CATEGORY 1

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:9804090312 DOC.DATE: 98/03/30 NOTARIZED: YES DOCKET #
FACIL:50-244 Robert Emmet Ginna Nuclear Plant, Unit 1, Rochester G 05000244
AUTH.NAME AUTHOR AFFILIATION
MECREDY,R.C. Rochester Gas & Electric Corp.
RECIP.NAME RECIPIENT AFFILIATION
VISSING,G.S.

See Reports

SUBJECT: Submits 90-day response to GL 97-06, "Degradation of Steam Generator Internals." Util committed to ensuring safe & reliable operation of plant replacement SGs.B&W Rev 1 to BWC-TR-98-03 encl.

DISTRIBUTION CODE: A001D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 21+45
TITLE: OR Submittal: General Distribution

NOTES:License Exp date in accordance with 10CFR2,2.109(9/19/72). 05000244

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD1-1 LA	1	1	PD1-1 PD	1	1
	VISSING,G.	1	1			
INTERNAL:	FILE CENTER 01	1	1	NRR/DE/ECGB/A	1	1
	NRR/DE/EMCB	1	1	NRR/DRCH/HICB	1	1
	NRR/DSSA/SPLB	1	1	NRR/DSSA/SRXB	1	1
	NUDOCS-ABSTRACT	1	1	OGC/HDS3	1	0
EXTERNAL:	NOAC	1	1	NRC PDR	1	1

C A T E G O R Y 1 D O C U M E N T

NOTE TO ALL "RIDS" RECIPIENTS:
PLEASE HELP US TO REDUCE WASTE. TO HAVE YOUR NAME OR ORGANIZATION REMOVED FROM DISTRIBUTION LISTS OR REDUCE THE NUMBER OF COPIES RECEIVED BY YOU OR YOUR ORGANIZATION, CONTACT THE DOCUMENT CONTROL DESK (DCD) ON EXTENSION 415-2083

TOTAL NUMBER OF COPIES REQUIRED: LTTR 13 ENCL 12

RG&E

ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649-0001 AREA CODE 716 546-2700

ROBERT C. MECREDY
Vice President
Nuclear Operations

March 30, 1998

U.S. Nuclear Regulatory Commission
Document Control desk
Attn: Guy Vissing
Project Directorate I-1
Washington, D.C. 20555

Subject: Response to NRC Generic Letter 97-06, dated December 30, 1997;
SUBJECT: DEGRADATION OF STEAM GENERATOR INTERNALS
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Vissing:

Generic Letter 97-06 requested from licensees of pressurized-water reactors (PWRs) to provide a response within 90 days to the information requested in the generic letter. The referenced generic letter referred to NRC Information Notice (IN) 96-09 and IN 96-09, Supplement 1, which detailed tube support plate and wrapper degradation mechanisms that have been observed at foreign PWR facilities. The referenced letter also referred to new information regarding degradation of carbon-steel "eggcrate" tube supports at a domestic PWR facility. The information requested in GL 97-06 is as follows:

<u>Requested Information</u>

(1) *Discussion of any program in place to detect degradation of steam generator internals and a description of the inspection plans, including the inspection scope, frequency, methods, and equipment.*

The discussion should include the following information:

(a) *Whether inspection records at the facility have been reviewed for indications of tube support plate signal anomalies from eddy-current testing of the steam generator tubes that may be indicative of support plate damage or ligament cracking. If the addressee has performed such a review, include a discussion of the findings.*

070119

A001

(b) *Whether visual or video camera inspections on the secondary side of the steam generators have been performed at the facility to gain information on the condition of steam generator internals (e.g., support plates, tube bundle wrappers, or other components). If the addressee has performed such inspections, include a discussion of the findings.*

(c) *Whether degradation of steam generator internals has been detected at the facility, and how the degradation was assessed and dispositioned.*

(2) *If the addressee currently has no program is in place to detect degradation of steam generator internals, include a discussion and justification of the plans and schedule for establishing such a program, or why no program is needed.*

Applicability of the Cited Degradation Mechanisms to the Ginna Replacement Steam Generators

RG&E replaced the two original steam generators at Ginna in 1996 with enhanced steam generators designed and manufactured by Babcock & Wilcox. These replacement steam generators (RSGs) incorporated many design features to mitigate problems experienced with the original steam generators. Specifically, the RSGs have thermally-treated Alloy 690 tubing, 410S stainless-steel lattice grid tube supports, 410S stainless-steel flat-bar U-bend supports, a feedwater distribution system designed to minimize the potential for water-hammer and thermal stratification, and improved steam separation capability.

RG&E, in co-operation with several other utilities that operate Babcock & Wilcox RSGs, has contracted with B&W to provide an assessment of the potential for the degradation mechanisms cited in IN 96-09 (incl. Supplement 1) and GL 97-06 to occur in B&W RSGs. Report BWC-TR-98-03 Rev. 1, dated March 18, 1998, contains this assessment and is attached to this letter. This report concludes that none of the cited degradation mechanisms are applicable to the RSGs in service at Ginna. The summary conclusions of this report are paraphrased below:

i) *Support Plate Wastage Due to Chemical Cleaning* is not currently a relevant degradation mechanism since the Ginna RSGs have not been chemically cleaned. In addition, the materials and designs in the Ginna RSGs have been pre-qualified for multiple chemical clean operations, should it be determined that this needs to be done in the future.

ii) *Broken Tube Support Ligaments* is not directly relevant since the Ginna RSG tube supports are lattice-bar type rather than drilled plates. Damage to tube supports during manufacturing thermal cycles is avoided by installation of internals after heat treatment of the lower vessel so that the tube bundle, tube supports, wrapper and related structures are not exposed to thermal effects. The shell final closure weld, which is performed after

tubing, is located at the top of the conical shell and is carefully isolated from the tube bundle, tube supports and wrapper. The closure weld is also carefully monitored and controlled during post-weld heat treatment activities.

