February 22, 2006

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

Gentlemen:

In the Matter of) Docket No. 50-327
Tennessee Valley Authority)

SEQUOYAH NUCLEAR PLANT (SQN) - RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING UNIT 1 STEAM GENERATOR (SG) REPORTS FROM CYCLE 13 REFUELING OUTAGE (TAC NO. MC8712)

Reference: NRC letter to TVA dated January 13, 2006, "Sequoyah Nuclear Plant, Unit 1 - Request for Additional Information Regarding the Cycle 13 Steam Generator Tube Inservice Inspections (TAC No. MC8712)"

The enclosure to this letter provides additional information requested by the referenced letter. The additional information includes diagrams that help clarify the design features of the SQN Unit 1 replacement SGs.

Please direct questions concerning this issue to me at (423) 843-7170 or J. D. Smith at (423) 843-6672.

Sincerely,

Original signed by James D. Smith for:

P. L. Pace
Manager, Site Licensing and
Industry Affairs

Enclosure
cc: See page 2

cc (Enclosure):
Mr. Douglas V. Pickett, Senior Project Manager
U.S. Nuclear Regulatory Commission
Mail Stop O8G-9a
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2739

NRC Resident Inspector
Sequoyah Nuclear Plant
2600 Igou Ferry Road
Soddy-Daisy, Tennessee 37379-3624

Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
61 Forsythe St., SW, Suite 23T85
Atlanta, Georgia 30303-3415

ENCLOSURE

TENNESSEE VALLEY AUTHORITY (TVA)
SEQUOYAH NUCLEAR PLANT (SQN)
UNIT 1

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING THE CYCLE 13 STEAM GENERATOR TUBE INSERVICE INSPECTIONS

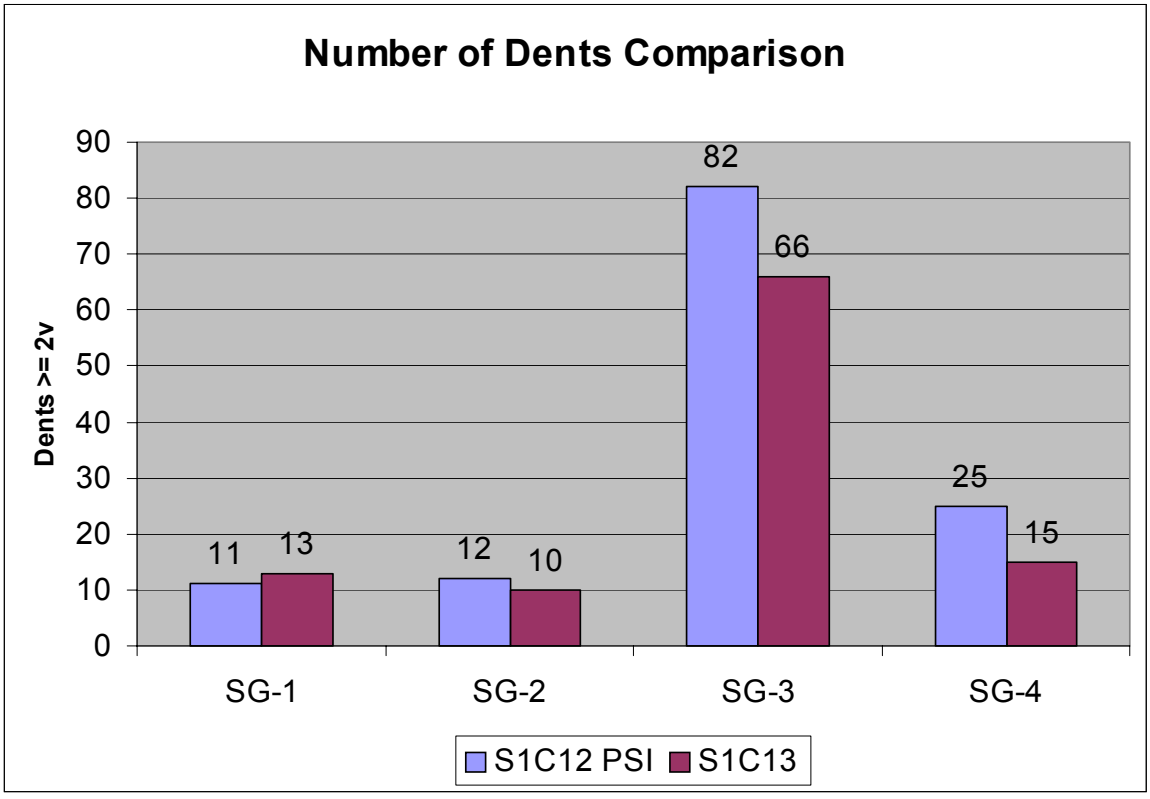
NRC Question 1

Your report indicated that 100-percent of the dents and dings greater than or equal to 2-volts between the top of the hot leg tubesheet and the top of the cold leg tubesheet were examined with a +Point™ probe. Discuss the results of these +Point™ probe inspections, including the number of dents/dings in each SG. In addition, discuss if there were any new dents/dings or any "anomalous" dent signals.

