Calculation FC05694, *Calculation of Minimum Reactor Coolant Time Using Shutdown Cooling System*

CALCULATION COVER SHEET

Calculation Number: FC05694	Page No.: 1
QA Category: [X] CQE [ ] Non-CQE [ ] LCQE	Total Pages: 259
Calculation Title: Calculation of Minimum Reactor Coolant Time Using Shutdown Cooling System	Short Term Calc: [ ] Yes [X] No Vendor Calc. No.: PM-44 Associated Project:: EC 35639
Software Tracking No.: (from PED-MEI-23, if applicable)	Responsible NED Dept No.: 356

Owner Assignment (by Dept Head):
(Required only if there are affected documents to be changed)

OPPD Engineer Assignment (by Dept Head): D. Molzer
(Required only for verification of vendor/contractor calculations)

Verification of Vendor/Contractor Calc. assumptions, inputs and conclusions complete:

OPPD Engineer: Doug Molzer Date:

APPROVALS - SIGNATURE AND DATE (Multiple preparers shall identify section prepared per PED-QP-3, Section 4.3.)				Supersedes Calc No.	Confirmation Required?	
Rev. No.	Preparer(s)	Reviewer(s)	Required for CQE Independent Reviewer(s)		Yes	No
3	See Attached Cover Sheet	→	→	2		X

CALCULATION COVER SHEET

Calculation Number: FC05694	Page No.:

Applicable System(s) / Tag Number(s)

SI, AC & RW

AC-4A, AC-4B, AC-1A/!B/!C/1D

EA's and/or Calculations Used as input in this Calculation

FC05888

FC05669

External Organization Distribution (Groups affected by this calculation)

Name and Location	Copy Sent (✓)	Name and Location	Copy Sent (✓)

CALCULATION REVISION SHEET

Calculation No.:FC05694	Page No.: 13
Rev. #	**Description/Reason for Change**
0	Initial Issue
1	Updated RW flow data from Ref.6 Degraded CCW flow data based on Ref. 4 Replaced Ref 8 data with Ref. 4 data
2	Updated entirely to check feasibly of having RC temperature of 350°F instead of 300°F.
3.	Update to remove 120°F RW outfall temperature limitation and incorporate a limit of 120°F on the CCW temperature.

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CALCULATION TITLE PAGE

CLIENT & PROJECT	PAGE 1 OF 2522
OPPD – Ft. Calhoun	Total Pages (including all Attachments) 171256

CALCULATION TITLE (Indicative of the Objective):

Calculation of Minimum Reactor Coolant Cooldown Time Using Shutdown Cooling System.

QA CATEGORY (X)

☒ I - NUCLEAR SAFETY RELATED

☐ II ☐ III ☐ _____ OTHER

CALCULATION IDENTIFICATION NUMBER				OPTIONAL WORK PACKAGE NO.
J.O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALCULATION NO.	OPTIONAL TASK CODE.	
17321.01	46	PM - 44		N/A

*APPROVALS-SIGNATURE & DATE			REV. NO. OR NEW CALC. NO.	SUPERSEDES CALC. NO. OR REV. NO.	CONFIRMATION REQUIRED (X)	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
JE Gormely 02/06/91	M.A. Iannucci 03/11/91	M.A. Iannucci 03/11/91	0	NA		X
CJ Baron 06/08/94	JH Hall 06/27/94	JH Hall 06/27/94	1	Rev 0		X
Peter Queenan 9/13/07	Dinesh Naik 9/13/07	Dinesh Naik 9/13/07	2	Rev 1		X
Peter Queenan 3/31/08 Peter Queenan	Dinesh Naik 3/31/08 Dinesh Naik	Dinesh Naik 3/31/08 Dinesh Naik	3	Rev 2		X

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No.	Description	No. of Pgs
1	Miscellaneous References	~~20~~23
2	Reactor Coolant Cool Down Rate Calculation Spreadsheet	~~62~~141
3	Calculation PM-44 Revision 1	67
	Total Pages	~~171~~256

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CALCULATION SHEET

CALCULATION IDENTIFICATION NUMBER			REV NO.	PAGE 3
JO OR WO NO.	DIVISION & GROUP	CURRENT NO.	~~2~~3	OF 25
17321.01	46	PM - 44		

REVIEW STATEMENT

Review of this calculation was based on the methods below:

		Check One	Initial Upon Completion
1)	Review of Calculation:		
a)	Inputs to ensure that they have been properly selected and correctly used in the calculation.		
	i) Limited review (provide justification)	☐	
	ii) Line by line review	☒	DNA
b)	Assumptions to assure their validity and need for later confirmation.	☒	DNA
c)	Methodology to assure the appropriateness of the overall approach, its implementation, and the correctness of the specific equations utilized.		
	i) Limited review (provide justification below)	☐	
	ii) Line by line review	☒	DNA
d)	Results to ensure reasonableness and accuracy	☒	DNA
e)	If alternate calculation is performed to verify c) and d) check here and attach calculation as an appendix	☐	
2)	Check of Calculation		
a)	Complete numerical check	☒	DNA
b)	Numerical check of critical items (state items and justification below)	☐	
3)	Administrative check of format and content	☒	DNA
4)	Comments/Justification		

Review Methods Selected as Indicated Above

D. NAIK Dinesh Naik	3/31/08
Reviewer	Date
D. NAIK Dinesh Naik	3/31/08
Independent Reviewer	Date
Lead Concurrence	Date

REVISION STATUS SHEET

Revision Number	Affected Sections	Description of Revisions
0	All	Original Issue
1	All	Updated RW flow data from Ref.6, Degraded CCW flow data based on Ref.4 and Replaced Ref.8 data with Ref.4 data
2	All	Updated entirely to check the feasibility of having RC temp of 350°F instead of 300°F
3	All	Update to remove the 120°F outfall temperature limitation and incorporate a limit of 120°F on the CCW temperature.

1.0 Objective

To demonstrate that with shutdown cooling initiated at 350°F primary coolant temperature, cool down to 130°F primary coolant temperature can be achieved in 24 hours~~, and that the outfall temperature (closed loop cooling heat exchanger river water return temperature) will not exceed 120°F~~.

2.0 Methodology

Reactor coolant cooling system consist of two cooling circuits namely primary and secondary cooling circuits.

Primary circuits consist of the two shutdown cooling heat exchangers (SDC HXs) in which primary coolant is cooled by closed loop cooling water (CCW). The secondary circuit consist of three[1] CCW heat exchangers in which CCW water is cooled by the river water. Heat load into the primary coolant consists of core fission product decay heat load, primary coolant pump work and LPSI pump work. The CCW heat load consists of heat rejected from the primary coolant through the SDC heat exchanger(s) plus other miscellaneous loads. Normally one SDC HX and 3 CCW HXs are in service. When the cool down took longer than 24 hours[2] with one SDC HX, the 2nd SDC HX was placed in service.

The CCW cold water temperature is uncontrolled and is a function of the river water temperature, heat load on the CCW system, ~~and~~ number of CCW heat exchangers in service, and the CCW HX cleanliness. The heat removed by the SDC HX depends, in turn on the CCW cold water temperature, CCW flow to the SDC HX and the SDC HX cleanliness. The CCW cold water temperature is calculated iteratively as part of the calculation. The overall process (cool down of the primary system) is judged slow enough the thermal dynamics of the CCW system is ignored; it assumed to operate continuously at the equilibrium (steady state) temperatures for the instantaneous heat loads and temperatures. The heat exchangers were modeled in an Excel spread-sheet based on the temperature of the reactor coolant and river water (CCW HX inlet) temperature by using number of transfer units method (NTU). Capacity ratio and effectiveness are calculated using the calculated primary, CCW, and river water temperatures.

Original Equipment Manufacturer (OEM) data sheets were used to develop equations for the variations in the shell side heat transfer coefficients for both the SDC and CCW heat exchangers. CCW flow to SDC heat exchanger is calculated by accounting for degraded pump performance curve From Calc PM-44 (Ref. 1), page 18.

The cool down rate of the primary coolant was calculated using the heat inputs into the primary loop, the heat removed by the SDC HX and the thermal mass of the primary coolant loop. The cool down rate was then applied to the primary loop initial temperature over a suitably short time span and a new primary loop temperature was obtained. The cooling system performance (SDC and CCW HX performances, CCW temperature and CCW river water outlet temperature) was then recalculated

---

1 Four CCW heat exchangers installed, three in service for this evaluation. (Three available is a Technical Specification limit.)

2 This occurred in the cases with maximum fouling on the SDC. Intermediate cases were not evaluated, but, by interpolation of the cases evaluated, the slow cool down is expected to occur with slightly greater than design fouling on the SDC exchanger and is slightly exacerbated by CCW exchanger fouling.

Total time required to cool reactor coolant system from 350°F to 130°F ~~were~~ was estimated by considering the river water inlet temperature of 90°F and maintaining the ~~river outlet~~CCW cold water temperature to~~of~~ less than 120°F (Ref. 20). The CCW flow to the SDC HX may be~~was~~ initially throttled to hold the ~~river outlet~~ CCW temperature within the limit. The CCW flow rate was increase to the full rate as soon as could be done without exceeding the ~~river outlet~~ CCW temperature limit. In Revision 3, the worst case evaluated required a throttled flow of 1,850 gpm. This case was used in all cases. "Un-throttling" occurred at 275°F RCS temperature.

3.0 Assumptions

1. It is assumed that the reactor coolant is cooled from normal operating temperature to 350°F at the maximum permissible cool down rate of 100°F/hr. Decay heat load decreases with "time after trip" and initiation of SD cooling as early as possible is conservative for both cool down time and outfall temperature.
2. It is assumed that shutdown follows a reactor trip from full licensed power (1500 MWt). This maximizes decay heat and is thus conservative for both cool down time and outfall temperature.
3. All calculations requiring steam table lookups are done using the ASME Steam Tables, 5th edition, via Excel spreadsheet function using an S&W proprietary add-in ME-367 V01L00 (Ref. 2). These are all implementations of the 1967 IFC Formation for Industrial Use.
4. When shut down heat exchanger load on the CCW system decreases due to decreasing RC temperature, the CCW inlet temperature will drop. As RC temperature drop, CCW flow to the shut down coolers can also be increased by opening the throttle valve fully, From Calc PM-44-1 (Ref. 1), page 17, last paragraph.
5. The thermal dynamics of CCW system have been ignored. Steady state equilibrium temperatures are assumed throughout the system.
6. The thermal inertia and heat transfer within the reactor coolant system have been ignored; it is assumed that the system instantaneously assumes the steady state temperature appropriate for the initial temperature, net heat input or output and thermal mass.
7. CCW temperature will be based on the performance of the CCW heat exchanger receiving the minimum raw water flow. Raw water outlet temperature will be based on the total raw water flow and total CCW heat load.
8. For the calculation of thermodynamic and transport properties, pressures of 300 psig, 75 psig and 15 psig were assumed for the reactor coolant, CCW and raw water respectively.
9. Maximum river water temperature is 90°F. (From Revision 1 of this calculation, but no source cited. Confirmed in Ref. 20.
10. Minimum river water temperature is 33°F. Based on an ice bound river and limitations in the steam table software of 32.016°F.