During operating transients such as heat-up, the tubing, tube supports, wrapper and particularly the shell may respond thermally at different rates. In such a case, the shell temperature lag will resist free radial and axial expansions of the wrapper, tube supports, etc. Such conditions are accommodated by local flexibility within the wrapper that allows the necessary differential expansion.

iii) *Support Plate Wastage in Operation* due to corrosion or erosion-corrosion is addressed by lattice bar and U-bend support bar material selection. The 410S stainless-steel material chosen is conditioned to provide the necessary corrosion resistance as well as structural strength. Erosion-corrosion is not a concern because of the chromium content of 410S stainless steel.

iv) *Wrapper Drop* due to failure of wrapper support lugs during vessel manufacturing is avoided by installing the wrapper after vessel thermal treatment as noted above. Failure during operation is addressed by providing robust shell lugs with full penetration welds to support the lower edge of the wrapper. Differential axial growth of the wrapper relative to the shell is provided by a slip joint in the wrapper above the top tube support plate. Differential radial growth is accommodated by wrapper flexibility.

v) *Wrapper Cracking* due to possible wrapper vibratory motion is avoided by effectively providing anti-vibration support at numerous points including each of the fixed lower shroud lugs and by the many levels of wrapper (to shell) lateral support pins. In addition, each of the lattice grid support ring to wrapper wedge points provides additional restraint for this type of condition.

vi) *Degradation of Eggcrate Supports* similar to that observed at the domestic PWR facility is addressed in (iii) above.

Beyond the six mechanisms cited in the various NRC documents, a manufacturing problem has been observed on some B&W RSGs in which the positioning of U-bend support components could result in contact between peripheral tubes. The U-bend support structure, which is free to move with the U-bend tubes during operating transients, is supported off of the peripheral tubes by elements called J-tabs. It was determined that the positioning of some of the J-tabs during manufacture may cause contact between certain pairs of vertically adjacent peripheral tube U-bends. The potential for and effect of this condition has been assessed in detail and documented. The assessment has confirmed that while some fretting may occur at such contact locations it

will be less than that predicted at the tube support locations and will not be sufficient to limit safe operation of the tubing. A summary is included in the attached BWC-TR-98-03 Rev. 1 report. ECT and direct examination have confirmed the presence of this condition in a small number of tubes at Ginna.

Response to Requested Information

1. Rochester Gas and Electric does not currently have a formal *program* in place for inspection of the steam generator secondary-side internals, although inspections have been completed as described in 1. (b) below.

   (a) Inspection records were not reviewed for indications of support plate damage since the only records available were from the pre-service examinations, and no damage would be expected based on the justifications provided in the *Applicability of the Cited Degradation Mechanisms to the Ginna Replacement Steam Generators* discussion above.

   (b) Although not programmatically dictated, fairly comprehensive secondary-side inspections were carried out in both of the Ginna RSGs during the refueling outage following the first cycle of operation. The attached "1997 Refueling Outage Replacement Steam Generator Secondary Internals Inspection Report", issued on February 20, 1998, provides details on the areas inspected, the equipment used, the inspection results, and recommendations for future inspections.

   (c) No degradation of steam generator internals was detected during the 1997 RFO visual inspections, although the presence of the U-bend tube proximity indications mentioned previously was verified with ECT and by direct measurements. Potential degradation as a result of this condition will be managed under the overall steam generator program to be established under Nuclear Energy Institute Initiative NEI 97-06, "Steam Generator Program Guidelines."

2. RG&E does not currently have a program in place for secondary internals inspections, but such a program will be developed as part of the response to NEI Initiative 97-06. RG&E intends to have this program in place by January 1, 1999, which is before the next scheduled refueling outage.

   NEI Initiative 97-06 states in section 3.8.1 that "the program should define when such (secondary-side) inspections are to be performed, the scope of inspection, and the inspection procedures and methodology to be used."

   RG&E has not established frequencies or requirements for these inspections at this time, although it is expected that the scope will be similar to the inspections done during the 1997 refueling outage. Frequency of inspection will be established in consultation with Babcock & Wilcox and other utilities that operate B&W RSGs. RG&E actively

participates in the B&W RSG Owners Group, and any feedback from other utilities' inspections will be used to adjust inspection requirements and frequencies, as necessary.

RG&E is committed to ensuring safe and reliable operation of the Ginna replacement steam generators and views secondary-side internals inspection and degradation management as an integral part of ensuring that steam generator tube structural integrity is maintained in accordance with the requirements of Appendix B to 10CFR Part 50.

Very truly yours,

Robert C. Mecredy

Subscribed and sworn to before me
on this 30th day of March, 1998

MARIE C. VILLENEUVE
Notary Public, State of New York
Monroe County
Commission Expires October 31, 1998

xc: Mr. Guy S. Vissing (Mail Stop 14B2)
Project Directorate I-1
Division of Reactor Projects – I/II
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

U.S. NRC Ginna Senior Resident Inspector

9804090312

Rochester Gas and Electric Corporation
Ginna Station

1997 Refueling Outage
Replacement Steam Generator Secondary Internals Inspection Report
(Issued February 20, 1998)

1 Introduction

A comprehensive secondary-side internals inspection was carried out on both Ginna replacement steam generators (RSGs) during the 1997 refueling outage after their first cycle of operation[1]. The inspection was done with the assistance of personnel and equipment from R. Brooks Associates of Williamson, New York.

This inspection was undertaken to verify that there were no unknown degradation mechanisms occuring in the RSGs and to assist with the response to the upcoming Nuclear Regulatory Commission Generic Letter on secondary internals degradation, which has since been issued as GL 97-06.

In addition, the inspection was intended to help determine whether the Ginna RSGs were experiencing the U-bend tube proximity issue that has affected several other Babcock & Wilcox RSGs[2]. Five potential proximity indications in each RSG had been determined using ECT analysis. Accessible locations were measured using specially made feeler gauges to determine the tube proximity.

The inspections revealed that no detectable degradation of secondary internals components had occurred. Several locations in each RSG U-bend region that had been identified by ECT as potentially having less than design tube spacing were confirmed; random "control" checks at other areas did not reveal any tube spacing problems.

2 Areas Inspected and Results

The areas inspected are itemized in Table 1 along with notes on access and suggestions for future inspection. The corresponding locations are marked on the Figures at the end of this report.

The upper internals inspection was done through the secondary manway located in the secondary head of each steam generator. Both the secondary and primary deck doors were opened to gain access to the top of the tube bundle.

