Commonwealth Edison Company
1400 Opus Place
Downers Grove, IL 60515

ComEd

August 14, 1995

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

Subject: Dresden Nuclear Power Station Units 2 and 3
Response to NRC Staff Request for Additional Information (RAI) -
Transmittal of Dresden Design Documents for the Core Shroud Repair
NRC Docket Nos. 50-237 and 50-249

References: (a) NRC Generic Letter (GL) 94-03, dated July 25, 1994.

(b) J. Stang (U.S. NRC) letter to D. Farrar (ComEd), dated July 26, 1995; Request for Additional Information - Core Shroud Repair (TAC Nos. M91301 and M91302).

(c) J. Schrage (ComEd) letter to the U.S. NRC, dated March 30, 1995.

(d) J. Schrage (ComEd) letter to the U.S. NRC, dated June 7, 1995.

The purpose of this letter is to provide ComEd's responses to the NRC staff's RAI (Reference (b)) regarding the Core Shroud repair for Dresden Station. In addition, ComEd is providing updated/revised drawing documentation for the subject Core Shroud repair. This information is provided as enclosures to this letter.

Attachment 1 provides a listing of Dresden's Core Shroud repair documentation. Some of the information contained therein is proprietary in nature. The listing of affidavits summarized in Attachment 1 identifies the information that is proprietary in nature. Because the information provided herein updates and/or revises some information previously provided by ComEd (Reference (d)) to the NRC staff, the attached affidavits encompass any such changes and/or revisions.

It should be noted that ComEd is deferring responses to NRC staff Questions No. 17 and No. 18 (Reference (b)). A complete response to those questions will be provided at a later date under a separate transmittal.

To the best of my knowledge and belief, the statements contained in this response are true and correct. In some respects, these statements are not based on my personal knowledge, but obtained information furnished by other ComEd employees, contractor employees and consultants. Such information has been reviewed in accordance with company practice, and I believe it to be reliable.

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Please direct any questions you may have concerning this response to this office.

Sincerely,

Gary G Benes

For Peter L. Piet
Nuclear Licensing Administrator

Attachment 1: Listing of Dresden Unit 2 and Unit 3 Core Shroud Repair Design Documentation

Enclosures: Response to NRC Staff RAI

cc: H. J. Miller, Regional Administrator - RIII
J. F. Stang, Project Manager - NRR
M. N. Leach, Senior Resident Inspector - Dresden
Office of Nuclear Facility Safety - IDNS

Signed before me on this 14th day

of August, 1995,

by Mary Jo Yack.
Notary Public

OFFICIAL SEAL
MARY JO YACK
NOTARY PUBLIC STATE OF ILLINOIS
MY COMMISSION EXPIRES 11/29/97

<u>**Attachment 1**</u>

1. ComEd's responses to the Request for Additional information - Core Shroud Repair (Reference (a)). (Proprietary Information - as indicated herein)

2. GENE 771-81-1194, Revision 2, "Commonwealth Edison Company Dresden Nuclear Power Plant Units 2 & 3, Shroud and Shroud Repair Hardware Analysis, Volume I, Shroud Repair Hardware".

3. GENE 771-81-1194 Supplement A to Revision 1 of volume II. Shroud Mechanical Repair Program Dresden Nuclear Power Station - Supplement A to shroud and Shroud Repair Hardware Stress Analysis, June 1995. (Proprietary Information)

4. Revised Construction Drawings: (Proprietary Information)
   a. Reactor Modification/Installation Drawing 107E5719, Revision 9, Sheet 1 of 4, Reactor Assembly
   b. Reactor Modification/Installation Drawing 107E5719, Revision 9, Sheet 2 of 4, Reactor Assembly
   c. Reactor Modification/Installation Drawing 107E5719, Revision 9, Sheet 3 of 4, Reactor Assembly
   d. Reactor Modification/Installation Drawing 107E5719, Revision 9, Sheet 4 of 4, Reactor Assembly
   e. Assembly Drawing 112D6636, Revision 1, Sheet 1 of 1, Bracket Yoke Assembly
   f. Assembly Drawing 112D6641, Revision 2, Sheet 1 of 1, Stabilizer Support Assembly
   g. Assembly Drawing 112D6642, Revision 1, Sheet 1 of 1, Upper Stabilizer Assembly
   h. Detail Drawing 112D6643, Revision 2, Sheet 1 of 1, Latch
   i Detail Drawing 112D6648, Revision 2, Sheet 1 of 1, Retainer
   j. Detail Drawing 112D6651, Revision 1, Sheet 1 of 1, Pin
   k. Detail Drawing 112D6652, Revision 1, Sheet 1 of 1, Nut, Tie Rod
   l. Detail Drawing 112D6655, Revision 1, Sheet 1 of 1, Extension, Lower Spring
   m. Detail Drawing 112D6658, Revision 1, Sheet 1 of 1, Clip, Retainer
   n. Detail Drawing 112D6668, Revision 2, Sheet 1 of 1, Support
   o. Detail Drawing 112D6669, Revision 2, Sheet 1 of 1, Upper Support, Long
   p. Detail Drawing 112D6670, Revision 2, Sheet 1 of 1, Spring, Upper
   q. Detail Drawing 112D6671, Revision 3, Sheet 1 of 1, Spring, Lower
   r. Detail Drawing 112D6672, Revision 1, Sheet 1 of 1, Rod, Tie
   s. Detail Drawing 112D6676, Revision 2, Sheet 1 of 1, Upper Support Short
   t Assembly Drawing 112D6680, Revision 2, Sheet 1 of 1, Mid Support Assembly
   u. Detail Drawing 112D6681, Revision 3, Sheet 1 of 1, Support, Mid-Shroud
   v. Assembly Drawing 112D6734, Revision 1, Sheet 1 of 1, Core Plate Wedge Assy
   w. Detail Drawing 112D6735, Revision 1, Sheet 1 of 1, Wedge, Core Plate
   x. Detail Drawing 112D6736, Revision 1, Sheet 1 of 1, Clip, Core Plate
   y. Detail Drawing 112D6737, Revision 1, Sheet 1 of 1, Bolt, Wedge
   z. Detail Drawing 112D6779, Revision 0, Sheet 1 of 1, Leg, Shroud Head and Separators

5. Proprietary Affidavits
   a. General Electrc Company Affidavit of Proprietary Information, By David J. Robare, Dated August 10, 1995, (GBS-95-6-afDRmod7.doc).
   b. General Electric Company Affidavit of Proprietary Information, By David J. Robare, Dated August 10, 1995, (GBS-95-6-afDRrail.doc).
   c. General Electric Company Affidavit of Proprietary Information, By George B Stramback, Dated June 29, 1995, (GBS-95-7-afBECOXM.doc).

ComEd's responses to the Request for Additional information - Core Shroud Repair (Reference (a)). (Proprietary Information - as indicated herein)

50-237 DRESDEN 2 CEC

REQUEST FOR ADDITIONAL INFORMATION CORE SHROUD REPAIR

REC'D W/LTR DTD 8/14/95...9508180294

REQUEST FOR ADDITIONAL INFORMATION (EMCB)
CORE SHROUD REPAIR
DRESDEN UNITS 2 AND 3

Question 1

In your design specification (25A5688, Revision 2), section 4.4.3 and 4.7, welding is identified as a repair contingency for austenitic 300 series stainless steel and in section 4.4.3, assembly welds were mentioned. Please identify under what conditions repair welding and assembly welds will be applied during the fabrication and installation of the core shroud repair components. What are the controls or mitigation methods that will be implemented to minimize the magnitude of the residual stresses and material sensitization when applying welding.

Response 1

Both the Fabrication Specification, GENE 25A5690, and the Installation Specification, GENE 25A5698, do not provide provisions for welding on the core shroud repair hardware. Hence, no welding is permitted or will be performed on the core shroud repair hardware during the fabrication or installation phases. Therefore, there is no need to minimize the magnitude of residual stresses or material sensitization to welding. Also, there is no need to estimate or quantify the effects of welding on the materials or on the structure.

Question 2

BWRVIP has issued the following documents to provide guidelines for visual examination (VT) and ultrasonic examination (UT) of core shrouds: (a) Standards For Visual Inspection of Core Shrouds and (b) Core Shroud NDE Uncertainty & Procedure Standard. The guidelines in these documents should be followed in the examination of the core shroud and repair assemblies. If you do not intend to reference the subject BWRVIP documents in your examination specifications or procedures, please identify all the exceptions you are going to take against the referenced BWRVIP guidelines.

Response 2

As was stated on page 2 of the Reference (c) inspection plan, " all visual examinations will be performed in accordance with the BWRVIP Standards for Visual Inspections of Core Shrouds and all ultrasonic examinations will be performed in accordance with the BWRVIP Standards for Ultrasonic Examination of Core Shroud Welds". Dresden Station has no intention of taking exception to these documents.

Question 3

When detailed heat treatment records (time, temperature and cooling rate) are not available, what kind of testing do you perform to ensure that the fabricated alloy X-750 components are properly heat treated?

Response 3

The purpose of the requirements on heat treatment of alloy X-750 core shroud repair materials is to provide material that is not sensitized. Accordingly, sensitization testing of the material after heat treatment is an accurate indicator that the heat treatment was effective. The attributes of the final material condition is considered as evidence that the engineering requirements of material performance have been met. Therefore, sensitization testing is considered an adequate alternative to detailed heat treatment records in assuring that proper heat treatment has been performed. Also, complete reliance on heat treatment records can be misleading. GE has indicated that isolated cases have occurred in which heat treatment details were recorded, even to the extent of using embedded thermocouples, but that the subject material failed to pass a sensitization test.

ASME NCA-3800 was followed to procure the core shroud repair material. With respect to material test reports, NCA-3860 does not require that detailed time/temperature records for heat treatment be recorded but that specific time and/or temperature parameters be recorded if such values are specified in the underlying Section II material specification. For the alloy X-750 used for the shroud restraints, the only stated requirement is a minimum temperature of 1900 degrees F (followed by rapid cooling).

Specification 25A5690, adds additional requirements for heat treating X-750 that is over and above the ASME code. When material is ordered in heat lots from a primary melter, it is possible to get such detailed records of heat treatment. However, in the current environment of performing internals repairs, materials are procured in small quantities, often from a third party supplier out of a warehouse inventory. In these cases, detailed records showing complete conformance to the additional requirements are not always retrievable. It is in these cases where, as an alternative to detailed heat treatment records, the attributes of the final material condition is considered as evidence that the engineering requirements for materials performance have been met.

