Wisconsin Electric POWER COMPANY
231 W. MICHIGAN, P.O. BOX 2046, MILWAUKEE, WI 53201

(414) 221-2345

VPNPD-89-209
NRC-89-039

10 CFR 2.790

April 3, 1989

U. S. NUCLEAR REGULATORY COMMISSION
Document Control Desk
Mail Station P1-137
Washington, D. C. 20555

Gentlemen:

DOCKETS 50-266 AND 50-301
REPLY TO INSPECTION REPORTS
50-266/89005(DRS);50-301/89005(DRS)
POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2

This letter responds to your referenced inspection report dated March 2, 1989, which requested a response to an open item regarding the failure to perform 10 CFR 50.59 reviews for several modifications which changed out the low-pressure and high-pressure feedwater heaters in Units 1 and 2. Page 5 regarding identification of the open item for Unit 1 incorrectly lists the docket number as 50-461; the correct number is 50-266.

In accordance with your request to respond to the open item and to furnish you a copy of the 10 CFR 50.59 evaluation, enclosed is a copy of Safety Evaluation Report 89-013 and associated technical supporting documentation.

We trust submittal of the requested safety evaluation report closes the identified open items. Should you have questions or concerns arising from your review of this document, please contact us.

Very truly yours,

C. W. Fay
Vice President
Nuclear Power

Enclosure

Copies to NRC Regional Administrator, Region III
NRC Resident Inspector

IE01
1/1

8904180187 890403
PDR ADOCK 05000266
Q PNU

NUCLEAR POWER DEPARTMENT
10CFR50.59 REPORT

Ser. # 89-013 Reference Document # See below (Attach additional pages if necessary)

Section I - Determination if Safety Evaluation is Required

Brief Description of Proposed Change, Test, or Experiment: Replace/upgrade feedwater heaters Unit 1 MRs 84-169/170, 82-083, 85-059; Unit 2 MRs 84-171/172, 82-084, 85-060

1. Will any system, structure, or component (SSC), as described in the PBNP FSAR, including its figures, be altered? ___ YES X NO

2. Could, within reasonable possibility, the proposed change affect the function or method of a SSC which is described in the FSAR? ___ YES X NO

3. Will any procedure or procedures as described in the PBNP FSAR be altered? ___ YES X NO

4. Will a test or experiment which is not described in the FSAR be performed? ___ YES X NO

5. Will a prior documented technical commitment to the NRC be altered? ___ YES X NO

6. Is a potential change to the facility or its operation as described in the FSAR involved? X YES ___ NO

7. Is an evaluation required (are any of the above questions answered YES)? X YES ___ NO

NOTE: If no, then provide basis for decision in summary section.

List the licensing basis documents and sections where the system, structure, component, procedure, test, or experiment is described. (FSAR Chapters 1 thru 15 and appendices, and technical NRC commitments).

Chapter 10
Chapter 14

Section II - Determination if an Unreviewed Safety Question is Involved:

1. Does the proposed activity increase the probability of occurrence of an accident previously in the SAR? ___ YES X NO

List the accident(s) previously evaluated in the SAR with which the proposed change to the SSC or procedure, or the proposed test or experiment could have any possible bearing, effect, or association, and describe the bearing, effect, or association. Describe why and/or how the probability of occurrence will or will not be increased.

14.1.6, "Reduction in Feedwater Enthalpy Incident." No changes were made in feedwater heater design to increase the chance of causing a loss of flow resulting in opening of bypass valve.

2. Does the proposed activity increase the consequences of an accident previously evaluated in the SAR? ___ YES X NO

Describe why and/or how the consequences of the accident(s) listed in #1 will or will not be increased.

Because the reduction in steam generator feedwater temperature is no worse with the new feedwater heaters.

3. Does the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the SAR? ___ YES X NO

List the malfunction(s) of equipment previously evaluated in the SAR with which the proposed change to the SSC or procedure, or the proposed test or experiment could have any possible bearings, effect, or association, and describe the bearing, effect or association. Describe why and/or how the probability of occurrence will or will not be increased.

None

4. Does the proposed activity increase the consequences of a malfunction of equipment important to safety previously evaluated in the SAR? ___ YES X NO

Describe why and/or how the consequences of the malfunction(s) listed in #3 will or will not be increased.

Not applicable

5. Does the proposed activity create the possibility of an accident of a different type than any previously evaluated in the SAR? ___ YES X NO

List any possible accident that may be created as a result of the proposed activity. Describe why and/or how each accident is or is not of a different type than any previously evaluated in the SAR.

Not applicable

6. Does the proposed activity create the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the SAR? ___ YES X NO

List any possible malfunction of equipment that may be created as a result of the proposed activity. Describe how and/or why each malfunction is or is not of a different type than any previously evaluated in the SAR.

Reduces the potential for steam generator tubing degradation from corrosion.

7. Does the proposed activity reduce the margin of safety as defined in the basis for any technical specification? ___ YES X NO

List any technical specification with which the proposed change, test, or experiment has any bearing, association, or effect, and describe the bearing, association, or effect. Describe why and/or how the margin of safety as defined in the basis for the technical specifications listed will not be reduced.

Accident in question is bounded by a 10% step load change.

DOES THE CHANGE, TEST, OR EXPERIMENT INVOLVE AN UNREVIEWED SAFETY QUESTION? ___ YES X NO

Section III - Determination if a Technical Specification change is Involved

Does the change, test, or experiment involve a change in the technical specifications? ___ YES X NO

If a change is required, briefly describe what the change should be and why it is required. ___ YES ___ NO

Section IV - Evaluation Summary - (Attach additional pages if necessary)

To alleviate feedwater heater tubing degradation and remove copper-bearing materials from the feedwater train, modifications 84-169, 84-170, 82-083, and 85-059 for Unit 1 (84-171, 84-172, 82-084, and 85-060 for Unit 2) basically replaced the feedwater heaters. The new feedwater heaters were not identical replacements.

During the NRC inspection of modifications in February, 1989, (see inspection report), it was noted that no 10 CFR 50.59 evaluation was performed on the feedwater heater replacement/upgrade modifications. It was also noted that feedwater heater replacement/upgrade could impact safety analysis 14.1.6, "Reduction in Feedwater Enthalpy Incident." Thus, the following will serve to document the acceptability, from a licensing basis standpoint, of the feedwater heater replacement/upgrade efforts.

The new feedwater heaters incorporate stainless steel tubing (304 or 439, depending upon the specific feedwater heater) for increased corrosion resistance. These materials do not transfer heat as readily as the original materials did (copper-bearing alloys). Thus, the new feedwater heater sizes were increased (as physical constraints allowed), tube wall thicknesses were minimized and tube numbers were increased to maximize performance. The new or resulting feedwater heaters either met or exceeded original design and construction codes and standards.

The "Reduction in Feedwater Enthalpy Incident" accident (FSAR Section 14.1.6) basically determines the steam generator feedwater temperature reduction and resulting primary system response for an opening of the low pressure feedwater heater bypass valve at full power. The bypass path will allow a certain percentage of feedwater flow to bypass the gland steam condenser/air ejector inter and after-condenser, condensate cooler, and Nos. 1 through 4A&B feedwater heaters. The flow split percentage is dependent on the pressure drop of the piping system and heat exchangers. The resulting flow is then pumped through the Nos. 5 feedwater heaters to the steam generators. The analysis shows that this event only results in a worst case transient of approximately 2% nuclear power, and is bounded by the "Excessive Load Increase" analysis (FSAR Section 14.1.7), which is a 10% nuclear power transient.

The changes in the feedwater heat exchangers were reviewed qualitatively to determine the possible impacts on the subject analysis. The intention is to show that the critical parameters did not change significantly with the feedwater heater replacement/upgrade. The critical parameters for this evaluation are the change in pressure from the No. 1 feedwater heater inlet to the No. 4 feedwater heater outlet, the feedwater temperature at the No. 4 feedwater heater outlet and the heat transfer capability of the No. 5 feedwater heater. These parameters were reviewed from a design and operational perspective. It should be noted that the contributions from the condensate cooler, gland steam condenser and air ejector, inter and after-condenser were ignored as their overall impact is small.

The overall design heat transfer rate for the combination of the Nos. 1 through 4 feedwater heaters shows a very slight (2.8%) increase with the newer units versus the original units. It should be noted that this apparent increase is not truly significant as it is mostly due to inputting operational data into the feedwater heater design specifications for the new units versus the Westinghouse thermal kit values for the original units. The terminal temperature differences are not as good with the newer units versus the original units. It is assumed that the accident analysis is based on the Westinghouse thermal kit values. The resulting real change is not significant as the feedwater flow temperature at the No. 4 feedwater heater output has not changed significantly (1972-3 field data: 340-343°F; 1987-88 field data: 342-343°F).