4.0 References/Design Inputs

Ref. No.	Source Identification	Application/Referenced Information
1.	Calculation 17321.01-PM-44, Rev 1, "Calculation of minimum reactor coolant cool down time using shut down cooling system", 06/27/94	Used entirely in the new calculation
2.	S&W Computer Program SWSteam (ME-367 V01L00), 1967 IFC Steam Tables	Thermodynamic properties of steam.
3.	S&W Computer Program FlowUtils (ME377 V00L01)	Interpolates effectiveness value based on NTU and capacity ratio from the table
4.	W.M. Kays and A.L. London, Compact Heat Exchangers, McGraw-Hill , 2nd Edition (Excerpts in Attachment 1)	Tables 2-7a & b. Capacity-NTU-Effectiveness table for split-flow exchanger
5.	Alan J. Chapman , Heat Transfer, Second Edition, Macmillan Company, 2nd Edition, 1967	Capacity-NTU-Effectiveness equation for counterflow exchanger, Page 505 ff Heat transfer film coefficients (Nusselt Numbers) for flow parallel to and across tube banks, pages 339, 344
6.	S.C. Stultz and J.B. Kitto, Steam Its Generation and Use, Babcock & Wilcox Company, 40th Edition, 1992	Nusselt No. for flow inside of tubes, Page 4-12 through Page 4-14
7.	OPPD Procedure PED-SEI-16 R9, "Evaluation of Heat Exchanger Performance", Issued 5-15-07	Limiting fouling coefficients: CCW Hx – 0.004 hr-ft^2-°F/Btu (para 5.2.1K) SDC Hx – 0.00418 hr-ft^2-°F/Btu (para 5.2.4M) CCW Hx – Tube dimensions (Attachment A-1)
8.	Component Cooling Heat Exchanger Data Sheets, Fort Calhoun Station #1, Whitlock Manufacturing Co., identified by "Reference No. EL-6817, sheets 1 to 6", undated (Copies in Attachment 1)	Heat transfer rates for CCW HX. See Section 5.1.2 for specific values.
9.	Drawing "CCW HX Internal Support and Flow Paths", Cramer and Lindell, File FC-AC1B1, 07-26-1999	Flow path
10.	Drawing "CCW HX Inlet Tube Sheet", Cramer and Lindell, File FC-AC1B, 07-26-1999	Flow path

Ref. No.	Source Identification	Application/Referenced Information
11.	Shutdown Heat Exchanger Data Sheets, Fort Calhoun Station #1, Whitlock Manufacturing Co., identified by "Job No. 20-69-4333 sheets 1 to 4", all March 9, 1970 (Copies in Attachment 1)	Heat transfer rates for SDC HX. See Section 5.1.2 for specific values.
12.	Shutdown Heat Exchanger Data Sheet, Fort Calhoun Station #1, Whitlock Manufacturing Co., identified by "Reference Number EI-6817", dated 12/27/68	Tube construction details. U-tubes, ¾" OD, 18 BWG, 304 stainless steel.
13.	Whitlock Drawing H-26133-D Rev. 2, "SDC HX Tubesheet Item AC-4A, 4B ", 8/26/82	Tube count per row. 514 total tubes per unit
14.	Whitlock Drawing A-26133-E Rev. -, "Tube Surface for U Bend Units", undated	Total tubes per row (determined to be total count for two exchangers)
15.	Whitlock Drawing B-26133-L Rev. 1, "Baffles AC-4A & 4B", undated (OPPD File No. 18621)	Confirmation of shell side flow pattern
16.	Whitlock Drawing L-26133 Rev. 6, "Shutdown Heat Exchangers" (Setting Plan), undated, (OPPD File No. 18676 Rev. 1)	General configuration of flow paths (shell center entry with outlets at each end. Tube data 514 tubes, ¾"OD 18 BWG, TP-304, stainless steel SA-249.
17.	Calculation 17321.01-PM-41-1, "Raw Water Flows to CCW Heat Exchangers", 6/2/94 (OPPD Identification FC-05888)	Raw water flow to min flow CCW Hx in mode 23, 2056 gpm. Total raw water flow = 7159 gpm (page 49).
18.	Shutdown Cooling Design Basis Document SDBD-SI-130, R18 (Excerpt in Attachment 1)	Flow through two SDC exchangers, 5000 gpm (p 94)
19.	Calculation FC05669, Rev. 3, "CCW System Flow Rates", 5/10/06 (Excerpts in Attachment 1)	CCW flow to two SDC Hx: 3254 gpm, page 64 (Mode 4)
20.	Email 3-28-08, Doug Molzer (OPPD) to Peter Queenan (Shaw)	Scope for Revision 3. Deletion of outfall temperature limit, imposition of 120°F CCW temperature limit.

5.0 Calculation

5.1 Calculation Basis

5.1.1 Primary Coolant Cool Down

Reactor coolant system cool down rate is accurately modeled by the following equation From Calc PM-44 (Ref. 1), page 4

$$\frac{dTrc}{dt} = \frac{1}{RMCp}(Qd + Ppp + Plp - Qhx)$$

Where Qhx = Heat removed by the shut down cooling heat exchangers, Btu/hr

$\frac{dTrc}{dt}$ = The rate of temperature change of the reactor coolant system, °F /hr

RMCp = The thermal capacitance of the primary system, the steam generators, and the shut down cooling system, including all water and steel = 1.1E06 Btu/°F

Qd = Core fission product decay heat, Btu/hr From Calc PM-44-1 (Ref. 1), page 19. Assuming a trip from full power, PM-44-1 give the equation

$Qd = (68.762*10E6)(t^{-0.32306})$, where t is the time in hours after trip[3].

Ppp = Primary pump work in to system when Rc >= 200°F, Ppp = 9E06 Btu/hr per pump with a maximum of two RC pumps operating with 200°F <= Rc <= 300°F, no RC pumps when Rc < 200°F.

Plp = LPSI pump work in to system = 1.5E06 Btu/hr for two pumps

dTrc/dt from the equation above is used to approximate ΔTrc / ΔT for small increments of time ΔT. At the end of the time increment, Qd is recalculated, as is a new heat removal rate for the shut down heat exchangers. Unknown temperatures and duties at the reduced reactor coolant temperature are recalculated using the effectiveness – NTU method, From Calc PM-44 (Ref. 1), page 4, last paragraph.

5.1.2 Heat Exchanger Performance

Since flow and temperatures of both the CCW and the reactor coolant differ greatly from the design specifications, shut down cooling heat exchanger performance at system initiation must be determined by calculating film coefficients at the each operating conditions.

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[3] PM-44-1 cites "Technical Data Book III-27-1, Rev.2" as the source the underlying data. That source was not checked in the preparation of Revision 2 of this calculation.

In general the heat transfer performance of a shell and tube heat exchanger is given by (Calc PM-44-1 (Ref. 1), page 7 or Chapman (Ref. 5, page 64):

$$U_{overall} = \frac{1}{\frac{OD}{ID*(h_i + f_i)} + \frac{OD*\ln(OD/ID)}{2k} + \frac{1}{h_o + f_o}}$$ (Equation 1)

Where OD = tube OD, inches

ID = tube ID, inches

k = tube material thermal conductivity, Btu/hr-ft-°F

h_i = tube inside heat transfer film coefficient, Btu/hr-ft^2-°F

h_o = tube outside heat transfer film coefficient, Btu/hr-ft^2-°F

f_i = tube inside fouling coefficient, Btu/hr-ft^2-°F

f_o = tube outside fouling coefficient, Btu/hr-ft^2-°F

(When only a total fouling is provided, by convention it is applied as an outside film coefficient.)

The tube material (TP-304 SS (Refs 10 & 16)) properties (conductivity) are available in any number of references. Values used are from Chapman (Ref. 5) and are shown in Attachment 2, Sheet "SDCHx", Cells T84:U117.

The tube inside heat transfer coefficient is a well established formula:

$$Nu = 0.023*\mathrm{Re}^{0.8}\,\mathrm{Pr}^{0.4}$$

or (Ref. 6, page4-13 (Equation 49)) (Equation 2)

$$h_i = 0.023*\mathrm{Re}^{0.8}\,\mathrm{Pr}^{0.4}\left(\frac{k}{l}\right)$$

Where Nu = Nusselt Number for the inside film coefficient

Re = The Reynolds Number for the tube side flow

Pr = Prandtl Number for the tube side fluid

k = fluid thermal conductivity, Btu/hr-ft-°F

l = tube id, feet

Note that the Reynolds and Prandtl Numbers are defined as

Re = ρ v d / μ

Pr = Cp μ / k

ρ is density, lb/ft3

v is velocity, ft/hr

μ is Dynamic viscosity is lbm/ft-hr

Cp is specific heat at constant pressure, Btu/lbm-°F

The relevant dimension (d) for the Reynolds Number is the tube ID or OD.

However the tube outside heat transfer coefficient is very application specific, varying with the flow pattern on the shell side of the exchanger. In well baffled exchangers, the shell side flow pass over most of the tube surface nearly perpendicular to the tube centerline (cross flow), while in other configurations the flow is nearly parallel to the tubes. Heat transfer references provide equations of a form similar to that for the inside film coefficient:

$$Nu = C * \mathrm{Re}^n \, \mathrm{Pr}^m \qquad \text{(Equation 3)}$$

It is assumed that the OEM's heat transfer coefficient has values which follow this form.

Where C, m, and n are constants related to the particular flow pattern. See Chapman (Ref. 5) Sections 8.3 and 8.5 and Steam (Ref. 6) pages 4-13, and 4-14. Text book values for flow normal to tubes are C=0.33, n=0.6, and m=0.33 (Chapman, page 344); values for flow parallel to the tubes are C=0.023, n=0.8 and m=0.4 (heating) or 0.3 (cooling) (Chapman, page 339).

Sufficient OEM data sheets (Refs 8 & 11) are available for both the SDC and CCW exchangers to develop values for C, n, and m.

Each OEM case provided a shell velocity along with the gpm flow. These were used to develop an equivalent "flow area" for the shell. The average flow area (2.5904 ft2) was then used in the performance calculation. (This was an attempt to compensate for the minimal precision in the velocity values.)

$$\text{Velocity(fps)} = \text{Flow(gpm)} / (\text{area(ft}^2) * 7.480519(\text{gal/ft}^3) * 60(\text{sec/min}))$$

Tube side velocities were calculated from the number of tubes in the exchanger, tube size and wall.

Properties of water (density, viscosity, specific heat, etc) were calculated at the average of the shell or tube inlet and outlet temperatures, in lieu of the average film temperature. This is a slight approximation, but is judged acceptable for the application.

For each OEM performance case provided, the tube side film coefficient was calculated using Equation 2. Equation 1 was then solved for the outside film coefficient, h_o, (Fouling coefficients were provided in each OEM case.) The result outside film coefficient was then divided by $k*Pr^m$, and the result plotted on a log-log grid to determine a value for n (the slope of the line on a log-log graph). The Prandtl Number exponent, m, was varied to see what value gave the "best" line on the log-log graph of $h_o / k*Pr^m$. The value of C was then adjusted to match the design point (Mode B), dirty heat transfer coefficient.

SDC Heat Exchanger

The SDC heat exchanger is a mixed flow configuration with primary coolant on the tube side in U-tubes and CCW water on the shell side. The shell flow enters at the mid-point of the shell and exits at each end (Refs 13, 15, & 16).

Four OEM data sheet cases were available for the SDC HXs (Ref. 11), identified as Mode A, B, C, and D. Critical values were:

Tube Side			Shell Side						
Q, gpm	Tin	Tout	Q, gpm	Tin	Tout	Fouling, Overall	Udirty	Uclean	Duty (Dirty)
gpm	°F	°F	gpm	°F	°F		Btu/hr-ft^2-°F		Btu/hr 10^6
Mode B (Design)									
3000	140	115.2	4500	93	109.5	0.0005[2]	320	487	37.1
Mode A									
1500	125	100.3	2250	78	94.5	0.00316	158.7	318.9	18.526
Mode C									
2250	212	159.8	2937	95	135.2	0.00342	178.1	455.2	58.931
Mode D									
3400	255	200	4728	95	135	0.00418	170.7	594.3	94.391[4]

[2] Shell and tube side, each (hr-ft^2-°F/Btu)

The SDC HX evaluation is shown on sheet "SDCHx" of the spreadsheet in Attachment 2. The OEM case data and specific calculation are shown in Cells A18 to R50. The heat transfer coefficient analysis is in rows 50 to 67. The U calculations are in Column Q (Udirty) and Column R (Uclean). Note that the calculation of $1/h_o$ is in Cell Q25 (for the Mode B case, dirty) and $h_o / k*Pr^m$ is in Cell Q26.

The SDC Hx shell side film coefficient was fairly insensitive to the value of m, and the text book valve of 0.333 was used. The value of n, based on the trend line through all 4 cases was 0.61689. This is close to the text book value for pure cross flow, which is reasonable given the physical design of the exchanger (Refs 15 & 16). The value of C which reproduced the OEM's design point coefficient was 0.09751.

The final equation for the SDC HX shell side film coefficient is thus:

$$h_o = 0.09751\ Re^{0.61709}\ Pr^{0.333}\ (12k/0.75)$$

This equation was then applied in all the OEM cases and the OEM's and calculated heat transfer rates are tabulated below. The difference between the OEM's and calculated heat transfer rates were expressed as fouling errors, (i.e. $1/U_{CALC}-1/U_{OEM}$).

Mode	OEM Udirty	Calc'd Udirty	Error as Fouling	Cited Total Fouling
Mode B (Design)	320	320.	0.0	~0.001
Mode A	158.7	157.28	0.000 06	0.003 16
Mode C	178.1	175.88	0.000 07	0.003 42
Mode D	170.7	169.13	0.000 05	0.004 18

The errors in reproducing the OEM's heat transfer rate are on the order of the last significant digit on the fouling factor and are believed to be at the level of the precision (number of digits) in the inputs.