Lower internals above the tubesheet were inspected through the four tubesheet hand-holes located on each end of the no-tube lane and on either end of the axis 90° from the no-tube lane.

---

[1] Refer to Ginna Procedure GMS-43-29 Rev. 03 with TPCN 97-T-0245.

[2] See Babcock & Wilcox Technical Report B&W-TR-97-18 Revision 0, "U-Bend Radial Gap Assessment Report" for more information regarding this phenomenon; disposition of this condition was done under Ginna ACTION Report 97-1429.

2.1 Steam Dome Region

Items inspected in the steam dome included the steam outlet nozzle venturis and their mounting hardware, seal skirt to secondary deck and shell welds, deck door hardware, secondary steam separators, and primary separator CAP-3 (curved arm primary) heads.

The seven steam outlet venturis were fabricated from stainless steel. Although the moisture carryover of the Ginna RSGs was measured to be a very low 0.015%, the velocity at the throat of these venturis is extremely high (~380 fps[3]). No erosion damage was visible on the venturis and the welds on the venturi retention plate were intact.

All secondary separator steam outlet and vent holes were inspected. No erosion was evident; all edges were in the as-fabricated condition. A subset of secondary separator internals were inspected. No erosion was evident on the skimmer slots or inlet swirl vanes. Unfortunately, the swirl vane to separator bottom plate and separator body welds were not visible with the available camera; a camera will be designed for this task before the next inspection[4].

A subset (10%) of the primary separator CAP-3 cyclone heads were inspected by lowering a video-probe down through the secondary separators. Controlling the video-probe while doing this is extremely difficult; attempts were made until there were at least two views of each selected cyclone head. There was no visible erosion damage to the cyclone heads and all visible welds were intact.

No degradation of the deck door hardware or seal skirt welds was seen.

2.2 Primary Separator Region and Feedwater Header

Access in this region was limited to the separator-free "tunnel" between the primary and secondary decks and the area under the feedwater gooseneck.

A subset of the secondary separators are visible from the tunnel, allowing some of the swirl vane to separator bottom plate and separator body welds to be inspected. No degradation of these welds was visible, and direct visual inspection of the inlet swirl vanes confirmed that no erosion damage had occurred. No problems were experienced with the visible secondary separator drain tubes or the associated attachment hardware.

The primary separator outer cylinders and riser tubes visible from the tunnel were inspected and found to be intact with no signs of degradation.

The visible areas of the primary deck, weir, and stiffener plates were inspected. All welds were intact. The expected buildup of deposit on the primary deck was not observed.

---

[3] See Babcock & Wilcox Calculation 222-7705-A14 Rev. 1.

[4] A sample of these could be seen from the access tunnel between the primary and secondary decks; no degradation was seen.

Access to the feedwater header was gained by crawling beneath the feedwater piping "gooseneck". This allowed several of the J-tubes closest to the tee to be inspected. Excellent views of the J-tube welds were obtained and no degradation was evident. One primary deck support lug was observed and was intact. The camera access track, installed in case more detailed feedwater header inspections are required in the future, was observed to be intact.

The original plan called for inspection of the area where the feedwater exits the J-tube in close proximity to the shroud. Shroud thinning had been observed at Diablo Canyon under similar geometric conditions, although none was expected at Ginna since J-tube exit velocities are lower by design. However, the stick camera intended for this inspection was too large to gain access between the feedwater header and shroud.

2.3 U-Bend Region

Inspections in the U-bend, with the exception of the tube proximity gap checks, were done remotely using a Pan/Tilt/Zoom (P/T/Z) camera. This camera had long telephoto capability and allowed extremely detailed inspections of the U-bend supports (tie tubes and lugs, arch bars, J-tabs and welds, and jaw bar assemblies), shroud welds and apurtenances, and primary separator to deck welds. The magnetic base P/T/Z camera was affixed to the underside of the primary deck and allowed access to most of the U-bend when repositioned at several points above the tube bundle.

Close-in inspection of the J-tab to tube contact areas revealed gaps at the edges of the J-tab lands. Subsequent review of the fabrication drawings revealed this to be normal; the land is curved to allow the J-tab to seat properly against the tube. There may have been slight deposit buildup at the J-tab to tube contact point although this was hard to confirm on the videotape.

No degradation of any items in the U-bend region was observed, and tube deposits were light.

An inspection of the periphery of the uppermost lattice grid tube support was originally planned but had to be aborted since the camera that had been meant for this task was too large to get around the lower tie-tube. A more labor-intensive video-probe inspection would have been possible but was not attempted since dose rates were high (3 Rem/hr contact) and there was felt to be a low probability of upper grid lattice bar deposit based on the minimal amount of tube deposit observed in the U-bend.

U-bend gap measurements were completed in both RSGs as indicated in Table 2. Four of five U-bend gaps identified by ECT were measured in SG B. One of five U-bend proximity indications was measured in SG A. The other tubes identified by ECT in SG A were in the vicinity of the collector bar and lowest fan bar and would have been very difficult to reach; they were not attempted since dose rates were high and the existence of the gap proximity problem had already been verified in SG B.

The nominal tube-to-tube gap in the Ginna RSGs is 0.369", although tube bending tolerances can reduce this to a design minimum of 0.269". All of the proximity

indications that were found by ECT and subsequently inspected were less than 0.100", indicating that the ECT upper detection limit is between 0.050" and 0.100". Several "control" gaps were checked in the U-bend and were found to be greater than 0.200" (the largest gauge available). This control group was not comprehensive, and it is likely that there are tube gaps between the ECT upper detection limit and the nominal minimum of 0.269" that ECT was not able to locate. This is an acceptable condition, based on the Babcock & Wilcox technical report disposition.

2.4 Lower Internals Inspection (Near Tubesheet)

The lower internals near the top of the tubesheet were inspected as part of the tubesheet Foreign Object Search and Retrieval (FOSAR) inspection that occurred before and after waterlancing. This inspection was carried out by R. Brooks Associates using a new FOSAR tool.

