ATTACHMENT 1

OCONEE NUCLEAR STATION

UNIT 1

STEAM GENERATOR OPERATING HISTORY

OCONEE NUCLEAR STATION

UNIT 1

I. BASIC PLANT INFORMATION

Startup Date: July 15, 1973

Utility: Duke Power Company

Location: Seneca, South Carolina

Thermal Power Level: 2568 MWt

NSSS Supplier: Babcock and Wilcox (B & W)

Number of Loops: 2

Steam Generator Supplier, Model No., Type: B & W, 177 FA, Once Through Steam Generator (OTSG)

Number of tubes per Generator: 15,530

Tube Size, Material: Alloy 600; 0.625" OD; 0.557" ID

II. STEAM GENERATOR OPERATING CONDITIONS

Normal Operation

Inlet Temperature: 602.8°F

Primary Pressure: 2200 psi

Secondary Pressure: 925 psi

Allowed Leak Rate: 0.3 gpm

Primary Flow Rate: 65.66×10^{6} lb/hr

Accidents

Design Basis LOCA; Maximum Delta-P: 925 psi

Main Steam Line Break; Maximum Delta-P: 2200 psi

III. STEAM GENERATOR SUPPORT PLATE INFORMATION

Material: SA 212 B Carbon Steel

Design Type: Broached

Design Code: ASME III (through 1967)

Dimensions: 58.7" R, thickness 1.5"

Steam Flow Rate: 5.3×10^{6} lb/hr

Tube Dimensions: 5/8" D x .034" wall (nominal)

IV. STEAM GENERATOR BLOWDOWN INFORMATION

Oconee Nuclear Station's Once Through Steam Generators (OTSG) are not designed to perform normal blowdowns. There is no operational requirement to perform normal blowdowns. The steam generator sample line, however, can provide a limited blowdown capability of 1 GPM during power operation.

V. WATER CHEMISTRY SPECIFICATIONS

A. Feedwater (Normal Power Operation)

Total Solids	10 ppb (max)
Cation Conductivity	0.5 μmho/cm (max)
Dissolved Oxygen as O_2	7 ppb (max)
Hydrazine as N_2H_4	1-25 ppb
Silica as SiO_2	20 ppb (max)
Total Iron as Fe	10 ppb (max)
Total Copper as Cu	2 ppb (max)
pH @ 77°F	9.3-9.6
Lead as Pb	1 ppb (max)

Feedwater (Startup*)

Total Iron as Fe	100 ppb (max)
Cation Conductivity	1.0 μmho/cm (max)
Dissolved Oxygen as O_2	100 ppb (max)
Hydrazine	300% of stoichiometric O_2

*Established prior to feeding OTSGs.

B. OTSG Water (Less Than 10% Steaming)

pH	9.0-10.5
Cation Conductivity	10 μmho/cm (max)
Chloride	1.0 ppm (max)
Sodium	2.0 ppm (max)

OTSG Water (Layup)

Ammonia as NH_3	10 ppm (nominal)
	2 ppm-20 ppm range
ph @ 77°F	9.5-10.5
Hydrazine	200 ppm initial
	50 ppm (min)
Sodium	1.0 ppm (max)
Cation Conductivity	10 μmho/cm (max)

C. Condenser Cooling Water

Condenser Cooling Water is obtained from Lake Keowee. There are no demineralizers or cooling towers installed. The following is a table of representative chemistry values:

Calcium	2.2 ppm
Magnesium	0.7 ppm
Sodium	1.7 ppm
Potassium	0.9 ppm
Bicarbonate Alkalinity	13.6 ppm
Sulfates	1.1 ppm
Chlorides	0.6 ppm
Phosphates	<0.2 ppm
Nitrates	0.1 ppm
Free Carbon Dioxide	11.0 ppm
Silica	6.1 ppm
Total Iron	0.05 ppm
Manganese	0.12 ppm
pH	6.5-7.0

VI. TURBINE STOP VALVE TESTING

Turbine Stop Valve Testing had been performed on a daily basis from initial startup until February 1974, when weekly testing was initiated. In July 1975, the testing frequency was returned to a daily basis for stop valves and weekly for the control valves. In March 1977 when it appeared that stop valve testing might possibly contribute to steam generator tube failure, the frequency was changed back to monthly.