TVA Response

All greater than or equal to 2 volt dents were examined during the Sequoyah (SQN) end of cycle 13 (EOC-13) inservice inspection (ISI) using Plus Point probes and no degradation was identified.

The number of dents identified per SG during the SQN EOC-13 ISI is compared to the number identified during the SQN preservice inspection (PSI) below.



The total number of dents identified during the EOC-13 ISI was 104 as compared to 130 identified during the SQN PSI. The differences in the reduction in numbers can be attributed to the following:

1. The screening criterion for identifying dents is 2 volts. It is expected that with operation of the unit an oxide layer forms causing measured voltages to decrease slightly. Some of the baseline dents that were called near 2 volts are measured less than 2 volts during the ISI, thus not meeting the screening criterion. This could also be attributed to eddy current uncertainties.
2. During the PSI, the rules for the computerized data system (CDS) for identifying dents were discovered to be too conservative inside the tubesheet. On the first two SGs (#3 and #4) when dents were examined with a plus point coil, some of the signals were actually slight geometry variations in the expanded region of the tube. For the next 2 SGs and for the ISI (#1 and #2), the rules were modified. Thus fewer dents were identified.

Six new DNT indications were identified during the SQN EOC-13 ISI using the greater than or equal to 2 volt screening criterion and are tabulated as follows showing the comparison to the SQN PSI calls:

RSG	Row	Col	Location	Cyc13 ISI	PSI
1	8	22	VS3+0.72	2.09v	1.94v
1	16	100	DS1+2.30	4.90v	(1)
1	16	122	DS1+2.32	4.05v	(1)
1	43	7	VS2+1.28	2.00v	1.93v
3	43	43	C02-1.60	2.41v	1.89v
3	43	49	C02-1.60	2.13v	1.98v

Note (1):

A look back to PSI shows a geometry anomaly at the bend transition for these two tubes that was interpreted during the ISI (EOC-13) as a dent. The same small signal was recognized during the PSI as an occasional consequence of the tube bending process and not identified as a dent. This signal is still present and unchanged.

The discussion above shows there were no new indications or anomalous signals identified during the EOC-13 ISI following operation after the baseline PSI.

NRC Question 2

Please indicate if the 11 wear indications in the area of the 2nd and 4th vertical straps were inspected with bobbin and +Point™ probes. If the wear indications were not inspected with a +Point™ probe, please discuss how you concluded that the indications were wear. In addition, the staff noted that several of the wear indications were located in the same general vicinity. Please provide any insights on the pattern of the wear indications.

TVA Response

The eleven wear indications in the area of the 2nd and 4th vertical straps were inspected with both bobbin and plus point probes. Wear was confirmed with plus point.

Westinghouse analyzed these wear indications by developing WCAP-16407-P to describe the likely cause and examine the probability of future indications. The results are summarized below.

Cause:

The most likely cause of tube wear was identified as local clearance variations. Vertical strip arrays VS2 and VS4 have no lock-bars so tube to support clearance has the potential for small localized deviations from optimal clearance. For example, when the vertical strips of VS2 and VS4 were welded to the middle arch plates, the strips might have had local deviations in spacing from each other or might have deviated from a vertical orientation due to weld distortion. Either case would result in less than optimal tube to support clearances. It is feasible that a few vertical strips could have slightly larger tube clearances. These larger clearances would result in increased tube vibration amplitudes. While the SQN U1 RSG's upper bundle support (UBS) design provides excellent support against flow induced vibration (FIV), the high circulation ratio, which is beneficial in avoiding tube corrosion phenomena, results in increased fluid forces in the UBS region. In some local regions enlarged tube to support clearances in combination with increased fluid forces might have lead to the mild tube wear indications.

Future Wear Prediction:

Comprehensive wear progression trending data for tube wear at vertical strips was available from operating experience of Reference SG's at a CE plant. The geometry of the UBS is

similar between the Reference plant and Sequoyah in the local region of interest. Trending demonstrates indication stabilization (i.e., rate slows down as tube to support bearing area increases) and suggests volumetrically linear wear progression. Using SQN U1 RSG Tube Wear Curves of WCAP-16407-P it can be projected that a tube which incurred a 17% wall penetration in the first cycle, would not reach the ASME Section XI (40%) plugging criteria until sometime during the ninth cycle of operation.

