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 TUCKER, H. B. Duke Power Co.
 RECIP. NAME RECIPIENT AFFILIATION
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SUBJECT: Forwards completed questionnaires providing info re util experience w/erosion corrosion in feedwater pipes, piping design & condensate chemistry per NRC 870717 request.

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DUKE POWER COMPANY

P.O. BOX 33189

CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

September 17, 1987

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

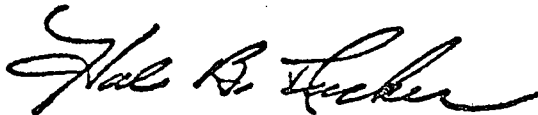
Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

Attached are completed questionnaires providing information regarding Duke Power Company's experience with erosion/corrosion in feedwater pipes, piping design and condensate chemistry at Oconee Nuclear Station. This information is provided in response to the NRC request dated July 17, 1987.

Please note that by a letter dated September 14, 1987 Duke Power Company, in response to NRC Bulletin 87-01, provided information regarding programs for monitoring the thickness of pipe walls in high energy single-phase and two-phase carbon steel piping systems. The information in Duke's response to Bulletin 87-01 was prepared in parallel to and complements the information provided in the attached questionnaires.

Very truly yours,



Hal B. Tucker

MAH/75/sbn

Attachment

xc: Dr. J. Nelson Grace, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Mr. J. C. Bryant
NRC Resident Inspector
Oconee Nuclear Station

Ms. Helen Pastis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

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Attachment

Duke Power Company
Oconee Nuclear Station

PWR EROSION/CORROSION QUESTIONNAIRE

PWR EROSION-CORROSION QUESTIONNAIRE
(Check or Circle All Applicable)

ENCLOSURE

Utility Company: Duke Power Company Unit Name: Unit #1 MWe 860

Filled by: A.W. Neely, N.S. Williams, D.A. Smith Date: 9/8/87 Phone No. (704)-373-3103

In service: 19 73. Water Treatment: AVT with ammonia, morpholine, hydrazine.
COMMERCIAL - 7/73

Condensate polishers: none, cation, powdex mixed bed; ...% of feedwater flow; installed 19 73; operated in: H-OH, NH4-OH Form

Cooling water: Fresh, salt, brackish, cooling tower.

Copper alloy condenser tubing: yes, no Copper alloy FW heater tubes: LP, HP, none

Boric acid used since: 19 ...; during: operation, layup, low load soaks, other. N/A

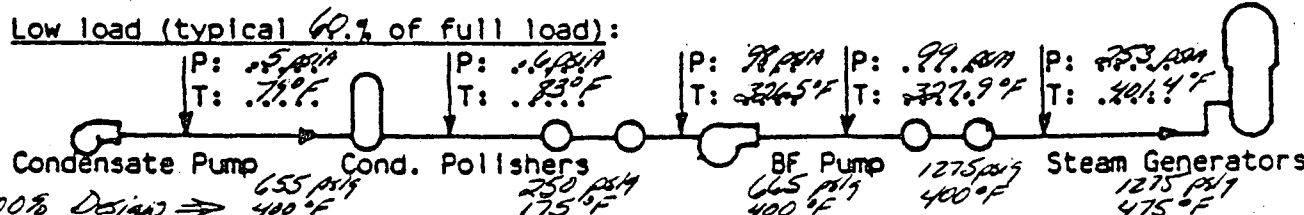
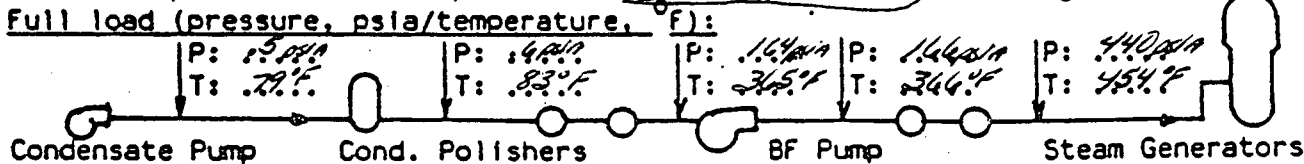
* 1973-79 - ~56%
1979-84 - ~60%
1984 - present - ~64%

