VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

January 23, 2002

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

Serial No.	01-490D
NL&OS/ETS	R1
Docket Nos.	50-338/339
	50-280/281
License Nos.	NPF-4/7
	DPR-32/37

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
SURRY POWER STATION UNITS 1 AND 2
SUPPLEMENTAL RESPONSE TO NRC BULLETIN 2001-01 CIRCUMFERENTIAL CRACKING OF REACTOR VESSEL HEAD PENETRATION NOZZLES
QUALIFIED VISUAL INSPECTIONS

On November 14, 2001, Virginia Electric and Power Company (Dominion) provided a supplemental response to NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles." Our response provided information regarding the qualified visual inspections of the reactor pressure vessel head penetration nozzles and a revised schedule for the visual inspection of those penetration nozzles on North Anna Unit 2 and Surry Unit 2. During a December 6, 2001 telephone conference call with Mr. William Bateman and other members of the NRC staff, the NRC requested additional information to support the qualification of the visual inspection activities.

The requested information contained in Attachment 1 for both Surry and North Anna demonstrates that all of the associated reactor vessel head penetrations have a sufficient leakage path to the reactor head surface to permit identification of a leaking penetration.

Westinghouse considers a portion of the requested information proprietary. In order to conform with the requirements of 10 CFR 2.790 concerning the protection of proprietary information, the proprietary information on the drawings in Attachment 1 is contained within brackets. Where the proprietary information has been deleted in the non-proprietary version, only the brackets remain (i.e., the information that was contained within the brackets in the proprietary version has been redacted). Attachment 2 has been redacted to provide a non-proprietary version of this information. The types of information Westinghouse customarily holds in confidence is identified on pages 1 and 2 of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

A088

Attachment 3 to this letter provides the Westinghouse "Application for Withholding Proprietary Information from Public Disclosure," affirming the proprietary nature of the document.

If you have any further questions or require additional information, please contact us.

Very truly yours,

Eugene S. Grecheck
Vice President – Nuclear Support Services

Commitments made in this letter: None

Attachments

cc: U.S. Nuclear Regulatory Commission (Atts. 2 & 3 only)
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SN: 01-490D
Docket Nos.: 50-338/339
50-280/281
Subject: Supplemental Response to NRC Bulletin 2001-01

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Eugene S. Grecheck, who is Vice President - Nuclear Support Services, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 23rd day of January, 2002.

My Commission Expires: March 31, 2004.

Maggie McClure
Notary Public

(SEAL)

Attachment 3

Westinghouse Application for Withholding
Proprietary Information from Public Disclosure

Virginia Electric and Power Company
(Dominion)
North Anna Units 1 and 2
Surry Units 1 and 2

I, Philip W. Richardson, depose and say that I am the Licensing Project Manager, Windsor Nuclear Licensing, of Westinghouse Electric Company LLC (WEC), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and referenced in the paragraph immediately below. I am submitting this affidavit in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations and in conjunction with the application of Dominion Generation for withholding this information.

The information for which proprietary treatment is sought is contained in the following drawings:

Originating Organization	Drawing No.	Sh. Nos.	Title
De Rotterdamsche Droogdok MIJ. N.V.	30660-1099	NA	157" PWR Vessel "Westinghouse" Control Rod Mechanism Housing
De Rotterdamsche Droogdok MIJ. N.V.	30660-1103	1	157" PWR Vessel "Westinghouse" Closure Head Assembly, CRD Housing Assy.
De Rotterdamsche Droogdok MIJ. N.V.	30660-1154	1	157" PWR Vessel "Westinghouse" Closure Head Subassembly, Drilling of Adapter Holes and Stud Holes
De Rotterdamsche Droogdok MIJ. N.V.	30678-1184	1	157" PWR Vessel "Westinghouse" Closure Head Subassembly, Drilling of Adapter Holes and Stud Holes
De Rotterdamsche Droogdok MIJ. N.V.	30678-1185	1	157" PWR Vessel "Westinghouse" Closure Head Assembly, CRD Housing Assy.
De Rotterdamsche Droogdok MIJ. N.V.	30678-1188	NA	157" PWR Vessel "Westinghouse" Control Rod Mechanism Housing
De Rotterdamsche Droogdok MIJ. N.V.	30679-1201	1	157" PWR Vessel "Westinghouse" Closure Head Subassembly, Drilling of Adapter Holes and Stud Holes
De Rotterdamsche Droogdok MIJ. N.V.	30679-1202	1	157" PWR Vessel "Westinghouse" Closure Head Assembly, CRD Housing Assy.
De Rotterdamsche Droogdok MIJ. N.V.	30679-1216	NA	157" PWR Vessel "Westinghouse" Control Rod Mechanism Housing
Westinghouse Electric Corporation	500B893	1	VPA As Built Coordinate Locations of Vessel Closure Head Penetrations as per Figure No. 8
Westinghouse Electric Corporation	500B893	2	VPA As Built Coordinate Locations of Vessel Closure Head Penetrations as per Figure No. 8
Westinghouse Electric Corporation	500B893	3	VPA As Built Coordinate Locations of Vessel Closure Head Penetrations as per Figure No. 8
Westinghouse Electric Corporation	500B893	4	VPA As Built Coordinate Locations of Vessel Closure Head Penetrations as per Figure No. 8
Westinghouse Electric Corporation	500B895	1	VPA Reactor Vessel-As Built Drawings-Control Rod Housing Measurements
Westinghouse Electric Corporation	500B895	2	VPA Reactor Vessel-As Built Drawings-Control Rod Housing Measurements
Westinghouse Electric Corporation	500B896	1	VIR Reactor Vessel-As Built Drawings-Control Rod Housing Measurements

Originating Organization	Drawing No.	Sh. Nos.	Title
Westinghouse Electric Corporation	500B896	2	VIR Reactor Vessel-As Built Drawings-Control Rod Housing Measurements
Westinghouse Electric Corporation	500B897	1	VIR As Built Coordinate Locations of Vessel Closure Head Penetrations as per Figure No. 8
Westinghouse Electric Corporation	500B897	2	VIR As Built Coordinate Locations of Vessel Closure Head Penetrations as per Figure No. 8
Westinghouse Electric Corporation	500B897	3	VIR As Built Coordinate Locations of Vessel Closure Head Penetrations as per Figure No. 8
Westinghouse Electric Corporation	500B897	4	VIR As Built Coordinate Locations of Vessel Closure Head Penetrations as per Figure No. 8
Westinghouse Electric Corporation	5655D14	8	VRA, Coordinates & Elevation of Closure Head Penetrations
Westinghouse Electric Corporation	5655D14	9	VRA, Record Data Sheet
Westinghouse Electric Corporation	5655D15	8	VGB (As-Built) Coordinates & Elevation of Closure Head Penetrations
Westinghouse Electric Corporation	5655D15	9	VGB (As-Built) Record Data Sheet

The drawings have been appropriately designated as proprietary.

I have personal knowledge of the criteria and procedures used by WEC in designating information as a trade secret, privileged, or as confidential commercial or financial information.

Pursuant to the provisions of Section 2.790(b)(4) of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information included in the documents listed above should be withheld from public disclosure.