The pressure differential across the combination Nos. 1 through 4 feedwater heater train has not changed significantly as evidenced by operational data (No. 1 feedwater heater inlets were 280 psig and No. 4 feedwater heater outlets were 220 psig during the periods of 1972-73 and 1987-88).

The overall design heat transfer rate for the No. 5 feedwater heaters increased (7.7%) with the new units. As with the low pressure feedwater heaters, a portion of this increase is due to the use of operational data in the design specification versus Westinghouse thermal kit information. The terminal temperature difference for the new unit is better than the old unit. The real change is a very slight increase in the No. 5 feedwater heater performance as evidenced by field data for the feedwater outlet temperature (425°F for the period of 1972-73 and 425-428°F) for the period of 1987-88).

It can be seen that the critical parameters have not changed significantly. Since the critical parameters have not changed, the basis for the original "Reduction in Feedwater Enthalpy Incident" analysis has not been affected, the original analysis is still valid.

The material change resulted in removal of copper-bearing alloys from the feedwater system. This served to minimize oxygen transport to the steam generators by removing the copper oxide transport mechanism. It also allowed a shift in feedwater pH which minimizes steel corrosion. The intended result was to enhance steam generator tubing reliability by minimizing corrosion.

These feedwater heater replacement/upgrades have no other impacts upon the accident analyses or nuclear safety-related systems.

The change does not pose an unreviewed safety question. The probability of occurrence or the consequences of an accident or malfunction of equipment important to safety is not increased. The change does not create the possibility for an accident or malfunction which has not been previously evaluated. The margin of safety as defined in the Technical Specifications is not reduced.

Prepared by W B Thomas Date 02/20/89

Reviewed by D L Wood Date 02/23/89

For the MSS (see attached serial review) MSS # 89-06

Manager - PBNP Approval (See attached serial review) Date 03/21/89

In lieu of MSS and Manager signatures, attach EQR-26d if serial review has been conducted.

POINT BEACH NUCLEAR PLANT

DOCUMENTATION OF SERIAL REVIEW & APPROVAL

DOCUMENT SER 89-013, 10 CFR 50.59 REPORT FOR FEEDWATER HEATER REPLACEMENTS/UPGRADES (MRs 84-169/170, 82-083, 85-059 84-171/172, 82-084, 85-060)

Revision N/A Date N/A Date Performed _____

(If applicable) Unit 1 & 2

NOTE:
1. THIS FORM MAY BE USED TO RECORD THE SERIAL REVIEW AND APPROVAL OF DOCUMENTS WHICH REQUIRE SUPERVISORY STAFF REVIEW AND MANAGER APPROVAL.
2. THE PROVISIONS OF 10 CFR 50.59 APPLY TO ALL CHANGES AND MUST BE EVALUATED AND DOCUMENTED IN ACCORDANCE WITH QP 3-3, "AUTHORIZATION OF CHANGES, TESTS AND EXPERIMENTS." ATTACH QP 3.3.1 IF REVIEW IS REQUIRED.
3. TECHNICAL SPECIFICATION 15.6.8 APPLIES FOR ALL PROCEDURAL CHANGES. A QUORUM OF MSS MEMBERS (FOUR) MUST REVIEW THE PROPOSED CHANGE PRIOR TO APPROVAL BY THE MANAGER.
4. FOLLOWING COMPLETION PROCEDURES ARE TO BE ROUTED TO THE SUPERVISOR - STAFF SERVICES. ALL OTHER DOCUMENTS ARE TO BE ROUTED TO THE ADMINISTRATIVE SPECIALIST - EQRS.

Date 3/13/89 By R Koehler General Superintendent

Date 3/15/89 By _____ Supt - Operations

Date 3/13/89 By _____ Supt - EQRS

Date _____ By _____ Supt - Maint & Const

Date _____ By _____ Supt - Chemistry

Date _____ By _____ Supt - Health Physics

Date 3/13/89 By _____ Supt - I&C

Date _____ By _____ Supt - Reactor Engineering

Date _____ By _____ Supt - Training

Date _____ By _____ Title _____

Date _____ By _____ Title _____

Date 3/13/89 Approved _____ Manager - PBNP

Noted for Record: MSSM 89-06 By _____

EQR-26d
(08-88)

INTERNAL
CORRESPONDENCE

TO: W. B. Fromm

FROM: R. P. Wood

DATE: February 23, 1989

SUBJECT: FEEDWATER HEATER REPLACEMENT/UPGRADE
10 CFR 50.59 EVALUATION

COPY TO:

An analysis to verify the assumptions in the 10 CFR 50.59 review regarding change in design performance of feedwater heaters was conducted. This analysis calculated overall heat transfer coefficient and heat transfer rate of the feedwater heaters based on Westinghouse thermal kit data and the design parameters of the feedwater heaters.

In this analysis, operational data was not used. Rather, the Westinghouse thermal kit data was used for both the new and old HX calculations. (Operational data had higher or equal steam inlet temperatures, which made the heat transfer rate appear higher than calculated in this analysis.)

The calculations showed that performance of the new feedwater heaters was nearly equal to that of the old heaters. The results are as tabulated below:

FWH	Change in Heat Transfer Rate Old to New Feedwater Heater
1	+.3%
2	+.2%
3	-.2%
4	+.03%
5	+.9%

This shows that the critical parameters change even less than as determined in the 10 CFR 50.59 review and that the assumptions are therefore valid.

Richard P. Wood

4-86
3045

HEAT EXCHANGER PROGRAM RESULTS

OLD #1 FWH

TYPE OF HEAT EXCHANGER: U-tube, 2-zone FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: Admirality
NUMBER OF TUBE COLUMNS = 30
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 9
NUMBER OF BAFFLES IN THE drain cooling ZONE = 9
NUMBER OF TUBES = 884
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .576
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 38
LENGTH OF DRAIN COOLING ZONE (ft) = 8
INLET FLUID TEMP. ON tube SIDE (F) = 89.9
INLET TEMP. OF THE EXTRACTION STEAM (F) = 160.6
INLET QUALITY OF THE EXTRACTION STEAM = 0.750
INLET TEMP. OF THE DRAINS (F) = 168.0
OUTLET FLUID TEMP. ON tube SIDE (F) = 143.1
OUTLET FLUID TEMP ON shell SIDE (F) = 106.0
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 5.9
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 1.8
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 6.0
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.21168E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.12215E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.22485E+06
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 666.3
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1109.0
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 1528.4
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1636.2
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 445.0
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 624.4
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.93444E+08
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.18920E+08

HEAT EXCHANGER PROGRAM RESULTS

NEW #1 FHW

TYPE OF HEAT EXCHANGER: U-tube, 2-zone FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: 304 Stainless steel
NUMBER OF TUBE COLUMNS = 30
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 12
NUMBER OF BAFFLES IN THE drain cooling ZONE = 16
NUMBER OF TUBES = 924
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .59
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 37
LENGTH OF DRAIN COOLING ZONE (ft) = 8
INLET FLUID TEMP. ON tube SIDE (F) = 89.9
INLET TEMP. OF THE EXTRACTION STEAM (F) = 160.6
INLET QUALITY OF THE EXTRACTION STEAM = 0.750
INLET TEMP. OF THE DRAINS (F) = 168.0
OUTLET FLUID TEMP. ON tube SIDE (F) = 143.1
OUTLET FLUID TEMP ON shell SIDE (F) = 105.0
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 5.4
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 3.1
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 5.4
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.21168E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.12215E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.22485E+06
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 823.6
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1103.3
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 1412.6
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1513.2
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 465.8
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 558.9
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.93444E+08
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.19267E+08

+.3%

HEAT EXCHANGER PROGRAM RESULTS

OLD #2 FWH

TYPE OF HEAT EXCHANGER: U-tube, 2-zone FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: Admirality
NUMBER OF TUBE COLUMNS = 22
TRANSVERSE TUBE PITCH (inches) = .9375
NUMBER OF BAFFLES IN THE condensing ZONE = 12
NUMBER OF BAFFLES IN THE drain cooling ZONE = 11
NUMBER OF TUBES = 504
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .701
Outer TUBE DIAMETER (inches) = .75
TUBE LENGTH (ft) = 39.0833
LENGTH OF DRAIN COOLING ZONE (ft) = 5
INLET FLUID TEMP. ON tube SIDE (F) = 155.6
INLET TEMP. OF THE EXTRACTION STEAM (F) = 213.8
INLET QUALITY OF THE EXTRACTION STEAM = 0.960
INLET TEMP. OF THE DRAINS (F) = 222.0
OUTLET FLUID TEMP. ON tube SIDE (F) = 207.9
OUTLET FLUID TEMP ON shell SIDE (F) = 171.0
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 7.1
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 4.2
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 7.2
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.21168E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.10803E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.11682E+06
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 922.5
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1221.1
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 2077.2
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 2264.1
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 611.4
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 753.1
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.10148E+09
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.96789E+07