A. EROSION-CORROSION EXPERIENCE

- Erosion-Corrosion identified in wet steam piping: yes no.
- Erosion-Corrosion of MSR Chevrons or mesh: yes no.
Chevron material: stainless steel, carbon steel, other
- Erosion-Corrosion of feedwater piping: yes, no. Date found ... N/A
- Erosion-Corrosion of: N/A elbows, ... Ts, ... diffusers, ...: reducers, ... valves, ... orifices, ... other components (specify).....
- Erosion-Corrosion of J-Tubes: yes no N/A
- Erosion-Corrosion of feedwater distribution ring: yes, no
- Erosion-Corrosion of turbine: HP, LP; Identify components: BLADES.....
- Erosion-Corrosion of other cycle components (identify)
- Feedwater temperature range where erosion-corrosion found: from N/A to°F
- Inspection frequency for feedwater piping 1 year years. Steam lines 1 year years.
- Inspection methods used: ultrasonic thickness, radiography, visual, other.....

B. PIPING DESIGN

- Maximum feedwater flow velocity ... 18.3 feet/second.
- No. of feed pumps operating at 100% load ... 2 ..., second pump On at 50 % load.
- Maximum flow velocity when only 1 pump is operating ... 7.683 feet/second.
- No. of feedwater piping components: 232... elbows, ... 65 Ts, ... 4... diffusers, ... 20... reducers, ... 27... valves, orifices, other components (specify)
- Maximum flow velocity in wet steam piping feet/second.
- Feedwater pressures and temperatures (actual (preferred) or design):



100% Design => 655 psia / 400°F
250 psia / 175°F
665 psia / 400°F
1275 psia / 475°F

Please attach copies of the heat balance diagrams for your actual full load and typical low load.

C. FEEDWATER AND CONDENSATE CHEMISTRY

1. Please complete the attached Table.
2. Feedwater chemistry history (average or typical values, final feedwater):

Year of oper.:	1st	1974	1976	1978	1980	1982	1983	1985	1986	1987
pH of FW	maximum	9.8	9.8	9.6	9.6	9.7	9.7	9.6	9.7	9.6
	minimum	9.1	9.1	9.1	9.1	8.5	9.1	8.9	8.9	9.2
	average	9.5	9.5	9.3	9.3	9.5	9.4	9.4	9.4	9.5
pH of condensate	maximum	9.6	9.6	9.6	9.6	9.7	9.7	9.7	9.6	9.6
	minimum	8.8	8.8	8.8	8.8	8.5	9.2	8.9	8.8	9.2
	average	9.3	9.3	9.3	9.3	9.5	9.5	9.4	9.4	9.5
DO, ppb	maximum	10	10	10	10	5.6	6.8	20	20	19.8
	minimum	2	2	2	2	0.6	0.5	0.2	0.5	0.3
	average	5.6	5.6	5.6	5.6	5.6	2.8	2.7	2.7	2.0
Cat. Cond. uS/cm	4	0.4	0.3	0.3	0.18	0.14	0.11	0.11	0.11	0.09
Spec. Cond. uS/cm	-	-	-	-	-	-	-	-	-	-
NH ₃ , ppb	-	-	-	-	-	-	-	-	-	-
N ₂ H ₄ , ppb	10	10	25	25	34	58	103	105	103	103
Boron, ppb	-	-	-	-	-	-	-	-	-	-
Air Inleakage, SCFM	72	72	72	60	25	14	9	8	8	9

Please send any water chemistry summary reports and data.

3. Chemical additions

- * 3.1 Ammonia: typical concentration in feedwater ~800 ppb; added at ... N/A ...
- 3.2 Hydrazine: typical concentration in feedwater ~125 ppb; added at *condensate*
- 3.3 Boric acid: typical concentration in feedwater N/A ppb as B; *demineralize*
added at ... N/A ... *effluent*

* Based on pH of Feedwater. Ammonia concentration

D. MATERIALS is controlled via hydrazine decomposition.

1. Feedwater piping - list ASTM or other specification numbers *A-106, Gr. B, A-234 WPB*
2. Wet steam piping: *A-106, Gr. B, A-234 WPB, A-105, A403/WR304, A 312/TP304*
3. Attach results of chemical analysis by you or pipe vendors.

