UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

April 17, 1992

Docket No. 50-271

LICENSEE: VERMONT YANKEE NUCLEAR POWER CORPORATION

FACILITY: VERMONT YANKEE NUCLEAR POWER STATION

SUBJECT: MEETING SUMMARY OF APRIL 8, 1992 MEETING TO DISCUSS VERMONT YANKEE REACTOR VESSEL FLAWS (TAC NO. M83100)

On April 8, 1992, the NRC staff met with Vermont Yankee Nuclear Power Corporation (the licensee) concerning indications found in the reactor vessel head and cylindrical section at Vermont Yankee Nuclear Power Station (VY). A list of attendees is provided in Enclosure 1. The slides presented by the licensee are included in Enclosure 2.

The following items were discussed during the meeting:

- High level of confidence

  In its April 5, 1992 letter, the licensee stated "The sampling performed by Vermont Yankee provides a high level of confidence that cladding indications do not penetrate into the basemetal." The licensee stated that the meaning of high level of confidence is a level in excess of 95% confidence that 95% of the indications do not extend from the cladding into the base metal.

- Machine weld laydown vs manual weld laydown of cladding

  The licensee stated that cladding by machine weld laydown was less sensitive to cracking than cladding by manual weld laydown.

- Fracture Mechanics Analysis

  The licensee presented the results of its Fracture Mechanics Analysis. The licensee's fracture mechanics analysis indicated that cracks would not grow to an unacceptable size for at least 39,000 hours (4.5 years) of operation. Some further fracture mechanics information was requested by the staff which the licensee agreed to provide by April 10, 1992.

- Future Inspection Plans

  The staff expressed an interest in the licensee's future inspection plans.

DF01
1/1

The licensee committed to provide a complete plan for future actions no later than 30 days prior to the next scheduled outage.

Past Records

The licensee committed to review past inspection records for any reported indications in the cladding of the reactor vessel.

original signed by

Patrick M. Sears, Project Manager
Project Directorate I-3
Division of Reactor Projects - I,
Office of Nuclear Reactor Regulat

Enclosures:
1. List of Attendees
2. Licensee Slides

cc: See next page

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DATE	:4/16/92	:4/16/92	:4/16/92	:4/17/92	:	:

DOCUMENT NAME: vyMc3100.mts

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Enclosure 1

Vermont Yankee Reactor Pressure Vessel Cladding Indications

NRC Presentation 4/8/92

Attendance

Name	Organization	Phone
David E. Smith	NRR/EMCB	301 504-2711
Barry J. Elliot	NRR/EMCB	301 504-2709
GD Watford	NRR/PDI-3	Tel. 504-1427
RA Herman, V	EDO Staff	301-504-1733
J.T. Wiggins	NRR/EMCB	301-504-2795
Warren Murphy	Vermont Yankee	802-257-5271
Frank Helin	Vermont Yankee	802-257-5271
John Herman	Yankee Atomic	508-779-6711
Tom O'Hara	Yankee Atomic	508-779-6711
Ken Wells	"	"
Art Demoorkk	Structural Integrity Associates	408-978-8200
Carl Larsen	Yankee Atomic	508-636-0291
Pat Sears	NRR/PDI-3	301-504-2021