HEAT EXCHANGER PROGRAM RESULTS

NEW #2 FWH

TYPE OF HEAT EXCHANGER: U-tube, 2-zone FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: 304 Stainless steel
NUMBER OF TUBE COLUMNS = 26
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 12
NUMBER OF BAFFLES IN THE drain cooling ZONE = 11
NUMBER OF TUBES = 661
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .59
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 37.9167
LENGTH OF DRAIN COOLING ZONE (ft) = 5
INLET FLUID TEMP. ON tube SIDE (F) = 155.6
INLET TEMP. OF THE EXTRACTION STEAM (F) = 213.8
INLET QUALITY OF THE EXTRACTION STEAM = 0.960
INLET TEMP. OF THE DRAINS (F) = 222.0
OUTLET FLUID TEMP. ON tube SIDE (F) = 208.0
OUTLET FLUID TEMP ON shell SIDE (F) = 170.0
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 7.7
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 3.6
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 7.7
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.21168E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.10803E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.11682E+06
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 911.2
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1289.3
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 2280.8
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 2486.5
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 573.2
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 722.3
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.10148E+09
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.99040E+07

+ .2%

HEAT EXCHANGER PROGRAM RESULTS

OLD #3 FWH

TYPE OF HEAT EXCHANGER: U-tube, 2-zone FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: Admirality
NUMBER OF TUBE COLUMNS = 27
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 13
NUMBER OF BAFFLES IN THE drain cooling ZONE = 6
NUMBER OF TUBES = 718
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .576
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 27.75
LENGTH OF DRAIN COOLING ZONE (ft) = 2
INLET FLUID TEMP. ON tube SIDE (F) = 208.8
INLET TEMP. OF THE EXTRACTION STEAM (F) = 300.0
INLET QUALITY OF THE EXTRACTION STEAM = 1.010
INLET TEMP. OF THE DRAINS (F) = 300.0
OUTLET FLUID TEMP. ON tube SIDE (F) = 265.1
OUTLET FLUID TEMP ON shell SIDE (F) = 189.0
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 7.6
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 5.6
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 7.7
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.21168E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.11682E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.00000E+00
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 1108.0
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1332.2
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 2630.9
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 2868.3
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 739.9
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 858.0
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.10743E+09
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.13163E+08

HEAT EXCHANGER PROGRAM RESULTS

NEW #3 FWH

TYPE OF HEAT EXCHANGER: U-tube, 2-zone FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: 304 Stainless steel
NUMBER OF TUBE COLUMNS = 27
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 13
NUMBER OF BAFFLES IN THE drain cooling ZONE = 6
NUMBER OF TUBES = 722
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .59
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 38.33
LENGTH OF DRAIN COOLING ZONE (ft) = 2.5
INLET FLUID TEMP. ON tube SIDE (F) = 208.8
INLET TEMP. OF THE EXTRACTION STEAM (F) = 300.0
INLET QUALITY OF THE EXTRACTION STEAM = 1.010
INLET TEMP. OF THE DRAINS (F) = 300.0
OUTLET FLUID TEMP. ON tube SIDE (F) = 265.0
OUTLET FLUID TEMP ON shell SIDE (F) = 191.0
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 7.2
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 4.5
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 7.3
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.21168E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.11682E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.00000E+00
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 1013.8
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1484.3
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 2508.0
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 2733.9
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 628.3
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 803.9
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.10743E+09
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.12928E+08

-.2%

HEAT EXCHANGER PROGRAM RESULTS

OLD #4 FWH

TYPE OF HEAT EXCHANGER: U-tube, cond. FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: 90-10 Copper-Nickel
NUMBER OF TUBE COLUMNS = 29
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 9
NUMBER OF BAFFLES IN THE drain cooling ZONE = 0
NUMBER OF TUBES = 725
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .576
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 29.25
LENGTH OF DRAIN COOLING ZONE (ft) = 0
INLET FLUID TEMP. ON tube SIDE (F) = 263.3
INLET TEMP. OF THE EXTRACTION STEAM (F) = 347.8
INLET QUALITY OF THE EXTRACTION STEAM = 0.890
INLET TEMP. OF THE DRAINS (F) = 356.5
OUTLET FLUID TEMP. ON tube SIDE (F) = 343.6
OUTLET FLUID TEMP ON shell SIDE (F) = 347.8
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 0.0
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 0.0
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 7.8
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.21168E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.21916E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.54204E+06
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 0.0
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1157.2
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 0.0
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 3124.5
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 0.0
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 769.2
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.17528E+09
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.00000E+00

HEAT EXCHANGER PROGRAM RESULTS

NEW #4 FWH

TYPE OF HEAT EXCHANGER: U-tube, cond. FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: 304 Stainless steel
NUMBER OF TUBE COLUMNS = 29
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 9
NUMBER OF BAFFLES IN THE drain cooling ZONE = 0
NUMBER OF TUBES = 778
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .59
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 30.0833
LENGTH OF DRAIN COOLING ZONE (ft) = 0
INLET FLUID TEMP. ON tube SIDE (F) = 263.3
INLET TEMP. OF THE EXTRACTION STEAM (F) = 347.8
INLET QUALITY OF THE EXTRACTION STEAM = 0.890
INLET TEMP. OF THE DRAINS (F) = 356.6
OUTLET FLUID TEMP. ON tube SIDE (F) = 343.6
OUTLET FLUID TEMP ON shell SIDE (F) = 347.8
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 0.0
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 0.0
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 7.0
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.21168E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.21916E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.54204E+06
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 0.0
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1175.0
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 0.0
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 2828.1
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 0.0
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 710.0
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.17534E+09
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.00000E+00

Although overall heat transfer coefficient is decreased, the heat transfer rate is improved due to additional length.

RPW 2/

+.03%

HEAT FXCHANGER PROGRAM RESULTS

OLD #5 FWH

TYPE OF HEAT EXCHANGER: U-tube, 2-zone FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: 90-10 Copper-Nickel
NUMBER OF TUBE COLUMNS = 34
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 9
NUMBER OF BAFFLES IN THE drain cooling ZONE = 10
NUMBER OF TUBES = 1149
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .576
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 34.20833
LENGTH OF DRAIN COOLING ZONE (ft) = 7
INLET FLUID TEMP. ON tube SIDE (F) = 346.5
INLET TEMP. OF THE EXTRACTION STEAM (F) = 436.9
INLET QUALITY OF THE EXTRACTION STEAM = 0.936
INLET TEMP. OF THE DRAINS (F) = 436.9
OUTLET FLUID TEMP. ON tube SIDE (F) = 423.2
OUTLET FLUID TEMP ON shell SIDE (F) = 365.0
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 7.6
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 5.6
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 7.8
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.31585E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.29676E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.24033E+06
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 1092.0
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1191.9
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 3242.6
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 3377.2
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 746.8
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 800.7
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.21936E+09
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.41817E+08

HEAT EXCHANGER PROGRAM RESULTS

NEW #5 FWH

TYPE OF HEAT EXCHANGER: U-tube, 2-zone FWH
ANALYSIS METHOD: 1 DESIGN
FLUID TYPE ON tube SIDE: Water
FLUID TYPE ON shell SIDE: Steam
TUBE MATERIAL: 304 Stainless steel
NUMBER OF TUBE COLUMNS = 34
TRANSVERSE TUBE PITCH (inches) = .8125
NUMBER OF BAFFLES IN THE condensing ZONE = 9
NUMBER OF BAFFLES IN THE drain cooling ZONE = 9
NUMBER OF TUBES = 1147
NUMBER OF PLUGGED TUBES = 0
Inner TUBE DIAMETER (inches) = .589
Outer TUBE DIAMETER (inches) = .625
TUBE LENGTH (ft) = 48.5833
LENGTH OF DRAIN COOLING ZONE (ft) = 10
INLET FLUID TEMP. ON tube SIDE (F) = 346.5
INLET TEMP. OF THE EXTRACTION STEAM (F) = 436.9
INLET QUALITY OF THE EXTRACTION STEAM = 0.936
INLET TEMP. OF THE DRAINS (F) = 436.9
OUTLET FLUID TEMP. ON tube SIDE (F) = 423.8
OUTLET FLUID TEMP ON shell SIDE (F) = 361.0
TUBE SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 7.3
SHELL SIDE FLUID VELOCITY IN THE drain cooling ZONE (ft/s) = 3.6
TUBE SIDE FLUID VELOCITY IN THE condensing ZONE (ft/s) = 7.5
MASS FLOW RATE ON tube SIDE (lbm/h) = 0.31585E+07
MASS FLOW RATE OF THE EXTRACTION STEAM (lbm/h) = 0.29676E+06
MASS FLOW RATE OF THE DRAINS (lbm/h) = 0.24033E+06
SHELL SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 911.7
SHELL SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 1339.5
TUBE SIDE H. T. COEFF. FOR drain cooling ZONE (Btu/(h ft^2 F)) = 3120.4
TUBE SIDE HEAT TRANSFER COEFF. FOR condensing ZONE (Btu/(h ft^2 F)) = 3251.0
OVERALL HEAT TRANSFER COEFF. IN drain cooling ZONE (Btu/(h ft^2 F)) = 615.3
OVERALL HEAT TRANSFER COEFF. IN condensing ZONE (Btu/(h ft^2 F)) = 792.9
HEAT TRANSFER RATE IN condensing ZONE (Btu/h) = 0.21936E+09
HEAT TRANSFER RATE IN drain cooling ZONE (Btu/h) = 0.44092E+08

Although overall heat transfer coefficient is lower, the total heat transfer is slightly larger due to additional length. This results in a slightly greater tube side outlet temperature. RPW

+.9%

INTERNAL
CORRESPONDENCE

TO: W. B. Fromm

FROM: S. M. Barkhahn

DATE: February 8, 1989

SUBJECT: COMPARISON OF OLD VERSUS NEW FWH DATA

COPY TO:

I did a comparison of old versus new feedwater heater data per your request. I could not find any old data on differential pressure across the Nos. 1 through 3 feedwater heaters, but was able to find data on the differential pressure across the Nos. 1 through 4 feedwater heaters.