In summary, the material ordering requirements are appropriate for the intended use and are in conformance with applicable codes.

Question 4

General Electric stated in their fabrication specification, 25A5690, revision 2, section 3.2, that critical, highly stressed, machined areas such as the tie rod threads (XM-19) will be resolution annealed after machining to remove a possible cold worked layer.

(a) *Please describe the re-solution annealing process and provide details regarding how this process was qualified and the results of your metallurgical evaluation of the tie rod threads after re-solution annealing such as its effect on the material hardness, grain sizes, surface oxidation and the state of sensitization. If the qualification was not performed on XM-19 materials, please justify why similar qualification process need not be applied to XM-19 materials?*

(b) *General Electric stated that a minimum of 0.030 inches of austenitic 300 series and XM-19 stainless steel and alloy X-750 materials may be removed after high temperature annealing as a control of intergranular attack (IGA). Please provide the test data to support that the removal of 0.030 inches surface material would effectively eliminate the IGA effect resulting from all high temperature annealing.*

(c) *In section 3.2.2.1 it was stated that electrolyzing process (hard chrome plating) will be applied to the locking pins after centerless grind to size. Please describe how this process was qualified and its controlling parameters established. What are the required quality control testing to ensure the plating has correct thickness and acceptable surface condition (no surface defect in the plating or pitting in the base metal)?*

Response 4a

The post machining, resolution annealing, process consists of localized induction heating of the threaded region. The induction annealing of the tie rod threads is as follows:

Induction heat is applied at approximately 8 kHz and held between 1950 and 2000 degrees F for 1 minute (plus 10 seconds; minus 0 seconds). Forced air cooling is applied directly to the threaded area for a minimum of 20 minutes and until a surface temperature less than 400 degrees F is achieved.

The local solution annealing of the threads is a very short cycle with very short heat up and cool down times. Based on the material hardness test results as described in laboratory test number 08068 (see Attachment A), the depth of the oxidation of the surface, will be very shallow. The rapid air cooling process described above is fast enough to avoid sensitization. This re-solution annealing process was qualified using heat treated 316L stainless steel threaded sections. The detailed results of the metallurgical evaluation are provided in Attachment A. This metallurgical evaluation addresses sensitization and material hardness after solution annealing. This process is considered applicable for XM-19 material with a higher solution annealing of 1950 to 2000 degrees F instead of the 1900 to 1940 degrees F for the 316L SS.

Response 4b

Over the past 25 to 30 years General Electric has implemented a metallographic receipt inspection requirement for heats of stainless steel. The receipt inspection requirements consist of a destructive metallographic examination of the cross section from each heat to determine the depth of IGA that may have occurred due to high temperature annealing atmosphere or due to an overaggressive acid pickling process. The acid pickling process is the primary cause of IGA. The results of the numerous tests performed have shown that less than one sample per year have shown IGA deeper than 0.001 inch and in those cases the depth of the IGA was less than 0.003 inches.

The criteria for removal of 0.030 inches of material was originally established many years ago to be a conservative bounding limit to ensure that any IGA induced by any process, especially due to overaggressive pickling would be removed. This criteria was established based on engineering judgement prior to the results of the material receipt inspection testing as described above. The requirement for removal of 0.030 inches from the affected surfaces has been implemented for this project to provide an order of magnitude of the margin over the maximum depth of IGA that has been observed.

Response 4c

The locking pins are electrolyzed (hard chrome plated) after being centerless ground to size, in accordance with the requirements of General Electric Specification P16BYP3, Revision 6, "Chromium Alloy Coating 'Electrolyzing'". The chromium alloy coating is applied in accordance with standard industrial practices. The finished product is required by the GENE Specification to be free of pits, flakes, spalling and chipping, as determined by visual inspection. The specification also requires the product to pass the same accept/reject criteria after a 180 degree bend over a 5t mandrel. The above reference is provided as Attachment B to this RAI.

Prior to electrolyzing the locking pins, the fabrication specification, 25A5690, section 3.2.2.1 requires a test sample to be provided from the same material, same fabrication shop, and the same process variables. The test sample must meet the requirements of sections 3.5, 3.5.1 and 3.5.2 of the fabrication specification. These sections address the condition/requirements (metallographic and microhardness evaluation, the cold work surface, and the cold work depth) the base metal (locking pins) shall meet prior to electrolyzing

Question 5

Please identify all the threaded areas and locations of crevices and stress concentration in each component of the core shroud repair assemblies. In the planning of in-service inspection those areas should be emphasized for inspection because these areas are most susceptible to stress corrosion cracking. Please provide these information in tables and supplement it with sketches.

Response 5

All threaded and creviced areas in the stabilizer hardware are identified in the table below and in figures 4 through 9. Areas identified as crevices all have some associated mechanical cold work, such as a deformed locking pin. All calculated stresses for steady state normal operation are less than 50 percent of the allowable; thus there are no areas where stress should influence inspection planning. There are no welds in any shroud stabilizer hardware. Provided below are figures that identify the crevice and threaded areas in the core shroud repair assembly. The table below provides a summary of the crevice and threaded areas for each figure.

Figure	Description	Crevice/ Threaded Area Ident. Number	
Figure 4	Front and Side Views of Shroud Repair Assembly		
Figure 5	Upper Stabilizer Assembly	C1 C2 C3 C4 C5	T1 T2 T3 T4 T5
Figure 6	Stabilizer Support Assembly	C6 C7 C8 C9	T6
Figure 7	Tie Rod and Lower Spring Assembly	C10 C11 C12 C13 C14 C15 C16 C17	T7 T8 T9 T10
Figure 8	Yoke Assembly	C18 C19 C20	T11
Figure 9	Toggle Assembly	C21 C22 C23 C24 C25 C26 C27	T12 T13

