UNITED STATES
NUCLEAR REGULATORY COMMISSION
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NRC INSPECTION MANUAL

TSIB

TEMPORARY INSTRUCTION 2515/118, REVISION 2

SERVICE WATER SYSTEM OPERATIONAL PERFORMANCE INSPECTION (SWSOPI)

SALP FUNCTIONAL AREA: PLANT OPERATIONS (OPS)

APPLICABILITY: Complete this temporary instruction (TI) at all sites that meet the selection criteria described in section 11.03 of this TI.

2515/118-01 OBJECTIVES

01.01 Assess the licensee's planned or completed actions in response to Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment," July 18, 1989.

01.02 Verify that the service water system (SWS) is capable of fulfilling its thermal and hydraulic performance requirements and is operated consistent with its design bases.

01.03 Assess the SWS operational controls, maintenance, surveillance, and other testing, and personnel training to ensure the SWS is operated and maintained so as to perform its safety-related functions.

2515/118-02 BACKGROUND

A large number of previously identified problems have called into question the ability of SWSs to perform their design function. These problems included: inadequate heat removal capability, biofouling, silting, single failure concerns, erosion, corrosion, insufficient original design margin, lapses in configuration control or improper 10 CFR 50.59 safety evaluations, and inadequate testing. NRC management has concluded that an in-depth examination of SWSs is warranted based upon the deficiencies which have arisen. A more complete history is contained within the SWS task action plan issued on September 11, 1991 from Ashok C. Thadani to the regional Directors of Reactor Safety. (Microfiche No. 71005-117)

2515/118-03 INSPECTION REQUIREMENTS

The inspection will be accomplished by performing a comprehensive review of the SWS components and system performance including design requirements; operating, maintenance, surveillance and other testing practices; maintenance and performance history; and implementation of corrective actions.

03.01 Mechanical Systems Engineering Design Review and Configuration Control

a. Review the design-basis and other design documents such as calculations and analyses for the SWS, and determine the functional requirements for the SWS and each active component during accident or abnormal conditions. This review should include the appropriateness of the design assumptions, boundary conditions, and models. This may include independent calculations by the engineering design inspector(s). During the review the team should determine if (a) the system design is in accordance with the facility's licensing commitments and regulatory requirements, (b) the system will meet the thermal and hydraulic performance requirements, and (c) associated design output documents such as facility drawings and procurement specifications are consistent with the design bases and engineering analyses.

b. Review the SWS configuration drawings for consistency with applicable design documents, NRC requirements, and licensing commitments.

c. Review the SWS operation as compared to the design documents. Advise the other team inspectors of any discrepancies for further review and operations evaluation.

d. Evaluate single active failure vulnerabilities of the system and the resulting impact on interfacing system components such as emergency diesel generators. Evaluate the effect on SWS operability of failures to interfacing systems, such as instrument air. Also examine potential common mode failures from fouling of common intakes or traveling screens.

e. Review the effectiveness of any design features installed to minimize silting and biofouling of the piping and components. Verify if features are provided for the timely detection of flow degradation and if flow balancing has been conducted during various system operating modes. Flow balance verification should be done for worst case combinations of pump operation. Verify that pump runout conditions are not present with minimum number of pumps operating with worst case alignment of non-safety related loads. Evaluate minimum and maximum limits for valve positions and ensure these limits are properly translated into operational controls. Verify that system flow balance data is consistent with key design assumptions, where available, for flow coefficients, rated pressure drops across components and piping, rated heat removal, heat exchanger fouling, and total system flow for operating modes.

f. Check whether design features are provided to mitigate the effects of flooding caused by SWS leaks. Review NUREG 1275, Volume 3, Section 3.3 for information on SWS events involving actual or potential flooding.

g. Review the safety-related portion of the system for seismic qualification and verify that non-safety-related portions can be isolated in accordance with the provisions specified in the system design bases.

h. Review all modification to the SWS and select at least three significant modification packages for a detailed review. This review should include 50.59 evaluations and should ensure that the changes have not compromised the system design bases and have included revised maintenance requirements and procedures, operating procedures, training, and periodic testing as necessary.

i. Evaluate the licensee's assessment to Action IV of GL 89-13. Coordinate with the operations inspector regarding system alignment.

j. Review the licensee's program for monitoring system degradation. Evaluate licensee's performance trending, and adequacy of engineering evaluation and operability determinations.

k. Review the setpoints for alarms and actuations to ensure they are consistent with the design basis and assumptions.

03.02 <u>Operations</u>

a. Perform an in-depth system walkdown. Review the SWS configuration for consistency with design drawings. (Generic Letter 89-13, Action IV)

b. Review the SWS alarm response procedures and operating procedures for normal, abnormal, and emergency system operations to assure the system is operated within the design envelope. This review should be coordinated with the mechanical systems design inspector. Review the implementation of operating and alarm response procedures. Assess adequacy of flow instrumentation relied upon during accident conditions. Review available operating logs to determine adequacy of temperature and flow monitoring. (Generic Letter 89-13, Action V)

c. Review operator training for the SWS, focusing on the technical completeness and accuracy of the training manual and lesson plans. Ensure that the lesson plans reflect the system modifications and that the licensed operators have been trained on these modifications. (Generic Letter 89-13, Action V)

d. Review the proper implementation of procedures for verifying periodic and post-maintenance alignments of valves in the SWS especially those valves that isolate flow to safety-related components. Verify that required accident condition flow is not degraded during normal system operation valve alignments. Review the method used to verify proper SWS throttle valve position. Review control of SWS heat exchanger flow variations due to changing climate (temperature) conditions.