The old data is from Unit 1 during 1972 and 1973. The new data is from the last two years on Unit 1.

The old data showed that the No. 1 feedwater heater inlet pressure was about 280 psig and the No. 4 feedwater outlet pressure was about 220 psig, although this varied from 206 to 232 psig. The new data is 280 psig on the No. 1 feedwater heater inlet pressure and 220 psig on the No. 4 feedwater outlet pressure. These values varied $\pm$5 psig.

The No. 3 feedwater heater outlet temperature old data varied from 270 to 282°F, but was usually in the 273-277°F range. The new data indicates about 280°F from the same instrument point.

The No. 4 feedwater heater outlet temperature old data was about 340-343°F. The new data is about 342-343°F.

The No. 5 feedwater heater outlet temperature old data was about 425°F. The new data is about 425 to 428°F.

It should be noted that other component performances, such as turbines and MSRs, would affect these values. At the time of the old data, the unit was usually running at about 3% less power than now. However, this should not have much affect, considering the variation in the values given above. A 15°F drop in feedwater temperature to the steam generators at full power will result in a 2% increase in power if the feed flow does not change.

Let me know if you need any additional data.

Steven M. Barkhahn

Form 3184-4-86
Lot # 704-3045

	Original Design	New* Design	Operating 1972-73	Operating 1987-88
No. 1 Feedwater Heater				
T_{in}	89.9	94.8		
T_{out}	155.6	155.3		
TTD	5.0	7.4		
DP (psi)	13.08	11.7		
Heat Xfr ($x10^6$)	139	134.3		
Inlet Press			280	280
No. 2 Feedwater Heater				
T_{in}	155.6	155.3		
T_{out}	208.8	208.6		
TTD	5	7.6		
DP (psi)	12.68	18.6		
Heat Xfr ($x10^6$)	113	118.8		
No. 3 Feedwater Heater				
T_{in}	208.8	208.6		
T_{out}	263.3	267.0	273-277	280
TTD	5.0	5.1		
DP (psi)	12.88	15.8		
Heat Xfr ($x10^6$)	117	131.3		
No. 4 Feedwater Heater				
T_{in}	263.3	263.3**		
T_{out}	242.8	342.8	340-343	342-343
TTD	5.0	5.1		
DP (psi)	13.14	10.4		
Heat Xfr ($x10^6$)	174	174		
Outlet Press			220	220
HEAT XFR NOS. 1-4 FWH	$543x10^6$	$558.4x10^6$	+2.8%	
No. 5 Feedwater Heater				
T_{in}	346.5	346.5		
T_{out}	431.9	438.6	425	425-428
TTD	5.0	2.0		
DP (psi)	14.42	20.0		
Heat Xfr ($x10^6$)	288	310.2	+7.71%	

* "New Design" parameters were based on operational data provided to the heat exchanger manufacturer during the design phase (versus Westinghouse thermal kit design parameters).

** "New Design" parameters for the Nos. 4 feedwater heaters were not based on operational information due to timing of replacement.

NEW NO. 1 FWH.

Southwestern Engineering Co
A SUBSIDIARY OF CRONUS INDUSTRIES, INC.

5701 S. EASTERN AVENUE
LOS ANGELES, CA 90040
P.O. BOX 54940
LOS ANGELES, CA 90054

UNIT #1
⚠1 1HX-17A , 1HX-1
UNIT #2
2HX-17A , 2HX-1
UNIT#1
85-1911 , 85-191
UNIT #2

FEEDWATER HEATER SPECIFICATION SHEET

JOB NO. 85-1901-2, 85-190
CUSTOMER WISCONSIN ELECTRIC POWER Co. FILE NO.
STATION POINT BEACH UNIT NO. 1&2 INQUIRY NO. 1209-JL
PLANT LOCATION TWO RIVERS WISCONSIN DATE 6-14-85
SERVICE OF UNIT REPLACEMENT BUNDLE LR1 IN COMMON SHELL WITH LR-2 ITEM NO.
SIZE 67"ID X 444" TYPE HORIZONTAL U-TUBE IN COND. NECK NO. OF UNITS 2 SHELLS/UNIT
SURFACE/SHELL 11,312 EFF SQ FT 11481 GROSS SQ FT SURFACE/UNIT 22,624 EFF SQ FT 22962 GR SQ

PERFORMANCE OF ONE UNIT

		SHELL SIDE			TUBE SIDE
FLUID CIRCULATED		STEAM		DRAINS	FEED WATER
TOTAL FLUID ENTERING	#/HR.	117732	28,707	244901	2,225,000
INLET ENTHALPY	BTU/#	1069.3	132.8	134.0	62.8
OUTLET ENTHALPY	BTU/#		72.0		123.4
INLET TEMPERATURE	°F	162.7 (162.7 SAT.)			94.8
OUTLET TEMPERATURE	°F		104.1		155.3
OPERATING PRESSURE	PSIA		5.06		
NUMBER OF PASSES PER SHELL			TWO ZONES		2
VELOCITY	FT./SEC.				6.33 AT 60°F.
PRESSURE DROP	PSI	(A) —		(C) 4.0	11.7

	HEAT EXCHANGED BTU/HR.	MTD °F	TRANSFER RATE BTU/HR/SQ FT/°F	SURFACE EFF SQ FT	BAFFLE SPACING	THK.	NUM
(A) DESUPERHEATING SECTION							
(B) CONDENSING SECTION	111,398,000	24.5	489	9290		.625"	12 F
(C) DRAIN COOLING SECTION	22,936,000	26.5	428	2022		.375"	16

CONSTRUCTION OF EACH SHELL

DESIGN PRESSURE	PSIG	50	415 ②
TEST PRESSURE	PSIG	75	623 ②
DESIGN TEMPERATURE	°F	STM SIDE SKIRT 300 SHELL 300	230
CONNECTIONS: SIZE		IN 20"(4) 10" OUT 8" 10"	IN 12" OUT -
TYPE		BW	BW

TUBES: NO. 924 U O.D. .625" BWG 20 AVG. LENGTH 444" STR. PITCH .8125"
DESUP SHROUD LENGTH — DR CLR SHROUD TYPE FULL PASS LENGTH 161
CONSTRUCTION — ASME SECTION VIII DIVISION 1 AND HEI STDS. CUST. SPEC.
WEIGHTS: EMPTY FULL OF WATER REMOVABLE SHELL/BUNDLE 50,000
STRESS RELIEVED PARTS MARKED (SR) — RADIOGRAPHED PARTS MARKED (XR)

PART	MATERIAL	THK.	CORR. ALLOW.	GASKETS	MATERIAL
TUBES	SA 268 TP 439			SKIRT FLG TO SHELL FLG	JM 60 OR EQUAL ⚠1
FIXED T.S.	SA 516-70	6.75"	.25"	COVER TO MANWAY	D.J. STL. CLAD SS ⚠1
SHELL, SKIRT	SA 515-70	.5"	.125"	TUBE TO TUBE SHEET JOINT	ROLLED
SHELL COVER	EXISTING	—		TUBE SHEET OVERLAY	NONE
TUBE SUPPORTS	A 283	.625"		TYPE OF SHELL SUPPORTS	EXISTING
CROSS BAFFLES	A 283	.375"		SHELL TO SKIRT JOINT	FLANGED
CHANNEL	SA 516-70	1.0"	.125"	TYPE OF CHAN. AND CLOSURE	HEMISPHERICAL HEA
MANWAY COVER	SA 516-70	2.0"	.125"	WITH 18" I.D. GASKETED MANWAY	
SHROUD	A 283	.25" .375"		INTERIOR CORR. CONTROL PROCEDURE	AS-410
IMPINGEMENT BAFFLE	A 240 TP 304	.25"		NUMBER OF TUBES (LINE ET) INCLUDES	4 INSTALLED SPARES

SHELL SAFETY VALVE: MANUF. EXISTING MODEL NO.
TUBESIDE RELIEF VALVE: MANUF. EXISTING MODEL NO.
OTHER ACCESSORIES: 10% OF REQUIRED NUTS AND BOLTS FOR FLANGED CONNECTIONS, 15 TUBE PLUGS

SPARES: TWO SETS OF GASKETS. TOOLS: ONE TUBE EXPANDER

REV 1 - N. 7-30-85 ● REVISE LINE ET, ES - 9-9-85 TNJ.

