be adequate to provide a barrier that prevents significant leakage from the pool. The current leakage to the leakage detection well is small and the makeup water capacity to the pool is large in comparison. In addition, it was determined that the spent fuel pool environment of low water temperature, low stresses, low chloride concentration, and high water pH, are not conducive to stress corrosion cracking. Edison will continue monitoring the leak detection well, pumping out the well when required, and performing chemical analysis of the contents as stated in the attached evaluation.

If you have any questions regarding this matter, please let me know.

Sincerely,

Walter C. Marsh
Manager of Nuclear Regulatory Affairs

Enclosure
RSG:c:\rich\sfpreprt.ltr

cc: A. B. Beach, Director, Division of Reactor Projects, Region IV
K. E. Perkins, Jr., Director, Walnut Creek Field Office, NRC Region IV
M. K. Webb, NRC Project Manager, San Onofre Unit 1
Louis Carson, Regional Project Inspector, San Onofre Unit 1
S. S. Bajwa, Section Chief, Decommissioning Section

bcc: (See attached sheet)

San Onofre Nuclear Generating Station Unit 1

Spent Fuel Pool Liner Plate Evaluation

March 1, 1995

EXECUTIVE SUMMARY

The long-term integrity of the spent fuel pool stainless steel liner was evaluated and concluded to be adequate to provide a barrier that prevents significant leakage from the pool. Chemical analysis, visual inspection of the dewatered upender area, and metallurgical analysis of the liner plate have resulted in the assessment that the liner is expected to retain pool water sufficiently to maintain the safety of the spent fuel assemblies in the spent fuel pool. Leakage monitoring will continue to be done on a weekly basis, and the spent fuel pool leak detection well will be pumped whenever the water level exceeds Elevation 2.5 feet. Procedural guidance was established to direct the chemical analysis of the leak detection well water subsequent to the NRC special inspection in October 1994. The frequency of performing chemical analysis will be modified when the measured parameters are observed to have constant trends. The waterproof membrane will continue to be evaluated to ascertain if groundwater is seeping into the leak chase system.

INTRODUCTION

The purpose of this report is to provide the results of the evaluation on the long-term integrity of the spent fuel pool liner. The evaluation was initiated at the request of the NRC during their special inspection on October 3-6, 1994 (Reference 1). The NRC requested an evaluation of "... the long-term metallurgical effects to the stainless steel from long-term contact with poor quality water." The evaluation was to include the chemical analyses of water samples from the leak detection well, and the potential for degradation of the stainless steel liner.

The spent fuel pool is located in the Fuel Storage Building and consists of three areas: the spent fuel storage pool, the upender equipment area and the shipping cask pool (see Figure 1). The spent fuel pool is about 66 feet long by 21 feet wide by 40 feet deep and is constructed of reinforced concrete and lined with welded stainless steel. The stainless steel plate is 11 gauge (0.12 inch) below Elevation 4' and 16 gauge (0.06 inch) above Elevation 4'. The stainless steel is ASTM A-240, Type 304. A minimum water level is maintained at Elevation 40'-3".

The liner is attached to the concrete by welding to embedded plates and structural angles. In order to monitor leakage passing through the liner, there is a leak chase system that is connected to a 12" diameter pipe which serves as the leak detection well (see Figure 2). The leak chase system consists of several 1" square channels that connect to a 2" square perimeter channel. These channels direct any water leakage through a pipe into the leak detection well which is located outside the building north wall. The well extends down below the bottom of the pool to collect water leakage from any portion of the pool liner. The well is covered with a plate, in which there is a vent pipe and a closed inspection nozzle. Liner leakage is checked by measuring any water discharged from the vent, or by removing the inspection nozzle cover and measuring the water level in the well (See Figure 4).

The average site groundwater table is at Elevation 5' and has varied from Elevation 2.7' to 5.7'. Also, the groundwater table has been correlated to reach a maximum elevation of 7' during a 23-year period of record (Reference 2). The Fuel Storage Building has a waterproof membrane that was installed between the concrete and the surrounding soil. The waterproof membrane encompasses the basemat and walls up to Elevation 12' (See Figure 3). The waterproof membrane serves the dual purpose of preventing in-leakage of groundwater into the building and its spent fuel pool, and leakage of spent fuel pool water to the groundwater and soil.

EVALUATION

In order to evaluate the long-term integrity of the spent fuel pool stainless steel liner, data was gathered on the chemical content of the leak detection well water, pool water temperature, liner plate stresses, and a visual inspection of the upender area was conducted.

1. WATER LEAKAGE

The current leakage from the spent fuel pool is approximately 2 gal/week. Historical leakage rates are tabulated in Table 1 and are approximate. The leakage paths will follow the gap between the liner plate and concrete, and go to either the 1 inch square or 2 inch square trenches underneath the liner plate. The water is then drained to the leak detection monitoring well (see Figure 2).

Leakage in the pool was observed in 1986 and monitored on a weekly basis. The leakage rate was measured to be about 6 gal/day in September 1986. As pumping of the leak detection well commenced on a weekly interval, the leakage rate was about 10 gal/day and continued this trend through 1988. During the Cycle 10 refueling outage in January 1989, the leakage rate increased to 100 gal/day for a period of about three weeks until the liner in the upender area was repaired with a localized epoxy coating. After the repair, the leakage rate decreased to 3.5 gal/day. In May 1993, the leak detection well was found to be dry which signified that the leakage had stopped.

Possible ground contamination was investigated as a result of the leakage occurrence in 1986. Contamination of the surrounding soil of the Fuel Storage Building was deemed to be a possibility as a result of the overflow of the leak detection well. The Radiological Environmental Monitoring Program which requires sensitive radiological analyses of several environmental media including shoreline sediment, ocean bottom sediment, and ocean water, indicates that radio nuclides are not accumulating in the environment due to SONGS operations. The SONGS 1 Decommissioning Plan, submitted November 3, 1994, indicates the site will be adequately characterized for radiological contamination. This will include the area surrounding the Fuel Storage Building.

The current leakage rate in the pool is well below the makeup capacity of the spent fuel pool cooling water makeup system. The normal makeup supply (non Seismic Category A) is from the primary plant makeup storage tank via the primary plant makeup pump which has a capacity of 100 gpm. The emergency makeup supply (Seismic Category A) is from the auxiliary feedwater tank by gravity flow and has a minimum capacity of 12 gpm in the event of loss of offsite power. The evaporation loss is calculated to be less than 2.3 gpm based on a scenario that the pool is cooled by natural cooling upon the loss of the spent fuel pool cooling system and the maximum pool water temperature reaches 160 degrees F. This loss will decrease to less than 1 gpm after October 1997 due to the decaying spent fuel heat load. As of the date of this report, the pool water will reach a maximum temperature of less than 120 degrees F. Thus, there is ample makeup capacity to mitigate the consequences of water leakage and evaporation from the spent fuel pool and ensure the safety of the spent fuel assemblies.

2. CHEMICAL ANALYSES

The chemical analyses of the leak detection well water and the spent fuel pool water are shown in Table 2. The data indicates that the water in the leak chase system is different from the spent fuel pool water chemistry. There are two possible explanations for the differences. Either the leaking pool water is being contaminated as it travels along the leak chase system or there may be groundwater intrusion. No groundwater samples were taken during this investigation, but the results from a 1986 investigation into the corrosion of the rebar in the intake structure showed that the groundwater had chloride content of less than 300 ppm at the site. Typical salt water contains 19,000 ppm of chlorides.