NRC Question 3

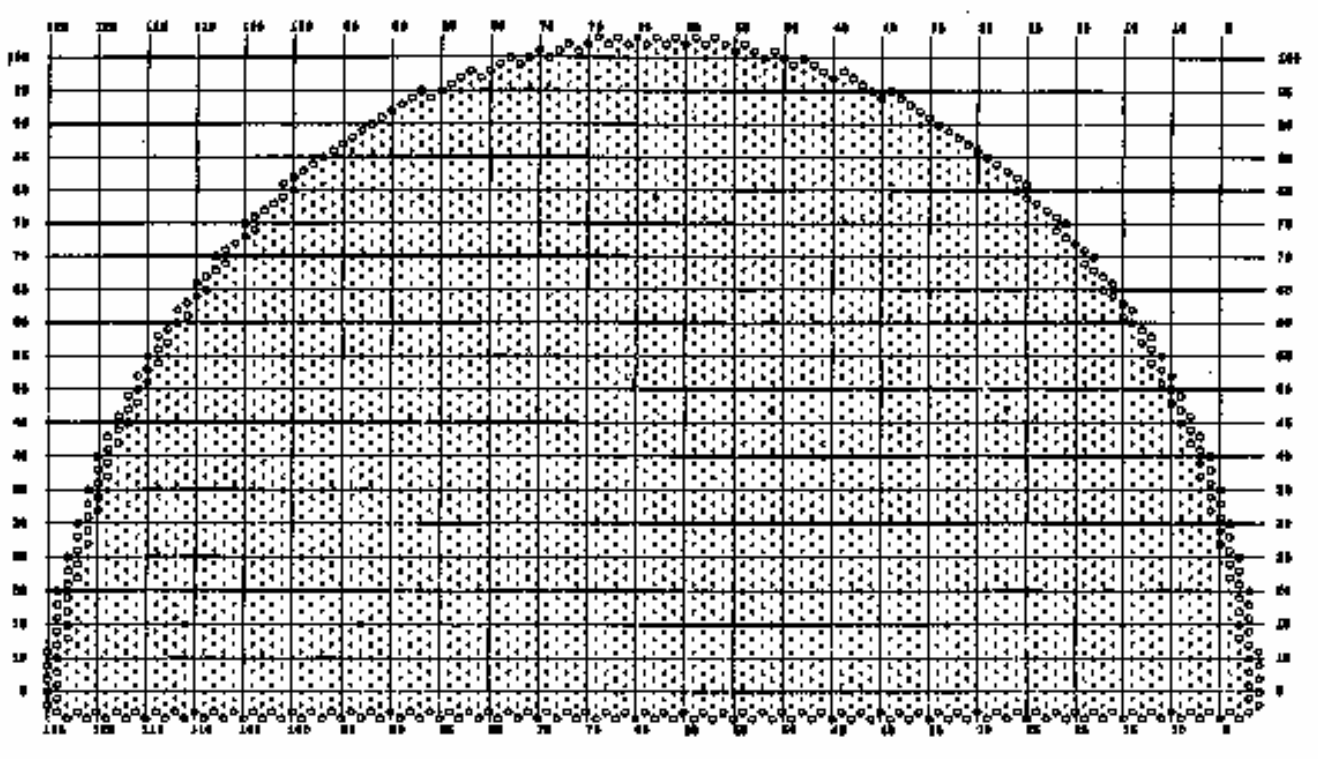
Your report provided information about flaws in specific tubes and at specific locations within a tube. In order for the U.S. Nuclear Regulatory Commission staff to better understand where your indications are being detected and for future reference, please provide the following information regarding the design of your replacement SGs: a tubesheet map, a tube support plate diagram, the heat transfer surface area, the tubesheet thickness (with and without the clad), the lattice grid thickness, the tube support plate thickness, and a description of the U-bend support system, including the thickness and the tubing supported by the various supports. In addition, discuss whether you have a flow distribution baffle to distribute flow at the top of the tubesheet, including the thickness.

TVA Response

Steam Generator Design:

There is no flow distribution baffle in the SQN U1 Replacement SG design.

Sequoyah Unit 1 is a Westinghouse PWR with 4 steam generators. These are replacements for the previous Westinghouse Model 51 steam generators. Each steam generator contains 4983 U-bend tubes made of thermally treated Inconel 690. The generators are designated as Model 57AG. This comes from approximately 57,000 square feet of surface area (57) and an "Advanced Grid" design for the tube supports, hence "57AG." The tubes are 0.750" in diameter with a nominal wall thickness of 0.043." All support structures are 409SS. Various descriptions and drawings follow.



Sequoyah Unit 1 Tubesheet

The tube sheet, as shown above, is a triangular pitch design with tubes designated by row and column. There are 103 rows and 125 columns in each leg of the four steam generators. The tubes are expanded full length of the tube sheet using a hydraulic expansion process. There are 13 blank spaces in each tubesheet for stay rods. The locations of these blanks are as follows:

Stay rod tube numbers					
	79-39	79-63	79-87		
	47-27	47-51	47-75	47-99	
15-15	15-33	15-51	15-75	15-93	15-111