e. Walk through the system operating procedures and the system piping and instrument diagrams with engineering and operations staff, as appropriate. Consider using the plant simulator for this walk through, if available. Verify that the procedures can be performed and that components and equipment are accessible for normal and emergency operation. If any special equipment is required to perform these procedures, determine if the equipment is available and in good working order. Verify that the operators' knowledge of equipment location and operation is adequate. (Generic Letter 89-13, Action V)

f. Interview the operators to determine the adequacy of their technical knowledge of such items as the operation of the system, its role in accident mitigation, technical specification surveillance requirements, and determination of operability. (Generic Letter 89-13, Action V)

g. Review the local operation of equipment. Determine if the indication available to operate the equipment is in accordance with applicable operating procedures and instructions. Verify that the environmental conditions, such as expected room temperature, emergency lighting, and steam, assumed under accident conditions are adequate for remote operation of equipment.

h. Assess operational controls for traveling screens and circulating water pumps to preclude excessive drawdown of the intake bay, with associated loss of SWS pump suction head, as a result of clogging the traveling screens.

03.03 <u>Maintenance</u>

a. Conduct an indepth system walkdown to review the as-configured system for material condition. See Appendix D for suggested examination attributes. (This task may be shared with or performed entirely by the operations inspector). (Generic Letter 89-13, Action IV).

b. If possible, witness maintenance performed on the selected system. Review maintenance package preparation and observe quality control involvement.

c. Review maintenance procedures for technical adequacy. Determine if the procedures are sufficient to perform the maintenance task and provide for identification and evaluation of equipment deficiencies. Compare the procedures to the vendor manuals to identify any vendor recommendations not incorporated into procedures. Verify that important vendor manuals are complete and up to date. (Generic Letter 89-13, Action V).

d. Review the maintenance program for removal and repair of SWS piping and interface system components due to silting, biofouling, corrosion, erosion, and failure of protective coating (Generic Letter 89-13, Action III).

e. Determine if the SWS components are being adequately maintained to ensure their operability under all accident conditions. Review information regarding unavailability due to planned maintenance as an indicator of maintenance adequacy.

f. Review the maintenance history for the selected components of the SWS for the past two operating cycles (minimum of 2 years) or longer if necessary. Look for recurring equipment problems and determine if any trends exist. Evaluate the adequacy of the root cause analysis and corrective actions implemented in response to adverse trends. Review several completed maintenance activities for technical adequacy, performance of appropriate post-maintenance testing and satisfactory demonstration of equipment operability.

g. Conduct detailed interviews with the maintenance personnel to determine their technical knowledge of how components are maintained, such as the setting of limit switches, the alignment of pump couplings, cleaning and replacing filters, and the maintenance of circuit breakers.

h. Determine if maintenance personnel receive adequate training pertaining to the SWS and if the degree of training provided is consistent with the amount of technical detail in the procedures. (Generic Letter 89-13, Action V).

i. Review the periodic inspection program used to detect corrosion, erosion, protective coating failure, silting, and biofouling. (Generic Letter 89-13, Action III).

03.04 Surveillance and Testing

a. Review and evaluate the technical adequacy and accuracy of the technical specification surveillance procedures and inservice test procedures performed in the past two operating cycles (minimum of 2 years) for the SWS. Coordinate the review with the mechanical systems design inspector to ensure design assumptions on system performance are satisfactorily demonstrated by the test methodology.

b. Review the SWS design and licensing basis. Verify that test acceptance criteria are consistent with the design basis to ensure the SWS testing adequately demonstrates that the SWS will operate as designed. Review indicators of SWS system performance (such as overall system unavailability or recurring problems) to identify if any testing inadequacies exist or if testing frequency is appropriate. Determine if surveillance test procedures comprehensively address required SWS responses.

c. Review results from preoperational testing to determine whether the SWS capabilities and limitations were appropriately demonstrated. Determine whether appropriate controls were established to avoid unacceptable system or component operating regimes such as limiting valve travel to avoid pump runout conditions.

d. Evaluate the support systems and plant modifications selected for review by the engineering team to ensure that surveillance and testing has been properly performed.

e. Review the inservice test records for pumps and valves in the SWS, with an emphasis on the technical adequacy of procedures, trending of test results and recurrent failures. Review the IST program for completeness.

f. Review how specific SWS instruments are calibrated and tested, how valve stroke time testing is performed, and how and where temporary test equipment is installed to verify compliance with technical specification operability requirements. Verify the tolerance used for instrument accuracy is acceptable.

g. If possible, witness post-maintenance, surveillance, and inservice tests performed on the SWS.

h. Review procedures for periodic testing of safety-related heat exchanger heat transfer capability and the trending of such results. Inform the mechanical systems inspector of unusual data trends or apparent procedural inadequacies (Generic Letter 89-13, Action II).

i. For the two previous operating cycles (2 years minimum) preceding the inspection, ascertain the system train, pumps, or significant component unavailability during power and shutdown conditions. This review shall be coordinated with the maintenance inspector. Compare the actual unavailability data to that assumed by the Individual Plant Examination (IPE). Assess the degree to which the licensee has input accurate unavailability data into the IPE. Any gross disparities identified with respect to licensee IPE/IPEEE submittals should not be addressed in the inspection report but should be communicated to the Probabilistic Risk Analysis Branch in the Office of Nuclear Regulatory Research.

j. Verify that the installed SWS components are tested to ensure the components will perform in accordance with their design bases. This review should be coordinated with the mechanical design inspector (Generic Letter 89-13, Action IV).

k. Review the implementation of the periodic inspection program to detect flow blockage from biofouling in other systems. This includes the fire protection system that uses the same source of water as the SWS (Generic Letter 89-13, Action I).

l. Review testing on one air-to-water heat exchanger served by the SWS to ensure proper heat transfer. Examine the air side for fouling.