PWR EROSION-CORROSION QUESTIONNAIRE
(Check or Circle All Applicable)

ENCLOSURE

Utility Company: Duke Power Company Unit Name: Oliver #2 MWe 860

Filled by: M.W. Kelly, N.S. Williams, D.A. Smith Date: 9/9/87 Phone No. (204)-373-3103

In service: 19 74. Water Treatment: AVT with ammonia, morpholine, hydrazine.
Commercial 9/74

Condensate polishers: none, cation, powdex, mixed bed; ..% of feedwater flow;
installed 19 74; operated in: H-OH, NH4-OH Form. *1974-79 - 56%*

Cooling water: fresh salt, brackish, cooling tower. *1979-82 - 60%*

Copper alloy condenser tubing: yes, no Copper alloy FW heater tubes: LP, HP, none *1982 - 64%*

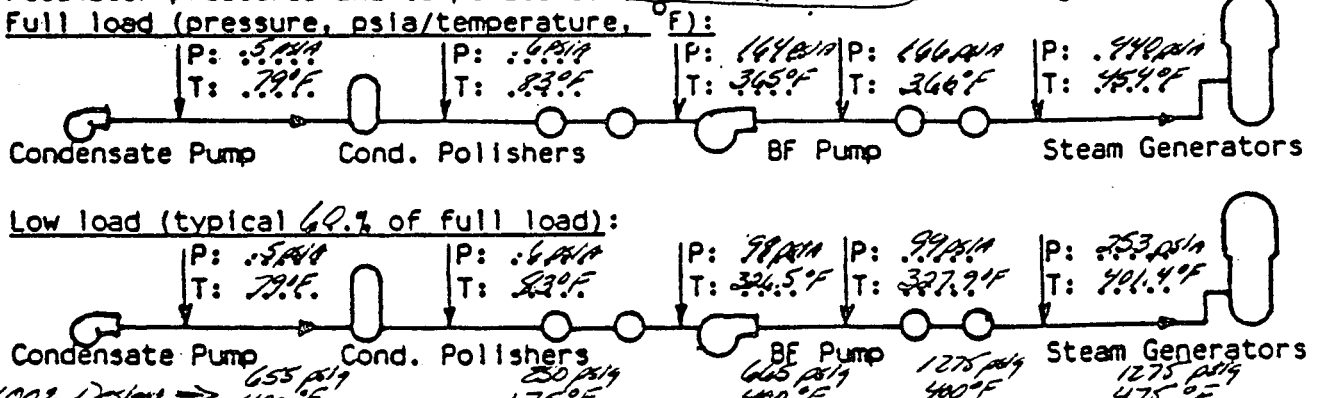
Boric acid used since: 19 ..; during: operation, layup, low load soaks, other. N/A.

A. EROSION-CORROSION EXPERIENCE

1. Erosion-Corrosion identified in wet steam piping: yes, no.
2. Erosion-Corrosion of MSR Chevrons or mesh: yes, no
Chevron material: stainless steel, carbon steel, other
3. Erosion-Corrosion of feedwater piping: yes, no. Date found ... N/A.....
Feedwater piping materials: P. 10%... Grade B.....
4. Erosion-Corrosion of: N/A elbows, Ts, diffusers, reducers,
..... valves, orifices, other components (specify).....
5. Erosion-Corrosion of J-Tubes: yes, no. N/A
6. Erosion-Corrosion of feedwater distribution ring: yes, no
7. Erosion-Corrosion of turbine: HP, LP; identify components: BLADES.....
8. Erosion-Corrosion of other cycle components (identify)
9. Feedwater temperature range where erosion-corrosion found: from N/A to F
10. Inspection frequency for feedwater piping 1 year years. Steam lines 1.5 years.
11. Inspection methods used: ultrasonic thickness, radiography, visual, other.....

