AUG 5 1976

Docket Nos: 50-438
and 50-439

Applicant: Tennessee Valley Authority

Facility: Bellefonte Nuclear Plant, Units 1 and 2

SUMMARY OF MEETING HELD ON JUNE 17, 1976, TO RECEIVE A PRESENTATION BY TVA ON THE ROCK ANCHOR TENDON STRESSING HEAD FAILURE PROBLEM

On June 17, 1976, representatives of TVA and their consultants gave a presentation of the results of their analysis of the rock anchor tendon stressing head failures. TVA also presented their proposed solution to the problem.

During a staff caucus after the meeting it was determined that the NRC Office of Inspection and Enforcement will retain lead responsibility for NRC activities concerning this problem. Enclosure 1 contains a summary of the meeting written by Mr. R. E. Shewmaker of the Office of Inspection and Enforcement. Enclosures 2 and 3 contain drawings presented at the meeting that show the Bellefonte containment, a rock anchor tendon, tendon coupling device, and the stressing head.

Also, during the staff caucus, the following recommendations were developed and TVA was subsequently informed of these recommendations:

1. TVA should insure that the second stage grouting begins from the bottom of the grout cavity and flows to the top.

2. TVA should insure that the rock anchor tendon wires are protected during installation of the new stressing heads.

3. After the lime water is flushed from the cavity, grouting should take place within 48 hours. The tendons should not be left unprotected for longer than 48 hours.

4. The handouts created for the meeting should be incorporated into bound reports (or report) to be docketed with TVA's 10 CFR 50.55 Section e report on the matter.

5. It was recommended that the Bellefonte PSAR be updated to reflect any changes made to the design to the extent of design discussion already contained in the PSAR.

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The NRC had Battelle's Columbus Laboratories provide consultation on this matter. Battelle's report, "Examination of the Cracked Rock Anchor Heads in the TVA Bellefonte Nuclear Plant to the Nuclear Regulatory Commission," dated April 12, 1976, is available in the NRC and local public document rooms.

Original signed by

Walter J. Pike, Project Manager
Light Water Reactors Branch No. 3
Division of Project Management

Enclosures:
As stated

cc: Herbert S. Sanger, Jr., Esq.
General Counsel
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Mr. E. G. Beasley
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| DATE | 8/04/76 | 8/5/76 | | | | |

Form AEC-318 (Rev. 9-53) AECM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1974-526-166

# ATTENDANCE LIST

## TENNESSEE VALLEY AUTHORITY
## BELLEFONTE NUCLEAR PLANT, UNITS 1 AND 2

Meeting held June 17, 1976

**TVA**

R. O. Barnett
R. G. Domer
L. M. Mills
L. W. Blevins
R. E. Bullock
P. V. Guthrie
C. Glidewell, Jr.
Mark Linn
Dennis L. Terrill

**NRC**

W. J. Pike
E. O. Porter
J. T. Chen
P. T. Kuo
George Georgiev
Hans Ashar
R. E. Shewmaker
Gunter Arndt

**INRYCO**

G. Chadha
J. W. Heise
Peter Reinhardt

**INLAND STEEL**

W. E. Heitmann

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ENCLOSURE 1

JUL 8 1976

K. V. Seyfrit, Chief, Reactor Technical
Assistance Branch, IE

SUMMARY OF BACKGROUND, MEETING AND STAFF DECISIONS REGARDING THE FAILED ROCK ANCHOR STRESSING HEADS AT BELLEFONTE, UNITS 1 AND 2, DOCKET NOS. 50-438/439

Background:

On September 16, 1975, the Licensee, the Tennessee Valley Authority, notified the NRC, R:II, of the failure of a stressing head associated with the containment rock anchor tendons. To date five apparently related failures have occurred at the site on the dates listed below.

| Failure Noted | Unit No. |
|---|---|
| 9/75 | 1 |
| 12/75 | 1 |
| 1/76 | 1 |
| 3/76 | 2 |
| 5/76 | 2 |

The first failure in this series is also known to have caused the failure of 23 wires in one of the 170 wire tendons. Since the first failure was noted the Licensee has submitted a series of reports dated as listed below.

| Report Date | Type of Report |
|---|---|
| 10/16/75 | First Written Interim |
| 12/5 /75 | Second Written Interim |
| 2/9/ 76 | Third Written Interim |
| 4/12/76 | Fourth Written Interim |
| 6/15/76 | Fifth Written Interim |

Actions taken by the Licensee have included metallurgical investigations on some of the failed pieces with the work being independently performed by Combustion Engineering, Inc., TVA and Inland-Ryerson Construction Products Co. As of the last interim report, the metallurgical investigations being conducted by TVA and Inland-Ryerson were incomplete and another report is expected by August 12, 1976.