Groundwater intrusion will continue to be evaluated as a possible source of water in the spent fuel pool leak chase system. The average groundwater table is at Elevation 5' and has been correlated to reach a maximum elevation of 7' during a 23-year period of record (Reference 2). The Fuel Storage Building has a waterproof membrane that was installed between the concrete and the surrounding soil. The waterproof membrane is 40 mils thick and encompasses the basemat and walls up to Elevation 12' (See Figure 3). The waterproof membrane serves the dual purpose of preventing in-leakage of groundwater into the building and leakage of spent fuel pool water to the groundwater and soil.

Records indicate that with spent fuel pool cooling system operating, the pool water temperature has varied from 65 degrees F. to a maximum of 99 degrees F. since February 1986. The pool water temperature over the last two years has averaged about 80 degrees F. The pool water temperature was allowed to reach almost 140 degrees F. during a heat-up test in May 1993 that was conducted to confirm a natural cooling calculation.

3. LINER INSPECTION

To investigate the current condition of the liner, the upender area was drained and visually inspected. Nothing was noted that would be detrimental to the liner's integrity. The long-term metallurgical integrity of the stainless steel liner was evaluated for contact with an uncertain water quality as a result of liner leakage. The leaks that occurred in 1986 through 1989 were all in the form of pin-hole leaks associated with welds that join the liner plates in the upender area of the spent fuel pool. These pin-holes were epoxy repaired and the leaks eventually stopped. The concern for the metallurgical integrity of the liner arises from the potential of borated water interaction with the concrete which allows the release of corrosive ingredients in the concrete (such as chlorides, sulfites, sulfates) that may corrode the seam welds and ultimately cause stress corrosion cracking.

The objective of this evaluation is to verify the presence or absence of any cracking in the welds or the heat affected zone at the most susceptible locations in the pool. The upender area has in the past been the primary source of leakage and the cause can be attributed to the cycles of stress changes due to the filling and draining as well as other refueling activities. Thus the visual inspection concentrated on the drained upender area. A video camera was utilized to scan the two lower horizontal seam welds and the vertical seams of the upender area walls. The videos were studied and the horizontal welds were determined to warrant visual inspection with magnifying glasses. Optical photographs were taken that are representative of the welds' current condition. The chemical analyses of the water from the leak detection well were reviewed for correlation with corrosion potential and stress corrosion cracking of the stainless steel liner.

The visual inspection of the lower horizontal and vertical welds in the upender area did not reveal any cracking. The previous leak repairs were intact and in good condition with no signs of degradation (See photographs 1 to 4). Weld defects were few and consisted of excessive weld build-up, mismatch and weld repairs. The weld repairs were most likely done during the initial construction of the liner since the search of pool history did not reflect any weld repairs. Despite the presence of the small number of localized weld defects, no corrosion or cracking was detected on the visible side of the liner.

The effects of borated water and boric acid on concrete are negligible as stated in ACI 515.1R-79 (Reference 3). Accumulation of pool water behind the liner and in contact with concrete will not degrade the concrete. However, it may produce minimal corrosion of any exposed rebars (approximately 0.002 inch per year according to EPRI Report NP2520-7). The presence of any localized weld defects may create locations susceptible to pitting corrosion and may produce localized pinhole leaks as previously experienced in the upender area.

The current leak rate (December 1994) is approximately 2 gallons per week. Since the leak rate did not change when the upender pool was dewatered, the current leak is outside the upender area and produced by a small pin-hole leak (estimated hole diameter is less than .0001 inch).

Stress corrosion cracking of Type 304 stainless steel is a function of the applied stress, and the environment (such as the concentration of chlorides, sulfates, pH and temperature). At temperatures of 260-300 degrees C. with chloride concentrations greater than 70 ppm, stresses equal to or greater than yield stress (welding residual stress), and low pH values, stainless steel is susceptible to stress corrosion cracking (Reference 5). However, at low temperatures (room temperature) and high pH values (greater than 6), the susceptibility to stress corrosion cracking is quite different and Type 304 stainless steel is practically immune to stress corrosion cracking (References 6 and 8). The effect of sulfates on Type 304 stainless steel is also known to be negligible even at high temperatures (boiling temperatures of 10% sodium bisulfates) because sulfates are oxidizing salts that do not affect austenitic stainless steels (Reference 7). The average pH of the leak detection well water is 9.

Results of the inspection revealed the following conditions. The visual examination did not reveal any cracking, even after being exposed to chloride contaminated borated water. All leaks were most likely associated with localized pitted weld defects. Literature review has revealed negligible degradation of the concrete if exposed to borated waters. Also the current leak detection well chemistry of high pH values, low temperature, low chloride and sulfate concentrations does not cause stress corrosion cracking in austenitic Type 304 stainless steel even when stresses are as high as the yield stress. This is supported by the fact that no cracks were observed in the liner seam welds and adjacent areas during the recently conducted visual inspection. Therefore, no stress corrosion cracking is anticipated in the pool liner.

4. PROCEDURAL CHANGES

Since the stainless steel liner will not be adversely affected by the water that is collected in the leak chase system, the operating procedure will be revised to require pumping of the spent fuel pool leak detection well when the water level exceeds Elevation 2.5 feet. Elevation 2.5 feet will provide a 9.5 feet margin to the top of the waterproof membrane and thus prevent leakage into the surrounding soil. Maintaining the water level below Elevation 2.5 feet will also prevent both a positive hydrostatic head above the minimum groundwater table recorded of Elevation 2.7 feet and water seepage to the soil if the waterproof membrane were to leak. Procedural guidance was established to direct the chemical analysis of the leak detection well water subsequent to the NRC special inspection in October 1994. Chemical analysis will initially be performed whenever water is pumped out. If the measured parameters are observed to exhibit a constant trend, the frequency of doing chemical analyses will be reduced. The following parameters will be measured: pH, activity, tritium, boron, chlorides, fluorides, and sulfates. Since chlorides are the primary concern for corrosion of the stainless steel liner, an acceptance level dependent on pH will be noted. These steps will be in addition to continuing the water level check in the wells on a weekly interval.

5. UNITS 2 & 3

The possibility of groundwater intrusion into the Units 2 and 3 spent fuel pool is not credible because the bottom of the basemat is at Elevation 10'-6". The spent fuel pool floor liner is at Elevation 17'-6". This height is above the average groundwater table of Elevation 5 feet. There has been no observed leakage from the spent fuel pools of Units 2 and 3.

Control of liquid leakage from the spent fuel pool is maintained by a system of leak chases which are placed behind the spent fuel pool liner plates. The leak chases are connected to drain lines that terminate in the leak detection sump. Observance of leakage from a drain line will allow identification of the general location of the leak. The bottom of the leak detection sump is at Elevation 13'-6" and the top of the sump is at Elevation 17'-6". Therefore, the open sump would have to overflow in order for water leakage to come in contact with the bottom of the pool liner.