1. The information sought to be withheld from public disclosure is owned and has been held in confidence by WEC. It consists of details of the Control Rod Drive Mechanism (CRDM) nozzles and vessel head penetrations for Surry Units 1 and 2 and vessel head penetrations for North Anna Units 1 and 2, including as-built data and tolerances.
2. The information consists of test data or other similar data concerning a process, method or component, the application of which results in substantial competitive advantage to WEC.
3. The information is of a type customarily held in confidence by WEC and not customarily disclosed to the public.
4. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.
5. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.
6. Public disclosure of the information is likely to cause substantial harm to the competitive position of WEC because:

a. A similar product or service is provided and sold by major competitors of WEC.

b. WEC invested substantial funds and engineering resources to develop this information. Access to this information would enhance a competitor's ability to provide engineering services in competition with WEC.

c. The information consists of details of the CRDM nozzles and vessel head penetrations for Surry Units 1 and 2 and vessel head penetrations for North Anna Units 1 and 2, including as-built data and tolerances, the application of which provides WEC a competitive economic advantage. The availability of such information to competitors would enable them to design their product to better compete with WEC, take marketing or other actions to improve their product's position or impair the position of WEC's product, and avoid developing similar information in support of their processes, methods or apparatus.

d. In pricing WEC's products and services, significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included. The ability of WEC's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.

e. Use of the information by competitors in the international marketplace would increase their ability to market comparable engineering services by reducing the costs associated with their technology development. In addition, disclosure would have an adverse economic impact on WEC's potential for obtaining or maintaining foreign licenses.

Further the deponent sayeth not.

Philip W. Richardson
Licensing Project Manager
Windsor Nuclear Licensing

Sworn to before me this 12 day of December, 2001

Laurie J. White
Notary Public

My Commission expires: 8/31/04

Attachment 2

Evaluation to Support Qualified Visual Inspections of the Reactor Vessel Heads (Non-Proprietary)

Virginia Electric and Power Company
(Dominion)
North Anna Units 1 and 2
Surry Units 1 and 2

REQUEST FOR ADDITIONAL INFORMATION
ON THE NORTH ANNA UNITS 1 AND 2 & SURRY UNITS 1 AND 2
SUPPLEMENTAL RESPONSE TO NRC BULLETIN 2001-01
PLANT-SPECIFIC ANALYSIS IN SUPPORT OF A
QUALIFIED VISUAL EXAMINATION
TAC NUMBERS MB2641, MB2642, MB2886 & MB2668

NRC Summary of Issue:

"Bulletin 2001-01 stated that plant-specific as-built geometries, such as measured dimensions on CRDM nozzles and RPV penetrations, are needed to characterize the interference fit population for a particular RPV head, and therefore determine the detectibility of nozzle leaks. The licensee was able to locate as-built dimensions of the reactor vessel head penetration holes and the control rod drive mechanism (CRDM) nozzles for Surry Units 1 and 2, but only dimensions of the reactor vessel head penetration holes for North Anna Units 1 and 2. The actual "as-built" diameter measurements produced an average interference fit of 1.9 mils for Surry Unit 1 and 1.2 mils for Surry Unit 2. However, the maximum interference fit for all of the North Anna and Surry units was assumed to be 1.2 mils using fabrication drawings."

NRC Question 1

Provide the justification for using design information (i.e., fabrication drawings) instead of the available "as-built" dimensions.

Response

As stated above, only the diameter of the penetration holes in the vessel head is available for the North Anna units as as-built information. Likewise for the Surry units, the only actual as-built information available is for the vessel head penetration holes. For Surry Unit 1, the "as-built" information that is available for the penetration tubes appears to document dimensions which were recorded prior to final assembly of the penetration tubes into their mating reactor vessel holes. This conclusion is based on the fact that evaluation of the data yields average interference fits that exceed the maximum permissible design value. For Surry Unit 2, it appears the data more likely represents actual (i.e., final) as-built information because the average interference (in every case) is equal to the design maximum. However, the closure head assembly drawings for each of the four units states, "The O.D. of each control rod mechanism housing shall be ground for this length at assembly to give 0.01 mm to 0.03 mm diametrical interference fit with the mating head penetration."

It should also be noted that on the control rod mechanism housing drawing, the outside diameter (102.2 mm = 4.024 inch) shows no tolerances and a note on the drawing states to "grind per note on fabrication drawing." Because this diameter significantly exceeds the reactor vessel penetration hole diameter, it makes it impossible to install the housing into the vessel penetration without additional machining. Clearly it was intended that the assembly drawings control the process that produced the design interference fit. Therefore, the maximum design interference was used for analysis purposes.

NRC Question 2

Provide all available as-built data for the CRDM nozzles and the vessel head penetrations of Surry Units 1 and 2 and the vessel head penetrations of North Anna Units 1 and 2. Provide a comparison of the available data to the appropriate design drawing tolerances for both the nozzles and the penetrations.

Response

The enclosed drawings listed below, including those noted in response to Question 4, provide as-built documentation relative to the dimensions of the reactor vessel head penetration holes:

North Anna Unit 1: Drawing 5655D14 sheets 8 and 9 of 9
North Anna Unit 2: Drawing 5655D15 sheets 8 and 9 of 9

Surry Unit 1: Drawing 500B893 sheets 1, 2, 3, & 4 of 4
Surry Unit 2: Drawing 500B897 sheets 1, 2, 3, & 4 of 4

Design details for the control rod drive mechanism (CRDM) penetration holes in the vessel head and the penetration housing (tubes) themselves are shown on the following drawings:

Surry Unit 1:	
Control Rod Mechanism Housing	Drawing 30678-1188
Closure Head Assembly – CRD Housing Assy.	Drawing 30678-1185
Closure Head Sub Assembly – Drilling of Adapter Holes and Stud Holes	Drawing 30678-1184
Surry Unit 2:	
Control Rod Mechanism Housing	Drawing 30679-1216
Closure Head Assembly – CRD Housing Assy.	Drawing 30679-1202
Closure Head Sub Assembly – Drilling of Adapter Holes and Stud Holes	Drawing 30679-1201
North Anna Units 1 and 2:	
Control Rod Mechanism Housing	Drawing 30660-1099
Closure Head Assembly – CRD Housing Assy.	Drawing 30660-1103
Closure Head Sub Assembly – Drilling of Adapter Holes and Stud Holes	Drawing 30660-1154

From these drawings, it can be seen for both of the North Anna Units and both of the Surry Units the CRDM hole diameter in the reactor vessel was designed at 101.6 +0.05 – 0 mm (4 +0.002 – 0 in.). The fabrication drawings for the CRDM housings (tubes) for all four units show a dimension for the part of the penetration to be inserted in the head of 102.2-mm (4.0236 in.) with no tolerance. As mentioned above, these dimensions would prevent insertion of the penetration in the holes no matter how much they were cooled. It is only after the appropriate length of each penetration was ground in accordance with the Closure Head Assembly drawing that the penetrations (tubes) could be shrunk fit for insertion in the

CRDM holes in the vessel head with the requisite 0.01 to 0.03 mm (0.0004 to 0.0012 in.) interference fit.

NRC Question 3

Provide the design drawings and other documentation that provides tolerances for the CRDM nozzles and the vessel head penetrations, and that describes the design match of the nozzle to the penetration.

Response

See response to Question 2 and the enclosed drawings.

NRC Question 4

Provide references 6.4 and 6.5 for both North Anna and Surry.

Response

The enclosed drawings listed below comprise references 6.4 and 6.5:

- North Anna Unit #1 Manufacturing Data for the Vessel Closure Head Penetrations, Drawing No. 5655D14, sheets 8 and 9.
- North Anna Unit #2 Manufacturing Data for the Vessel Closure Head Penetrations, Drawing No. 5655D15, sheets 8 and 9.
- Surry Unit #1 Manufacturing Data; Westinghouse Drawing Nos.
  500B893, "VPA As Built Coordinate Location of Vessel Closure Head Penetrations As per Figure No. 8"
  500B895, "VPA Reactor Vessel – As Built Drawings – Control Rod Housing Measurements"
- Surry Unit #2 Manufacturing Data; Westinghouse Drawing Nos.
  500B897, "VIR As Built Coordinate Location of Vessel Closure Head Penetrations As per Figure No. 8"
  500B896, "VIR Reactor Vessel - As Built Drawings – Control Rod Housing"

NRC Question 5

The conclusion for both North Anna and Surry is that there is a 100% probability that an external visual inspection will identify leakage from CRDMs. Provide the statistical basis for this statement.