Location of Stay Rods

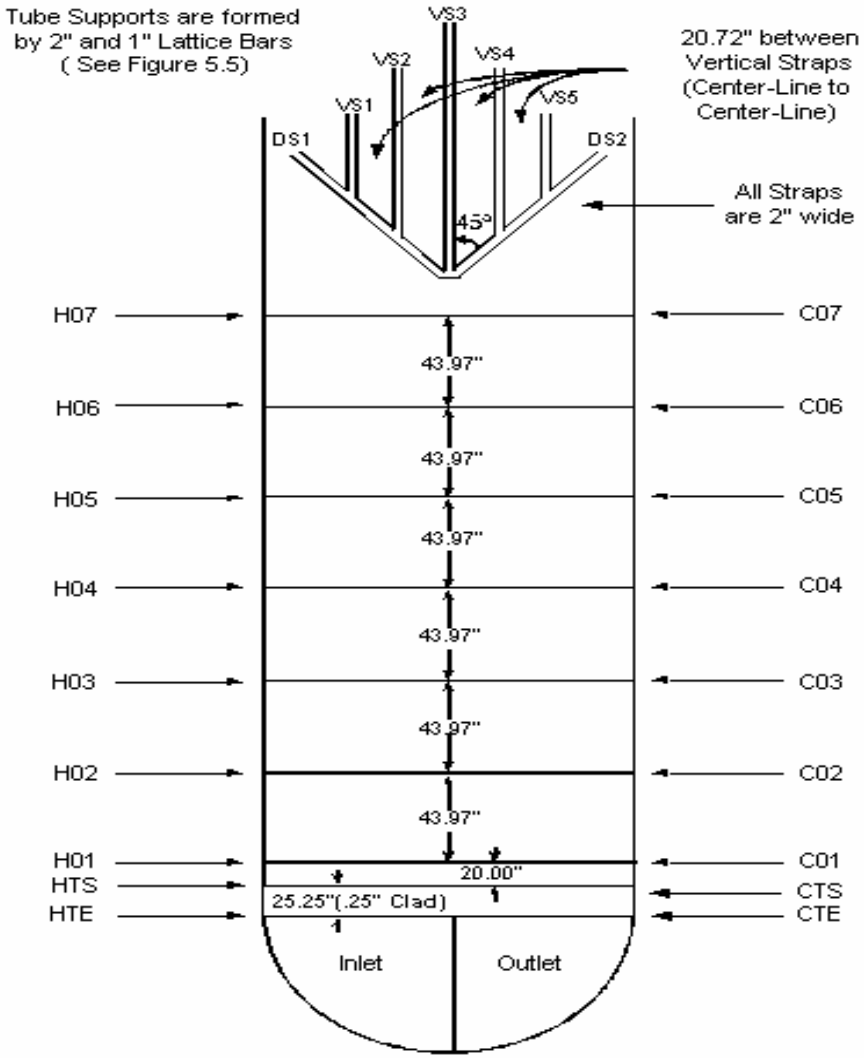
The Advanced Tube Support Grid (ATSG) structures are 409 stainless steel which is a ferritic stainless. Tubes will be even numbered row - even numbered column or odd numbered row – odd numbered column. Support structure measurements are provided in the following table while figures following illustrate a cross sectional view of the steam generator support structures and specific support nomenclature. Additional tables list all dimensional and design specifics relative to the support structures within the Sequoyah steam generators and give the u-bend support structures through

which the various tubes pass. In addition, lists of tube dimensions by row with respect tostraight and curved sections are provided. Finally, figures show drawings of the supports and Ventilated Support Bars (VSB). The tubes through and including row 16 were heat treated the entire length.

Sequoyah Support Structure Measurements

Location	Inches from TE	Center to Center
Tube End	0.0	
Top of Tubesheet	25.25	25.25
Center #1 TSP	45.25	20.0
Center #2 TSP	89.22	43.97
Center #3 TSP	133.19	43.97
Center #4 TSP	177.16	43.97
Center #5 TSP	221.13	43.97
Center #6 TSP	265.10	43.97
Center #7 TSP	309.07	43.97

Steam Generator Cross Section



Model 57AG

SEQUOYAH 1 DESIGN SPECIFICS

Tube-sheet Data:

Hole diameter	-	0.758
Pitch	-	1.0625
Thickness	-	25.25 (includes 0.25" clad)
Expansion process	-	Hydraulic (full expansion)

Tube Support Data:

Hole geometry	-	Lattice Grid
Lattice dimensions	-	0.765 minimum tube clearance
Width x thickness	-	2.00 & 1.00 x 0.145 (thick portion)
Material	-	409 SS

Ventilated Support Bar Data:

Lock Bar Shape	-	rectangular
Width x thickness	-	0.5 x 0.09
Straps Shape	-	rectangular
Width x thickness	-	2.0 x 0.16
Material	-	409 SS

Tube Data:

OD	-	0.750
ID	-	0.664

Wall thickness:

Nominal	-	0.043

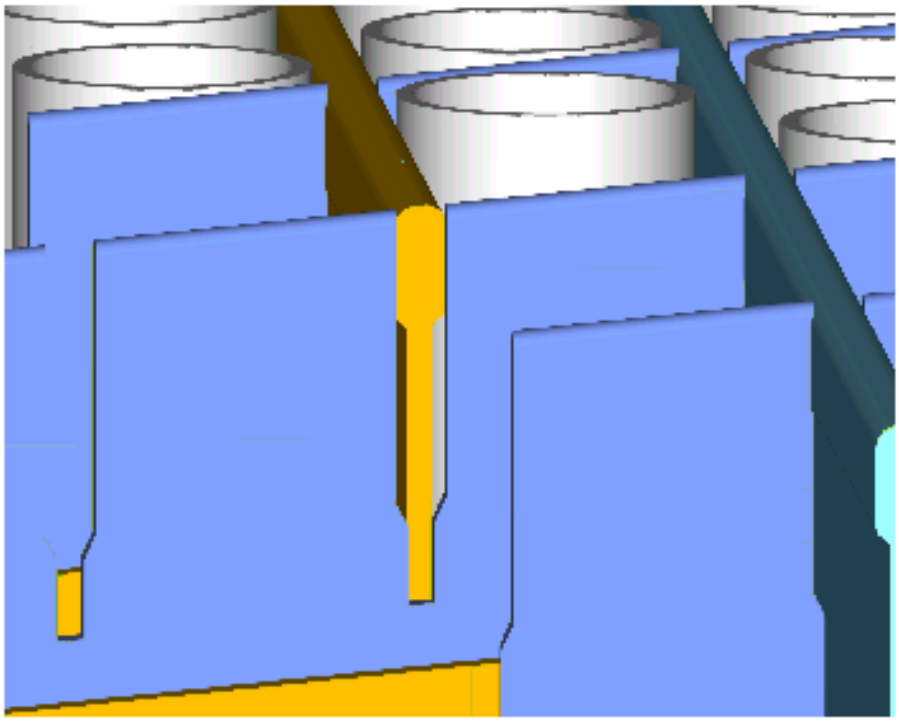
Number of tubes/SG - 4983

U-bend radius:

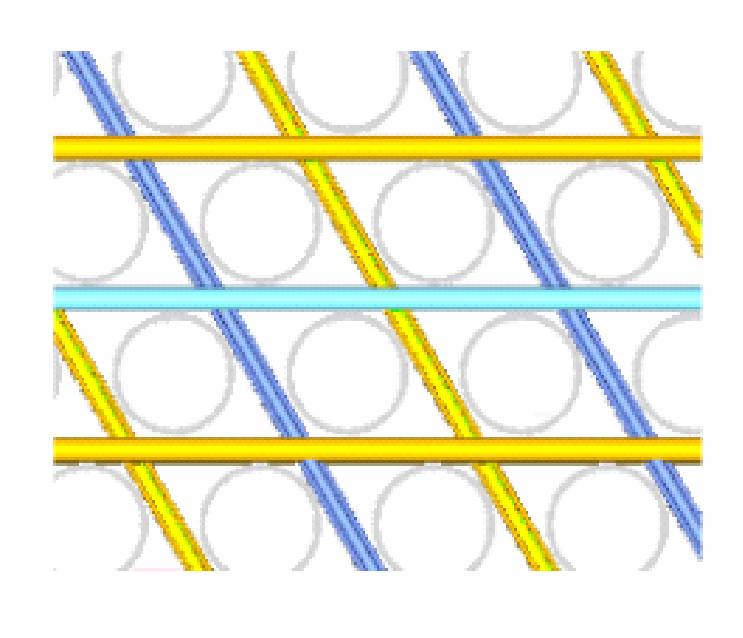
Maximum	-	57.375
Minimum	-	3.188

Rows	Structures Through Which the Tubes Pass						
1-36	DS1			VS3			DS2
37-75	DS1		VS2	VS3	VS4		DS2
76-103	DS1	VS1	VS2	VS3	VS4	VS5	DS2