6. CONCLUSIONS

The long-term integrity of the stainless steel liner has been examined and found to be acceptable for continuing to safely store the spent fuel assemblies of SONGS 1. Although there is leakage occurring, the leakage rate is very small and there is a large safety margin of makeup water capacity to refill the pool. The spent fuel pool and leak chase system environments consist of low stresses and low temperature in the liner, and low chlorides and high pH in the water. These conditions are not conducive to stress corrosion cracking. Leakage monitoring will continue to be done on a weekly basis, and the spent fuel pool leak detection well will be pumped whenever the water level exceeds Elevation +2.5 feet. Procedural guidance has been established to direct the chemical analysis of the leak detection well water. The frequency of performing chemical analysis will be modified when the measured parameters are observed to have constant trends. The waterproof membrane will continue to be evaluated to ascertain if groundwater is seeping into the leak chase system.

REFERENCES

1. NRC Inspection Report 50-206/94-23, dated December 12, 1994.

2. SONGS 1 Updated Final Safety Analysis Report, Appendix 2.4A.

3. American Concrete Institute (ACI) 515.1R-79, "A Guide to the Use of Water Proofing, Dampproofing, Protective and Decorative Barrier Systems for Concrete."

4 Electric Power Research Institute (EPRI) Report NP2520-7.

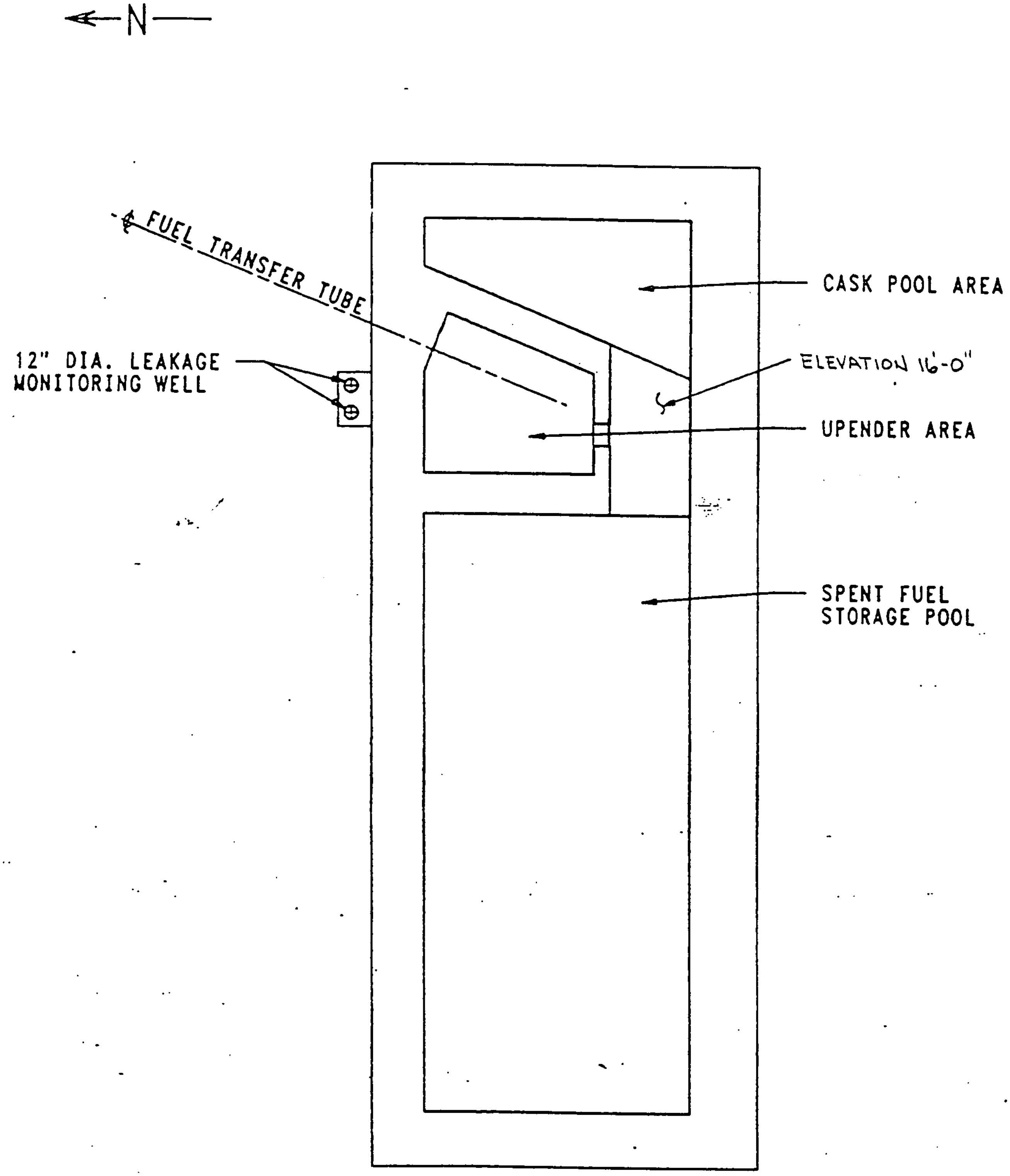
5. Atlas of Stress Corrosion and Corrosion Fatigue Curves, Page 174.

6. Atlas of Stress Corrosion and Corrosion Fatigue Curves, Page 175.

7. H. E. Uhlig, "Corrosion Handbook," 24th printing; Pages 150-155.

8. Journal of Science and Engineering, "Corrosion", "Effect of pH and Chloride Contents on Stress Corrosion Cracking of Austenitic Stainless Steels at Room Temperatures", by H. K. Juang and C, Altstettler; Vol. 46, No. 11, Page 881.