C - crevice area
T - threaded area

Figure 1
Tie Rod Assembly

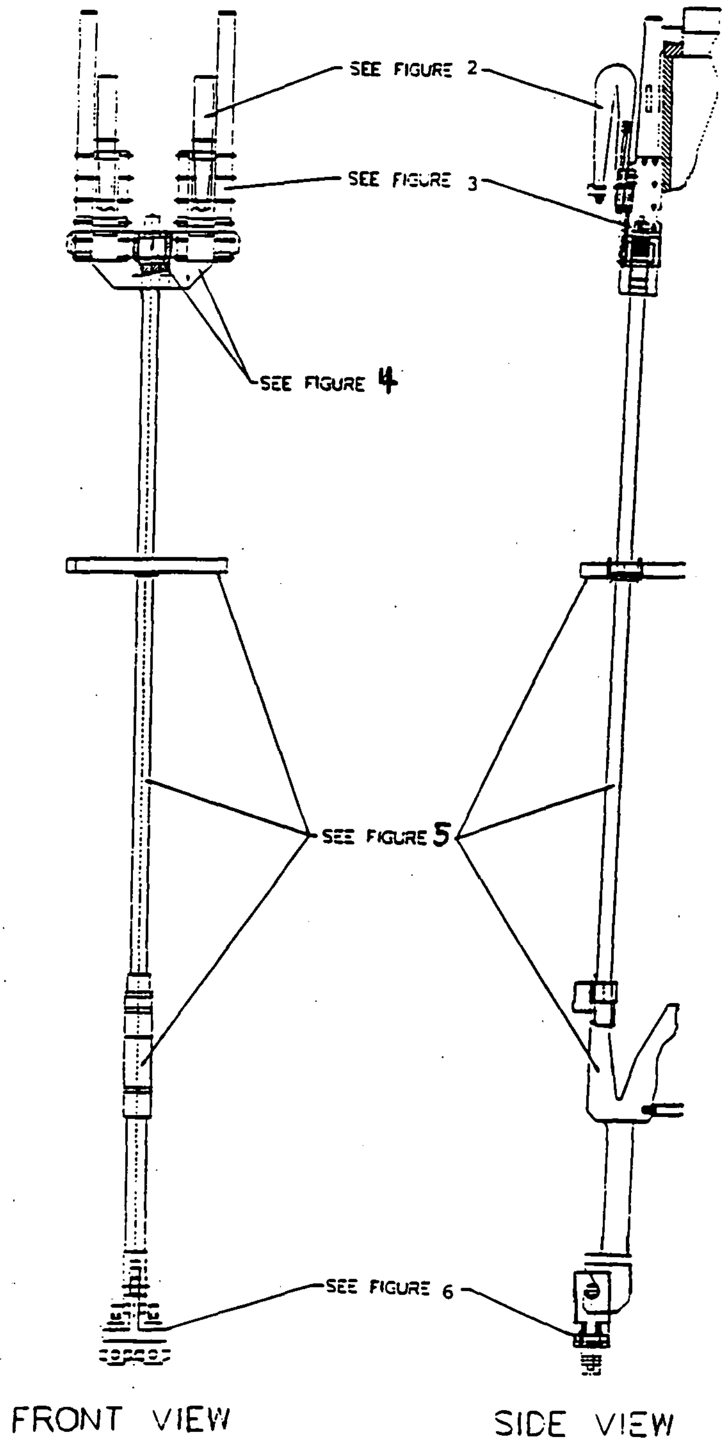


Figure 2
Upper Stabilizer Assembly

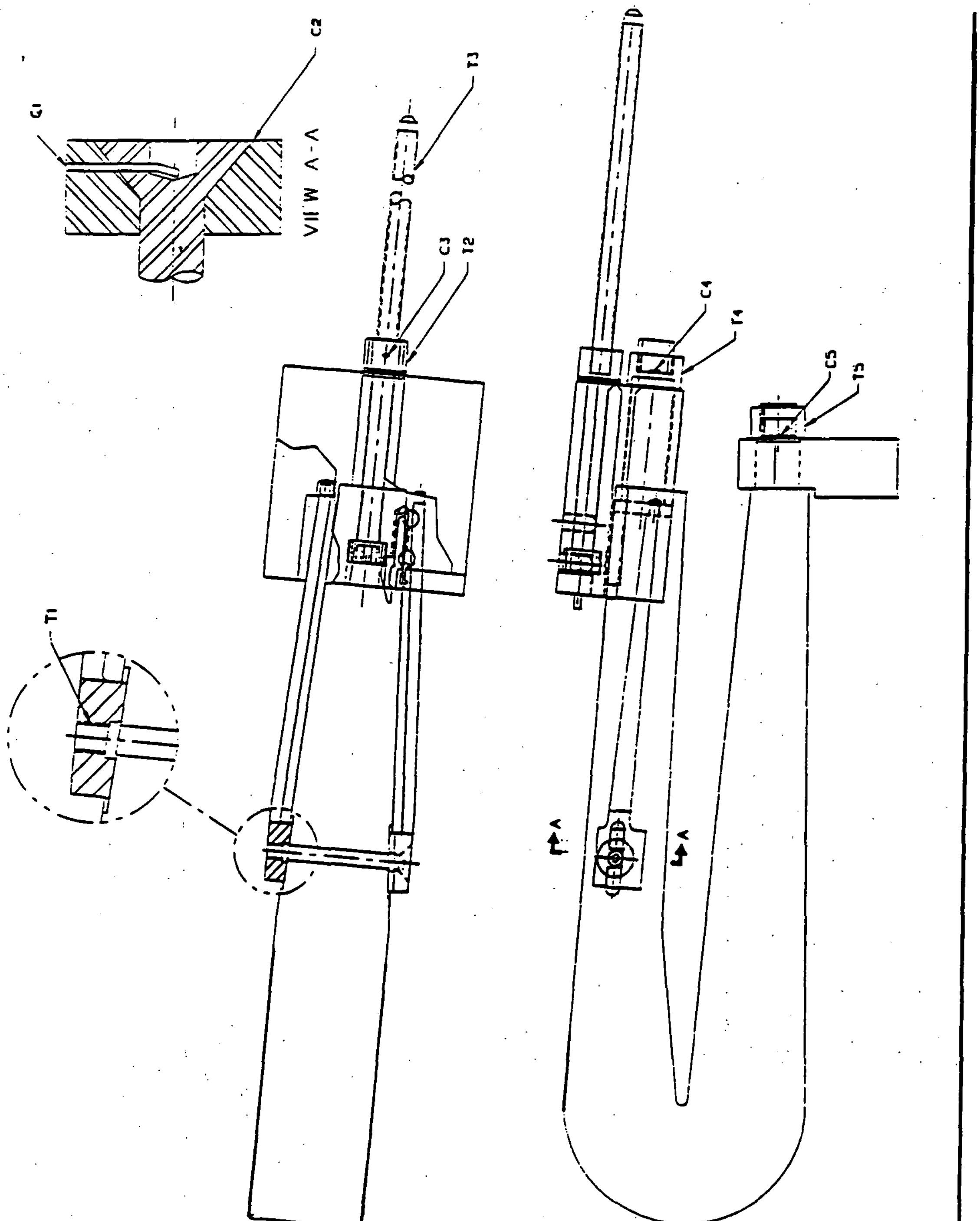


Figure 3
Stabilizer Support Assembly

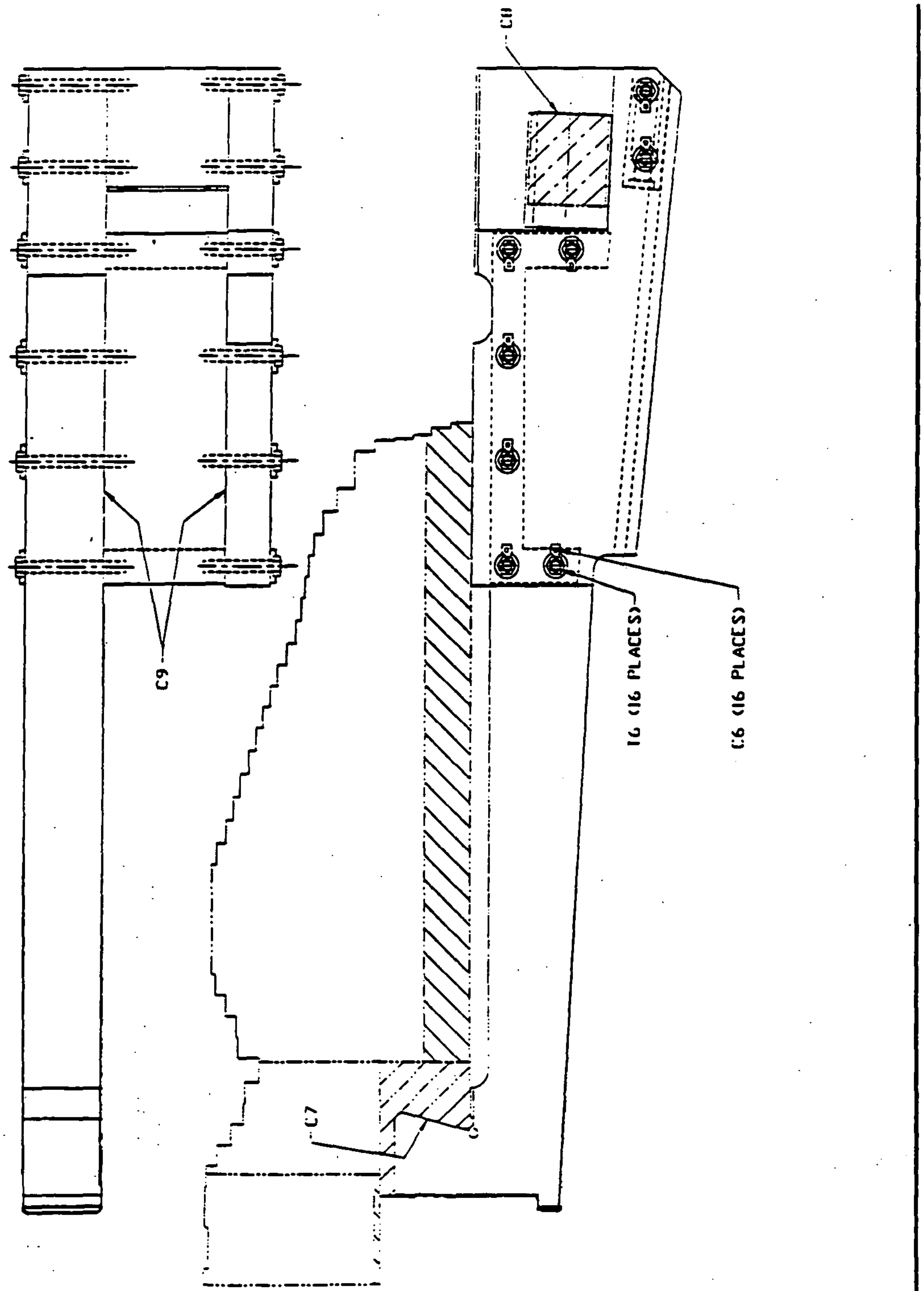


Figure 4
Tie Rod & Lower Spring Assembly

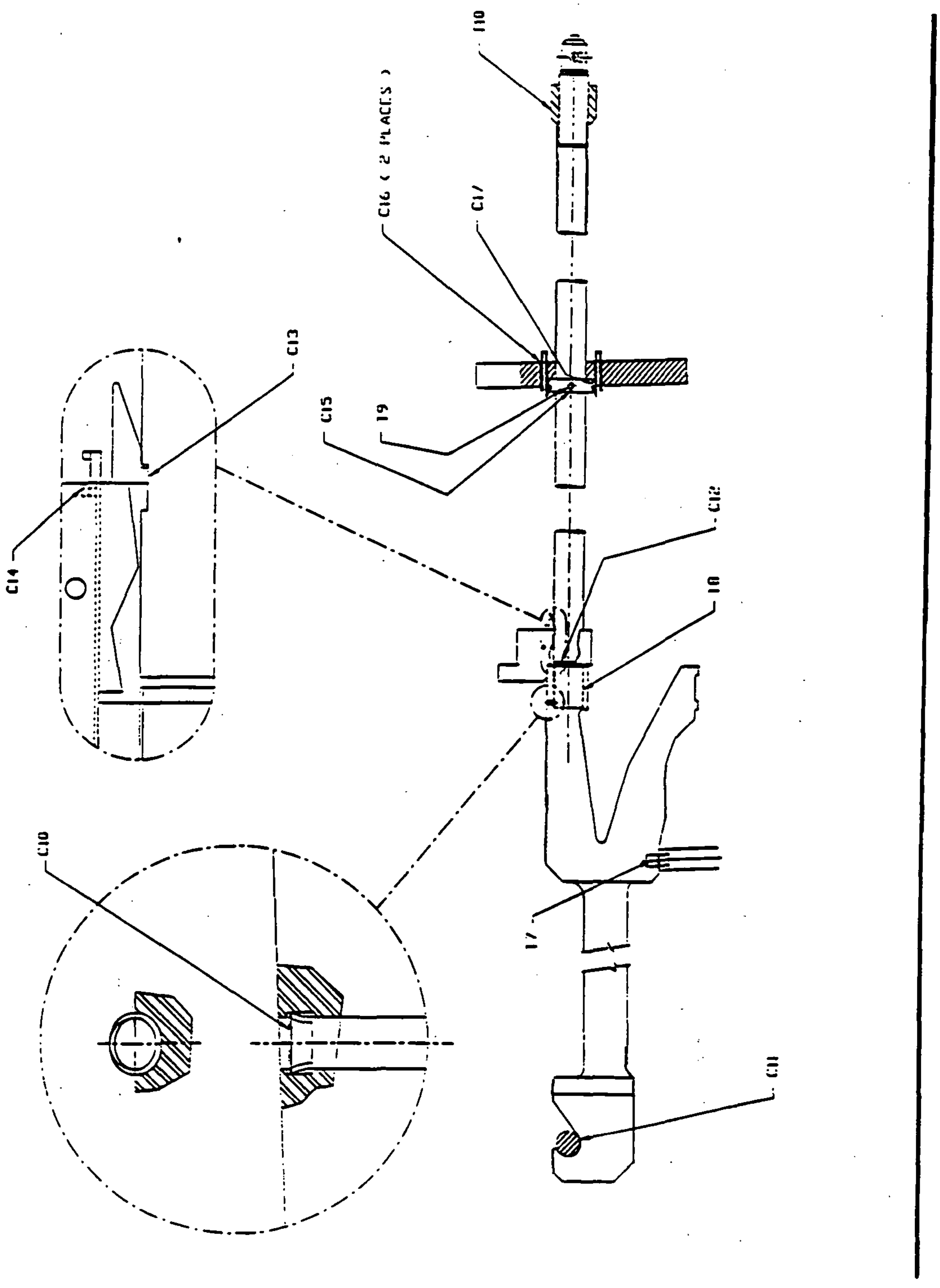


Figure 5
Yoke Assembly

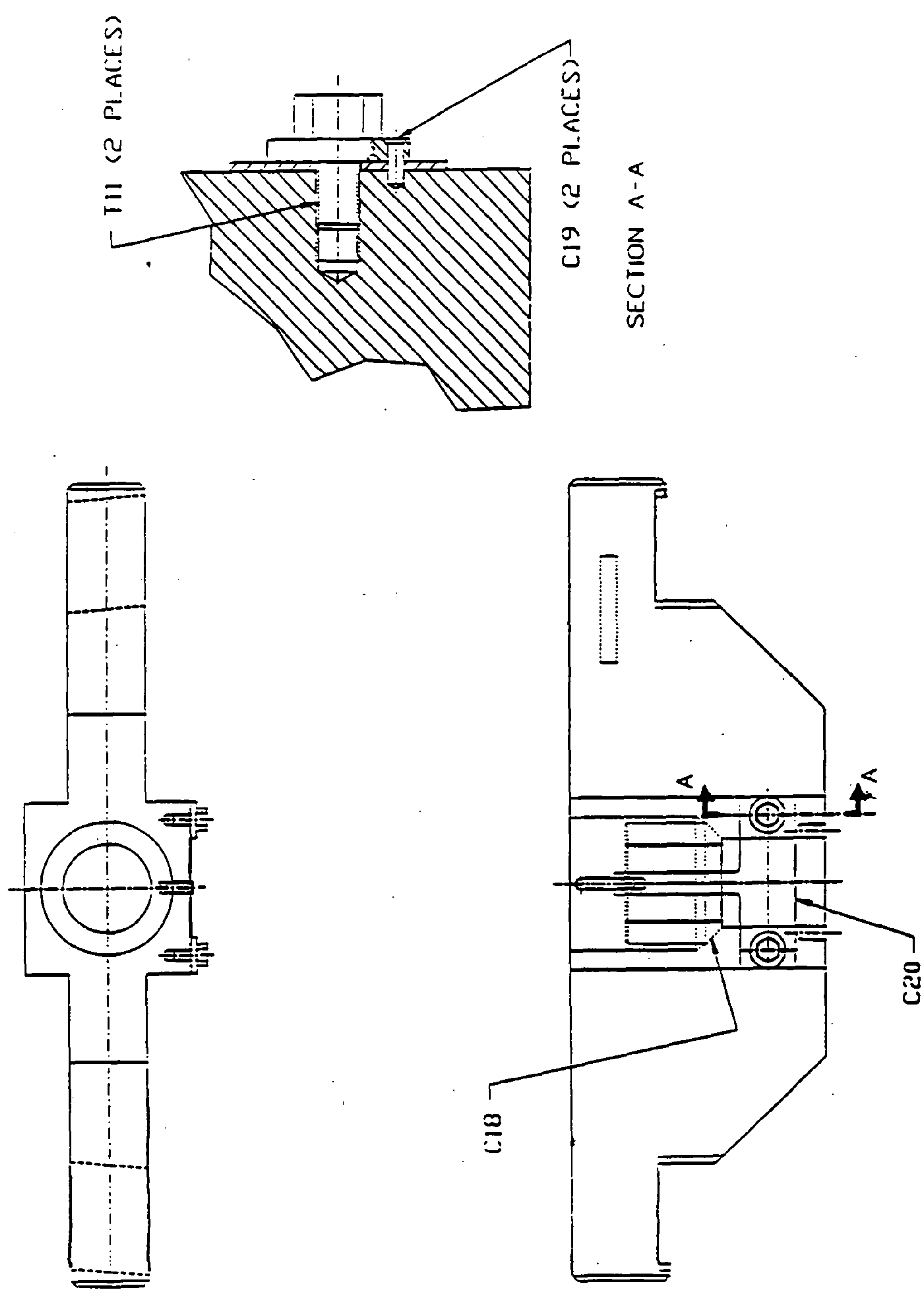
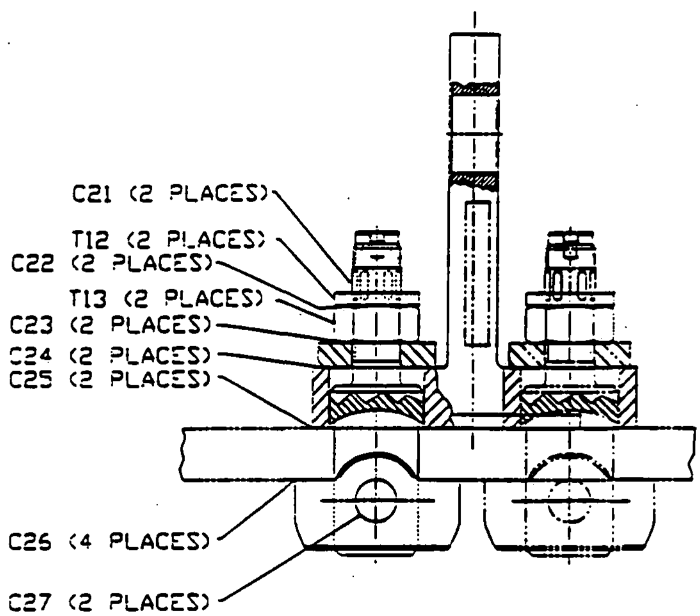


Figure 6
Toggle Assembly



Question 6

Please provide details of your controls in the practices of machining, grinding and threading to minimize the effect of cold work, such as amount of materials to be removed in each pass, application of coolant and sharpness of the tool.

Response 6

Each item that is manufactured has its own specific requirements when it comes to "how much" material is removed per pass and which machine is doing the work. Generally speaking, parts are "rough machined" down to within .100" of final dimensions. Then the final clean up (about .010") pass skims off the required amount of material to achieve the required size and surface finish. If a tool is dull, then the 125 rms surface finish would not be produced as required on all drawings. A dull tool produces a smeared or torn surface appearance which is the primary method of monitoring the adequacy of the tooling and the process in general.

The judgement and experience of the machinist is relied upon to determine how much material can be safely removed per cut or per pass. Written documents could not possibly address all possible eventualities of work piece size, shape, and material or machine type and capacity or dimensions, tolerances, and surface finish necessary. Vendor in process control sheets or travelers are used to control the flow of material in the shop. While in process, machining is seldom, if ever, controlled by fixed documents. The end results are carefully specified on the drawings.

In addition, the fabrication specification section 3.5 states " Machined components that are not solution annealed after machining shall have metallographic and microhardness evaluation on test samples. Samples shall be provided from the same material, same fabrication shop and using the same process variables." The purpose of these evaluations is to verify the materials' surface conditions have very shallow cold work depth. Control of the cold work depth will minimize the materials susceptibility to IGSCC.

The coolant used during the machining process is Trim-Sol. A stream of Trim-Sol is applied directly to the cutting tool where it makes contact with the part. Afterward, the component is washed with acetone and followed by a demineralized water wash prior to any other operation.

Question 7

The staff realized that the repair assemblies may be inspected by a combination of visual and ultrasonic examinations. However, the staff has some concerns regarding the reliability of such inspection to identify the potential degradation in the threaded joints and areas of crevices and stress concentration, which have limited access for inspection. Please provide a discussion and/or propose an alternative inspection such as disassembling the threaded joints for inspection to ensure that the areas mentioned above in the repair assemblies will be adequately inspected for early detection of potential degradation.

