UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064

APR 28 1994

MEMORANDUM FOR: L. J. Callan, Regional Administrator

L. A. Reyes, Acting Associate Director for Projects
Office of Nuclear Reactor Regulation

FROM: A. Bill Beach, Director, Division of Reactor Projects

Elinor G. Adensam, Assistant Director for Region IV
Reactors, Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

SUBJECT: SOUTH TEXAS PROJECT UNIT 2 RESTART ACTION PLAN, REVISION 0

On April 12, 1993, NRC management agreed that NRC Inspection Manual Chapter 0350, "Staff Guidelines for Restart Approval," was applicable for the South Texas Project Electric Generating Station (STP) because of its extended shutdown and indications of serious deficiencies in licensee management effectiveness. The STP Review Panel assumed the role and responsibilities of the STP Restart Panel. The Panel developed a detailed Restart Action Plan for Unit 1. The final revision of the Unit 1 Plan was issued on March 2, 1994, following NRC approval of Unit 1 restart on February 15, 1994.

Most of the items in the Unit 1 Restart Action Plan applied to both units at STP. This Unit 2 Restart Action Plan is intended to include only those remaining items specific to Unit 2 restart which the STP Restart Panel must consider before recommending approval of Unit 2 restart. The STP Restart Panel developed this plan and submits it for your approval. Minor revisions may be made without seeking additional formal approval, but approval will be requested for any significant revisions.

The STP Restart Panel is responsible for the implementation of the approved STP Restart Action Plan.

A. Bill Beach, Director, Division of Reactor Projects

Elinor G. Adensam, Assistant Director for Region IV
Reactors, Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Approved:

L. J. Callan 4/30/94 Date
Regional Administrator
Region IV

L. A. Reyes 4/26/94 Date
Acting Associate Director for Projects
Office of Nuclear Reactor Regulation

Enclosure: South Texas Project Unit 2 Restart Action Plan, Revision 0

cc w/enclosure:

J. Callan, RIV	L. Reyes, NRR	W. Russell, NRR
S. Collins, RIV	A. B. Beach, RIV	E. Adensam, NRR
W. Johnson, RIV	J. Roe, NRR	W. Ang, RIV WCFO
D. Loveless, SRI, RIV	L. Kokajko, NRR	S. Black, NRR
D. Chamberlain, RIV	A. Howell, RIV	J. Montgomery, RIV
A. Thadani, NRR	B. Boger, NRR	C. Rossi, NRR
F. Congel, NRR	J. Wiggins, NRR	C. Hackney, RIV
J. Gilliland, RIV	W. Jones, RIV	T. Westerman, RIV
D. Powers, RIV	J. Pellet, RIV	L. Constable, RIV
I. Barnes, RIV	B. Murray, RIV	

L. J. Callan
L. A. Reyes

APR 28 1994

RIV:C:DRP/A	SRI	NRR:PM	NRR:PD	D:DRSS
WDJohnson;df	DPLoveless	LEKokajko	SCBlack	SJCollins
04/20/94	04/21/94	04/21/94	04/20/94	04/21/94

D:DRP	NRR:AD		
ABBeach	EGAdensam		
04/21/94	04/26/94		

SOUTH TEXAS PROJECT UNIT 2 RESTART ACTION PLAN

PLANT SPECIFIC STARTUP ISSUES

The list of plant specific restart issues was developed from a review of the Diagnostic Evaluation Team Report, the Confirmatory Action Letter and supplements, the licensee's Operational Readiness Plan, routine and special NRC reports, the allegation process, and NRC staff actions assigned by the Executive Director for Operations following the Diagnostic Evaluation. NRC Inspection Report 50-498/499-9331 identified issues which require resolution prior to the restart of either STP unit.

The following table lists the plant-specific restart issues and their current status. This table will be updated periodically to reflect the status of inspection activities at STP.

RESTART ISSUE		RELATED ITEMS	DATE CLOSED UNIT 2	DATE CLOSED UNIT 1
1	Turbine-driven Auxiliary Feedwater Pump Reliability and Testing Methodology	9331-07(9338-O) (9346-O) (9404-O), 08(9338-O) (9344-O) (9345-O) (9353-O) (9404-O), 09(9338-O) (9344-O) (9353-O) (9404-O), 10(9338-O) (9346-O) (9348-C), 43(9338-C), 50(9338-O), 71(9338-C) 9305-04(9338-C), 05(9338-O) (9406-C), 07(9338-C) Unit 1 LER 9307(9338-O) Unit 2 LER 9304(9338-O) (9355-C)	/	02/14/94 9338 9409
2	Station Problem Report Process, Threshold, Licensee's Review of Existing Reports for Issues Affecting Operability and Safe Plant Operation	9331-06(9338-O) (9354-C) 18(9344-O) (9345-O) (9354-O), 23(9354-O) (9348-C) (9355-O), 25(9406-C), 26(9354-O), (9348-C), 27(9354-O) (9348-C), 28(9344-O) (9354-C), 67(9354-C) 9235-02(9354-C) (9404-C), 9224-01(9354-C) (9404-C) 9321-01(9333-C), 9322-02(9333-C) 9308-02(9345-C), 04(9345-C)	/	02/01/94 9354
3	Service Request Backlog, Including Reduction Accomplished During the Current Outages and the Licensee's Review of Outstanding Srs for Issues Affecting Equipment Operability, Safe Plant Operation, and Operator Work-arounds	9331-02(9345-O) (9353-C), 03(9340-O) (9341-C) (9346-O) (9353-C), 07(9338-O) (9346-O) (9404-O), 08(9338-O) (9344-O) (9345-O) (9353-O) (9404-O), 09(9338-O) (9344-O) (9353-O) (9404-O), 29(9353-C), 31(9345-C), 37(9353-O) (9408-C), 38(9353-O), 39(9353-O) (9408-O), 47(9353-O) (9348-O) (9408-O), 49(9345-C) (9353-O) (9408-C), 62(9353-O) (9408-O), 79(9353-O) (9346-O), 80(9353-C)	/	02/01/94 9408

	RESTART ISSUE	RELATED ITEMS	DATE CLOSED UNIT 2	DATE CLOSED UNIT 1
4	The Postmaintenance Test Program, Including Corrective Actions in Response to Violations and Other Process Improvements and the Basis For the Licensee's Confidence That Equipment Removed From Service for Maintenance is Properly Restored to an Operable Status	9331-03(9340-0) (9341-C) (9346-0) (9353-C), 04(9337-0) (9346-0) (9353-0), 07(9338-0) (9346-0) (9404-0), 10(9338-0) (9346-0) (9348-C), 13(9339-0) (9344-0) (9346-0) (9348-C), 14(9339-C), 15(9346-0), 51, 63 (9346-C), 68(9339-C), 79(9353-0) (9346-0), 9226-03(9339-C) (9404-C), 9320-02(9339-C) 9305-01, 05, 07(9344-C) Unit 1 LER 9204(9339-C), 9207(9339-C), 9214(9339-C), 9216(9339-C), 9305(9344-C)		02/01/94 9346 9354
5	The Outstanding Design Modifications, Temporary Modifications, and Other Engineering Backlog Items, Including the Licensee's Review of These For Issues Affecting Equipment Operability, Safe Plant Operation, and Operator Work-arounds	9331-02(9337-0) (9345-0) (9353-C), 04(9337-0) (9346-0), 08(9338-0) (9344-0) (9345-0) (9353-0) (9404-0), 12(9344-0) (9348-C), 16(9355-C), 18(9344-0) (9345-0) (9354-0) (9355-0), 19(9344-0) (9345-C), 20(9404-C), 21(9404-C), 30(9345-0), (9348-C) (9355-C), 31(9345-C), 40(9345-C), 41(9345-0) (9348-C) (9355-C), 42(9345-0) (9348-C) (9355-C), 44(9404-C), 45(9404-C), 48(9345-C), 52(9338-0) (9345-C), 64(9345-C), 65(9340-0) (9341-C), 77(9345-C), 81(9345-C), 9208-01(9406-C) 9306-07(9353-0), 9315-01(9345-C) Unit 1 LER 9220(9345-C) Unit 2 LER 9204(9345-C)		02/01/94 9355

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RESTART ISSUE		RELATED ITEMS	DATE CLOSED UNIT 2	DATE CLOSED UNIT 1
6	Adequacy of Operations Staffing	9331-01(9340-O) (9341-C), 03(9340-O) (9341-C) (9346-O) (9353-C), 24(9340-C), 56(9340-O) (9341-C), 57(9340-O) (9341-O) (9406-C), 59(9340-O) (9341-C), 60(9340-C), 65(9340-O) (9341-C), 66(9340-O) (9341-C), 73(9340-O) (9341-C) 9116-02(9340-O) (9341-O) (9406-C) 9304-03(9340-C), 04(9340-C), 9311-04(9340-C), 9322-01(9340-C) Unit 2 LERs 9305(9340-C), 9312(9340-C)	✓	02/01/94 9341
7	Adequacy of Fire Brigade Leader Training and Qualifications	9331-04(9337-O) (9346-O), 33(9337-C), 75(9337-O) (9345-C)	04/19/94	02/01/94 9337
8	Adequacy of Fire Protection Computers and Software, the Licensee's Success in Reducing the Number of Spurious Fire Protection System Alarms, and Other Fire Protection Hardware Problems	9331-02(9337-O) (9345-O) (9353-C), 04(9337-O) (9346-O), 17(9337-O) (9345-C), 22(9337-O) (9345-C), 58(9337-C), 75(9337-O) (9345-C) 9235-06(9337-O), 9309-01(9337-C)		02/01/94 9345

	RESTART ISSUE	RELATED ITEMS	DATE CLOSED UNIT 2	DATE CLOSED UNIT 1
9	Licensee Management's Effectiveness in Identifying, Pursuing, and Correcting Plant Problems	9331-04(9337-O) (9346-O), 05(9406-C), 06(9338-O) (9354-C), 17(9338-O) (9345-C), 18(9344-O) (9345-O) (9354-O) (9355-O), 22(9337-O) (9345-C), 23(9354-O), (9348-C), 25(9406-C), 32, 34, 35(9338-O) (9345-C), 37(9353-O) (9408-C), 46(9355-C), 54(9406-C), 55(9343-O) (9406-C), 56(9340-O) (9341-C), 61(9406-C), 62(9353-O) (9408-O), 65(9340-O) (9341-C), 67(9354-C), 69, 70(9338-C), 72(9338-C), 73(9340-O) (9341-C), 80(9353-C), 82(9343-C), 9321-01, 9322-02 9224-01(9354-C) (9404-C) 9217-02(9406-C), 04, 9303-01(9406-O) 9308-02(9345-C), 04(9345-C) Unit 1 LER 9204(9339-C)	✓	02/01/94
10	NRC Review of the Effectiveness of the Licensee's SPEAKOUT Program	9331-78(9352-C)	✓	02/01/94 9352
11	Standby Diesel Generator Reliability	9331-08(9338-O) (9344-O) (9345-O) (9353-O) (9404-O), 09(9338-O) (9344-O) (9353-O) (9404-O), 11(9344-C), 12(9344-O) (9348-C), 13(9344-O) (9348-C), 16(9355-C), 19(9344-O) (9345-C), 28(9344-O) (9354-C) 9214-03(9344-C), 9221-03(9344-C) 9305-01(9344-C), 9315-03(9330-C) Unit 1 LER 9305(9344-C)	✓	02/01/94 9344

RESTART ISSUE		RELATED ITEMS	DATE CLOSED UNIT 2	DATE CLOSED UNIT 1
12	Essential Chiller Reliability	9331-10(9338-0) (9346-0) (9348-C), 13(9344-0) (9348-C), 20(9404-C), 21(9404-C), 44(9404-C), 45(9404-C), 74(9404-C), 9224-03(9404-C)	✓	02/01/94 9404
13	Monitoring of the Licensee's System Certification Program	9331-35(9338-0) (9345-C), 53(9345-0)	✓	02/01/94 9345
14	Adequacy of the Licensee's Resolution of the Reliability and Operability of the Feedwater Isolation Bypass Valves	9319-01 through 07(9335-C) 9324-01(9335-0) (9406-C) Unit 1 LER 9317(9335-C) Unit 1 LER 9320(9335-0) (9406-C) 9335-01(9406-C)	✓	02/15/94 9406 9409
15	Tornado Damper Issues	9331-76(9342-C)	✓	02/01/94 9342
16	Emergency Preparedness Accountability Issues	URI 498;499/9325-02(9347-C)	04/19/94	02/01/94 9347

Reference/Information (Unit 1)

1. Resolved with exception of Mode 3 testing in IR 9338. Mode 3 testing completed IR 9409.
2. IR 9354 proposed closing this issue. ORAT found corrective action program to be weak, but improvements were in progress and program was adequate to support restart. Discussed in Panel meeting 02/01/94.
3. Progress noted in IR 9353. Followup in IR 9408. Discussed in Panel meeting 02/01/94.
4. Progress noted in IR 9339. Significant program improvement noted in IR 9346, but implementation weaknesses exist. Correction of weaknesses addressed in IR 5354. Discussed in Panel meeting 02/01/94.
5. Progress noted in IR 9345. Followup conducted in IR 9355. Discussed in Panel meeting 02/01/94.
6. Progress noted in IR 9340. Operator administrative workload reductions noted in IRs 9346 and 9353. Closed in IR 9341 dated 12/16/93. Discussed in Panel meeting 02/01/94.
7. Closed in IR 9337 dated 11/23/93. Discussed in Panel meeting 02/01/94.
8. Addressed in IR 9345. Discussed in Panel meeting 02/01/94.
9. Favorable observations with respect to fire protection issues in IR 9337. Favorable comments with respect to TDAFW issues in IR 9338. Favorable observations with respect to operator staffing issues in IRs 9339 and 9341. Favorable observations with respect to tornado damper issues in IR 9342. Good response to refueling machine problems noted in IR 9335. Good response to SR backlog noted in IR 9353. Favorable overall findings in IR 9343. Favorable findings with respect to PMT noted in IR 9346. Favorable observations with respect to standby diesel generators in IR 9344. Favorable observations in IR 9345. Addressed in IR 9355. Panel discussions on 01/27/94 and 02/01/94.
10. IR 9352 issued 01/21/94. Panel discussion on 02/01/94.
11. Addressed in IR 9344. Followup open items in IR 9355. Discussed in Panel meeting 02/01/94.
12. Addressed in IR 9404. Discussed in Panel meeting 02/01/94.
13. Favorable observations in IR 9336. Addressed in IR 9345. Discussed in Panel meeting 02/01/94.
14. Significant progress noted in IR 9335. Addressed in IR 9406. Mode 3 testing completed IR 9409.
15. Closed in IR 9342 dated 11/19/93. Discussed in Panel meeting 02/01/94.
16. Closed in IR 9347 dated 12/08/93. Discussed in Panel meeting 02/01/94.