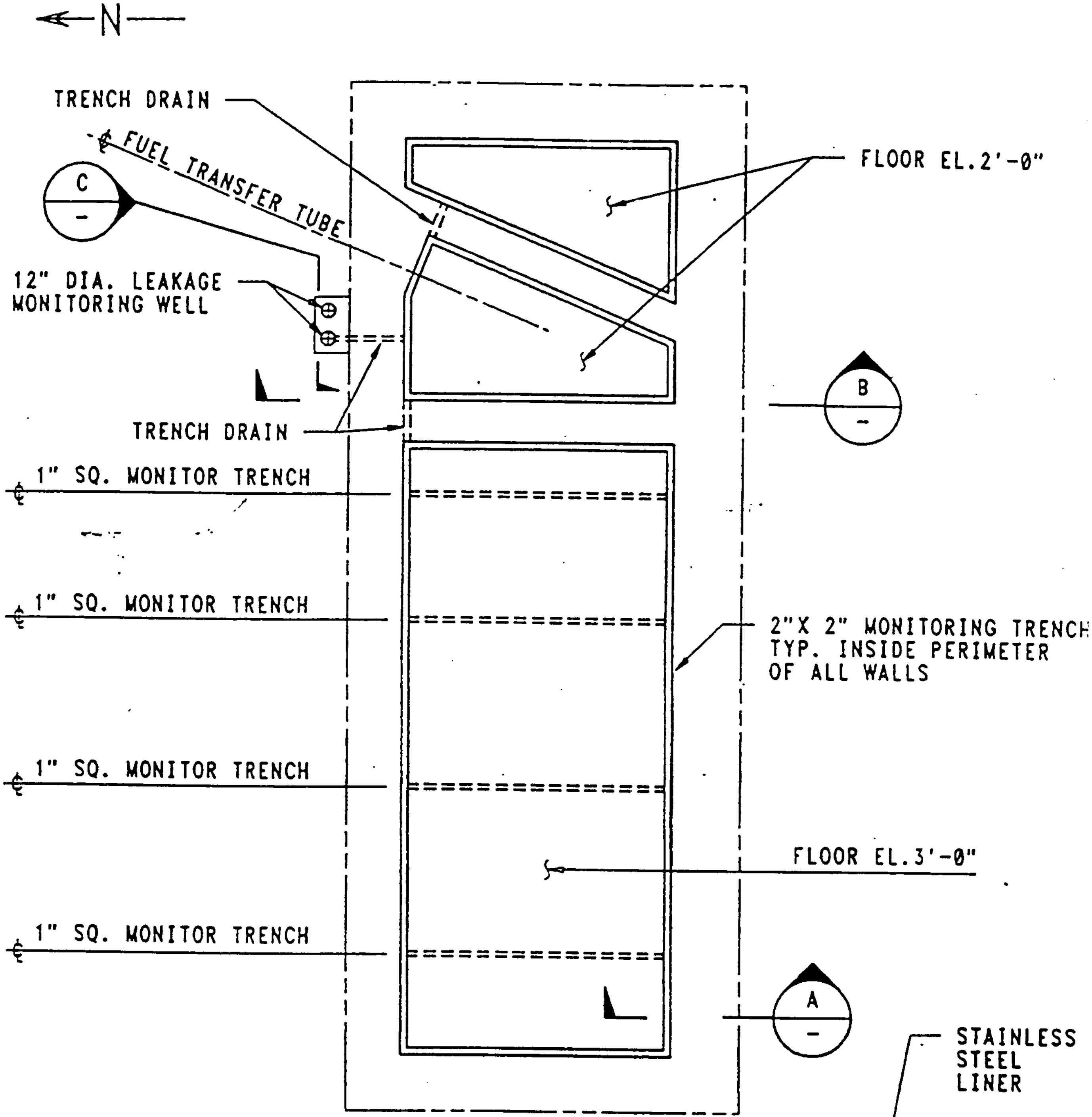
9. Failure Analysis Report #95-003, "Spent Fuel Pool Liner Corrosion Analysis, Unit 1," M. S. Mostafa, dated February 2, 1995.



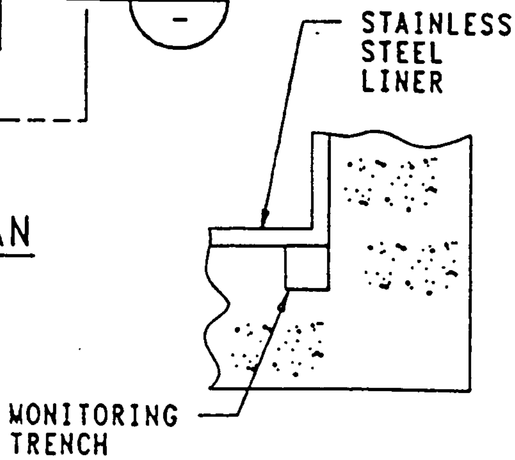
FUEL STORAGE BUILDING
SPENT FUEL POOL PLAN

EL.42'-0"

FIGURE 1

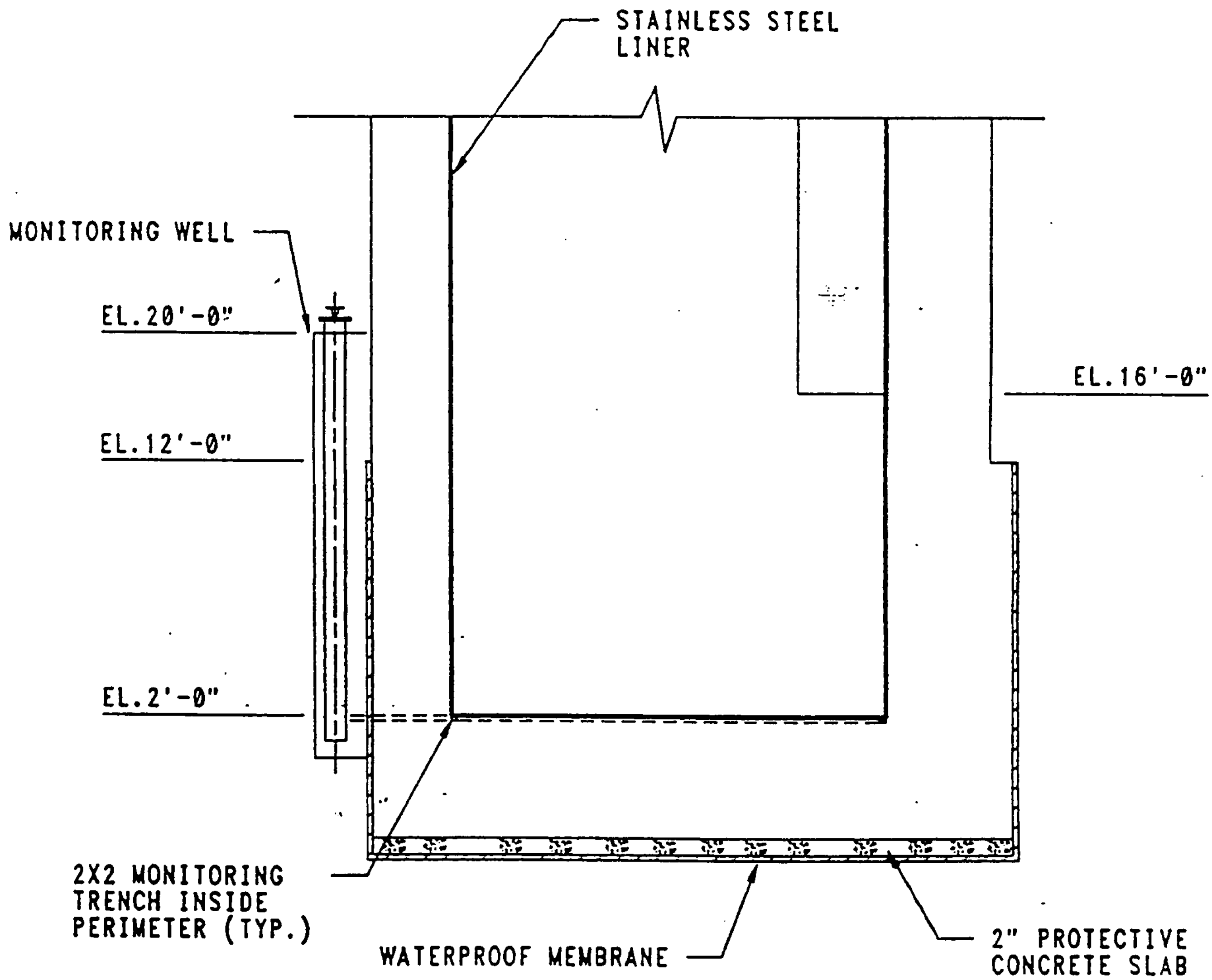


FUEL STORAGE BUILDING
SPENT FUEL POOL LINER PLAN
EL. 3'-0"