85-1901-A02 ● REV. 2
SHEET 1 OF 2

FORM NO. 809-A

TAP 12/3/86

OLD NO. 1 FWH

FEEDWATER HEATER

Customer WISCONSIN MICHIGAN POWER COMPANY Date 4/3/68
Inquiry or Spec. No. Heat Balance CT-18613 Item No. 16-A-6266-1,-2
Apparatus #1 L.P. Feedwater Heater

Area, Sq. ft.
Drain Cooling 2,385 Condensing 8,615 Desuperheating -- Total 11,000
Horizontal X Vertical --
Vertical Heater Position—Tube Plate at Top -- Bottom --

PERFORMANCE

	SHELL	TUBES
		2,116,846 lbs./hr. 57.8 Btu/lb.
Feedwater	122,154.5 lbs./hr. 1070.2 Btu/lb.	
Steam	224,854 lbs./hr. 133.5 Btu/lb.	
Drains to Heater	25,210 lbs./hr. 130.6 Btu/lb.	
Other Flow		
Steam Pressure at Heater Inlet	4.80 psia	
Saturated Temperature at Heater Inlet	160.6 °F	89.9 °F
Temperature In	160.6 °F	155.6 °F
Temperature Out	99.9 °F	

Drain Cooler Approach 10.0 °F Terminal Difference, Outlet Feedwater +5.0 °F
Total Heat Transferred 139 x 100 Btu/hr.
Velocity in Tubes 7.044 ft/sec @60°F
Pressure Drop in Tubes, at average operating temperature 13.08 psi

Design Temperature	Skirt 300 °F, Shell 300 °F	230 °F
Design Pressure	50 psig	400 psig
Test Pressure	75 psig	600 psig

CONSTRUCTION DETAILS

Shell: Inside dia 67 in. Thickness 1.2 in. Material Steel
Connections: Steam Inlet 4-20" Drains In 10" Drain Out 10" Vent 1" & 4
Tube Channel: Material Steel
Connections: Inlet 12" Outlet Internal
Number of Passes 2
Type: Bolted -- Single piece -- Dished -- Hemispherical x
Tube Channel Cover: Material Steel
Tubes: Material Admiralty Pitch 13/16" Triangul
Number, Total 884 U's O.D 5/8 in. Gauge No. 18 AVG BW
Average Effective Length 28 ft 6 in
Tube Plates: Material Steel
Baffles: Material Steel
Tube Supports: Material Steel
Gaskets: Material, Shell Welded Joint Tube Channel Welded Joint

Weights: Empty 81,000 lbs. Operating 102,000
Removable Section 50,000 (Tube Bundle) lbs. Flooded 143,000

NEW NO. FROM

Southwestern Engineering Co
A SUBSIDIARY OF CRONUS INDUSTRIES, INC.

5701 S. EASTERN AVENUE,
LOS ANGELES, CA 90040
P.O. BOX 54840,
LOS ANGELES, CA 90054

△1 1HX-1A : 1HX-1
UNIT #2
2HX-1A : 2HX-1
UNIT #1
85-1911, 85-1912
UNIT #2
85-1901, 85-1902

FEEDWATER HEATER SPECIFICATION SHEET

JOB NO. 2
FILE NO.
INQUIRY NO. 1209-JL
DATE 4-14-85
ITEM NO.

CUSTOMER WISCONSIN ELECTRIC POWER Co.
STATION POINT BEACH UNIT NO. 1 & 2
PLANT LOCATION TWO RIVERS, WISCONSIN
SERVICE OF UNIT REPLACEMENT BUNDLE LP-2 IN COMMON SHELL WITH LP-1
SIZE 67" IDX 455" TYPE HORIZONTAL U-TUBE IN COND. NECK NO. OF UNITS 2 SHELLS/UNIT
SURFACE/SHELL 8245 EFF SQ FT 8366 GROSS SQ FT SURFACE/UNIT 16490 EFF SQ FT 16732 GROSS SQ FT

PERFORMANCE OF ONE UNIT

		SHELL SIDE		TUBE SIDE
FLUID CIRCULATED		STEAM	DRAINS	FEED WATER
TOTAL FLUID ENTERING	#/HR.	113,487	131,414	2,225,000
INLET ENTHALPY	BTU/#	1119.3	187.1	123.4
OUTLET ENTHALPY	BTU/#	134.0		176.8
INLET TEMPERATURE	°F	216.2 ; 216.2 SAT.)		155.3
OUTLET TEMPERATURE	°F	166.1		208.6
OPERATING PRESSURE	PSIA	16.0		
NUMBER OF PASSES PER SHELL		TWO ZONES		2
VELOCITY	FT./SEC.			8.87 AT 60°F.
PRESSURE DROP	PSI	(A) — (C) 1.9		18.6

	HEAT EXCHANGED BTU/HR.	MTD °F	TRANSFER RATE BTU/HR/SQ FT/°F	SURFACE EFF SQ FT	BAFFLE SPACING	THK.	NUMB
(A) DESUPERHEATING SECTION							
(B) CONDENSING SECTION	106,450,000	24.2	601	7311		.625"	12 F.
(C) DRAIN COOLING SECTION	12,343,000	27.3	484	934		.375"	11

CONSTRUCTION OF EACH SHELL

DESIGN PRESSURE	PSIG	50	415 △2
TEST PRESSURE	PSIG	75	623 △2
DESIGN TEMPERATURE	°F	STM BOX SKIRT 300 SHELL 300	230
CONNECTIONS: SIZE		IN 18" (2) 8" OUT 6" 8"	IN — OUT 12"
TYPE		BW	BW

TUBES: NO. 661 U O.D. .625" BWG 20 AVG LENGTH 455" STR. PITCH .8125" T
DESUP SHROUD LENGTH — DR CLG SHROUD TYPE FULL PASS LENGTH 104"
CONSTRUCTION—ASME SECTION VIII DIVISION 1 AND HEI STDS. CUST. SPEC.
WEIGHTS: EMPTY FULL OF WATER REMOVABLE SHELL/BUNDLE 50,000
STRESS RELIEVED PARTS MARKED (SR) — RADIOGRAPHED PARTS MARKED (XP)

PART	MATERIAL	THK.	CORR ALLOW.	GASKETS	MATERIAL
TUBES	SA 268 TP439			SKIRT FLG TO SHELL FLG	JM60 OR EQUAL △1
FIXED T.S.	SA 516-70	6.75"	.25"	COVER TO MANWAY	D.J. STL. CLAD. ASB. △1
SHELL, SKRT	SA 515-70	.5"	.125"	TUBE TO TUBE SHEET JOINT	ROLLED
SHELL COVER	EXISTING	—		TUBE SHEET OVERLAY	NONE
TUBE SUPPORTS	A 283	.625"		TYPE OF SHELL SUPPORTS	EXISTING
CROSS BAFFLES	A 283	.375"		SHELL TO SKIRT JOINT	FLANGED
CHANNEL	SA 516-70	1.0"	.125"	TYPE OF CHAN. AND CLOSURE	HEMISPHERICAL HEAD
MANWAY COVER	SA 516-70	2.0"	.125"	WITH 18" I.D. GASKETED MANWAY	
SHROUD	A 283	.25" .375"		INTERIOR CORR. CONTROL PROCEDURE	AS-410
IMPINGEMENT BAFFLE	A 240 TP 304	.25"		NUMBER OF TUBES (LINE 37) INCLUDES 4	INSTALLED SPARES

SHELL SAFETY VALVE: MANUF. EXISTING MODEL NO.
TUBESIDE RELIEF VALVE: MANUF. EXISTING MODEL NO.
OTHER ACCESSORIES: REFER TO SHEET 1 OF 2

REV. 1 S.N. 7-30-85 • REV. 2 LINE 22, 23 - 9-4-85 TW.