[4] Data sheet contains typographic error in that the final zero of the duty value was omitted. Value is shown as "94,391,00 " rather than "94,391,000". Check of tube and shell mass flows and temperature changes confirm 94+ million Btu/hr duty.

CCW Heat Exchanger

The CCW heat exchangers are tube and shell exchangers with three tube side passes and three shell side passes. The baffling is arranged to give a virtually pure counterflow configuration (Refs 9 & 10). The tubes are 3/4", 18 BWG[5], TP 304 stainless steel (Refs 9).

Six OEM data sheet cases were available for the CCW HXs (Ref. 11), identified as Mode A, B, C, D, E and F. Critical values were:

Tube Side			Shell Side						
Q	Tin	Tout	Q	Tin	Tout	Fouling, Overall	Udirty	Uclean	Duty (Dirty)
gpm	°F	°F	gpm	°F	°F	hr-ft^2-°F /Btu	Btu/hr-ft^2-°F		Btu/hr 10^6
Mode E (Design)									
2673	85	185	2283	239.8	120	0.0015	244	408	134
Mode A									
1575	85	100.3	1550	105.5	90	0.0015	190.1	266	12
Mode B									
3270	70	100	2885	118.4	85	0.0015	233.6	359.6	48.18
Mode C									
2518	70	85	2200	95.2	78	0.0015	203.7	293.3	18.92
Mode D									
2518	85	100	2200	110.2	93	0.0015	215.5	318.4	18.92
Mode F									
3333	85	108.7	2025	134	95	0.0015	228.3	347.2	39.49

The CCW HX evaluation is shown on sheet "CCWHx" of the spreadsheet in Attachment 2. The OEM case data and specific calculation are shown in Cells A12 to Y55. The heat transfer coefficient analysis is in rows 58 to 69. The U calculations are in columns Q (dirty) and R (clean). Note that the calculation of $1/h_o$ is in Cell Q26 (for the Mode E case, dirty) and $h_o / k*Pr^m$ is in Cell Q27.

Case A gave a shell side film coefficient which was clearly out-of-trend with the others. The case A coefficient was not used in the development of the shell side film equation.

The CCW Hx shell side film coefficient was sensitive to the value of m, and the best fit was obtained with a valve of 0.333. The value of n, based on the trend line through all 5 cases was 0.75551. This is close to the text book value for flow parallel to the tube, which is reasonable given the physical design of the exchanger (Refs 15 & 16). The value of C which reproduced the OEM's design point coefficient was 0.023*1.0213[6].

The final equation for the CCW HX shell side film coefficient is thus:

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5 Ref. 9 clearly contains a typo, in stating "78 BWG", since the BWG (Birmingham Wire Gage) is only defined up to 36 gage (0.004"). Reference 7, page 21 gives an OD of 0.750" and an ID of 0.652", which corresponds to 18 BWG.

6 The textbook form of the equation for parallel flow is 0.023 Re^n Pr^m. Since the final correction (1.0326) was fairly close to unity, both multipliers were carried. The final correction can also be conceptualized as a correction on the "average" velocity for local departures around the baffles.

$h_o = 0.023*1.0213\ Re^{0.75645}\ Pr^{0.333}\ (12k/0.75)$

This equation was then used in all the OEM cases and the difference between the calculated heat transfer rates and the OEM's values were expressed as fouling errors, (i.e. $1/Ucalc-1/U_{OEM}$). The results (below) are in the range of the last significant figure in the fouling and are attributed to the limits of precision of the values on the OEM data sheets.

Mode	OEM Udirty	Calc'd Udirty	Error as Fouling	Cited Total Fouling
Mode E (Design)	244	244	0	0.001 65[7]
Mode A	190.1	174.97	0.000 46	0.001 50
Mode B	233.6	237.20	-0.000 06	0.001 50
Mode C	203.7	204.06	-0.000 01	0.001 50
Mode D	215.5	215.01	0.000 01	0.001 50
Mode F	228.3	231.63	-0.000 06	0.001 50

With the exception of Mode A, the errors in reproducing the OEM's heat transfer rate are on the order of the last significant digit on the fouling factor and are believed to be at the level of the precision (number of digits) in the inputs. Mode A was an outlier in the analysis and is not understood. There may be errors on the data sheet, or it may be evaluating a condition, the details of which are not clearly/fully described on the data sheet.

5.1.3 Evaluation of CCW Heat Exchanger Capability

The overall thermal performance of the SDC and CCW heat exchangers were calculated using the NTU-Capacity Ratio-Effectiveness method (Chapman (Ref. 5), page 505).

Number of transfer units (NTU) for and exchanger is defined as:

$$NTU = \frac{UA}{(\dot{m}c_P)_{MIN}}$$

Where UA is the heat transfer rate (Btu/lb-ft^2-°F) – heat transfer area (ft^2) product, and $(mc_P)_{min}$ is the mass flow (lb/hr) – specific heat (Btu/lb-°F) product for the side with the lower value.

Capacity ratio (C_R) is defined as:

$$C_R = \frac{(\dot{m}c_P)_{MIN}}{(\dot{m}c_P)_{MAX}}$$

Where $(mc_P)_{max}$ and $(mc_P)_{min}$ are the mass flow (lb/hr) – specific heat (Btu/lb-°F) products for the two sides of the exchanger.

The effectiveness (ε) is given by

7 Data sheet states "Total fouling = 0.0015", but the difference in the inverses of the clean and service heat transfer rate is 0.00165. (In all other data sheets, the clean and service rates properly reflect the stated fouling.)

$$\varepsilon = \frac{t_{co} - t_{ci}}{t_{hi} - t_{ci}} \qquad if\ m_c c_{pc} < m_h c_{ph}$$

$$\varepsilon = \frac{t_{hi} - t_{ho}}{t_{hi} - t_{ci}} \qquad if\ m_c c_{pc} > m_h c_{ph}$$

Where the t's are the inlet and outlet temperatures of the hot and cold sides.

Graphs and/or tables of effectiveness vs capacity ratio and NTU are available for various heat exchanger configurations.

For a pure counterflow exchanger, the relationship is given by:

$$\varepsilon = \frac{1 - e^{-NTU(1-C_R)}}{1 - C_R e^{-NTU(1-C_R)}}$$ (Ref. 5, page 509 (Eq. 12.32))

This applies to the CCW Hx.

For the mixed flow configuration the relationship is given by the graph and table in Compact Heat Exchangers (Ref. 4) and excerpted in Attachment 1. This applies to the SDC Hx.

These equations (table) were used to regenerate the OEM performance in the OEM cases on sheets SDCHx and CCWHx in the spreadsheet in Attachment 2. The analysis appears in Columns S through Y. The final duty matches (Column Y, with OEM values in bold, blue text below the rows labeled "shell") are not exact, but are judged to be in sufficiently reasonable agreement to validate the calculation. The Cr-NTU-effectiveness table for the mixed flow SDC exchanger is entered in B85:Q109 of sheet "SDCHx".

5.2 Process Conditions

The process scenario being evaluated consists of flow being established from the reactor coolant loop (primary coolant system) to one of the two installed shutdown cooling (SDC) heat exchangers. The SDC HX is in turn cooled by the closed cooling water system (CCW). CCW rejects the heat from the SDC HX(s), along with other heat to the river through three operating (out of four installed) CCW heat exchangers.

The maximum inlet river water to the CCW heat exchangers is defined for this evaluation as being 90°F (Assumption 9). This is presumed to be the design basis temperature. A minimum river water temperature of 33°F was assumed (Assumption 10).

River water flow is taken from Revision 1 of this calculation as 7159 gpm total (Ref. 1, page 13) with 2056 gpm (Ref. 1, page 15) going to the minimum flow CCW HX. Values come from Calculation FC-05888 (Ref. 17).[8]

CCW flow to the CCW Hx's is taken from Revision 1 of this calculation as 8100 gpm total (Ref. 1, page 14), 2664 gpm to the minimum CCW Hx (Ref. 1, page 14). The average flow (2700 gpm) was used in calculating the performance of the heat exchangers.

CCW flow to the SDC Hx~~'s~~ is taken from Revision 1 of this calculation as ~~1962 gpm throttled (Ref. 1, page 8) and~~ 4246 gpm un-throttled (Ref. 1, page 18)(one SDC Hx in service).

8 ~~Calculation FC05888 does not define the raw water operating modes; the selection is taken directly from Ref. 1~~

Reactor coolant flow to the SDC Hx is taken from Revision 1 of this calculation as 3000 gpm (Ref. 1, page 10) with one SDC Hx in service.

For the calculation of thermodynamic and transport properties, pressures of 300 psig, 75 psig and 15 psig were assumed for the reactor coolant, CCW and raw water respectively. (Assumption 8)

The mass flow through all exchangers is calculated from the above volumetric flows at the specific volume corresponding to the average of the inlet and outlet temperatures.

From Revision 1 of this calculation (Ref. 1, page 10), it is assumed that the CCW flow to the SDC Hx is throttled at the start of the cool down to limit ~~the outfall temperature and~~ the rate of temperature drop of the primary loop (limit of 100°F/hr). Revision 3 of this calculation imposed an additional limit of 120°F CCW temperature.

Additionally it is assumed that only one SDC Hx is in service initially. Discussion with station personnel indicated that the degree of throttling (i.e. the throttled flow) may be considered adjustable, as may the primary coolant temperature used as a indicator as to when the CCW flow may be "un-throttled". ~~(This temperature was 250°F in Revision 1.)~~

The CCW provides cooling to additional services during this the reactor cool down period. From Revision 1 of this calculation (Ref. 1, page 25), this additional heat load is $7.358*10^6$ Btu/hr.

Heat Exchanger Fouling

The heat exchanger performances, and thus the cool down time and CCW ~~outfall~~ temperatures are functions of the fouling rates used. The cleaner the heat exchangers, the faster the cool down, but also the higher the CCW ~~outfall~~ temperature.

The OEM data sheets provide "clean" and "service" heat transfer rates and the accompanying fouling film coefficients. In addition Station document PED-SEI-16 (Ref. 7) provides limiting fouling coefficients. The various fouling coefficients values are:

	SDC Hx	CCW Hx
	hr-ft^2-°F/Btu	hr-ft^2-°F/Btu
Clean	0.000	0.000
Service	0.001	0.0015
Operability Limit	0.00418	0.004

The primary analysis will be done using the service fouling, but additional checks will be made at clean and maximum fouling.

Within this calculation "Clean" is also referred to as minimum or no fouling; "Service" as design, normal or nominal fouling; and the "Operability Limit" as maximum fouling.

5.3 Spreadsheet Description

The entire heat exchanger and cool down analysis is performed in ~~an~~ a set of Excel spreadsheets. Each ~~The~~ spreadsheet contains the following sheets: SDCHx, CCWHx, CCW, multiple copies of Cooldown$ and Chart$ (where $ is a number indicating the case within the spreadsheet ~~from 1 to 8~~) and a sheet Summary. (Separate spreadsheets were needed for different river water temperatures and for repeat analyses with different operating bases.)

All sheets use thermodynamic and transport properties calculated using function calls into S&W computer Program SWSteam (Ref. 2). Viscosity calls use the liquid viscosity call (SWSVISL) in

S&W Computer Program FlowUtils (Ref. 3). Curve interpolations are done using functions SPLINE and SPLINE3D in FlowUtils.

Sheet SDCHx contains the shutdown cooling heat exchanger analysis discussed in Section 5.1.2 above. It contains clean heat transfer coefficient, dirty heat transfer coefficient, heat transfer area, number of tubes, effectiveness – capacity ratio – NTU values table, and thermal conductivity table for TP304 stainless steel.

Similarly, Sheet CCWHx contains CCW heat exchanger analysis discussed in Section 5.1.2. The sheet is very similar to Sheet SDCHx, but uses the counterflow Cr-NTU-effectiveness equation instead of tabulated values. The TP304 steel conductivity table from sheet SDCHx is used.

Sheet CCW contains a series of single performance calculations for the CCW heat exchangers. These calculate the Hx performance at raw water and CCW flows given in Section 5.2, at fouling coefficients of 0, 0.0015, 0.0030, and 0.004 hr-ft^2-°F/Btu, 90°F raw water temperature, and various CCW inlet water temperatures. Each calculation (spreadsheet row) give a heat exchanger duty. The temperature-duty values were then interpolated to give CCW outlet temperatures at duties of 1, 20, 40, 60 and 80 million Btu/hr. These were used in the SDC cooling time sheets.

Heat exchanger duty calculation is contained in number of columns. In general the column labels are self explanatory. Cells with blue text are user input values, either manual or ad hoc links; black text is either fixed or calculated values which are part of the base template. The heat transfer tube and shell side film coefficients are calculated using the equations developed above, and the overall heat transfer rate (U) using Equation 1 in Section 5.1.2.