Response

In References 3 and 4, the condition of the interference fit at normal operating conditions is determined for the North Anna and Surry units, respectively. Two-dimensional, axisymmetric finite element analyses were also performed in References 1 and 2. The analyses for both Surry and North Anna indicate that for the maximum specified interference fit, a positive radial gap exists between the control rod drive mechanism (CRDM) housing and the vessel head penetration in the normal operating condition. Consequently, the deterministic analyses show that a leakage path exists if there is a through-wall crack in the cylindrical wall of the housing or the J-groove weld. No statistical analysis is necessary or was performed to establish the 100% probability that an external visual inspection will identify leakage from CRDM head penetrations. The basis of the conclusion is entirely deterministic.

NRC Question 6

The two-dimensional model used to predict the final interference fit may not be adequate because the CRDM penetration was attached to the vessel head by the J-groove weld at the bottom of the interface only, and effects from this constraint are not modeled in the analysis. Provide results using an approach, which could estimate the variation of the interference fit along the length (axial) of the interface (e.g., using finite element method).

Response

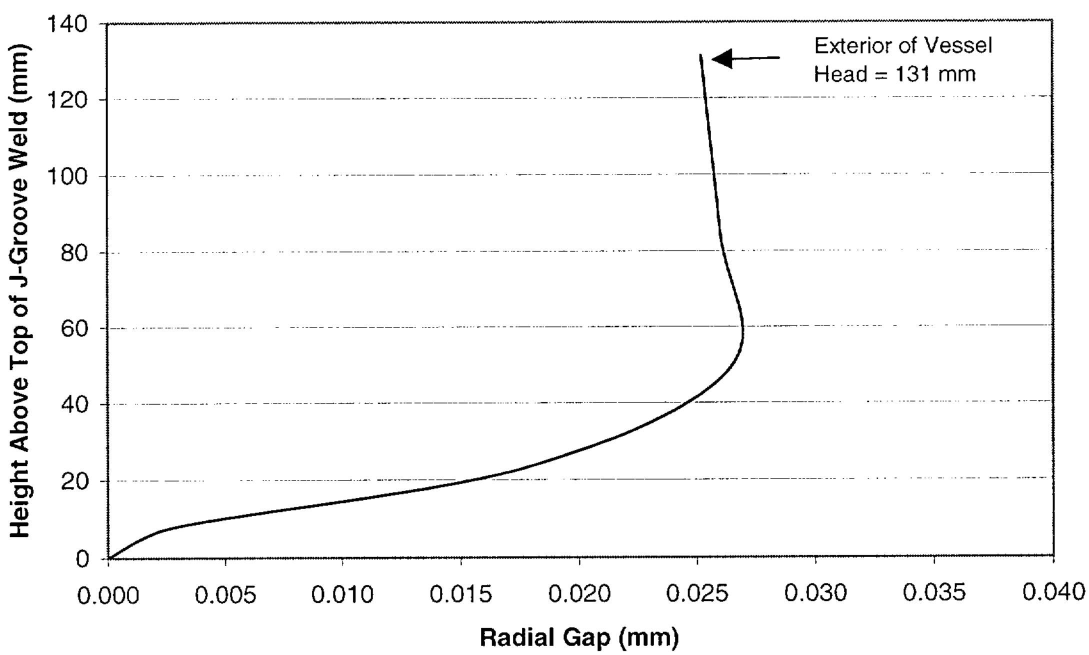
In References 3 and 4, the condition of the interference fit at normal operating conditions is determined for the North Anna and Surry units, respectively. The calculational approach used in these references consists of classical formulations for the effect of pressure and temperature on cylindrical (CRDM housing) and spherical (RV head) vessels. The conclusion of these evaluations is that for even the maximum specified diametrical interference fit, the interference would be relieved at normal operating conditions and a positive radial gap will exist.

In the original ASME design report for the reactor vessel for the Surry and North Anna units (References 1 and 2), the displacements and stresses at the CRDM vessel head penetration were evaluated using an axisymmetric finite element model. The J-groove weld is included in this model. The outline of the finite element model is provided in the attached Figure 9.4-5 from the North Anna stress report. A figure of the finite element mesh is provided in the attached Figure 9.4-3 from the Surry stress report. Additional figures of the finite element model are provided in the attached Figures F.9.4-8 and F.9.4-9 from the Surry stress report. For the purposes of this discussion, the structural models for both North Anna and Surry are identical.

As part of the analysis in the design report, the condition of the shrink fit is evaluated for the purpose of applying appropriate boundary conditions for the structural finite element model. The evaluation of the shrink fit is performed by determining the relative radial displacements of node pairs located on the CRDM housing and the ID of the vessel head penetration. The attached pages 9.4-36 through 9.4-39 from the Surry stress report (which includes Tables T.9.4-5 through T.9.4-8) provide a discussion and the results of the shrink fit evaluation. The locations of the node pairs used to assess the condition of the shrink fit are shown on the attached Figure 9.4-3. In assessing the condition of the shrink fit, the maximum specified shrink fit is evaluated (diametrical interference of 0.03 mm, 0.015 mm radially). For the normal steady state condition, it is determined that a positive radial clearance exists for both Surry and North Anna along the length of the head penetration above the J-groove weld (Refer to attached Table T.9.4-7). Since the J-groove weld is modeled in the analysis, the radial clearance at the top of the weld will always equal zero. An additional, handwritten column has been added to Table T.9.4-7 to indicate the approximate distance from the top of the weld to the node pair locations. As shown in this table, the calculated radial gap reaches its maximum value approximately 49 mm above the J-groove weld, and maintains this approximate value to the outside of the vessel head penetration. The condition of the radial gap over the length of the vessel head penetration for normal operating conditions is shown graphically in Figure 1 below.

Based on the results of 1) manual calculations utilizing classical formulations for deflection of cylinders and spheres under internal pressure and temperature, and 2) detailed finite element analyses of the components, it is concluded that a radial gap will exist between the CRDM housing and the vessel upper head penetration. This gap will exist over the full length of the penetration above the J-groove weld. Based on the existence of this gap, leakage from CRDM penetrations (either through J-groove weld or the CRDM housing) can be identified by an external visual inspection of the reactor vessel upper head.

Figure 1. Variation of Radial Gap Over CRDM Housing Upper Head Penetration - Normal Operating Conditions



References

1. Calculation 30678-1130, "Reactor Vessel – Final Stress Report (Parts I & II)," Surry Power Station Units 1 and 2, Rotterdam Dockyard Company.

2. Calculation 30660-1130, "Reactor Vessel – Final Stress Report (Parts I & II)," North Anna Power Station Units 1 and 2, Rotterdam Dockyard Company.

3. Westinghouse Letter No VRA-01-179, from M. P. Osborne to Gary Modzelewski - "Detectability of Leakage in North Anna 1 and 2 Reactor Vessel Heads," dated September 28, 2001.

4. Westinghouse Letter No VPA-01-010, from M. P. Osborne to Gary Modzelewski - "Detectability of Leakage in Surry 1 and 2 Reactor Vessel Heads," dated October 11, 2001.