Frequency

Actual: Monthly (maximum time between tests is 6 weeks)

Recommended: Daily (turbine vendor)

Monthly (steam generator vendor)

Power Level

Actual: 65 percent full power, or

94 percent full power if power reduction not desirable

Recommended: 65 percent full power (steam generator vendor)

No recommendation (turbine vendor)

Testing Procedures

Actual: Stroke Length - full - 8.5 inches

- to trip - 8.0 inches

Stroke Rate - open to closed - 13 sec.

- closed to open - 27 sec.

Recommended: same as actual

VII. STEAM GENERATOR TUBE DEGRADATION HISTORY

INSERVICE INSPECTION RESULTS

A. November 1974

Initial Refueling Inservice Inspection

OTSG 1A:

Number of tubes inspected: 573 (3.69%)

Number of tubes plugged prior to this ISI: 40 (.26%)

Number of tubes plugged this ISI: 0

Eddy-current Exam Results: No evidence of degradation in excess of 20%.

OTSG 1B:

Number of tubes inspected: 493 (3.17%)

Number of tubes plugged prior to this ISI: 33 (.21%)

Number of tubes plugged this ISI: 0

Metallurgical Exam Results: No evidence of degradation in excess of 20%.

B. March 1976 - 293 Effective Full Power Days (EFPD) since last refueling inspection

OTSG 1A

Number of tubes inspected: 469 (3.02%)

Number of tubes plugged prior to this ISI: 40 (.26%)

Number of tubes plugged this ISI: 0

Eddy-current Exam Results: No evidence of degradation in excess of 20%.

OTSG 1B

Number of tubes inspected: 495 (3.19%)

Number of tubes plugged prior to this ISI: 33 (.21%)

Number of tubes plugged this ISI: 0

Eddy-current Exam Results: No evidence of degradation in excess of 20%.

C. August 1977 - 308 EFPD since last refueling inspection

OTSG 1A

Number of tubes inspected: 2500 (16.10%)

Number of tubes plugged prior to this ISI: 42 (.27%)

Number of tubes plugged this ISI: 5 (.03%)

Eddy-current Exam Results: All 5 tubes were in periphery region and exceeded degradation limits. All five tubes showed corrosion/erosion type degradation with a maximum wall thinning of 60%. The defect area was at the 14th support plate. The tubes were 7-4, 8-5, 117-107, 146-14, and 147-11.

OTSG 1B

Number of tubes inspected: 5004 (32.22%)

Number of tubes plugged prior to this ISI: 53 (.34%)

Number of tubes plugged this ISI: 37 (.24%)

Eddy-current Exam Results: All tubes were in the periphery region. All tubes plugged showed localized OD degradation with a maximum wall thinning of almost 100%. The defect area was at the 14th support plate except as noted:

88-122 (9th)	8-49	100-124
75-121 (12th)	60-114 (12th)	101-120
76-122 (12th)	100-122 (13th)	101-122
43-108	75-113	62-11
41-110	9-51 (12th)	61-12
16-71	8-48	7-32 (between 12th-13th)
37-4	76-111	7-53 (11th)
60-127	83-117	133-56 (11th)
61-123	99-125	51-123
17-79 (13th)		

Tubes 43-108 and 83-117 were removed for further study.

Tubes 69-128 and 69-132 were mistakenly plugged. Plugs should have been inserted in tubes 68-127 and 68-131, respectively.

Tube 17-79 was correctly plugged at the UTS, but the LTS plug was mistakenly inserted in tube 15-75. Tube 133-56 was correctly plugged at the LTS, but the UTS plug was mistakenly inserted in tube 132-55.