03.05 Quality Assurance and Corrective Actions

a. Review the meeting minutes of the plant onsite safety review committee and the offsite safety review committee for the past six months for items pertaining to the SWS. Inform the operations and design inspectors of any discrepancies and unusual operability determinations.

b. Review the operational history of the SWS, including licensee event reports, nuclear plant reliability data system reports (NPRDS), 10 CFR 50.72 reports, enforcement actions, nonconformance reports, technical specifications operability determinations, maintenance work requests, and adverse test results or recurrent test failures. Emphasize the adequacy of root-cause evaluations.

c. Compare the results of the team's assessment of the areas inspected for the SWS with the results of applicable licensee quality verification activities in the same areas (i.e., operations, maintenance, surveillance and testing, engineering design, and design control). Determine why the licensee's quality verification activities did not uncover significant issues identified by the team.

d. Review the timeliness and technical adequacy of licensee resolution of findings from its self-assessments. Review the open item tracking system items pertaining to the SWS for adequate tracking and closure of identified deficiencies.

e. Evaluate the interface between engineering and technical support (E&TS) and plant operations, regarding corrective actions to resolve operational problems.

2515/118-04 INSPECTION GUIDANCE

General Guidance

Inspection Planning. The team leader should develop an inspection plan that includes, as a minimum, the following:

a. The five recommended actions of Generic Letter 89-13.

b. Assignments for each inspector based on the requirements of Section 3 and the specific components in the inspection sample.

c. Logistics for the inspection such as transportation, hotels, schedules, etc.

System and Component Selection. The team leader, with input from the Senior Resident Inspector, should select a number of specific mechanical components for detailed review. Most of these shall be components of the SWS; the remainder shall be components of the support systems that are necessary for the successful operation of the SWS. The emphasis of the review of support systems should be their interfaces with the SWS. The selected components should include the SWS pumps and several representative heat exchangers.

Inspection Preparation. Since these inspections will require extensive participation by contractor mechanical design engineers, their acquisition by contract and performance will require close coordination with headquarters staff. The Special Inspection Branch (TSIB) of the Division of Technical Support Licensee Performance (DOTS), Office of Nuclear Reactor Regulation (NRR), shall be responsible for monitoring and providing technical oversight for these inspections.

Inspectors should read the inspection requirements, Section 3, in their areas of review to identify the documents and information needed for the inspection. The team leader and inspector(s), as appropriate, should make a pre-inspection visit to the site and engineering offices to assemble applicable procedures, drawings, modification packages, calculations, analyses, documents demonstrating GL 89-13 implementation, and other necessary information concerning the SWS inspection sample. Some of this material can be obtained by letter request.

Team members should review pertinent generic SWS background (see Appendix A) and plant specific information, as well as inspection findings on SWSs at other sites. Inspection plans should be developed for their assigned areas of inspection to examine the areas identified in Section 3. Inspectors should review and be familiar with Generic Service Water System Risk-Based Inspection Guide (NUREG/CR-5865). Licensee response to Appendix A documents should be reviewed with particular attention on Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment."

Conduct of Inspection. After arriving on site, the team should conduct a general SWS walkdown, preferably led by the licensee's system engineer, to become familiar with the SWS hardware, components, and layout. Some suggested walkdown inspection attributes have been included as Appendix D. Completion of this walkdown during the pre-inspection visit discussed above could provide insights for developing inspection plans. The operations and maintenance inspectors shall conduct a more detailed walkdown later in the inspection.

Enforcement guidance is available in Enforcement Guidance Memorandum-Service Water System Policy Guidelines.

Specific Guidance

No specific guidance is provided.

2515/118-05 REPORTING REQUIREMENTS

Inspection findings will be documented in a routine inspection report. There are no special reporting requirements identified for this TI.

2515/118-06 INSPECTION RESOURCES

06.01 Team Composition. Every attempt should be made by the team leader to limit the size of the team to only those personnel essential to perform an effective inspection as determined by the scope of the effort planned for a particular site. Generally, the SWSOPI team should be comprised of the team leader and 4 inspectors. The inspectors should be assigned as follows:

Inspector	Assigned Area
Mechanical design engineer (with SWS design experience)	Engineering design and configuration control
Operations inspector	Operations/Surveillance
Operations engineer	Maintenance, quality assurance and corrective actions
Operations engineer (with expertise in fluid flow in piping systems and associated components such as would be obtained by training in mechanical, nuclear, or chemical engineering as appropriate)	Surveillance and Testing

An additional team member may be appropriate for multi-unit sites where service water systems differ substantially from one another. In addition, consideration can be given to including an electrical engineer on the team. This can be extremely beneficial for plants with complex electrical distribution system supplies to SWS equipment. Attributes such as load sequencing, timing and electrical alignment of power supplies can be examined.

06.02 Inspection Duration. The length of the inspection cycle, including one week of preparation, should be approximately six weeks. The region should notify the licensee of the SWSOPI at least two months before the pre-inspection visit to ensure that the licensee has sufficient time to locate and assemble the design-basis documents. The pre-inspection visit of the team to the site and, if necessary, the corporate offices should take place during the first week of the inspection. If time permits, the team should start the engineering design review and obtain unrestricted plant access during this visit.

