U. S. NUCLEAR REGULATORY COMMISSION

REGION V

Report No. 50-206/90-27

Docket No. DPR-13

Licensee: Southern California Edison Company
Irvine Operations Center
23 Parker Street
Irvine, California 92718

Facility Name: San Onofre Nuclear Generating Station Unit 1

Inspection at: San Clemente, California

Inspection Conducted: July 10 - September 14, 1990

Inspectors: C. Clark, Reactor Inspector
E. Murphy, Senior Material Engineer
D. Smith, Material Engineer

Consultants: J. Gieske, Sandia Laboratory
S. Doctor, Battelle Pacific Northwest Laboratories
C. Dodd, Oak Ridge National Laboratory
T. Taylor, Battelle Pacific Northwest Laboratories

Approved by: F. R. Huey, Chief 10/4/90
Date Signed

Inspection Summary:

Inspection During the Period July 10 - September 14, 1990 (Report No. 50-206/90-27)

Areas Inspected: Routine announced and unannounced inspections to assess the effectiveness of specific areas of the licensee's ISI program for Unit 1. Specifically, the Ultrasonic (UT) inspection of the "4C" weld in the three steam generators, the remote UT inspection of the reactor vessel, and the Eddy Current Test (ECT) inspection of steam generator tubing were reviewed during these inspections.

Inspection procedures nos. 30703, 73051, 73052, 73753, and 73755 were used as guidance for the inspections.

Results:

General Conclusions and Specific Findings:

- All the ISI examinations observed and reviewed, were performed in accordance with the requirements of the ASME Code, Section XI, 1974 Edition, through the 1975 Summer Addenda. Visual examinations (VT-1, VT-2, VT-3, and VT-4), used the later inspection criteria of ASME Code, Section XI, 1977 Edition, through the 1978 Summer Addenda.

- Some of the examination procedures reviewed provided minimum information. Additional information had to be obtained from the contractor's staff performing the examinations, to fill in the details not provided in the written procedures.

- NRR suggested that rotating pancake probe inspections be included as part of future inspections for intergranular attack at the top of the steam generator tubesheet.

Significant Safety Matters: None

Summary of Violation: None

Open Items Summary: During these inspections there were no new items opened, and no existing open items were closed.

DETAILS

1. Persons Contacted

*H. Newton, Site Support Services Manager
*D. Brevig, Onsite Nuclear Licensing (ONL) Supervisor
*M. Speer, ONL Engineer
*D. Werntz, Engineering Representative
*J. Mundis, Nuclear Services Supervisor
*J. Butcher, Fuel Services Supervisor
*J. Boardman, ISI Engineer
*R. DeLong, ISI Engineer
A. Matheny, ISI Engineer
*R. Sidhar, QA Engineer

*Denotes those attending exit meetings held during the three inspection visits.

The inspectors also held discussions with other licensee and contractor personnel during the course of the inspection.

2. Inservice Inspection - Review of Program (73051)

A cursory review was made of the basis for the licensee's ISI program.

a. Program Organization

The Unit 1 ISI program is based on the requirements of the ASME Code, Section XI, 1974 Edition, with Addenda through Summer of 1975 (74S75). A December 12, 1988 SCE memorandum for file from J. D. Boardman specified that the visual examinations for the Unit 1 ISI shall be as defined in the 1977 Edition, 1978 Summer Addenda (77S78), Section XI, IWA-2210.

3. Inservice Inspection - Review of Procedures (73052)

A review of the following ISI procedures was conducted.

a. Remote ultrasonic inspection of the reactor vessel.

The inspectors were augmented by Dr. Steven Doctor and Mr. Tom Taylor of Battelle-Pacific Northwest Laboratories. The ultrasonic procedures were reviewed and no discrepancies or errors were found (see attachment 1).

b. Eddy current testing of steam generator tubing.

The inspectors were augmented by Mr. Caius Dodd of Oak Ridge National Laboratory. The main eddy current examination procedures were reviewed and no discrepancies or errors were identified (see attachment 3). During review of the examination procedures, it was identified that while there were analyst guidelines provided for use of the bobbin coil probe, there were no analyst guidelines provided for use of the 8x1 probe and the Rotating Pancake (RPC) probe. The interpretation of the signals from the inspection of the sleeved tubes with the 8x1 probes and RPC probes, is particularly difficult, and analyst guidelines could aide in the interpretation of these signals.

4. Inservice Inspection - Observation of Work and Work Activities (73753)

During this inspection, the licensee was conducting the Unit 1, Cycle 11 refueling outage, which is the first refueling outage of the third inspection period of the second 10-year interval.

a. Remote ultrasonic inspection of the reactor vessel.

While on site, remote ultrasonic inspections had been conducted on some welds, and the inspectors observed the data acquisition during examination of the bottom head weld. A video tape had been made of the reactor pressure vessel internal surfaces, with the aid of a remotely controlled submersible vessel, which was also reviewed by the inspectors. The surfaces appeared smooth and should provide an acceptable surface for ultrasonic testing. No discrepancies or errors were identified (see attachment 1).

b. Eddy current testing of steam generator tubing.

Eddy current examination activities were observed, and no discrepancies or errors were identified (see attachment 3). On September 26, 1990, per telecon, the licensee identified that twenty-nine steam generator tubes were plugged this outage as a result of steam generator examinations. Sixteen tubes were plugged as a result of eddy current examination results, and thirteen were plugged based on leak testing results. The inspectors observed that the licensee has departed from the past practice of using a Rotating Pancake (RPC) probe to inspect for Intergranular Attack (IGA) at the top of the tubesheet. The current program relies mainly on the bobbin probe with supplemental inspection using an 8x1 probe for tubes within two rows of the sleeving boundary. After reviewing a sample of past data, NRR noted that a good eddy current test program normally includes inspections for IGA, and suggested that RPC probe inspections be included as part of future inspections for IGA.

5. Inservice Inspection - Data Review and Evaluation (73755)

a. Steam Generator Girth Welds ("4C" weld on each of 3 steam generators).

The NRC's consultant, Mr. John Geiske, reviewed the ISI inspection data and other gathered information for the cycle 9 outage ultrasonic inspection of the "4C" weld in the three steam generators. These ISIs had been conducted by Westinghouse Nuclear Service Division, Inspection Services between February 14 and March 19, 1986. A length of 44 inches had been UT inspected of the 4C weld in each steam generator. The review determined that the licensee had established to a reasonable degree of assurance that these welds were free of cracks at the time of inspection (see attachment 2).

b. Pressurizer Cladding (interior surface visual examination by underwater video camera).