Vermont Yankee

Reactor Pressure Vessel

Clad Indications

1992 Refueling

NRC Presentation

April 8, 1992

Warren Murphy (VYNPC) - Senior Vice President and Manager of Operations

Frank Helin (VYNPC) - Project Engineer

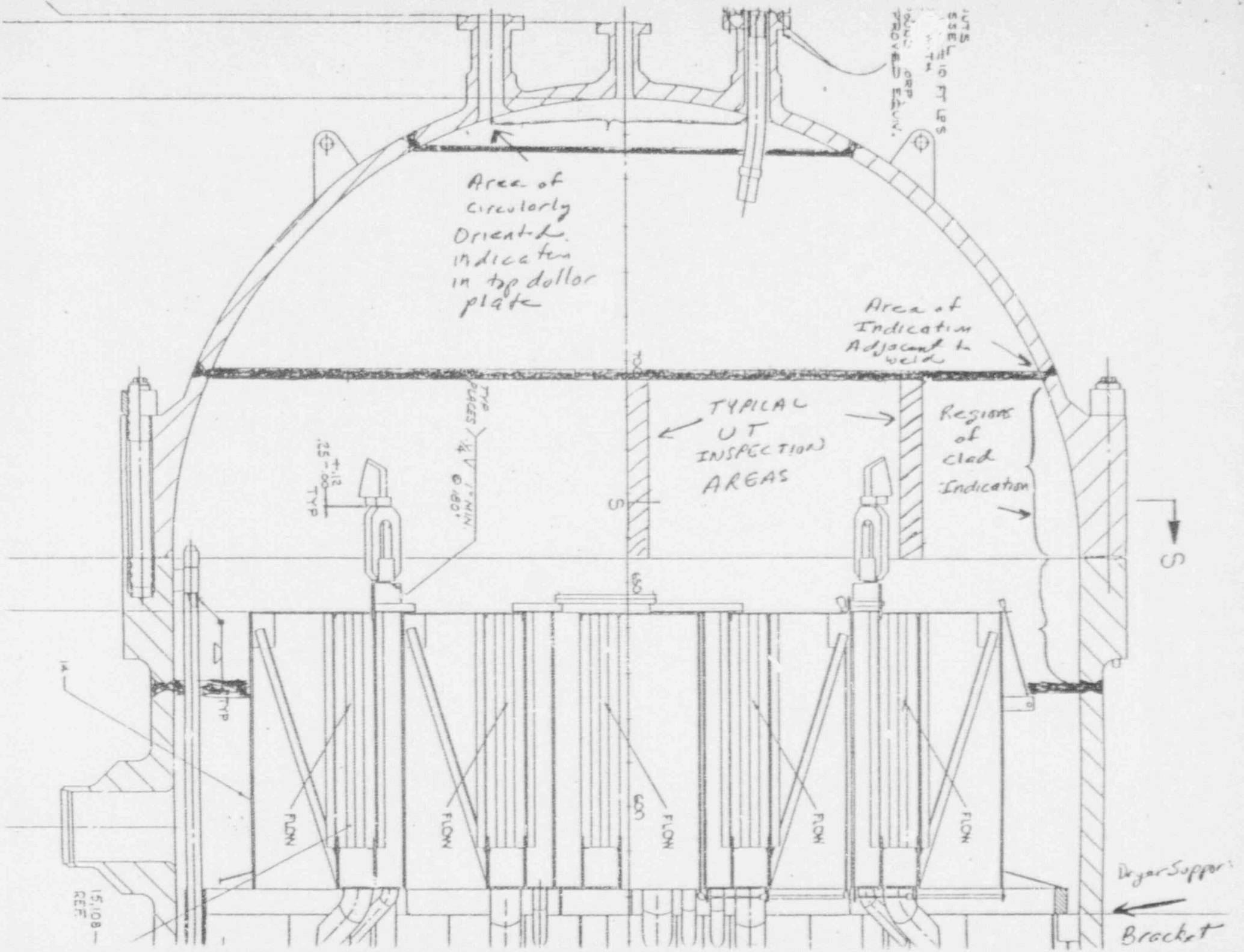
John Hoffman (YAEC) - Engineering Manager

Carl Larsen (YAEC) - ISI Level III

Tom O'Hara (YAEC) - Senior Engineer

Ken Willens (YAEC) - Principal Engineer

Art Deardorff (SIA) - Associate


Area of circularly Orientated indication in top dollar plate
Area of Indication Adjacent to weld
TYPICAL UT INSPECTION AREAS
Region of clad Indication
S
.25 +.12 -.00 TYP
TYP 4 PLACES @ 90°
TYP
FLOW
FLOW
FLOW
FLOW
FLOW
15,108 REF.
Dryer Support Bracket

Sequence of Events

-Under head examination conducted as recommended by GE SIL 539

-Linear rust indications observed visually

-One indication manually explored to determine depth and character. Indication became tighter and more diffuse as depth increased, indicative of IGSCC

-A number of indications were ultrasonically evaluated to determine depths

-All flaws examined in this phase were sized to be within the nominal clad thickness of 3/16"