IE contracted with Battelle, Columbus Laboratories, to conduct an independent investigation on the metallurgical aspects of this occurence. Battelle was provided samples from the failed components for their studies. The conclusion was as follows:

The results suggest that stress-corrosion cracks (SCC) initiated in the lime water environment and after attaining a critical size caused the remainder of the anchor head to crack under plan strain conditions. No sulfides or other hydrogen-entry promoters were found which could have contributed to rapid SCC failure. However, there were indications that some zinc-filled coating was applied to the cans that contained the lime water. These cans were galvanically coupled to the heads and probably contributed to SCC by promoting hydrogen entry into the heads.

Copies of this report have been provided to NRR through the LPM, W. Pike.

TVA contacted W. Pike to arrange a meeting to discuss the failed rock anchor stressing heads. The meeting was set for June 17, 1976 in Bethesda.

Meeting of June 17, 1976

A meeting was held in P-118 of the Phillips Building on June 17, 1976 between the Licensee, and representatives of the various offices of the NRC for the purpose of discussing the proposed solution to the failed stressing heads. A copy of the agenda as prepared by the Licensee is enclosed.

1. Construction Status:

   All first stage grouting (20'-0") in all 370 rock anchors for both units is completed and 3 have had the second stage grouting completed. The 367 without 2nd stage grouting are being maintained in a lime water solution with a pH of 11.0-13.0 which is retained by 2 grease cans over the anchorage. Concrete has been placed in the primary containment up to approximately the top of the base in both units indicating that the anchorages are accessible only via two access points in the tendon gallery which is approximately 5' x 7' in cross-section.

2. Observed Failures:

   The first failed stressing head was found when the grease can was removed to allow for the pump out of lime water prior to 2nd stage grouting. The failure was easily visible once the cap and fluid had been removed. The remaining four failed stressing heads were detected during the Licensee's surveillance program conducted on the quantity and pH of the lime water protection. Cracks in the stressing head were either observed or felt by hand while checking under the water surface through an access hole in the grease can.

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3. Determination of Cause(s)

a. Metallurgy - Studies were conducted to compare the material to the specifications, ASTM A-322 (AISI 4140 or 4142), by Combustion Engineering, Inryco and TVA. The conclusion was that the steel did meet the specifications, but appeared to be a "dirtier steel" that would normally be expected from an electric furnace steel. This was evidenced by longitudinal stringers of sulfide and silicate type materials. These stringers resulted in low transverse tensile and ductility properties not uncommon in such material, but probably lower in value than normal.

b. Design - Tests and studies were completed on the end anchorage hardware from the standpoint of structural integrity. Tests were performed on end anchorage hardware considering different stressing head geometry as well as support conditions including unequal shim stacks and dished bearing surfaces. These tests were performed on a test block and stand using 1000 ton hydraulic ram. The results indicated that the center grouting hole in the stressing washer could contribute to stress increases in the anchor washer.

c. Support Conditions - Observations in the field indicated that the tendon gallery floor was curved, apparently as a result of the large rock anchor forces. The orientation of the split shims was such as not to tend to reduce this curvature, but merely reflect it upward. Additionally, testing completed on the cement grout beneath the bearing plates to determine the strength and deformation characteristics revealed poorly consolidated and "soft" grout. The tolerances on the "as rolled" flatness of plate were also reviewed.

4. Corrective Action:

Three methods of repair were considered as follows:

a. A bolted external coupler - Rejected because of size required to transmit sufficient force the complete the coupling.

b. A heat-shrunk external coupler: Considered to be a possible solution.

c. Stressing Washer Replacement - Selected as the best choice from among the various choices.