This examination had been performed during this refueling outage because of concerns raised by an incident at Haddam Neck 1, a Westinghouse design of the same vintage as SONGS 1. The video tape demonstrated that the cladding and other interior details of the pressurizer vessel were of different design and configuration. Although the video had not been electronically enhanced, it was of high enough resolution to show the differences in configuration, that the cladding had been finished to remove the grooves between weld passes, and there appeared to be areas of grinding to accomplish this. No discrepancies or errors were identified.

c. Remote ultrasonic Inspection of Reactor Vessel Welds.

The NRC consultants, Dr. Steven Doctor and Mr. Tom Taylor, reviewed the video tape of the reactor vessel's internal surface, observed data acquisition during a weld examination, and reviewed inspection data of various vessel shell welds. The remote ultrasonic reactor vessel weld inspections were conducted by Rockwell International. The review determined that these examinations met the requirements of the applicable ASME Code and guideline of Regulatory Guide 1.150 (see attachment 1).

d. Eddy current testing of steam generator tubing.

The NRC consultant, Mr. Caius Dodd, reviewed available eddy current data, and no discrepancies or errors were identified (see attachment 3). The eddy current examinations were conducted by Conam Nuclear and Allen Nuclear Associates Inc. performed an independent data analysis.

6. <u>Exit Meetings (30703)</u>

The inspectors and NRC consultants met with the licensee management representatives denoted in paragraph 1, during the three inspection visits. The scope of the inspection and the findings of the inspectors and NRC consultants, up to the time of the meetings, were discussed. At the time of these meetings, the inspectors identified that additional information had been obtained, that would be reviewed in the NRR and NRC regional offices. The information was reviewed and the findings included in paragraphs 3, 4, and 5 of this report.

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 375-2838
FAX: 509-375-3641

September 27, 1990

Dr. J. Muscara
Nuclear Regulatory Commission
NS 217C
Washington, DC 20555

Subject: Review of Reactor Pressure Vessel Ultrasonic Inservice Examination at San Onofre 1

Dear Joe:

PNL was requested to assist in reviewing the ten year ultrasonic inservice examination of the reactor pressure vessel at San Onofre 1. To provide this assistance, Tom Taylor and Steve Doctor conducted a review of the ultrasonic reactor pressure vessel examination which included the following activities.

- Reviewing the ultrasonic procedures used for the inservice examination
- Visiting the site to review ISI activities during the examination

I. Review of Ultrasonic Procedures for San Onofre 1 Reactor Pressure Vessel

The reactor pressure vessel examination conducted at San Onofre during August 1990 was required to meet the requirements of the 1974 Edition including the Summer 1975 Addenda of ASME Section XI and the recommendations of Regulatory Guide 1.150.

The reactor pressure vessel examination was conducted by Rockwell International using the following procedures.

- Inservice Inspection - Ultrasonic Examination of Reactor Vessel Longitudinal and Circumferential Shell Welds, Doc. #204IS000001

- Inservice Inspection - Ultrasonic Examination of Nuclear Reactor Safe End-to-Nozzle Welds, Doc. #204IS000002
- Inservice Inspection - Ultrasonic Examination of Reactor Nozzle to Vessel Welds, Doc. #204IS000003
- Inservice Inspection - Ultrasonic Examination for Detection of Underclad Cracking and Examination for Near-Surface Reflectors from the Inside Surface, Doc. #204IS000004
- Inservice Inspection - Ultrasonic Examination of Nuclear Reactor Nozzle Inside Radius Section, Doc. #204IS000005
- Inservice Inspection - Ultrasonic Examination of the Reactor Flange to Vessel Weld from the Flange Surface, #204IS000006
- Inservice Inspection - Ultrasonic Examination of Reactor Vessel Flange Ligament Areas, Doc. #204IS000007
- Inservice Inspection - Ultrasonic Examination of Reactor Vessel Integral Supports, Doc. #204IS000008

After reviewing the procedures, PNL concludes that the ultrasonic procedures used to conduct the reactor pressure vessel examination meet the requirements of the 1974 Edition of Section XI including the Summer 1975 Addenda.

It should be noted that although the procedures met the ASME requirements, it was necessary to review the procedure with Rockwell staff to understand and fill in the details not provided in the written procedures. There are many pieces of the procedures that are not spelled out and the review process is the only way to gather this kind of information. This is an unfortunate shortcoming of the past requirements.

A brief summary of the recording and reporting criteria for indications is attached to this report (Attachment 1).

II. Review of Reactor Vessel ISI Activities at the Plant Site

A review of the reactor pressure vessel examination activities at the plant site was conducted from August 1-3 and 6, 1990. The review activities included:

- discussions with Rockwell personnel,
- reviewing a video tape of the reactor pressure vessel internal surface created by a submersible vessel,

Attachment 1

- observation of data acquisition during examination of the bottom head weld,

- review of inspection data of the peel weld and circumferential shell welds.

The following information resulted from the site review.

- The clad/base metal region of the reactor vessel is being examined with a 70° longitudinal wave technique. The clad/base metal region of all welds that are scanned is examined with the 70° inspection technique.

- The search unit head is designed for a constant water path. Rockwell monitors the water path to ensure consistent coupling of the search unit head.

- A review of a video tape of the vessel clad surface indicated that the clad surface (probably multi-wire cladding process) was relatively smooth and should not be excessively difficult to examine.

- The inspection system used by Rockwell has the capability to digitize (record in digital form) the RF waveform of every transducer used during the vessel examination but they normally only digitize the envelope detected signals exceeding a selected threshold value.

Discussions with Rockwell personnel indicated that Rockwell had performed some demonstration during the development of the inspection tool. Rockwell also indicated that testing had been performed on two test blocks owned by the EPRI NDE Center. Rockwell had provided some limited data to the EPRI NDE Center for preliminary assessment of the technique effectiveness for under-clad crack detection and sizing. Some of the reports that were provided by Rockwell were proprietary and were reviewed as part of our evaluation. Subsequently, Rockwell has provided the NDE Center with all of the data that they have collected and analyzed. Unfortunately, a report describing this more detailed and complete evaluation is not available yet. Based on the Rockwell reports PNL reviewed and laboratory tests conducted at PNL on various techniques to determine their effectiveness, the technique developed by Rockwell appears effective for detecting under-clad defects. Furthermore, the data supports the position that Rockwell personnel can effectively employ this technique.

III. Conclusions

As a result of our review, PNL concludes that the reactor pressure vessel examination being performed at San Onofre meets the requirements of Section XI 1974 Edition including Addenda through 1975.