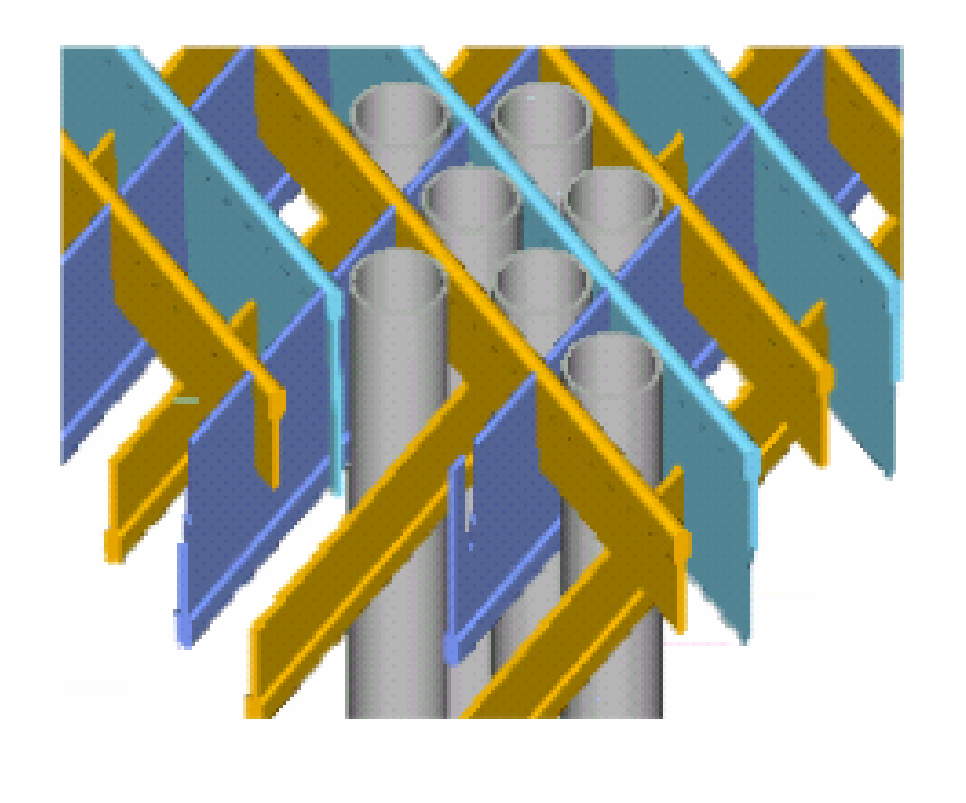
U-Bend Support Intersections



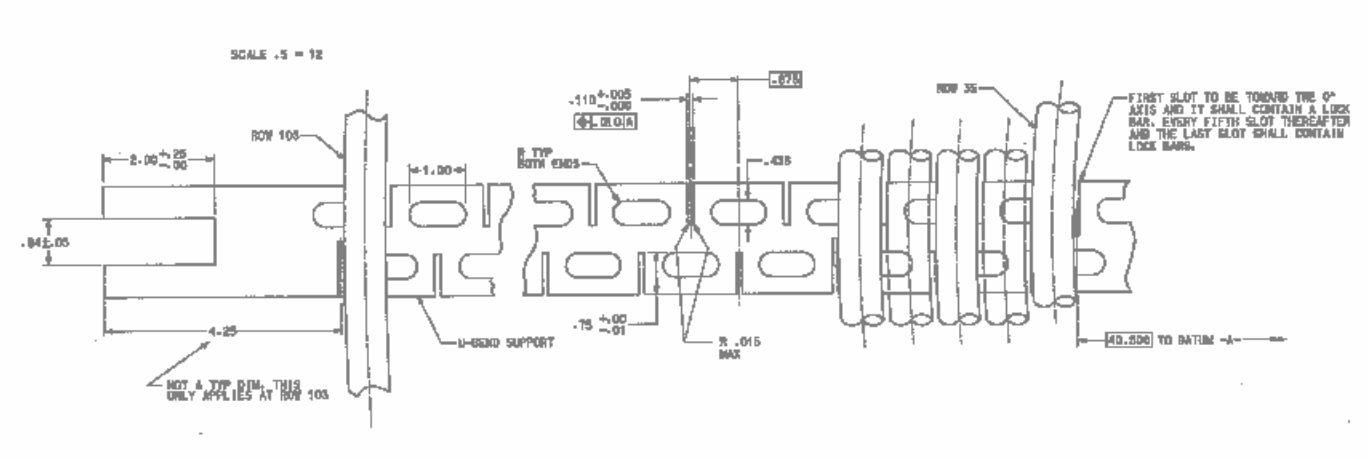
ATSG Lattice



ATSG Top View