Reference/Information (Additional for Unit 2)

1. IR 9311 documented testing of Unit 2 TDAFW pump. Surveillance testing to be performed again in Mode 3 prior to restart.
2. Programmatic revisions reviewed during Unit 1 restart inspections. Need to review licensee's evaluation of existing SPRs for issues affecting operability and safe plant operation.
3. Programmatic revisions reviewed during Unit 1 restart inspections. Need to review current Unit 2 backlog status and the licensee's review for issues affecting equipment operability, safe plant operation, and operator work-arounds.

4. Revised program reviewed during Unit 1 restart inspections. Monitor effectiveness of program on Unit 2.
5. Engineering backlog reductions reviewed during Unit 1 restart inspections. For Unit 2, need to review backlog status and review licensee's evaluation of outstanding items for issues affecting equipment operability, safe plant operation, and operator work-arounds.
6. Covered during Unit 1 restart inspections. For Unit 2, need to review status of operations staffing enhancements and administrative workload reductions, including effectiveness of the operations work control group.
7. Issue resolved during Unit 1 restart inspections. No specific inspection required for Unit 2 prior to restart. Discussed in Panel meeting 04/19/94.
8. For Unit 2, need to verify reduction of service request backlog on fire protection equipment and effectiveness of modifications made to the fire protection computer.
9. For Unit 2, need to verify continued effectiveness in this area.
10. Reviewed during Unit 1 restart inspection. For Unit 2, need to check status of revised program implementation.
11. Reviewed extensively during Unit 1 restart inspections. For Unit 2, monitor resolution of issues involving SDG 22.
12. Design modifications reviewed during Unit 1 restart inspections. For Unit 2, need to verify successful completion of postmodification testing.
13. Reviewed in depth during Unit 1 restart inspections. Smaller scope inspection needed for Unit 2.
14. Design modifications reviewed during Unit 1 restart inspections. For Unit 2, need to verify successful completion of postmodification testing.
15. Reviewed during Unit 1 restart inspections. For Unit 2, need to verify completion of damper testing under revised procedures.
16. Issue resolved during Unit 1 restart inspections. No specific inspection required for Unit 2 prior to restart. Discussed in Panel meeting 04/19/94.

ASSESSMENT OF PHYSICAL READINESS OF THE PLANT:

The physical condition of the plant is of principal importance not only when a shutdown is the result of a physical event or a hardware deficiency but for other reasons as well, especially following prolonged outages.

The causes of significant equipment problems should be identified and appropriate corrective actions taken. Operational testing should verify that each significant equipment problem has been resolved. As appropriate, the complete spectrum of preoperational and startup testing programs may need to be expanded to cover the more complex types of problems or the effects on plants that have been shut down for extended periods.

The licensee must be able to demonstrate that all needed safety equipment is operational before restart. Systems and equipment need to be available and aligned. Surveillance tests should also be up to date. The maintenance backlog should be managed at controllable levels and should be evaluated for impact on safe operation. Maintenance must also be capable of responding to equipment failures during startup and operation and should not be hindered by unresolved chronic problems with equipment readiness. Procedures should be adequate and up to date. The emergency preparedness function both onsite and offsite needs to be capable of protecting public health and safety.

ISSUES	RESP ORG	DATE CLOSED
1. Operability of technical specifications systems	RIV/DRP	✓
2. Operability of required secondary and support systems	RIV/DRP	✓
3. Adequacy of system lineups	RIV/DRP	✓
4. Adequacy of the power ascension testing program	PANEL	✓
5. Adequacy of plant housekeeping and equipment storage	RIV/DRP	✓

Reference/Information

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ASSESSMENT OF COMPLIANCE WITH REGULATORY REQUIREMENTS:

The plant and its prospective operation must not be in conflict with any applicable regulations or requirements of any document authorizing restart (such as license amendments, orders, or a CAL). Restart should not conflict with any ongoing matter such as an Atomic Safety and Licensing Board hearing.

ISSUES	RESP ORG	DATE CLOSED
1. Applicable license amendments have been issued	NRR	✓
2. Confirmatory Action Letter conditions have been satisfied	PANEL	✓
3. Significant enforcement issues have been resolved	PANEL	✓
4. Allegations have been appropriately addressed	PANEL	✓
5. 10 CFR 2.206 Petitions have been appropriately addressed	NRR	07/08/93

Reference/Information

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5. Saporito petition acknowledgement letter of 07/08/93.

COORDINATION WITH INTERESTED AGENCIES/PARTIES:

Coordination with other interested parties and agencies is important to ensure that concerns and requirements of these organizations are factored into the restart authorization.

ORGANIZATION	RESP ORG	DATE CLOSED
1. Federal Emergency Management Agency	RIV/NRR	✓
2. Department of Justice	PANEL	✓
3. Department of Labor	PANEL	✓
4. Appropriate State and Local Officials	RIV	✓
5. Appropriate Public Interest Groups	RIV	✓
6. Local News Media	RIV	

Reference/Information

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CLOSEOUT ACTIONS:

When the actions to resolve the restart issues and significant concerns are substantially complete, closeout actions are needed to verify that planned inspections and verifications are complete. The licensee should certify that corrective actions required prior to restart are complete and that the plant is physically ready for restart. This table provides actions associated with completion of significant NRC reviews and preparations for restart.

TASK	RESP ORG	DATE CLOSED
1. Evaluate licensee's restart readiness self-assessment	PANEL	✓
2. Verify that licensee has incorporated lessons learned from Unit 1 restart process	PANEL	
3. Restart issues closed	PANEL	
4. Issue Augmented Restart Coverage Inspection Plan	RIV/DRP	✓
5. Comments from other parties considered	PANEL	
6. Determine that all conditions of the CAL and its Supplements are satisfied	PANEL	

Reference/Information

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RESTART AUTHORIZATION:

When the restart review process has reached the point that the issues have been identified, corrected, and reviewed, a restart authorization process is begun. At this point the restart panel should confirm that all actions are substantially complete and that the panel has not overlooked any items.

TASK	RESP ORG	DATE CLOSED
1. Prepare restart authorization document and basis for restart	RIV/DRP	✓
2. NRC Restart Panel approves Restart Authorization	PANEL	✓
3. No restart objections from other applicable HQ offices	PANEL	✓
4. No restart objections from applicable Federal agencies	PANEL	✓
5. Regional Administrator concurs in Restart Authorization	RIV	
6. NRR Associate Director and/or NRR Director concurs in Restart Authorization	NRR	
7. EDO concurs in Restart Authorization	RIV	

Reference/Information

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RESTART AUTHORIZATION NOTIFICATION:

Notify the applicable parties of the restart authorization. Communication of planned actions is important at this stage to ensure that NRC intentions are clearly understood.

TASK	RESP ORG	DATE CLOSED
1. Commission	NRR	
2. EDO	RIV/NRR	
3. Congressional Affairs	NRR	
4. ACRS	NRR	
5. Applicable Federal Agencies	RIV/NRR	
6. Public Affairs	RIV	
7. State and Local Officials	RIV	

Reference/Information

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

June 14, 1994

MEMORANDUM FOR: James M. Taylor
Executive Director for Operations

FROM: William T. Russell, Director
Office of Nuclear Reactor Regulation

SUBJECT: NRR STAFF ACTIONS RESULTING FROM THE DIAGNOSTIC EVALUATION AT SOUTH TEXAS PROJECT (WITS-93133)

In a memorandum dated August 3, 1993, you assigned responsibilities for resolution of certain generic and plant-specific actions resulting from the diagnostic evaluation team's (DET's) assessment at the South Texas Project. The staff actions involved various administrative and technical issues that were assigned to NRR, Region IV, AEOD, or some combination thereof. In memoranda dated November 2, 1993, and February 1, 1994, Dr. Thomas E. Murley sent you the status of the items assigned to NRR. Mr. James L. Milhoan sent the Region IV response to you in memoranda dated November 2, 1993, and January 12, 1994, which closed the tasks assigned to Region IV.

The status of the remaining items assigned to NRR is summarized below. Memoranda from the technical branches are enclosed for your use.

Action 1.b: Evaluation of generic implications of assigning multiple conflicting responsibilities

The staff has addressed this South-Texas-specific item by including the DET's observations with the operational data used in an ongoing NRC research project, "Nuclear Power Plant Shift Staffing Levels." The research project will establish a technical basis for minimum shift staffing levels of licensed and nonlicensed personnel at nuclear power plants, confirming the adequacy of the requirements of 10 CFR 50.54(m), or will establish a regulatory basis for modifying these requirements. The project team will analyze the workload and function allocation for licensed and nonlicensed personnel both inside and outside the control room for high-workload transient responses. This research project is being tracked under NRR Human Factors Research User Need No. 6, "Shift Staffing Levels."

On February 3 and 4, and May 12 and 15, 1994, NRR and RES staff held discussions with the Brookhaven National Laboratory project team regarding project status and details of the project plan. In addition to the South Texas DET report, the staff specified that operational data from other off-normal events (e.g., at Quad Cities) where shift crews appear to have been challenged in their ability to mitigate events would be included in the research data. The project team has completed the initial review of this data and has observed an emergency exercise to identify situations in which shift staffing may play a significant role. This information has been used to select scenarios for simulator research and task network modeling to evaluate minimum staffing levels needed to successfully accomplish all necessary safety functions. The staff is currently working on candidate sites to conduct the research. The Office of Nuclear Regulatory Research has scheduled completion of this project for early 1995.

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Action 6: Evaluation of the emergency diesel generator high-pressure fuel injection pump hold-down studs and associated operability analysis

In a memorandum dated June 3, 1994 (Chan to Quay), the staff concluded that the failure of the hollow hold-down studs in the fuel injection pumps (which led to the operability analysis of 18 and 19 cylinder operation) was caused by manufacturing tolerances, inadequate design margins, and deficiencies in installation practices. The new fastener design (solid hold-down studs with Belville washers) is considered adequate. Additionally, the standby diesel generators would be operable with up to two cylinders out of service, provided the standby diesel generators are required to operate at steady-state or decreasing load conditions. This action is considered closed.

Action 7: Evaluation of the applicability of technical specification overtime requirements for plants on 12-hour shifts

The staff concluded in the November 2, 1994, memorandum (Murley to Taylor) that current NRC guidance is applicable to 12-hour shift rotations and additional guidance is not appropriate. This item was closed in that memorandum.

This memorandum completes the reporting requirement for the NRR South Texas Project staff actions as a result of the DET at South Texas Project. Except as noted above, all South Texas Project actions are closed. For those potential generic issues (Action Items 1.b and 4), these items will be tracked and reported through normal generic review methods and reporting requirements by the aforementioned NRR branches.

Frank J. Miraglia for
William T. Russell, Director
Office of Nuclear Reactor Regulation

Enclosures:
1. Memorandum, McCracken to Black, 03/16/94
2. Memorandum, Chan to Quay, 06/03/94

cc w/enclosures:
E. Jordan, AEOD
J. Callan, Region IV
S. Rubin, AEOD

the chillers to perform their safety function under design basis maximum and minimum heat loads, the testing in combination with the engineering analysis did satisfactorily demonstrate that capability. In addition, HL&P provided a letter documenting agreement of the essential chiller vendor with the licensee's evaluation of essential chiller performance. The licensee submitted the post-modification test procedure, the safety evaluation for the bypass modification, and the vendor agreement letter as attachments to a letter dated February 15, 1994.