This tool is ideal for tubesheet FOSAR inspections, allowing the operator to quickly and easily position the cameras for optimal viewing. The FOSAR tool also provided very good views of the bottom of the lower lattice grid, the shroud support lugs, and shroud pins. It is recommended that this tool be further developed and qualified for the task of inspecting items further up into the downcomer. Properly adapted, it would also be ideal to ride on the camera track for feedwater header and upper downcomer inspections.

No problems were observed with the full penetration shroud support lug welds. Several shroud pins were observed and were not degraded. The lower lattice grid bars were not fouled.

Two foreign objects were found in SG B. A 4 ¼" long x ⅜" OD hex-head bolt and matching nut were found near the center of the no-tube lane and removed. No tube damage was observed by ECT. Subsequent investigation revealed that the bolt and nut were not native to the steam generator[5].

3 Recommendations for Future Inspection

The 1997 RFO RSG inspections were planned and executed very quickly. Table 3 contains recommendations that would improve future inspections considerably.

[5] Refer to RGE Inter-Office Correspondence, G. Geiken to J. F. Smith, "Bolt and Nut Found in B S/G Tube Lane, 1997 Refueling Outage", dated 1/14/98.

TABLE 1

Items Inspected

Item	Component	Reference Figure(s)	Number Inspected	Notes / Condition
1	Steam Line Venturi	1	7 (100%)	NDD
2	Venturi Retainer Plate and Capscrews	1	1 (plate), 6 (screws) (100%)	NDD
3	Seal Skirt to Secondary Head Weld	1	1 (360°)	NDD
4	Seal Skirt to Secondary Deck Weld	1	1 (360°)	NDD
5	Secondary Separator Steam Outlet Holes	1, 2	85 (100%)	NDD, edges sharp, no erosion evident
6	Secondary Separator Steam Vent Holes	2	360 (100%)	NDD, edges sharp, no erosion evident
7	Secondary Separator to Deck Fillet Welds	2	85 (100%)	NDD
8	Secondary Separator Skimmer Slots	2	27 (10%)	NDD, edges sharp, no erosion evident, QC marks still evident
9	Secondary Separator Inlet Swirl Vane to Bottom Plate Welds	2	All visible from ladder tunnel	NDD, had originally intended to inspect all from above secondary deck but new tooling needed
10	Secondary Separator Inlet Swirl Vane to Body Welds	2	All visible from ladder tunnel	NDD, had originally intended to inspect all from above secondary deck but new tooling needed
11	Secondary Deck Door Lock Wires and Tabs	6	8 (100%)	NDD, no new locking tabs required
12	Primary Separator Cyclone Heads	1, 2	9 (10%)	NDD, edges sharp, no erosion, welds intact
13	Secondary Separator Drain Tubes	2	All visible from ladder tunnel	NDD, lugs that connect these to primary separator outer cylinders intact

TABLE 1

Items Inspected (cont'd)

Item	Component	Reference Figure(s)	Number Inspected	Notes / Condition
14	Secondary Separator Swirl Vanes	2	All visible from ladder tunnel	NDD, edges sharp, no erosion evident
15	Primary Separator Outer Cylinders	2	All visible from ladder tunnel	NDD, no erosion evident under top lip
16	Primary Separator Riser Tubes	2	All visible from ladder tunnel	NDD, external view at deck only
17	Primary Deck	1, 2, 3	Areas visible from ladder tunnel	No deposits or loose parts visible from tunnel area; improved tooling would allow more to be seen
18	Primary Deck Weir	3	Segments visible from ladder tunnel	NDD
19	Primary Deck Stiffener Plates	Not Shown	All visible from ladder tunnel	NDD
20	Primary Deck Lugs	1, 3, 4	All visible from under gooseneck	NDD, only one (1) seen; modify Brooks FOSAR tool to run on camera track to inspect more of these
21	Feedwater Gooseneck	1, 3	1	NDD
22	J-Tubes	3, 4	All visible from under gooseneck	NDD, very good views of welds obtained
23	Camera Track	3	Segment visible under gooseneck	NDD
24	Shroud Impingement Area	3	N/A	Not accessible due to camera limitations; new tooling should be developed for next inspection
25	U-Bend Assembly Tie Tubes	5	2 (100%)	NDD
26	Tie Tube Lugs	5	22 (100%)	NDD

TABLE 1

Items Inspected (cont'd)

Item	Component	Reference Figure(s)	Number Inspected	Notes / Condition
27	Arch Bar / Clamping Bar / Fan Bar / J-Tab Assemblies	5	8 (100%)	NDD, 50% of length of 2°, 14°, and 27° assemblies, 10% of length of 44° assemblies targeted
28	J-Tab to Tube Contact	5	15 / arch assembly	Slight deposit at contact possible but hard to confirm
29	Restraint Spring Bar / Jaw Bar Assemblies	5	2 (100%)	NDD, better views would be possible by optimizing camera placement
30	Primary Deck Lug Welds	3	11 (100%)	NDD, seen inside shroud
31	Feedwater Header Supports	3, 4	4 (100%)	NDD
32	Shroud Slider to Shroud Extension Weld	3	1 (360°)	NDD
33	Primary Separator to Deck Attachment Welds	2	9 (10%)	NDD
34	Recirculation Nozzle	1, 3, 4	1	NDD
35	Maintenance Deck Attachment Lugs	3, 4	6 (100%)	NDD
36	Shroud Support Lugs	7	12	NDD, not originally in plan but seen incidentally by FOSAR tool cameras
37	Shroud Pins	7	2	NDD, not originally in plan but seen incidentally by FOSAR tool cameras

TABLE 2

U-Bend Gap Measurements

Steam Generator A

Tube	Upper Extent	Lower Extent	Measured Gap	Note
95,43	14° Fan Bar (Hot Leg)	27° Fan Bar (Hot Leg)	gap = 0.050"	0.050" gauge very tight

Steam Generator B

Tube	Upper Extent	Lower Extent	Measured Gap	Note
76,24	27° Fan Bar (Hot Leg)	44° Fan Bar (Hot Leg)	gap < 0.050"	No confirmation of contact
74,22	2° Fan Bar (Hot Leg)	27° Fan Bar (Cold Leg)	0.050" < gap < 0.100"	
92,86	2° Fan Bar (Cold Leg)	14° Fan Bar (Cold Leg)	0.050" < gap < 0.100"	
92,86	14° Fan Bar (Cold Leg)	27° Fan Bar (Cold Leg)	gap < 0.050"	No confirmation of contact
91,87	2° Fan Bar (Cold Leg)	14° Fan Bar (Cold Leg)	0.050" < gap < 0.100"	
91,87	14° Fan Bar (Cold Leg)	27° Fan Bar (Cold Leg)	gap < 0.050"	No confirmation of contact

Note: Several random gap checks at other locations in Steam Generator A were all > 0.200", which was the largest gap gauge available. However, it appears that ECT is not able to locate gaps between 0.100" and the nominal design gap.