Response 7

The tendency toward stress corrosion cracking is promoted by material type, condition, local water chemistry, applied loads, residual stresses, etc.. In the case of stainless steel threaded fasteners, crevices, surface condition (surface cold work) and sustained tensile stress are of specific concern. For the shroud restraint hardware several factors mitigate the concern for potential stress corrosion cracking.

Material - Type 316 L

Austenitic 300 series stainless steel shroud repair hardware material is provided solution annealed at 2000 ± 100 degrees F after completion of final reduction, sizing, and forming operations. All Austenitic 300 series stainless steel have sensitization testing performed for each heat and each heat treat lot. The sensitization requirements exceed the requirements ASTM A-262. The stainless steel is low carbon Type 316 L which by virtue of the presence of molybdenum offers greater resistance to cold work induced martensite, crevice corrosion, and pitting than conventionally used Type 304. In addition the lower carbon content affords greater resistance to IGSCC. Per the fabrication specification, 25A5690, all Type 316L stainless steel threaded areas are re-solution annealed after final machining. This process alleviates the residual stresses and cold work formed during fabrication.

Material - XM-19

In the middle 1970's in the interest of improving the margin of control rod drive (CRD) performance, GE implemented the use of XM-19 for piston and index tubes in place of Type 304 stainless steel. The logic was that as a low carbon, high chromium, mildly stabilized (Nb,V) austenitic alloy XM-19 would offer a higher margin of resistance to intergranular stress corrosion cracking (IGSCC) in the nitrided condition than Type 304. Nitriding involves heating the material to approximately 1100 degrees F for several hours and results in furnace sensitization of 300 series stainless steels. As a side benefit, XM-19 has a significantly higher strength than Type 304 so equivalent components are stressed to a lower fraction of yield stress in service. Since the late 1970's all control rod drives manufactured by GE have contained XM-19 piston and index tubes. This includes all BWR-6s (more than 1500 drives) plus several other BWR-4/5's under construction at the time; as well as, all replacement drives manufactured since. In total there are easily more than 2000 such control rod drives in service.

By the nature of the CRD design there are numerous crevices including threaded joints exposed to the reactor environment. On the average 10 to 20 per cent of the drives at a given plant are refurbished each outage. During this work the drives are disassembled giving ample opportunity for examination and detection of problems. To date no instances of intergranular attack or IGSCC of nitrided XM-19 have been reported.