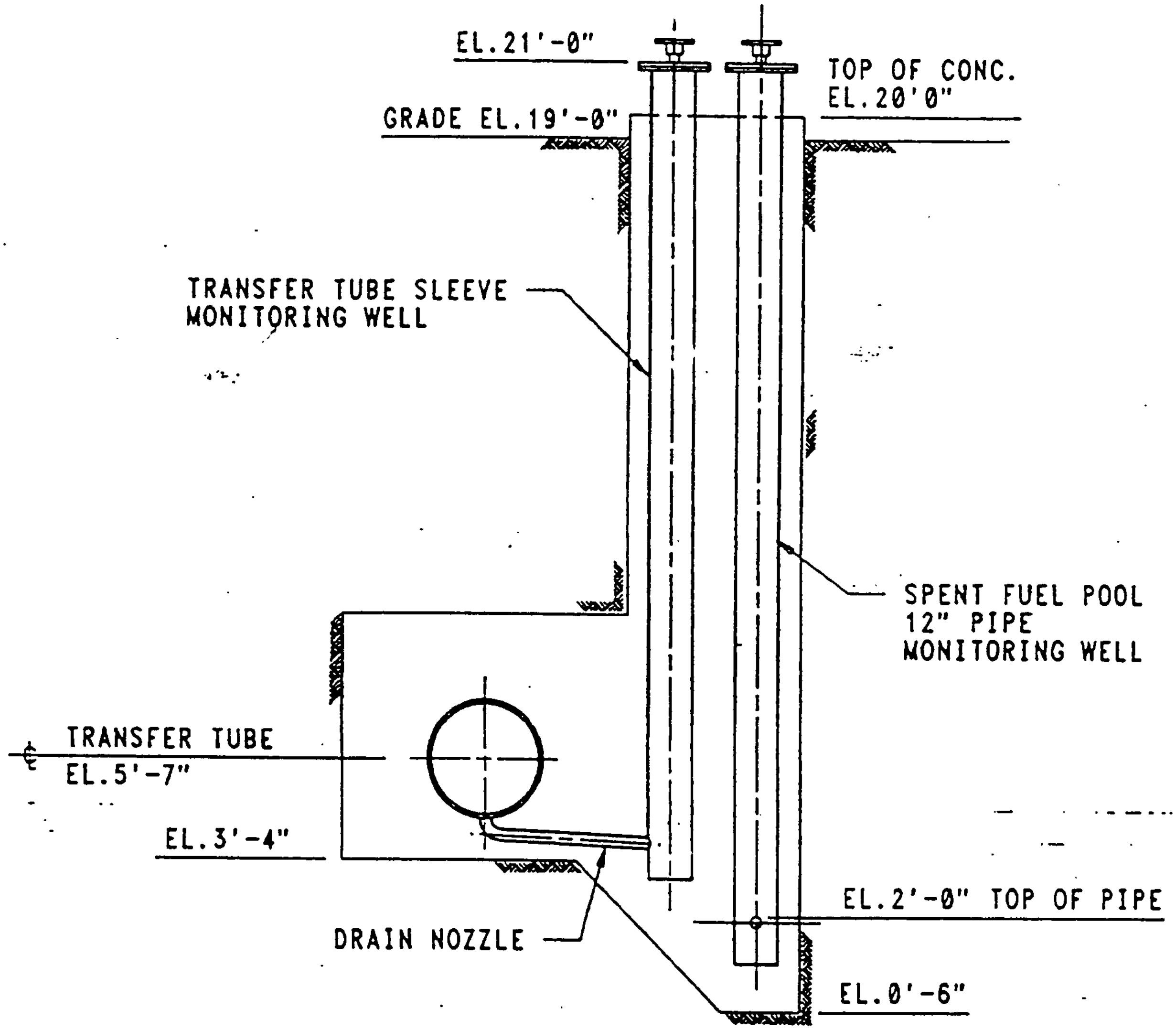
MONITORING
TRENCH SECTION A

FIGURE 2



FUEL STORAGE BUILDING SECTION B/—

FIGURE 3



MONITORING WELL SECTION C

FIGURE 4

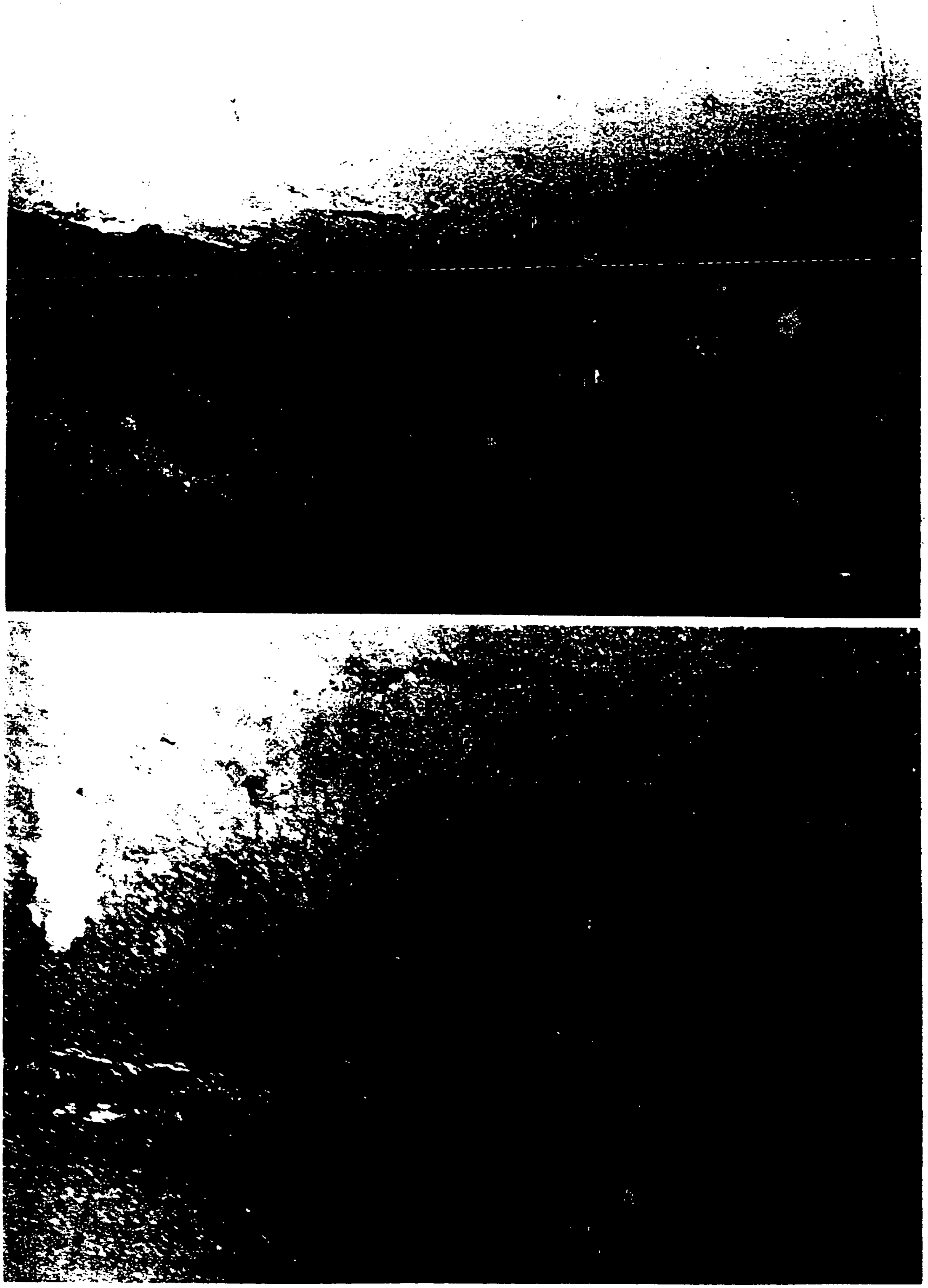


Photo 1: Appearance of an epoxy repaired spot on west wall, showing intact conditon, and absence of cracking in the weld.