06.03 Inspection Schedule. The following schedule is provided to allow the commitment of resources and planning for conducting an SWSOPI.

Week 1	Pre-inspection visit by the team to the site, and if necessary to corporate engineering offices, to collect necessary background information, to present expectations to the licensee concerning the remainder of the inspection, and to get badged.
Week 2	In-office review of material for on-site inspection.
Week 3	The entire team on site for the inspection.
Week 4	In-office review of inspection documentation and internal NRC management briefings on preliminary inspection findings and potential operational issues.

	This off-site period will give the licensee time to review the outstanding concerns and questions identified during the first week of the inspection on site.
Week 5	Final week of inspection during which the entire team is on site and follows up the outstanding concerns and questions from inspections during previous weeks. The pre-exit meeting at which NRC management representatives are present is to be conducted late Thursday afternoon. The exit meeting with the licensee is to be conducted on Friday morning.
Week 6	Inspection report prepared by the team.
Weeks 7-11	Inspection report assembled by the team leader, reviewed, and issued.

2515/118-07 COMPLETION SCHEDULE

Complete these team inspections by July 1, 1997.

2515/118-08 EXPIRATION

This temporary instruction will expire on September 1, 1997.

2515/118-09 CONTACTS

Address any questions regarding this temporary instruction to D. P. Norkin, (301) 415-2954 or S. K. Malur (301) 415-2963. Request contractor support directly to DOTS via memorandum.

The Division of Systems Safety and Analysis/Plant Systems Branch (SPLB) has been assigned lead technical responsibility for SWS problems. J. E. Tatum (301) 415-2805 is the point of contact within SPLB.

Both TSIB and SPLB should receive a copy of all inspection reports generated as a result of this TI. Copies should also be sent to other regional Division of Reactor Safety points of contact.

2515/118-10 STATISTICAL DATA REPORTING

For RITS input, the actual inspection effort should be recorded against 2515/118. At the discretion of the team leader and regional management, credit may be taken for completing other appropriate inspection procedures on the basis of the efforts expended on this TI. See Appendix B.

2515/118-11 ORIGINATING ORGANIZATION

11.01 <u>Organization's Responsibilities</u>. TSIB shall provide support and overall guidance for conducting these inspections.

11.02 Estimated Resources. The actual inspection effort will require about 5 weeks and 5 persons: 1½ weeks (8 staff-weeks) preparing for the inspection onsite and in-office, 2 weeks (10 staff-weeks) conducting the inspection, 1 week (5 staff-weeks) of in-office review, and 1 week (5 staff-weeks) writing the inspection report. An additional week (one staff-week) will be spent on staff briefings, and regional supervisors and managers participating in pre-exit and exit meetings and providing guidance to the team leader. The team leader will require an additional 5 weeks (5 staff-weeks) on a part-time basis to issue the final report.

Preparation effort spent in becoming familiar with the licensee's programs and activities is not considered to be an inspection activity. However, if effort spent in the preparation phase is part of an individuals critical review of the scope and adequacy of the licensee's documents, and the results of that review will be included in the inspection report, then that effort may be considered as direct inspection effort. With the mix of the team and the type of documents expected to be addressed in the preparation phase for this inspection, it is estimated that the division of time between inspection effort and preparation effort will be about one-third inspection and two thirds preparation.

Thus, the total resources required for the activities directly related to the performance of this inspection are approximately 34 staff-weeks per site. For Master Inspection Plan Systems planning purposes, 560 hours of direct inspection hours are to be used for NRC personnel, exclusive of contractor assistance. Normally, only one team member will be a contractor, accounting for five staff weeks per inspection.

11.03 Inspection Implementation Latitude.

Regions will select plants and determine the scope of the inspection on the basis of factors such as SWS operating experience; contribution of SWS to plant risk assessment; licensee programs in response to Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment"; complexity of SWS; and potential for SWS degradation because of design, location, water source, and plant age. For cases where in-depth NRC inspections have recently been performed in the areas addressed by the TI, the inspection scope requirements can be reduced (including team size) up to and including complete waiver for cases where the recent inspection provided the equivalent of a SWSOPI in scope. The term "recent" usually applies to the past two years, but judgement should be applied as to whether it is likely that the "recent" inspection reflects the most current conditions. Reductions or complete waivers require regional division director level approval and concurrence by Director, Program Management, Policy Development and Analysis Staff.

11.04 Program Effectiveness Review. A joint headquarter and region review of results and effectiveness of the inspection activity associated with this TI is planned after a number of these inspections have been conducted. Feedback of regional experience with implementation of the TI and revision of the TI approach will be provided by the joint review. DOTS will coordinate the timing for this review activity with the regional offices.

11.05 Training. No special training requirements have been identified for the performance of this TI.

END

Appendices

A. Background Information
B. Supplemental Inspection Procedures for the SWSOPI
C. Service Water Systems and Key Components
D. SWS Walkdown - Suggested Examination Attributes

APPENDIX A

BACKGROUND INFORMATION

The following NRC documents are directly related to the service water system (SWS). A brief summary of what is desired of, or recommended to, the licensee in each document is provided for your convenience. However, these documents are not legal requirements unless the licensee has committed to the NRC document. If you have any questions or need additional clarification you may wish to review the individual document in detail.