XM-19 shroud repair hardware material is provided solution annealed at 2000 ± 50 degrees F after completion of final reduction, sizing, and forming operations. All XM-19 material has had sensitization testing performed for each heat and each heat treat lot. The sensitization requirements exceed the requirements ASTM A-262. Per the fabrication specification, 25A5690, all XM-19 material threaded areas are re-solution annealed after final machining (see the response to question 4.a.). This process alleviates the residual stresses and cold work layer formed during fabrication.

Material - X-750

X-750 shroud repair hardware material is provided solution annealed at 1975 ± 25 degrees F after completion of final reduction, sizing, and forming operations. In addition, this material is age hardened at 1300 ± 15 degrees F. All X-750 has Intergranular attack (IGA) testing performed after annealing for each heat and each heat treat lot.

Typical UNS N07750 (X-750) samples were selected at random from their actual production runs, cross-sectioned, and the microhardness measured as a function of depth into the metal from the polished surface. The sequence of manufacture was:

Sample "A"	Sample "B"
Machined	Age Hardened
Polished	Machined
Age Hardened	Polished
Penetrant Examined	Penetrant Examined
Dimensions Checked	Dimensions Checked

In both specimens, the hardness at and near the polished surfaces was identical to that of the unaffected interior: Rc 36 for "A" and Rc 35 for "B". All readings remained within a plus or minus 3-point tolerance band, which is uniform and unusually consistent for 100-gram Knoop readings. The surface showed no evidence of work hardening or cold work.

It should be noted that there are no welds in the shroud restraint design, so there are no weld residual stresses. Also, there is no grinding in the shroud restraint design, so there are no grinding induced residual stresses or cold work. As a consequence, the threaded fasteners in the restraint design experience a relatively low level of sustained tensile stress compared to welded crevice joints.

Finally, machined components that are not solution annealed after machining shall have metallographic and microhardness evaluation on test samples. Samples shall be provided from the same material, same fabrication shop and using the same process variables as the components which are being fabricated for the repair. The purpose of these evaluations is to verify the material's surface condition have very shallow cold work depth. Control of the cold work depth will minimize the materials susceptibility to IGSCC initiation.

Based on the material properties and fabrication processes described above, future disassembly of threaded fasteners, crevices, and stress concentrations areas for the express purpose of inspection is not intended. However, if these areas require disassembly in the future for other reasons, a visual inspection of the threaded, creviced, and stress concentration areas will be performed prior to reassembly. The detailed plans for future inservice inspection of the installed core shroud repair components have not yet been finalized. Dresden will submit these plans to the NRC staff at least ninety days prior to the first refueling outage following the outage in which the shroud repair components are installed."

Question 8

Please provide details of your planned baseline in-service inspection (location, extent, frequency, methodology and justification) of the core shroud to support the core shroud repair.

Response 8

The details of the planned baseline inservice inspection (including location, extent, methodology and justification) of the core shroud to support the core shroud repair at Dresden Unit 2 is provided in Reference (c), page 2 and Table 1.

Question 9

Please provide details of your planned in-service inspection (location, extent, frequency, methodology and justification) of the installed core shroud repair components. Your planned inspection should consider the staff recommendation in item 7. If complete information for items 5 and 9 can not be provided at this time, identify the date when such information will be provided.

Response 9

The detailed plans for future inservice inspection of the installed core shroud repair components have not yet been finalized. Dresden will submit these plans to the NRC staff at least ninety days prior to the first refueling outage following the outage in which the shroud repair components are installed.

Question 10

Please identify the lubricants that would be used on the machined threads during installation. What are the controls of the content of chlorides, sulfides, halogens and other elements that are known to promote stress corrosion cracking in stainless steel and high nickel alloy?

Response 10

The use of a Nickel-Graphite antiseize thread lubricant is specified during installation of threaded surface. The applicable specifications for this lubricant limit the following elements known to promote intergranular stress corrosion cracking of stainless steel and high-nickel alloys:

- The maximum allowable level of halogens, when both sulfur and nitrates are less than 1 ppm, is 450 ppm.

- The maximum allowable level of sulfur, when both halogens and nitrates are less than 1 ppm, is 630 ppm.

- The maximum allowable level of nitrates, when both total halogens and total sulfur are less than 1 ppm, is 820 ppm.

- Allowable combined levels of halogens, sulfur and nitrates are limited by the below formula.

$$\frac{ppm_{Halogens}}{35.453}+\frac{ppm_{Sulfur}}{48.096}+\frac{ppm_{Nitrates}}{62.004}<13.2$$

Station Procedure DAP 16-01, Chemical Control Program, provides control of consumable chemicals. The purpose of the procedure is to provide instructions for the control of consumable chemical materials and products used on site, establish criteria for chemicals which contain chlorides, sulfides, halogens and other elements that are known to promote stress corrosion cracking in stainless steel and high nickel alloy, and control chemical input to plant waste streams.

Question 11

Please discuss how are you going to monitor the magnitude of the spring preload to ensure there is no substantial relaxation of the preload. Please also discuss the safety consequences if the spring preload is completely relaxed and the feasibility of measuring the overall preload during plant operation.

Response 11

The preload applied by the tie rod nut assures all connections are initially tight. The designed repair uses mechanical locking methods (such as crimped jam nuts on top of the tie rod nuts) for threaded connections. The differential thermal expansion between the shroud and stabilizer hardware provide the load to assure any failed weld remains tight during normal reactor operation. The plans for future examinations of the shroud repair hardware are currently being developed and will be submitted as noted in the response to question 9. As the shroud design is based on differential thermal expansion, complete loss of the mechanical preload will not affect the thermal preload and thus would not result in a loss of preload under operating conditions (See GENE 771-81-1194, supplement A to Revision 1, Volume II). The safety consequences of a total loss of all preload on the tie rods is bounded by the results of the safety assessment that was submitted as an Attachment "B" to the December 14, 1994 submittal.

This safety assessment, which was previously reviewed by the NRC staff, concludes that even without the shroud stabilizer hardware the required safety functions are satisfied. The loss of preload with the shroud stabilizers installed is thus bounded by this previous analysis.

The above noted reference, GENE 771-81-1194, Supplement A to revision 1, Volume 2, "Supplement A to the Shroud and Shroud Repair Hardware Stress Analysis", Dresden Nuclear Power Station, June 1995, is being provided with this RAI submittal.

Question 12*

In your shroud and shroud repair hardware stress analysis (GENE-771-81-1194, Revision 2), section 3.2, tie rods are specified to be made of XM-19 material.

(a) *Please discuss the reasons for selecting XM-19 material instead of austenitic 304 or 316 stainless steel (low carbon content), and provide the relevant service experience and laboratory testing data to support its application in the BWR environment.*

(b) *It should be noted that the acceptable yield strength of XM-19 material is limited to 90 ksi. Is this upper limit of the yield strength for XM-19 identified in your procurement specification?*

(c) *The staff finds that your specified heat treatment of air-cooling from the solution annealing temperature for XM-19 materials is not consistent with the BWRVIP guidelines provided in the document (BWROG-VIP-9410) of "BWR Core shroud Repair Design Criteria," where water quenching from the solution annealing temperature is recommended. Since there is very limited service experience of XM-19 material in the BWR environment, the staff recommends that an accelerated stress corrosion testing of a mock-up simulating the XM-19 tie rod thread joint in a BWR environment should be performed to ensure there is no development of unexpected degradation.*

Response 12a

When considering the applicable environmental conditions, XM-19 has a higher resistance to IGSCC then 304L or 316L due to its chemical composition. The higher chromium content adds corrosion resistance and inherent resistances to IGSCC.

XM-19 was extensively studied and tested in the mid-1970s. Results of these tests were published in Document NEDE-21653, of which the NRC received a copy during the Quad Cities RAI submittals. This document contains all of the applicable test information. XM-19 has experienced no known failures or other problems in approximately twenty years of BWR service. This is considered to be adequate confirmation that the material is acceptable for use.

One of the first BWR applications of XM-19 was as piston tubes and index tubes in the control rod drive mechanisms (BWR 4,5 & 6). It is still used in that role. It has also used in a number of bolting applications (shroud head, top guide, flow deflector, etc.). The material is especially useful where the highest possible resistance to IGSCC is needed; for example, the piston and index tubes are nitrided at 1060°F of ± 5°F in furnace cycles up to 48 hours in duration. The 300-series stainless steels, even with low carbon contents, would be sensitized to IGSCC by such a treatment - - XM-19 is not sensitized.

It should be noted that XM-19 has a higher allowable stress as compared to 304/316. In addition, XM-19 has a slightly lower coefficient of thermal expansion as compared to 304/316 which when used as a tie rod results in an increased thermal preload.

Response 12b

The upper limit for yield strength of XM-19 material is not identified in the procurement specification for the material. Although the upper limit for the yield strength is not specified, the values used in the analysis of the hardware are those of Section III of the ASME Boiler and Pressure Vessel Code which are below 90 ksi.

Response 12c

A partial list of service experience in BWR's as well as extensive qualification testing by General Electric of XM-19 material is documented in the Materials Technology report "A Stress Corrosion Cracking Evaluation of XM-19 in the BWR Environment" by B. M. Gordon dated June 15,1995, which is provided as Attachment C to this RAI. Included in the report is the affect of the cooling rate (water verses air), cold work and irradiation on the XM-19 material corrosion performance. This document provides the justification for air cooling from the solution annealing temperature for XM-19 instead of water quenching from the solution annealing temperature.

In addition, XM-19 was extensively studied and tested in the mid-1970s. XM-19 has experienced no known failures or other problems in approximately twenty years of BWR service. This is considered to be adequate confirmation that the material is acceptable for use. Hence, no additional testing is required. See response "12a" of this RAI for further details.

Question 13

If the credit for the fillet or any circumferential welds in the core shroud is taken in the design of the proposed repair to maintain the required preload, please discuss in detail and provide the justification regarding the measures you plan to take such as inspection to ensure the welds are and remain in the condition assumed in the analyses.