Regulatory Guide 1.150, Rev. 1, Section 6.0 states that the ability to detect and size flaws should be demonstrated. However, the guide does not state what constitutes an acceptable demonstration or acceptable documentation of a demonstration. Based upon a review of reports and ISI activities performed by Rockwell, PNL concludes that the examination of the clad/base metal region meets the intent of the guidance specified in Regulatory Guide 1.150, Rev. 1.

Very truly yours,

STEVEN R. DOCTOR
Project Manager
NDE Technical Group Leader

Concurrence:

THEODORE T. TAYLOR
Senior Research Engineer

SRD:kh

Enclosures

cc: CA Clark, NRC, Region V
RA Hermann, NRC, 9H-15
DE Smith, NRC, 7E-23

Attachment 1
Recording and Reporting Criteria

A. AREA OF EXAMINATION

- Reactor Flange to Vessel Weld from the Flange
- Reactor Nozzle to Vessel Weld
- Reactor Vessel Circumferential and Longitudinal Welds

RECORDING CRITERIA

GENERAL. The ISI Examination Form is completed at the conclusion of each weld examination. Recordable level indications (20% DAC or greater for the inner 1/4t and 50% DAC or greater for the outer 3/4t) will be documented or a statement "No recordable level indications" will be entered. The form will be signed by a certified UT Level II, IIA, or III examiner. Those signal amplitudes which are above the "recordable level" threshold are printed out as hard copies for evaluation. All relevant indications will be recorded in accordance with criteria of the ASME Code, Section XI and U.S. NRC Regulatory Guide 1.150, Rev. 1. All signal amplitudes above the "save data" threshold level are recorded and stored on magnetic tape.

CALIBRATION RECORDS. A Calibration Form is completed for each calibration performed. Calibration rechecks are noted in the Operations Log and recorded in the Calibration Recheck Form.

WELD IDENTIFICATION. Scan data for each weld will be referenced to a known zero reference or bench mark on the vessel and recorded.

REPORTING CRITERIA

Indications exceeding 20% DAC size limitations or indications of 50% DAC and greater will be documented and reported using a report form. Indications having no size (point indications) will not be reported. All relevant indications shall be sized and characterized in accordance with criteria of the ASME Code, Section XI, IWA-3000 and IWB-3000. For reporting purposes, data shall be obtained at increments no greater than 0.6 cm. Coordinates will be recorded at least to the nearest 0.1 cm or the azimuthal equivalent.

NONRELEVANT INDICATIONS. Nonrelevant indications, such as those from geometric sources, shall be identified as such on the computer printout by the certified examiner, along with the source of the indication. No further sizing, evaluation, or recording shall be required.

RELEVANT INDICATIONS.

Traveling Indications.

1. Indications that change metal path distances (indicating through-wall dimension) for a distance greater than that recorded from the calibration holes (at 20% DAC) shall be reported.

2. Indications which are at metal paths representing 25% and greater of the through-wall thickness of the vessel wall, measured from the inner surface, shall be characterized and reported at 50% DAC.

3. Indications which are within the inner 25% of the through-wall thickness shall be reported at 20% DAC. If the indication exceeds 50% DAC, the length shall be reported between the 20 and 50% DAC limits. Beam spread shall be measured at 20% DAC for the transducer used for sizing.

Nontraveling Indications.

1. Indications above the 50% DAC level which do not change metal path and are within the outer 75% of the through-wall thickness that persist for a scanning distance of more than 1 inch shall be reported.

2. Indications that are within the inner 25% of the through-wall dimension shall be reported at 20% DAC. If indication amplitude exceeds 50% DAC, the length shall be reported between the 20 and 50% DAC limits.

3. Beam spread shall be measured at 20% DAC for the transducer used for sizing.

4. All indications outside the examination volume and having an amplitude equal to or greater than the remaining back surface amplitude shall be sized and reported. All continuous indications within the examination volume which produce a continuous loss of back reflection shall be reported.

Notification. Prompt (24 hours) notification of reportable indications shall be made to the customer. This notification will be made by the Site Representative.

EVALUATION. Each detected indication or group of indications shall be characterized by the rules of IWA-3100. When the indication is sized at 20% DAC, the size will be corrected by subtracting the beam width in the through-wall thickness direction obtained from the calibration hole (between 20% DAC points) which is at a depth similar to the flaw depth. The determined size shall be the larger of the two. These dimensions, in conjunction with the acceptance standards of IWB-3500, shall be used to establish acceptability. Disposition of indications that exceed the acceptance standards shall be the responsibility of the utility-owner.

B. AREA OF EXAMINATION

- Reactor Safe End-to-Nozzle Weld

RECORDING CRITERIA

GENERAL. The ISI Examination Form is completed at the conclusion of each weld examination. Recordable level indications (greater than 20% DAC) will be documented or a statement "No recordable level indications" will be entered. The form will be signed by a certified UT Level II, IIA, or III examiner.

CALIBRATION RECORDS. A Calibration Form is completed for each calibration performed. Calibration rechecks are noted in the Operations Log and recorded in the Calibration Recheck Form.

WELD IDENTIFICATION. Scan data for each weld will be referenced to a known zero reference or bench mark on the vessel and recorded on the data record.

REPORTING CRITERIA

The computerized data acquisition system will automatically record the position coordinates, depth in the metal, and signal amplitude of all indications greater than 20% DAC. The position data coordinates will be recorded in reference to a known zero reference or benchmark on the vessel. All indications within the examination zone will be evaluated in the manual mode by a Level II, IIA, or III ultrasonic examiner.

Recordable level indications greater than 20% DAC will be investigated and evaluated for relevancy. Indications having no size (point indications) will not be reported. All relevant indications shall be characterized. For reporting purposes, data shall be obtained at increments no greater than 0.6 cm. Coordinates will be recorded at least to the nearest 0.1 cm or the azimuthal equivalent.

NONRELEVANT INDICATIONS. Nonrelevant indications, such as those from geometric sources, shall be identified as such on the computer printout by the certified examiner, along with the source of the indication. No further sizing, evaluation, or recording shall be required.

RELEVANT INDICATIONS. All relevant indications having amplitudes greater than 20% DAC shall be recorded and sized. Relevant indications shall be investigated to the extent that the operator can evaluate the shape, identity, and location of indications.

NOTIFICATION. Prompt (24 hours) notification of reportable indications shall be made to the customer.