NUREG

1275 Vol. 3 Operating Experience Feedback Report - Service Water System Failures and Degradations

The report makes the following four recommendations:

1. Conduct, on a regular basis, performance testing of all heat exchangers which are cooled by the service water system and perform a safety functional test to verify heat exchanger heat transfer capability.

2. Verify that service water systems are not vulnerable to a single failure of an active component.

3. Inspect, on a regular basis, portions of the piping of the service water system that are prone to corrosion, erosion, or biofouling.

4. Reduce human errors in the operation, repair, and maintenance of the service water system.

2797 Evaluation of Events Involving Service Water Systems in Nuclear Power Plants

3054 Closeout of Bulletin 81-03: Flow Blockage of Cooling Water to Safety System Components by Corbicula (Asiatic clam) and Mytilus (mussel)

4070 Vol. 3 Bivalve Fouling of Nuclear Power Plant Service Water Systems - Factors that may Intensify the Safety Consequences of Biofouling

4070 Vol. 2 Bivalve Fouling of Nuclear Power Plant Service Water Systems - Current Status of Biofouling Surveillance and Control Techniques

4070 Vol. 1 Bivalve Fouling of Nuclear Power Plant Service Water Systems - Correlation of Bivalve Biological Characteristics and Raw-Water System

4233 Distribution of Corbicula Fluminea at Nuclear Facilities

4626 Vol. 1 Improving the Reliability of Open-Cycle Water Systems - An Evaluation of Biofouling Surveillance and Control Techniques for Use at Nuclear Power Plants

5379 Vol. 1 Nuclear Plant Service Water System Aging Degradation Assessment

CR-5865 Generic Service Water System Risk-Based Inspection Guide

GENERIC LETTER

89-13 Service Water System Problems Affecting Safety-Related Equipment

Requests licensees to adopt either the specific recommended surveillance and control procedures delineated in the generic letter or an equally effective alternative course of action for preventing biofouling of their nuclear service water systems. Specifically, the actions required are:

1. Implement and maintain an ongoing program of surveillance and control techniques to significantly reduce the incidence of flow blockage problems as a result of biofouling in open-cycle service water systems;

2. Conduct a test program to verify the heat exchanger capability of all safety-related heat exchangers cooled by service water. The total test program should consist of an initial test program and a periodic retest program. Both the initial test program and the periodic retest program should include heat exchangers connected to or cooled by one or more open-cycle systems;

3. Ensure by establishing a routine inspection and maintenance program for open-cycle service water system piping and components that corrosion, erosion, protective coating failure, silting, and biofouling cannot degrade the performance of the safety-related systems supplied by service water;

4. Confirm that the service water system will perform its intended function in accordance with the licensing basis for the plant; and

5. Confirm that maintenance practices, operating and emergency procedures, and training that involve the service water system are adequate to ensure that safety-related equipment cooled by the service water system will function as intended and that operators of this equipment will perform effectively. This confirmation should include reviews of practices, procedures, and training modules.

*Licensee response to GL 89-13 should be reviewed prior to utilizing the following for assessing licensee compliance.

BULLETINS

80-24 Prevention of Damage Due to Water Leakage Inside Containment

1. Provide a summary description of all open cooling water systems present inside containment. The licensees' description of the cooling water systems must include:

   a. Mode of operation during routine reactor operation and in response to a LOCA;

   b. Source of water and typical chemical content of water;

   c. Materials used in piping and coolers;

d. Experience with system leakage;

e. History and type of repairs to coolers and piping systems;

f. Provisions for isolating portions of the system inside containment in the event of leakage including vulnerability of those isolation provisions to single failure;

g. Provisions for testing isolation valves in accordance with 10 CFR 50 Appendix J;

h. Instrumentation (pressure, dew point, flow, radiation detection, etc.) and procedures in place to detect leakage; and

i. Provisions to detect radioactive contamination in service water discharge from containment.

2. Plants with open cooling water systems inside containment are to take the following actions:

   a. Verify the existence of or provide redundant means of detecting and promptly alerting control room operators of a significant accumulation of water in containment;

   b. Verify the existence of or provide positive means for control room operators to determine flow from containment sump(s) used to collect and remove water from containment;

   c. Verify the existence of or establish at least monthly surveillance procedures, with appropriate operating limitations, to assure plant operators have at least two methods of determining water level in each location where water may accumulate. The surveillance procedures shall assure that at least one method to remove water from each such location is available during power operation. In the event either the detection or removal systems become inoperable, it is recommended that continued power operation be limited to seven days and added surveillance measures be instituted;

   d. Review leakage detection systems and procedures and provide or verify the ability to promptly detect water leakage in containment and to isolate the leaking components or system. Periodic containment entry to inspect for leakage should be considered;

   e. Establish procedures to notify the NRC of any service water system leaks within containment via a special licensee event report (24 hours with written report in 14 days) as a degradation of a containment boundary; and

   f. Until (a) through (d) are implemented, conduct interim surveillance measures.

3. For plants with closed cooling water systems inside containment provide a summary of experiences with cooling water system leakage into containment.

4. Provide a written response. Include the schedule for completing the above items.

81-03 Flow Blockage of Cooling Water to Safety System Components by Corbicula (Asiatic clams) and Mytilus (mussel)

1. Determine whether Corbicula or Mytilus is present in the local environment in either the source or the receiving water body.

2. Determine whether fire protection or safety-related systems that directly circulate water from the station source or receiving water body are fouled by clams or mussels or debris consisting of their shells if either are present in the local environment.