Response 13

There was no credit taken for the fillet nor any circumferential shroud welds in the core shroud in the design in order to maintain the required tie rod preload. This is documented in GENE-771-81-1194, Volume 2, Revision 1 and GENE-771-81-1194, Supplement A to Revision 1, Volume 2. It was explained that the analysis to determine the preload in the rod included the effects of the shroud flexibility due to postulated through wall cracking of the circumferential welds. This analysis included the effects of bending of the top guide and core plate ring segments due to cracking in the heat affected zone of the shell course and ring segments (circumferential welds). The effect of the deflection of the ring segments was incorporated into the calculation of the shroud stresses and the tie rod preload determination. Under all normal and upset conditions the thermal preload is maintained in the tie rod and thus the circumferential welds will remain in compression. Verification of this preload under operating conditions is not necessary as the design (through the selection of material properties with different thermal expansion characteristics) ensures that the preload is maintained under the critical operating conditions.

The preload in the tie rod will be overcome in the governing Emergency and beyond design basis Faulted conditions (e.g., MSLOCA, and DBE plus MSLOCA) but the tie rod stresses are less than the code allowables. The effect of any potential yielding caused by these accidents would be evaluated prior to restart of the unit.

All design reliant structures are included in the inspection plan as referenced in the response to question 8. The scope of this inspection will verify the integrity of all components that are relied upon to perform a structural function.

The above noted reference, GENE 771-81-1194, Supplement A to revision 1, Volume 2, "Supplement A to the Shroud and Shroud Repair Hardware Stress Analysis", Dresden Nuclear Power Station, June 1995, is being provided with this RAI submittal.

Question 14

Note: The number 14 was skipped in the RAI questions. Hence, there is no question or response.

Question 15

In GENE 771-81-1194, Revision 1, Volume 1 "Shroud Repair Hardware," Figure 6.3.2, p. 37 shows the deformed configuration of long upper supports. Clarify the boundary conditions applied to the finite element model at the interface between the long upper support, the shroud flange, and the shroud head flange.

Response 15

The description of the Long Upper Support (LUS) loading and restraining boundary conditions is provided below. The boundary conditions discussed were those applied on the Finite Element (FE) model. Figures 7, 8 and 9 provide the FE model node numbering information at the LUS' upper and lower contact locations to aid the illustration.

The Loads

1. The axial tie rod load was applied at three rows of nodes, 73, 76, 79, 80 / 42, 47, 50, 51 / 63, 68, 70 and 72. These nodes cover the surface where the LUS and the bracket yoke come into contact.

2. The horizontal seismic load was applied at two locations, namely,

   a. at three rows of nodes, 749 thru 752 / 709 thru 712 / 673 thru 676, where the shroud head flange comes into contact with the LUS,
   b. at three rows of nodes, 222 thru 225 / 185 thru 188 / 157 thru 160, where the top guide flange comes into contact with the LUS.

The Restraints

1. At the upper contact, restraints perpendicular to the interface between the LUS and the shroud head flange were defined at three rows of nodes, 745 thru 748 / 729, 733 thru 735 / 693, 697 thru 699.

   The rationale to choose this restraint arrangement is as follows: The upper inclined portion of the LUS is embedded in the shroud, and there are gaps existing between it and the shroud flange and the shroud head flange. The size of this gap may be as large as 0.1 inch. Depending on the actual gap size, and the magnitude of the applied load, contact between the shroud head and the top surface of the upper inclined support can occur.

When contact occurs, the LUS upper inclined portion will be restrained by the shroud in a way similar to the two-directional nodal restraints applied. Since it has been assessed that the resulting stresses were higher for the case where contact occurred, we chose to report this restraint model in GENE-771-81-1194, Rev.1 as a bounding case for a conservative design evaluation.

In GENE-771-81-1194, Rev.2, we have added a case to illustrate the above considerations. The original case, as reported in Revision 1, was named as Case C (for Contact condition), and the added case was named as Case NC (for No-Contact condition). In Case NC, there was no contact between the LUS' upper inclined portion and the shroud head flange. All the tensile reaction forces at the interface, between the bottom surface of the LUS' upper inclined portion and the shroud flange, were released to simulate a compression-only reaction. For that, only one row of nodes, 745 thru 748, was retained. Figures 10 and 11 provide the exploded views of the resulting stress contours from Cases C and NC, respectively.

2. At the lower contact, restraints were defined in the horizontal direction at three rows of nodes, 217, 226, 231, 232 / 189, 198, 203, 204 / 161, 174, 182, and 184.

This location is at about the same elevation as the top guide flange location. The rationale to choose this location is as follows: As shown in Figure 12, the Upper Spring (US) is attached to the LUS through a block at the bottom of the US leg. This block can slide in a groove inside the LUS in the direction of the jacking bolt, AB. The entire US assembly can be positioned at a ~3" elevation range depending on the existing dimensional constraints. At the US' lowest position, the contact point D (between the upper contact and the RPV wall) is approximately at the same elevation as the contact point E (between the top guide flange and the LUS). Since the support has been analyzed at this lowest location, the resulting maximum stress (due primarily to the higher resultant bending moment) provides a conservative upper bound. We chose this bounding hardware configuration location for the lower restraint location to include in our report (GENE-771-81-1194, Revision.2).

The length of the engagement between the US and the LUS is about 7.5" and the height of the upper contact at point D is about 2". Because of the connection to both the core shroud and RPV, two-directional nodal restraints are possible. For the same "higher stress" reason, the height of ~2" was chosen as the height of the restraint area and the restraints were modelled as two-directional as well.

The above noted reference, GENE-771-81-1194, Revision 2, is being provided with this RAI submittal.

3. There were also other types of restraint arrangements that were modeled as part of a sensitivity study. For example, the bearing on the vertical upper surface (i. e., one row of horizontal restraints imposed at nodes 673 thru 676) was considered in one case (Case VC). By comparing all the stress results from this sensitivity study on all the parameters evaluated, it shows that, overall speaking Case C provides a higher stress distribution, and can be considered as a conservative basis for the design evaluation.

Figure 7
Node Numbering
Upper End of Long Upper Support

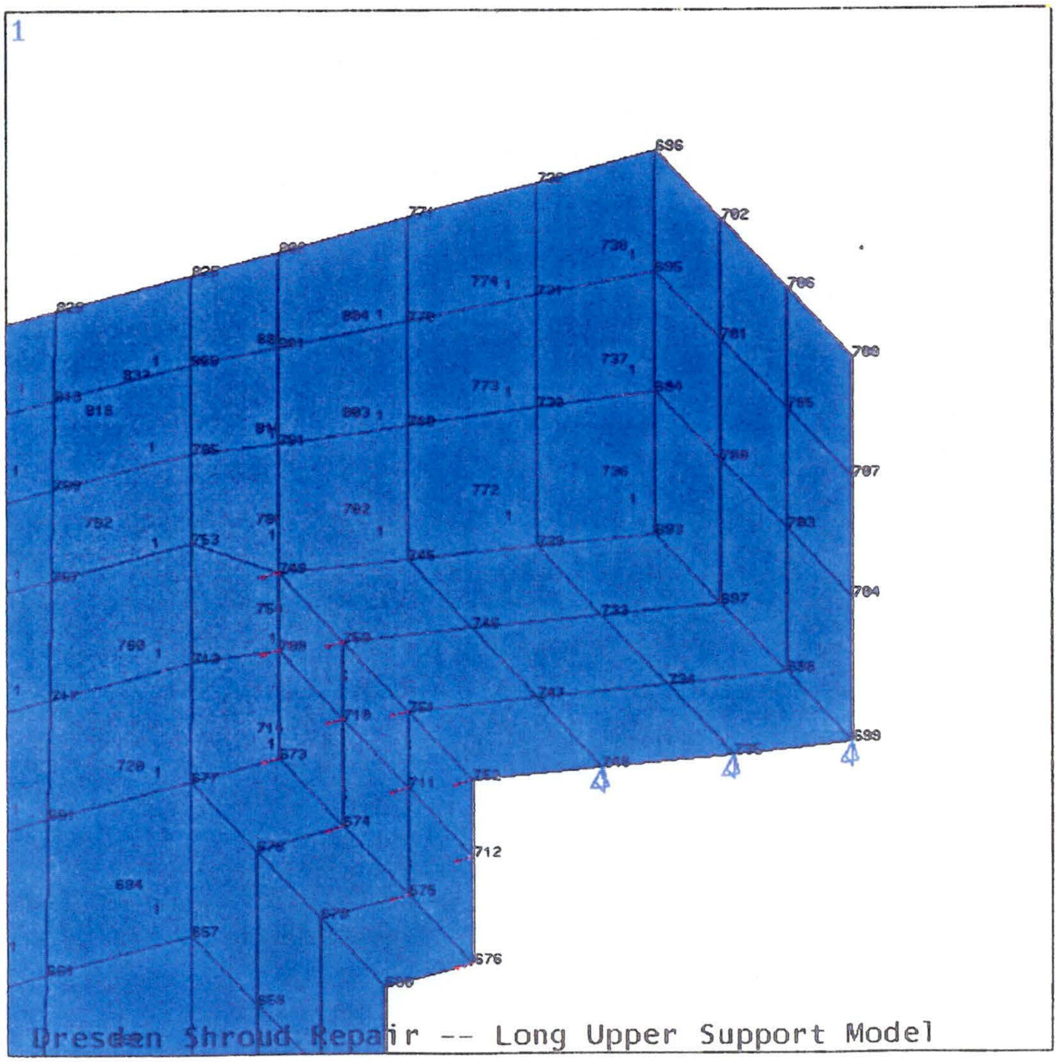
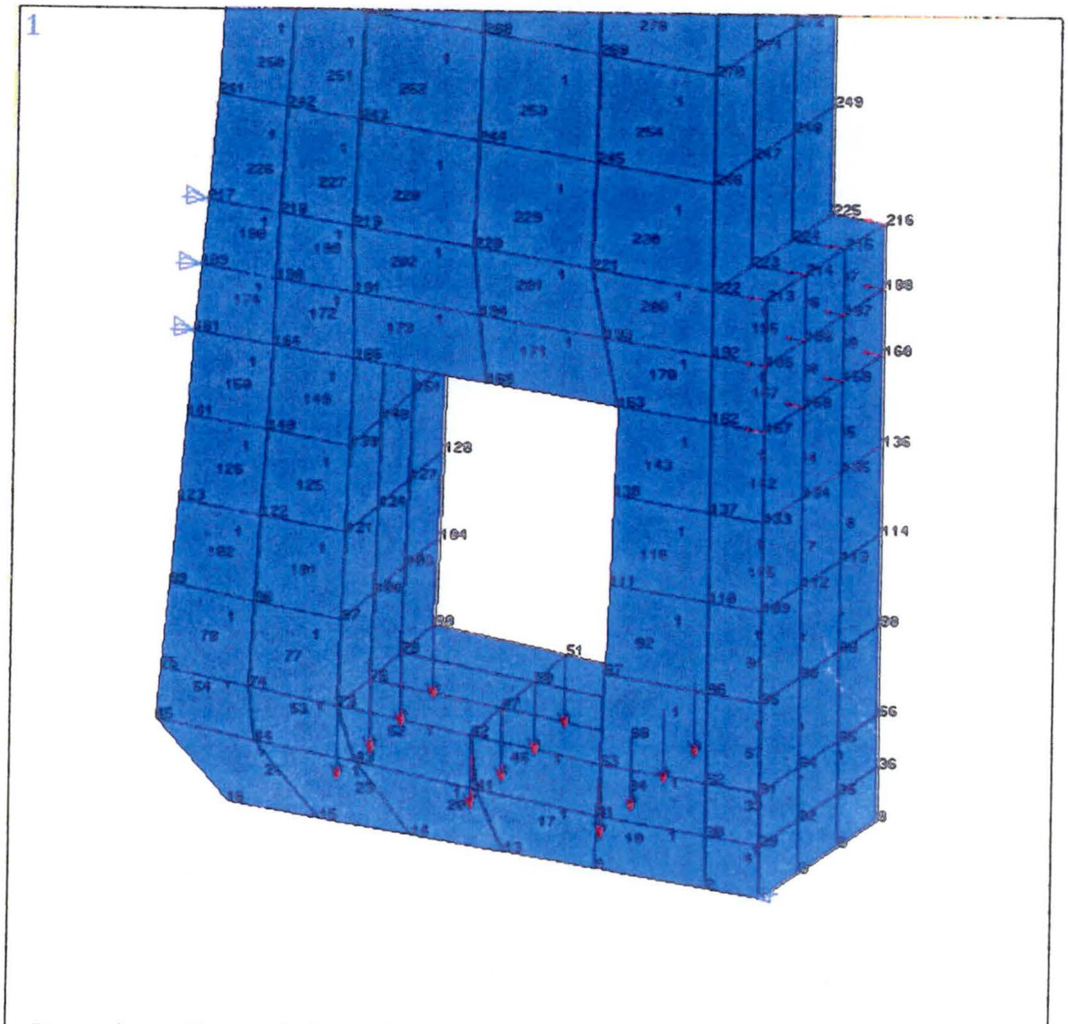