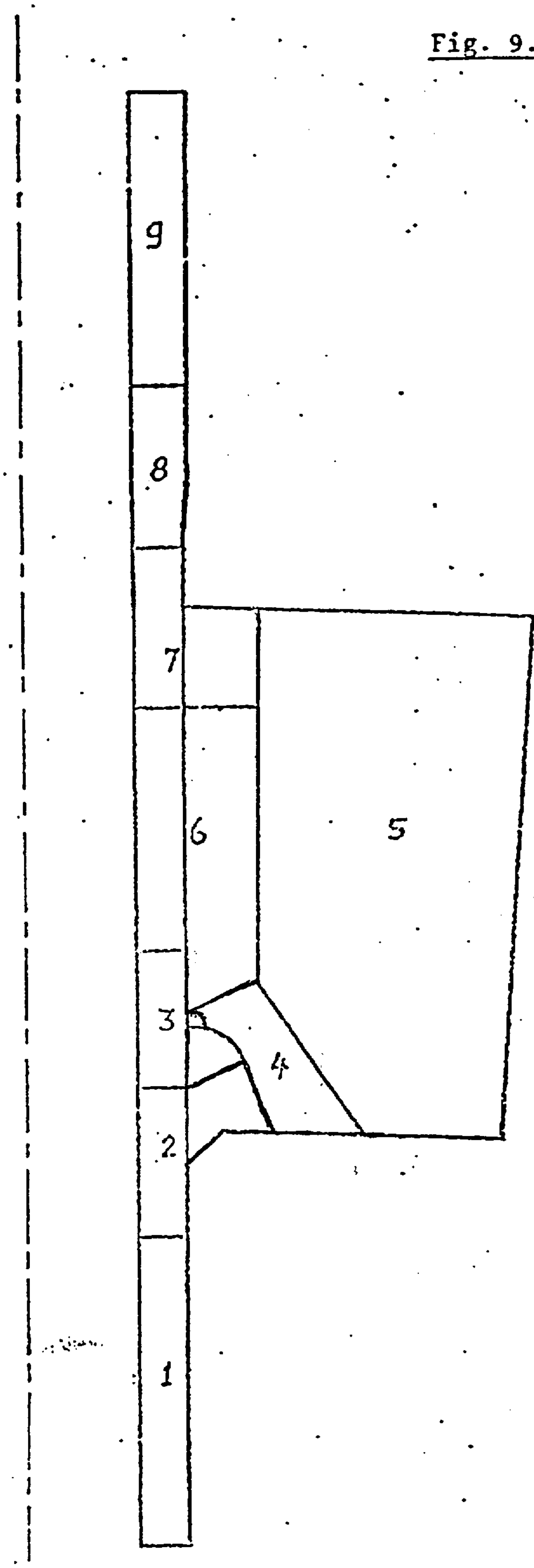


Fig. 9.4-5 Numbering of the plotted parts of the FINEL geometry.

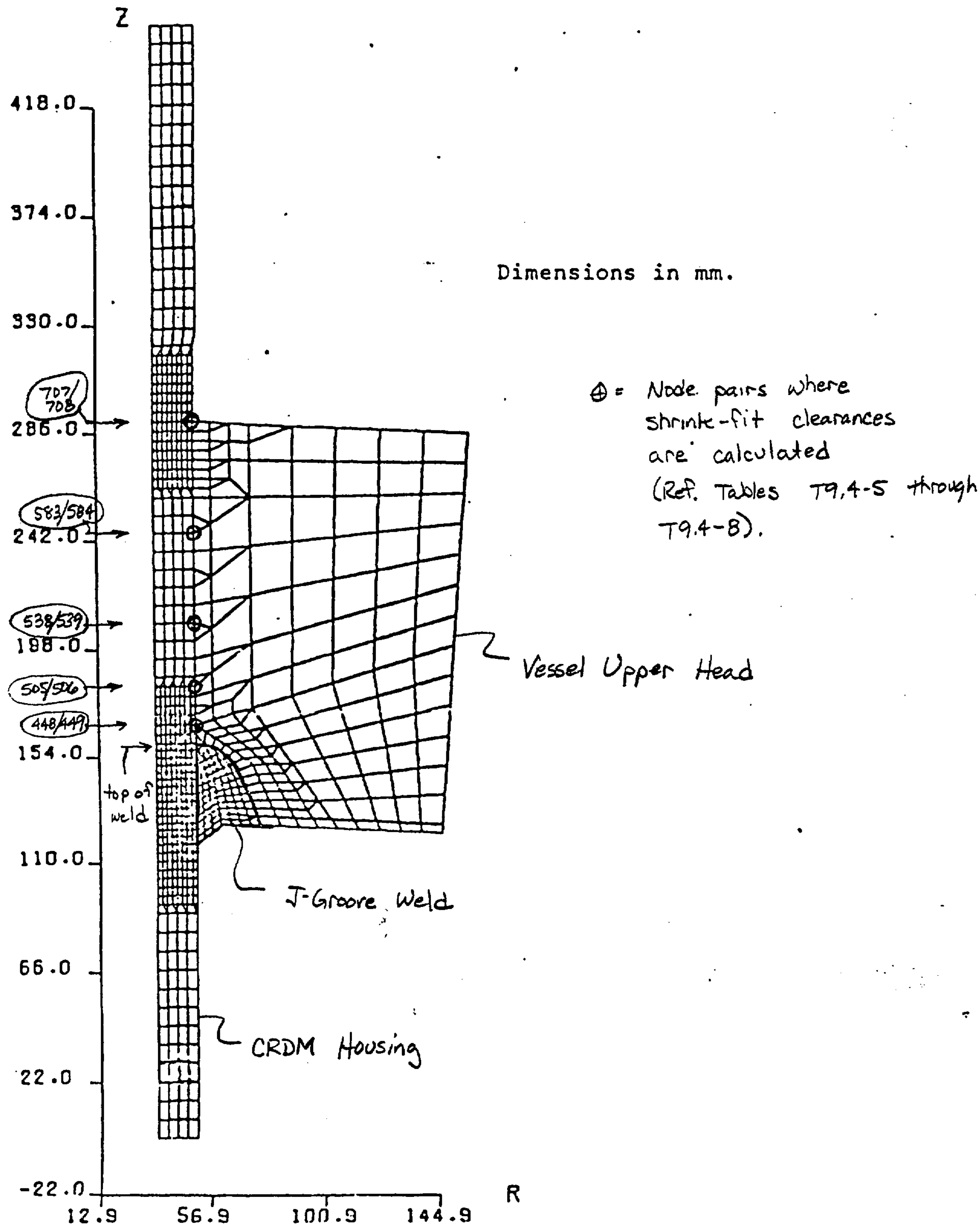
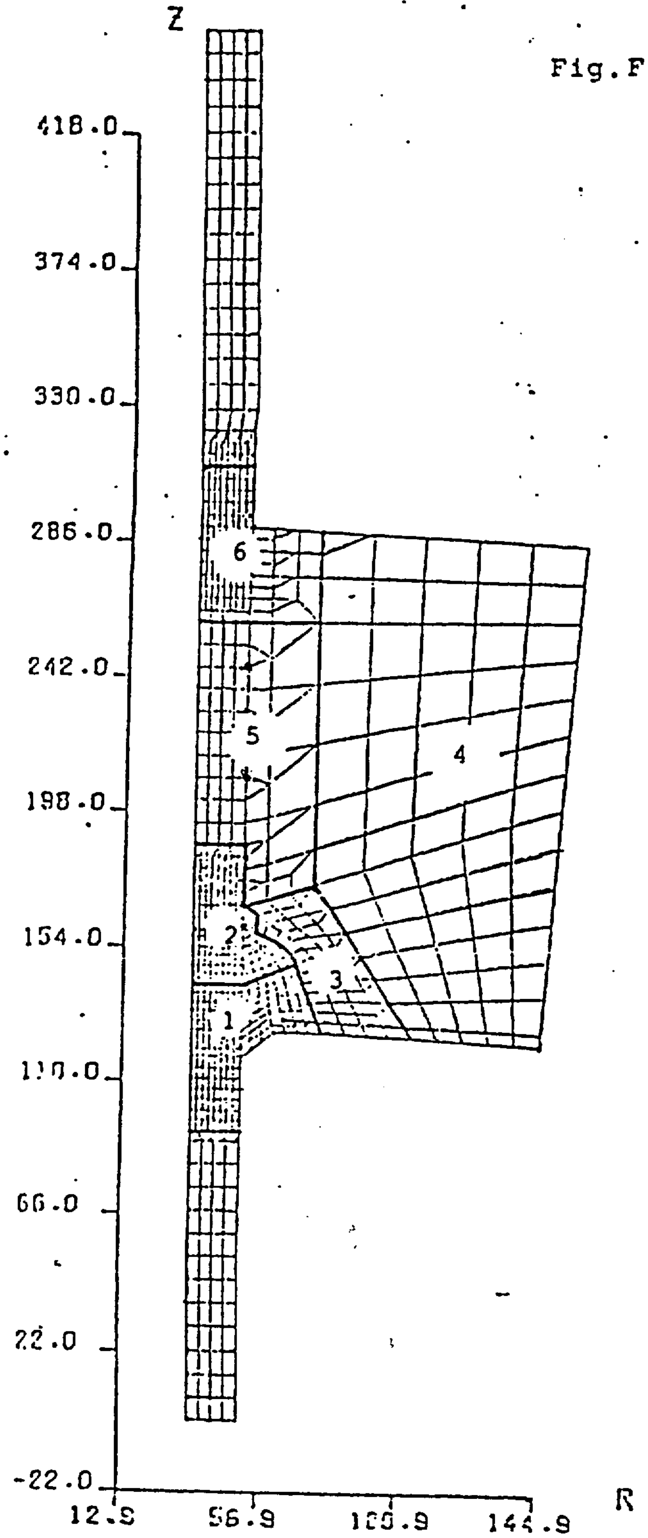