3. Measure the flow rates through individual components in potentially affected systems to confirm adequate flow rate.

4. Describe methods in use or planned (including implementation date) for preventing and detecting future flow blockage or degradation due to clams, mussels, or shell debris. Include the following information in this description:

   a. Applicable portions of the environmental monitoring program including last sample date and results;

   b. Components and systems affected;

   c. Extent of fouling if any existed;

   d. How and when fouling was discovered;

   e. Corrective and preventive actions.

83-03 Check Valve Failures in Raw Water Cooling Systems of Diesel Generators

1. Review the plant pump and valve in-service test (IST) program required by Section XI of the ASME Boiler and Pressure Vessel Code and modify it if necessary to include check valves in the flow path of cooling water for the diesel generators.

2. Examine the IST program for the valves described above and modify it if necessary to include verification procedures that confirm the integrity of the valve internals.

3. Submit a report which lists the valves, describes the valve integrity verification procedure methods, and provides the completion schedule. Include the history of any known previous failures and, for those valves which are found to have undergone either a partial or complete disassembly of valve internals, a description of the failure mode.

CIRCULAR

78-13 Inoperability of Service Water Pumps

Discusses loss of four of six service water pumps at Salem Unit 1 resulting from failed self-cleaning features on the pump's strainers. The failures were attributed to a combination of surface ice, river water level, and high silt levels in the service water bays which caused the pump suction to receive only ice-entrained water.

INFORMATION NOTICES

81-21 Potential Loss of Direct Access to Ultimate Heat Sink

Supplements Bulletin 81-03 by discussing situations which may occur and result in a loss of direct access to the ultimate heat sink. These situations include:

1. Debris from shell fish other than Asiatic clams and mussels that could cause flow blockage problems essentially identical to those described in the bulletin.

2. Flow blockage in heat exchangers that could cause high pressure drops which could in turn deform baffles, allowing bypass flow and reducing the pressure drop to near normal values. Once this occurs, heat exchanger flow blockage may not be detectable by pressure drop measurements.

3. Change in operating conditions characterized by a lengthy outage with no flow through seawater systems. This scenario could permit a buildup of mussels in systems where previous periodic inspections over more than a ten year period showed no appreciable problem.

84-71 Graphitic Corrosion of Cast Iron in Salt Water

Discusses graphitic corrosion of cast iron in salt or brackish water. In this particular situation, the licensee reported that a through-wall corrosion attack had been identified in the salt water side of a component cooling system heat exchanger. The licensee determined that corrosion damage to the salt water heat exchangers was so extensive that the systems could not survive a design-basis seismic event.

85-24 Failures of Protective Coatings in Pipes and Heat Exchangers

Addresses selection and application of protective coatings for safety-related use, especially painting interior surfaces of pipes and tubing. Delamination and peeling of the interior epoxy lining could occur due to inadequate preparation, misapplication, or insufficient curing time.

85-30 Microbiologically Induced Corrosion of Containment Service Water System

Examines significant corrosion pitting due to microbiologically induced corrosion identified on weld joints in stainless steel piping sections of a service water system after an extended plant outage. This event is similar to several incidents reported over the past several years.

86-11 Inadequate Service Water Protection Against Core Melt Frequency

Considers the possible failure to provide sufficient redundancy in the essential service water system. A probabilistic risk assessment identified a circumstance in which loss of essential service water could result in a core melt. See Circular 78-13, "Inoperability of Service Water Pumps" if more information is desired.

86-96 Heat Exchanger Fouling Can Cause Inadequate Operability of Service Water System

Reviews potential fouling in heat exchangers in raw water systems. The result of this fouling (mud, silt buildup, or corrosion) could affect the facility's ability to reject heat to the ultimate heat sink, which could be adverse under accident and post-accident conditions.

87-06 Loss of Suction to Low-Pressure Service Water System Pumps Resulting From Loss of Siphon

Discusses loss of suction to the low-pressure service water system pumps resulting from loss of siphon. Shedding the component cooling water pumps allowed sufficient air in-leakage due to low lake level to cause the high point in the piping to drain and cause a loss of siphon flow.

88-37 Flow Blockage of Cooling Water to Satisfy System Components

Address a generic problem involving flow blockage in safety-related piping interconnections due to biofouling. This condition could occur and remain undetected due to stagnant water in the system's interconnecting piping which is not routinely flushed or flow tested. Highlights the importance of maintaining these lines free of clams, corrosion, and other foreign material.

89-49 Failure to Close Service Water Cross-Connection Isolation Valves

Considers problems that could result from failure to close isolation valves in service water system loop cross-connect piping during certain scenarios, two of which include:

1. Loss of offsite power with a single failure (failure of one of two diesel generators to start) could lead to the loss of the operating diesel generator due to insufficient cooling water flow from the service water system.

2. Inadequate flow of service water to essential loads following a loss of coolant accident given a loss of offsite power and the failure of the number 1 diesel generator to start. The failure of this diesel will prevent the motor operated block valve which isolates non-essential service water loads from automatically closing, causing the service water system to maintain higher than designed loads during accident conditions.

89-76 Biofouling Agent: Zebra mussel

Discusses problems with biofouling of service water and cooling water systems that could result from a recently identified biofouling agent, <u>Dreissena polymorpha</u> (zebra mussel). Similar to previous discussions.

90-26 Inadequate Flow of Essential Service Water to Room Coolers and Heat Exchangers for Engineered Safety-Featured Systems

Alerts licensees to potential problems that could result from using the wrong flow and pressure drop relationship in establishing adequate flow of essential service water to room coolers for engineered safety-feature systems. It also addresses the failure to establish or maintain balanced flows in essential service water systems.