Action 2(b) requested that the staff assess the need and scope of baseline testing of the CH system that would more closely simulate design basis accident heat load conditions and validate operability. The engineering analysis and the post-modification testing provide assurance of the adequacy of CH system design, consistent with Criterion III, "Design Control," of Appendix B to 10 CFR Part 50. Simulation of design basis conditions for testing is impractical and unnecessary to demonstrate operability under limiting conditions. Therefore, we conclude that the scope of baseline testing performed by the licensee is acceptable.

Action 2(c) requested that the staff assess the need and scope of periodic testing of the CH system to ensure that it can perform its safety function. The licensee had previously developed procedure OPEP07-CH-0001, "Essential Chiller Performance Test," to conduct periodic performance monitoring of the essential chillers and for post-maintenance testing of the essential chillers. The licensee submitted a description of this test in a letter dated February 10, 1994. Periodic verification of CH system valve position to the positions established during flow balancing, and periodic inservice testing of the CH system pumps and valves in accordance with 10 CFR 50.55a provide assurance that acceptable chilled water flow rates are maintained. Based on this periodic monitoring, we conclude that the licensee conducts acceptable periodic testing of the CH system that is consistent with Criterion XI, "Test Control," of Appendix B to 10 CFR Part 50.

The generic adequacy of chilled water system testing has been evaluated in NUREG-1427, "Regulatory Analysis for the Resolution of Generic Issue 143: Availability of Chilled Water System and Room Cooling." The regulatory analysis determined that the evaluated alternatives did not satisfy the Commission's guidance for imposing new requirements and that safety significant deficiencies are likely to be plant specific. Individual licensee quality assurance programs implementing the requirements of Appendix B to 10 CFR Part 50 provide an enforcement mechanism to address testing deficiencies identified at individual facilities through inspection activity. Based on these considerations, we concluded that the appropriate generic correspondence is an Information Notice to inform the industry of actions taken by HL&P to demonstrate the functional capability of the CH system.

11/0 -5219

①Copy to Feda
~~②Copy Encl 2 to Pete~~
③File

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

June 14, 1994

MEMORANDUM FOR: James M. Taylor
Executive Director for Operations

FROM: William T. Russell, Director
Office of Nuclear Reactor Regulation

SUBJECT: NRR STAFF ACTIONS RESULTING FROM THE DIAGNOSTIC EVALUATION AT SOUTH TEXAS PROJECT (WITS-93133)

In a memorandum dated August 3, 1993, you assigned responsibilities for resolution of certain generic and plant-specific actions resulting from the diagnostic evaluation team's (DET's) assessment at the South Texas Project. The staff actions involved various administrative and technical issues that were assigned to NRR, Region IV, AEOD, or some combination thereof. In memoranda dated November 2, 1993, and February 1, 1994, Dr. Thomas E. Murley sent you the status of the items assigned to NRR. Mr. James L. Milhoan sent the Region IV response to you in memoranda dated November 2, 1993, and January 12, 1994, which closed the tasks assigned to Region IV.

The status of the remaining items assigned to NRR is summarized below. Memoranda from the technical branches are enclosed for your use.

Action 1.b: Evaluation of generic implications of assigning multiple conflicting responsibilities

The staff has addressed this South-Texas-specific item by including the DET's observations with the operational data used in an ongoing NRC research project, "Nuclear Power Plant Shift Staffing Levels." The research project will establish a technical basis for minimum shift staffing levels of licensed and nonlicensed personnel at nuclear power plants, confirming the adequacy of the requirements of 10 CFR 50.54(m), or will establish a regulatory basis for modifying these requirements. The project team will analyze the workload and function allocation for licensed and nonlicensed personnel both inside and outside the control room for high-workload transient responses. This research project is being tracked under NRR Human Factors Research User Need No. 6, "Shift Staffing Levels."

On February 3 and 4, and May 12 and 15, 1994, NRR and RES staff held discussions with the Brookhaven National Laboratory project team regarding project status and details of the project plan. In addition to the South Texas DET report, the staff specified that operational data from other off-normal events (e.g., at Quad Cities) where shift crews appear to have been challenged in their ability to mitigate events would be included in the research data. The project team has completed the initial review of this data and has observed an emergency exercise to identify situations in which shift staffing may play a significant role. This information has been used to select scenarios for simulator research and task network modeling to evaluate minimum staffing levels needed to successfully accomplish all necessary safety functions. The staff is currently working on candidate sites to conduct the research. The Office of Nuclear Regulatory Research has scheduled completion of this project for early 1995.

6/17

Since this potentially generic issue is currently under active review, it will be tracked and reported through normal generic review methods and reporting requirements. Accordingly, the Human Factors Branch in NRR, in conjunction with the Office of Nuclear Regulatory Research, will supply the necessary update on this issue.

Action 2: Assessment of essential chilled water (ECW) systems, including chiller units

The staff conducted a review of the ECW system. The staff determined that the licensee has completed an acceptable engineering evaluation demonstrating that the system is capable of performing its safety function under design-basis maximum and minimum heat load conditions. The licensee performed a thorough analysis demonstrating that the ECW system would perform acceptably under minimum loading conditions after the modifications to the service water system piping providing cooling water to the essential chillers were implemented. Data from the licensee's post-modification testing were used to validate the results of the analysis. This is documented in NRC Inspection Report 94-04.

The staff found the licensee's test program (baseline and periodic) for the system to be acceptable. The Plant Systems Branch in NRR will prepare an information notice during calendar year 1994 to notify the industry of the licensee's actions in addressing this issue. For additional information, please refer to Enclosure 1, which includes NRC Inspection Report 94-04. This action is considered closed.

Action 4: Assessment of tornado dampers and their periodic testing

The Mechanical Engineering Branch has been reviewing available information related to damper testing and probabilistic risk assessment. A meeting was held with the Probabilistic Safety Assessment Branch to discuss the action plan for damper testing, and the branch commented on the statement of work for contractor assistance. A contractor is expected to be assigned in the near future. Since this issue covers several topical areas (e.g. fire protection, control room habitability, tornado protection, emergency core cooling system equipment room cooling, and isolation/filtration of radiation release), finding a single experienced contractor may be difficult.

Since this issue may be an emerging generic issue, it will be tracked and reported through normal generic review methods and reporting requirements. Additionally, because of the dampers' effect on system operability, the Plant Systems Branch has taken over the lead for, and will supply the necessary update on, this issue.

Action 5: Assessment of rapid refueling system with rod-lockout condition and analysis of boron dilution event

The staff concluded in the February 1, 1994, memorandum (Murley to Taylor) that the licensee's reevaluation of the boron dilution event under all-rods-out conditions and the related Technical Specifications are acceptable. This item was closed in that memorandum.

Action 6: Evaluation of the emergency diesel generator high-pressure fuel injection pump hold-down studs and associated operability analysis

In a memorandum dated June 3, 1994 (Chan to Quay), the staff concluded that the failure of the hollow hold-down studs in the fuel injection pumps (which led to the operability analysis of 18 and 19 cylinder operation) was caused by manufacturing tolerances, inadequate design margins, and deficiencies in installation practices. The new fastener design (solid hold-down studs with Belville washers) is considered adequate. Additionally, the standby diesel generators would be operable with up to two cylinders out of service, provided the standby diesel generators are required to operate at steady-state or decreasing load conditions. This action is considered closed.

Action 7: Evaluation of the applicability of technical specification overtime requirements for plants on 12-hour shifts

The staff concluded in the November 2, 1994, memorandum (Murley to Taylor) that current NRC guidance is applicable to 12-hour shift rotations and additional guidance is not appropriate. This item was closed in that memorandum.

This memorandum completes the reporting requirement for the NRR South Texas Project staff actions as a result of the DET at South Texas Project. Except as noted above, all South Texas Project actions are closed. For those potential generic issues (Action Items 1.b and 4), these items will be tracked and reported through normal generic review methods and reporting requirements by the aforementioned NRR branches.

Frank J. Miraglia
for William T. Russell, Director
Office of Nuclear Reactor Regulation

Enclosures:
1. Memorandum, McCracken to Black, 03/16/94
2. Memorandum, Chan to Quay, 06/03/94

cc w/enclosures:
E. Jordan, AEOD
J. Callan, Region IV
S. Rubin, AEOD

ENCLOSURE 1

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

MAR . : 1994

MEMORANDUM FOR: Suzanne C. Black, Director
Project Directorate IV-2
Division of Reactor Projects III, IV, V

FROM: Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Safety and Analysis

SUBJECT: SOUTH TEXAS PROJECT DET STAFF ACTIONS
(TAC NOS. M87165 AND M87166)

Plant Systems Branch has completed its review of staff actions resulting from the Diagnostic Evaluation at South Texas Project Electric Generating Station (STP) regarding essential chilled water (CH) system operation. We determined that Houston Lighting and Power Company (HL&P), the licensee for STP, has completed an acceptable engineering evaluation demonstrating that the CH system is capable of performing its safety function under design basis maximum and minimum heat load conditions. We also found HL&P's test program for the CH system to be acceptable. Plant Systems Branch will draft an Information Notice for release in the second quarter of calendar 1994 to notify the industry of HL&P's actions in addressing this issue.

In response to Staff Action 2(a), the staff assessed HL&P's engineering analysis of CH system operation. This assessment is documented in Section 2 of NRC Inspection Report 50-498/94-04; 50-499/94-04 (Enclosure 1), issued February 11, 1994. Steve Jones, a Reactor Systems Engineer in Plant Systems Branch, participated in the inspection and provided the input for that section of the report. In the report, the inspectors concluded that the licensee's analysis had demonstrated that the essential chillers will perform acceptably under minimum loading conditions after full implementation of modifications to the service water piping providing cooling water to the essential chillers. However, the inspectors noted that additional administrative controls were necessary to justify certain assumptions in the analysis. These controls consisted of providing additional procedural guidance to operators to ensure acceptable chiller performance greater than 30 minutes following the accident initiating event when the chillers may be operating at a minimum steady state load and maintaining control room temperature above a minimum temperature when operating with low service water temperatures in order to satisfy assumptions used in computing the minimum chiller loading. Region IV is tracking these needed administrative controls for followup.

The licensee performed post-modification testing to evaluate the ability of the essential chillers to start and operate successfully with the modified service water piping configuration. The licensee evaluated the data collected from these tests to validate the methodology used in the engineering analysis of essential chiller operation. The staff also reviewed the test procedure and the evaluation of results. This review is documented in Section 3 of Enclosure 1. Although the testing alone did not demonstrate the ability of the chillers to perform their safety function under design basis maximum and minimum heat loads, the testing in combination with the engineering analysis did satisfactorily demonstrate that capability. In addition, HL&P provided a letter documenting agreement of the essential chiller vendor with the licensee's evaluation of essential chiller performance. The licensee submitted the post-modification test procedure, the safety evaluation for the bypass modification, and the vendor agreement letter as attachments to a letter dated February 15, 1994.

Action 2(b) requested that the staff assess the need and scope of baseline testing of the CH system that would more closely simulate design basis accident heat load conditions and validate operability. The engineering analysis and the post-modification testing provide assurance of the adequacy of CH system design, consistent with Criterion III, "Design Control," of Appendix B to 10 CFR Part 50. Simulation of design basis conditions for testing is impractical and unnecessary to demonstrate operability under limiting conditions. Therefore, we conclude that the scope of baseline testing performed by the licensee is acceptable.

Action 2(c) requested that the staff assess the need and scope of periodic testing of the CH system to ensure that it can perform its safety function. The licensee had previously developed procedure OPEP07-CH-0001, "Essential Chiller Performance Test," to conduct periodic performance monitoring of the essential chillers and for post-maintenance testing of the essential chillers. The licensee submitted a description of this test in a letter dated February 10, 1994. Periodic verification of CH system valve position to the positions established during flow balancing, and periodic inservice testing of the CH system pumps and valves in accordance with 10 CFR 50.55a provide assurance that acceptable chilled water flow rates are maintained. Based on this periodic monitoring, we conclude that the licensee conducts acceptable periodic testing of the CH system that is consistent with Criterion XI, "Test Control," of Appendix B to 10 CFR Part 50.

The generic adequacy of chilled water system testing has been evaluated in NUREG-1427, "Regulatory Analysis for the Resolution of Generic Issue 143: Availability of Chilled Water System and Room Cooling." The regulatory analysis determined that the evaluated alternatives did not satisfy the Commission's guidance for imposing new requirements and that safety significant deficiencies are likely to be plant specific. Individual licensee quality assurance programs implementing the requirements of Appendix B to 10 CFR Part 50 provide an enforcement mechanism to address testing deficiencies identified at individual facilities through inspection activity. Based on these considerations, we concluded that the appropriate generic correspondence is an Information Notice to inform the industry of actions taken by HL&P to demonstrate the functional capability of the CH system.

If you have questions regarding our assessment of essential chilled water system capability, please contact Steve Jones at 504-2833. Our SALP input is provided in Enclosure 2.

Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Safety and Analysis

Enclosure:
As stated

cc w/enclosure:
L. Kokajko

CONTACT: S. Jones
504-2833

ENCLOSURE 1

NRC INSPECTION REPORT 50-498/94-04; 50-499/94-04

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064

FEB 11 1994

Dockets: 50-498
50-499
Licenses: NPF-76
NPF-80

Houston Lighting & Power Company
ATTN: William T. Cottle, Group
Vice President, Nuclear
P.O. Box 289
Wadsworth, Texas 77483

SUBJECT: NRC INSPECTION REPORT 50-498/94-04; 50-499/94-04

This refers to the inspection conducted by Mr. Mark A. Satorius, and the inspectors identified in the attached report, during the period January 3-7, 1994. The inspection included a review of activities authorized for your South Texas Project facility. At the conclusion of the inspection, the findings were discussed with those members of your staff identified in the enclosed report.

Areas examined during the inspection are identified in the report. Within these areas the inspection consisted of a review of the actions that you have taken to improve the reliability of your essential chillers, especially your efforts to ensure that the essential chillers are capable of operation under low heat load and at low ultimate heat sink temperatures. Based on the results of this inspection, we have concluded that the cold weather enhancement modifications and the operating procedural changes that have been made to the essential chillers will provide additional assurance that these components will perform their as-designed safety-related functions. As a result, Restart Issue 12, as identified in NRC Inspection Report 50-498/93-31; 50-499/93-31 is considered resolved.

During this inspection, an activity was identified where procedural steps associated with the postmodification testing of the essential chillers were performed out of sequence. This violation is not being cited because the criteria in paragraph VII.B.1 of Appendix C to 10 CFR Part 2 of the NRC's "Rule of Practice," were satisfied. Prompt and effective actions were taken to correct the problem.

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

Should you have any questions concerning this inspection, will be pleased to discuss them with you.

Sincerely,

A. Bill Beach, Director
Division of Reactor Projects

Enclosure:
NRC Inspection Report
50-498/94-04; 50-499/94-04 w/attachments

cc:
Houston Lighting & Power Company
ATTN: James J. Sheppard, General Manager
Nuclear Licensing
P.O. Box 289
Wadsworth, Texas 77483

City of Austin
Electric Utility Department
ATTN: J. C. Lanier/M. B. Lee
721 Barton Springs Road
Austin, Texas 78704

City Public Service Board
ATTN: K. J. Fiedler/M. T. Hardt
P.O. Box 1771
San Antonio, Texas 78296

Newman & Holtzinger, P. C.
ATTN: Jack R. Newman, Esq.
1615 L Street, NW
Washington, D.C. 20036

Central Power and Light Company
ATTN: G. E. Vaughn/T. M. Puckett
P.O. Box 2121
Corpus Christi, Texas 78403

INPO
Records Center
700 Galleria Parkway
Atlanta, Georgia 30339-5957

Mr. Joseph M. Hendrie
50 Bellport Lane
Bellport, New York 11713

Bureau of Radiation Control
State of Texas
1100 West 49th Street
Austin, Texas 78756

Judge, Matagorda County
Matagorda County Courthouse
1700 Seventh Street
Bay City, Texas 77414

Licensing Representative
Houston Lighting & Power Company
Suite 610
Three Metro Center
Bethesda, Marvland 20814

Houston Lighting & Power Company
ATTN: Rufus S. Scott, Associate
General Counsel
P.O. Box 61867
Houston, Texas 77208

Shaw, Pittman, Potts & Trowbridge
ATTN: Joseph R. Egan, Esq.
2300 N Street, N.W.
Washington, D.C. 20037

E-Mail report to D. Sullivan (DJS)

bcc to DMB (IE01)

bcc distrib. by RIV:

L. J. Callan
Section Chief (DRP/A)
MIS System
RIV File
R. Bachmann, OGC, MS: 15-B-18
Resident Inspector
Lisa Shea, RM/ALF, MS: MNBB 4503
DRSS-FIPS
Project Engineer (DRP/A)
Section Chief (DRP/TSS)

*PE:DRP/A	*RI:DRP/A	*NRR:PSS	*C:DRP/A	D:DRP
MASatorius;df	DMGarcia	SRJones	WDJohnson	ABBeach
2/07/94	2/07/94	2/07/94	2/07/94	2/11/94

* previously concurred

E-Mail report to D. Sullivan (DJS)

bcc to DMB (IE01)

bcc distrib. by RIV:

L. J. Callan
Section Chief (DRP/A)
MIS System
RIV File
R. Bachmann, OGC, MS: 15-B-18

Resident Inspector
Lisa Shea, RM/ALF, MS: MNBB 4503
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Project Engineer (DRP/A)
Section Chief (DRP/TSS)

*PE:DRP/A	*RI:DRP/A	*NRR:PSS	*C:DRP/A	D:DRP
MASatorius;df	DMGarcia	SRJones	WDJohnson	ABBeach
2/07/94	2/07/94	2/07/94	2/07/94	2/11/94

* previously concurred

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APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report No.: 50-498/94-04
50-499/94-04

Licenses: NPF-76
NPF-80

Licensee: Houston Lighting & Power Company
P.O. Box 1700
Houston, Texas 77251

Facility Name: South Texas Project Electric Generating Station (STPEGS), Units 1 and 2

Inspection At: Matagorda County, Texas

Inspection Conducted: January 3-7, 1994

Inspectors: Mark A. Satorius, Project Engineer, Project Branch A, Division of Reactor Projects
D. M. Garcia, Resident Inspector, Project Branch A, Division of Reactor Projects
S. R. Jones, Reactor System Engineer, Plant Systems Branch, Division of Systems Safety and Analysis, Office of Nuclear Reactor Regulation

Approved: W. D. Johnson, Chief, Project Branch A   2/9/94 Date

Inspection Summary

Areas Inspected (Units 1 and 2): Routine, announced inspection to review the actions taken to improve the reliability of the essential chillers.

Results (Units 1 and 2):

- Restart Issue 12, as identified in NRC Inspection Report 50-498/93-31; 50-499/93-31 was considered resolved.

- The inspectors concluded that the cold weather enhancement modifications and the operating procedural changes that have been made to the essential chillers will provide additional assurance that these components will perform their as-designed safety-related functions (Sections 2.3 and 4.1).

- A noncited violation for failing to follow procedures was identified (Section 3.1).

- The inspectors concluded that the maintenance backlog associated with the essential chillers contained no safety significant outstanding service requests or modifications that were not scheduled for completion during the current outage; however, the inspectors determined that it would challenge the licensee to complete all of the outage scope prior to the end of the outage and that previously scoped outage work may need to be deferred (Section 4.2).

- The licensee has taken positive steps to improve the quality and quantity of maintenance training provided to workers (Section 4.3).

- The inspectors concluded that licersee management had been satisfactory in their identification and correction of problems associated with the essential chillers and the chill water system (Section 7).

Summary of Inspection Findings:

- Inspection Followup Item (IFI) 498;499/9404-01 was opened (Section 2.2.2.2).

- IFI 498;499/9404-02 was opened (Section 2.2.2.2).

- IFI 498;499/9331-07 was reviewed concerning the essential chiller issues and remained open (Section 5.1).

- IFI 498;499/9331-08 was reviewed and remained open (Section 5.2).

- IFI 498;499/9331-09 was reviewed and remained open (Section 5.3).

- Violation 498;499/9224-01 was closed (Section 6.1)

- IFI 498;499/9224-03 was closed (Section 6.2).

- Violation 499/9226-03 was closed (Section 6.3).

- Example 2 of Violation 498;499/9235-02 was closed (Section 6.4).

- Violation 498;499/9235-03 was closed (Section 6.5).

- IFI 498;499/9331-20 was closed (Section 6.6).

- IFI 498;499/9331-21 was closed (Section 6.7).

- IFI 498;499/9331-44 was closed (Section 6.8).

- IFI 498;499/9331-45 was closed (Section 6.9).

- IFI 498;499/9331-74 was closed (Section 6.10).

Attachment:

- Persons Contacted and Exit Meeting

DETAILS

1 BACKGROUND

Both units at STPEGS were shut down in early February 1993 and remain shutdown as a result of numerous broad scope problems identified by the NRC and the licensee.

NRC Inspection Report 50-498/93-31; 50-499/93-31, issued on October 15, 1993, identified 16 Restart Issues that required resolution prior to the restart of Unit 1. In addition to these Restart Issues, a number of items related to these Restart Issues were identified. The purpose of this inspection was to determine the licensee's effectiveness in resolving Restart Issue 12, "Essential Chiller Reliability." The specific concern of this Restart Issue was focused around the chillers being capable of functioning for extended periods during low heat load conditions and reduced ultimate heat sink temperatures.

2 ESSENTIAL CHILLER OPERATIONS (92720)

The inspectors conducted a review of the essential chillers, and their ability to operate at different loads and under various ambient conditions.

2.1 System Description

Each unit at STPEGS is equipped with three essential chilled water system trains, which provide cooling for the control room ventilation system, the electrical auxiliary building (EAB) ventilation system, and various individual air handling units providing room cooling. The system's safety function is to maintain the temperatures in these areas at acceptable levels to ensure the operability of safety-related systems. Each chilled water system train is cooled by a 150-ton essential chiller and a 300-ton essential chiller arranged in parallel. Based on vendor documents, the essential chillers are capable of operating at loads from 10 percent of rated capacity to loads in excess of 100 percent of rated capacity, depending on chiller condenser water supply temperature and other conditions. The essential chillers reject heat through the chiller condensers to the essential cooling water (ECW) system, which in turn transfers the heat to the essential cooling pond.

Under normal operating conditions, heat from the chilled water system vaporizes the refrigerant within the evaporator. The refrigerant vapor is drawn off the evaporator and compressed by a centrifugal compressor. The refrigerant, now at a higher pressure, is condensed by rejecting heat from the refrigerant vapor to the ECW system in the condenser. The condenser is physically located above the evaporator. The liquid refrigerant in the condenser is returned to the evaporator through a float valve. In order for the liquid refrigerant flow to exist, the condenser pressure must be maintained higher than the evaporator pressure.

The refrigerant side of the essential chiller condenser is a saturated system at a temperature slightly above the ECW essential chiller outlet temperature. Therefore, the pressure within the condenser is affected by the ECW supply temperature and the ECW differential temperature across the condenser. The ECW differential temperature is in turn affected by the ECW flow rate and the heat rejected to the ECW system in the condenser.

Similarly, the refrigerant side of the evaporator is a saturated system at a temperature slightly below the chilled water system outlet temperature. Therefore, evaporator pressure is primarily determined by the chilled water system outlet temperature.

The essential chiller condenser cooling water (in this application, ECW) supply temperature is typically higher than the chilled water system outlet temperature ensuring that the condenser is at a higher pressure than the evaporator. However, the ECW supply temperature decreases during occasional periods of cold weather, causing the condenser refrigerant pressure to also decrease. The essential chiller attempts to control chilled water system outlet temperature and, therefore, evaporator pressure, at a nearly constant value for a given load by controlling the flow of refrigerant vapor from the evaporator to the compressor with prerotation vanes located at the inlet to the compressor. When chilled water system outlet temperature is below the setpoint, the prerotation vanes close to reduce the flow rate of refrigerant vapor from the evaporator. This action reduces the rate of heat removal from the chilled water system, and chilled water outlet temperature increases.

If condenser refrigerant pressure is not sufficiently high relative to evaporator pressure to maintain stable operation of the essential chiller, the essential chiller will be shut down on low evaporator temperature or pressure. Automatic shutdown of the essential chillers is more likely under low heat load conditions because refrigerant vapor is condensed at a lower rate in the condenser, which results in a reduced ECW differential temperature across the condenser and a reduced condenser pressure. When condenser pressure is lower than evaporator pressure, no liquid refrigerant is added to the evaporator. The continued withdrawal of refrigerant vapor by the compressor under that condition causes evaporator temperature to decrease.

The ECW piping from the essential chillers was originally provided with electrohydraulic controlled ECW essential chiller outlet valves. The electrohydraulic actuators were designed to throttle the flow of ECW as the supply temperature decreased to control condenser pressure and maintain stable operation of the essential chiller. However, due to excessive maintenance and control problems with the electrohydraulic actuators, the valve actuators were removed and replaced with manual operators under temporary modifications. The butterfly valves associated with the manual operators were large and do not provide acceptable control at low flow rates. The licensee has subsequently installed a bypass line, including flow instrumentation and a throttle valve, around each ECW essential chiller outlet valve under Modifications 93-049 and 93-050 for Units 1 and 2, respectively. The modification is intended to permit the precise control of ECW flow necessary for stable essential chiller operation when the essential cooling pond temperature is low.

The essential chiller operation at low heat loads is also limited by compressor surge. Compressor surge occurs when the compressor is operating at low volumetric flow capacity. When the volumetric flow through the compressor is low, the compressor may not be capable of continuously producing sufficient discharge head to overcome the pressure at the discharge of the compressor. Because the refrigerant vapor is compressible, the flow may reverse momentarily when the compressor discharge head is low. The resulting periodic flow reversal of the refrigerant, which is characteristic of compressor surge, causes vibration that may eventually damage the compressor. The essential chillers are equipped with prerotation vanes and a hot gas bypass valve to help maintain compressor operation in a stable state. Closure of the prerotation vanes is limited with the hot gas bypass valve closed in order to ensure sufficient compressor flow to prevent a surge is available. When the prerotation vanes reach this limit and a further reduction in refrigerant flow from the evaporator is necessary, the hot gas bypass valve opens to recirculate refrigerant from the compressor discharge back to the compressor suction. The hot gas bypass valve provides the capability to operate the essential chillers in a stable state at loads as low as 10 percent of rated capacity.