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The repairs for this deficiency are to be accomplished by removing all existing stressing washers from both units and substituting a stressing washer of a new configuration. The new configuration will not have the center grout hole and is a normal stressing end for the Inryco post-tensioning tendons. Button heads will be cut after the rock anchor tendons are detensioned. The bearing plates and grout pads will be removed. New stressing washers will be fabricated from vacuum degassed steel without the center grout hole. Bearing plates will have a more stringent control on surface planeness than the rolled surface tolerances. Split shim stacks will be controlled so that a close tolerance is held on pair differential heights. Grouting will be completed by small side pipes cut into the tendon gallery floor which will pass beneath the new grout pad and bearing plate. The grout pad will be reduced from 3/4" to 1/4" thickness to make up approximately 1/2" of tendon length loss due to button head removal and rebutton heading. Epoxy grouts may be used for the grout pad. For those anchorages which have failed it will be necessary to cut several inches into the tendon gallery floor to make up enough length to rebutton head. The sequence of detensioning and repair can range from one rock anchor at a time to releasing all tendons and restarting. Most likely the work will be completed in groups of perhaps 10 or 20 anchors. The licensee indicated that lime water may or may not be used again once the tendon is flushed. This will depend on how soon after retensioning is complete that second stage grout could be introduced.

The licensee is of the opinion that these corrective actions will address all the major parameters which affected the stressing washers. These include the metallurgy, the design and the support conditions.

5. Staff Caucus:

After the meeting the staff caucussed except for the SEB representative, and it was agreed that there appeared to be no reason for a Transfer of Lead Responsibility to NRR on this matter. The new hardware involved in the rock anchors have been utilized on other facilities which have been reviewed by NRR. IE agreed to keep NRR informed of the progress of the repairs and any new problems which could arise.

R. E. Shewmaker
Senior Structural Engineer
RTAB

Enclosures:
1. TVA;s Outline of Presentation
2. Mtg. Attendance List

(cc's: see next page)

JUL 8 1976

cc w/enclosures:
W. Anderson, SD
I. Sihweil, NRR
S. Pawlicki, NRR
C. Murphy, NRC:II
G. Arndt, SD
H. Ashar, SD
J. Chen, SD
P. Kou, NRR
G. Georgiev, NRR
E. Porter, NRC:II
G. Gower, IE:HQ

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OUTLINE OF PRESENTATION TO NUCLEAR REGULATORY COMMISSION
ON PROPOSED SOLUTION TO ROCK ANCHOR TENDON STRESSING HEAD
FAILURE PROBLEM

1. Statement of purpose of presentation (TVA).

2. Orientation to familiarize everyone with problem area (TVA). (Narrative with 8-1/2 x 11 view-o-graph sketches)

3. Synopsis of results of investigations conducted by Tennessee Valley Authority and INRYCO, Incorporated, into head failures.

   a. Tennessee Valley Authority

   b. INRYCO, Incorporated

4. Solutions considered and reasons for choice of selected solution (INRYCO, Incorporated). (Narrative with 8-1/2 x 11 view-o-graph sketches)