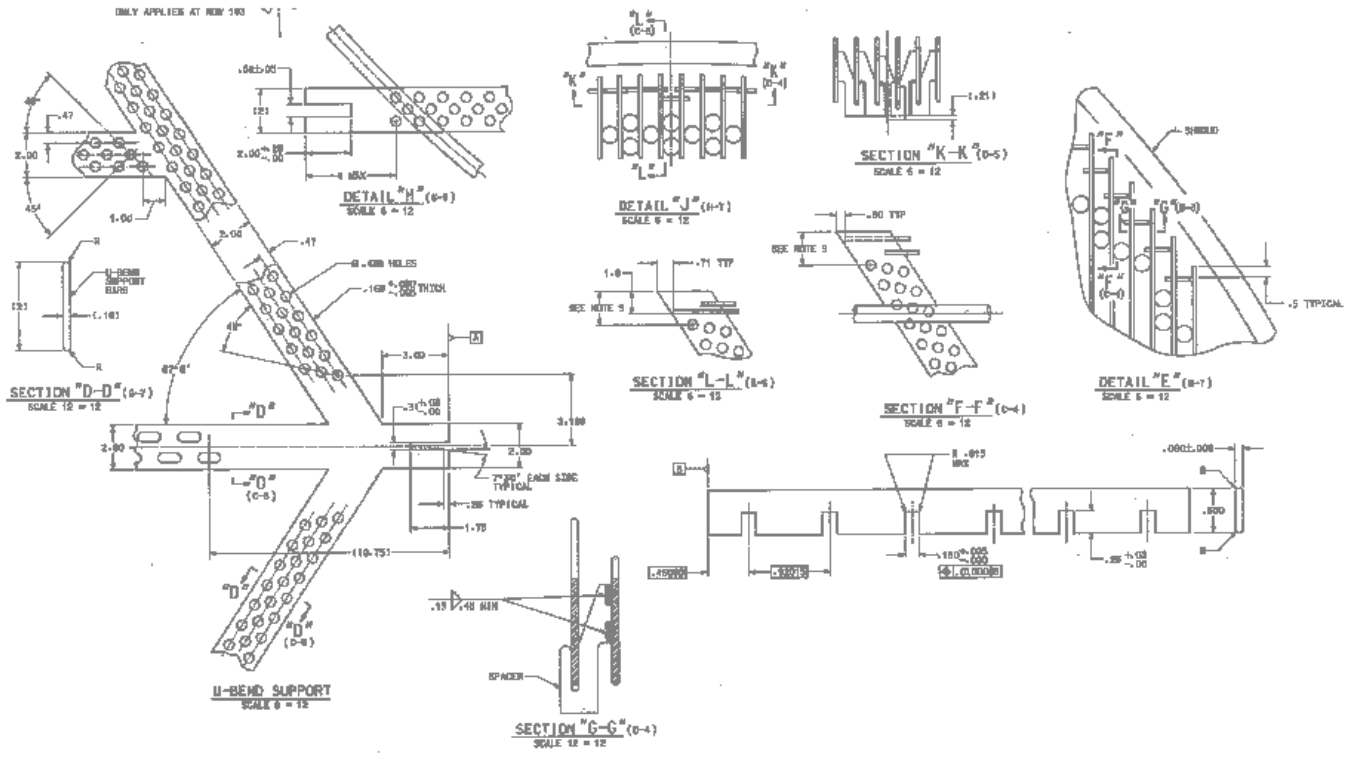


ATSG



U-Bend Support Strap

Ventilated Support Bar (VSB)



Bend Support Structures

Ventilated Support Bars (VSB)