2.2 Licensee Evaluation of Essential Chiller Operation

The licensee computed the essential chiller load for each train of the chilled water system under various conditions, including the maximum and minimum expected chiller load with low ECW supply temperatures. A similar evaluation had been conducted prior to licensing during the process of chilled water system design. That evaluation had determined that the system was capable of remaining operable with various ECW supply temperatures; however, due to chiller reliability questions and the lack of a rigorous analysis of chiller performance under low ECW temperatures, this second analysis was performed. The licensee documented the results in Calculation MC-6412. In addition to analyzing chiller performance with low ECW supply temperatures, Calculation MC-6412 and other analyses performed by the licensee did not provide any basis that would conclude that the essential chillers were previously incapable of performing their safety-related function. The installation of Modifications 93-049 and 93-050 improved chiller performance and removed the previous burden on operators that had been required to repetitively adjust ECW flow in order to maintain chiller performance.

Calculation MC-6412 determined that the total calculated chiller load included steady-state, in addition to transient chiller loading resulting from transfer of the stored heat of the safety-related heat loads to the chilled water system following realignment of the system on a safety injection signal from the normal system configuration. For the maximum chiller heat load case, the licensee considered two separate accident scenarios: the first being a loss of coolant accident (LOCA) as the initiating event and the second a LOCA coincident with a loss of offsite power (LOOP). For this maximum chiller loading case, Calculation MC-6412 addressed the following limiting single failures: loss of one EAB supply fan; loss of one chilled water system train; and failure of a safety injection train. The licensee's calculation determined that a LOCA initiated with a failure of the safety injection Train A from steady-state operation of a single train of the chilled water system produced the maximum chiller loading under low ECW supply temperature operation. For the minimum chiller loading case, the licensee's calculation concluded that a LOOP without a single failure was more limiting than a LOOP with a single failure. These most limiting failures were utilized throughout the licensee's evaluation.

2.2.1 Chiller Operation at ECW Temperatures Greater than 60°F

In Calculation MC-6412, the licensee concluded that, with no changes from the current mode of operation and with ECW supply temperatures above 60°F, the installed chiller capacity of 450 tons per train (300-ton and 150-ton chillers operated in parallel) was adequate to maintain an acceptable chilled water outlet temperature for both maximum and minimum chiller loads. For the maximum chiller loading case, when transient loading was included, the total chiller loading at the design chilled water outlet temperature exceed 450 tons for a period of time. However, the licensee determined that safety-related heat loads were acceptably serviced at this short period of higher chilled water temperatures. The licensee based this conclusion on an analysis, which determined that actual heat removal capacity of the chillers exceeds the specified design value. Licensee communications with the chiller vendor confirmed this conclusion. The licensee concluded that the chiller will not shut down on high condenser pressure because peak chiller loading occurs on startup before accident heat loads raise the ECW supply temperature to higher levels and near the design value. Computed steady-state chiller loads were well below train capacity for the evaluated design basis events and, therefore, conservative.

2.2.2 Chiller Operation at ECW Temperature Between 60°F and 42°F

Calculation MC-6412 also evaluated chiller operation at ECW supply temperatures below 60°F, but above 42°F. This calculation determined that certain actions would enhance the chilled water system performance under these lower ECW supply temperature conditions. The changes for low ECW supply temperatures included: throttling ECW flow to the 300-ton chiller to 240 gallons per minute by positioning and locking in place the bypass valve around the ECW discharge valve installed by Modifications 93-049 and 93-050; limiting the ECW flow to the 150-ton chiller to prevent significant heat transfer between the ECW and chilled water systems by natural circulation of the refrigerant within the idle chiller and to reduce micro-biological induced corrosion; electrically locking out the 150-ton chiller to prevent an automatic start, thereby increasing the loading on the 300-ton chiller; and adjustment of the chilled water temperature control for the 300-ton chiller to control chilled water outlet temperature in a range from 40°F at 10 percent of rated load to 48°F at rated load in order to limit transient loading on the start of an idle chilled water system train. In addition, chilled water flow was maintained through the idle 150-ton chiller to further limit transient loading by mixing the chilled water flow from the operating 300-ton chiller and the idle 150-ton chiller to increase the temperature of the chilled water supplied to the cooling coils. The licensee's analysis concluded that, given these changes, increased chiller performance would be attained in this band of ECW temperatures. In addition, with these operational changes, the analysis determined that maximum chiller load conditions were also satisfied. The licensee documented these changes in Unreviewed Safety Question Evaluation Number 93-0036 for Modifications 93-049 and 93-050, which the inspectors reviewed.

The analysis also established that in the ECW supply temperature band of 60°F to 69°F the chiller would perform acceptably either configured in the manner described in Section 2.2.1 of this report or as just described in the previous paragraph. This would allow operators a band to facilitate shifting chiller operation from the normal line-up to a colder ECW supply temperature line-up.

2.2.2.1 Maximum Chiller Loading

While reviewing this portion of the licensee's analysis, the inspectors noted that, for the most limiting case of maximum chiller load, the computed transient chiller load was based on initial, preaccident control room temperature at the upper limit of Technical Specification allowed values, which was 78°F. This assumption was conservative and would place the maximum transient load on the chilled water system following the postulated accident. However, the inspectors also noted that temperatures of other rooms cooled by individual air handling units were assumed to be below the design maximum values. Consequently, transient heat removal from the EAB in this case was found to be slightly below the steady-state heat generation rate. However, the inspectors found this assumption to be realistic. Overall, the licensee's calculation indicates that the total steady-state chiller load for the same initiating event was approximately equal to the computed transient chiller load, and both the transient and steady-state maximum chiller loads were bounded by the rated capacity of the 300-ton chiller. The inspectors concluded that the licensee's approach was acceptable.

2.2.2.2 Minimum Chiller Loading

In Calculation MC-6412, the licensee calculated the minimum chiller loading from initial equilibrium conditions, with two chilled water system trains in service for a LOOP without a single failure. The heat removal rate from the EAB was based on the steady-state value, and the removal rate from the control room was based on an initial temperature of 72°F. Heat removal from the other air handling units was neglected to conservatively model the minimum chiller load. Based on the additional transient conduction available from the Train C structure, the licensee concluded that the Train B computed heat load of 108 tons would be the minimum chiller load during the first 30 minutes following the initiating event. The licensee determined that the minimum steady-state chiller load would be about 90 tons.

The inspectors noted that Calculation MC-6412 did not include conductive heat losses from the EAB, which the inspectors considered would occur during periods of cold weather. In order to resolve this concern, the licensee provided Calculation MC-5159, which computed heater capacity needed to compensate for conductive losses. Based on this calculation, the inspectors determined that the minimum chiller load for Train B should be reduced by approximately 8 tons in order to compensate for conductive heat losses at the assumed EAB and outdoor temperatures used in Calculation MC-6412. When applied to the original calculated transient chiller load of 108 tons and the minimum steady-state chiller load of 90 tons, this resulted in a conservative minimum transient load of 100 tons, 30 minutes following the initiation of the accident, and a steady-state load of 82 tons following the initiation of the accident.

In Calculation MC-6429, the licensee modeled chiller evaporator and condenser performance. The results of the model indicated that a chiller load of 100 tons could be accommodated at an ECW supply temperature of 42°F without an automatic chiller shutdown or unstable chiller operation. The inspectors questioned the licensee concerning the chiller's ability to operate in a stable manner without operator action greater than 30 minutes following the initiating event when the heat loads would be expected to stabilize at a steady-state load as low as 82 tons. The licensee stated that they considered there was sufficient margin in their calculations to support steady-state chiller operation at 82 tons; however, they would consider providing additional procedural guidance to operators. This issue will be tracked for future followup as an IFI (498/9404-01; 499/9404-01).

The inspectors noted that the transient minimum heat load was based on an initial control room temperature of 72°F; any initial temperature less than 72°F would be nonconservative. Review of the licensee's operating and administrative procedures addressing the control room envelope revealed that there was no specific guidance or requirement for maintaining minimum control room temperature other than for operator comfort. Although the licensee's analysis contained conservatisms that increased the margin of the calculation, the inspectors considered the use of 72°F in the analysis, without administrative controls in place to ensure the control room was bounded by a lower temperature limit, a weakness. This issue will be tracked for future followup as an IFI (498/9404-02; 499/9404-02).

2.2.3 Chiller Operation at ECW Temperatures Less Than 42°F

The licensee further evaluated chiller operations at ECW supply temperatures less than 42°F in order to provide the basis for continued chiller operation at those extreme supply temperatures. Historical information indicated that ECW temperatures in that low range were rare, with an occurrence approximately once each 15 to 20 years, and further less likely if one or both units were operating and adding heat to the essential cooling pond.

The licensee's evaluation concluded that chiller performance could be maintained by configuring and operating the chillers in the manner described in Section 2.2.2, with the exception that an operator would be required to be stationed to manually throttle the ECW supply flow, maintaining condenser pressure within prescribed limits. The analysis further concluded that at ECW supply temperature less than 37°F, chiller operation was not reliable and that the essential chillers would be required to be declared inoperable.

2.3 Conclusions

The inspectors concluded that the licensee's calculation had demonstrated that the chillers will perform acceptably under maximum and minimum loading conditions after implementation Modifications 93-49 and 93-50, as described in Unreviewed Safety Question Evaluation Number 93-0036. However, the inspectors noted that additional controls appeared necessary to justify assumptions in the calculations. These controls consisted of providing additional procedural guidance to operators to ensure acceptable chiller performance 30 minutes or greater following the initiating event at a minimum steady-state load and administratively maintaining control room temperature above 72°F when operating under low ECW supply temperatures in order to satisfy assumptions used in computing the minimum chiller loading.

3 MODIFICATION TESTING ON ESSENTIAL CHILLER 12B (62703)

On January 5, 1994, the inspectors observed portions of the postmodification testing on Essential Chiller 12B following the installation of Modification 93-049. The purpose of the test was to determine if the chilled water system would perform as required by Modification 93-049 during cold weather conditions and to field validate the analysis conducted in Calculation MC-6412.

3.1 Field Observation of Chiller Postmodification Testing

The test was performed in accordance with Procedure 1PEP07-CH-0002, Revision 0, "300-ton Essential Chiller Bypass Modification Verification Test." The procedure consisted of four separate test sequences which obtained various pressure, temperature, and amperage readings while operating the essential chillers. All tests were conducted with the chillers and chilled water configured in the manner described in Section 2.2.2 of this report.

The first test involved a single 300-ton idle chiller (12B) safety injection start during cold weather conditions. The second test simulated a single 300-ton chiller (12B), starting with a LOOP during cold weather conditions. The third test simulated two 300-ton chillers (12B and 12C) operating in steady-state cold weather conditions, which was the normal system lineup. In this test, the principle objective was to obtain data in order to calculate chiller load. The fourth test simulated a single 150-ton idle chiller (11B) safety injection start during cold weather conditions. The intent of this test was to ensure the chiller would successfully start and run while ECW was configured in the cold weather mode.

Acceptance criteria required the chiller to start and operate successfully for the duration of the test. Additionally, design engineers evaluated the results for peak condenser pressure and peak load on the condenser.

The inspectors observed the pretest briefing conducted by the test coordinator and given to all personnel involved in the testing. The briefing emphasized the STAR (Stop, Think, Act, and Review) program and the importance of self-verification.

At the start of the test, the required test equipment was being installed in Step 6.1.4 of the procedure. The technicians performed Substeps 6.1.4.3 and 6.1.4.4. prior to Substeps 6.1.4.1 and 6.1.4.2. The technicians were questioned by the inspectors on performing procedural steps out of sequence and work was stopped. Further review of the procedure revealed that a caution early in the procedure clearly stated that, "Substeps shall be performed in the order written." The test coordinator was notified and a station problem report was initiated to identify and follow up on the problem. The activities performed out of order were evaluated by the shift supervisor and the test coordinator and a decision was made to continue with the procedure in the order written without having to rework the steps previously performed.

The failure to follow procedures was a violation of the requirements of Technical Specification 6.8.1.a. This violation was not cited because the criteria in paragraph VII.B.1 of Appendix C to 10 CFR Part 2 of the NRC's "Rules of Practice," were satisfied. This violation was an isolated occurrence and the licensee staff took prompt and effective actions to correct the problem.

When performing Step 6.1.9.3 of the procedure for the first test, the chiller tripped on low oil pressure. The control room was contacted and the test was stopped. Electrical maintenance determined that a packing leak existed on the high pressure oil isolation valve to the purge unit. Electrical maintenance tightened the packing and purged remaining air in the oil lines. The oil pressure appeared satisfactory and the chiller was restarted. The chilled water discharge temperature stabilized at 48.5°F, as required.

The third test that was performed had to be repeated twice before the technicians were able to retrieve the data collected from the data logger. Apparently, when the test data were transferred to the laptop computer, it was lost. The third time the test was performed, a tape printout was used to collect the data for engineering evaluation purposes. Data were consistent for all three performances of the test.

The inspectors did not observe the second or fourth test; however, the test results were reviewed.