TABLE 3

Recommendations for Future Inspections

Number	Recommendation
1	Develop formal procedures for inspecting steam generator secondary internals. A Temporary Procedure Change Notice was taken out on an old procedure for this inspection due to time limitations.
2	Include lower internals inspection requirements in FOSAR procedure and qualify tool for this purpose. Ability to remotely focus the cameras on the Brooks FOSAR tool should be investigated.
3	Adapt the Brooks FOSAR tool to run on the installed camera track. This will allow the primary deck lugs and entire feedwater header to be easily inspected.
4	Develop camera capable of inspecting the secondary separator swirl vane to bottom plate and body welds.
5	Develop segmented pole camera (with smaller head than current stick camera) that can be assembled from straight or curved segments to allow better inspections in the feedwater header, steam separator, and top of bundle regions.
6	Produce simple 3D model of U-bend to determine optimal placement of P/T/Z camera.
7	Develop hand-held camera tool that can look into gaps between U-bend tubes. This will allow visual confirmation of tube touching, deposit buildup, and fretting.
8	Look into use of digital video to improve image quality, ability to edit and produce summary tapes, and long term storage.
9	Establish the Foreign Material Exclusion (FME) boundary at the ladder to the SG top hat. Although no FME events occurred during the inspection, nothing should be brought anywhere near the secondary manway unless it has been logged on the FME sheets.