FIG. 9.4-3 FINEL network

C.R.D.-HOUSING

Fig.F.9.4-8 Numbering of the plotted parts of the FINEL geomet[...]



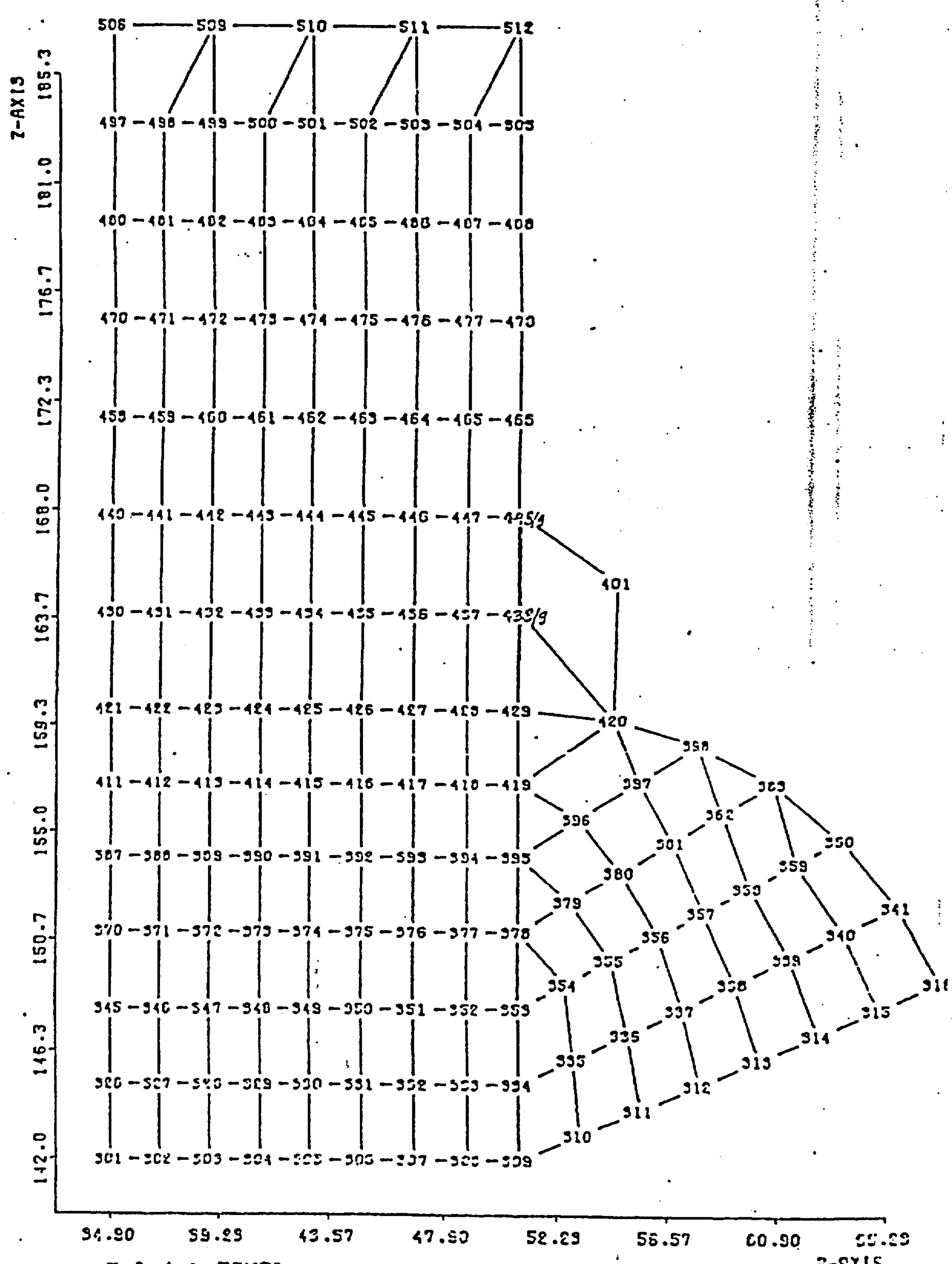


FIG. F.9.4-9. FINEL geometry, part 2.
C.R.D.-HOUSING WITH SLIT
GEOMETRY (NODAL POINTS)