EVALUATION. Each detected indication or group of indications shall be characterized by the rules of IWA-3100. The dimensions of the indications, in conjunction with the acceptance standards of IWB-3514, shall be used to establish acceptability. Disposition of indications that exceed the acceptance standards shall be the responsibility of the utility.

C. AREA OF EXAMINATION

- Examination for Detection of Underclad Cracking

RECORDING CRITERIA

GENERAL. The ISI Examination Form is completed at the conclusion of each weld examination. Recordable level indications (20% DAC or greater) will be documented or a statement "No recordable level indications" will be entered. The form will be signed by a certified UT Level II, IIA, or III examiner.

A rough clad surface may reflect a high noise baseline making a 20% record level impractical. In such a case, the data recording level may be raised at the discretion of a Level III UT examiner.

The volume not effectively examined due to physical obstructions will be documented.

CALIBRATION RECORDS. A Calibration Form is completed for each calibration performed. Calibration rechecks are noted in the Operations Log and recorded in the Calibration Re-h-.k Form.

WELD IDENTIFICATION. Scan u-ta for each weld will be referenced to a known zero reference or bench mark on the vessel and recorded.

REPORTING CRITERIA

The computerized data acquisition system will automatically record the position coordinates, depth in the metal, and signal amplitude of all indications exceeding 20% DAC (10% full screen height). The position data coordinates will be recorded in reference to a known zero reference or benchmark on the vessel. All indications within the examination zone will be evaluated in the manual mode by a Level II, IIA, or III ultrasonic examiner.

Indications exceeding 20% DAC will be investigated to the extent that the examiner can determine the identity, shape, and location of such indications. All relevant indications shall be sized and characterized in accordance with criteria on the ASME Code, Section XI, IWA-3000 and IWB-5000. For reporting purposes, data shall be obtained at increments no greater than 0.6 cm. Coordinates will be recorded at least to the nearest 0.1 cm or the azimuthal equivalent.

NONRELEVANT INDICATIONS. Nonrelevant indications, such as those from geometric sources, shall be identified as such on the computer printout by the certified examiner, along with the source of the indication. No further sizing, evaluation, or recording shall be required.

RELEVANT INDICATIONS.

Traveling Indications. Relevant indications exceeding 50% DAC shall be reported. Sizing shall be performed at the 50% DAC limits. Due to the nature of this examination, the ASME Code size criterion may not be the most accurate. Additional sizing techniques are available that may provide more reliable information. These techniques include the use of additional angle beams and crack tip diffraction. These techniques shall only be used at the discretion of the Level III by Utilities request.

Notification. Prompt (24 hours) notification of reportable indications shall be made to the customer. This notification will be made by the Site Representative.

EVALUATION. Each detected indication or group of indications shall be characterized by the rules of IWA-3300. The dimensions of the indication(s), in conjunction with the acceptance standards of IWB-3500, shall be used to establish acceptability. Disposition of indications that exceed the acceptance standards shall be the responsibility of the utility-owner.

RECORDING CRITERIA

GENERAL. The ISI Examination Form is completed at the conclusion of each weld examination. Recordable level indications (20% DAC or greater) will be documented or a statement "No recordable level indications" will be entered. The form will be signed by a certified UT Level II, IIA, or III examiner.

A rough clad surface may reflect a high noise baseline making a 20% record level impractical. In such a case, the data recording level may be raised at the discretion of a Level III UT examiner.

The volume not effectively examined due to physical obstructions will be documented.

CALIBRATION RECORDS. A Calibration Form is completed for each calibration performed. Calibration rechecks are noted in the Operations Log and recorded in the Calibration Recheck Form.

WELD IDENTIFICATION. Scan data for each weld will be referenced to a known zero reference or bench mark on the vessel and recorded.

REPORTING CRITERIA

The computerized data acquisition system will automatically record the position coordinates, depth in the metal, and signal amplitude of all indications exceeding 20% DAC (10% full screen height). The position data coordinates will be recorded in reference to a known zero reference or benchmark on the vessel. All indications within the examination zone will be evaluated in the manual mode by a Level II, IIA, or III ultrasonic examiner.

Indications exceeding 20% DAC will be investigated to the extent that the examiner can determine the identity, shape, and location of such indications. All relevant indications shall be sized and characterized in accordance with criteria on the ASME Code, Section XI, IWA-3000 and IWB-5000. For reporting purposes, data shall be obtained at increments no greater than 0.6 cm. Coordinates will be recorded at least to the nearest 0.1 cm or the azimuthal equivalent.

NONRELEVANT INDICATIONS. Nonrelevant indications, such as those from geometric sources, shall be identified as such on the computer printout by the certified examiner, along with the source of the indication. No further sizing, evaluation, or recording shall be required.

RELEVANT INDICATIONS.

Traveling Indications. Relevant indications exceeding 50% DAC shall be reported. Sizing shall be performed at the 50% DAC limits. Due to the nature of this examination, the ASME Code size criterion may not be the most accurate. Additional sizing techniques are available that may provide more reliable information. These techniques include the use of additional angle beams and crack tip diffraction. These techniques shall only be used at the discretion of the Level III by Utilities request.

Notification. Prompt (24 hours) notification of reportable indications shall be made to the customer. This notification will be made by the Site Representative.

EVALUATION. Each detected indication or group of indications shall be characterized by the rules of IWA-3300. The dimensions of the indication(s), in conjunction with the acceptance standards of IWB-3500, shall be used to establish acceptability. Disposition of indications that exceed the acceptance standards shall be the responsibility of the utility-owner.

D. AREA OF EXAMINATION

- Reactor Vessel Flange Ligament Area

RECORDING CRITERIA

All reflectors which produce a response greater than 20% of the reference level shall be investigated to the extent that the examiner can determine the shape, identity, and location of all such reflectors.

The size of reflectors shall be measured between points which give amplitudes equal to 100% of the reference level.

For each indication that exceeds 50% of reference level amplitude, but does not exceed the reference level, the search unit position at peak amplitude and the peak amplitudes as either dB from reference level, or as a percent of DAC, shall be recorded.

REPORTING CRITERIA

If any recordable indications are detected, a detailed ultrasonic examination report shall be prepared along with any additional sketches or photographs as may be applicable. If no recordable indications are detected, it shall be so noted on the appropriate form.

Further evaluation of reportable indications to determine disposition and/or the need to make repairs shall be the responsibility of the utility-owner.

E. AREA OF EXAMINATION

- Reactor Nozzle Inside Radius

RECORDING CRITERIA

GENERAL.