-Independent of this activity the In-Vessel Visual Examination (IVVI) was underway as part of Inservice Inspection Program

-IVVI observed a rust indication adjacent to one of the four Dryer Support Brackets

-Area was ultrasonically examined from outside the reactor vessel

-No indication of flaw propagation into the basemetal or lack of bond was observed

-IVVI also reported some visual rust indications on inside surface of pressure vessel

-IVVI Team reviewed the photographs of the under head condition and concluded that the conditions were similar

Engineering Evaluation

-Engineering concluded that the condition was stress corrosion cracking of the stainless steel clad

-Cladding one layer of 309 low carbon stainless steel for machine deposited clad and two layers (309/308L) for manually deposited clad

-Based on prior experience it was concluded that the low carbon properties were probably lost during welding due to carbon pickup from the basemetal

-Cladding was furnace sensitized during vessel heat treatment process

-Weld metal can develop IGSCC depending on carbon/ferrite ratio

-Industry studies show negligible probability of propagation beyond the clad

Follow-on Actions

-Fracture mechanics studies performed for added assurance of safe plant operation

-Analyses based on reactor vessel stress analysis

-Consideration given to welding residual stress in clad and pressure vessel welds

-Worst case condition shows minimum of three cycles before a flaw would exceed Code allowable size. (For this to occur it must be assumed that flaw initiated just prior to shutdown and that it grows at worst case rate)

-Additional UT evaluations conducted on reactor vessel head flange cladding

-Eight locations 45 degrees apart were selected to ensure areas representative of the entire surface were examined

-Starting location was 0 Degree azimuth for ready reference in future inspections

-Sixty (60) indications were sized. All were within the clad thickness

-Portions of the circumferential indications at upper head region and flange/head weld were UT'd. A number of UT reflectors were observed. None were identified to be greater than the clad thickness

-Four additional areas on the reactor head flange inside surface were examined. Forty two (42) additional UT indications were sized. All were within the clad thickness

-Thirty two (32) indications were UT examined on the vessel shell flange cladding. All were determined to be within the clad thickness

-Ferrite readings were taken at 24 locations on the head flange and twelve locations on the shell flange. All readings were in excess of 5 percent, with the majority greater than 7.5 percent. This would rule out microfissuring, which can occur in low ferrite stainless steel weld metal

-Metal chips were removed from the head and shell flange cladding. The chemical analysis showed high carbon content (0.079 w/o and 0.111 w/o respectively). This supports previous judgement concerning possible carbon pickup from the basemetal during welding

-Follow-on evaluations all support original conclusion that condition is due to IGSCC of cladding

-More probable in manual clad regions due to low carbon content of machine welded clad (greater tolerance for carbon pickup)

-Very low likelihood of propagation into low alloy steel basemetal

-Detailed UT investigation of dryer support bracket indication, which is now known to be at least nine years old, demonstrates no propagation beyond the clad