Figure 1

Steam Drum

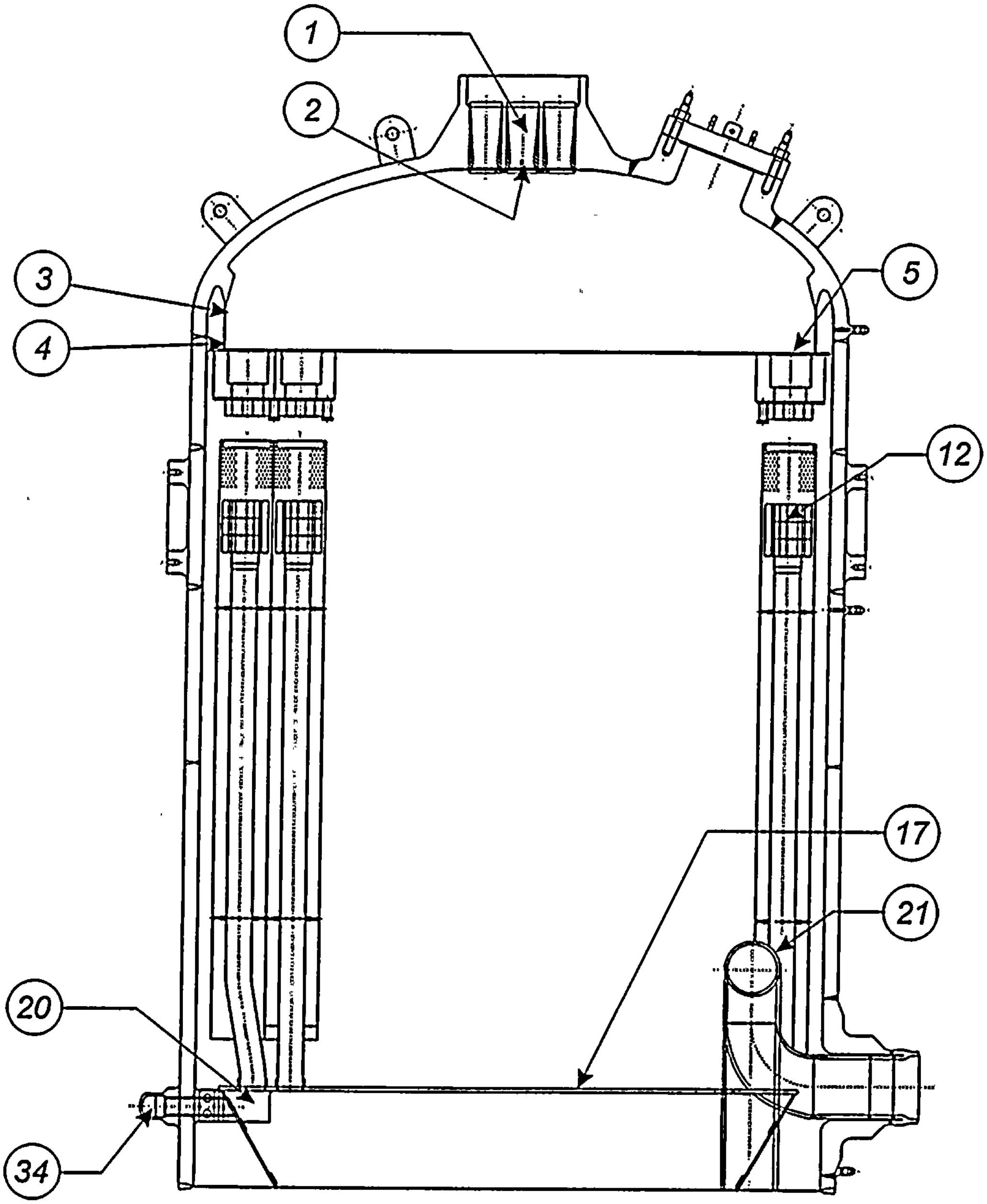

Figure 2

Primary / Separator Separator Pair

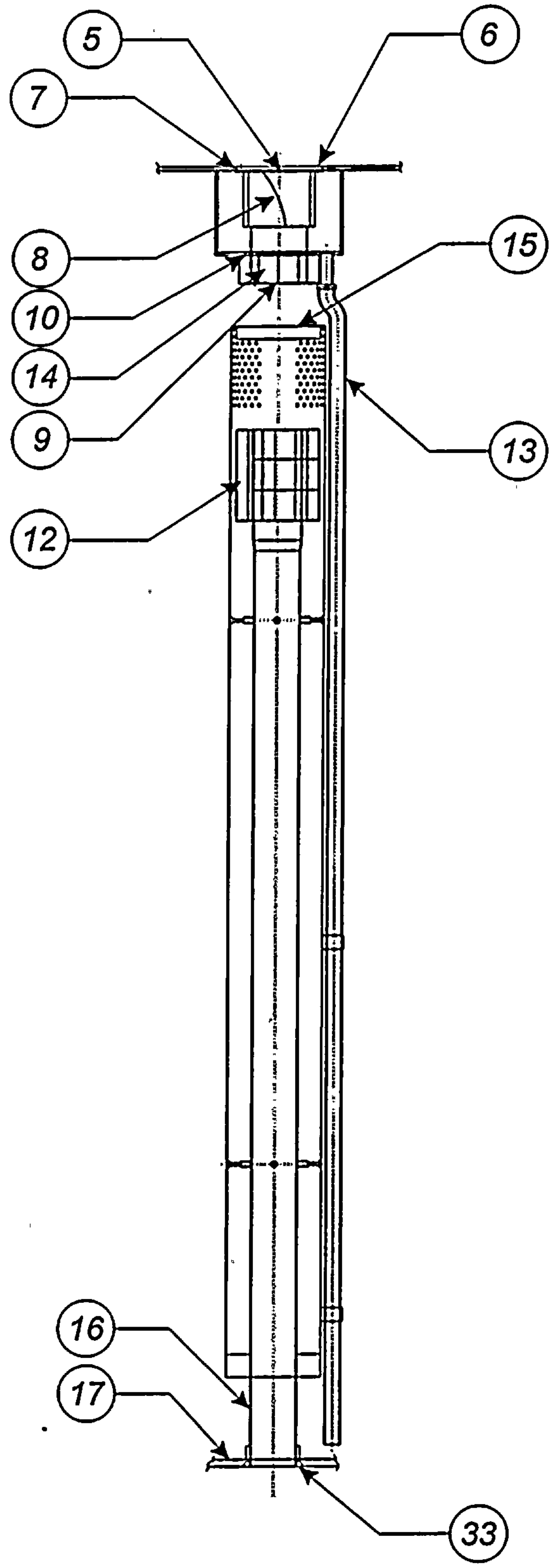

Figure 3

Feedwater Header Region (Elevation)

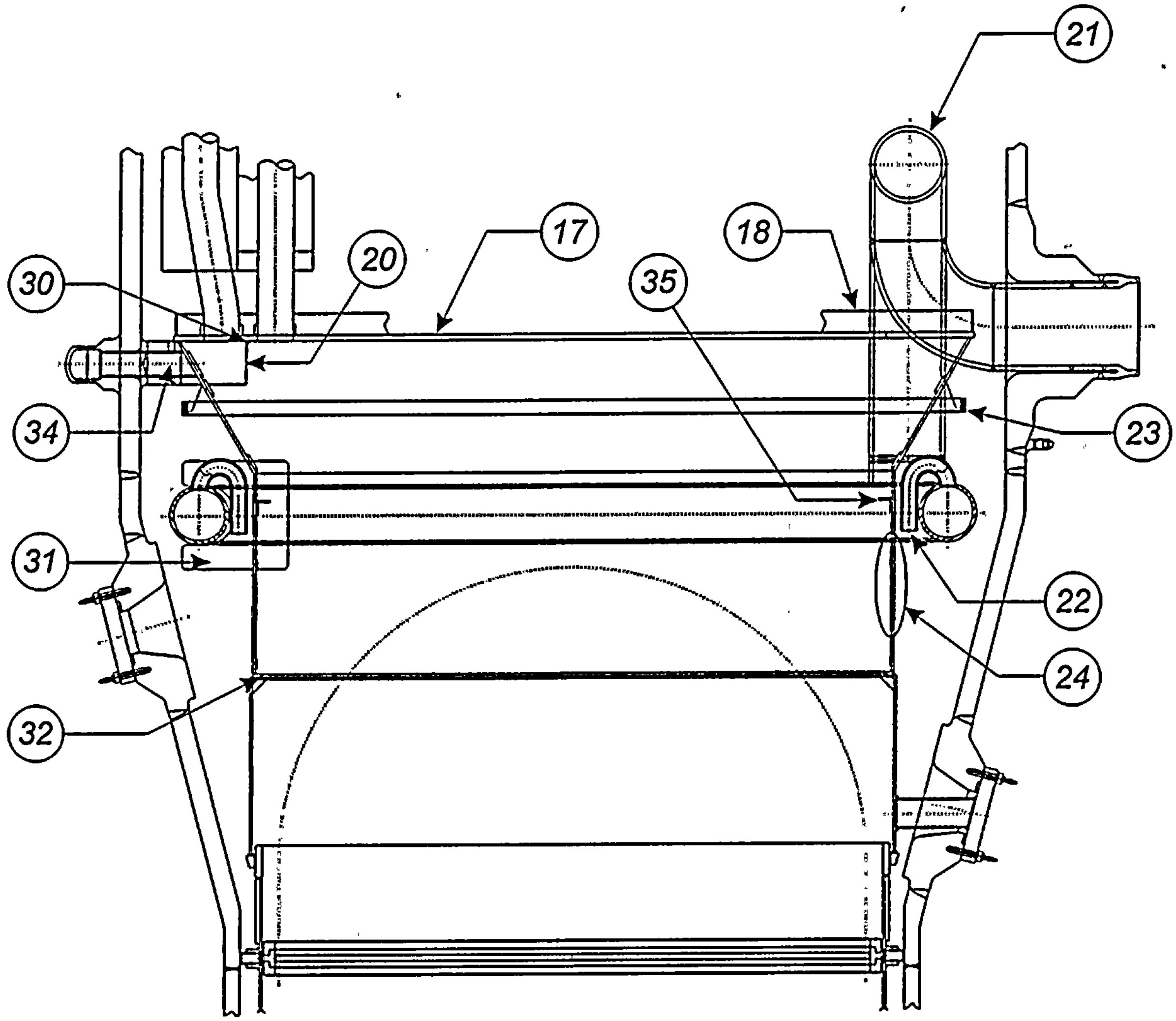

Figure 4

Feedwater Header Region (Plan)