Sheet "Cooldown$" consist of reactor coolant system cool down time calculation. Multiple cases of the sheet, and it accompanying graph "Chart$" exist, each dealing with a different combination of fouling factors. The different cases run will be discussed in Section 5.4. ~~As indicated above, the analysis will be performed with clean, service, and maximum fouling conditions. It will also be performed at the target 350°F primary coolant initiation temperature, but also at the 300°F initiation temperature used in revision 1 of this calculation (Ref. 1). This will be done to provide values with 300°F using the more detailed analysis used in the revision and as a general check of the new analysis.~~

~~The analyses done are:~~

	~~RC Initial Temperature, °F~~	~~SDHX Fouling Coefficient~~	~~CCWHx Fouling Coefficient~~
~~Cooldown1~~	~~350~~	~~0.001~~	~~0.0015~~
~~Cooldown2~~	~~350~~	~~0~~	~~0~~
~~Cooldown3~~	~~350~~	~~0.00418~~	~~0.004~~
~~Cooldown4~~	~~350~~	~~0.001~~	~~0.004~~
~~Cooldown5~~	~~350~~	~~0.00418~~	~~0.0015~~
~~Cooldown6~~	~~300~~	~~0.001~~	~~0.0015~~
~~Cooldown7~~	~~300~~	~~0.00418~~	~~0.004~~

~~(See Section 5.5 for discussion of Shutdown8).~~

Column A and B consist of time in hours and the time step in hours. It was assumed that shut down cooling would be initiated 2 hours after reactor trip, at the Trc = 350°F (Implying a cool down rate of 100-°F/hr up to that time). For an initial period, time steps of 0.1 hour were used. There after the time steps were allowed to vary using a variety of expedient logics, to give temperature changes on the order of 5°F maximum, but small enough that the calculation converged. The specific value of the time step is not critical, provided the increments are small enough to provide a smooth curve.

~~In the less fouled cases, reasonable time steps resulted in the primary coolant temperature dropping below 130°F in a reasonable time period. In the more highly fouled cases, the calculation failed to converge. It was determined that in these cases, the decay heat and the other heat loads on the CCW, held the CCW temperature and the primary coolant temperature at higher than 130°F and the cooling them tracked the decay heat curve rather than a force cooling curve. These cases all exceed 60 hours and failed the 24 hour limit.~~

~~(As an estimate of the final cool down time, the heat removed by the system across the fouled heat exchangers with 130°F primary coolant was calculated, and the time at which the decay heat (plus pump heat) matched that value was determined. This was then provided as an approximate value of the cool down time. This calculation is shown in a row of the "Cooldown$" sheet, a line or two below the last row of the time step calculations.)~~

Column C contains core fission product decay heat, column D contains primary pump work in to system and column E contains LPSI pump work in to system. Column F contains heat removed by the shut down cooling heat exchangers for each time step, linked from Column AY. Column G contains summation of the above heat loads. Column H contains ratio of summation heat loads to the thermal capacitance of the primary system, which is the cooling rate for the primary system.

Column I to L contains SDC heat exchanger tube side RC coolant flow, pressure, inlet temperature and estimated outlet temperature information. The initial RC temperature is as assumed for the case. The RC temperature in each succeeding line is the previous temperature less the duration of the previous time step (Column B) times the cooling rate (Column H).

Column M to P contains SDC heat exchanger shell side CCW water flow, pressure, inlet temperature and estimated outlet temperature information. The initial CCW flow (Cell J6) is varied to hold the outfall temperature at just below 120°F. The flow then increases to the un-throttle flow when the temperature of the primary coolant entering the exchanger drops below the switch point (Cell J7). Column O contains the CCW temperature used to check the 120°F limits.

Column Q to Y contains SDC heat exchanger tube side RC coolant thermal properties calculated at the time step average temperature - density, specific heat at constant pressure, dynamic viscosity, thermal conductivity, velocity, Reynolds number, Prandtl number. and inside heat transfer coefficient.

Similarly Column Z to AH contains SDC heat exchanger shell side CCW water thermal properties - density, specific heat at constant pressure, dynamic viscosity, thermal conductivity, velocity, Reynolds number, Prandtl number and outside heat transfer coefficient. Column AI contains metal thermal conductivity at the average of tube and shell side temperatures.

Column AJ contains overall heat transfer calculation using the tube and shell side coefficients from Columns Y and AH, the metal conductivity (Col AI) and the total fouling coefficient for the Sheet.

Column AK to AQ contains SDC heat exchanger tube side RC coolant mass flow, multiplication of mass flow and specific heat, capacity ratio, NTU, effectiveness, inside and outside temperature difference, estimated RC outlet temperature.

Column AR to AX contains SDC heat exchanger shell side CCW coolant mass flow, multiplication of mass flow and specific heat, capacity ratio, NTU, effectiveness, inside and outside temperature difference, estimated CCW outlet temperature. Column AY contains heat transferred in the SDC heat exchanger.

Column AZ and BA contains SDC heat exchanger tube side outlet temperature and shell side outlet temperature that has been iterated with an estimated value until variation of both the temperature is less than 0.01.

Column BD contains miscellaneous heat load, and column BE contains summation of miscellaneous heat load and heat transferred in the SDC heat exchanger.

Column BF contains total river water flow and Column BG contains number of CCW heat exchangers, both by reference to the values on Sheet "CCW". Column BH contains the duty on a single CCW heat exchanger. Column BJ contains shell side CCW outlet temperature, though a lookup into the CCW Hx duty-fouling-outlet temperature table on Sheet "CCW".

~~Column BK is the river water outlet temperature calculated from the total CCW duty and river water flow. River water density and specific heat are calculated at average river water inlet and outlet temperature.~~

Each Cooldown$ sheet is accompanied by a graph of the primary coolant temperatures entering and leaving the SDC Hx and the outfall temperature. These are printed in Attachment 2

5.4 Analysis and Results ~~Summary~~

As indicated above, the analysis will be performed with clean, service, and maximum fouling conditions, in various combinations from cleanest to most fouled.

The analyses with high heat exchanger fouling took more than 24 hours to cool to 130°F when only one SDC exchanger was used. Additional cases were added with the second SDC heat exchanger added when the RCS cooled to 225°F. See Section 5.5 for discussion of the spreadsheet modification for the 2 SDC heat exchanger.

The analyses done are:

	RC Initial Temperature, °F	SDHX Fouling Coefficient	CCWHx Fouling Coefficient	
Cooldown1	350	0.001	0.0015	
Cooldown2	350	0	0	
Cooldown3	350	0.00418	0.0015	
Cooldown9	350	0.00418	0.0015	2 SC Hx
Cooldown6	350	.0	0.004	
Cooldown4	350	0.001	0.004	
Cooldown5	350	0.00418	0.004	
Cooldown8	350	0.00418	0.004	2 SC Hx

(The case order was rearranged in Revision 3 to clarify the successful and unsuccessful cases.)

The analyses was initially run with full, unthrottled CCW flow (4,246 gpm) to the SDC heat exchanger in all 8 cases. The results are tabulated below. The high initial CCW flow resulted in too rapid a RCS cool down (> 100°F/hour) and, when the CCW exchanger was highly fouled, too hot an initial CCW temperature (> 120°F).

RC Initial Temp, F	SDHX Fouling Factor	CCWHx Fouling Factor	Initial CCW Flow gpm	Initial CCW Temp degF	Initial RCS cooldown rate degF/hr	Time from SDC initiation to 130F RCS hours	
350	0	0	4,246	109.64	-141	12.89	
350	0.001	0.0015	4,246	114.93	-113	20.00	
350	0.00418	0.0015	4,246	108.41	-58	71.21	
350	0.00418	0.0015	4,246	108.41	-53	12.95	with 2nd SDC HX
350	0	0.004	4,246	129.46	-123	16.55	
350	0.001	0.004	4,246	126.11	-104	24.42	
350	0.00418	0.004	4,246	116.79	-54	> 60	
350	0.00418	0.004	4,246	116.79	-49	16.19	with 2nd SDC HX

This analysis was done in spreadsheet "Calc-PM-44-3 Att2-1 SDC CooldownTime4246Q.xls" which is printed on pages 1 to 61 of Attachment 2.

By trial and error, it was found that the throttling the initial CCW flow to 1,850 gpm would reduce the CCW temperature to below 120°F. This extended the cooling time too much and the flow was "un-throttled" at 275°F RCS temperature. The unthrottling point was determined by trial and error

as the RCS temperature at which full CCW flow would not raise the CCW temperature above the limit.[9] These parameters were then used in all cases. This was done to provide a common basis of operation, and address the too high RCS cool down rate. With these parameters the analysis results were:

RC Initial Temp, F	SDHX Fouling Factor	CCWHx Fouling Factor	Initial CCW Flow gpm	Initial CCW Temp degF	Initial RCS cooldown rate degF/hr	Time from SDC initiation to 130F RCS hours	
350	0	0	1,850	104.24	-74	11.75	
350	0.001	0.0015	1,850	108.95	-63	19.99	
350	0.00418	0.0015	1,850	105.29	-33	64.02	
350	0.00418	0.0015	1,850	105.29	-30	12.99	with 2nd SDC HX
350	0	0.004	1,850	118.91	-65	16.55	
350	0.001	0.004	1,850	117.54	-58	24.42	
350	0.00418	0.004	1,850	112.29	-30	> 60	
350	0.00418	0.004	1,850	112.29	-27	16.30	with 2nd SDC HX

This analysis was done in spreadsheet "Calc-PM-44-3 Att2-2_SDC_CooldownTime1850Q.xls" which is printed on pages 62 to 122 of Attachment 2.

CCW temperature and the RCS cool down rate are acceptable in all cases. When the heat exchanger fouling is high, the second SDC exchanger is needed to give a 24 hour cooled when the river is at 90°F.

An additional check was made to verify that the 1,850 gpm / 275°F parameters would work acceptably at the minimum river water temperature. It was expected that the colder heat sink would increase the RCS cool down rate. The river was assumed to be at 33°F (Assumption 10). This approximated a river with ice. (The steam table programming used does not support 32.00°F.) To give the highest cool down rate, zero fouling was used. The results are:

RC Initial Temp, F	SDHX Fouling Factor	CCWHx Fouling Factor	Initial CCW Flow gpm	Initial CCW Temp degF	Initial RCS cooldown rate degF/hr	Time from SDC initiation to 130F RCS hours	
350	0	0	4,246	54.86	-169	2.68	
350	0	0	1,850	49.60	-97	3.07	

This analysis was done in spreadsheet "Calc-PM-44-3 Att2-3_SDC_CooldownTime33F.xls" which is printed on pages 123 to 141 of Attachment 2. (The metal conductivity table on sheet SDCHx had to be extended from 70°F to 32°F for this analysis. The 32°F conductivity value was an extrapolation of the Reference 5 values.)

As expected the cool down is more rapid, but the 1,850 gpm flow is low enough to meet the 100 F/hr limit.

~~The results of the calculations are summarized below.~~

-	-	-	~~By time increment~~	-	-	~~Outfall Temperature~~

[9] A CCW temperature of 119° rather than 120° was used to provide slightly more margin. From review of the results, this was judged to have negligible consequence on the cool down time,

			~~calculation~~					
~~Initial Temp °F~~	~~SDHX Fouling Coef~~	~~CCWHx Fouling Coef~~	~~SDC Initiation after trip hrs~~	~~SDC initiation to 130F hrs~~	~~Initial CCW Flow gpm~~	~~Flow step up temp °F~~	~~Initial Outfall Temp °F~~	~~Outfall Temp after flow step up °F~~
~~350~~	~~0~~	~~0~~	~~2.00~~	~~22.4~~	~~1,015~~	~~213~~	~~119.5~~	~~119.6~~
~~350~~	~~0.001~~	~~0.0015~~	~~2.00~~	~~22.1~~	~~1,075~~	~~233~~	~~119.6~~	~~119.8~~
~~350~~	~~0.001~~	~~0.004~~	~~2.00~~	~~26.3~~	~~1,125~~	~~235~~	~~119.7~~	~~119.1~~
~~350~~	~~0.00418~~	~~0.0015~~	~~2.00~~	~~>60[1]~~	~~1,480~~	~~290~~	~~119.3~~	~~119.7~~
~~350~~	~~0.00418~~	~~0.004~~	~~2.00~~	~~>60[2]~~	~~1,600~~	~~300~~	~~119.5~~	~~119.99~~
-	-	-	-	-				
~~300~~	~~0.001~~	~~0.0015~~	~~2.50~~	~~21.5~~	~~1,500~~	~~232~~	~~119.3~~	~~119.5~~
~~300~~	~~0.00418~~	~~0.004~~	~~2.50~~	~~>60[3]~~	~~3,540~~	~~295~~	~~119.6~~	~~119.5~~

~~1 - Estimated at 67.4 hours~~

~~2 - Estimated at 78.4 hours~~

~~3 - Estimated at 77.9 hours~~

~~Note that the calculated CCW flows are significantly lower than estimated in Revision 1 of this calculation (1962 gpm throttled (Ref. 1, page 8)), even in the rerun of the Revision 1 case. The calculated cool down time is shorter than calculated in Revision 1 (24 hrs (Ref. 1, page 24)), but this is not unexpected, given the conservative simplifications used in Revision 1.~~

~~The system performance (cool down time and outfall temperature) is highly dependent on the cleanliness of the heat exchangers, particularly the SDC Hx. This is both from the heat removal rate as the primary loop nears the final temperature, but also due to the constrains that the outfall temperature limit places on the initial CCW flow and the timing for un-throttling the flow. (Note that the cool down time for the zero fouling case is actual longer than for the nominal (service) fouling case. This is a consequence of delaying the un-throttling.)~~

5.5 Additional Analysis with 2 SDC Heat Exchangers

In response to Client comments after the base calculation was completed, ~~an~~ additional ~~analysis~~ analyses ~~was~~ were performed with the second SDC HX being brought into service ~~in the maximum fouling case~~.