VESSEL/HEAD FLANGE/EVALUATION

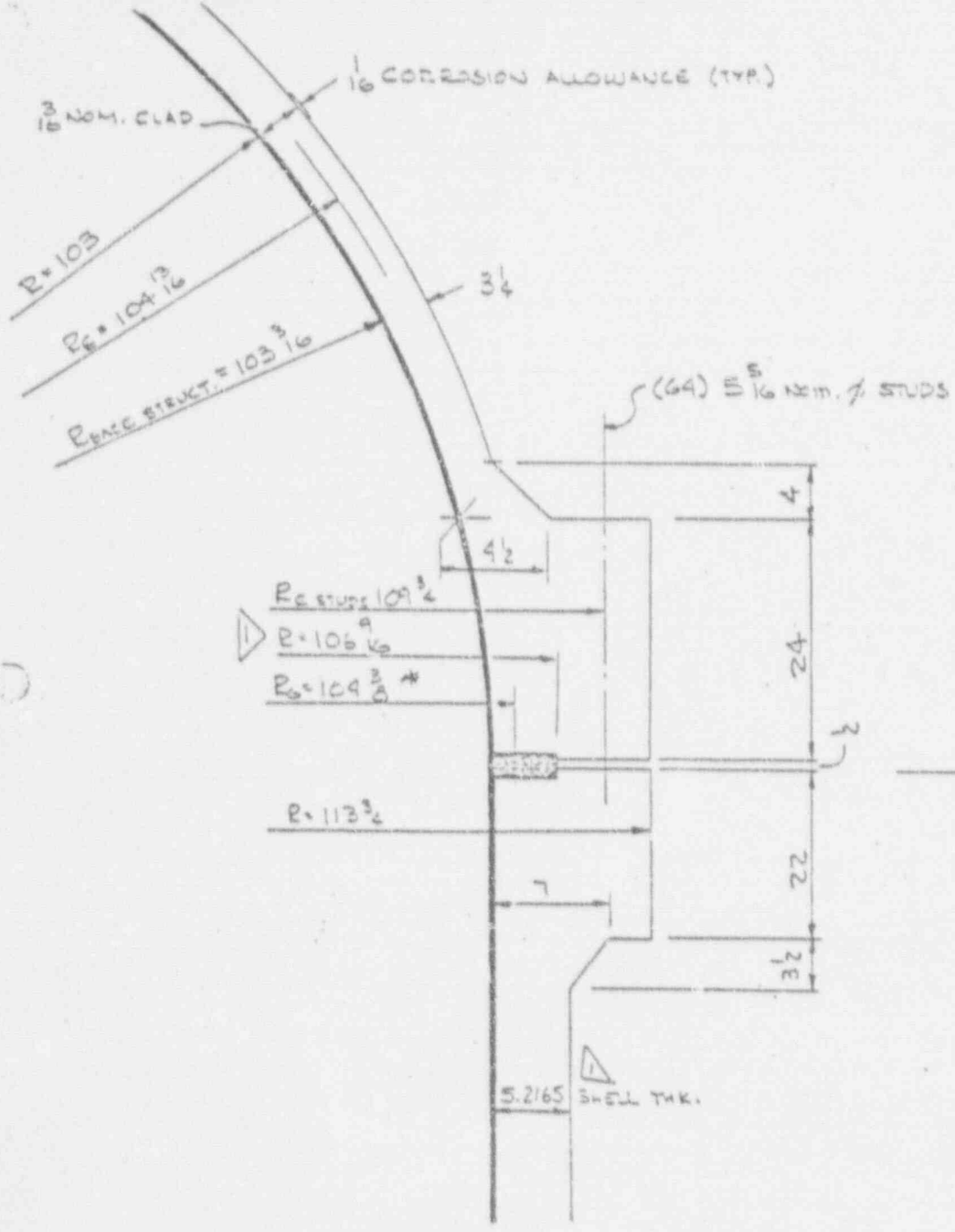
- STRESSES
  - Pressure/Bolt-up from Original Stress Report
  - Clad Stress
  - Weld Residual Stress

- FRACTURE MECHANICS MODEL
  - 360° Circumferential Crack in Cylinder

- CRACK GROWTH LAWS
  - SCC: Ford & Andresen Low Sulfur Law
  - Fatigue: ASME Section XI, Appendix A (Negligible)