B. PIPING DESIGN

1. Maximum feedwater flow velocity ... 18.3..... feet/second.
2. No. of feed pumps operating at 100% load ... 2...., second pump On at 50% load. *13.20*
3. Maximum flow velocity when only 1 pump is operating ... 26.3..... feet/second. *13.20*
4. No. of feedwater piping components: 232... elbows, 15... Ts, 4... diffusers,
20... reducers, 27... valves, orifices,
..... other components (specify)
5. Maximum flow velocity in wet steam piping feet/second.
6. Feedwater pressures and temperatures actual (preferred) or design):



Please attach copies of the heat balance diagrams for your actual full load and typical low load.

C. FEEDWATER AND CONDENSATE CHEMISTRY

- Please complete the attached Table.
- Feedwater chemistry history (average or typical values, final feedwater):

Year of oper.:	1st	1974	1976	1978	1980	1982	1983	1985	1986	1987
pH of FW	maximum	9.8	9.8	9.6	9.6	9.6	9.7	9.8	9.6	9.7
	minimum	9.1	9.1	9.1	9.1	8.4	9.1	9.2	8.3	8.7
	average	9.5	9.5	9.3	9.3	9.3	9.4	9.5	9.5	9.5
pH of condensate	maximum	9.6	9.6	9.6	9.6	9.6	9.7	9.7	9.7	9.7
	minimum	8.8	8.8	8.8	8.8	8.3	9.2	9.3	9.3	9.3
	average	9.3	9.3	9.3	9.3	9.2	9.5	9.4	9.5	9.5
DO, ppb	maximum	10	10	10	10	15	6.5	14	13.5	20
	minimum	2	2	2	2	2.4	0.3	0.5	0.3	0.2
	average	5.6	5.6	5.6	5.6	6.6	3.0	3.4	2.9	2.3
Cat. Cond. uS/cm	0.4	0.4	0.3	0.3	0.14	0.14	0.12	0.10	0.09	
Spec. Cond. uS/cm	-	-	-	-	-	-	-	-	-	-
NH ₃ , ppb	-	-	-	-	-	-	-	-	-	-
N ₂ H ₄ , ppb	10	10	25	25	121	57	117	137	148	
Boron, ppb	-	-	-	-	-	-	-	-	-	-
Air Inleakage, SCFM	72	72	72	60	31	16	15	9	8	

Please send any water chemistry summary reports and data.

3. Chemical additions

- * 3.1 Ammonia: typical concentration in feedwater ~800 ppb; added at N/A
- 3.2 Hydrazine: typical concentration in feedwater ~12.5 ppb; added at condensate
- 3.3 Boric acid: typical concentration in feedwater ... ppb as B; demineralizer effluent

* Based on pH of Feedwater

D. MATERIALS

- Feedwater piping - list ASTM or other specification numbers A106, A234 WPB, A234 WPB
- Wet steam piping: A106, A234 WPB, A105, A403/TP304, A312/TP304
- Attach results of chemical analysis by you or pipe vendors.

PWR EROSION-CORROSION QUESTIONNAIRE
(Check or Circle All Applicable)

ENCLOSURE

Utility Company: Duke Power Company Unit Name: Omaha #3 MWe 860

Filled by: Mar. Neill, N.S. Williams, D.A. Smith Date: 9/8/87 Phone No. (704)-373-3103

In service: 19 74. Water Treatment: AVT with ammonia, morpholine, hydrazine.
COMMERCIAL 12/74