The performance of the tests was satisfactory and the essential chilled water system functioned as expected. The inspector verified that the test had the proper work start authorization. The instrumentation that was used had proper calibration. The technicians performing the test were knowledgeable of the system. Plant operations was informed of all conditions concerning the test, and the chronological test log was appropriately maintained.

3.2 Postmodification Test Results

The inspectors reviewed the data collected during the performance of the postmodification testing in order to determine if the test results validated the conclusions made by the licensee's analysis.

Based on the test results reviewed by the inspectors and a briefing provided by the licensee, the postmodification testing confirmed the engineering analysis conducted by the licensee and reviewed by the inspectors (refer to Section 2 of this report). For the plant conditions available at the time the tests were conducted, chiller capacities and heat loads calculated in the analysis matched acceptably with the actual recorded data.

3.3 Conclusions

The inspector noted that chiller postmodification testing was conducted appropriately. Initially there was a problem with procedure adherence; however, appropriate corrective actions were taken to ensure compliance with the remainder of the procedure. The postmodification testing validated the engineering analysis conducted by the licensee.

4 REVIEW OF IMPROVEMENTS TO CHILLER RELIABILITY (92720)

4.1 Operational Procedure Changes

The inspectors reviewed Procedure OPOP02-CH-0001, Revision 1, "Essential Chilled Water System." This latest revision of Procedure OPOP02-CH-0001 incorporated the necessary operational changes following implementation of Modification 93-049 on Train B of the chilled water system. The procedure directed plant personnel to operate the system in one of three configurations, depending on the ECW supply temperature. These temperature bands corresponded to the bands described in Section 2.2 of this report which were correlated to the licensee's analysis of the chilled water system.

For ECW temperatures greater than 69°F, system configuration and operation were unchanged from the manner that the chilled water system had been previously operated.

For ECW temperatures in the band 42-60°F, the following operational changes were required:

- The 150-ton chiller is made inoperable by placing its control switch on the main control board in the pull-to-lock position.

- The ECW supply flow to the 300-ton chiller is throttled using the ECW discharge bypass valve and a flow of 240 gallons per minute is established.

- The ECW discharge bypass valve on the 150-ton chiller is throttled open 3/4 turn in order to prevent microbiological induced corrosion.

- The temperature control valves for the EAB are closed, which places full chilled water flow through the EAB cooling coils and reduces the transient on the chilled water system following the initiation of the most limiting postulated accident.

For the temperature band 60-69°F, Procedure OPOP02-CH-0001 permits chiller operation in either the greater than 60°F mode of operation or the 42-60°F mode.

For ECW temperatures in the band 37-42°F, Procedure OPOP02-CH-0001 requires that an operator be stationed at each operable chiller train and further instructs that operator to throttle the ECW bypass valve in order to maintain chiller condenser pressure between 2 inches vacuum of mercury to 7 pounds per square inch gage.

For ECW temperatures less than 37°F, Procedure OPOP02-CH-0001 requires that the essential chiller be declared inoperable.

The inspectors concluded that these procedural changes were effective in implementing the chiller enhancements described in Modifications 93-049 and 93-050. The licensee plans to further revise Procedure OPOP02-CH-0001, as the modification was installed on the remaining trains of the essential chillers.

4.2 Essential Chiller Maintenance Backlog

The inspectors reviewed the maintenance outstanding on all Unit 1 essential chillers, with a particular focus on maintenance activities not scheduled to be completed during the current outage.

As of January 5, 1994, the list of outstanding maintenance not planned for work prior to the restart of the unit was relatively small with only 15 open service requests (SRs). Of these 15 SRs, 11 were modifications planned for enhancing chiller performance; 3 were SRs to improve compressor lube oil pressure switch calibration problems identified in Station Problem Report (SPR) 931842; and 1 generic SR was open, with no intention of closing, to provide support to collect oil samples, clean purge orifices as required, obtain refrigerant system levels, and provide general maintenance assistance to operations in starting and maintaining chilled water system availability.

Three of the modification SRs, although not scoped for work during the outage, would be worked and were associated with resetting the chilled water outlet temperature to 48°F in each of the chilled water trains, in support of the installation of Modification 93-049 (refer to Section 2.2.2 of this report). Two of the SRs were associated with Modification 89-063 and involved the installation of thrust covers and collars and vibration probes on two of the 300-ton chillers. This modification was under review by Design Engineering to determine if the hardware scoped for installation was actually beneficial.

The remaining six modification SRs involved the installation of refrigerant clean-up kits, an initiative recommended by the chiller vendor. A review of the chiller performance since 1989 indicated that the licensee had not been successful in maintaining the chillers' refrigerant and oil systems properly sealed; as a result, the intrusion of water and noncondensable gases had caused an unacceptable level of refrigerant and lubricating oil contamination. Although the system cleanliness had been improved by the licensee's heightened awareness to this past problem, the vendor had recommended that clean-up kits be installed. The inspectors were concerned that this modification, which would improve the chillers' reliability, was being deferred until the next outage in approximately 18 months. The licensee responded that there was not sufficient time for completion of the installation of the clean-up kits on Unit 1 chillers during the current outage, but that the modification would be completed on the Unit 2 chillers prior to the restart of that unit. As an interim measure, they had changed preventive maintenance Procedure EM-1-CH-93000272 for chiller lubricating oil and filter changes from the previous periodicity of 78 weeks to every 26 weeks. The inspectors considered this acceptable.

The inspectors reviewed the three open SRs not related to the installation of modifications that were not scheduled for work during the outage. All were associated with problems identified during the calibration of compressor lube oil pressure switches. During previous preventive maintenance activities conducted at refueling outages, the licensee identified a high occurrence of these pressure switches being out of tolerance. Although continuing to research the root cause of the problem, as an interim measure, the licensee revised preventive maintenance Procedure IC-1-CH-93000635 to change the periodicity of oil pressure switch calibration from each refueling outage (every 72 weeks) to every 52 weeks. The inspectors considered this acceptable.

Since the end of this inspection, the licensee has identified maintenance items previously scoped for completion during this outage that will not be worked and will have to be deferred. The adequacy of the licensee's deferral process and the thoroughness of their review of maintenance activities prior to deferring work was reviewed in NRC Inspection Report 50-498/94-08; 50-499/94-08.

4.3 Chiller Training Enhancements

The inspectors reviewed recent revisions to the licensee's chiller training program. The chiller training program consisted of three courses of instruction. All three courses had been revised in late 1993.

Course EMT901, "Air Conditioning and Refrigeration," was the first course taught to electrical maintenance personnel and was a prerequisite for all subsequent training on the chillers. This course was designed to require 80 hours of instruction and covered the refrigeration cycle, systems checks, and mechanical, and electrical troubleshooting. All training was conducted utilizing York chillers. Subsequent courses, EMT911, "York Chiller Maintenance," and EMT966, "Chiller Instrumentation," focused training on achieving higher levels of electrical maintenance personnel expertise. Both of these courses were of 40 hours duration and trained workers on accelerated skills associated with chiller maintenance and troubleshooting.

The inspectors determined that the training was based on a systems approach to training and represented improvements on the previous courses of instruction.

4.4 Conclusions

The inspectors concluded that the changes made to Procedure OPOP02-CH-0001 were effective in implementing the chiller enhancements described in Modifications 93-049 and 93-050. The chiller maintenance backlog was small. The licensee had taken appropriate steps following the deferral of the installation of two modifications to ensure reliable chiller operations. However, some maintenance items previously scoped for work during the current outage would have to be deferred. The deferral of these items were reviewed in another NRC inspection. The licensee had revised their chiller training and the resultant course of instruction was considered an improvement.

5 REVIEW OF ITEMS RELATED TO RESTART ISSUES (92701)

The following items related to Restart Issues were reviewed concerning the manner that the licensee had resolved the issue within the scope of Restart Issue 12, which addressed the licensee's efforts to improve the reliability of the essential chillers. They will remain open pending further NRC inspection effort to completely resolve the items during future Restart Issues and other inspections.

5.1 (Open) IFI 498;499/9331-07: The team found that maintenance and testing weaknesses reduced the reliability of safety-related and balance-of-plant equipment.

The inspectors determined that, based on the relatively small SR backlog, the improved material condition, and the extensive postmodification testing program, the portion of this IFI that refers to the reliability of the chillers was closed.

5.2 (Open) IFI 498;499/9331-08: Ineffective corrective and weak preventive maintenance significantly contributed to poor equipment performance.

Based on the improvements made to preventive maintenance conducted on the essential chillers and the SR backlog reduction (refer to Section 4.2), the portion of this IFI that refers to the chillers was closed.

5.3 (Open) IFI 498;499/9331-09: Ineffective corrective maintenance, caused by inadequate root cause analysis, poor prioritization of work, and poor craft performance, adversely affected safety-related equipment performance.

Based on the SR backlog reduction (refer to Section 4.2), the portion of this IFI that refers to the chillers was closed.

6 CLOSED ITEMS RELATED TO RESTART ISSUES (92701)

The inspectors determined that the licensee's actions to address the following issues was adequate. These items were considered closed.

6.1 (Closed) Violation 498;499/9224-01: Failure to take adequate corrective action to preclude essential chill water switch malfunctions during valving-in processes following maintenance.

The licensee's corrective action to this violation consisted of revising the preventive maintenance activities to include precautions concerning the acceptable manner of valving-in these particular differential pressure switches. Additional actions taken included the installation of equalization valves to facilitate test equipment installation by the implementation of Engineering Change Notice Packages 92-J-0012 and 92-J-0013. These engineering change notice packages were completed on both units' essential chillers during the current outages.

One of the root causes of this violation was the licensee's failure to implement a maintenance feedback request (MFR) that initially identified the problem associated with the differential pressure switches. This MFR had been rejected without receiving the concurrence of engineering, which was the department that originated to MFR. The licensee's corrective action to address this root cause consisted of revising Procedure OPGO03-ZM-00002, "Preventive Maintenance Program," to procedurally require that all rejected MFRs receive concurrence from the initiating department.

The final corrective action consisted of the licensee revising Procedure OPGP03-ZX-0002, "Corrective Action Program," to provide guidance on the expectations for correspondence involving SPRs. This procedure had been revised numerous times since the occurrence of this violation and currently provides specific guidance to station personnel regarding management's expectations concerning the corrective action program.

6.2 (Closed) IFI 498;499/9224-03: Essential chiller unavailability rates were excessive.

Based on the action taken by the licensee (refer to Section 4.2) this item was closed.

6.3 (Closed) Violation 499/9226-03: Failure to perform a postmaintenance test of the Essential Chiller 21C supply breaker following maintenance, resulting in a failure of the chiller to start on demand.

The licensee's corrective action to this violation consisted of revising the Maintenance Planners Guide to provide guidelines for the handling of multiple component work packages or work packages which were cross-referenced to ensure that the required postmaintenance testing was performed in individual components. In addition, operations department training was conducted in the licensed requalification training to reinforce the lessons learned from this inadequate postmaintenance testing activity. The operations manager issued a memorandum to all operations personnel emphasizing the requirements of Operations Policy 0-0054, "Electrical Breaker Continuity Checks."

6.4 (Closed) Example Two of Violation 498;499/9235-02: Failure to take prompt corrective action to correct equipment deficiencies with Essential Chiller 21A by not installing Plant Equivalency Change (PCF) CH-178119.

PCF CH-178119 was installed on all the essential chillers. In addition, the licensee has taken the initiative to install other equipment reliability enhancing modifications and PCFs, as well as evaluated the basis for deferring the installation of other modifications and PCFs (refer to Section 4.2).

6.5 (Closed) Violation 498;499/9235-03: Failure to verify that the automatic load sequence timer was operable with the first sequenced load verified to be loaded within 1.0 second and 1.6 second and all other load blocks within ±10 percent of its design interval.

This issue was first identified by the licensee in September 1991 and, at that time corrective action was taken to revise the load sequence timer Procedure 1/2PSP02-SF-0001A/1B/1C/2A/2B/2C, which was accomplished by procedural field changes. The issue consisted of the engineering safety features load sequence timer procedure failing to verify the essential chiller's internal timer for initiating the chiller starting sequence. After the field change to Procedure 1/2PSP02-SF-0001A/1B/1C/2A/2B/2C, this verification was performed.

6.6 (Closed) IFI 498;499/9331-20: Functional and programmatic weaknesses were observed in the design, testing, modification, and maintenance of the essential chilled water system that, if uncorrected, could adversely affect the operability of the system.

Based on the action taken by the licensee (refer to Sections 2, 3, and 4) this item was closed.

6.7 (Closed) IFI 498;499/9331-21: The ability of the essential chilled water system to function for extended periods, during a design basis accident under low heat load conditions, was never demonstrated, either by testing the system at various design basis accident heat loads or by engineering analysis.

Based on the action taken by the licensee (refer to Section 2) this item was closed.

6.8 (Closed) IFI 498;499/9331-44: Engineering will perform calculations, related to the essential chilled water system, which will provide the basis for evaluation and analysis of minimum and maximum chilled water loads under a range of weather-related conditions and postulated design basis accidents. Strategies will be developed to operate and test the system, and an evaluation of proposed chiller enhancements will be completed.