The analysis spreadsheet described above was modified by:

- Adding an additional instance of the Cooldown$ and Chart$ pages ($=8 & 9)
- Combining the pump heat loads in columns D and E into a single column and moving the F, G, and H into E, F and G.
- A new parameter "Number of SDC HX's Inservice" was added in Column H, with a value toggling from 1 for when the RC temperature (Col K) was above the value in Cell J8, and 2 when the value was less. Cell J8 thus services as the control temperature for starting the 2nd SDC Hx.
- The primary coolant flow (SDC tube flow) was modified to be 3000 gpm when 1 SDC HX was in service and 2000 gpm (per HX) when 2 SDC HXs were in service. The 2000 gpm

value is a conservative value based on language in the Shutdown Cooling Design Basis Document SDBD-SI-130 (Ref. 18, page 94).

- The CCW flow (SDC shell flow) was modified to allow a maximum of 4246 gpm when 1 SDC HX was in service and 3254 gpm (per HX) when 2 SDC HXs were in service. The 3254 gpm value is from Calculation FC05669 (Ref. 19, page 64, lesser of the 2 HX flows).

With these changes the heat load calculated in columns I to BA is for one SDC HX.

- The SDC heat load used in columns F and BE was then multiplied by the number of SDC HX in service (Col H) so as to reflect the total heat transferred from the primary to the CCW system and thus to the river water.

The case fouling coefficients were set to the maximum values (0.00418 and 0.004 above) and the control temperature and throttled flow were adjusted to provide the fastest cooling consistent with a ~~120°F~~ 120°F ~~maximum~~ CCW~~outfall~~ temperature. (The time increments were adjusted as needed.)

(The results are discussed in Section 5.4.) ~~The results were that with the limiting fouling coefficients, using two SDC heat exchanger and initiation shutdown cooling 2 hours after a trip from full load (1500 MWt) with the primary coolant at 350°F, the primary system can be cooled to 130°F within 24 hours. (The calculation gives 18 hours from initiation of SDC.) The CCW flow to the single SDC HX operating initially needs to be throttled to 1675 gpm. The flow should be un-throttled at 295°F, primary coolant temperature and the second SDC HX placed in service at 225°F, primary coolant temperature.~~

6.0 Conclusion

With shut down cooling initiated 2 hours after a trip from full power, with the a reactor coolant temperature of 350°F and river water at 90°F, the shut down cooling system can reduce the reactor coolant system temperature to 130°F within 24 hours, under all combination of heat exchange fouling permitted by station procedures.

CCW flow to a single SDC heat exchanger should be initially throttled to 1,850 gpm, and then unthrottled when the RCS temperature reaches 275°F. This is necessary to maintain the CCW system at less than 120°F when the river is at 90°F. This flow also limits the RCS cool down rate to less than 100°F/hour at all river temperatures.

When both the SDC and CCW heat exchangers are at their nominal service fouling levels or cleaner, only one SDC heat exchanger is needed to reach 130°F in less than 24 hours.

With higher levels of fouling in either set of heat exchangers, cooling times increase and the second SDC heat exchanger may be needed to achieve the 24 hour cool down. The criteria for starting the second SDC exchanger was not established analytically, but a RCS temperature above 160°F, 6 hours after SDC initiation would work for the cases analyzed.

~~With cooling initiated at a reactor coolant temperature of 350°F, the one shutdown cooling heat exchanger can cool the primary loop to 130°F in less than 24 hours from the initiation of cooling. This is based on a trip from full licensed power (1500 MWt), the SDC and CCW heat exchangers at their nominal service fouling level.~~

~~To hold the river water outfall temperature below 120°F, the CCW flow to the SDC heat exchanger must be throttled to 1,075 gpm until the primary coolant temperature has been reduced to 230°F, at which point it can be increased to the full un-throttled flow of 4,246 gpm.~~

These calculations use raw water and closed loop cooling flows based on calculations with degraded pump flows. If the actual system flows are higher, the CCW flow to the SDC heat exchanger may need to be throttled further and the "un-throttling" temperature adjusted ~~raised~~.

With a single SDC heat exchanger in service and that heat exchanger at its maximum fouling per PED-SEI-16 R9, cool down will take well in excess of 24 hours, estimated at over 60 hours, depending on the CCW heat exchanger fouling. If a second SDC heat exchanger is brought into service, the cool down to 130°F can be achieved in less than 24 hours.

(~~Afterword~~After word: Review of the portions of Reference 19 provided near the end of this task's execution, suggest that the CCW flow estimates used herein were not correct. However the flow values used were lower than those in Reference 19, thus making the conclusion, above, valid. This calculation should be considered a validation of the capability of the shutdown cooling system to cool the primary coolant system from 350°F to 130°F in less than 24 hours from initiation, and not a definitive prediction of the actual time, throttled flow rate, un-throttling control point, or CCW and river water temperatures.)

7.0 Attachments

1. Miscellaneous References
   - CCW HX Data Sheets (Ref. 8)
   - SDC HX Data Sheets (Ref. 11)
   - Excerpt from Compact Heat Exchangers (Ref. 4)
   - Excerpt from Shutdown Cooling Design Basis Document SDBD-SI-130
   - Excerpt from Calc. FC05669
2. Calculation Spreadsheets
3. Calculation PM-44 Revision 1 (Ref. 1)

Revision 3 Note: Pages in Attachments 1 and 3 which were not changed from Revision 2 retain the "Rev. 2" marking.

THE WHITLOCK MANUFACTURING CO.

Design & Mode B

EXCHANGER SPECIFICATION SHEET

			JOB No. 20-69-4333 ed 2
CUSTOMER	Peter Kiewitt Sons' Co.		REFERENCE No.
ADDRESS			INQUIRY No.
PLANT LOCATION			DATE March 9, 1970
SERVICE OF UNIT	Shutdown Heat Exchanger		ITEM No. AC-~~1~~A-~~1~~B
SIZE	35-B-300	TYPE 1-R-2	CONNECTED IN
SURFACE PER UNIT		SHELLS PER UNIT	SURFACE PER SHELL 5020 sq. ft. eff.

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	"B" Fluid		"A" Fluid	
TOTAL FLUID ENTERING	4500 GPM		3000 GPM	
VAPOR				
LIQUID	4500 GPM		3000 GPM	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY-LIQUID				
VISCOSITY-LIQUID				
MOLECULAR WEIGHT-VAPORS				
SPECIFIC HEAT-LIQUIDS		B.T.U./#		B.T.U./#
LATENT HEAT-VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	93	°F	140	°F
TEMPERATURE OUT	109.5	°F	115.2	°F
OPERATING PRESSURE		#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES	1 - Divided Flow		2	
VELOCITY	4.0 (mean)	FT./SEC.	5.5	FT./SEC.
PRESSURE DROP	5.3	#/SQ. IN.	6.0	#/SQ. IN.
Fouling	.0005		.0005	

HEAT EXCHANGED-B.T.U./HR. 37,100,000 M.T.D. (CORRECTED) 23.19°F

TRANSFER RATE-SERVICE 320 CLEAN 487

CONSTRUCTION

DESIGN PRESSURE		#/SQ. IN.	#/SQ. IN.
TEST PRESSURE		#/SQ. IN.	#/SQ. IN.
DESIGN TEMPERATURE		°F	°F

TUBES NO. O.D. BWG LENGTH PITCH

SHELL I.D. O.D. THICKNESS

SHELL COVER FLOATING HEAD COVER

CHANNEL CHANNEL COVER

TUBE SHEETS-STATIONARY FLOATING

BAFFLES-CROSS TYPE THICKNESS

BAFFLE-LONG TYPE THICKNESS

TUBE SUPPORTS THICKNESS

GASKETS

CONNECTIONS-SHELL-IN OUT SERIES

CHANNEL-IN OUT SERIES

CORROSION ALLOWANCE-SHELL SIDE TUBE SIDE

CODE REQUIREMENTS

WEIGHTS-EACH SHELL BUNDLE FULL OF WATER

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:-

RECEIVED
MAR 16 1970
GIBBS & HILL, INC.

01921 01921

FORM E-710A

THE WHITLOCK MANUFACTURING CO.

Mode A

EXCHANGER SPECIFICATION SHEET

DATA 166

CUSTOMER	Peter Kiewitt Son's Co.	JOB No.	20-69-4333 ✓. /
ADDRESS		REFERENCE No.	
PLANT LOCATION	Fort Calhoun Unit #1	INQUIRY No.	cont. 763 Spec. 25
		DATE	March 9, 1970
SERVICE OF UNIT	Shutdown Heat Exchanger	ITEM No.	AC-1A-1B
SIZE 35-B-300	TYPE 1-R-2	CONNECTED IN	
SURFACE PER UNIT	SHELLS PER UNIT	SURFACE PER SHELL	5020 sq. ft. eff.

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	"D" Fluid		"A" Fluid	
TOTAL FLUID ENTERING	2250 GPM		1500 GPM	
VAPOR				
LIQUID	2250 GPM		1500 GPM	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY-LIQUID				
VISCOSITY-LIQUID				
MOLECULAR WEIGHT-VAPORS				
SPECIFIC HEAT-LIQUIDS		B.T.U./#		B.T.U./#
LATENT HEAT-VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	78	°F	125	°F
TEMPERATURE OUT	94.5	°F	100.3	°F
OPERATING PRESSURE		#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES	Div. Flow		2	
VELOCITY	1.9	FT./SEC.	2.8	FT./SEC.
PRESSURE DROP	2.9	#/SQ. IN.	1.8	#/SQ. IN.
Total Fouling 0.00316				

HEAT EXCHANGED-B.T.U./HR.	18,526,000	M.T.D. (CORRECTED)	23.26°F
TRANSFER RATE-SERVICE	158.7	CLEAN	318.9

CONSTRUCTION

DESIGN PRESSURE		#/SQ. IN.	#/SQ. IN.
TEST PRESSURE		#/SQ. IN.	#/SQ. IN.
DESIGN TEMPERATURE		°F	°F

TUBES	No.	O.D.	BWG	LENGTH	PITCH
SHELL		I.D. O.D.		THICKNESS	
SHELL COVER				FLOATING HEAD COVER	
CHANNEL				CHANNEL COVER	
TUBE SHEETS-STATIONARY				FLOATING	
BAFFLES-CROSS		TYPE		THICKNESS	
BAFFLE-LONG		TYPE		THICKNESS	
TUBE SUPPORTS				THICKNESS	
GASKETS					
CONNECTIONS-SHELL-IN		OUT		SERIES	
CHANNEL-IN		OUT		SERIES	
CORROSION ALLOWANCE-SHELL SIDE				TUBE SIDE	
CODE REQUIREMENTS					
WEIGHTS-EACH SHELL		BUNDLE		FULL OF WATER	

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:-

RECEIVED
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01919

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FORM E-710A

THE WHITLOCK MANUFACTURING CO.

Mode C

EXCHANGER SPECIFICATION SHEET

		JOB No. 20-69-4333	6.3
CUSTOMER	Peter Kiewitt Sons' Co.	REFERENCE No.	
ADDRESS		INQUIRY No	
PLANT LOCATION		DATE	March 9, 1970
SERVICE OF UNIT	Shutdown Heat Exchanger	ITEM No.	AC-4A,4B
SIZE 35-B-300	TYPE 1-R-2	CONNECTED IN	
SURFACE PER UNIT	SHELLS PER UNIT	SURFACE PER SHELL	5020 sq.ft. eff.