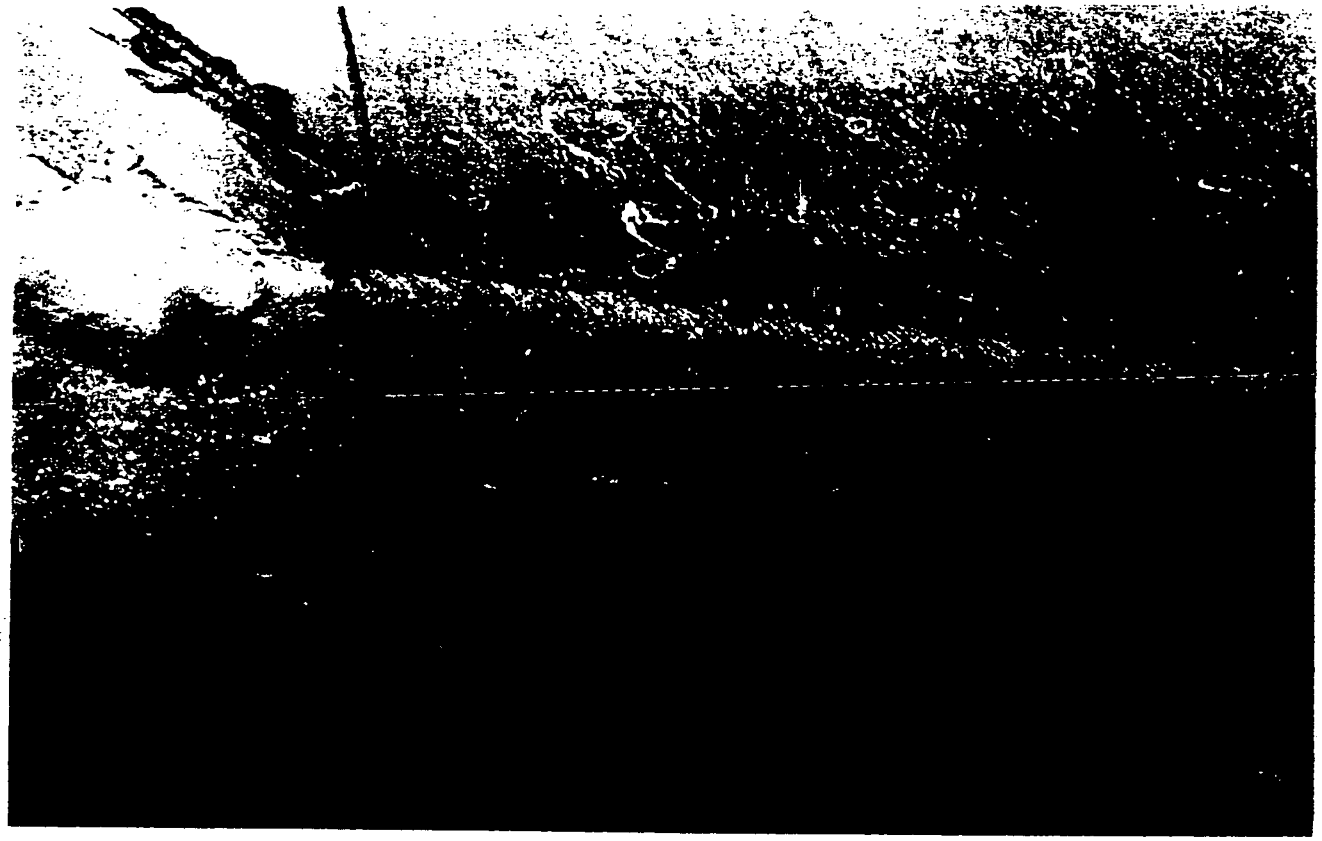


Photo 2: Appearance of weld in the vicinity of an epoxy repaired spot showing absence of cracking.

Photo 3: Appearance of weld, east wall showing absence of cracking and pitting.