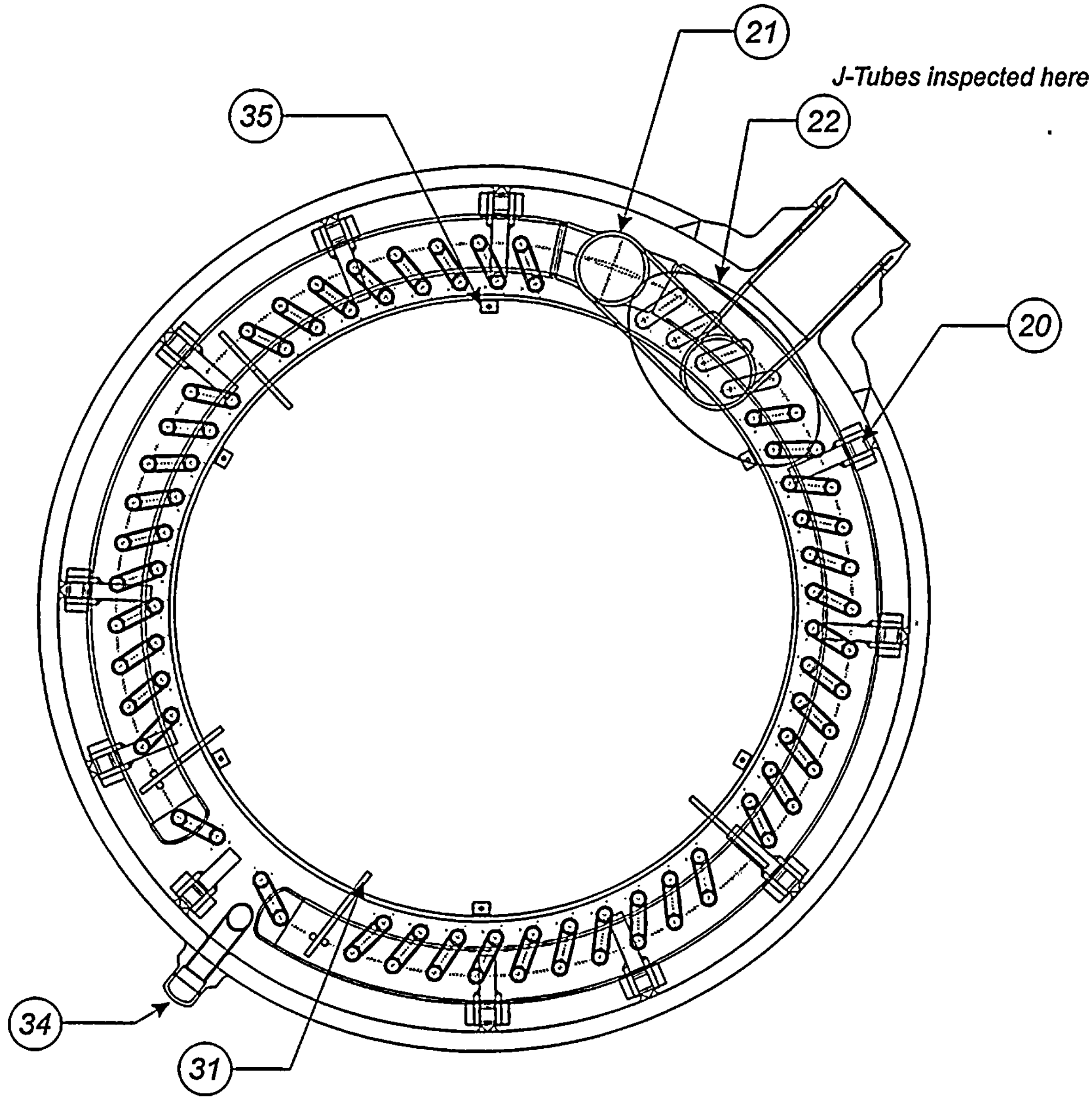

Figure 5

U-Bend Supports

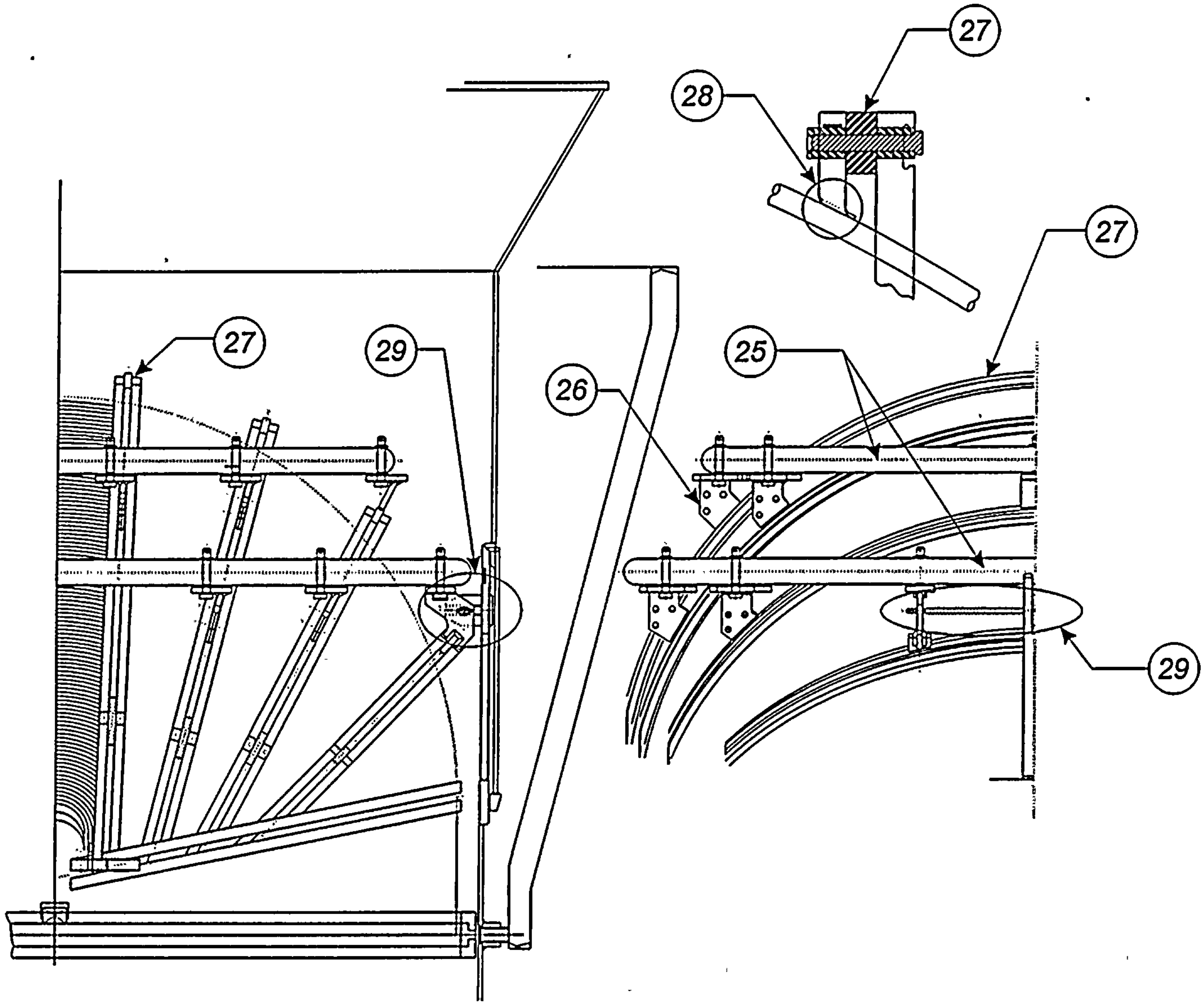