Tube Dimensions by Row

103 rows x 125 columns

Tubes

Row	#	"A"	"B"	"C"	"D"	(Developed Length)	Row	#	"A"	"B"	"C"	"D"	(Developed Length)
1	61	6.37500	10.013830	322.26000	319.07250	648.15883	53	53	61.62500	96.800324	367.76000	336.94750	770.69532
2	62	7.43750	11.682798	323.13500	319.41625	650.51530	54	52	62.68750	98.469295	368.63500	337.29125	773.05179
3	63	8.50000	13.351769	324.01000	319.76000	652.87177	55	53	63.75000	100.138266	369.51000	337.63500	775.40827
4	62	9.56250	15.020740	324.88500	320.10375	655.22824	56	52	64.81250	101.807237	370.38500	337.97875	777.76474
5	63	10.62500	16.689711	325.76000	320.44750	657.58471	57	51	65.87500	103.476208	371.26000	338.32250	780.12121
6	62	11.68750	18.358682	326.63500	320.79125	659.94118	58	52	66.93750	105.145179	372.13500	338.66625	782.47768
7	63	12.75000	20.027653	327.51000	321.13500	662.29765	59	51	68.00000	106.814150	373.01000	339.01000	784.83415
8	62	13.81250	21.696624	328.38500	321.47875	664.65412	60	50	69.06250	108.483121	373.88500	339.35375	787.19062
9	63	14.87500	23.365595	329.26000	321.82250	667.01060	61	49	70.12500	110.152092	374.76000	339.69750	789.54709
10	62	15.93750	25.034566	330.13500	322.16625	669.36707	62	50	71.18750	111.821064	375.63500	340.04125	791.90356
11	63	17.00000	26.703538	331.01000	322.51000	671.72354	63	49	72.25000	113.490035	376.51000	340.38500	794.26003
12	62	18.06250	28.372509	331.88500	322.85375	674.08001	64	48	73.31250	115.159006	377.38500	340.72875	796.61651
13	61	19.12500	30.041480	332.76000	323.19750	676.43648	65	47	74.37500	116.827977	378.26000	341.07250	798.97298
14	62	20.18750	31.710451	333.63500	323.54125	678.79295	66	48	75.43750	118.496948	379.13500	341.41625	801.32945
15	55	21.25000	33.379422	334.51000	323.88500	681.14942	67	47	76.50000	120.165919	380.01000	341.76000	803.68592
16	62	22.31250	35.048393	335.38500	324.22875	683.50589	68	46	77.56250	121.834890	380.88500	342.10375	806.04239
17	61	23.37500	36.717364	336.26000	324.57250	685.86236	69	45	78.62500	123.503861	381.76000	342.44750	808.39886
18	62	24.43750	38.386335	337.13500	324.91625	688.21884	70	46	79.68750	125.172832	382.63500	342.79125	810.75533
19	61	25.50000	40.055306	338.01000	325.26000	690.57531	71	45	80.75000	126.841803	383.51000	343.13500	813.11180
20	62	26.56250	41.724277	338.88500	325.60375	692.93178	72	44	81.81250	128.510774	384.38500	343.47875	815.46827
21	61	27.62500	43.393249	339.76000	325.94750	695.28825	73	43	82.87500	130.179746	385.26000	343.82250	817.82475
22	60	28.68750	45.062220	340.63500	326.29125	697.64472	74	42	83.93750	131.848717	386.13500	344.16625	820.18122
23	61	29.75000	46.731191	341.51000	326.63500	700.00119	75	43	85.00000	133.517688	387.01000	344.51000	822.53769
24	60	30.81250	48.400162	342.38500	326.97875	702.35766	76	42	86.06250	135.186659	387.88500	344.85375	824.89416
25	61	31.87500	50.069133	343.26000	327.32250	704.71413	77	41	87.12500	136.855630	388.76000	345.19750	827.25063
26	60	32.93750	51.738104	344.13500	327.66625	707.07060	78	40	88.18750	138.524601	389.63500	345.54125	829.60710
27	59	34.00000	53.407075	345.01000	328.01000	709.42708	79	36	89.25000	140.193572	390.51000	345.88500	831.96357
28	60	35.06250	55.076046	345.88500	328.35375	711.78355	80	38	90.31250	141.862543	391.38500	346.22875	834.32004
29	59	36.12500	56.745017	346.76000	328.69750	714.14002	81	39	91.37500	143.531514	392.26000	346.57250	836.67651
30	60	37.18750	58.413988	347.63500	329.04125	716.49649	82	38	92.43750	145.200485	393.13500	346.91625	839.03299
31	59	38.25000	60.082959	348.51000	329.38500	718.85296	83	37	93.50000	146.869457	394.01000	347.26000	841.38946
32	58	39.31250	61.751931	349.38500	329.72875	721.20943	84	36	94.56250	148.538428	394.88500	347.60375	843.74593
33	59	40.37500	63.420902	350.26000	330.07250	723.56590	85	35	95.62500	150.207399	395.76000	347.94750	846.10240
34	58	41.43750	65.089873	351.13500	330.41625	725.92237	86	34	96.68750	151.876370	396.63500	348.29125	848.45887
35	59	42.50000	66.758844	352.01000	330.76000	728.27884	87	33	97.75000	153.545341	397.51000	348.63500	850.81534
36	58	43.56250	68.427815	352.88500	331.10375	730.63531	88	32	98.81250	155.214312	398.38500	348.97875	853.17181
37	57	44.62500	70.096786	353.76000	331.44750	732.99179	89	31	99.87500	156.883283	399.26000	349.32250	855.52828
38	58	45.68750	71.765757	354.63500	331.79125	735.34826	90	30	100.93750	158.552254	400.13500	349.66625	857.88475
39	57	46.75000	73.434728	355.51000	332.13500	737.70473	91	29	102.00000	160.221225	401.01000	350.01000	860.24123
40	58	47.81250	75.103699	356.38500	332.47875	740.06120	92	28	103.06250	161.890196	401.88500	350.35375	862.59770
41	57	48.87500	76.772670	357.26000	332.82250	742.41767	93	27	104.12500	163.559168	402.76000	350.69750	864.95417
42	56	49.93750	78.441642	358.13500	333.16625	744.77414	94	26	105.18750	165.228139	403.63500	351.04125	867.31064
43	57	51.00000	80.110613	359.01000	333.51000	747.13061	95	25	106.25000	166.897110	404.51000	351.38500	869.66711
44	56	52.06250	81.779584	359.88500	333.85375	749.48708	96	22	107.31250	168.566081	405.38500	351.72875	872.02358
45	55	53.12500	83.448555	360.76000	334.19750	751.84355	97	21	108.37500	170.235052	406.26000	352.07250	874.38005
46	56	54.18750	85.117526	361.63500	334.54125	754.20003	98	20	109.43750	171.904023	407.13500	352.41625	876.73652
47	51	55.25000	86.786497	362.51000	334.88500	756.55650	99	17	110.50000	173.572994	408.01000	352.76000	879.09299
48	54	56.31250	88.455468	363.38500	335.22875	758.91297	100	16	111.56250	175.241965	408.88500	353.10375	881.44947
49	55	57.37500	90.124439	364.26000	335.57250	761.26944	101	13	112.62500	176.910936	409.76000	353.44750	883.80594
50	54	58.43750	91.793410	365.13500	335.91625	763.62591	102	10	113.68750	178.579907	410.63500	353.79125	886.16241
51	53	59.50000	93.462381	366.01000	336.26000	765.98238	103	7	114.75000	180.248878	411.51000	354.13500	888.51888
52	54	60.56250	95.131353	366.88500	336.60375	768.33885