Tubes 79-2, 133-57, 22-92, and 138-68 were plugged for reasons other than exceeding the degradation limit. The LTS plug for tube 22-92 was mistakenly inserted in tube 21-89.

D. August 1978 - 246 EFPD since last refueling inspection

OTSG 1A

Number of tubes inspected: 1380 (8.89%)

Number of tubes plugged prior to this ISI: 47 (.30%)

Number of tubes plugged this ISI: 3 (.02%)

Eddy-current Exam Results: All three tubes were in the periphery region and exceeded degradation limits. All three tubes showed localized OD degradation with a maximum wall thinning of 65%. The three tubes and their respective defect areas were: 75-9 at the 15th support plate, and 6-3 and 9-7 at the 14th support plate.

OTSG 1B

Number of tubes inspected: 1121 (7.22%)

Number of tubes plugged prior to this ISI: 95 (.66%)

Number of tubes plugged this ISI: 36 (.23%)

Eddy-current Exam Results: All tubes were in the periphery region. Twenty-four tubes showed localized OD degradation with a maximum wall thinning of 75%. The defect area is as noted:

6-32 (14th SP)	55-125 (14th SP)	90-129 (11th SP)
6-51 (14th SP)	64-125 (14th SP)	93-119 (10th SP)

7-1 (14th SP)	69-2 (13th SP)	98-125 (14th SP)
8-45 (14th SP)	85-126 (14th SP)	101-121 (13th SP)
12-68 (13th SP)	85-127 (14th SP)	112-6 (13th SP)
53-125 (12th SP)	86-127 (14th SP)	113-112 (14th SP)
54-2 (11th SP)	89-125 (12th SP)	143-6 (7th SP)
55-124 (14th SP)	90-124 (14th SP)	150-16 (7th SP)

Tube 77-18 and 85-127 were removed for study.

Tubes 56-126, 66-127, 85-125, and 151-11 were mistakenly plugged.

Tubes 7-2, 72-68, 77-18, and 115-110 were plugged for reasons other than exceeding degration limit.

Tubes 61-89, 68-127, 68-131, and 73-129 were plugged to correct errors made previously.

Plugging of tubes 15-75, 17-79, 21-89, 22-92, 96-4, 101-4, 132-55, and 133-56, which were previously plugged at only one end, was completed.

REGION IDENTIFICATION

Region	# Tubes Within Region
Periphery of Bundle (1)	6806 (43.82%)
Tube Lane (2)	636 (4.09%)
Interior	8088 (52.08%)
Total	15,530

Allowed wall thinning before plugging = 40%

(1) Defined as tubes outside a 12 sided polygon connecting support rod positions (~20 rows)

(2) Within 5 rows of open tube lane

VIII. ABNORMAL OPERATIONAL EVENTS

A. October 31, 1976 RO-269/76-17 OTSG 1A

Number of tubes leaking 1

Number of additional tubes inspected 15

Total number of tubes plugged/removed 2

Summary

a) Tube 77-17 plugged due to leakage at UTS

b) Tube 77-18 also plugged

B. December 8, 1976 RO-269/76-19 OTSG 1B

Number of tubes leaking 2

Number of additional tubes inspected 139

Total number of tubes plugged/removed 4

Summary

a) 114-109 plugged due to leakage at 14th support plate (SP); 75-18 plugged due to leakage at UTS

b) Tubes 113-110 and 107-115 also plugged

C. January 15, 1977 RO-269/77-2 OTSG 1B

Number of tubes leaking 1

Number of additional tubes inspected 140

Number of tubes plugged/removed 2

Summary

a) Tube 75-12 plugged due to crack at UTS

b) Tube 81-128 also plugged

D. February 28, 1977 RO-269/77-8 OTSG 1B

Number of tubes leaking 2

Number of additional tubes inspected 490

Number of tubes plugged/removed 7

Summary

a) Tube 32-13 plugged due to leakage at 14th SP; tube 77-25 plugged due to leakage at UTS, removed for further study