Based on the action taken by the licensee (refer to Sections 2) this item was closed.

6.9 (Closed) IFI 498;499/9331-45: Ensure that the essential chillers were capable of performing their design function.

Based on the action taken by the licensee (refer to Sections 2) this item was closed.

6.10 (Closed) IFI 498;499/9331-74: NRC assess the licensee's engineering analysis for essential chiller operation under low heat load accident conditions.

Based on the action taken by the licensee (refer to Sections 2) this item was closed.

7 ASSESSMENT OF MANAGEMENTS RECEPTIVENESS TO IDENTIFYING AND CORRECTING PLANT PROBLEMS (92720)

The inspectors determined that licensee management had responded adequately to the issue of improving the reliability of the essential chillers.

ATTACHMENT

1 PERSONS CONTACTED

1.1 Licensee Personnel

R. Caldwell, Assessor, Planning and Assessment
T. Cloninger, Vice President Nuclear Engineering
J. Conly, Licensing Engineer, Nuclear Licensing
E. Halpin, Manager, Fluid Systems Division
S. Head, Deputy General Manager, Nuclear Licensing
J. Johnson, Supervisor, Quality Assurance
T. Jordan, Manager, Systems Engineering
M. Kanavos, Manager, Mechanical-Civil Division
R. Kerr, Senior Engineer, Nuclear Safety Review Board
R. Pierce, Staff Engineer, Independent Safety Evaluation Group
J. Sheppard, General Manager, Nuclear Licensing
M. Smith, Senior Consultant, Planning and Assessment

The personnel listed above attended the exit meeting conducted on January 7, 1994. In addition to the personnel listed above, the inspectors contacted other personnel during this inspection period.

1.2 NRC Personnel

M. Satorius, Project Engineer, Project Branch A, Division of Reactor Projects
D. Garcia, Resident Inspector, Project Branch A, Division of Reactor Projects

2 EXIT MEETING

An exit meeting was conducted on January 7, 1994. During this meeting, the inspectors reviewed the scope and findings of this report. The licensee did not take exception with any of the inspection findings nor identify as proprietary any information provided to, or reviewed by, the inspectors.

Enclosure 2

SPLB SALP INPUT

Plant Name: South Texas Project Electric Generating Station
SER Subject: Staff Actions Resulting from the Diagnostic Evaluation
TAC No.: M87165 and M87166

Summary of Review

Plant Systems Branch conducted a review of staff actions resulting from the Diagnostic Evaluation at South Texas Project Electric Generating Station (STP) regarding essential chilled water (CH) system operation. We determined that Houston Lighting and Power Company (HL&P), the licensee for STP, has completed an acceptable engineering evaluation demonstrating that the CH system is capable of performing its safety function under design basis maximum and minimum heat load conditions. We also found HL&P's test program for the CH system to be acceptable. Plant Systems Branch will draft an Information Notice for release in the second quarter of 1994 to notify the industry of HL&P's actions in addressing this issue.

Narrative Discussion of Licensee Performance-Engineering/Technical Support

The licensee performed a thorough analysis demonstrating that the essential chilled water system will perform acceptably under minimum loading conditions after full implementation of modifications to the service water piping providing cooling water to the essential chillers. Additionally, the licensee conducted post-modification testing that provided data used to validate the results of the analysis. However, the inspectors noted that additional administrative controls were necessary to justify certain assumptions in the analysis.

Author: S. Jones

Date: MAR 1 5 1994

ENCLOSURE 2

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

June 3, 1994

MEMORANDUM FOR: Theodore R. Quay, Director
Project Directorate IV-2
Division of Reactor Projects III/IV

FROM: Terence L. Chan, Acting Chief
Mechanical Engineering Branch
Division of Engineering

SUBJECT: STAFF ACTIONS RESULTING FROM THE DIAGNOSTIC EVALUATION AT SOUTH TEXAS PROJECT (TAC NOS. M87165, M87166)

Reference: Memorandum from James M. Taylor, EDO, to Thomas E. Murley, Director, NRR, dated August 3, 1993, relating to staff actions resulting from the diagnostic evaluation at the South Texas Project

As requested in the above referenced memorandum, the Mechanical Engineering Branch has completed its evaluation of Issue No. 6 relating to the fuel injection pump hold-down stud failures in the standby diesel generators (SDGs) at South Texas Project (STP). The staff evaluated the hollow hold down stud design and determined that the design is marginally acceptable. A number of causal factors for the stud failures were evaluated. These included deficiencies in installation methods, manufacturing tolerances and design margins. These factors appear to offer a reasonable explanation for loss of preload in the studs leading to fatigue failure. The licensee has proposed a new fastener arrangement for installation of fuel pumps at the STP SDGs. This new design, which incorporates a solid stud with Belville washers, offers a higher margin against fatigue failure.

Based on its review, the staff finds the proposed fix to be acceptable. The licensee has completed the installation of these studs at the STP Unit 2 diesel engines and has provided an acceptable schedule for completing installation in the remaining engines. The other issue relating to the operability of SDGs with as many as two cylinders out of service is also addressed in the enclosed safety evaluation (SE). Our SE incorporates observations and evaluations from a site inspection as well as review of applicable documents.

This completes our review under TAC Nos. M87165 and M87166. Please contact Kamal A. Manoly, Section Chief, Mechanical Engineering Branch, at 504-2765, if you have any questions regarding this issue.

Terence Chan, Acting Chief
Mechanical Engineering Branch
Division of Engineering

Enclosure:
As stated

9406100250 XA

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
MECHANICAL ENGINEERING BRANCH STAFF ACTIONS
RESULTING FROM THE DIAGNOSTIC EVALUATION
AT THE SOUTH TEXAS PROJECT

INTRODUCTION

The Mechanical Engineering Branch was requested to evaluate fuel injection pump hold-down stud failures in the standby diesel generators (SDGs) at the South Texas Project (STP). This was identified as Issue No. 6 in the memorandum from James M. Taylor, EDO, to Thomas E. Murley, Director, NRR, dated August 3, 1993 (Reference 1) relating to staff actions resulting from the diagnostic evaluation team (DET) inspection at the STP. Four hold-down studs (5/8" x 3 3/8") are used for mounting the fuel pumps to the pedestal as shown in Figure 1 on each cylinder of the Cooper-Bessemer (CB) SDGs. A number of hold-down stud failures occurred from 1987 through 1993 in the SDGs at STP. Each time a failure occurred, the SDG was declared inoperable. Subsequent licensee operability reviews determined that failure of the fuel injector hold-down studs would render the associated cylinder inoperable, but would not render the SDG inoperable. The licensee was informed by CB, the SDG vendor, that as many as two cylinders could be out of service and the SDG would still be operable. However, no analysis was available for the DET to review, to support the vendor's determination.

The licensee attributed the failures to various root causes, such as, faulty material, use of improper installation tools and improper lubrication of the hold-down studs prior to torquing. Preliminary indications from the licensee also indicated that other utilities with Cooper Bessemer SDGs have experienced fuel injector hold-down stud failures. The licensee has proposed a new fastener arrangement for installation of fuel pumps at the STP SDGs. This new design, which incorporates a solid stud with Belville washers (Figure 2), offers a higher margin against fatigue failure. Based on its review, the staff finds the alternate stud design acceptable. The licensee has completed the installation of these studs at the STP Unit 2 diesel engines and has provided an acceptable schedule for completing installation in the remaining engines. The other issue relating to the operability of SDGs with as many as two cylinders out of service is also addressed in this SE.

EVALUATION

The most recent failure of fuel injection pump hold-down studs occurred in April 1994, during post-maintenance testing in cylinder 6-L of SDG 22. A metallurgical examination by the licensee indicated that the studs failed in fatigue as in the past. The licensee contracted MPR Associates, Failure Prevention Incorporated (FPI) International, and Cooper-Bessemer to assist in the failure root cause analysis. Calculations were performed to evaluate the margins of safety in the hollow stud design and the proposed solid stud design (Reference 2). The design of the fasteners for the fuel injection pump mounting was analyzed using operating and design basis loads, which were provided by the manufacturer. As part of the evaluation, the magnitude of fastener preloads required to prevent fatigue failure were calculated. Various design loads from previous calculations were utilized to analyze

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and confirm the structural adequacy of the proposed fasteners under design basis conditions.

Evaluation of the root cause analysis

The licensee has identified three causal factors which influenced failure of the hollow studs. These are related to deficiencies in installation methods, manufacturing tolerances and design margins. The licensee considers the hollow stud design adequate but marginal, and is replacing the hollow studs with a fastener arrangement which includes solid studs and Belville washers.

Installation-related practices are suspected to contribute to the loss of stud preload which leads directly to the high cycle fatigue failure of the studs. Preload is the tensile force developed in the stud when it is tightened against the joint. Initial preload is the tension created when a fastener is first tightened, before the wrench is disengaged from the nut. Preload is affected by a number of factors which can result in a residual preload considerably lower than the initial preload. Studs can become loosened by vibration, joint flexure, and cyclic shear loading. Other factors affecting preload are embedment, thermal effects and torquing accuracy. These effects could cause relaxation of the preload on the studs to the point where the joint is subject to excessive cyclic loading. The fuel pumps operate 300 times per minute and raise the pressure of the fuel from 35 psig to a peak of 11,000 psig. This rapid application and relaxation of force on the loosened stud could produce the type of high cycle fatigue failure observed during the metallurgical examination.

Embedment, in relation to fasteners, is associated with high spots on the contact surfaces, especially in new fasteners, which tend to creep and flow when initially torqued. Joints subject to cyclic loads will embed, and therefore relax more than joints under purely static loads. The material of the pump support pedestal into which the studs thread is M-40 Cast Iron. This material is softer than the hollow stud materials (AISI 1045 material used prior to 1984 and an ASTM A193, Grade B7 material used after 1984). It is possible that the M-40 Cast Iron deformed due to the forces exerted by the harder studs. A study of the potential for embedment of the studs is currently being prepared by the licensee's contractor, FPI International.

Torquing procedures typically require that mating surfaces (i.e., studs and threaded holes) be free of foreign particles, nicks, cuts and other potential stress risers. These attributes are addressed in site bolting and torquing procedures and were not considered to be viable candidates for the root cause of this problem. It was determined, however, that the studs are not torqued in a sequence, nor are they torqued to a nominal value (e.g., 30%) before the final torque is applied. This practice can result in the first stud tightened to be very highly stressed (possibly beyond the yield point) by the subsequent torquing of the second stud. Torquing of the third and fourth studs would relax the load on the first stud resulting in plastic deformation. With one stud incapable of effectively carrying its share of the load, the other studs could be over-stressed and subject to fatigue failure. Calculations indicate that there is very little design margin in that the existing studs and the yield point could be easily exceeded by torquing in a random sequence to full torque values. Two instances where studs were found to be loose on SDG 22 were probably caused by the above practice. This procedural inadequacy is considered to be a possible root cause of the stud failure.

The use of LocTite (a liquified metal bonding agent which hardens after application) on the stud and pedestal surfaces is also considered to be a possible root cause of the stud failures. The LocTite is applied only to the lower 3/4 inch of the stud and to the entire length of the pedestal threaded hole. The pump is assembled on the mounting before the LocTite has had time to harden. The nuts are then tightened to the required torque value of 50 ft-lb. Once the LocTite sets up, it compresses under the forces between the mated threads of the stud and hole. This compression can cause the studs to lose tension, exacerbating the effects of the cyclically applied load from pump operation.

The procedure for assembling the pumps at one time called for only one drop of LocTite to be used in each connection, however, the current practice seems to indicate that several drops have been applied. It can be assumed, that since this practice is not controlled by procedure, that excessive amounts of LocTite could have been used, creating a greater loosening effect. Manufacturing tolerances, such as stud dimensions, hole dimensions, and thread manufacturing method, are all considered as potential root causes for reduced load capacity of the studs.

According to the licensee, the threads of three of the seven studs supplied to them appear to have been machined rather than rolled. The vendor's specification calls for the threads to be rolled. This would give a rolled stud between 10% and 20% greater strength in comparison to a machined stud. Rolling the threads compresses the threaded surface, thereby enhancing resistance to fatigue. However, based on metallurgical examinations by the licensee, two studs removed from SDG 22 were machined. Lack of strength and fatigue resistance due to machining of stud threads is also considered to be a possible root cause by the licensee.

The strength of the studs is directly related to their cross sectional area, inside and outside diameters and thread engagement area. The licensee indicates that the only dimensional check which is performed on these studs is a go/no-go gage check of the inside diameter on a 10% - 20% sample from a batch of studs. The other dimensions which could affect the ultimate strength of these studs were not required to be verified. Laboratory checks performed during materials testing show that the studs removed from SDG 22 were within the required dimensional tolerances (for inside diameter).

When the pedestal of SDG 22 cylinder 6-L was removed for inspection, it was found that one of the holes could allow the stud to be inserted either straight or at an angle. If the stud were installed off center, side loading could develop which would lead to rapid fatigue failure. The licensee speculated that during thread checking and cleaning that a thread tap was used which deformed the hole threads, allowing the stud to enter at an angle. This manufacturing deficiency is considered to be a possible root cause for at least one of the reported failures.