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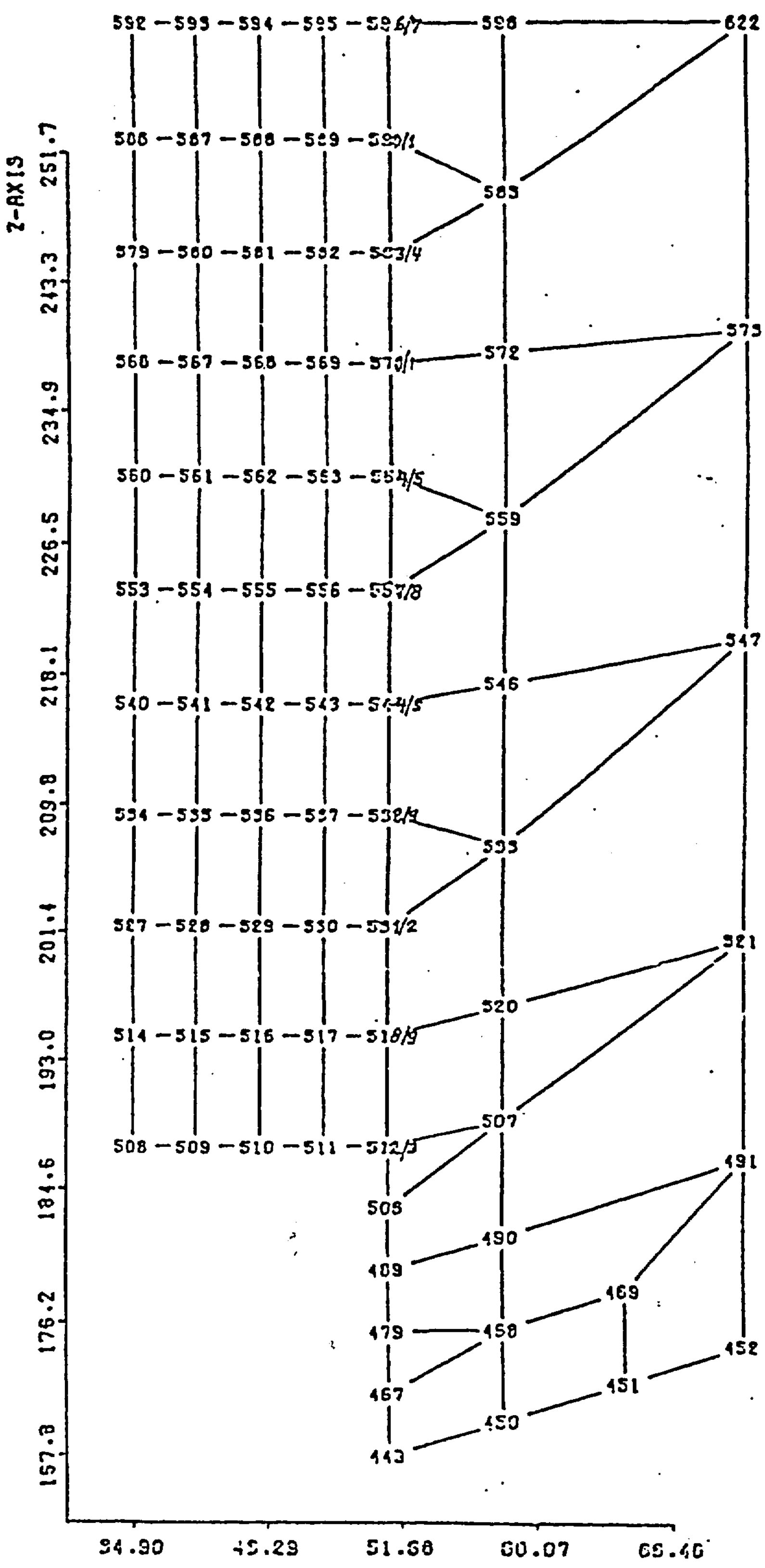

FIG. F.9.4- 9 FINEL geometry, part 5.
C.R.D.-HOUSING WITH SLIT
GEOMETRY (NODAL POINTS

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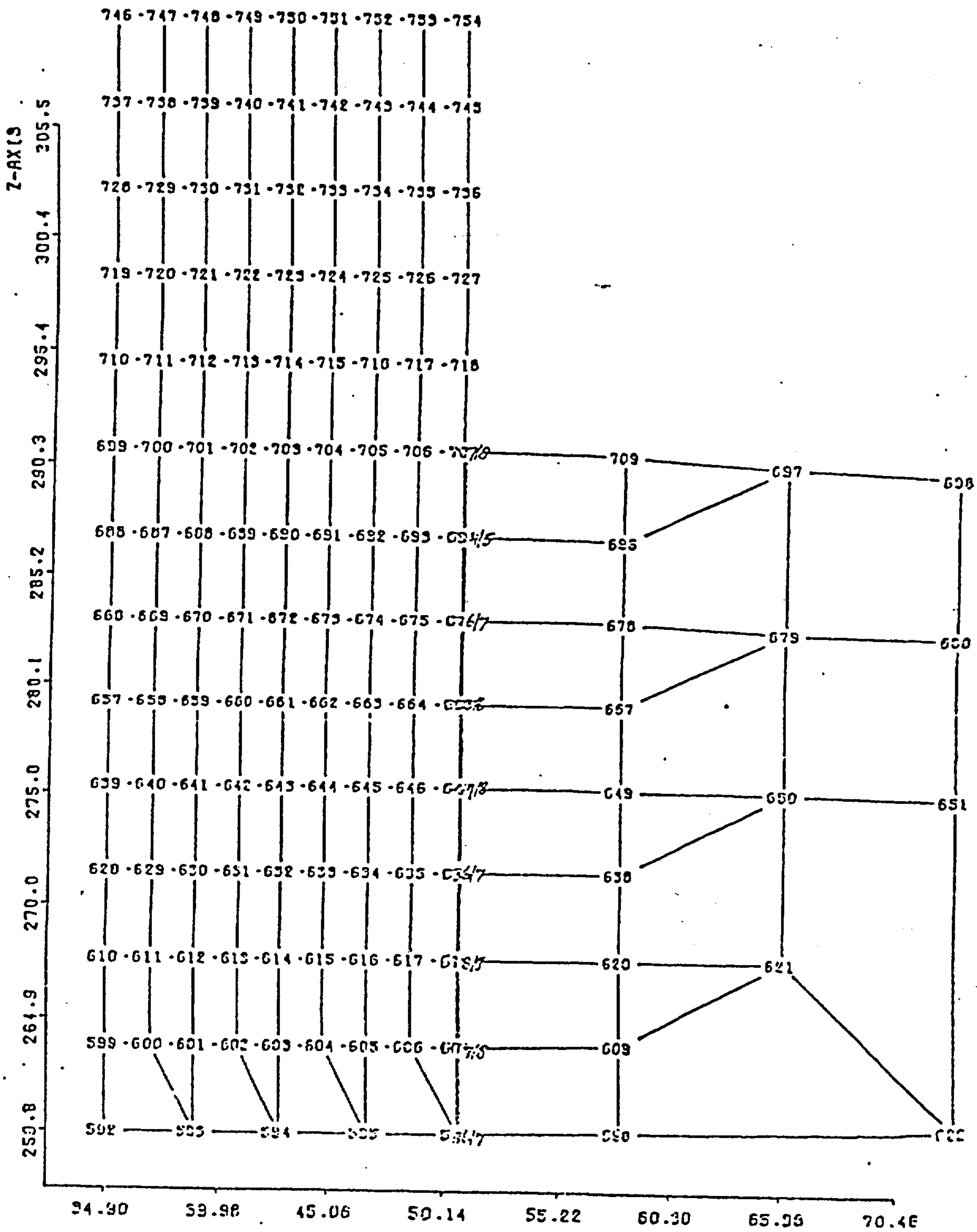

FIG. F.9.4- 9 FINEL geometry, part 6.
C.R.D.-HOUSING WITH SLIT
GEOMETRY (NODAL POINTS

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9.4.5.4. Calculation model in connection with the shrink fit

Three calculation models of the C.R.D.-housing are possible:

1. The clearance between the C.R.D.-housing and the vessel wall is positive under all conditions, so except for the welding no interaction between C.R.D.-housing and vessel wall is possible.
2. The clearance is always negative, thus the motion of the tube is forced by the motion of the inside of the hole in the vessel wall.
3. The value of the clearance varies with time and with the axial coordinate of the housing.

From ref. 4 it can be seen that the shrink fit over the diameter can be 0.01 ÷ 0.03 mm.

The clearances that will be calculated are based upon the maximum shrink fit 0.03 mm = 0.015 mm over the radius.
The dimension reports of the C.R.D.-housing and the holes in the vessel wall show a shrink fit equal to 0.03 mm over the diameter.

At begin of heat up, the clearance between the C.R.D.-housing and the hole between the C.R.D.-housing and the vessel wall due to the shrink fit will be 0.015 mm. The clearance due to internal pressure will be less than the clearance due to shrink fit. (see T.9,4-5) In this case there is no slit at begin heat up, and the calculations for this condition are based upon the geometry without a slit.

At end of heat up the clearance due to internal pressure 2235 psi are higher than the negative clearance.

due to shrink fit and the negative clearance due to the expansion of the materials at end of heat up (see T.9.4-6)
For this condition the stresses are calculated by using the geometry with a slit.