b) Tubes 33-14, 2-7, 2-8 also plugged

c) Tube 101-4 plugged at LTS only; UTS plug mistakenly placed in 96-4

E. March 22, 1977 RO-269/77-11 OTSG 1B

Number of tubes leaking 1

Number of additional tubes inspected 100

Number of tubes plugged/removed 5

Summary

a) Tube 77-22 plugged due to crack at 15th SP

b) Tubes 77-3, 77-5, 77-8, and 77-29 also plugged

F. May 7, 1977 RO-269/77-16 OTSG 1B

Number of tubes leaking 1

Number of additional tubes inspected 507

Number of tubes plugged/removed 2

Summary

a) Tube 77-15 identified as leaking at crack 1/4" below UTS

b) Tube 17-5 also plugged

c) Tube 75-18 removed (plugged previously)

G. April 27, 1978 RO-269/78-13 OTSG 1B

Number of tubes leaking 2

Number of additional tubes inspected 481

Number of tubes plugged/removed 5

Summary

a) Tube 74-2 plugged due to leakage at UTS; tube 69-1 plugged due to tube-to-tubesheet leakage at the LTS

b) Tubes 59-1 and 70-1 plugged as precautionary measure

c) Tube 77-27 plugged after unsuccessful extraction attempt

IX. CONDENSER INFORMATION

As stated earlier in Section V of this report, water from Lake Keowee is used to provide condenser cooling. Condenser tubes are made of 304 Stainless Steel. During operation, tube leakage is detected by secondary chemistry analysis for silica; a maximum of 20 ppb is allowed. A search for a tube leak occurs whenever the silica concentration in the secondary begins to increase.

Condenser tube leakage:

Date	Remarks
November 1974	2 tubes plugged

X. RADIATION EXPOSURE WITH RESPECT TO STEAM GENERATORS

Date	OTSG	Dose (Exam & Repair) [1]	Comment:
11/74	1A & 1B	44	First Refueling ISI
3/76	1A & 1B	28.3	Second Refueling ISI
10/76	1A	22	OTSG 1A leak
12/76	1B	25	OTSG 1B leak
1/77	1B	18.7	OTSG 1B leak
2/77	1B	25.4	OTSG 1B leak
5/77	1B	18	OTSG 1B leak
8/77	1A & 1B	25.7 (exam) 20.4 (repair)	Third Refueling ISI
4/78	1B	51.7	OTSG 1B leak
8/78	1A & 1B	276.4	Fourth Refueling ISI
Total	1A & 1B	555.6	

(1) Dose in man-rem; testing and repair were not always separable.

XI. DEFECT GROWTH

OTSG 1A

Tube Number	% Through Wall Indication 9/77 ISI	9/78 ISI	Growth
4-14	25	40	15
72-128	30	25	--
75-21	20	20	0
75-26	20	20	0
78-22	20	30	10

Type of Degradation: Corrosion/erosion at 14th SP, tube 4-14; wear, tube 78-22.

Two tubes which were inspected at the 9/77 ISI and which exceeded degradation limits at the 9/78 ISI were plugged. They exhibited an average degradation growth of approximately 30%.

OTSG 1B

Tube Number	% Through Wall Indication 9/77 ISI	9/78 ISI	Growth
7-54	15	20	5
9-53	10	35	25
12-68	28	38	10
22-90	13	40	27
44-109	25	40	15
90-125	20	35	15
92-117	25	40	15
5-38	0	20	20

OTSG 1B (cont'd)

Tube Number	% Through Wall Indication 9/77 ISI	9/78 ISI	Growth
6-43	15	25	10
12-9	20	20	0
17-80	18	20	2
18-85	20	20	0
26-6	20	40	20
35-91	20	20	0
58-122	0	23	23
61-110	33	40	7
64-129	0	33	33
73-130	0	25	25
74-8	20	30	10
75-10	0	38	38
75-21	10	10	0
76-119	10	10	0
90-124	15	33	18
91-126	10	33	23
110-111	18	20	2
143-5	20	28	8
Average			13.5

The degradation data presented for OTSG 1B is the result of an independent review of the eddy-current readings, and may not reflect the data presented in the ISI report in all cases. It is considered to be the best data available.