- ALLOWABLE FLAW SIZE DETERMINED PER ASME SECTION XI, IWB-3600

B.2 FLANGE CONFIGURATION

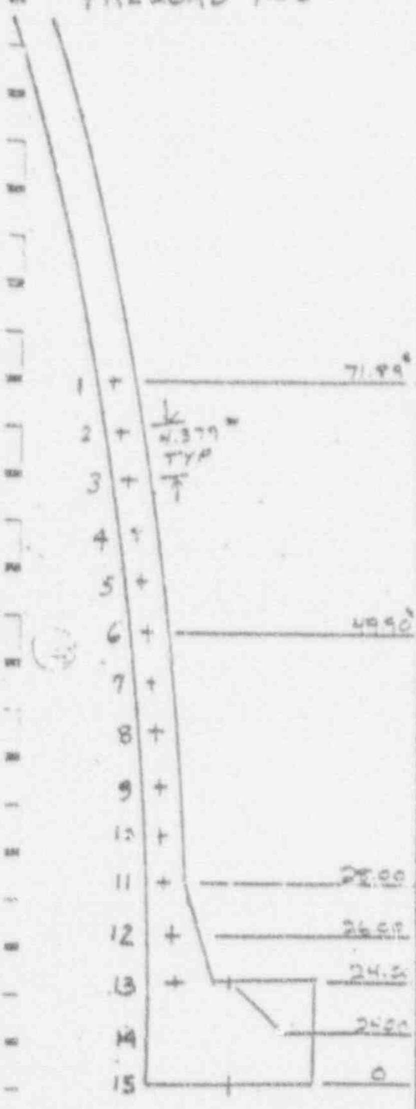


* R_G = RAD TO ℄ OF 1ST O-RING GALLET USED TO CONTAIN PRIMARY SEAL

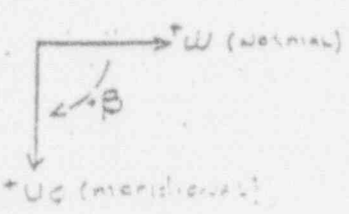
CHICAGO BRIDGE & IRON COMPANY **TABLE IX** OAK BROOK ENGINEERING

PRINCIPAL STRESSES & DEFORMATIONS — SOURCE OF TABULATED VALUES - See Pgs. I-S1-A32/43

HEAD FLANGE
PRELOAD P=0

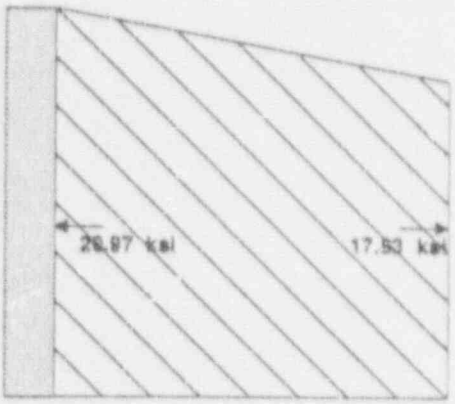


Point	Arc*	DISPLACEMENTS: Normal w	DISPLACEMENTS: mer U_ϕ	DISPLACEMENTS: Rotation β	Membrane Stresses: mer. $\sigma_{m\phi}$	Membrane Stresses: Hoop $\sigma_{m\theta}$	Bending Stresses**: mer. $\sigma_{b\phi}$	Bending Stresses**: Hoop $\sigma_{b\theta}$
1	71.89	-.00534	.00394	-.00005	-83	-594	1516	474
2		-.00464	.00416	-.00022	-93	-427	2353	797
3		-.00298	.00432	-.00047	-92	-26	3274	1152
4		-.00004	.00436	-.00091	-76	700	4352	1526
5		.00454	.00421	-.00122	-40	1941	5074	1824
6	49.50	.01101	.00377	-.00166	21	3457	5160	1923
7		.01935	.00244	-.00207	106	5547	4086	1644
8		.02910	.00104	[illegible]	212	7992	1157	763
9		.03910	-.00119	-.00217	331	10490	[illegible]	[illegible]
10		.04716	[illegible]	[illegible]	445	[illegible]	[illegible]	[illegible]
11	28.00	.04991	-.00234	[illegible]	654	13080	-27616	[illegible]
12	26.62	.04782	[illegible]	[illegible]	872	12560	[illegible]	-11440
13	24.6	.04199	[illegible]	[illegible]	973	11070	-46757	[illegible]
14	25.00	.03359	.00581	[illegible]	-5185	[illegible]	5151	[illegible]
15	0	-.05157	0.0	[illegible]	-6537	-15100	-13313	[illegible]