85-1901-A02 • REV. 2
SHEET 2 OF 2

FORM NO. 809-A

THP 12/3/86

OLD NO. 2 FWH

FEEDWATER HEATER

Customer WISCONSIN MICHIGAN POWER COMPANY Date 4/3/68
Inquiry or Spec. No. Heat Balance CT-18613 Item No. 16-A-0200-1,-2
Apparatus #2 L.P. Feedwater Heater
Area, Sq. ft.
Drain Cooling 915 Condensing 6,835 Desuperheating -- Total 7,750
Horizontal X Vertical --
Vertical Heater Position—Tube Plate at Top -- Bottom --

PERFORMANCE

	SHELL	TUBES
Feedwater		2,116,846 lbs./hr. 123.4 Btu/lb.
Steam	108,033 lbs./hr. 1121.1 Btu/lb.	
Drains to Heater	116,821 lbs./hr. 186.9 Btu/lb.	
Other Flow	lbs./hr. Btu/lb.	
Steam Pressure at Heater Inlet	15.22 psia	
Saturated Temperature at Heater Inlet	213.8 °F	
Temperature In	213.8 °F	155.6 °F
Temperature Out	165.6 °F	208.8 °F

Drain Cooler Approach 10.0 °F Terminal Difference, Outlet Feedwater +5.0 °F
Total Heat Transferred 113 x 106 Btu/hr.
Velocity in Tubes 8.08 ft./sec @60°F
Pressure Drop in Tubes, at average operating temperature 12.68 psi

Design Temperature	Skirt * °F, Shell * °F	* °F
Design Pressure	* psig	* psig
Test Pressure	* psig	* psig

CONSTRUCTION DETAILS

**Shell: Inside dia. * in. Thickness * in. Material *
Connections: Steam Inlet 2-18" Drains In 8" Drain Out 8" Vent 1" & 2-1/2"
Tube Channel: Material *
Connections: Inlet Internal Outlet 12"
Number of Passes 2
Type: Bolted -- Single piece -- Dished -- Hemispherical X
Tube Channel Cover: Material *
Tubes: Material Admiralty Pitch 15/16" Triangular
Number, Total 504 U's O.D. 3/4 in. Gauge No. 18 AVG. BWG
Average Effective Length 39 Ft. 1 in.
Tube Plates: Material *
Baffles: Material *
Tube Supports: Material *
Gaskets: Material Shell * Tube Channel *

Weights: Empty * lbs. Operating * lbs.
Removable Section * lbs. Flooded * lbs.

*See Data Sheet for #1 L.P. Feedwater Heater
**#1 & #2 L.P. Feedwater Heaters in Common Shell.

0838 0005

NEW NO. 3 FWH

Southwestern Engineering Co
A SUBSIDIARY OF CRONUS INDUSTRIES, INC.
5701 S. EASTERN AVENUE
LOS ANGELES, CA 90040
P.O. BOX 54940
LOS ANGELES, CA 90054

FEEDWATER HEATER SPECIFICATION SHEET

1HX-19A, 1HX-19
UNIT #1

JOB NO. 85-1913, 85-1914
FILE NO. 85-19
INQUIRY NO.
DATE 9-9-85
ITEM NO.

CUSTOMER WISCONSIN ELECTRIC POWER Co.
STATION POINT BEACH UNIT NO. 1
PLANT LOCATION TWO RIVERS WISCONSIN
SERVICE OF UNIT REPLACEMENT BUNDLE LP-3A & 3B
SIZE 42" ID x 460" TYPE HORIZONTAL U-TUBE IN COND. NECK NO. OF UNITS 1 SHELLS/UNIT 1
SURFACE/SHELL 9122 EFF. SQ. FT. 9203 EFF. SQ. FT. SURFACE/UNIT 18244 EFF. SQ. FT. 18406 EFF. SQ. FT.

PERFORMANCE OF ONE UNIT

		SHELL SIDE	TUBE SIDE
FLUID CIRCULATED		STEAM / DRAINS	FEED WATER
TOTAL FLUID ENTERING	#/HR.	131,414	2,225,000
INLET ENTHALPY	BTU/#	1186.1	176.9
OUTLET ENTHALPY	BTU/#	187.1	235.9
INLET TEMPERATURE	°F	300 (272.1 SAT.)	208.6
OUTLET TEMPERATURE	°F	218.9	267.0
OPERATING PRESSURE	PSIA	43.3	
NUMBER OF PASSES PER SHELL		TWO ZONES	2
VELOCITY	FT./SEC.		8.12 AT 68°F.
PRESSURE DROP	PSI	(A) – (C) 1.1	16.8

	HEAT EXCHANGED BTU/HR.	MTD °F	TRANSFER RATE BTU/HR/SQ FT/°F	SURFACE EFF SQ FT	BAFFLE SPACING	THK.	NUMBER
(A) DESUPERHEATING SECTION							
(B) CONDENSING SECTION	124,207,000	22.3	651	8556		.625"	13 FU
(C) DRAIN COOLING SECTION	7,076,000	28.3	442	566		.375"	6

CONSTRUCTION OF EACH SHELL

DESIGN PRESSURE	PSIG	50	415
TEST PRESSURE	PSIG	75	623
DESIGN TEMPERATURE	°F	STM BOX — SHELL 350 SKIRT 350	285
CONNECTIONS: SIZE		IN 18" OUT 6", 6"	IN 12" OUT 12"
TYPE		BW	BW

TUBES: NO. 722 U O.D. .625" BWG 20 BWG LENGTH 460" STR. PITCH .8125" TRI
DESUP SHROUD LENGTH — DR CLR SHROUD TYPE FULL PASS LENGTH 58"
CONSTRUCTION — ASME SECTION VIII DIVISION 1 AND NEI STDS. CUST. SPEC.
WEIGHTS: EMPTY FULL OF WATER REMOVABLE BUNDLE 21,200
STRESS RELIEVED PARTS MARKED (SR) — RADIOGRAPHED PARTS MARKED (XR)

PART	MATERIAL	THK.	CORR. ALLOW.	GASKETS	MATERIAL
TUBES	SA 268 TP 439			COVER TO MANWAY	D.J. STL CLAD ASB
FIXED T.S.	SA 516-70	4.375	.25"	PARTITION COVER	S.M.I.P. OR EQUAL
SHELL, SKRT, SPOOL	SA 515-70	4375	.125"	TUBE TO TUBE SHEET JOINT	ROLLED
SHELL COVER	EXISTING	—	—	TUBE SHEET OVERLAY	NONE
TUBE SUPPORTS	A 283	.625"		TYPE OF SHELL SUPPORTS	EXISTING
CROSS BAFFLES	A 283	375"		SHELL TO SKIRT JOINT	WELDED
CHANNEL	SA 516-70	.75"	125"	TYPE OF CHAN. AND CLOSURE	HEMISPHERICAL HEAD
MANWAY COVER	SA 516-70	1.81.75"	.125	WITH 16" I.D. GASKETED MANWAY	
SHROUD	A 283	.25"		INTERIOR CODE CONTROL PROCEDURE	MS-410
IMPINGEMENT BAFFLE	A 240 TP 304	.25"		NUMBER OF TUBES (LINE 27) INCLUDES 4 INSTALLED SPARES	

SHELL SAFETY VALVE: MAKE-UP EXISTING MODEL NO.
TUBESIDE RELIEF VALVE: MAKE-UP EXISTING MODEL NO.
OTHER ACCESSORIES: 10% OF REQUIRED NUTS AND BOLTS FOR FLANGED CONNECTIONS, TUBE PLUG.
SHELL SPOOL FIELD WELDED BY CUSTOMER, CLOSURE PLATE
SPARES: TWO SETS OF GASKETS TOOLS: ONE TUBE EXPANDER

85-1913 - A02 REV. 0

FORM NO. 805-A

OLD NO. 3 FWH

FEEDWATER HEATER

Customer WISCONSIN MICHIGAN POWER COMPANY Date 4/3/68

Inquiry or Spec. No. ~~Hunt Reference ET-1063~~ Dwg. No. 16-A-6267-1,-2

Apparatus #3 L.P. Feedwater Heater

Area, Sq. ft.

Drain Cooling ~~430~~ Condensing ~~6,110~~ ~~Desuperheating~~ Total ~~6,540~~

Horizontal X" Vertical "--"

Vertical Heater Position—Tube Plate at Top

PERFORMANCE

		TUBES	
Feedwater		~~1,110,046~~ lbs./hr	~~175.8~~ Btu/lb.
Steam	~~116,881~~ lbs./hr ~~1197.0~~ Btu/lb.		
Drains to Heater	--- lbs./hr --- Btu/lb.		
Other Flow	--- lbs./hr --- Btu/lb.		
Steam Pressure at Heater Inlet	~~40.0~~ psia		
Saturated Temperature at Heater Inlet	~~[illegible]~~ °F		
Temperature In	~~300.0~~ °F	~~608.0~~	°F
Temperature Out	~~210.0~~ °F	~~263.3~~	°F
Drain Cooler Approach	~~10.0~~ °F	Terminal Difference, Outlet Feedwater	~~5.0~~ °F
Total Heat Transferred		~~111,106~~ Btu/hr.	
Velocity in Tubes		~~0.94~~ ft./sec @60°F	
Pressure Drop in Tubes, at average operating temperature		~~12.88~~ psi	
Design Temperature Skirt 350 °F	~~350~~ °F	285	°F
Design Pressure	50 psig	~~400~~	psig
Test Pressure	75 psig	~~600~~	psig

CONSTRUCTION DETAILS

Shell: Inside dia. 42 in. Thickness 3/8 in. Material Steel

Connections: Steam Inlet 18" Drains In --- Drain Out 6" Vent 1" & 1.5"

Tube Channel: Material Steel

Connections: Inlet 12" Outlet 12"

Number of Passes 2

Type: Bolted -- Single piece -- Ditched -- Hemispherical X

Tube Channel Cover: Material Steel

Tubes: Material ~~Aluminum~~ Brass

Number, Total ~~710~~ 710 OD 5/8 in. Pitch 13/16" Triangular

Average Effective Length ~~27'-7"~~ 27'-6" in. Gauge No. ~~18 AWG~~ BWG

Tube Plates: Material Steel

Baffles: Material Steel

Tube Supports: Material Steel

Gaskets: Material, Shell ~~Welded joint~~ Tube Channel ~~Welded Joint~~

Weights: Empty ~~22,500~~ lbs. Operating ~~28,500~~ lbs.