Twenty-two tubes which were inspected at the 9/77 ISI and which exceeded degradation limits at the 9/78 ISI were plugged. They exhibited an average degradation growth of approximately 32%.

Type of Degradation: Corrosion/erosion at the 14th support plate

EFP Days between 9/77 ISI and 9/78 ISI: 246.

ATTACHMENT 2

OCONEE NUCLEAR STATION

UNIT 2

STEAM GENERATOR OPERATING HISTORY

OCONEE NUCLEAR STATION

UNIT 2

I. BASIC PLANT INFORMATION

Startup Date: September 9, 1974

Utility: Duke Power Company

Location: Seneca, South Carolina

Thermal Power: 2568 MWt

NSSS Supplier: Babcock and Wilcox (B & W)

Number of Loops: 2

Steam Generator Supplier, Model No., Type: B & W, 177 FA, Once Through Steam Generator (OTSG)

Number of tubes per Generator: 15,530

Tube Size, Material: Alloy 600; 0.625" OD; 0.557" ID

II. STEAM GENERATOR OPERATING CONDITIONS

Normal Operation

Inlet Temperature: 602.8°F

Primary Flow Rate: 65.66×10^{6} lb/hr

Primary Pressure: 2200 psi

Secondary Pressure: 925 psi

Allowed Leak Rate: 1 gpm

Accidents

Design Basis LOCA; Maximum Delta-P: 925 psi

Main Steam Line Break; Maximum Delta-P: 2200 psi

III. STEAM GENERATOR SUPPORT PLATE INFORMATION

Material: SA 212 B Carbon Steel

Design Type: Broached

Design Code: ASME III (thru 1967)

Dimensions: 58.7"R, thickness 1.5"

Steam Flow Rate: 5.3×10^6 lb/hr

Tube Dimensions: 5/8" D x .034" wall (nominal)

IV. STEAM GENERATOR BLOWDOWN INFORMATION

Oconee Nuclear Station's Once Through Steam Generators (OTSG) are not designed to perform normal blowdowns. There is no operational requirement to perform normal blowdowns. The steam generator sample line, however, can provide a limited blowdown capability of 1 GPM during power operation.

V. WATER CHEMISTRY SPECIFICATIONS

Water chemistry specifications for Unit 2 are the same as Unit 1, and are contained in Attachment 1, Section V.

VI. TURBINE STOP VALVE TESTING

Turbine stop valve testing procedures for Unit 2 are the same as those for Unit 1 and are contained in Attachment 1, Section VI.

VII. STEAM GENERATOR DEGRADATION HISTORY

A. April 1976 - Initial Refueling Inspection

OTSG 2A

Number of tubes inspected: 479 (3.08%)

Number of tubes plugged prior to this ISI: 3 (.02%)

Number of tubes plugged this ISI: 0

Eddy-current Exam Results: No evidence of degradation in excess of 20%.

OTSG 2B

Number of tubes inspected: 476 (3.07%)

Number of tubes plugged prior to this ISI: 5 (.03%)

Number of tubes plugged this ISI: 0

Eddy-current Exam Results: No evidence of degradation in excess of 20%

B. August 1977 - 277 EFPD since last refueling inspection

OTSG 2A

Number of tubes inspected: 506 (3.26%)

Number of tubes plugged prior to this ISI: 3 (.02%)

Number of tubes plugged this ISI: 0

Eddy-current Exam Results: No evidence of degradation in excess of 20%

OTSG 2B

Number of tubes inspected: 987 (6.36%)

Number of tubes plugged prior to this ISI: 8 (.05%)

Number of tubes plugged this ISI: 4 (.03%)

Eddy-current Exam Results: Three tubes plugged were in the lane region and one in the interior. Maximum degradation was in excess of 40%. All were degraded at the 15th SP except the interior tube, which was at the 12th SP.