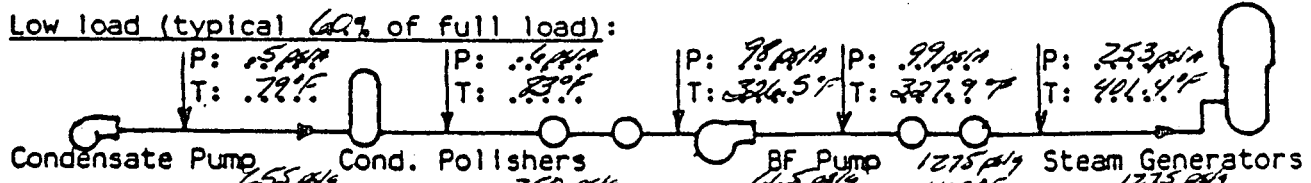
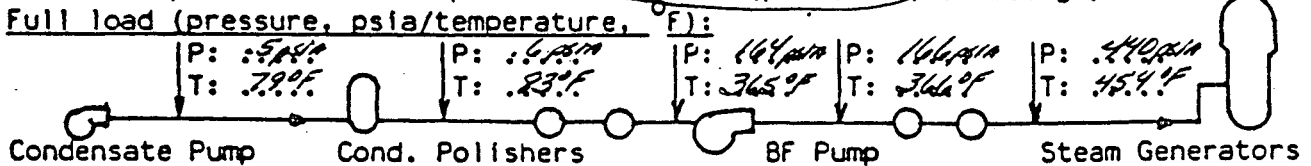
Condensate polishers: none, cation, powdex, mixed bed; .2% of feedwater flow; installed 19 74; operated in: H-OH, NH4-OH form. *# 1974-79 - 56%*
Cooling water: fresh, salt, brackish, cooling tower. *1979-84 - 60%*
Copper alloy condenser tubing: yes, no Copper alloy FW heater tubes: LP, HP, none *1984-Present - 64%*
Boric acid used since: 19 74; during: operation, layup, low load soaks, other. N/A.

A. EROSION-CORROSION EXPERIENCE

- Erosion-Corrosion identified in wet steam piping: yes, no.
- Erosion-Corrosion of MSR Chevrons or mesh: yes, no.
Chevron material: stainless steel, carbon steel, other
- Erosion-Corrosion of feedwater piping: yes, no. Date found N/A.
Feedwater piping materials: API 6, Carbon S.
- Erosion-Corrosion of: 1/2" elbows, Ts, diffusers, reducers, valves, orifices, other components (specify)
- Erosion-Corrosion of J-Tubes: yes, no. N/A
- Erosion-Corrosion of feedwater distribution ring: yes, no
- Erosion-Corrosion of turbine: HP, LP identify components: BLADES
- Erosion-Corrosion of other cycle components (identify) MAIN FEEDPUMP, NOZZLE, SPRAY PUMP
- Feedwater temperature range where erosion-corrosion found: from 1/2" to F
- Inspection frequency for feedwater piping 1 year years. Steam lines 1 year years.
- Inspection methods used: ultrasonic thickness, radiography, visual, other

B. PIPING DESIGN

- Maximum feedwater flow velocity 18.3 feet/second.
- No. of feed pumps operating at 100% load 2, second pump On at 50% load. *(13,000 gpm)*
- Maximum flow velocity when only 1 pump is operating 26.3 feet/second.
- No. of feedwater piping components: 232 elbows, 15 Ts, 4 diffusers, 20 reducers, 37 valves, orifices, other components (specify)
- Maximum flow velocity in wet steam piping feet/second.
- Feedwater pressures and temperatures actual (preferred) or design):



100% Design => 655 psia / 400°F, 250 psia / 175°F, 665 psia / 400°F, 1275 psia / 400°F, 1275 psia / 475°F
Please attach copies of the heat balance diagrams for your actual full load and typical low load.