Removable Section ~~11,500~~ (Tube Bundle) lbs. Floor Load ~~41,000~~ lbs.

TAP 12/3/84

6

0228 0013

OLD NO. 3 FWH

FEEDWATER HEATER

Customer WISCONSIN MICHIGAN POWER COMPANY Date 4/3/68

Inquiry or Spec. No. Heat Balance of 10/10 Dwg. No. 16-A-6267-1,-2

Apparatus #3 L.P. Feedwater Heater

Area, Sq. ft.

Drain Cooling 430 Condensing 6,110 Desuperheating Total 6,540

Horizontal X Vertical

Vertical Heater Position—Tube Plate at Top

PERFORMANCE

		TUBES	
Feedwater		1,216,646 lbs./hr.	175.8 Btu/lb.
Steam	126,887 lbs./hr.	1197.1 Btu/lb.	
Drains to Heater	lbs./hr.	Btu/lb.	
Other Flow	lbs./hr.	Btu/lb.	
Steam Pressure at Heater Inlet	40.7 psi		
Saturated Temperature at Heater Inlet	268.0 °F		
Temperature In	209.0 °F	208.8	°F
Temperature Out	243.0 °F	263.3	°F
Drain Cooler Approach	19.0 °F	Terminal Difference, Outlet Feedwater	5.0 °F
Total Heat Transferred	117 x 10⁶	Btu/hr.	
Velocity in Tubes		8.07 ft./sec @60°F	
Pressure Drop in Tubes, at average operating temperature		12.88 psi	
Design Temperature Skirt 350 °F, Shell 350 °F		285	°F
Design Pressure 50 psig		400	psig
Test Pressure 75 psig		600	psig

CONSTRUCTION DETAILS

Shell: Inside dia. 42 in. Thickness 3/8 in. Material Steel

Connections: Steam Inlet 18" Drains In -- Drain Out 6" Vent 1" & 1.5"

Tube Channel: Material Steel

Connections: Inlet 12" Outlet 12"

Number of Passes 2

Type: Bolted -- Flange plate -- Welded -- Hemispherical X

Tube Channel Cover: Material Steel

Tubes: Material Admiralty

Number, Total 1,216 OD 5/8 in. Gauge No. 18 AWG BWG Pitch 13/16" Triangular

Average Effective Length 24' 9" ft.

Tube Plates: Material Steel

Baffles: Material Steel

Tube Supports: Material Steel

Gaskets: Material, Shell Welded Joint Tube Channel Welded Joint

Weights: Empt., 22,500 lbs. Operating 28,500 lbs.

Removable Section 21,500 Tube Bundle lbs. Flooded 41,600 lbs.

THP 12/3/84

6

NEW NO. 4 HTR

STRUTHERS WELLS

FEEDWATER HEATER SPECIFICATION SHEET

CUSTOMER Wisconsin Electric Power Company — JOB 3-82-06-53338
ADDRESS — REF.
PLANT LOCATION Two Rivers, Wisconsin — PROPOSAL 4863-C6
DATE May 7, 1982

1 SERVICE OF UNIT Replacement Heater No. 4 — ITEM NO. 4.0 Alt. #2
2 SIZE 46-361 TYPE U-Tube One Zone — POSITION Horizontal
3 SURFACE PER UNIT 7,873. SQ. FT EFF 7,966. SQ. FT. TOTAL 4 = NO OF UNITS

PERFORMANCE OF ONE UNIT

		SHELL SIDE			TUBE SIDE
4	FLUID CIRCULATED	STEAM		DRAINS	FEED WATER
5	TOTAL FLUID ENTERING #/HR.	219,153.	--	542,039.	2,116,846.
6	INLET ENTHALPY BTU/#	1089.90	--	328.40	232.00
7	OUTLET ENTHALPY BTU/#	--	314.20	--	315.40
8	INLET TEMPERATURE °F	347.8	(347.8 SAT.)	356.50	263.30
9	OUTLET TEMPERATURE °F	--	347.80	--	342.80
10	OPERATING PRESSURE P.S.I.A.	--	131.00	--	--
11	NUMBER OF PASSES PER SHELL	One Zone (no shrouds)			Two
12	VELOCITY F.P.S.	--	--	--	7.22 AT SP. GR.: 1.0
13	PRESSURE DROP P.S.I.	(A) --		(C) --	10.4

		HEAT EXCHANGED BTU/HR	SURFACE SQ. FT.	M T D °F	TRANSFER RATE BTU/HR/SQ. FT./°F
14	(A) DESUPERHEATING SECTION	--	--	--	--
15	(B) CONDENSING SECTION	174,000,000.	7,873.	28.12	786.
16	(C) DRAIN COOLING SECTION	--	--	--	--

CONSTRUCTION OF ONE SHELL

		SHELL SIDE	TUBE SIDE
17	DESIGN PRESSURE PSI	175.	400.
18	TEST PRESSURE PSI	263.	600.
19	DESIGN TEMPERATURE °F	400.	370.

20 TUBES W SS A688-304 NO. 778U'S O.D. 5/8 B.W.G 20Avg. S.E.T.L.* 30-1 PITCH 13/16 Δ
21 SHELL Steel I.D. 46 THICKNESS ½ (A-285-C)
22 SHELL COVER Steel WELDED TO SHELL SHELL SKIRT Steel ½ Thk (A-285-C)
23 CHANNEL (SR) Steel ID 46 CHANNEL COVER Steel
24 TUBE SHEETS Steel IMPINGEMENT BAFFLE - STNLS STEEL (2) 3/8
25 SUPPORT PLATES - STEEL Air Vent Pipe Dia. 2.00 SEGMENTAL BAFFLE None
26 SHROUDS (A) None (C) None
27 TYPE JOINTS - SHELL SIDE Welded** TUBE SIDE Hemispherical (16" opening)
28 GASKETS - SHELL None CHANNEL Spiral Wound Gasket
29 CONNECTIONS: STEAM-INLET (1) 16 DRAINS-INLET 10 SERIES Weld Ends
30 DRAINS-OUTLET 12 SERIES Weld End
31 FEED WATER-INLET 12 OUTLET 12 SERIES Weld Ends
32 CODE REQUIREMENTS ASME CODE SECTION VIII, DIV. 1 & HEAT EXCHANGE INSTITUTE
33 WEIGHTS - SHELL AND BUNDLE BUNDLE ONLY FULL OF WATER
34 ACCESSORIES: SHELL SAFETY VALVE By Others TUBE SIDE RELIEF VALVE By Others
35 SHELL DRAINER By Others SHELL GAGE GLASS By Others
36 REMARKS: (SR) INDICATES STRESS RELIEVING (XR) INDICATES RADIOGRAPHING
37 "U" TUBES WILL BE DUAL GAGE WHERE REQUIRED TO COMPENSATE FOR BEND THINNING
38 * S.E.T.L. - STRAIGHT EFFECTIVE TUBE LENGTH

**Stainless steel flame protecting band provided at cut point.

1. Internal shroud provided in outlet pass of channel.
2. Tubes are of feedwater heater quality materials.
3. Bends stress relieved after bending.

(See Page 2)

Standard Construction for ASME

OLD NO. 4 FWH

CONTROL #000120

FEEDWATER HEATER

Customer WISCONSIN MICHIGAN POWER COMPANY Date 4/3/68

Inquiry or Spec. No. Heat Balance CT-18613 Item No. 16-A-6268-1,-2

Apparatus #4 L.P. Feedwater Heater

Area, Sq. ft.

Drain Cooling -- Condensing 6,940 Desuperheating -- Total 6,940

Horizontal X Vertical --

Vertical Heater Position—Tube Plate at Top -- Bottom --

PERFORMANCE

	SHELL	TUBES
Feedwater		2,116,846 lbs./hr. 232.0 Btu/lb.
Steam	219,155.5 lbs./hr. 1089.9 Btu/lb.	
Drains to Heater	542,039 lbs./hr. 328.4 Btu/lb.	
Other Flow	-- lbs./hr. -- Btu/lb.	