Figure 8
Node Numbering
Shroud Side, Lower End
Long Upper Support



Dresden Shroud Repair -- Long Upper Support Model

Figure 9
Node Numbering
RPV Side, Lower End
Long Upper Support

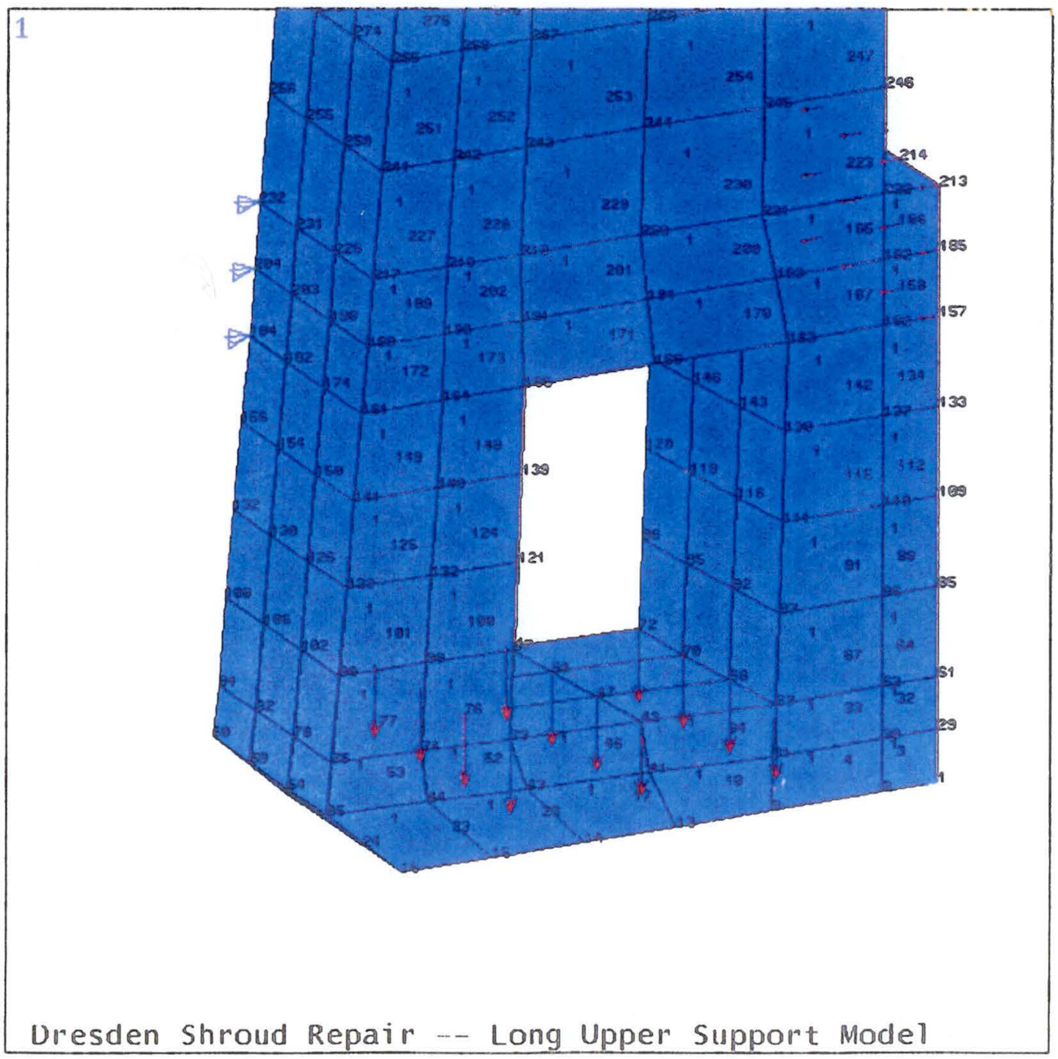


Figure 10
Case C

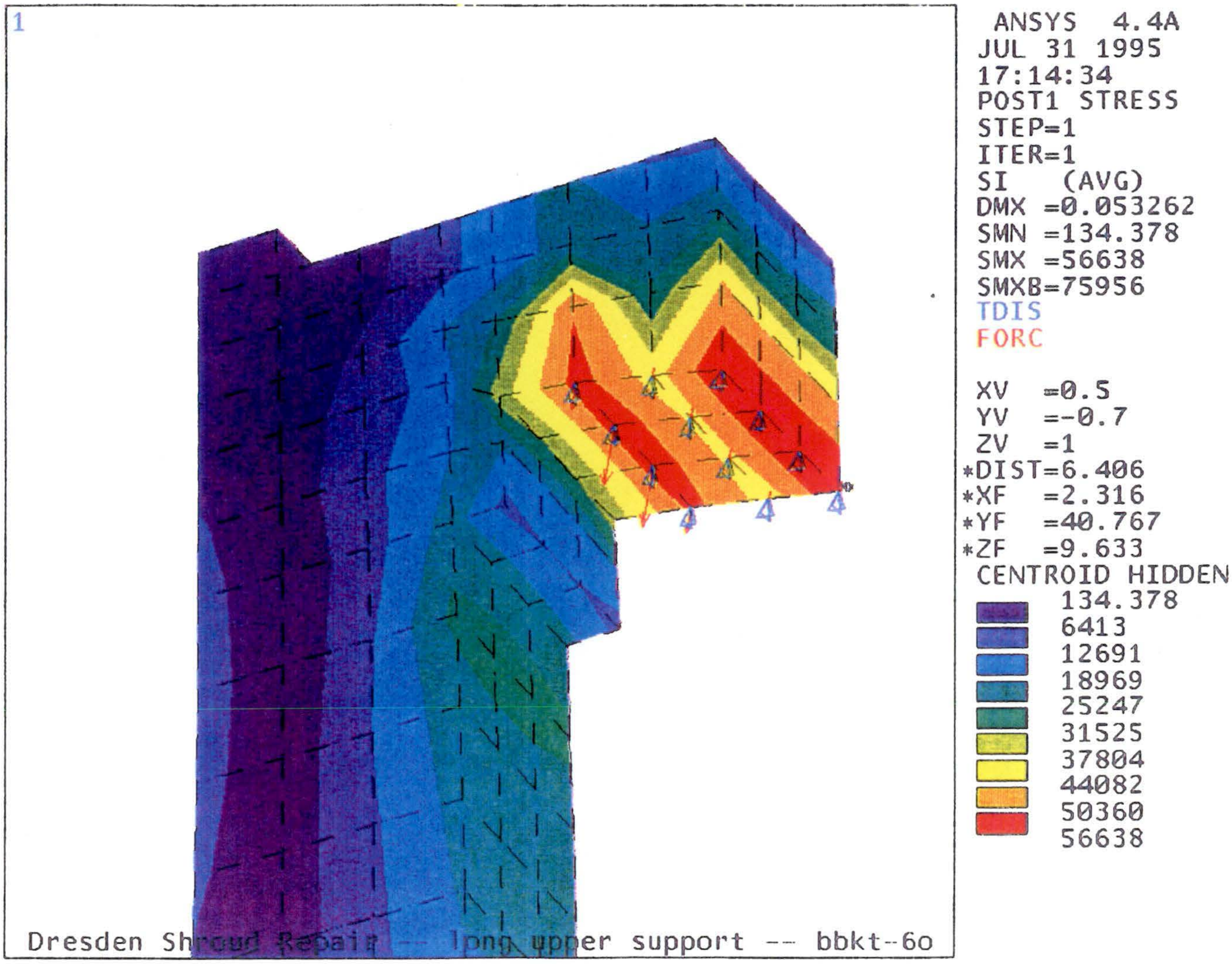


Figure 11
Case NC

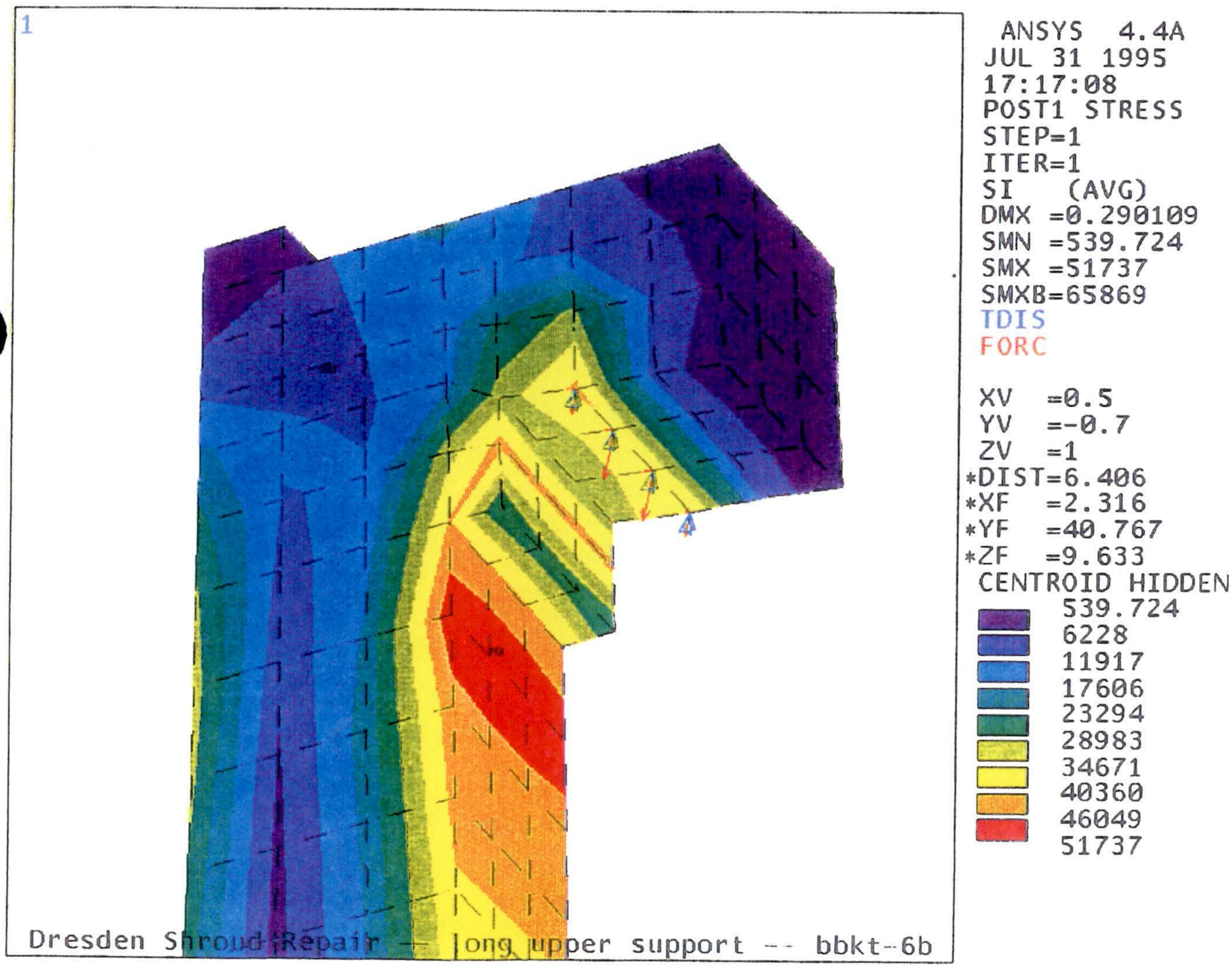
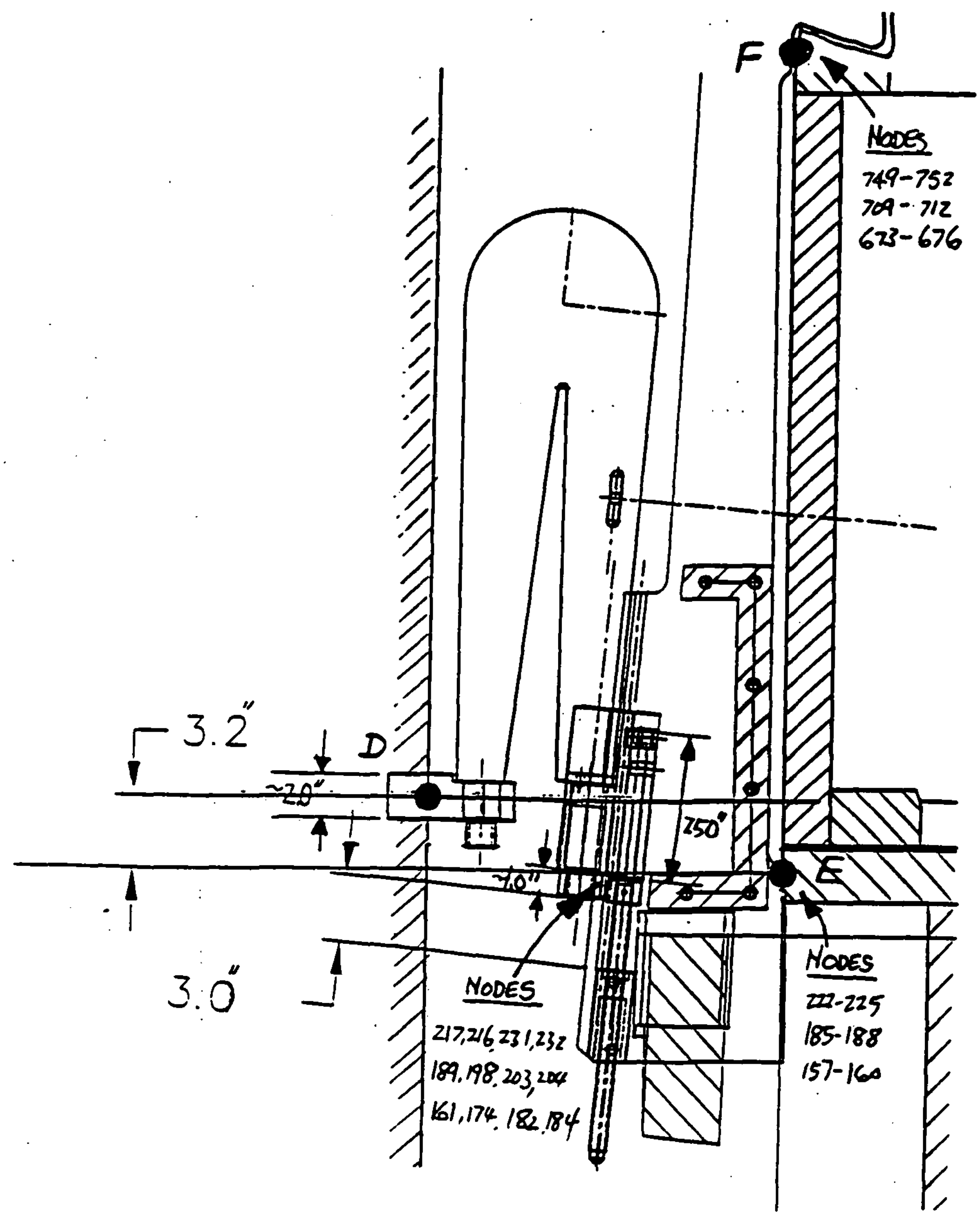


Figure 12
Long Upper Support and Upper Spring Connection



Question 16

Provide the preload and gap calculations, similar to those provided for Quad Cities 1 and 2, in GENE-771-68-1094, Supplement A to Rev. 4, Apr. 95.

Response 16

The preload and gap calculations, similar to those provided by Quad Cities 1 and 2 are contained in GENE 771-81-1194, Supplement A to revision 1, Volume 2, "Supplement A to the Shroud and Shroud Repair Hardware Stress Analysis", Dresden Nuclear Power Station, June 1995. The above noted document is being provided with this RAI submittal.

Question 17

In GENE 771-84-1194, "Shroud Repair Seismic Analysis," (Enclosure 9) and GENE-523-A181-1294 "Primary Structure Seismic Models" (Enclosure 15). Show the weights which form the basis for the masses comprising the shroud.

Response 17

The weights which form the basis for the masses comprising the shroud will be provided in a future submittal.

Question 18

*Provide an evaluation of the Core Spray piping for emergency and faulted loading combinations which include MSLB and RLB loads.**

Response 18

The evaluation of the core spray piping will be provided in a future submittal.

ATTACHMENT A

GENE Metallurgy Laboratory, Laboratory Test No. 08068, Metallographic Analysis Report, Subject - Microstructural Analysis of Heat Treated 316L SS Threaded Sections