The clearance at normal steady state is always positive (see T.9.4-7)
In this case the stresses are calculated by using the geometry with a slit.

At end of cool down the negative clearance due to the shrink fit are higher than the positive clearance due to internal pressure 385 psi and the positive clearance due to the expansion of the materials at end cool down (see T.9.4-8)
The stresses for this condition are calculated by using the geometry without a slit.
At design pressure the clearance diverted from the calculations of the geometry with slit and is always positive (see table T.9.4-5)

The shrink fit has been simulated by raising the temperature of the C.R.D.-housing with respect to the vessel wall in the geometry without slit
For the stress analysis, a mean shrink fit of 0.03 mm. has been chosen, or 0.015 mm over the radius.
The radius of the housing is 50.8 mm, the thermal expansion at 70°F is 10.44 x 10^{-5} mm/°C, thus:

$$\text{temp.diff.C.R.D.} = \frac{0.015}{10.44 \times 10^{-6} \times 50.8} = 28.39\,^{\circ}\text{C}.$$

The stresses for this condition are calculated by using the geometry without a slit.

T.9.4-5 Clearance due to internal pressure

Displacements of the nodal points are derived from internal pressure 1000 psi ; geometry with slit.

nodal points	pressure 1000 psi displace-ments	1000 psi clearance	2235 psi clearance	385 psi clearance	shrink fit clearance
707	0.00250				
708	0.02178	0.01928	0.04309	0.00742	-0.015
583	0.00230				
584	0.02196	0.01966	0.04394	0.00756	-0.015
538	0.00222				
539	0.02205	0.01983	0.04432	0.00763	-0.015
505	0.00579				
506	0.02141	0.01562	0.03491	0.00601	-0.015
448	0.01169				
449	0.01992	0.00823	0.01839	0.00317	-0.015

T.9.4-6 Clearance at end heat up

nodal points	end heat up displace-ments with slit	clearance	pressure 2235 psi clearance	shrink fit clearance	total clearance
707	0.17893				
708	0.17666	-0.00227	0.04309	-0.015	+0.0258
583	0.17905				
584	0.17461	-0.00444	0.04394	-0.015	+0.0245
538	0.17396				
539	0.17182	-0.00754	0.04432	-0.015	+0.0218
505	0.17699				
506	0.16961	-0.00738	0.03491	-0.015	+0.0125
448	0.17189				
449	0.16834	-0.00355	0.01839	-0.015	-0.0002

T.9.4-7 Clearance at normal steady state

Approximate Distance above J-Groove Weld (mm)	nodal points	normal steady state, displacements with slit	clearance	pressure 2235 psi clearance	shrink fit clearance	radial gap total clearance
131	707	0.17917				
	708	0.17629	-0.00288	0.04309	-0.015	+0.0252
85	583	0.17922				
	584	0.17630	-0.00292	0.04394	-0.015	+0.0260
49	538	0.17941				
	539	0.17644	-0.00297	0.04432	-0.015	+0.0264
23	505	0.17858				
	506	0.17640	-0.00218	0.03491	-0.015	+0.0177
8	448	0.17642				
	449	0.17597	-0.00045	0.01839	-0.015	+0.0029

T.9.4-8 Clearance at end cool down

nodal points	end cool down, displacements without slit	clearance	pressure 385 psi clearance	shrink fit clearance	total clearance
707	-0.00022				
708	-0.00088	0.00014	0.00742	-0.015	-0.0074
583	0.00114				
584	0.00141	0.00027	0.00756	-0.015	-0.0072
538	0.00194				
539	0.00218	0.00024	0.00763	-0.015	-0.0071
505	0.00255				
506	0.00275	0.00020	0.00601	-0.015	-0.0068
448	0.00289				
449	0.00306	0.00017	0.00317	-0.015	-0.0117

POS NR.	AANT.	BENAMING		MATERIAAL		BESTELNR	GEW. KG.
22	65	CONTROL ROD SAFE ENDS		ASME SA 182 TYPE 304		D 14273	
21	65	CONTROL ROD TUBES		ASME SA 167		D 14273	

1X DE STUKLIJST TE VERVAARDIGEN

STUKLIJST PER VAT — VOOR W.E.C.

DE ROTTERDAMSCHE DROOGDOK MIJ. N.V.

AFD. SCHEEPSBOUW

157' P.W.R VESSEL "WESTINGHOUSE"

CONTROL ROD MECHANISM HOUSING

GETEKEND	DATUM	SCHAAL	AFGEG. AAN
G. PICO	22.4.1970	1.25	VCA RCPCRV-1 VGA RCPCRV-1

	WIJZIGING	DATUM	GEZIEN
30660 - 1099	F		

SEE NOTE 4 TE VERVAARDIGEN

30678 VOOR O.

DE ROTTERDAMSCHE DROOGDOK MIJ. N.V.

AFD.

157" P.W.R. VESSEL „WESTINGHOUSE"

CONTROL ROD MECHANISM HOUSING

V/A-RCPCRV-01

GETEKEND	DATUM	SCHAAL	AFGEG. AAN
[illegible]	10-11-'69	1:2 4:1	W.E.C.

TEK. NR.	WIJZIGING	DATUM	GEZIEN
30678-1188 BLAD	C	28 FEB. 1970	[illegible]

12/13/01 9:57:01 AM

DE ROTTERDAMSCHE DROOGDOK MIJ. N.V.

AFD.

157" P.W.R. VESSEL „WESTINGHOUSE"

CONTROL ROD MECHANISM HOUSING

VJA-RC PC SV-01

GETEKEND	DATUM	SCHAAL	AFGEG. AAN
V.	4-12-69	1:2 4:1	

1 × TE VERVAARDIGEN

30679 VOOR O.

TEK. NR.	WIJZIGING	DATUM	GEZIEN
30679- 1216 BLAD	B		

VPA 105 DE ROTTERDAMSCHE DROOGDOK MIJ. N.V.
AFD. KERNENERGIE

157" P.W.R. VESSEL „WESTINGHOUSE"

CLOSURE HEAD SUB ASSEMBLY

DRILLING OF ADAPTER HOLES AND STUD HOLES.

SEE NOTE 5 TE VERVAARDIGEN

GETEKEND	DATUM	SCHAAL	AFGEG. AAN
[illegible]	19-3-69	1:20 1:25	W.E.C.

30678 VOOR O.

TEK. NR.	WIJZIGING	DATUM	GEZIEN
30678-1184 BLAD 1 VAN 2	A	13 JAN. 1970	

DE ROTTERDAMSCHE DROOGDOK MIJ. N.V.
AFD. KERNENERGIE

157" P.W.R. VESSEL „WESTINGHOUSE"

CLOSURE HEAD ASSEMBLY
CRD. HOUSING ASSY.

GETEKEND	DATUM	SCHAAL	AFGEC. AAN
[illegible]	5-9-69	1:20 1:25 VPA 105	W.E.C.

TEK. NR.	WIJZIGING	DATUM	GEZIEN
30678-1185 BLAD 1 VAN 3	A	8 DEC. 1969	

DE ROTTERDAMSCHE DROOGDOK MIJ. N.V. AFD. KERNENERGIE			
157" P.W.R. VESSEL „WESTINGHOUSE" CLOSURE HEADASSEMBLY C.R.D. HOUSING ASSY			
GETEKEND	DATUM .1970	SCHAAL 1:80 1:2.5	AFGEG. AAN
TEK. NR. 30660-1103	BLAD 1 van 3	WIJZIGING A B K D	DATUM / GEZIEN

VERIFIED REPRODUCIBLE

STUKLIJST PER		VOOR	
DE ROTTERDAMSCHE DROOGDOK MIJ. N.V. AFD. KERNENERGIE VRA/V6B RCPCRV-1			
157" P.W.R. VESSEL „WESTINGHOUSE" **CLOSURE HEAD SUB ASSEMBLY** DRILLING OF ADAPTER HOLES AND STUD HOLES.			
GETEKEND	DATUM 9-2-1970	SCHAAL 1:2n 1:2.5	AFGEG AAN
TEK. NR 30660-1154 BLAD 1 van 2	WIJZIGING A	DATUM	GEZIEN

DE ROTTERDAMSCHE DROOGDOK MIJ. N.V.
AFD. KERNENERGIE

157" P.W.R. VESSEL „WESTINGHOUSE"

CLOSURE HEAD SUB ASSEMBLY

DRILLING OF ADAPTER HOLES AND STUD HOLES

GETEKEND	DATUM	SCHAAL	AFGEG. AAN
	18-11-'69	1:20 1:2,5	W.E.C.