Nozzle Radius. Indications whose amplitudes are equal to or exceed 50% of DAC will be recorded or a statement "No recordable level indications" will be entered. The form will be signed by a certified UT Level II, IIA, or III examiner.

Adjacent Areas. The ISI Examination Form is completed at the conclusion of each weld examination. Recordable level indications (50% DAC or greater) will be documented or a statement "No recordable level indications" will be entered. The form will be signed by a certified UT Level II, IIA, or III examiner.

CALIBRATION RECORDS. A Calibration Form is completed for each calibration performed. Calibration rechecks are noted in the Operations Log and recorded in the Calibration Recheck Form.

WELD IDENTIFICATION. Scan data for each weld will be referenced to a known zero reference or bench mark on the vessel.

REPORTING CRITERIA

The computerized data acquisition system will automatically record the position coordinates, and signal amplitude of all indications exceeding the calibration reference level (50% full screen height). The position data coordinates will be recorded in reference to a known zero reference on the nozzle. All indications within the examination zone will be evaluated in the manual mode by a Level II, IIA, or III ultrasonic examiner.

Indications whose amplitudes equal or exceed the calibration reference level (50% full screen height) will be documented and reported using a report form. Indications having no size (point indications) will not be reported. For reporting purposes, data shall be obtained at increments no greater than 0.6 cm. Coordinates will be recorded at least to the nearest 0.1 cm or the azimuthal equivalent.

ADJACENT AREAS. The computerized data acquisition system will automatically record the position coordinates, depth in the metal, and signal amplitude of all indications exceeding 50% DAC (25% full screen height). The position data coordinates will be recorded in reference to a known zero reference or benchmark on the vessel. All recorded indications within the examination zone will be evaluated in the manual mode by a Level II, IIA, or III ultrasonic examiner.

Relevant indications whose amplitudes equal or exceed the calibration reference level (50% full screen height) will be documented and reported using a report form. All relevant indications shall be characterized. For reporting purposes, data shall be obtained at increments no greater than 0.6 cm. Coordinates will be recorded at least to the nearest 0.1 cm or the azimuthal equivalent.

Nonrelevant Indications. Nonrelevant indications, such as those from geometric sources, shall be identified as such on the computer printout by the certified examiner, along with the source of the indication. No further sizing, evaluation, or recording shall be required.

Relevant Indications. All indications having amplitudes of 100% DAC or more shall be recorded and sized. For indications over 100% DAC amplitude, the through-wall depth will be measured between the reference amplitude boundaries. Peak amplitude and location also shall be recorded. The length of each indication shall be measured between the reference amplitude boundaries.

NOTIFICATION. The customer will be notified of any reportable indication within 24 hours of detection. This notification will be made by the site representative.

Evaluation. Each detected indication or group of indications shall be characterized by the rules of IWA-3300. These dimensions, in conjunction with the acceptance standards of IWB-3412, shall be used to establish acceptability. Disposition of indications that exceed the acceptance standards shall be the responsibility of the utility-owner.

F. AREA OF EXAMINATION

- Reactor Vessel Integral Supports

RECORDING CRITERIA

GENERAL. The ISI Examination Form is completed at the conclusion of each weld examination. Recordable level indications (50% DAC or greater) will be documented or a statement "No recordable level indications" will be entered. The form will be signed by a certified UT Level II, IIA, or III examiner. Those signal amplitudes which are above the "recordable level" threshold are printed out as hard copies for evaluation. All relevant indications will be recorded in accordance with criteria of the ASME Code, Section XI. All signal amplitudes above the "save data" threshold level are recorded and stored on magnetic tape.

CALIBRATION RECORDS. A Calibration Form is completed for each calibration performed.

WELD IDENTIFICATION. Scan data for each weld will be referenced to a known zero reference or bench mark on the vessel and recorded.

REPORTING CRITERIA

NONRELEVANT INDICATIONS. Nonrelevant indications, such as those from geometric sources, shall be identified as such on the computer printout by the certified examiner, along with the source of the indication. No further sizing, evaluation, or recording shall be required.

RELEVANT INDICATIONS. Relevant indications of 50% DAC and greater will be documented and reported using a report form. Indications having no size (point indications) will not be reported. All relevant indications shall be characterized and evaluated in accordance with criteria of the ASME Code, Section XI, IWB-3000. For reporting purposes, data shall be obtained at increments no greater than 0.6 cm. Coordinates will be recorded at least to the nearest 0.1 cm or the azimuthal equivalent.

Prompt (24 hours) notification of reportable indications shall be made to the customer. This notification will be made by the Site Representative.

EVALUATION. Each detected indication or group of indications shall be characterized by the rules of IWA-3300. The dimensions of the indication(s), in conjunction with the acceptance standards of IWB-3512, shall be used to establish acceptability. Disposition of indications that exceed the acceptance standards shall be the responsibility of the utility-owner.

Sandia National Laboratories

Albuquerque, New Mexico 87185

July 13, 1990

Mr. D. E. Smith
U. S. Nuclear Regulatory Commission
Materials Engineering Branch
Washington, DC 20555

Subject: Evaluation of the Ultrasonic Indications in the Girth Weld of the Westinghouse Steam Generators at San Onofre Nuclear Generating Station, Unit 1.

Dear Mr. Smith:

Because of recent steam generator operating experience showing that Westinghouse steam generator girth weld "C" joining the transition cone to upper cylinder is susceptible to cracking, the UT examination of one of the steam generators was going to take place at the present refueling outage of San Onofre Unit 1 starting July 10,1990. After review of the UT data taken 5 years ago and from considerations of doing a similar examination in future refueling outages, Southern California Edison decided not to do the UT examination in this outage. Therefore, I was asked by NRC to review the UT data taken 5 years ago on the three steam generators at San Onofre Unit 1, and evaluate the indications recorded from the ID surface at the welds to determine if they were from cracks or geometric reflectors at the root of the welds.

Evaluation of 1986 UT Data Package of the Upper Cone Weld of Steam Generators A, B, C

Several indications recorded above 50% DAC were located at the ID surface of the weld in all three steam generators. On all three generators the indications were recorded only from one side of the weld. From UT thickness measurements and contour profiling of the ID surface, the indications were determined to be generated by geometric reflectors at the ID surface and not from cracks at that surface. An actual ID profile measurement was made on the C generator at the location of an indication with a profile gauge. A plot of the cross section of the welds at the indications as generated by Robert W. Pechacek of Combustion Engineering in 4-1-1986, are shown in Figure 1. The plots of the UT indications shown for the three welds were made by Mr. Peckacek who did an independent evaluation of the indications for Southern California Edison in 1986.