Metallurgy Laboratory
GE Nuclear Energy, San Jose

Laboratory Test No. 38068

Metallographic Analysis Report

SUBJECT: Microstructural analysis of heat treated 316L SS threaded sections for Plant Hatch. Heat # of the threaded bar is # 38593

Two threaded sections of 316L ss were received for evaluation of the effect of a solution anneal of the thread area to reduce the induced cold work from the threading operation. One section in the as-received threaded condition and one section in the solution anneal (1900-1940^{0}F-1min) condition were metallographically sectioned to examine the thread root area for residual cold work effects, grain growth, grain recrystallization and sensitization.

The microhardness results (KHN 25 gm) show that the as-threaded condition hardness is above R_B 95 to a depth of 6.6 mils, as seen in previous coupons. The solution anneal condition shows a marked improvement with a resultant R_B level ranging from 78 near the surface to about 80 at a depth of 6.6 mils.

The solution annealed section was tested per E50YP20 for any indication of sensitization during the cooling portion of the heat treatment. No evidence of sensitization was detected.

The grain size of the un-treated coupon is ASTM # 9 with evidence of cold work extending to a depth of 1.9 mils (depth of visible grain distortion). The solution annealed coupon shows that recrystallization has occurred at the surface where the machining cold work was visible. Below this layer the grain size increased to ASTM # 6 but decreased to ASTM # 7-7½ from a depth of 200 mils to the extent of the mounted coupon.

Performed by: Gail Hummins

Date 9/6/94