90-39 Recent Problems With Service Water Systems

Reviews problems resulting from the failure of service water systems to provide an adequate and reliable supply of cooling water to safety-related structures, systems, and components.

1. A diesel engine failed to start during the performance of a surveillance test on one of three diesel-driven emergency service water pumps. The licensee found that the root cause was that dampers in the air supplies to all three diesel engines were closed.

2. Emergency service water flows to various components were inadequate for design basis conditions due to accumulations of silt and corrosion products.

3. Continuing service water problems due to microbiologically induced corrosion and acidic attack due to the use of acidic well water when the system was first filled.

4. The uniform buildup of silt and corrosion products in the tubes of the containment air coolers caused unacceptably low air flow. Cleaning of the tubes improved the flow by 50 percent, but during the subsequent refueling outage indications of continued degradation were apparent.

5. A design deficiency concerning the adequate flow of service water to all safety-related loads during certain accident scenarios without operator action was identified.

6. A gasket failed on an emergency service water discharge strainer consequently causing water to spray on several components including a control power transformer and motors. Subsequently the emergency service water pump and the diesel that it cools were declared inoperable.

7. Silt was found in check valves in emergency service water lines to the seal coolers for two pumps in the residual heat removal system, thus bringing the operability of the residual heat removal system into question.

90-73 Corrosion of Valve-to-Torque Tube Keys in Spray Pond Cross-Connect Valves

Examines potential problems related to the corrosion of valve-to-torque tube keys in submerged valve applications. The corrosion in this case resulted from the misapplication of material during the manufacture of manual cross-connect valves for the essential spray pond.

92-49 Recent Loss or Severe Degradation of Service Water Systems

Alerts addressees of recent operating experience problems involving the loss or potential loss of safety-related heat transfer capability in service water systems.

AEOD TECHNICAL REPORTS

AEOD/E416 EROSION IN NUCLEAR POWER PLANTS

Covers a broad overview of erosion events. Identifies water with suspended solids and the use of throttling devices as situations that warrant monitoring to detect degradation.

AEOD/T341 CORROSION OF CARBON STEEL PIPE IN SERVICE WATER HEADERS

Discusses corrosion problems in service water headers at North Anna attributed to Lake Anna water characteristics.

AEOD/T333 DEGRADATION OF SALT WATER COOLING SYSTEM AT SAN ONOFRE 1 - CAUSED BY A LOSS OF INSTRUMENT AIR

Discusses loss redundancy of the salt water cooling system at San Onofre Unit 1 due to a worker inadvertently drilling through an instrument air line. Modifications are being initiated on the system to prevent degradation due to loss of instrument air.

AEOD/E318 BIOFOULING AT SALEM UNITS 1 AND 2

Discusses biofouling at Salem Units 1 and 2 by bivalve mollusks, including the flushing and chlorination procedures being initiated.

AEOD/E311 LOSS OF SALT WATER FLOW TO THE SERVICE WATER HEAT EXCHANGERS FOR 23 MINUTES AT CALVERT CLIFFS UNIT 2

Examines loss of both redundant trains of the service water system at Calvert Cliffs Unit 2 due to a single failed butterfly valve in the common service water heat exchanger discharge header.

AEOD/T305 FLOW BLOCKAGE IN ESSENTIAL RAW COOLING WATER SYSTEM DUE TO ASIATIC CLAM INTRUSION

Discusses biofouling at Sequoyah Unit 1 by asiatic clams, notes ineffective chlorination procedures.

AEOD/E302 POTENTIAL LOSS OF SERVICE WATER FLOW RESULTING FROM A LOSS OF INSTRUMENT AIR

Discusses potential loss of service water unique to Palisades resulting from the scenario of LOCA, LOOP, and DG failure, as fail-open service water flow control valves would cause runout and subsequent possible trip of single running service water pump. The valves were modified to fail at preset throttled condition.

AEOD/E215 SALT SERVICE WATER SYSTEM FLOW BLOCKAGE AT THE PILGRIM NUCLEAR POWER STATION BY BLUE MUSSELS (MYTILUS EDILUS)

Discusses deformed and eroded RBCCW HX baffle plates at Pilgrim caused by an accumulation of blue mussels and a structural design deficiency in the baffle plates. Chlorination and flushing are addressed, as well as possible T/S changes on SWS surveillances.

AEOD/E214 DUANE ARNOLD LOSS OF RIVER WATER SYSTEM LOOP - FEBRUARY 8, 1982

Discusses inoperable river water system loop at Duane Arnold due to a clogged filter.

AEOD/C204 SAN ONOFRE UNIT 1 LOSS OF SALT WATER COOLING EVENT ON MARCH 10, 1980

Examines total loss of the salt water cooling (SWC) system at San Onofre Unit 1 due to multiple equipment failures; 1) shearing of the south SWC pump shaft, 2) failure of the north SWC pump discharge valve to open, and 3) failure of the auxiliary SWC pump air priming system. Discusses necessary improvements in inservice testing program and instrument air system monitoring.

AEOD/C202 SERVICE WATER SYSTEM FLOW BLOCKAGES BY BIVALVE MOLLUSKS AT ANO1 AND BRUNSWICK

Discusses ANO1 plugged containment air coolers by Asiatic clams and Brunswick blocked RHR HX tubes by shells and shell fragments from marine organisms (principally oysters).