Attachment 2

The positions of the plotted UT indications is consistent with the presence of the geometric ID surface being almost perpendicular to the ultrasonic beam. The geometry of the ID surface is also consistent with the fact that no UT indications were recorded with the ultrasonic beam directed from the opposite direction to the weld.

Therefore, it is my conclusion that the UT indications are not from cracks since indications were not recorded from both sides of the weld, and the recorded indications are consistent with the geometry of the ID surface plotted in Figure 1.

Sincerely,

John H. Gieske

JHG:jk

Copy to:
NRC Brian Thomas

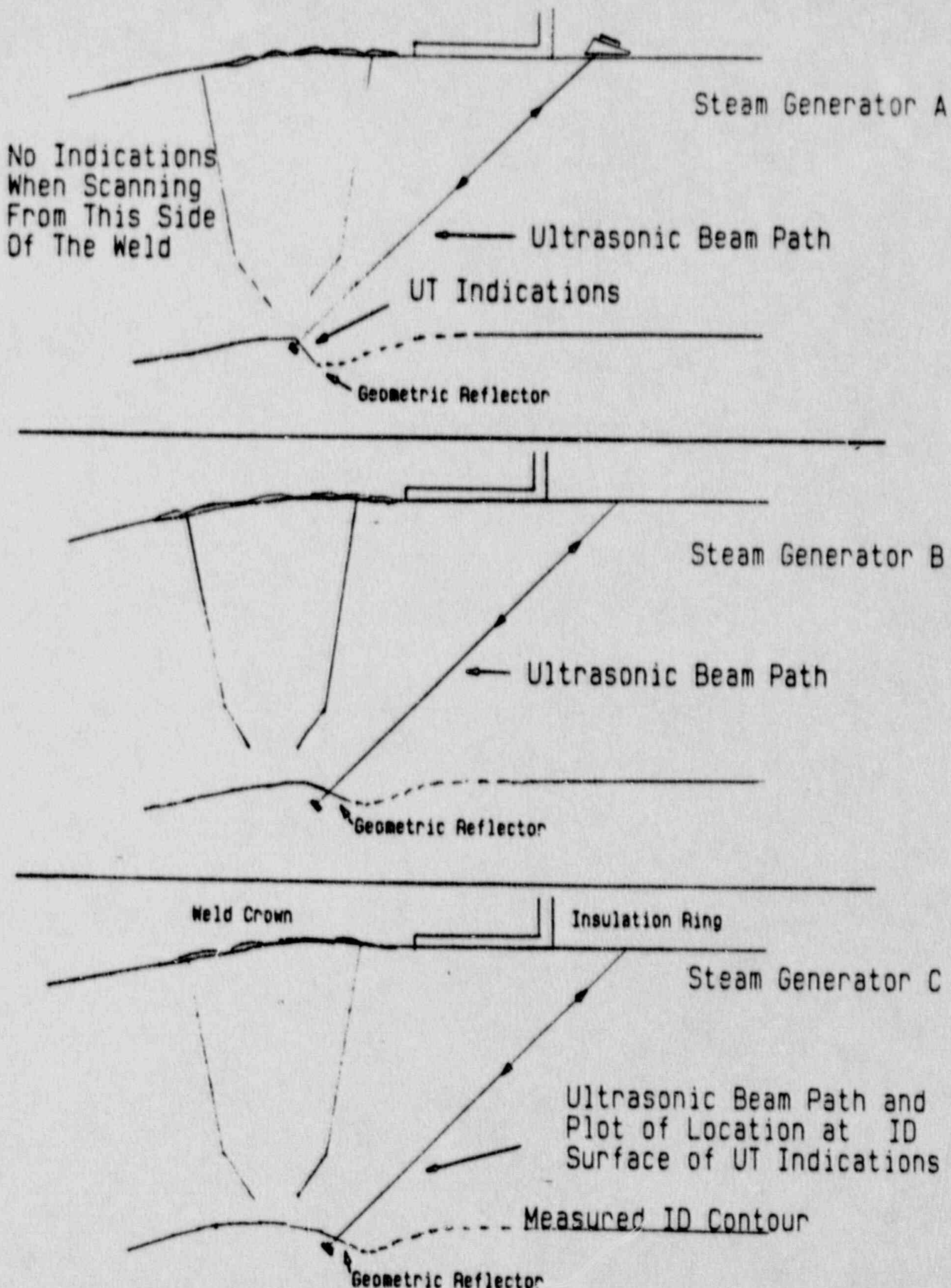

Figure 1. Cross Sectional Plots of the Ultrasonic Beam Location and UT Indications with respect to the ID Surface Contour of San Onofre Unit 1 Steam Generator Welds.

TRIP REPORT

REVIEW OF INSERVICE INSPECTION OF
STEAM GENERATOR TUBES AT SAN ONOFRE UNIT 1

INTRODUCTION

Emmett Murphy of the Materials and Chemical Engineering Branch (EMCB), NRR, visited the San Onofre site on August 29 and 30, 1990, to review the ongoing inservice inspection of the San Onofre Unit 1 steam generator tubes. Mr. Murphy was accompanied by Caius Dodd of Oak Ridge National Laboratory who is an expert consultant to EMCB in the field of eddy current testing (ECT). This review was performed at the request of Region V.

Persons Contacted

- Charles Towsend, NRC Resident Inspector
- J. Mundis, Southern California Edison (SCE)
- A. Mathini, SCE
- T. Holden, Allen Nuclear Associates (ANA)
- M. Davidson, ANA
- J. Vanage, Conam
- D. Werntz, SCE
- Dave Brevig, SCE

Scope of Review

- Planned Inspection Scope - Eddy Current test (ECT) sampling plan was provided to the staff in the form of tubesheet maps and summary sheets. This information was broken down by steam generator number, hot leg vs. cold leg, types of ECT probes utilized, sleeved tubes, and unsleeved tubes.
- SCE "Data Analysis Guidelines, San Onofre Nuclear Generating Station, Unit 1", Draft, dated August 1990 -- These Guidelines were prepared for SCE by ANA. These guidelines are intended to describe the specific examination techniques and the corresponding data evaluation practices

Attachment 3

considered necessary by SCE to meet current examination requirements. (The staff did not notice until after the site visit that these guidelines were still in draft form. Nonetheless, it was clearly the licensee's intent to implement these guidelines for the current steam generator inspection. Furthermore, these guidelines were the subject of the site-specific training program that the data analysts received.