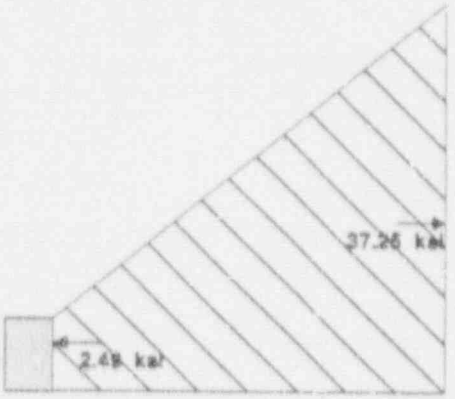


* ARC ON R ℄

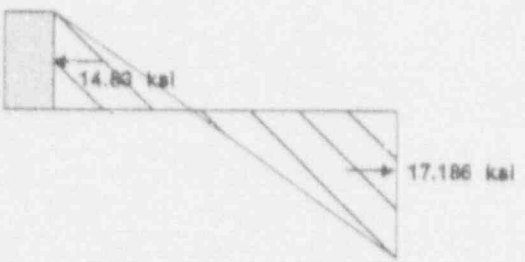
** + Bending = Tension on inside



Location No. 1



Location No. 10



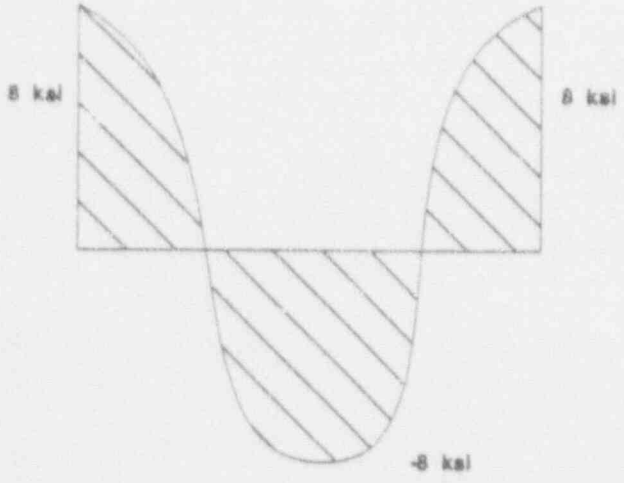
Location No. 14

MERIDIONAL STRESS DISTRIBUTIONS
(Applied Stress)

STRUCTURAL INTEGRITY ASSOCIATES, INC.

92257r0

CLAD STRESS DISTRIBUTION



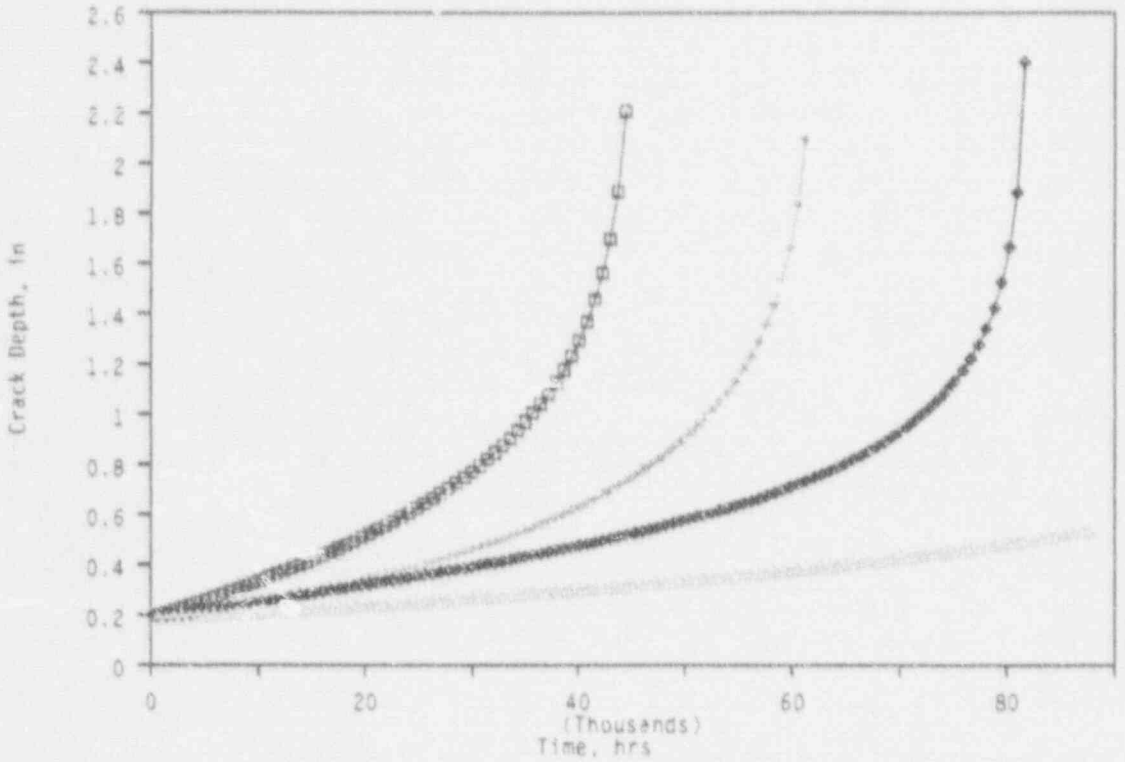
WELD RESIDUAL STRESS DISTRIBUTION
(Cosine Distribution)