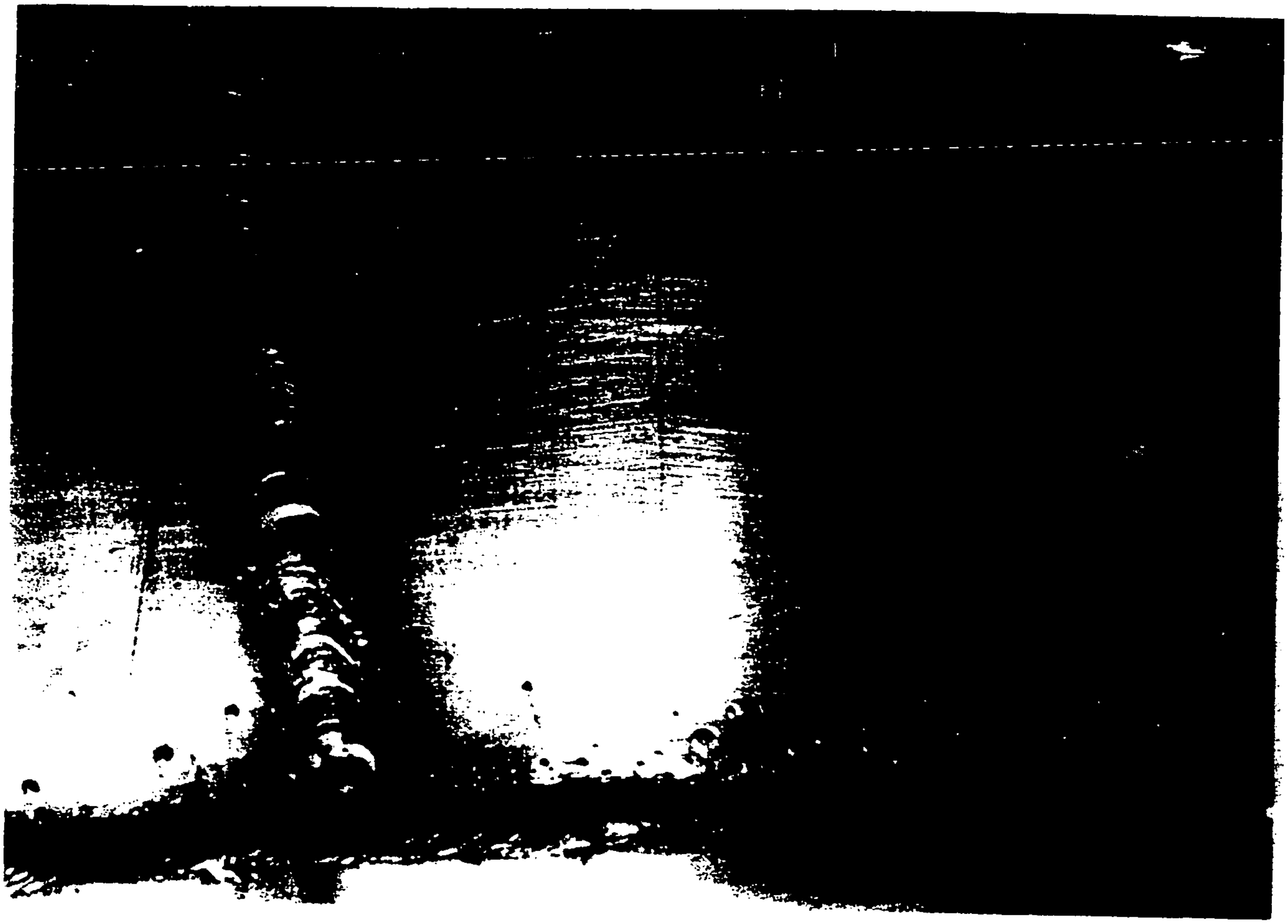


Photo 4: Appearance of vertical/horizontal weld joint illustrating absence of cracking (east wall).

TABLE 1

SPENT FUEL POOL LEAKAGE RATE

DATE	LEAKAGE (gal/week)	DATE	LEAKAGE (gal/week)
09/08/86	42	01/01/94	3
12/05/88	70	01/08/94	4
01/17/89	717	01/15/94	4
02/06/89	25	01/22/94	4
11/07/89	25	01/29/94	1
05/03/93	0	02/05/94	1
05/15/93	5	02/12/94	2
06/15/93	5	02/19/94	2
06/19/93	5	02/26/94	2
06/26/93	5	03/05/94	1
07/03/93	5	03/12/94	2
07/10/93	5	03/19/94	2
07/17/93	1	03/26/94	1
07/24/93	1	04/02/94	1
07/31/93	1	04/09/94	1
08/07/93	1	04/16/94	1
08/14/93	1	04/23/94	2
08/21/93	1	04/30/94	2
08/28/93	1	05/07/94	1
09/04/93	1	05/14/94	1
09/11/93	1	05/21/94	1
09/18/93	2	05/28/94	2
09/25/93	2	06/04/94	1
10/03/93	1	06/11/94	2
10/10/93	1	10/18/94	2
10/17/93	1	10/25/94	1
10/24/93	1	11/01/94	3
10/31/93	1	11/08/94	2
11/06/93	1	11/15/94	2
11/13/93	1	11/22/94	2
11/20/93	2	11/29/94	2
11/27/93	2	12/06/94	2
12/04/93	2	12/14/94	2
12/11/93	2	12/19/94	2
12/18/93	2	12/27/94	2
12/25/93	3	01/03/95	2
		01/11/95	3
		01/19/95	3
		01/24/95	1
		01/31/95	4
		02/07/95	2
		02/14/95	2

TABLE 2

UNIT 1 LEAK DETECTION WELL SAMPLE ANALYSIS

WEST WELL - SFP LINER

DATE	TIME	pH	COND uS	ACT uCI/ML	TRITIUM uCI/ML	BORON PPM	CHLOR. PPM	FLUOR. PPM	SULFATE PPM	CALCIUM PPM	MAGNESIU PPM	SODIUM PPM	IRON PPM
10/07/94	1500	9.6	5630	1.10E-04	2.60E-02	1320	24 3	0.4	169	32	1		<0.05
10/11/94	1340	9.3	5700	1.06E-04	2.40E-02	1320	29.8	<0.4	162	116	16		0 37
10/18/94	1430	9.4	5650	2.80E-04	2.22E-02	1513	77.4	<0.2	166			1390	2.5
10/25/94	0905	9.4	5200	3.98E-04	2.33E-02	1560	54.1	<0.7	108	212	20		
11/01/94	1400	9.2	4900	1.85E-04	2.32E-02	1480	132	<0.2	130	321	33	1170	3.16
11/08/94	O940	9.1	4670	1.64E-04	2.59E-02	1685	66	<0 2	149	82	10		1.28
11/15/94	0835	9.1	4520	3.95E-04	2.94E-02	805*	44.3	<0.2	126				
11/22/94	0830	9	4270	2.28E-04	3.24E-02	1610	37.2	<0.2	85				
11/29/94	0930	9	4000	1.24E-04	2.82E-02	1860	50.8	<0.2	188	43	47		<0 05
12/06/94	1345	9.1	4000	2.86E-04	2.66E-02	1750	21.7	<0.2	72.4	41	45	1050	
12/14/94	915	8.9	3800	1.43E-04	2.90E-02	1750	15.4	<0.2	62.2				
12/19/94	1100	9.1	4000	1.01E-04	2.76E-02	1560	13	<0.2	64.3	49	5.8		
12/27/94	1030	9.3	3800	8.75E-05	2.50E-02	1180	9.3	<0.2	40.6				
01/03/95	1000	9.2	3750	8.03E-05	2.37E-02	1100	10.1	<0.2	35.7				
01/11/95	1205	9.2	4010	6.72E-05	2.37E-02	1110	9.2	<0.2	38.1				
01/19/95	1330	9.2	3680	1.12E-04	2.18E-02	1140	10 6	0.16	52.2				
01/24/95	1623	9.2	3650	1.04E-04	2.14E-02	1050	7.6	0.1	31.2				
01/31/95	1300	9.1	3510	1.76E-04	2.23E-02	1230	13	0.18	34.2				
02/07/95	920	9.1	3790	9.94E-05	1.99E-02	1310	14.5	0.16	33.8				
02/14/95	1900	9.1	3610	9.98E-05	2.00E-02	1340	13.7	<0.2	42 6				
Average		9.18	4307.00	1.67E-04	2.48E-02	1343	32.70	0.05	90.52	112 0	22.2	1203	1.2

*Judged to be erroneous value

UNIT 1 SPENT FUEL POOL

DATE	TIME	pH	COND uS	ACT uCI/ML	TRITIUM uCI/ML	BORON PPM	CHLOR. PPM	FLUOR. PPM	SULF. PPM	CALC. PPM	MAG. PPM	SODIUM PPM	IRON PPM
11/30/94	110	4.6	8.7	2.59E-03	4.70E-02 (10/94)	2437	0.004	0.0012	0.015				

TYPICAL SEA WATER

DATE	TIME	pH	COND uS	ACT uCI/ML	TRITIUM uCI/ML	BORON PPM	CHLOR. PPM	FLUOR. PPM	SULF. PPM	CALC. PPM	MAG. PPM	SODIUM PPM	IRON PPM
		8-9	73698	<LLD	<LLD	4.6	19000	1.4	2650	400	1272	10561	2-20