- SNT-TC-IA certifications of ECT data analysts
- Site-specific training and performance demonstration of data analysts
- Eddy current test hardware (including probes) and software, including calibration records
- Runs on the calibration standards required by ASME Code, Section XI
- Eddy current signal displays for selected sleeved and unsleeved tubes

Findings

1. Findings of staff's Oak Ridge consultant are attached.

2. No deviations from Technical Specification or ASME Code requirements were identified.

3. Several comments bearing on the effectiveness of the licensee's steam generator inspection program were identified. These comments were provided orally to representatives of the licensee's staff during a closeout meeting at the site on August 30, 1990, and were as follows:

   1) The licensee has departed from his past practice of using a rotating pancake coil (RPC) probe to inspect for IGA at the top of the tubesheet. The current program relies mainly on the bobbin probe with supplemental inspection using an 8X1 probe for tubes within two rows of the sleeving boundary. It is the licensee's position, as stated in its letter to the NRC staff dated May 23, 1988, that absence of a bobbin coil signal assures that any IGA is less than 20% through-wall, even in cases where an 8X1 or RPC probe shows the presence of an "IGA-like" signal.

      We have some concerns regarding the licensee position on this matter. These concerns are underscored by our on-site review of eddy current signals obtained in 1988 for tube R26C21 in SG B. The licensee reported (letter dated May 23, 1988) that an RPC inspection of this tube in 1988 showed an "IGA-like" signal at the top of the tubesheet location. The licensee further reported that a reexamination (performed in 1988) of 8X1 probe data obtained in 1985 for this tube also revealed an "IGA-like" signal. (This signal was not called at the time of the 1985 inspection). However, bobbin coil data for this tube obtained in 1985 and again in 1988 revealed no indication of IGA on the 100 kHz absolute channel, and thus the licensee concluded that IGA was less than 20% through-wall. As a conservative measure, the licensee elected to plug this tube.

We established on the basis of our review that the 1988 RPC indication reported by the licensee can be described as a planar indication within the crossectional plane of the tube, very much like a circumferential crack. It is our experience that the development of relatively sharp cracks in regions of IGA involvement is not at all unusual. The RPC crack-like indication appears to measure between 50% and 70% through-wall. Because of its circumferential orientation, we do not find it at all unexpected that the bobbin coil could not detect this indication.

We believe RPC probe inspections to be a key element of an inspection program which will ensure the reliable detection of IGA and associated cracks. We recommend that RPC inspections be included on part of future inspections for IGA. Bobbin coil inspections, in our view, have not been demonstrated to be adequately effective for the reliable detection of IGA and associated cracking in excess of the 50% plugging limit.

The level of concern we attach to this issue is tempered by the fact that there has been little new IGA activity at SONGS-1 since the early 1980's. Furthermore, the bobbin probe inspection is being supplemented by an 8X1 probe inspection for the tubes most susceptable to IGA. Although, not as sensitive to small defects as the RPC probe, the 8X1 probe provides enhanced capability relative to the bobbin probe for detecting circumferential crack-like defects such as that for tube R26C51. However, any evidence of new IGA activity from the ongoing bobbin coil and 8X1 inspections would heighten our concern about the need for RPC inspections.

2) The "Data Analysis Guidelines" should be upgraded to include all eddy current probe types which may be utilized. At present, only bobbin type probes are addressed.

3) The site-specific practical examination was prepared by one of the lead analysts who also participated in the production data analysis. The EPRI "Steam Generator Inspection Guidelines" recommends that individuals involved in the preparation of an examination should not be qualified for plant analysis using that same material. We concur with the EPRI recommendation that a separate examination be prepared for such individuals.

4) There is a problem with magnetite deposits in the crevice between the sleeves and the parent tubing at the top of the sleeve. While a mix has been attempted that will eliminate the effect of the magnetite deposits and still pick up the ASME Section XI defects on the parent tube with no magnetite present, it has not been demonstrated that it will pick up these defects with magnetite in the crevice. Due to the shielding nature of ferromagnetic materials on eddy currents, we believe it would be prudent to construct a standard with holes, add a sleeve and pack the crevice with ferrite to demonstrate that defects can be picked up through the ferrite.

5) In an internal SCE memorandum from Mr. J.A. Mundis to Mr. B. Katz, dated November 6, 1989, a schedule for repair/replacement of Westinghouse mechanical plugs was identified. We understand this schedule to be consistent with NRC Bulletin 89-01 for Inconel 600 heats 3513 and 4523 and with Westinghouse recommendations for Inconel 600 heats not covered by the bulletin. We understand from Mr. Mundis that this schedule has not yet been incorporated into a formal tracking system at the plant. We believe this should be done at the earliest possible time to assure that the schedule is met.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831-6158
(615) 574-4839

September 6, 1990

Mr. Emmett L. Murphy
Office of Reactor Regulation
Materials Engineering Branch
U.S. Nuclear Regulatory Commission
MS WFN-9H15
Washington, DC 20555

Dear Emmett:

On Wednesday, August 29, I traveled to the San Onofre Nuclear Power Plant to review the inspection of the steam generators in Unit 1. This trip was made in response to a request by Region 5 to aid in a general review of the plant. In particular, I was requested to review the Analyst Guidelines for the inspection and the Analyst certification. In addition, since there has been a problem with intergranular attack at the top of the tube sheet, I paid particular attention to this region.

The steam generators for unit one are three Westinghouse model 28 generators, that have a hard, ceramic-like sludge pile. The units experienced intergranular attack at the top of the tube sheet in 1980, which resulted in extensive sleeving. The inspection guidelines used were adequate for the bobbin coil inspection, but no guide lines were included for the 8X1 probe and the rotating pancake probe. The bobbin coil has the most complex and difficult-to-interpret signals, and is used as the main inspection method. The interpretation of the signals from the inspection of the sleeved tubes is particularly difficult. However, a written procedure for the other probes should be included.

I reviewed the certification of the personnel and looked at the test scores. The personnel had to pass a site-specific exam, consisting of a set of runs from previous defects found at the site. The main criticism of the test is that one of the lead analysts that made up the test was also taking the test. While this is not a good practice, there is no easy solution. The person most familiar with the signals from the site will be the lead analyst, and this

Attachment 3

is the best qualified person to make up the test, and also the best qualified person to perform the lead analyst function.

I reviewed the personnel qualification of the data analyst and most of them passed the required test with high grades and their records showed the required levels of experience. The calibration records of the MIZ-18 units were within the one year period required by the ASME Section XI Code. I also reviewed the runs on the calibration standards and the certified drawings of the standards.