STRUCTURAL INTEGRITY ASSOCIATES, INC.

9226-r0

Vermont Yankee Vessel Head

Crack Growth - Location No. 1



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VESSEL ADJACENT TO STEAM DRYER BRACKET

- STRESSES
  - Pressure
  - Thermal
  - Clad
  - Bracket Loads

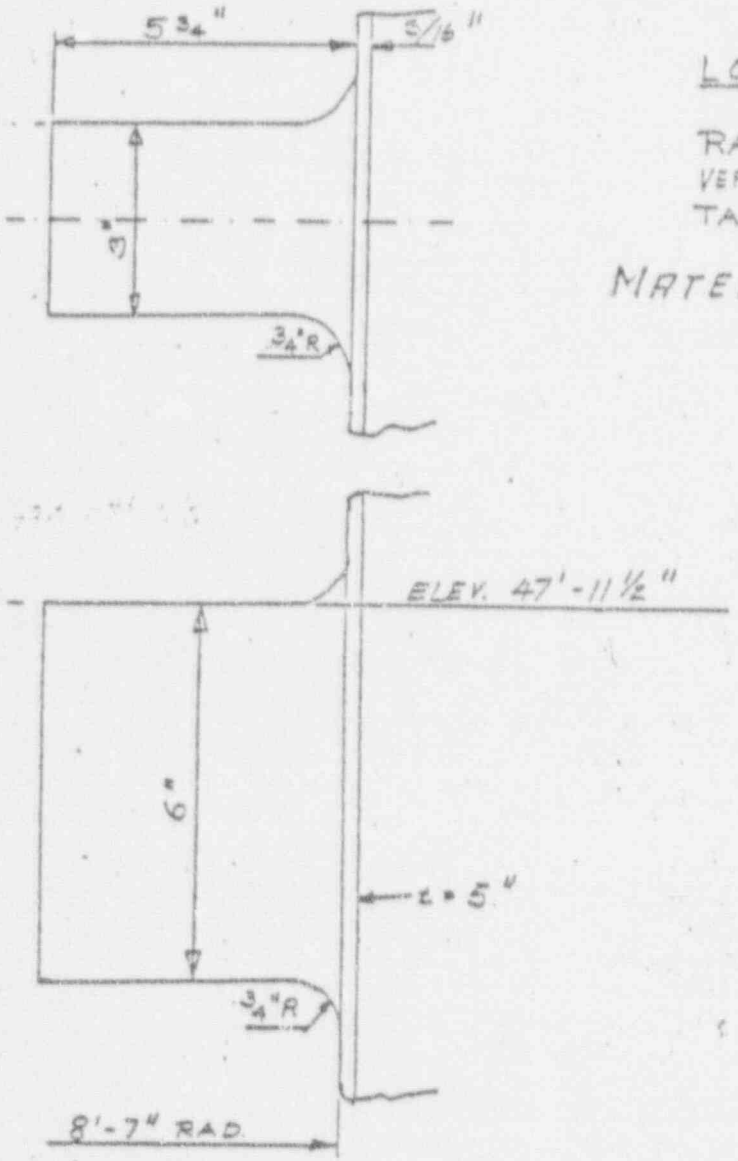
- FRACTURE MECHANICS MODEL
  - 360° Circumferential Crack in Cylinder

- CRACK GROWTH LAWS
  - SCC: Ford & Andresen Low Sulfur Law
  - Fatigue: ASME Section XI, Appendix A (Negligible)

- ALLOWABLE FLAW SIZE DETERMINED PER ASME SECTION XI, IWB-3600

E. - STEAM DRYER SUPPORT BRACKETS

E.1 BRACKET ANALYSIS



LOADING:

RADIAL	: 13 KIPS	= P	①
VERTICAL - DOWN	: 31 KIPS	= V_L	①
TANGENTIAL	: 8 KIPS	= V_C	①

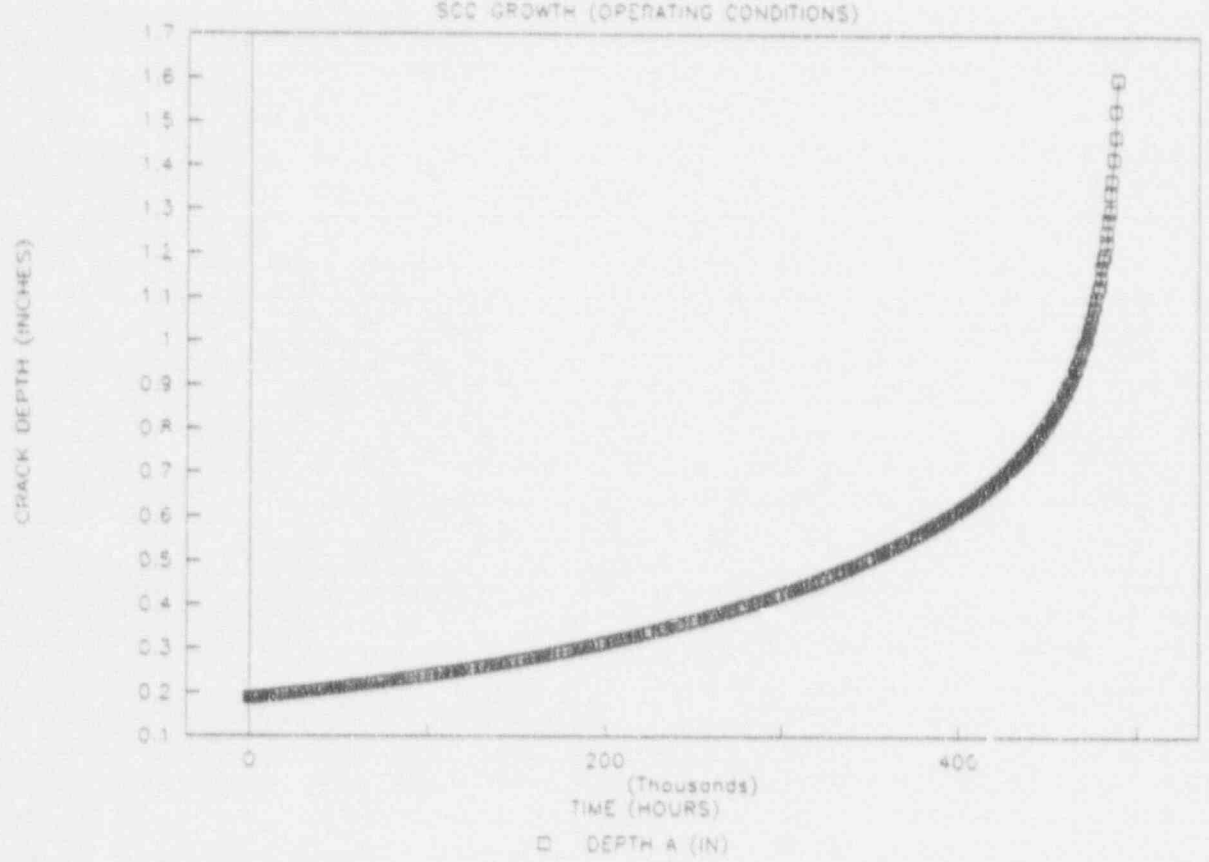
MATERIAL : SA 240 TYPE 304

Subject VERMONT YANKEE REACTOR-REACTOR 9-6201-I Date 6/10/67 By KSS Sht ___ of ___

Checked by AEE Date 9-2-67 Rev. No. 1 Date 11/17/69 Rev. No. ___ Date ___ Rev. No. ___ Date ___

VERMONT YANKEE STEAM DRYER BRACKET

SCC GROWTH (OPERATING CONDITIONS)



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