SAN CLEMENTE GROUND WATER

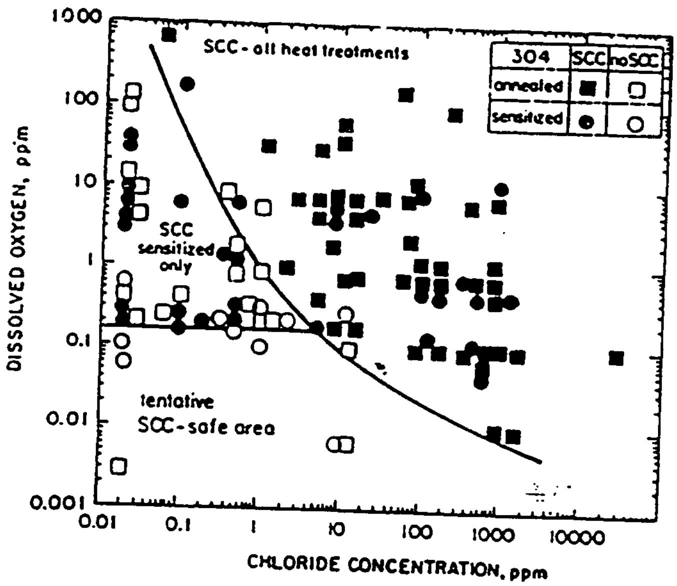
DATE	TIME	pH	COND uS	ACT uCI/ML	TRITIUM uCI/ML	BORON PPM	CHLOR. PPM	FLUOR. PPM	SULF. PPM	CALC. PPM	MAG. PPM	SODIUM PPM	IRON PPM
		7-7.5	830				98.5	0.46	105	55	23	76	0.01

Atlas of Stress-Corrosion and Corrosion Fatigue Curves

Edited by
A.J. McEvily, Jr.

ASM INTERNATIONAL®
Materials Park, Ohio 44073

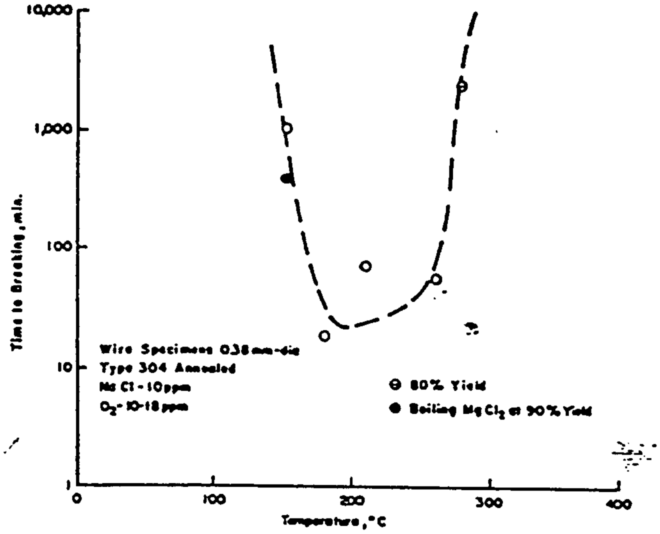
Type 304 Stainless Steel: Effect of Dissolved Oxygen and Chloride on Stress-Corrosion Cracking



Concentration ranges of dissolved oxygen and chloride that may lead to stress-corrosion cracking of type 304 stainless steel in water at 260 to 300 °C. Applied stresses in excess of yield strength and test times in excess of 100 h, or strain rates greater than 10^{-5}/s.

Source: A.J. Sedriks, Corrosion of Stainless Steels, John Wiley & Sons, New York, 1979, p 158.

Type 304 Stainless Steel: Time-to-Breaking at 100% of Yield Stress



Time-to-breaking of first specimen at 100% of yield stress for type 304 stainless steel versus temperature.

Source: J.W. Frey and R.W. Staehle, Effect of Temperature, Stress and Alloy Composition on the Role of Stress Corrosion Cracking in Fe-Ni-Cr Alloys, in High Purity Water Corrosion of Metals, National Association of Corrosion Engineers, Houston, 1968.

THE

CORROSION HANDBOOK

edited by

HERBERT H. UHLIG, PH.D.

PROFESSOR OF METALLURGY IN CHARGE OF THE CORROSION LABORATORY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS

and sponsored by

THE ELECTROCHEMICAL SOCIETY, INC.

NEW YORK, N. Y.

JOHN WILEY & SONS, INC.

NEW YORK · LONDON · SYDNEY

TABLE 2. CORROSION OF 18-8 STEEL (TYPE 304) IN VARIOUS MEDIA

(Air-cooled from 1050° C [1920° F])

Corrosive Medium	Temperature	Duration of Test, hours	Wt. Loss	
			mdd	ipy
20% Nitric acid	Room	1	Nil*	.....
20% Nitric acid	Boiling	18	Nil	.....
3% Nitric acid	Boiling	18	Nil.	.....
1% Nitric acid	Boiling	18	Nil	.....
Nitric acid fumes	110° C (230° F)	13	100	0.018
10% Hydrochloric acid	Room	1	360	0.065
10% Sulfuric acid	Room	1	432	0.079
1% H_2SO_4 + 2% HNO_3	Room	17	Nil	.....
0.25% H_2SO_4 + 0.25% HNO_3	Room	17	Nil	.....
10% Acetic acid, C. P.	Room	3	Nil	.....
10% Acetic acid, C. P.	Boiling	12	Nil	.....
Glacial acetic acid, U. S. P.	Room	276	0.1	0.000
Glacial acetic acid, U. S. P.	Boiling	167	130	0.024
Crude acetic acid	Boiling	166	375.5	0.068
10% Phosphoric acid, C. P.	Boiling	17	Nil	.....
10% Carbolic acid, C. P.	Boiling	16	Nil	.....
10% Chromic acid (tech.)	Boiling	41	204	0.037
Concentrated sulfurous acid	Room	22	Nil	.....
0.5% Lactic acid	Boiling	16	4.1	0.001
1.0% Lactic acid	65° C (150° F)	16	Nil	.....
2.0% Lactic acid	Boiling	16	5.1	0.001
50% Lactic acid	Boiling	16	12,240	2.23
85% Lactic acid	Boiling	16	1,560	0.284
10% Tartaric acid	Boiling	39	Nil	.....
1% Oxalic acid	Boiling	39	177.6	0.032
10% Oxalic acid	Room	17	139.2	0.025
10% Formic acid	Boiling	1	3,240	0.590
10% Formic acid	Room	17	2.4	0.000
10% Malic acid	Room	17	Nil	.....
10% Sodium sulfite	Boiling	16	Nil	.....
10% Sodium bisulfate	Boiling	16	Nil	.....
10% Ammonium sulfate	Boiling	16	Nil	.....
10% Ammonium chloride	Boiling	16	Pitted	.....
Lemon juice	Room	89	Nil	.....
Orange juice	Room	91	Nil	.....
Sweet cider	Room	23	Nil	.....
Canned rhubarb	Boiling	16	Nil	.....
Canned tomatoes	Boiling	16	Nil	.....
10% Sodium hydroxide	Boiling	41	Nil	.....

* "Nil" refers to a weight loss of the specimen not detectable within time of the test.