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	"D" or "S" Fluid		"A" or "E" Flair	
TOTAL FLUID ENTERING	2937 GPM		2250 GPM	
VAPOR				
LIQUID	2937 GPM		2250 GPM	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY-LIQUID				
VISCOSITY-LIQUID				
MOLECULAR WEIGHT-VAPORS				
SPECIFIC HEAT-LIQUIDS		B.T.U./#		B.T.U./#
LATENT HEAT-VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	95	°F	212	°F
TEMPERATURE OUT	135.2	°F	159.8	°F
OPERATING PRESSURE		#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES	Div. Flow		2	
VELOCITY	2.5	FT./SEC.	4.3	FT./SEC.
PRESSURE DROP	4.7	#/SQ. IN.	3.6	#/SQ. IN.
Total Fouling = .00342				

HEAT EXCHANGED-B.T.U./HR.	58,931,000	M.T.D. (CORRECTED)	65.31°F
TRANSFER RATE-SERVICE	178.1	CLEAN	455.2

CONSTRUCTION

DESIGN PRESSURE	#/SQ. IN.		#/SQ. IN.
TEST PRESSURE	#/SQ. IN.		#/SQ. IN.
DESIGN TEMPERATURE	°F		°F

TUBES	No.	O.D.	BWG	LENGTH	PITCH
SHELL		I.D. O.D.		THICKNESS	
SHELL COVER				FLOATING HEAD COVER	
CHANNEL				CHANNEL COVER	
TUBE SHEETS-STATIONARY				FLOATING	
BAFFLES-CROSS		TYPE		THICKNESS	
BAFFLE-LONG		TYPE		THICKNESS	
TUBE SUPPORTS				THICKNESS	
GASKETS					
CONNECTIONS-SHELL IN		OUT		SERIES	
CHANNEL-IN		OUT		SERIES	
CORROSION ALLOWANCE-SHELL SIDE				TUBE SIDE	
CODE REQUIREMENTS					
WEIGHTS-EACH SHELL		BUNDLE		FULL OF WATER	

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:-

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01922

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FORM E-710A

THE WHITLOCK MANUFACTURING CO.

EXCHANGER SPECIFICATION SHEET

Mode D

CUSTOMER	Peter Kiewitt Sons' Co.	JOB No.	20-69-4333 ✓.4
ADDRESS		REFERENCE No.	
PLANT LOCATION		INQUIRY No.	
		DATE	March 9, 1970
SERVICE OF UNIT	Shutdown Heat Exchanger	ITEM No	AC-~~A~~,~~A~~B
SIZE 35-B-300	TYPE 1-R-2	CONNECTED IN	
SURFACE PER UNIT	SHELLS PER UNIT	SURFACE PER SHELL	5020 sq. ft. eff.

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	"D" Fluid		"A" Fluid	
TOTAL FLUID ENTERING	4728 GPM		3400 GPM	
VAPOR				
LIQUID	4728 GPM		3400 GPM	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY-LIQUID				
VISCOSITY-LIQUID				
MOLECULAR WEIGHT-VAPORS				
SPECIFIC HEAT-LIQUIDS		B.T.U./#		B.T.U./#
LATENT HEAT-VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	95	°F	255	°F
TEMPERATURE OUT	135	°F	200	°F
OPERATING PRESSURE		#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES	Div. Flow		2	
VELOCITY	4.05	FT./SEC.	6.6	FT./SEC.
PRESSURE DROP	11.7	#/SQ. IN.	7.8	#/SQ. IN.
Total Fouling ~~H~~ .00418				

HEAT EXCHANGED-B.T.U./HR.	94,391,00	M.T.D. (CORRECTED)	108.98°F
TRANSFER RATE-SERVICE	170.7	CLEAN	594.3

CONSTRUCTION

DESIGN PRESSURE		#/SQ. IN.	#/SQ. IN.
TEST PRESSURE		#/SQ. IN.	#/SQ. IN.
DESIGN TEMPERATURE		°F	°F

TUBES	NO.	O.D.	BWG	LENGTH	PITCH
SHELL		I.D. O.D		THICKNESS	
SHELL COVER				FLOATING HEAD COVER	
CHANNEL				CHANNEL COVER	
TUBE SHEETS-STATIONARY				FLOATING	
BAFFLES-CROSS		TYPE		THICKNESS	
BAFFLE-LONG		TYPE		THICKNESS	
TUBE SUPPORTS				THICKNESS	
GASKETS					
CONNECTIONS-SHELL-IN		OUT		SERIES	
CHANNEL-IN		OUT		SERIES	
CORROSION ALLOWANCE-SHELL SIDE				TUBE SIDE	
CODE REQUIREMENTS					
WEIGHTS-EACH SHELL		BUNDLE		FULL OF WATER	

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:-

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GIBBS & HILL, INC

01920 01920

FORM E-710A

THE WHITLOCK MANUFACTURING CO.

EXCHANGER SPECIFICATION SHEET

MODE E (DESIGN)

CUSTOMER	Gibbs, Hill, Durham & Richardson, Inc.	JOB No.	
ADDRESS		REFERENCE No.	EL-6817 SH1
PLANT LOCATION	Fort Calhoun Station #1	INQUIRY No.	
SERVICE OF UNIT	Component Cooling Heat Exchanger	DATE	March 30, 1970
SIZE	58-B-336	ITEM No.	Alt. II-AC-1A,1B,1C,
TYPE	3-V1-3	CONNECTED IN &	1D
SURFACE PER UNIT	12,500 ft^2 tot	SHELLS PER UNIT	
SURFACE PER SHELL	12,400 ft^2 eff.		

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	"D"		"S"	
TOTAL FLUID ENTERING	2283 GPM		2673 GPM	
VAPOR				
LIQUID	2283 GPM		2673 GPM	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY-LIQUID				
VISCOSITY-LIQUID	-			
MOLECULAR WEIGHT VAPORS				
SPECIFIC HEAT-LIQUIDS		B.T.U./#		B.T.U./#
LATENT HEAT-VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	239.8	°F	85	°F
TEMPERATURE OUT	120	°F	185	°F
OPERATING PRESSURE		#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES	3		3	
VELOCITY	2.92 (mean)	FT./SEC.	3.4	FT./SEC.
PRESSURE DROP	11.5	#/SQ. IN.	4.1	#/SQ. IN.

Total Fouling = .0015

HEAT EXCHANGED-B.T.U./HR.	134,000,000	M.T.D. (CORRECTED)	44.3 F°
TRANSFER RATE SERVICE	244	CLEAN	408

CONSTRUCTION

DESIGN PRESSURE		#/SQ. IN.	#/SQ. IN.
[illegible]		#/SQ. IN.	#/SQ. IN.
DESIGN TEMPERATURE		°F	°F

TUBES	NO.	O.D.	BWG	LENGTH	PITCH
SHELL		I.D. O.D.		THICKNESS	
SHELL COVER				FLOATING HEAD COVER	
CHANNEL				CHANNEL COVER	
TUBE SHEETS-STATIONARY				FLOATING	
BAFFLES-CROSS		TYPE		THICKNESS	
BAFFLE-LONG		TYPE		THICKNESS	
TUBE SUPPORTS				THICKNESS	
GASKETS					
CONNECTIONS-SHELL-IN		OUT		SERIES	
CHANNEL-IN		OUT		SERIES	
CORROSION ALLOWANCE-SHELL SIDE				TUBE SIDE	
CODE REQUIREMENTS					
WEIGHTS-EACH SHELL		BUNDLE		FULL OF WATER	

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:-

FORM E-710A

THE WHITLOCK MANUFACTURING CO.

MEMBER TEMA

Mode A

EXCHANGER SPECIFICATION SHEET

CUSTOMER	Gibbs, Hill, Durham & Richardson, Inc.	JOB No.	
		REFERENCE No.	EL-6817 SH2
ADDRESS		INQUIRY No.	
PLANT LOCATION	Fort Calhoun Station #1	DATE	
SERVICE OF UNIT	Component Cooling Heat Exchanger	ITEM No.	Alt. II-AC-1A, 1B, 1C, 1D
SIZE	58-B-336 TYPE 3-V1-3	CONNECTED IN	
SURFACE PER UNIT	12,500 SqFt (Total) SHELLS PER UNIT	SURFACE PER SHELL	12,400 SqFt (Eff.)

PERFORMANCE OF ONE UNIT

		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		"D"		"S"	
TOTAL FLUID ENTERING	GPM.	1550		1575	
VAPOR					
LIQUID	GPM	1550		1575	
STEAM					
NON-CONDENSABLES					
FLUID VAPORIZED OR CONDENSED					
STEAM CONDENSED					
GRAVITY—LIQUID					
VISCOSITY—LIQUID					
MOLECULAR WEIGHT—VAPORS					
SPECIFIC HEAT—LIQUIDS			B.T.U./#		B.T.U./#
LATENT HEAT—VAPORS			B.T.U./#		B.T.U./#
TEMPERATURE IN		105.5	°F	85	°F
TEMPERATURE OUT		90	°F	100.3	°F
OPERATING PRESSURE			#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES		3		3	
VELOCITY			FT./SEC.	2	FT./SEC
PRESSURE DROP		5.7	#/SQ. IN.	1.6	#/SQ. IN.
Total Fouling = .0015					

HEAT EXCHANGED—B.T.U./HR.	12,000,000	M.T.D. (CORRECTED)	5.1
TRANSFER RATE—SERVICE	190.1	CLEAN	266

CONSTRUCTION

DESIGN PRESSURE				#/SQ. IN.		#/SQ. IN.
TEST PRESSURE				#/SQ. IN.		#/SQ. IN.
DESIGN TEMPERATURE				°F		°F
TUBES	NO.	O.D.	BWG	LENGTH	PITCH	
SHELL		I.D. O.D.		THICKNESS		
SHELL COVER				FLOATING HEAD COVER		
CHANNEL				CHANNEL COVER		
TUBE SHEETS—STATIONARY				FLOATING		
BAFFLES—CROSS		TYPE		THICKNESS		
BAFFLE—LONG		TYPE		THICKNESS		
TUBE SUPPORTS				THICKNESS		
GASKETS						
CONNECTIONS—SHELL—IN		OUT		SERIES		
CHANNEL—IN		OUT		SERIES		
CORROSION ALLOWANCE—SHELL SIDE				TUBE SIDE		
CODE REQUIREMENTS						
WEIGHTS—EACH SHELL		BUNDLE		FULL OF WATER		

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:—

FORM E-710A

1174 TSB

THE WHITLOCK MANUFACTURING CO.

EXCHANGER SPECIFICATION SHEET

Mode B

CUSTOMER	Gibbs, Hill, Durham & Richardson, Inc.	JOB No.	
		REFERENCE No.	EL-6817 SH3
ADDRESS		INQUIRY No.	
PLANT LOCATION	Fort Calhoun Station #1	DATE	
SERVICE OF UNIT	Component Cooling Heat Exchanger	ITEM No.	Alt. II-AC-1A,1B,1C,1D
SIZE	58-B-336 TYPE 3-V1-3	CONNECTED IN	
SURFACE PER UNIT	12,500 SqFt (Total) SHELLS PER UNIT	SURFACE PER SHELL	12,400 SqFt (Eff.)

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	"D"		"S"	
TOTAL FLUID ENTERING GPM	2885		3270	
VAPOR				
LIQUID GPM	2885		3270	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY—LIQUID				
VISCOSITY—LIQUID				
MOLECULAR WEIGHT—VAPORS				
SPECIFIC HEAT—LIQUIDS		B.T.U./#		B.T.U./#
LATENT HEAT—VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	118.4	°F	70	°F
TEMPERATURE OUT	85	°F	100	°F
OPERATING PRESSURE		#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES	3		3	
VELOCITY		FT./SEC.	4.16	FT./SEC.
PRESSURE DROP	17.5	#/SQ. IN.	5.9	#/SQ. IN.
Total Fouling = .0015				

HEAT EXCHANGED—B.T.U./HR.	48,180,000	M.T.D. (CORRECTED)	16.64F°
TRANSFER RATE—SERVICE	233.6	CLEAN	359.6

CONSTRUCTION

DESIGN PRESSURE				#/SQ. IN.	#/SQ. IN.
TEST PRESSURE				#/SQ. IN.	#/SQ. IN.
DESIGN TEMPERATURE				°F	°F
TUBES	NO.	O.D.	BWG.	LENGTH	PITCH
SHELL		I.D. O.D.		THICKNESS	
SHELL COVER				FLOATING HEAD COVER	
CHANNEL				CHANNEL COVER	
TUBE SHEETS—STATIONARY				FLOATING	
BAFFLES—CROSS		TYPE		THICKNESS	
BAFFLE—LONG		TYPE		THICKNESS	
TUBE SUPPORTS				THICKNESS	
GASKETS					
CONNECTIONS—SHELL—IN		OUT		SERIES	
CHANNEL—IN		OUT		SERIES	
CORROSION ALLOWANCE—SHELL SIDE				TUBE SIDE	
CODE REQUIREMENTS					
WEIGHTS—EACH SHELL		BUNDLE		FULL OF WATER	

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:—

FORM E-710A

1178

THE WHITLOCK MANUFACTURING CO.

