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NUCLEAR REGULATORY COMMISSION
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March 7, 1983

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50-206

The Honorable Jerry M. Patterson
United States House of Representatives
Washington, D.C. 20515

Dear Congressman Patterson:

This is in response to the questions in your January 19, 1983 letter relative to the steam generator leaks at the San Onofre Unit 1 Power plant.

The basic cause of steam generator tube degradation was earlier operation of the unit by the licensees, Southern California Edison Company and San Diego Gas and Electric Company, with a type of secondary water treatment known as "phosphate chemistry" combined with some leakage of sea water into the secondary system through the main condenser. Phosphate chemistry is similar to the water treatment used in conventional steam plants. A result of its use, however, was the formation of sludge deposits which concentrated at the tube sheet and in the small crevice between the steam generator tubes and tube sheet. During the extended period that the alkaline sludge was present, the tubes were subjected to a phenomenon identified as caustic-induced intergranular attack. Continued attack led to localized minute cracks that grew and opened up resulting in leakage.

When tubes are severely degraded, often large numbers of them must be removed from service by plugging to assure safe operation of the plant. Plugging steam generator tubes results in a loss of heat transfer surface and can eventually necessitate a reduction in power. If tubes then continue to degrade and are plugged, the steam generators may have to be replaced. Some utilities have elected to replace their steam generators. Such replacements require a long outage, involve considerable cost, and entail significant occupational exposures. To prolong life of severely degraded steam generator tubes, repairs may be done by sleeving. Sleeving leaves the repaired tubes functional. Sleeving was developed through laboratory testing and has been successfully used in commercial nuclear plants.

Sleeving provides a sound technical method for restoring the integrity of degraded or defective steam generator tubing as a primary pressure boundary. However, there is no absolute assurance that every sleeved or unsleeved tube will serve throughout the life of the plant without degradation and the corresponding need for corrective action. The aspects of the tube sleeving process and secondary water chemistry control discussed below, in conjunction with the technical specification leakage limits and surveillance requirements, provide reasonable assurance that degradation will be minimized and that tube integrity will be monitored and maintained within allowable limits adequate for protecting the health and safety of the public. It should be noted that the tubes and sleeves are periodically examined for degradation.

The sleeves used at San Onofre were fabricated using the same material as the original tubes in order to provide the same strength but were thermally treated to increase their corrosion resistance. The sleeves were inserted inside the existing tube, joined at the upper end to the inner surface of the tube above the tube sheet elevation and rolled into the tube and tube sheet at the lower end.

Structural analyses of the sleeved tube assembly have been performed by the licensee in accordance with American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III. Results of these analyses indicate acceptable fatigue performance and adequate structural margins for the full range of normal operating, transient and accident condition loadings. These analyses considered both the case where the outer tube is intact and the case where the outer tube is completely severed because of corrosion.

Analyses have been performed to establish the minimum wall requirements for the degraded sleeves during normal operation and for postulated accident conditions. Structural analyses of the sleeved tube assemblies have been supplemented by extensive mechanical and metallurgical testing to verify acceptable structural strength, fatigue performance, and leak-tight integrity of the upper and lower sleeve joints.

In addition to the repairs of the steam generators, the plant is operated with a tight control on condenser leakage and the secondary water treatment program has been modified. Both of these measures are expected to remove the environment under which the intergranular attack occurred.

The steam generators in the San Onofre Units 2 and 3 have included a number of improvements which should avoid some of the problems experienced with Unit 1. Residual tube stress is minimized by having a large bending radius for the inner tube rows and using improved bending techniques which introduce much lower residual tube stress. An explosive technique for placing the tubes in contact with the tube sheet for the full tube sheet thickness has been used. This eliminates the tube-to-tube sheet crevice which has been the site of corrosion problems such as stress cracking and intergranular attack.

San Onofre 2 and 3 have employed a chemistry control program to assure that secondary water chemistry is maintained within appropriate control bounds during operation and that timely corrective actions are taken in the event abnormal chemistry occurs. An all volatile treatment water chemistry program is utilized for the secondary system. This method of control reduces the tube corrosion and related problems due to the chemical additives, and it minimizes the amount of sludge deposited within the steam generator. By the above chemistry control program, chemistry related challenges to the integrity of the steam generator tubes are minimized.

As you have requested we will keep you informed of other major issues involving the San Onofre facilities. If you have any further questions, please let us know.

Sincerely,

Nunzio Palladino

Nunzio J. Palladino

Originated in NRR:DL: ORB #5: GDick

Retyped in CR on 3/3/83 to include Cmr. Asselstine, Gilinsky and the Chm's. comments.