5. Details of proposed solution (INRYCO, Incorporated).

   a. Physical properties and dimensions

   b. Nondestructive examination

   c. Load testing

   d. Installation procedure

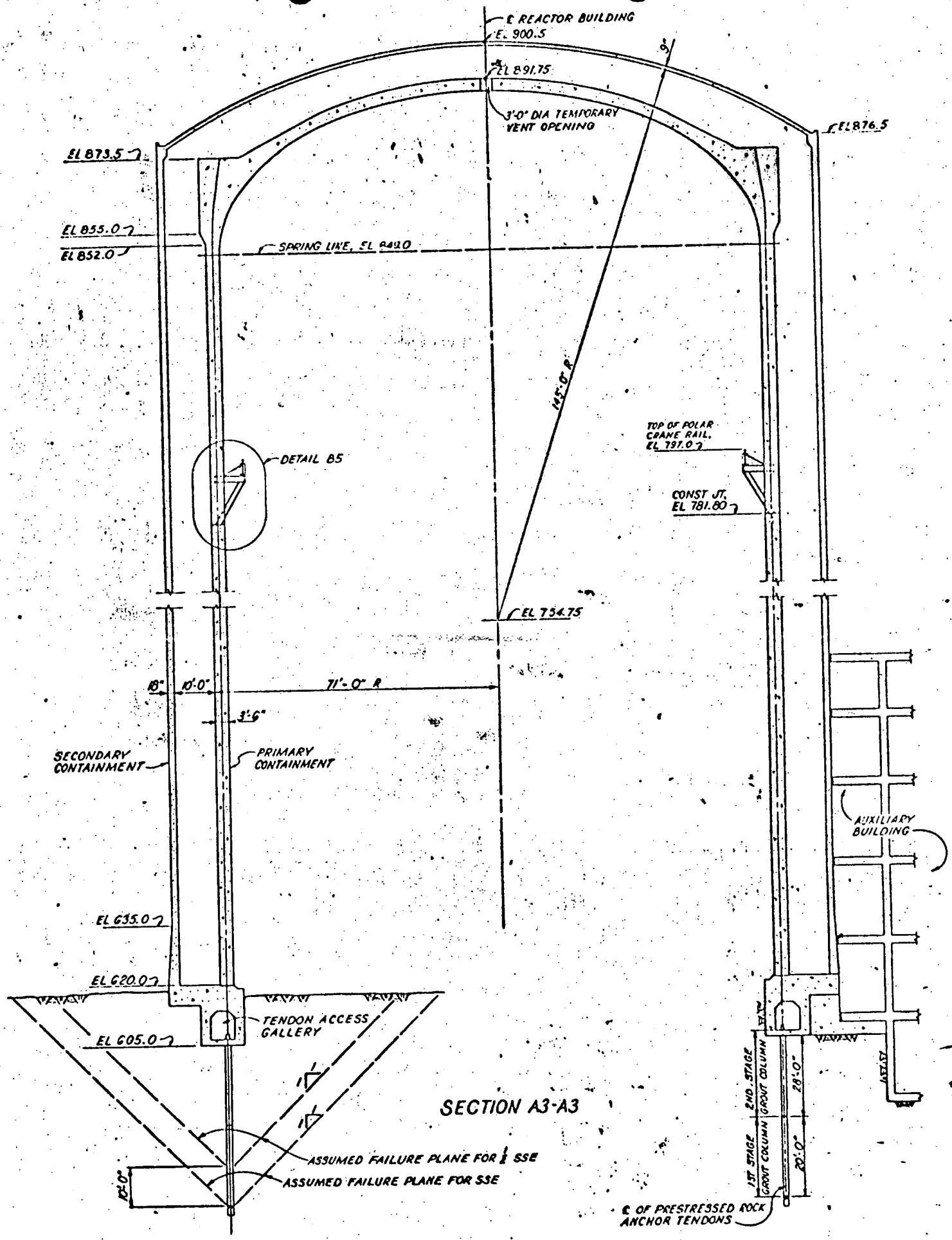
   e. Construction feasibility tests

   f. Proposed schedule for test and construction

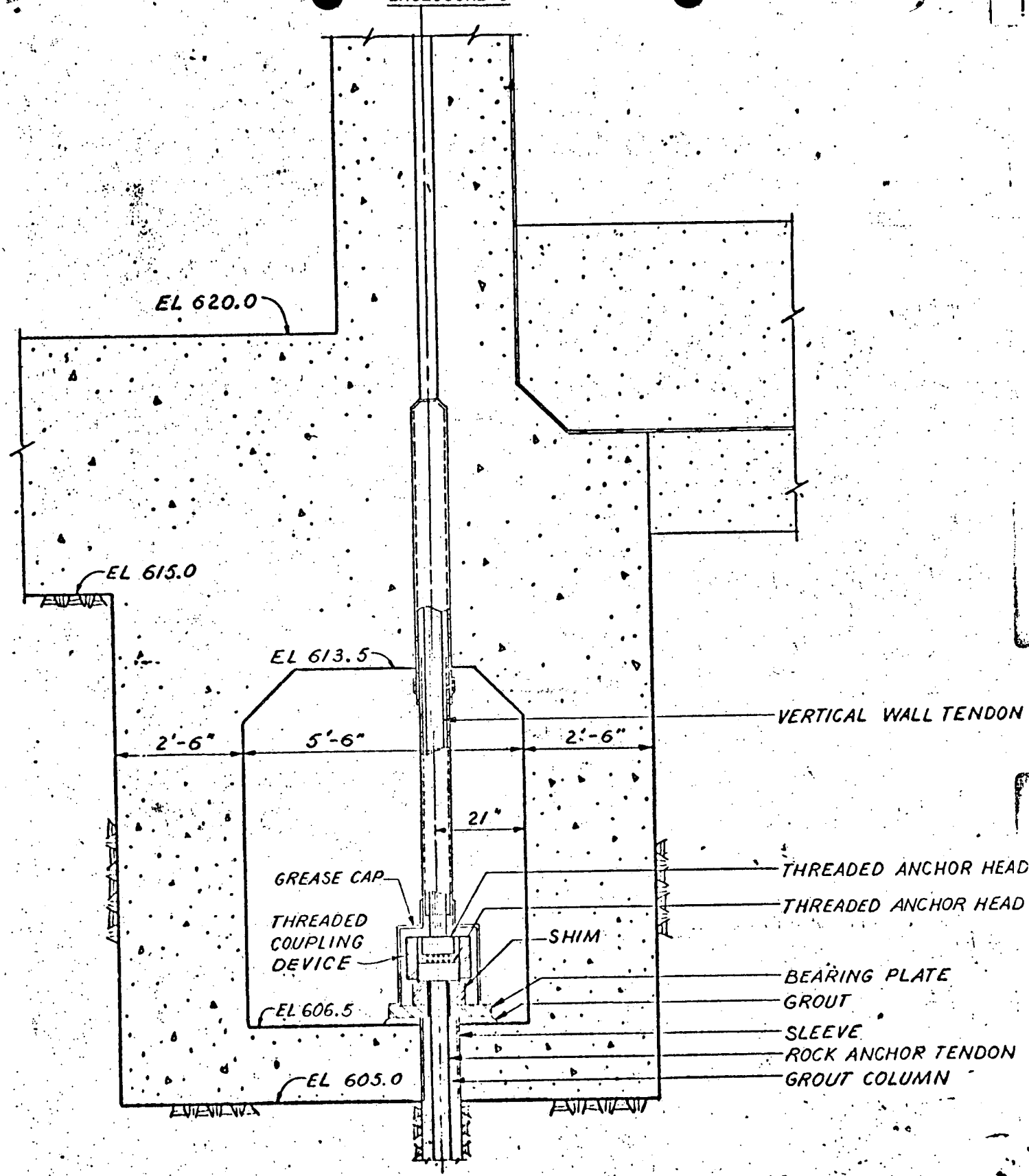
6. Response to questions raised by NRC (no draft required - TVA and/or INRYCO, Incorporated).

7. Closing statement (TVA). (No draft required)

ENCLOSURE 2


℄ REACTOR BUILDING
EL. 900.5
EL 891.75
3'-0" DIA TEMPORARY VENT OPENING
EL 876.5
EL 873.5
EL 855.0
EL 852.0
SPRING LINE, EL 842.0
145'-0" R
TOP OF POLAR CRANE RAIL, EL 797.0
CONST JT. EL 781.80
DETAIL B5
EL 754.75
18"
10'-0"
71'-0" R
3'-6"
SECONDARY CONTAINMENT
PRIMARY CONTAINMENT
AUXILIARY BUILDING
EL 635.0
EL 620.0
TENDON ACCESS GALLERY
EL 605.0
SECTION A3-A3
ASSUMED FAILURE PLANE FOR ½ SSE
ASSUMED FAILURE PLANE FOR SSE
10'-0"
1ST STAGE GROUT COLUMN
2ND STAGE GROUT COLUMN
28'-0"
20'-0"
℄ OF PRESTRESSED ROCK ANCHOR TENDONS

ENCLOSURE 3




# TENDON COUPLING DEVICE

## MEETING SUMMARY DISTRIBUTION

Docket File
NRC PDR
Local PDR
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ACRS (16)
IE (3)
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NRR Reading
LWR-3 File
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R. DeYoung

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W. Kreger
R. Ballard
M. Spangler
J. Stepp
L. Hulman
H. Smith
M. Rushbrook (3)
Project Manager
NRC Participants