The plugged tubes were: 75-5 Lane
75-9 Lane
78-2 Lane
112-29 Interior

C. October 1978 - 289 EFPD since last refueling inspection

OTSG 2A

Number of tubes inspected: 1336 (8.60%)

Number of tubes plugged prior to this ISI: 3 (.02%)

Number of tubes plugged this ISI: 0

Eddy-current Exam Results: Eight tubes showed degradation in excess of 20%, with a maximum through wall indication of 35%.

OTSG 2B

Number of tubes inspected: 1310 (8.44%)

Number of tubes plugged prior to this ISI: 19 (0.05%)

Number of tubes plugged this ISI: 0

Eddy-current Exam Results: Eight tubes showed degradation in excess of 20%, with a maximum through wall indication of 35%.

REGION IDENTIFICATION

Region	# Tubes with Region
Periphery of Bundle (1)	6806 (43.82%)
Tube Lane (2)	636 (4.09%)
Interior	8088 (52.08%)
Total	15,530

Allowed wall thinning before plugging = 40%

(1) Define as tubes outside a 12 sided polygon connecting support rod positions (~20 rows)

(2) Within 5 rows of open tube lane.

VIII. ABNORMAL OPERATIONAL EVENTS

A. December 4, 1976 RO-270/76-15 OTSG 2B

Number of tubes leaking	1
Number of additional tubes inspected	133
Number of tubes plugged/removed	3

Summary

a) Tube 77-23 plugged due to leakage at upper tube sheet

b) Tubes 77-27 and 124-42 also plugged

c) Tubes 77-23 and 77-27 were removed

B. October 7, 1977 RO-270/77-12 OTSG 2B

Number of tubes leaking	1
Number of tubes plugged/removed	7

Summary

a) Tube 77-25 plugged due to leakage at upper tube sheet

b) Tubes also plugged: 75-21, 77-4, 77-18, 77-19, 77-21, 78-4

c) All previously plugged tubes were replugged as an added precaution

IX. CONDENSER INFORMATION

As stated earlier in Section V of this report, water from Lake Keowee is used to provide condenser cooling. Condenser tubes are made of 304 Stainless Steel. During operation, tube leakage is detected by secondary chemistry analysis for silica; a maximum of 20 ppb is allowed. A search for a tube leak occurs whenever the silica concentration in the secondary begins to increase.

Condenser tube leakage:

Date	Remarks
January 1975	2 tubes plugged

X. RADIATION EXPOSURE WITH RESPECT TO STEAM GENERATORS

Date	Generator	Dose (Exam & Repair)(1)	Comments
4/76	A & B	2.1	First Refueling ISI
12/76	B	25	OTSG B leak
8/77	A & B	13.5 (exam)	Second Refueling ISI
		36.5 (repair)	SOAK (2) Instrumentation insertion and OTSG repair
10/77	B	18 (exam)	OTSG B leak
1/78	B	11.5	OTSG B leak and SOAK removal
10/78	A & B	23.0	Third Refueling ISI
Total	A & B	129.6	

(1) Dose in man-rem; examination and repair dosages could not always be separated.

(2) SOAK (Second-of-a-Kind) Flow-vibration instrumentation added for additional information on possible causes of OTSG leakage.

XI. DEFECT GROWTH

OTSG 2A

There are no tubes with a degradation history in Steam Generator 2A.

OTSG 2B

		% through wall indication	
Tube Number	Location	8/77 ISI	10/78 ISI
75-14	15th S.P.	20	30
75-39	3 - 4th S.P.	30	30

Type of Degradation: Wear (for tube 75-14)

EFP Days between 8/77 ISI and 10/78 ISI: 289