Steam Pressure at Heater Inlet	131 psia	
Saturated Temperature at Heater Inlet	347.8 °F	
Temperature In	347.8 °F	263.3 °F
Temperature Out	347.8 °F	342.8 °F

Drain Cooler Approach -- °F Terminal Difference, Outlet Feedwater +5.0 °F

Total Heat Transferred 174 x 106 Btu/hr.

Velocity in Tubes 8.59 ft./sec @60°F

Pressure Drop in Tubes, at average operating temperature 13.14 psi

Design Temperature	Skirt 400 °F, Shell 400 °F	370 °F
Design Pressure	175 psig	400 psig
Test Pressure	265 psig	500 psig

CONSTRUCTION DETAILS

Shell: Inside dia. 42 in. Thickness 3/8 in. Material Steel

Connections: Steam Inlet 16" Drains In 10" Drain Out 12" Vent 1"

Tube Channel: Material Steel

Connections: Inlet 12" Outlet 12"

Number of Passes 2

Type: Bolted -- Single piece -- Dished -- Hemispherical X

Tube Channel Cover: Material Steel

Tubes: Material 90-10 Copper-Nickel Pitch 13/16" Triangular

Number, Total 725 U's O.D. 5/8 in. Gauge No. 18 AVG. BWG

Average Effective Length 29 Ft. 3 in.

Tube Plates: Material Steel

Baffles: Material Steel

Tube Supports: Material Steel

Gaskets: Material, Shell Welded Joint Tube Channel Welded Joint

Weights: Empty 23,700 lbs. Operating 31,000 lbs.

Removable Section 5,500 (Shell) lbs. Flooded 43,000 lbs.

0028 0005

YUBA HEAT TRANSFER CORPORATION

P. O. BOX 3188 • TULSA, OKLAHOMA 74101 • (918) 224-6000

FEED WATER HEATER SPECIFICATION SHEET

"AS BUILT"

NEW NO. 5 FWH

85-H-110-1AB

CUSTOMER	WISCONSIN ELECTRIC POWER COMPANY	DATE	NOVEMBER 25, 1985
		CUST. INQ. NO.	
ADDRESS	TWO RIVERS, WISCONSIN	CUST. ORDER NO.	B-83714-S
PLANT LOCATION	POINT BEACH NUCLEAR PLANT UNIT NO. 1	PROPOSAL NO.	OH-330-85
		JOB NO.	85-H-110
1 SERVICE OF UNIT	HIGH PRESSURE HEATERS NO. 5A & NO. 5B	ITEM NO.	EH-5AB Rev 1
2 SIZE 51 - 583 TYPE	U-Tube	ENGRS.	AD
3 SURFACE PER SHELL EFF.	18430 SQ. FT.	TOTAL	18660 SQ FT.
4 NO. OF SHELLS PER UNIT	TWO NO. OF UNITS ONE	POSITION	Horizontal

PERFORMANCE OF ONE SHELL

		SHELL SIDE		TUBE SIDE
5 FLUID CIRCULATED		STEAM	DRAINS *	FEED WATER
6 TOTAL FLUID ENTERING	#/HR.	323,957	240,333.5	3,158,473
7 INLET ENTHALPY	BTU/#	1,154.3	504.4	319.9
8 OUTLET ENTHALPY	BTU/#		328.6	418.1
9 INLET TEMPERATURE	°F.	440.6 (440.6 SAT.)		346.5
10 OUTLET TEMPERATURE	°F.		356.5	438.6
11 OPERATING PRESSURE		370.0 psig		
12				
13 NUMBER OF PASSES		Two Zone		Two
14 VELOCITY	FT./SEC.			8.65 AT 392.6
15 PRESSURE DROP	P.S.I.	(A) —	(C) 5.0	20.0
16				

	HEAT EXCHANGED BTU/HR.	SURFACE SQ. FT.	M.T.D. °F.	TRANSFER RATE BTU/HR./SQ.FT./°F.	BAFFLE SPACING	BAFFLE CUT %
17 (A) DESUPERHEATING SECTION	—					
18 (B) CONDENSING SECTION	258,258,000	15310	21.2	796		
19 (C) DRAIN COOLING SECTION	51,936,000	3120	33.2	501		

CONSTRUCTION – EACH SHELL

		SHELL SIDE	TUBE SIDE
20 DESIGN PRESSURE	P.S.I.	425	1600
21 TEST PRESSURE	P.S.I.	640	2400
22 DESIGN TEMPERATURE	°F.	500	450

23 TUBES SA688-304 (.05Mo) NO 1147 O.D. 5/8 .036 WALL min** LENGTH 48' 7" STR.

24 SHELL STEEL 51" I.D. PITCH 13/16 Δ

25 SHELL COVER STEEL-WELDED TO SHELL SHELL SKIRT steel

26 CHANNEL (SR) STEEL CHANNEL COVER STEEL

27 TUBE SHEETS STEEL W/SS OVERLAY IMPINGEMENT BAFFLE STAINLESS STEEL

28 SUPPORT PLATES – STEEL AIR BAFFLE-STEEL SEGMENTAL BAFFLE – STEEL

29 SHROUDS (A) — (C) steel

30 TYPE JOINTS-SHELL END welded TUBE SIDE hemispherical

31 CAPACITY-SHELL — CHANNEL 16" MW w/gasket

32 CONNECTIONS: STEAM-INLET 12" DRAINS-INLET 10" SERIES W.E.

33 DRAINS-OUTLET 12" SERIES W.E.

34 FEED WATER-INLET 14" x 16" OUTLET 16 SERIES W.E.

35 CODE REQUIREMENTS: ASME 1983 Section VIII, Division 1

36 WEIGHTS-SHELL AND BUNDLE 71500 BUNDLE 48200 FULL OF WATER 114,200

37 ACCESSORIES: SHELL SAFETY VALVE — TUBE SIDE RELIEF VALVE —

38 SHELL DRAINER — SHELL GAGE GLASS —

39 REMARKS – Tubes welded and rolled into tubesheet.

*4941.5 lb/hr @ 421 BTU/lb

Shell rollers MIN. HYDRO TEST TEMP. - 60°F

**Seven rows .040 min.

Two Shell Cut Bands Provided SCHEMATIC DWG. NO. FW-1024

FORM B-7

OLD NO. 5 FWH

FEEDWATER HEATER

Customer WISCONSIN MICHIGAN POWER COMPANY Date 4/3/68
Inquiry or Spec. No. HEAT BALANCE CT-18613 Item No. 16-A-6265-1,-2
Apparatus #5 H.P. Feedwater Heater
Area, Sq. ft.
Drain Cooling 2,389 Condensing 10,447 Desuperheating -- Total 12,836
Horizontal X Vertical --
Vertical Heater Position—Tube Plate at Top -- Bottom --

PERFORMANCE

	SHELL	TUBES
Feedwater		3,158,473 lbs./hr 319.2 Btu/lb.
Steam	296,764 lbs./hr 1154.3 Btu/lb.	
Drains to Heater	240,333.5 lbs./hr 504.4 Btu/lb.	
Other Flow	4,941.5 lbs./hr 421.0 Btu/lb.	
Steam Pressure at Heater Inlet	370 psia	
Saturated Temperature at Heater Inlet	436.9 °F	
Temperature In	436.9 °F	346.5 °F
Temperature Out	356.5 °F	431.9 °F

Drain Cooler Approach 10.0 °F Terminal Difference, Outlet Feedwater +5.0 °F
Total Heat Transferred 288 x 10⁶ Btu/hr
Velocity in Tubes 8.08 ft./sec @ 60°F
Pressure Drop in Tubes, at average operating temperature 14.42 psi

Design Temperature	Skirt 500 °F, Shell 500 °F	450 °F
Design Pressure	425 psig	1,600 psig
Test Pressure	640 psig	2,400 psig

CONSTRUCTION DETAILS

Shell: Inside dia. 51 in. Thickness 7/8 in. Material Steel
Connections: Steam Inlet 12" Drains In 10" Drain Out 12" Vent 2-1"
Tube Channel: Material Steel
Connections: Inlet 14" Outlet 14"
Number of Passes 2
Type: Bolted -- Single piece -- Dished -- Hemispherical X
Tube Channel Cover: Material Steel
Tubes: Material 80-20 Cu Ni
Number, Total 1,149 U's O.D. 5/8 in. Gauge No. 18 AVG. BWG Pitch 13/16" Triangular
Average Effective Length 34 Ft. 2-1/2 in.
Tube Plates: Material Steel
Baffles: Material Steel
Tube Supports: Material Steel
Gaskets: Material, Shell Welded Joint Tube Channel Welded Joint

Weights: Empty 58,000 lbs. Operating 70,000 lbs.
Removable Section 18,500 (Shell) lbs. Flooded 91,000 lbs.

0046 0004