TEK. NR.	WIJZIGING	DATUM	GEZIEN
30679-1201 BLAD 1 VAN 2		8 DEC. 1969	

DE ROTTERDAMSCHE DROOGDOK MIJ. N.V.
AFD. KERNENERGIE

157" P.W.R. VESSEL „WESTINGHOUSE"

CLOSURE HEAD ASSEMBLY

CRD. HOUSING ASSY.

GETEKEND	DATUM	SCHAAL	AFGEG. AAN
[illegible]	20-1-70	1:20 1:25	W.E.C.

TEK. NR.	WIJZIGING	DATUM	GEZIEN
30679-1202 BLAD 1 VAN 3	A	4 MAART 1970	

VTR

Westinghouse Electric Corporation NUCLEAR ENERGY SYSTEMS, PITTSBURGH, PA., U.S.A.	
TITLE: -VRA- COORDINATES & ELEVATION OF CLOSURE HEAD PENETRATIONS	
SPIN # RCPCRV	5655D14
SCALE NTS	SHEET 8 OF 9
DIMENSIONS IN INCHES	
DO NOT SCALE	SUB # 2

6 5 4 3 2 1

Westinghouse Electric Corporation NUCLEAR ENERGY SYSTEMS, PITTSBURGH, PA., U.S.A.	
TITLE: −VRA− RECORD DATA SHEET	
SPIN-RCPCRV	5655D14
SCALE N.T.S.	
DIMENSIONS IN INCHES	SHEET 9 OF 9
DO NOT SCALE	SUB 2

6 5 4 3 2 1

Westinghouse Electric Corporation NUCLEAR ENERGY SYSTEMS, PITTSBURGH, PA., U.S.A.	
TITLE: VGB (AS-BUILT) COORDINATES & ELEVATION OF CLOSURE HEAD PENETRATIONS	
SPIN # RCPCRV	5655D15 SHEET 8 OF 9
SCALE NTS	
DIMENSIONS IN INCHES	
DO NOT SCALE	SUB # 2

6 5 4 3 2 1

Westinghouse Electric Corporation NUCLEAR ENERGY SYSTEMS, PITTSBURGH, PA., U.S.A.	
TITLE: VGB (AS-BUILT) RECORD DATA SHEET	
SPIN-RCPCRV	5655D15
SCALE N.T.S.	SHEET 9 OF 9
DIMENSIONS IN INCHES	
DO NOT SCALE	SUB /2

6 5 4 3 2 1

Westinghouse Electric Corporation ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.	
TITLE VPA AS BUILT COORDINATE LOCATIONS OF VESSEL CLOSURE HEAD PENETRATIONS AS PER FIGURE NO. 8	
SCALE ~	500B893
DIMENSIONS IN INCHES	SHEET 1 OF 4
DO NOT SCALE	SUB 2

Westinghouse Electric Corporation ATOMIC POWER DIV. PITTSBURGH. PA., U.S.A.	
TITLE: VPA AS BUILT COORDINATE LOCATIONS OF VESSEL CLOSURE HEAD PENETRATIONS AS PER FIGURE NO. 8	
SCALE ~	500B893
DIMENSIONS IN INCHES	SHEET 2 OF 4
DO NOT SCALE	SUB 2

Westinghouse Electric Corporation

ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.

TITLE: VPA AS BUILT COORDINATE LOCATIONS OF VESSEL CLOSURE HEAD PENETRATIONS AS PER FIGURE NO. 8

SCALE ~	500B893
DIMENSIONS IN INCHES	SHEET 3 OF 4
DO NOT SCALE	SUB M 2

Westinghouse Electric Corporation ATOMIC POWER DIV. PITTSBURGH. PA., U.S.A.	
TITLE: VPA AS BUILT COORDINATE LOCATIONS OF VESSEL CLOSURE HEAD PENETRATIONS AS PER FIGURE NO. 8	
SCALE ~	500B893
DIMENSIONS IN INCHES	SHEET 4 OF 4
DO NOT SCALE	SUB 2

Westinghouse Electric Corporation ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.	
TITLE VPA REACTOR VESSEL - AS BUILT DRAWINGS - CONTROL ROD HOUSING MEASUREMENTS	
SCALE ∼	500B895
DIMENSIONS IN INCHES	SHEET 1 OF 2
DO NOT SCALE	SUB # 2

Westinghouse Electric Corporation

ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.

TITLE: VPA REACTOR VESSEL - AS BUILT DRAWINGS - CONTROL ROD HOUSING MEASUREMENTS

SCALE ~	500B895
DIMENSIONS IN INCHES	SHEET 2 OF 2
DO NOT SCALE	SUB 2

Westinghouse Electric Corporation

ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.

TITLE VIR REACTOR VESSEL - AS BUILT DRAWINGS - CONTROL ROD HOUSING MEASUREMENTS

SPIN-RCPCRV	500B896
SCALE ~	SHEET 1 OF 2
DIMENSIONS IN INCHES	
DO NOT SCALE	SUB 1/2

Westinghouse Electric Corporation ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.	
TITLE VIR REACTOR VESSEL - AS BUILT DRAWINGS - CONTROL ROD HOUSING MEASUREMENTS	
SPIN-RCPCRV	500B896
SCALE ~	SHEET 2 OF 2
DIMENSIONS IN INCHES	
DO NOT SCALE	SUB 1/2

Westinghouse Electric Corporation

ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.

TITLE VIR AS BUILT COORDINATE LOCATIONS OF VESSEL CLOSURE HEAD PENETRATIONS AS PER FIGURE NO. 8	
SPIN-RCPCRV	500B897
SCALE ~	SHEET 1 OF 4
DIMENSIONS IN INCHES	
DO NOT SCALE	SUB 12

Westinghouse Electric Corporation ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.	
TITLE VIR AS BUILT COORDINATE LOCATIONS OF VESSEL CLOSURE HEAD PENETRATIONS AS PER FIGURE NO. 8	
SPIN-RCPCRV	500B897
SCALE ~	
DIMENSIONS IN INCHES	SHEET 2 OF 4
DO NOT SCALE	SUB 1/2

Westinghouse Electric Corporation ATOMIC POWER DIV PITTSBURGH, PA., U.S.A.	
TITLE VIR AS BUILT COORDINATE LOCATIONS OF VESSEL CLOSURE HEAD PENETRATIONS AS PER FIGURE NO. 8	
SPIN-RCPCRV	500B897
SCALE ~	
DIMENSIONS IN INCHES	SHEET 3 OF 4
DO NOT SCALE	SUB ~~1~~ 2

Westinghouse Electric Corporation

ATOMIC POWER DIV. PITTSBURGH, PA., U.S.A.

TITLE VIR AS BUILT COORDINATE LOCATIONS OF VESSEL CLOSURE HEAD PENETRATIONS AS PER FIGURE NO. 8	
SPIN-RCPCRV	500B897
SCALE ~	
DIMENSIONS IN INCHES	SHEET 4 OF 4
DO NOT SCALE	SUB 2