C. FEEDWATER AND CONDENSATE CHEMISTRY

1. Please complete the attached Table.
2. Feedwater chemistry history (average or typical values, final feedwater):

Year of oper.:	1st	1974	1976	1978	1980	1982	1983	1985	1986	1987
pH of FW	maximum	—	9.8	9.6	9.6	9.6	9.7	9.7	9.7	9.7
	minimum	—	9.1	9.1	9.1	8.5	9.1	8.9	8.9	8.7
	average	—	9.5	9.3	9.3	9.3	9.5	9.5	9.5	9.5
pH of condensate	maximum	—	9.6	9.6	9.6	9.6	9.7	9.8	9.7	9.8
	minimum	—	8.8	8.8	8.8	8.6	9.2	8.0	9.0	8.0
	average	—	9.3	9.3	9.3	9.3	9.5	9.5	9.5	9.5
DO, ppb	maximum	—	10	10	10	25	11.2	20	20	20
	minimum	—	2	2	2	5.6	0.1	0.4	0.3	0.4
	average	—	5.6	5.6	5.6	6.3	3.9	4.8	3.1	3.1
Cat. Cond. uS/cm	—	0.4	0.3	0.3	0.09	0.14	0.14	0.10	0.14	—
Spec. Cond. uS/cm	—	—	—	—	—	—	—	—	—	—
NH ₃ , ppb	—	—	—	—	—	—	—	—	—	—
N ₂ H ₄ , ppb	—	10	25	25	45	105	100	114	135	—
Boron, ppb	—	—	—	—	—	—	—	—	—	—
Air Inleakage, SCFM	—	72	72	60	45	33	9	7	7	—

Please send any water chemistry summary reports and data.

3. Chemical additions

- * 3.1 Ammonia: typical concentration in feedwater ⁸⁰⁰ ppb; added at ..N/A.....
- 3.2 Hydrazine: typical concentration in feedwater ¹²⁵ ppb; added at ^{condensate} ..N/A.....
- 3.3 Boric acid: typical concentration in feedwater ... ppb as B; ^{demineralizer} added atN/A..... ^{effluent}

* Based on pH of Feedwater.