Ref: CR-83-21

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The Honorable Jerry M. Patterson
United States House of Representatives
Washington, D. C. 20515

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When tubes are severely degraded, often large numbers of them must be removed from service by plugging to assure safe operation of the plant. Plugging steam generator tubes results in a loss of heat transfer surface and can eventually necessitate a reduction in power. If tubes then continue to degrade and are plugged, the steam generators may have to be replaced. Some utilities have elected to replace their steam generators. Such replacements require a long outage, involve considerable cost, and entail significant occupational exposures. To prolong the life of severely degraded steam generator tubes, repairs may be done by sleeving. Sleeving not only decreases the plant downtime but also leaves the repaired tubes functional. Sleeving was developed through laboratory testing and has been successfully used in commercial nuclear plants.

The sleeves used at San Onofre were fabricated using the same material as the original tubes in order to provide the same strength but were thermally treated to increase their corrosion resistance. The sleeves were inserted inside the existing tube, joined at the upper end to the inner surface of the tube above the tubesheet elevation and rolled into the tube and tubesheet at the lower end to form a leak-tight seal.

OFFICE ▶
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Analyses have been performed to establish the minimum wall requirements for the degraded sleeves during normal operation and for postulated accident conditions. Structural analyses of the sleeved tube assemblies have been supplemented by extensive mechanical and metallurgical testing to verify acceptable structural strength, fatigue performance, and leak-tight integrity of the upper and lower sleeve joints.

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As you have requested, I would be pleased to keep you informed of other major issues involving San Onofre Unit No. 1. If you have any further questions, please let me know.

Sincerely,

Nunzio J. Palladino
Chairman

*SEE PREVIOUS TISSUE FOR CONCURRENCE

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The Honorable Jerry M. Patterson - 3 -

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I would be pleased to keep you informed of issues involving San Onofre Unit No. 1. I hope that your questions have been adequately answered.

Sincerely,

Nunzio J. Palladino
Chairman

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MEMORANDUM FOR: Chairman Palladino
FROM: William J. Dircks
Executive Director for Operations
SUBJECT: PROPOSED REPLY TO REPRESENTATIVE PATTERSON
CONCERNING SAN ONOFRE UNIT NO. 1

Enclosed for your approval is a proposed reply to Mr. Patterson's
January 19, 1983 letter concerning steam generator tube degradation and
repair at San Onofre Unit No. 1.

William J. Dircks
Executive Director for Operations

Enclosure:
Proposed letter to
Representative Patterson

cc: Commissioner Gilinsky
Commissioner Ahearne
Commissioner Roberts
Commissioner Asselstine
OPE
OGC
SECY

*EDO
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DATE	2/17/83	2/16/83	2/18/83	2/17/83	2/14/83	2/15/83	1/83

FROM: Rep. Jerry M. Patterson	ACTION CONTROL	DATES	CONTROL NO.
	COMPL DEADLINE	2/10/83	12717
TO: Chairman Palladino	INTERIM REPLY		DATE OF DOCUMENT
	FINAL REPLY	<i>AS Palladino</i>	1/19/83
	FILE LOCATION	<i>3/7/83</i>	PREPARE FOR SIGNATURE
			<input checked="" type="checkbox"/> CHAIRMAN <input type="checkbox"/> EXECUTIVE DIRECTOR OTHER:

DESCRIPTION LETTER MEMO REPORT OTHER

Q's fm 12/13/82 hearing re steam generator leaks at San Onofre Unit I power plant

SPECIAL INSTRUCTIONS OR REMARKS

PRIORITY

ASSIGNED TO	DATE	INFORMATION ROUTING
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		Funches
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		2. Mattson
		3. Thompson
		4. <i>Spice</i>
		5. Snyder
		6. Grace

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NRC SECRETARIAT

- TO: Commissioner _____ Date _____
- Exec. Dir./Oper. Gen. Counsel
- Cong. Liaison Solicitor
- Public Affairs Secretary
- _____ Inspector & Auditor
- _____ Policy Evaluation

Incoming: Rep Jerry M. Patterson

From: _____

To: Palladino Date 1/19/83

Subject: addl ques from the 12/13 hearing on steam gen
breaks tube degradation--SONGS #1

- Prepare reply for signature of:
- Chairman and Comm Review
- Commissioner _____
- EDO, GC, CL, SOL, PA, SECY, IA, PE
- Signature block omitted Date due Comm: Feb 10
- _____
- Return original of incoming with response

- For direct reply*
- For appropriate action
- For information

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Date..... 1-27-83

Time..... 2:00 p.m.

Remarks: Cpys to: OCA to Ack, RF, docket 27257

For the Commission: billie

*Send three (3) copies of reply to Secy Correspondence and Records Branch