Mode C

EXCHANGER SPECIFICATION SHEET

CUSTOMER	Gibbs, Hill, Durham & Richardson, Inc.	JOB No. / REFERENCE No.	EL-6817 SH4
ADDRESS		INQUIRY No.	
PLANT LOCATION	Fort Calhoun Station #1	DATE	
SERVICE OF UNIT	Component Cooling Heat Exchanger	ITEM No.	Alt II-AC-1A,1B,1C,1D
SIZE 58-B-336	TYPE 3-V1-3	CONNECTED IN	
SURFACE PER UNIT 12,500 SqFt (Total)	SHELLS PER UNIT	SURFACE PER SHELL	12,400 SqFt (Eff.) 17% Extra Surface

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	"D"		"S"	
TOTAL FLUID ENTERING GPM	2200		2518	
VAPOR				
LIQUID GPM	2200		2518	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY—LIQUID				
VISCOSITY—LIQUID				
MOLECULAR WEIGHT—VAPORS				
SPECIFIC HEAT—LIQUIDS		B.T.U./#		B.T.U./#
LATENT HEAT—VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	95.2	°F	70	°F
TEMPERATURE OUT	78	°F	85	°F
OPERATING PRESSURE		#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES	3		3	
VELOCITY		FT./SEC.	3.2	FT./SEC.
PRESSURE DROP	10.5	#/SQ. IN.	3.7	#/SQ. IN.
Total Fouling = .0015				

HEAT EXCHANGED—B.T.U./HR.	18,920,000	M.T.D. (CORRECTED)	9.05F°
TRANSFER RATE—SERVICE	203.7	CLEAN	293.3

CONSTRUCTION

DESIGN PRESSURE				#/SQ. IN.		#/SQ. IN.
TEST PRESSURE				#/SQ. IN.		#/SQ. IN.
DESIGN TEMPERATURE				°F		°F
TUBES	NO	O.D.	BWG.	LENGTH	PITCH	
SHELL		I.D. O.D.		THICKNESS		
SHELL COVER				FLOATING HEAD COVER		
CHANNEL				CHANNEL COVER		
TUBE SHEETS—STATIONARY				FLOATING		
BAFFLES—CROSS		TYPE		THICKNESS		
BAFFLE—LONG		TYPE		THICKNESS		
TUBE SUPPORTS				THICKNESS		
GASKETS						
CONNECTIONS—SHELL—IN		OUT		SERIES		
CHANNEL—IN		OUT		SERIES		
CORROSION ALLOWANCE—SHELL SIDE				TUBE SIDE		
CODE REQUIREMENTS						
WEIGHTS—EACH SHELL		BUNDLE		FULL OF WATER		

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:—

FORM E-710A

1679 TSB

THE WHITLOCK MANUFACTURING CO.

MEMBER TEMA

Mode D

EXCHANGER SPECIFICATION SHEET

CUSTOMER	Gibbs, Hill, Durham & Richardson, Inc.	JOB No.	
		REFERENCE No.	EL-6817 SH5
ADDRESS		INQUIRY No.	
PLANT LOCATION	Fort Calhoun Station #1	DATE	
SERVICE OF UNIT	Component Cooling Heat Exchanger	ITEM No.	Alt. II-AC-1A, 1B, 1C, 1D
SIZE 58-B-336	TYPE 3-V1-3	CONNECTED IN	
SURFACE PER UNIT 12,500 SqFt (Total)	SHELLS PER UNIT	SURFACE PER SHELL 12,400 SqFt (Eff.)	

PERFORMANCE OF ONE UNIT

21.87 Extra Surface

		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		"D"		"S"	
TOTAL FLUID ENTERING	GPM	2200		2518	
VAPOR					
LIQUID	GPM	2200		2518	
STEAM					
NON-CONDENSABLES					
FLUID VAPORIZED OR CONDENSED					
STEAM CONDENSED					
GRAVITY-LIQUID					
VISCOSITY-LIQUID					
MOLECULAR WEIGHT-VAPORS					
SPECIFIC HEAT-LIQUIDS			B.T.U./#		B.T.U./#
LATENT HEAT-VAPORS			B.T.U./#		B.T.U./#
TEMPERATURE IN		110.2	°F	85	°F
TEMPERATURE OUT		93	°F	100	°F
OPERATING PRESSURE			#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES		3		3	
VELOCITY			FT./SEC.	3.2	FT./SEC.
PRESSURE DROP		11.5	#/SQ. IN.	3.7	#/SQ. IN.
Total Fouling = .0015					

HEAT EXCHANGED-B.T.U./HR.	18,920,000	M.T.D. (CORRECTED)	9.05F°
TRANSFER RATE-SERVICE	215.5	CLEAN	318.4

CONSTRUCTION

DESIGN PRESSURE			#/SQ. IN.		#/SQ. IN.
TEST PRESSURE			#/SQ. IN.		#/SQ. IN.
DESIGN TEMPERATURE			°F		°F
TUBES	NO.	O.D.	BWG.	LENGTH	PITCH
SHELL		I.D. O.D.		THICKNESS	
SHELL COVER				FLOATING HEAD COVER	
CHANNEL				CHANNEL COVER	
TUBE SHEETS-STATIONARY				FLOATING	
BAFFLES-CROSS		TYPE		THICKNESS	
BAFFLE-LONG		TYPE		THICKNESS	
TUBE SUPPORTS				THICKNESS	
GASKETS					
CONNECTIONS-SHELL-IN		OUT		SERIES	
CHANNEL-IN		OUT		SERIES	
CORROSION ALLOWANCE-SHELL SIDE				TUBE SIDE	
CODE REQUIREMENTS					
WEIGHTS-EACH SHELL		BUNDLE		FULL OF WATER	

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:-

1702 TSB

THE WHITLOCK MANUFACTURING CO.

EXCHANGER SPECIFICATION SHEET

Mode F

CUSTOMER	Gibbs, Hill, Durham & Richardson, Inc.	JOB No.	
		REFERENCE No.	EL-6817 SH 6
ADDRESS		INQUIRY No.	
PLANT LOCATION	Fort Calhoun Station #1	DATE	
SERVICE OF UNIT	Component Cooling Heat Exchanger	ITEM No.	Alt II-AC-1A,1B,1C,1D
SIZE 58-B-336	TYPE 3-V1-3	CONNECTED IN	
SURFACE PER UNIT 12,500 SqFt (Total)	SHELLS PER UNIT	SURFACE PER SHELL	12,400 SqFt (Eff.)

PERFORMANCE OF ONE UNIT — 15.4% Extra Surface

		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		"D"		"S"	
TOTAL FLUID ENTERING	GPM	2025		3333	
VAPOR					
LIQUID	GPM	2025		3333	
STEAM					
NON-CONDENSABLES					
FLUID VAPORIZED OR CONDENSED					
STEAM CONDENSED					
GRAVITY—LIQUID					
VISCOSITY—LIQUID					
MOLECULAR WEIGHT—VAPORS					
SPECIFIC HEAT—LIQUIDS			B.T.U./#		B.T.U./#
LATENT HEAT—VAPORS			B.T.U./#		B.T.U./#
TEMPERATURE IN		134	°F	85	°F
TEMPERATURE OUT		95	°F	108.7	°F
OPERATING PRESSURE			#/SQ. IN.		#/SQ. IN.
NUMBER OF PASSES		3		3	
VELOCITY			FT./SEC.	4.24	FT./SEC.
PRESSURE DROP		9.3	#/SQ. IN.	6.1	#/SQ. IN.
Total Fouling = .0015					

HEAT EXCHANGED—B.T.U./HR.	39,488,000	M.T.D. (CORRECTED)	16.5F°
TRANSFER RATE—SERVICE	228.3	CLEAN	347.2

CONSTRUCTION

DESIGN PRESSURE				#/SQ. IN.		#/SQ. IN.
TEST PRESSURE				#/SQ. IN.		#/SQ. IN.
DESIGN TEMPERATURE				°F		°F
TUBES	No.	O.D.	BWG.	LENGTH	PITCH	
SHELL		I.D. O.D.		THICKNESS		
SHELL COVER				FLOATING HEAD COVER		
CHANNEL				CHANNEL COVER		
TUBE SHEETS—STATIONARY				FLOATING		
BAFFLES—CROSS		TYPE		THICKNESS		
BAFFLE—LONG		TYPE		THICKNESS		
TUBE SUPPORTS				THICKNESS		
GASKETS						
CONNECTIONS—SHELL—IN		OUT		SERIES		
CHANNEL—IN		OUT		SERIES		
CORROSION ALLOWANCE—SHELL SIDE				TUBE SIDE		
CODE REQUIREMENTS						
WEIGHTS—EACH SHELL		BUNDLE		FULL OF WATER		

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:—

FORM E-710A

20303 [redacted] TSB

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COMPACT HEAT EXCHANGERS

SECOND EDITION

W. M. KAYS
Professor of Mechanical Engineering
Stanford University

A. L. LONDON
Professor of Mechanical Engineering
Stanford University

McGRAW-HILL BOOK COMPANY
NEW YORK SAN FRANCISCO TORONTO LONDON

Table 2-7*a*. Split-flow Exchanger, $C_{tube} = C_{min}$

Split-flow exchanger with shell fluid mixed. Exchanger effectiveness (ε) as a function of capacity-rate ratio (C_{min}/C_{max}) and number of transfer units (N_{tu}) for $C_{tube} = C_{min}$

N_{tu}	ε for indicated capacity-rate ratios					
	0	0.2	0.4	0.6	0.8	1.0
0	0	0	0	0	0	0
0.5	0.393	0.378	0.364	0.350	0.337	0.324
1.0	0.632	0.593	0.557	0.523	0.491	0.462
1.5	0.777	0.718	0.663	0.613	0.566	0.524
2.0	0.865	0.791	0.722	0.660	0.603	0.552
2.5	0.918	0.833	0.755	0.683	0.619	0.562
3.0	0.950	0.857	0.771	0.693	0.624	0.564
3.5	0.970	0.870	0.778	0.695	0.623	0.561
4.0	0.982	0.876	0.779	0.693	0.619	0.556
4.5	0.989	0.878	0.777	0.689	0.614	0.551
5.0	0.993	0.877	0.773	0.683	0.607	0.545
5.5	0.996	0.875	0.768	0.676	0.601	0.538
6.0	0.998	0.872	0.762	0.670	0.594	0.532
6.5	0.999	0.868	0.756	0.663	0.588	0.526
7.0	0.999	0.864	0.750	0.656	0.581	0.520
7.5	0.999	0.860	0.744	0.650	0.575	0.515
8.0	1.000	0.856	0.738	0.644	0.569	0.510
8.5	1.000	0.852	0.732	0.638	0.564	0.505
9.0	1.000	0.849	0.727	0.632	0.559	0.500
9.5	1.000	0.846	0.722	0.627	0.554	0.496
10.0	1.000	0.843	0.718	0.622	0.549	0.492

Table 2-7*b*. Split-flow Exchanger, $C_{shell} = C_{min}$

Split-flow exchanger (shell fluid mixed) effectiveness (ε) as a function of capacity rate (C_{min}/C_{max}) and number of heat transfer units (N_{tu}) for $C_{shell} = C_{min}$

N_{tu}	ε for indicated capacity-rate ratios					
	0	0.2	0.4	0.6	0.8	1.0
0	0	0	0	0	0	0
0.5	0.393	0.378	0.364	0.350	0.337	0.324
1.0	0.632	0.593	0.557	0.523	0.492	0.462
1.5	0.777	0.718	0.664	0.613	0.567	0.524
2.0	0.865	0.792	0.723	0.661	0.603	0.552
2.5	0.918	0.835	0.757	0.685	0.620	0.562
3.0	0.950	0.861	0.775	0.697	0.626	0.564
3.5	0.970	0.876	0.785	0.701	0.627	0.561
4.0	0.982	0.884	0.789	0.702	0.624	0.556
4.5	0.989	0.889	0.791	0.700	0.620	0.551
5.0	0.993	0.892	0.790	0.697	0.615	0.544
5.5	0.996	0.893	0.789	0.693	0.609	0.538
6.0	0.998	0.893	0.787	0.689	0.604	0.532
6.5	0.999	0.893	0.785	0.685	0.599	0.526
7.0	0.999	0.892	0.782	0.680	0.593	0.520
7.5	0.999	0.892	0.780	0.676	0.588	0.515
8.0	1.000	0.891	0.777	0.672	0.583	0.510
8.5	1.000	0.890	0.774	0.668	0.578	0.505
9.0	1.000	0.889	0.771	0.664	0.573	0.500
9.5	1.000	0.888	0.769	0.660	0.569	0.496
10.0	1.000	0.887	0.766	0.656	0.564	0.492

Fig. 2-24. Heat transfer effectiveness as a function of number of transfer units and capacity rate ratio; split-flow exchanger, shell fluid mixed.