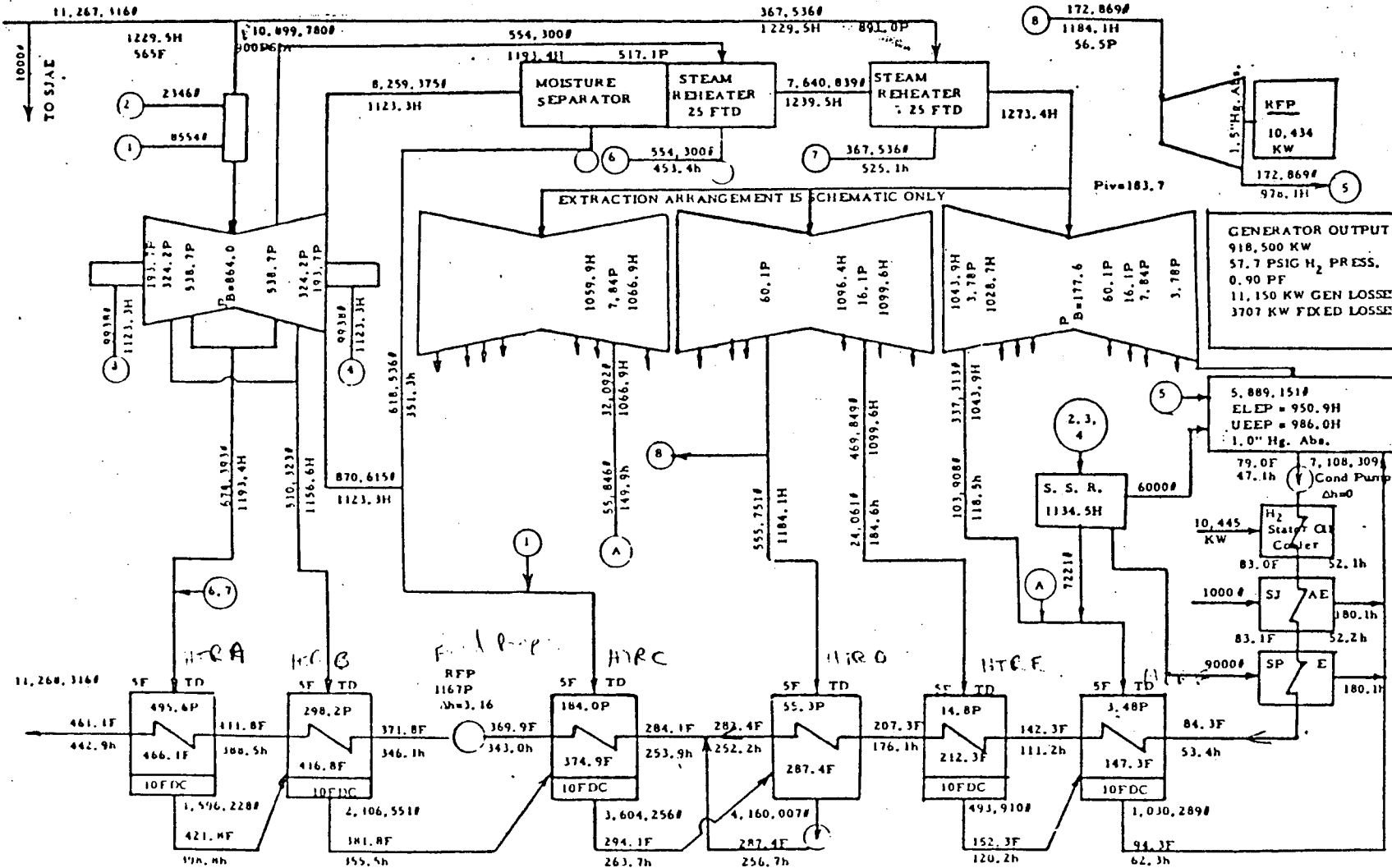
D. MATERIALS

1. Feedwater piping - list ASTM or other specification numbers *A106, Cond. B, A234 WPB*
2. Wet steam piping: *A106, Cond. B, A234 WPB, A105, A403/WP 304, A312/TP 304*
3. Attach results of chemical analysis by you or pipe vendors.

LEGEND: H, h - Enthalpy - Btu/Lb.
 # - Flow - Lb/hr.
 P - Pressure, PSIA
 F - Temperature, F degrees

CALCULATED DATA - NOT GUARANTEED

Rating Flow (Guaranteed) is 10,367,933#/Hr. at inlet steam conditions of 400 PSIA 1230.5H. To assure that the turbine will pass this flow, considering variations in flow coefficients from expected values, shop tolerances on drawing areas, etc. which may affect the flow, the turbine is being designed for a Design Flow of (Rating Flow + 5%), 10,886,310#/Hr. The equivalent Design Flow at 900 PSIA and 1229.5H is 10,899,780#/Hr.



100%

CONDENSOR

VALVE REST POINT
 NET HEAT RATE
 (CUSTOMER'S DEFINITION)