Figure 6

Secondary Deck and Separator Layout

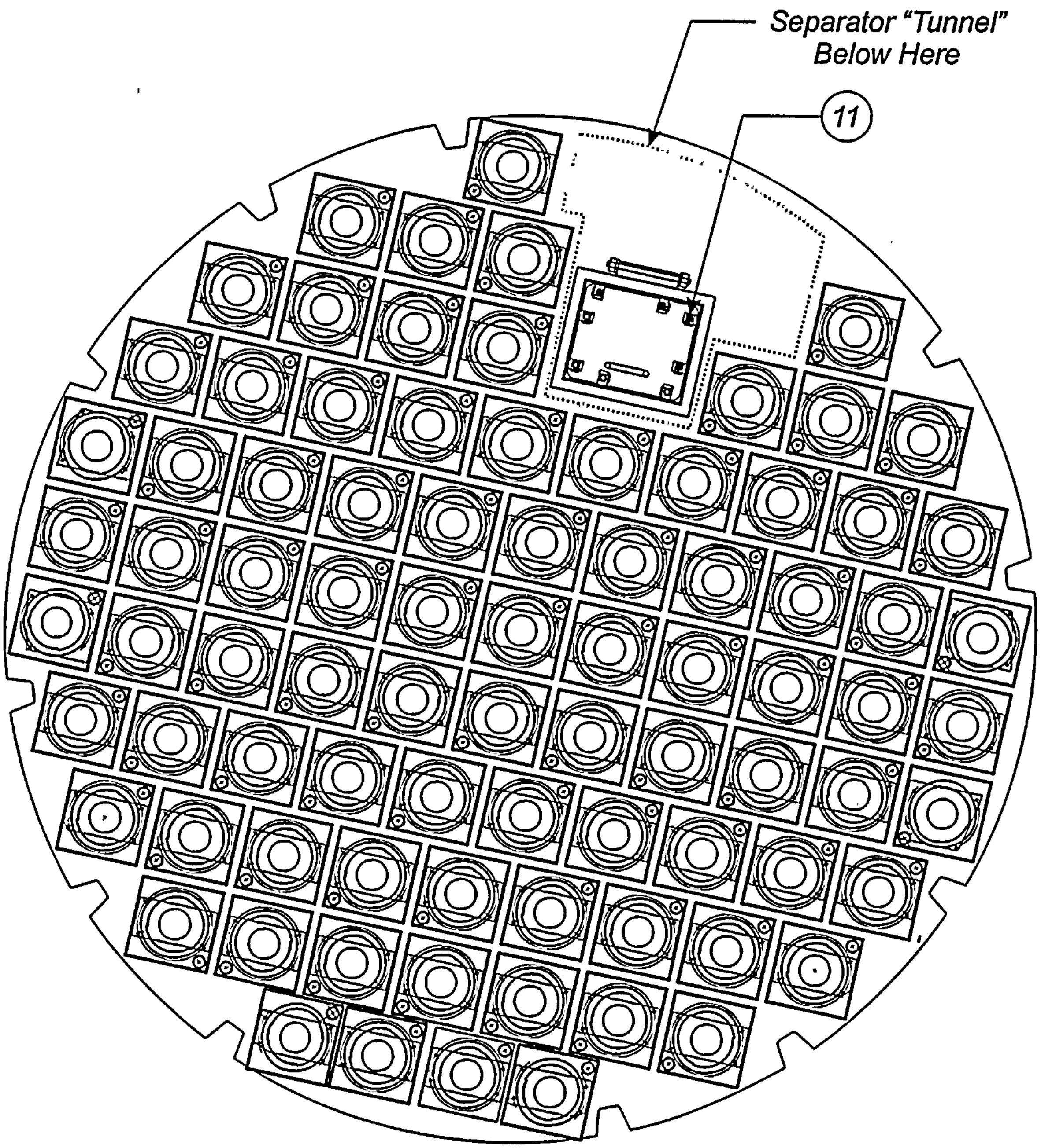

Figure 7

Lower Internals