The new Eddynet software and hardware from Zetec were being used for this inspection. The new system uses one computer as a file server and the others as work stations attached to the server with Ethernet. The system runs under Hewlett-Packard X-windows. The data is now taken on magnetic tape and then copied to optical disk. The system seems to have good response but slows down considerably when a set of scans is being copied to a disk. In future inspections, it is planned to read the data directly to the optical disk, eliminating the need to recopy it. The optical disks hold about 10 times as much data as one tape and are physically smaller than a tape. I would also recommend that the utility copy the archive tapes from previous inspections to optical disk, so they would be ready for comparison to the present inspections. This would save considerable time in comparing the scans, since the entire tape must be copied to view a single tube. This could be done before the outage, so that the data would be ready for a quick comparison.

One crack-like defect was detected at the top of the tube sheet with the rotating pancake probe, as shown in Figure 1. This defect was missed with the bobbin probe. The defect was present on a review of the 8X1 inspection made in 1985, but not called at the time. This emphasizes the need to scan at least a sampling of the tubes at the top of the tube-sheet with the rotating pancake probe. About 600 tubes can be scanned in a day with the rotating pancake probe. The rotating pancake probe is about half the size of the pancake probe in the 8X1 array and therefore has a better response to small defects. The lift-off compensation technique used for the pancake probes by Zetec is outdated and interferes

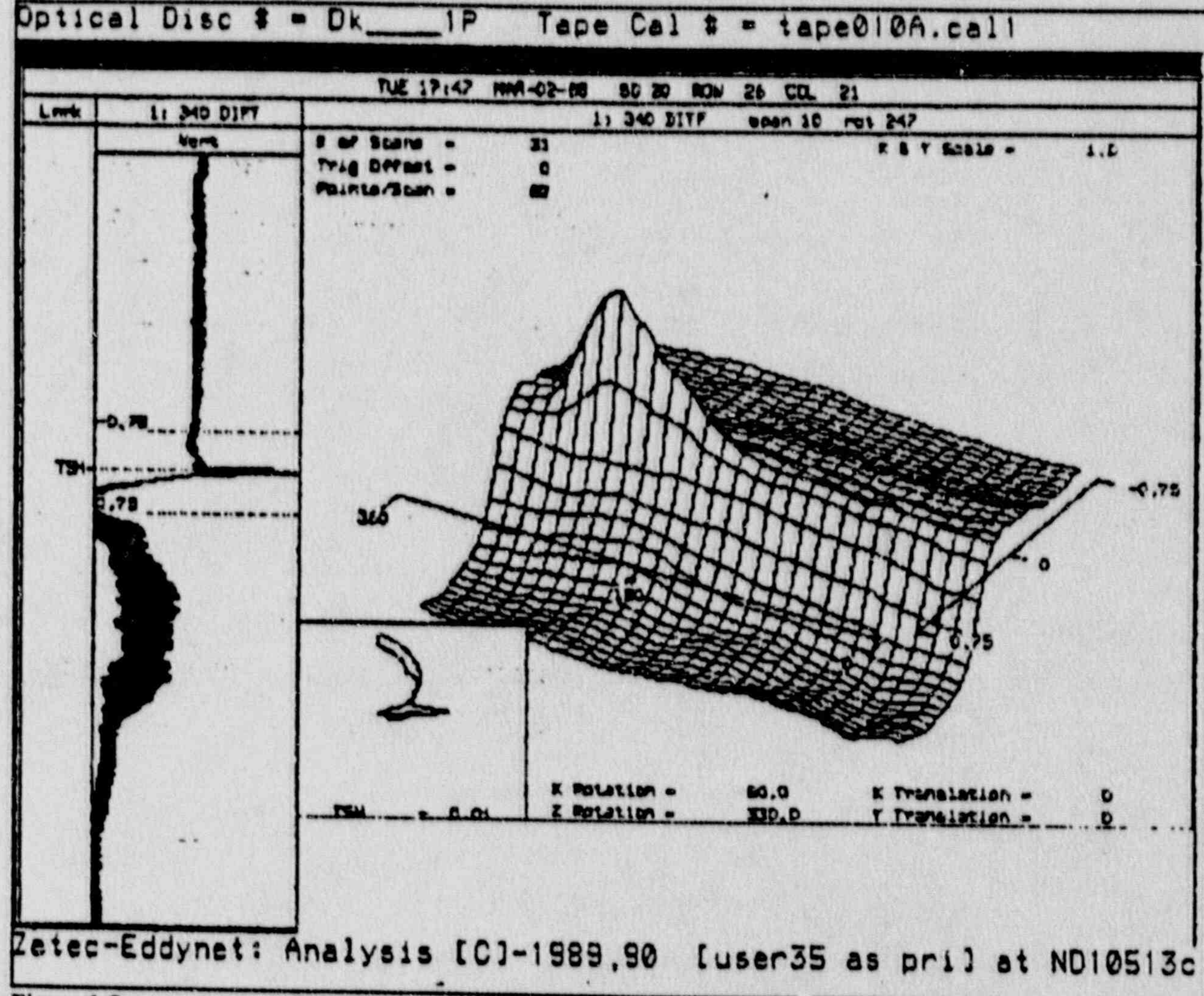

Figure 1 Scan at the top of the tube sheet with a motorized rotating pancake probe.

with the measurement of the defect depth. Therefore, no calibration of the defect depth is made. I would recommend that the lift-off compensation method be updated and that the defect depth be measured. The depth of the defect in Figure 1 measures between 50 to 70 %.

There is a problem with magnetite deposits in the crevice between the sleeves and the parent tubing, at the top of the sleeve. While a mix has been attempted that will eliminate the effect of the magnetite deposits and still pick up the ASME Section XI defects on the parent tube with no magnetite present, it has not been demonstrated that it will pick up these defects with magnetite in the crevice. Due to the shielding nature of ferromagnetic materials on eddy currents, I believe it would be prudent to construct a standard with holes, add a sleeve and pack the crevice with ferrite to demonstrate that we can pick up defects through the ferrite.

The personnel at San Onofre were very helpful and seemed very competent and committed to doing the best job possible of inspecting and maintaining their generators, and running their plant in a safe and efficient manner.

Sincerely yours,

Caius V. Dodd

Caius V. Dodd
Nondestructive Testing Group
Metals and Ceramics Division

Attachment

cc: L. H. Bell
C. Clark
L. K. Fletcher - DOE/ORO
D. J. McGuire
C. E. Pugh
G. M. Slaughter
C. V. Dodd/File