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Based on the above discussion, the staff concludes that a possible combination of deficiencies in installation practices and manufacturing tolerances contributed to the stud failures in the STP diesel engines.

Evaluation of design margins

According to Cooper-Bessemer, the design margins to failure for the hollow AISI 1045 and ASTM 193 B-7 studs were 3.63 and 4.30 respectively. These margins are based on operating loads only and do not account for preload.

The staff reviewed Calculation MC-6440 (Reference 2), related to the design margin in the studs based on measurements of stud root diameter, and minimum and maximum wall thickness taken during metallurgical examinations. Several different cases were computed by varying stud root diameter, nut factor and material properties. For the case in which nominal values and AISI 1045 material were used, the design margin to failure from initial preload was calculated to be only 1.26. For the nominal case using the ASTM 193, Gr. B7 properties, the margin was only 1.36. In each of the other cases when dimensions were varied, the calculated design margin was less than that for the nominal cases. Given that there is some uncertainty in the calculations due to assumptions made and measurement inaccuracies, there is still considerable difference between the vendor-supplied margin and that which was calculated. The marginal strength of the hollow studs provided a strong motivation for the licensee to go to a solid stud configuration, which provides higher margins and is considered a more conservative design.

The licensee and his contractor, MPR Associates, performed a fatigue evaluation of the hollow studs (AISI 1045 material with a 25/64" center hole, and of the studs delivered after 1984, ASTM A193 Grade B-7 material with a 27/64" center hole) and compared the results to the stresses in solid studs of the A193 Grade B-7 material. The cyclic operational loads on the bolts are primarily generated during pump operation as the pump fluid pressure cycles between 35 psi to 1500 psi. This results in operating loads of over 9000 lbs. along the axis of the bolts. The analysis assumed a loose joint with no preload. Failure by fatigue was not predicted for the hollow studs if the alternating loads were assumed to be evenly distributed. However, with an uneven distribution of loads, fatigue failure was considered probable. The predicted maximum stresses in the solid studs were determined to be half the calculated stresses in the hollow studs. Confirmatory calculations performed by the licensee indicate that the amount of relaxation which can be tolerated in the solid stud design is more than twice as much as in the hollow stud design and the pumps could operate indefinitely with one of the four studs completely unloaded in the solid stud arrangement. Preload stress must remain in excess of operating loads to preclude fatigue failure. An applied preload stress of 30 ksi can result in an actual preload stress of 21 ksi due to margins of error in the torque application technique. With this minimum preload, the stress in the solid stud design is well above the operating stress of 11.5 ksi. By comparison, the preload stress in the hollow stud arrangement needs to be maintained at about 65 ksi. The operating load in the hollow stud design is calculated to be approximately 2500 lbs per stud (or 30 ksi stress). Thus, a relaxation of about 3 mils is enough to unload the stud during a portion of the load cycle. With the new design, relaxation of 3 mils will leave the Belville washers compressed by about 0.009 inches, giving a spring force of 5000 lbs, or nearly twice the operating load.

In the hollow stud design, the licensee calculated the combined stress due to preload and operating loads to be about 108 ksi. Thus, even with nominal dimensions, the peak stress could exceed yield stress for a portion of the stress cycle. With worst case dimensions, the maximum ultimate tensile strength could be exceeded. With the solid stud design, the sum of the prestress and operating stresses on the studs are well below yield stress, even after allowing for variations in preload. The required compression of the Belville washer to equal the operating load is 5 mils, allowing a substantial available margin for accidental relaxation. Since loss of preload has been identified as a primary cause of failure, the solid stud design with Belville washers offers a wide margin of safety.

Other evaluations performed by the licensee include analyses to determine the effect of seizure of the push rod due to a hydraulic lock. The marginal design of the hollow studs was intended to prevent damage to the camshaft during such an event. The solid stud fastener would presumably exert a much higher force on the camlobe prior to failure. Since keyed camlobes are also not expected to fail due to loading from a seized push rod, there is a high likelihood of damage to the camshaft. For the STP SDGs, however, there is an interference fit between the camshaft and the camlobes. Calculations by the licensee indicates that in the event of a hydraulic lock, the cam-follower is likely to break this interference fit without damaging the camshaft.

Based on the above discussion, the staff concluded that the solid stud design was acceptable for mounting fuel injection pumps at STP diesel engines.

Evaluation of SDG operability with two cylinders out of service

Section 4.6 of NRC Inspection Report 50-498/93-44 and 50-499/93-44 dated January 12, 1994, includes a discussion of the licensee's assertion that the SDGs at STP can its carry design-rated load (5500 KW) with up to two of the SDGs' 20 cylinders inoperable. The staff reviewed the licensee's position and concluded that the SDGs could, in concept, carry design-rated load with as few as 18 cylinders without excessive engine stresses. However, the staff's conclusion would only be valid if the engines were balanced, and the cylinder failures occurred only after all loads had been sequenced on to the SDGs; i.e., the SDGs would not be required to accept and accelerate any additional loads with less than 20 cylinders operating.

During the review of this issue at the above subject inspection, the staff determined that the cycle-to-cycle firing pressures on any given cylinder varied by as much as 130 psi in an unpredictable manner. Given this apparent erratic operation, the staff was unable to establish whether or not the SDGs were balanced. Therefore, the issue of SDG OPERABILITY with less than 20 cylinders operating, remained open in the above referenced inspection reports.

Subsequent to the above staff review and issuance of the above referenced report, it was determined that the erratic operation of the SDGs at STP was due to electronic governor "hunting" when the SDGs are paralleled with offsite

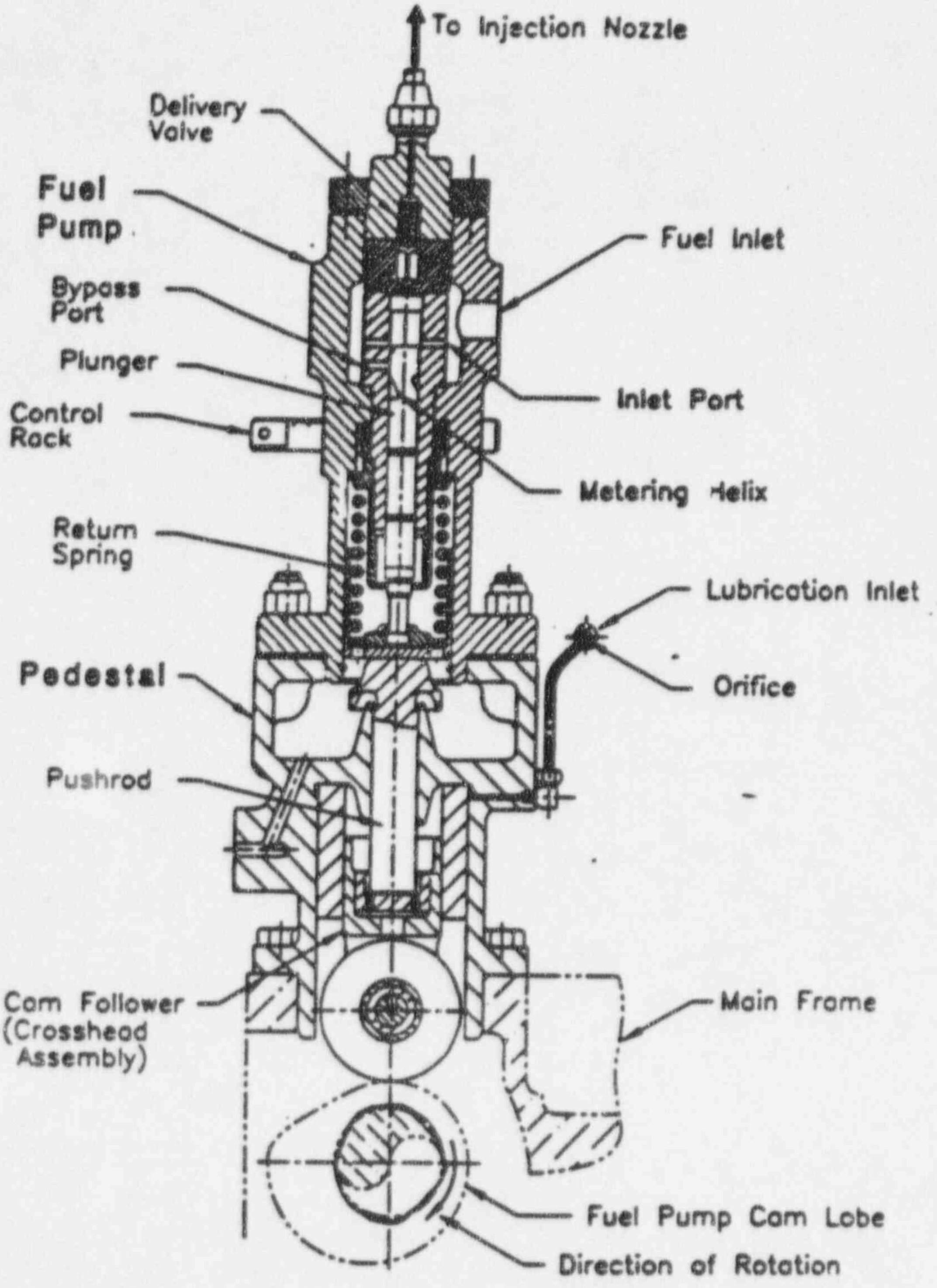

Figure 1 Fuel Pump and Pedestal Assembly

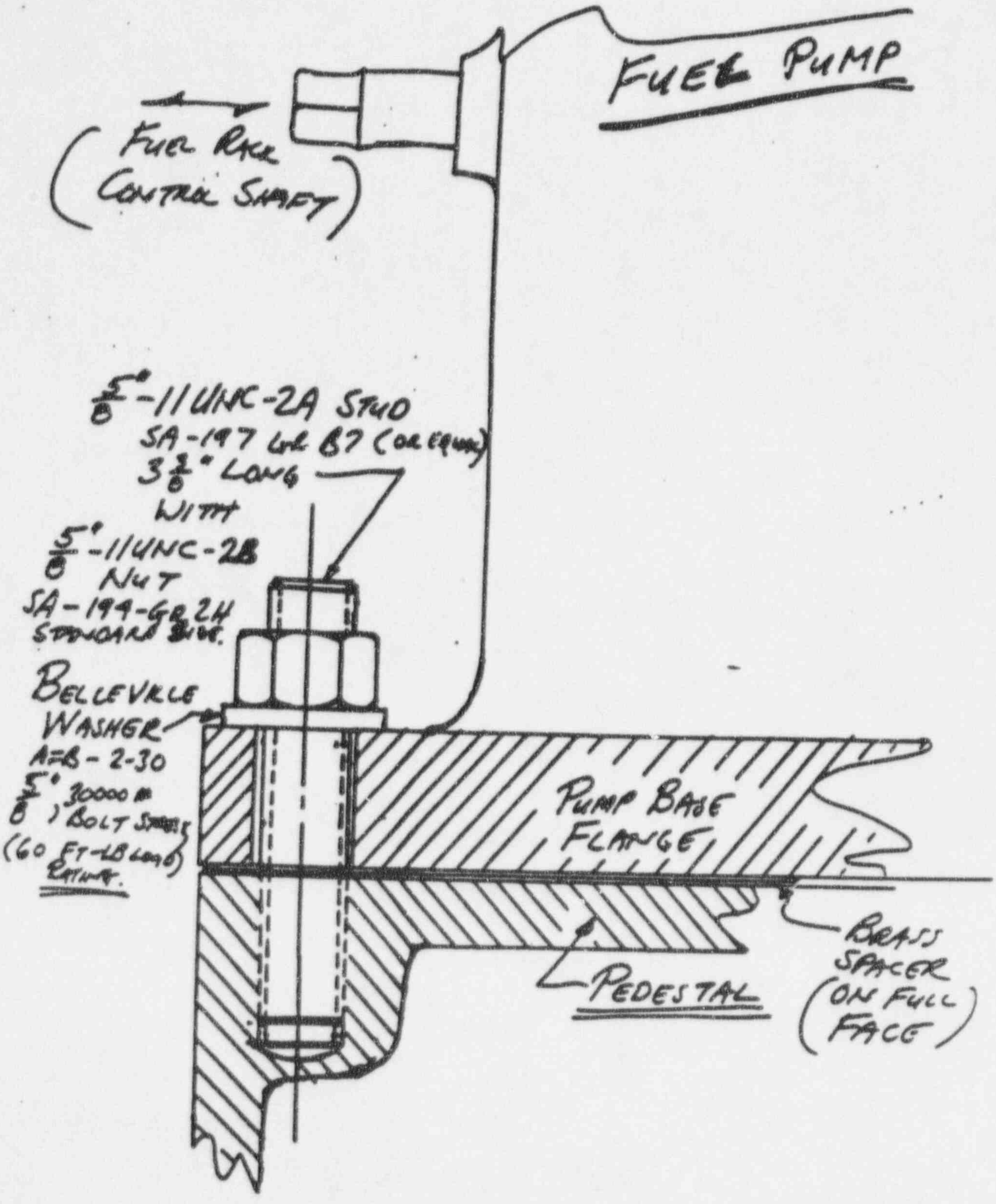
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Figure 2