$$= \frac{11,268,316 (1229.5 - 442.9)}{918,500} = 9650 \text{ BTU/KW-HR}$$

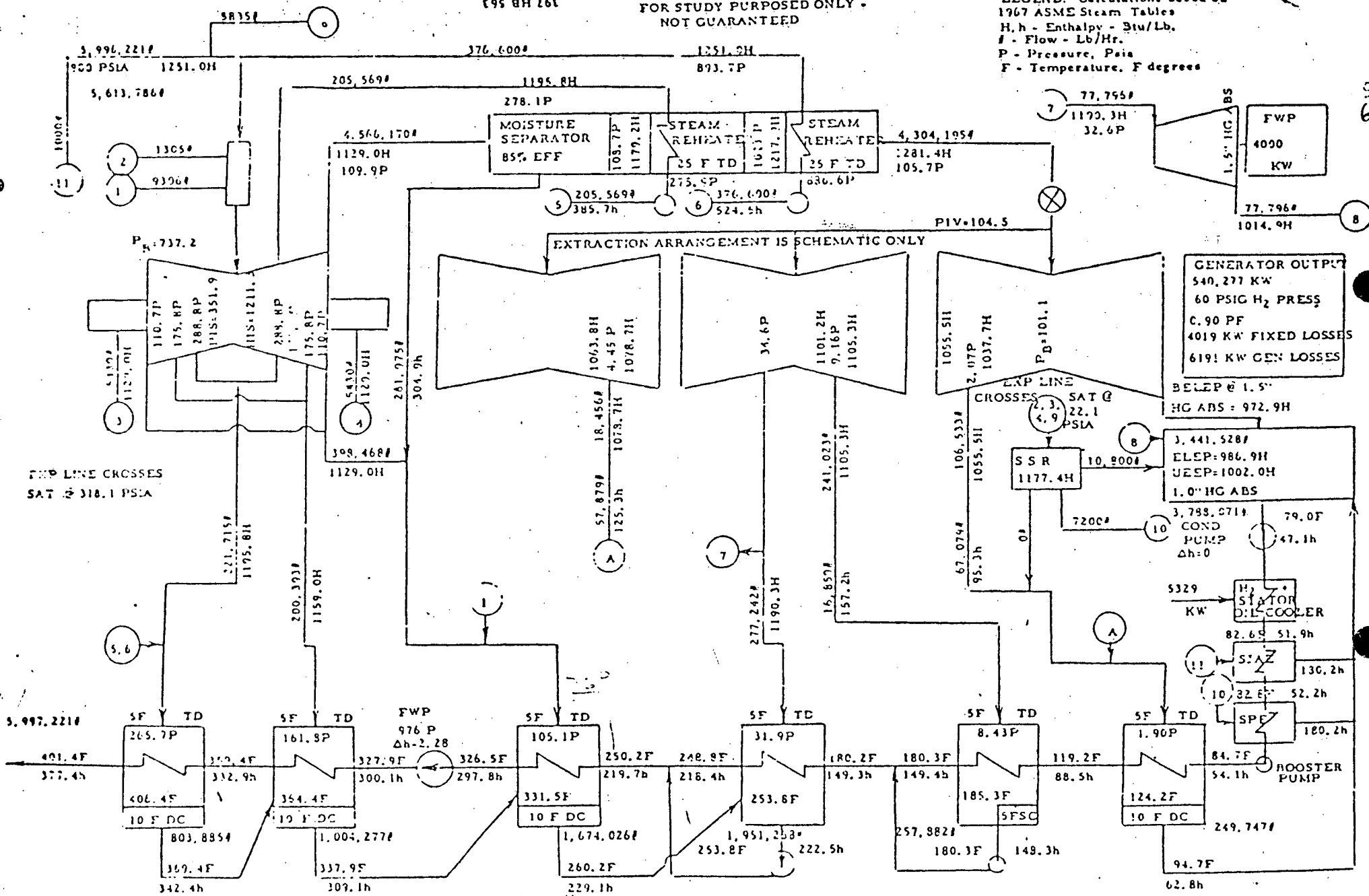
886,669 KW @ 1.0" Hg. Abs. 0%MU
 TC6F - 38N LSB 1800 RPM
 900 PSIA 1230.5H 566F 2STAGE REHEAT
 GEN: 1,037,937 KVA @ 60 PSIG H₂ PRESS. & 0.90 PF (LD)

F. Dawson
 H.K.

195 BH 266

FOR STUDY PURPOSED ONLY - NOT GUARANTEED

LEGEND: Calculations based on 1967 ASME Steam Tables
H, h - Enthalpy - Btu/Lb.
I - Flow - Lb/Hr.
P - Pressure, Psia
F - Temperature, F degrees



EXP LINE CROSSES SAT @ 318.1 PSIA

EXTRACTION ARRANGEMENT IS SCHEMATIC ONLY

GENERATOR OUTPUT
540.277 KW
60 PSIG H₂ PRESS
C.90 PF
4019 KW FIXED LOSSES
6191 KW GEN LOSSES

BELEP @ 1.5"
HG ABS = 972.9H

SSR
1177.4H
10,900#

COND PUMP
79.0F
47.1h

STATOR COOLER
82.6F
51.9h

ROOSTER PUMP
84.7F
54.1h

VALVE BEST POINT
NET HEAT RATE (CUSTOMER DEFINITION)
5,997.221 (1251.0 - 377.4) = 9697 BTU/KW-HR
540.277

893,271 KW @ 1.0" HIG ABS 0% MU
TC6F-38N LSD 1800 RPM
900 PSIA 1230.5H/566°F 2 STAGE REHEAT
GEN: 1,037,937 KVA @ 60 PSIG H₂ PRESS & 0.90 PF (L10)

1536 MW
60%

F. H. Lawson
BL.