AEOD/E111 EVALUATION OF HPSI PUMP OPERABILITY WITHOUT SERVICE WATER

Examines discovery of flow blockage from silt accumulation in the bearing oil and seal water coolers of all three HPSI pumps during the investigation of fouling by Asiatic clams in the ANO2 service water system. States doubts about licensee's submittal regarding cooling water not being necessary for HPSI operation.

AEOD/C105 CALVERT CLIFFS UNIT 1 LOSS OF SERVICE WATER ON MAY 20, 1980

Examines loss of both redundant trains of Calvert Cliffs service water system when the system became air bound as a result of the failure of a non-safety-related instrument air compressor aftercooler. Additional vents will be installed in the service water system.

AEOD/E016 FLOW BLOCKAGE IN ESSENTIAL EQUIPMENT AT ANO CAUSED BY CORBICULA sp. (ASIATIC CLAMS)

Discusses biofouling at ANO by Asiatic clams. Notes chlorination and heat needed to kill clams, and recommends installation of flow instrumentation for each essential component supplied with service water where such does not already exist.

GENERIC ISSUES

51 Implementing the Reliability of Open-Cycle Service Water Systems

This issue was considered resolved by the issuance of Generic Letter 89-13.

130 Essential Service Water System Failures at Multi-Unit Sites

This issue was established to address and resolve concerns related to shared SWSs at multi-unit sites. Draft NUREG/CR-5526, "Analysis of Risk Reduction Measures Applied to Shared ESW Systems at Multi-unit Sites" documents this issue and recommends that affected licensees install independent reactor coolant pump (RCP) seal cooling systems and revise Technical Specification requirements and operating procedures to resolve this issue.

153 Loss of Essential Service Water in LWRs

This issue was established to address and resolve concerns related to significant SWSs contributions to plant risks at other multi-unit and single unit sites not covered by GI-130.

END

APPENDIX B

SUPPLEMENTAL INSPECTION PROCEDURES FOR THE SWSOPI

Manual Chapter	Title
35701	QA Program Annual Review
37700	Design, Design Changes and Modifications
37701	Facility Modifications
37702	Design Changes and Modifications Program
41701	Licensed Operator Training
42700	Plant Procedures
61700	Surveillance Procedures and Records
61725	Surveillance Testing and Calibration Control Program
61726	Monthly Surveillance Observations
62702	Maintenance Program
62703	Monthly Maintenance Observations
62704	Instrumentation Maintenance Observation of Work
62705	Electrical Maintenance Observation of Work
71707	Operational Safety Verification
71710	ESF System Walkdown
72701	Modification Testing
73051	Inservice Inspection - Review of Program
73055	Inservice Inspection - Data Review and Evaluation
73756	Inservice Testing of Pumps and Valves
93801	Safety System Function Inspection (SSFI)

END

APPENDIX C

SERVICE WATER SYSTEMS AND KEY COMPONENTS

PRESSURIZED WATER REACTORS (PWRs)*

The service water system is known by different names at various PWRs. It may be called the essential service water (ESW) system, the emergency equipment cooling water (EECW) system, the essential raw cooling water (ERCW) system, the salt water cooling (SWC) system, or the nuclear service water (NSW) system.

Whatever the service water system is called, it should have two seismic flow Category I paths, which supply cooling water (typically) to the following systems and components:

1. component cooling heat exchangers
2. containment spray heat exchangers
3. emergency diesel generator heat exchangers
4. shutdown cooling heat exchangers
5. safety injection pump coolers
6. control room air conditioning systems
7. reactor coolant pump motor coolers
8. control rod drive cooling water heat exchangers
9. backup water supply to auxiliary feed pumps
10. alternate source to fire protection system
11. various air conditioning and ventilation systems
12. station control air compressors
13. containment ventilation system

BOILING WATER REACTORS (BWRs)*

The service water system is known by different names at various BWRs. It may be called the emergency equipment cooling water (EECW) system, the standby service water (SSW) system, the plant service water (PSW) system, or the residual heat removal service water (RHRSW) system.

Whatever the service water system is called, it should have two seismic Category I flow paths, which supply cooling water (typically) to the following systems and components:

1. residual heat removal pump seal coolers
2. core spray pump bearing coolers
3. diesel generator engine coolers
4. residual heat removal room coolers
5. core spray room coolers
6. control room air conditioning
7. control and station service air compressors
8. emergency service water system
9. high pressure coolant injection room coolers
10. reactor core isolation cooling room coolers

*These are only typical listings because the design and operation of the service water systems as well as the systems and components for which cooling is supplied vary significantly among nuclear plants.

END

APPENDIX D

SWS WALKDOWN - SUGGESTED EXAMINATION ATTRIBUTES

The material condition of the Service Water System can be indicative of the degree of importance which the licensee attaches to the system. The following attributes are suggested for observation.

1. Good lubrication practices are evident. Sight glasses full of oil, spherical bearings on snubbers and adjustable rod supports are free to move.

2. Material deficiencies are included in the work control system. Note age of maintenance request tags.

3. Equipment is protected from adverse environmental conditions, e.g., rust, dust, dirt, falling objects, humidity/water leaks.

4. Pump motor filters are clean and unobstructed.

5. Motor operated valve operators have all fasteners installed and tight.

6. Excessive oil leaks, puddles not cleaned up, excessive use absorbent material.

7. Fluid leakage from packing/gaskets.

8. Plant equipment and instruments are properly labeled.

9. Fasteners and supports are properly installed and maintained. For example, snubber pins should have keepers installed and bolts on bolted connections should have full thread engagement.

END