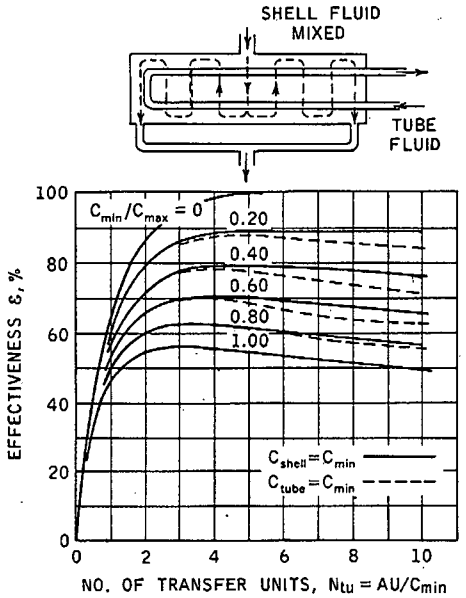
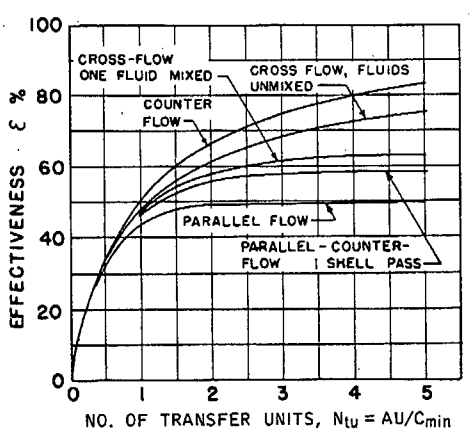


Fig. 2-25. Heat transfer effectiveness as a function of number of transfer units; effect of flow arrangement for $C_{min}/C_{max} = 1$.



Queenan, Peter

From: Manning, John
Sent: Friday, August 31, 2007 11:03 AM
To: Queenan, Peter
Subject: FW: CCW Flow Rates and SDC Fl
Attachments: CCW Flows SDC Flow.pdf

Pete

FYI

John Manning
(617) 589-1168

From: MOLZER, DOUGLAS S [mailto:dmolzer@oppd.com]
Sent: Thursday, August 30, 2007 4:35 PM
To: Manning, John
Subject: CCW Flow Rates and SDC Fl

John,

Please forward this to Peter Quenin (sp?).

The attachment contains:

1. Pages 64-67 of Calc. FC05669 showing CCW flow rates through AC-4A/B for 1 and 2 pump cases
2. Shutdown Cooling Design Basis Document SDBD-SI-130 indicating that RC flow through 2 SDC ht ex. Is approximately 5000 gpm. We could conservatively assume 2000 gpm flow through each heat exchanger for use with the maximum fouling factor.

Thanks,

Doug Molzer

This e-mail contains Omaha Public Power District's confidential and proprietary information and is for u
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Attachment 10 - Requirements and Design of Low Pressure Safety Injection Pumps (SI-2A, SI-2B

Requirements

Functional Requirements

- Safety Related Functional Requirements

  The Low Pressure Safety Injection Pumps shall be capable of delivering 159 gpm through the shutdown cooling suction line to provide an alternate hot leg injection flow path following a Large Break LOCA coincident with loss of instrument air and a single failure that would prevent the use of the pressurizer spray line (Ref. 4.20, 8.9, 9.9).

- Non-Safety Related Functional Requirements

  The Low Pressure Safety Injection pumps shall be capable of delivering 3000 GPM through the two shutdown cooling heat exchangers (Ref. 7.2, page 61; Ref. 7.3 Sec I-D-2).

Design

Functional Design

$ Safety Related Performance

The LPSI pumps are capable of delivering flows in excess of 200 gpm. A caution statement incorporated in EOP-3 warns the operator of possible pump damage if the pump is operated at flows below 200 gpm and RCS pressure above 140 psig (Ref. 4.20)

$ Non-Safety Related Performance

A calculation of available Shutdown cooling flow shows that two Low Pressure Safety Injection pumps are capable of delivering almost 5000 GPM through the two shutdown cooling heat exchangers (Ref. 8.1).

The LPSI pump delivery curves show that a considerable margin exists over the required flow rates (Attachment 6).

O-SEC-59
CALC. WIP # 61102

(Refer to SDBD-SI-LP-133 for additional information.)

There are no specific requirements imposed on the design of the Low Pressure Safety Injection pumps for the following design basis attributes:

Layout
Chemistry
Access Control
Environmental
Fire Protection
Alternate Shutdown
Safety Evaluation
Radiological
Seismic
Thermal/Hydraulic

Suitability of Materials, Processes, Parts and Equipment
Testing
Electrical Separation
Protection Against Dynamic Effects of Pipe Rupture, Jet Impingement and Missiles
Handling, Storage and Shipping
Personnel
Containment Isolation
Redundancy and Diversity
Material

CALCULATION COVER SHEET

Calculation Preparation, Review and Approval
Form PED-QP-3.1 Form Page No. 1 of 2
Calculation Cover Sheet

* Short Term Calc: ☐ YES ■ NO

CALCULATION NUMBER: ○ FC05669

Calc. Page No. 1
*TOTAL PAGES 446

QA Category: ■ CQE ☐ LIMITED CQE ☐ FIRE PROT ☐ NON CQE

○ FILE NO.

PED DEPARTMENT 357 DEN-Mechanical

CALCULATION TITLE
CCW SYSTEM FLOW RATES

VENDOR CALC. NO. 17321.01-PM-42

☐ MR NO.
☐ ENGR. ANALYSIS
■ DBD NO. SDBD-AC-CCW-100
☐ ECN NO.
☐ OTHER

* APPROVALS - SIGNATURE & DATE			*REV. NO.	SUPERSEDES *CALC. NO.	CONFIRMATION *REQUIRED (✓)	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
NOTE! NEW COVER SHEET USED FOR REV. 1 DUE TO CHANGE IN CALC. TITLE						
SEE ATTACHED SWEC TITLE PAGE FOR SIGNATURES 4-30-94			1	REV. 0 AND FC05543 REV 0		✓
SEE ATTACHED SWEC TITLE PAGE FOR SIGNATURES 8/25/94			2	REV 1		✓
J. W. Dingler J W Dingler 05-10-06	B. J. Dionne 5-10-06 Barbara J Dionne	B. J. Dionne 5-10-06 Barbara J Dionne	3	Rev. 2		X

* EXTERNAL ORGANIZATION DISTRIBUTION:

NAME & LOCATION	COPY SENT (✓)	NAME & LOCATION	COPY SENT (✓)

* SEE INSTRUCTIONS ON REVERSE SIDE
○ COMPLETED BY DOCUMENT CONTROL

17321.01-PM-42

Calc. No. FC05669, Rev. 4
Page 64 2

MODE	1	2	3	4	5	6	7	7A	7B	8	8A
No. Pumps	1	1	2	2	1	2	2	2	2	3	3
TDH (psi)	37.8	34.3	79.4	76.3	32.0	73.9	82.2	85.1	88.4	98.1	100.1
Total Flow	5807	5801	9035	9412	5606	9688	8399	8027	7597	9350	8849
AC-1A	1863	1861	3002	3128	1863	3219	2791	2667	2525	3107	2940
AC-1B	1849	1847	2979	3104	1849	3195	2770	2647	2505	3083	2918
AC-1C	1895	1893	3053	3181	1894	3274	2838	2713	2567	3160	2990
AC-1D	0	0	0	0	0	0	0	0	0	0	0
AC-4A	32	1937	51	3254	2152	28	61	67	73	68	74
AC-4B	32	1956	51	3287	16	3734	61	67	73	68	74
VA-1A	1118	0	1802	0	704	1215	2283	2586	2882	2542	2851
VA-1B	1148	0	1850	0	723	1247	2344	2655	0	2609	2927
VA-8A	620	0	999	0	390	673	1265	1437	1597	1408	1585
VA-8B	635	0	1023	0	400	689	1296	0	1635	1442	0
AC-8	760	650	1225	1092	459	791	0	0	0	0	0
CH-7	690	590	1112	991	416	718	0	0	0	0	0
SI-1A/B	12	11	20	18	8	13	29	32	35	32	35
SI-2A/B/C	48	41	78	69	29	49	110	123	137	123	136
SI-3A/B/C	19	16	30	26	12	19	42	47	53	47	52
VA-46A	60	57	96	96	38	65	155	176	196	173	194
VA-46B	60	58	97	97	38	65	0	0	0	0	0
CH-1A/B/C	15	15	24	21	9	15	33	39	42	39	42
RCP Lube	46	39	73	65	27	47	95	108	117	105	117
RCP Seal	89	76	144	128	54	93	185	207	229	206	229
CEDMs	59	50	95	84	35	61	122	137	151	136	151
WD-28A/B	48	26	77	44	26	44	93	101	109	103	110
SL-3	24	17	39	29	14	25	47	51	56	52	57
SL-8A/B	22	16	36	26	12	22	42	46	50	46	50
DW-46, SL-51	71	50	114	84	42	72	136	149	162	152	164

2

17321.01-PM-42

MODE	8B	9	9A	9B	10	10A	10B	10C	11	12	13
No. Pumps	3	3	3	3	2	2	2	2	1	1	1
TDH (psi)	103.2	96.5	99.1	101.6	71.8	72.4	72.9	73.9	40.0	39.9	43.6
Total Flow	8328	9895	9318	8673	9606	9554	9497	9411	5598	5606	5602
AC-1A	2767	2527	2379	2215	3192	3175	3156	3127	1860	1863	1861
AC-1B	2746	2507	2361	2198	3168	3150	3132	3103	1846	1849	1847
AC-1C	2814	2422	2281	2123	3246	3229	3210	3180	1892	1894	1893
AC-1D	0	2438	2296	2137	0	0	0	0	0	0	0
AC-4A	80	72	78	83	2573	2723	2870	3094	36	35	41
AC-4B	80	72	78	83	2599	2750	2899	3124	36	35	41
VA-1A	3160	2689	3002	3290	1235	1351	1460	1614	1285	1270	1506
VA-1B	0	2761	3082	0	1268	1388	0	0	1320	1304	1546
VA-8A	1751	1490	1668	1823	684	751	809	888	713	704	835
VA-8B	1793	1526	0	1867	700	0	828	0	730	721	856
AC-8	0	0	0	0	0	0	0	0	0	884	0
CH-7	0	0	0	0	0	0	0	0	813	0	0
SI-1A/B	39	33	37	41	15	16	17	19	16	15	19
SI-2A/B/C	149	130	144	155	58	62	67	73	61	55	73
SI-3A/B/C	56	50	56	59	22	24	25	28	24	22	28
VA-46A	215	183	204	224	84	92	99	110	69	68	80
VA-46B	0	0	0	0	0	0	0	0	69	68	81
CH-1A/B/C	45	39	45	48	18	18	21	23	18	18	23
RCP Lube	128	111	123	134	49	53	57	62	53	52	62
RCP Seal	251	218	241	262	96	104	111	122	104	103	122
CEDMs	165	144	159	172	63	68	73	81	68	68	81
WD-28A/B	121	109	117	125	35	37	39	42	54	53	61
SL-3	61	55	60	64	23	24	26	28	27	27	31
SL-8A/B	54	50	52	56	20	22	22	24	24	24	28
DW-46, SL-51	178	160	173	185	66	70	74	80	79	78	90

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17321.01-PM-42

MODE	14	15	16	17	18	19	20	21	22	23	24	25
No. Pumps	1	1	1	2	1	1	2	2	2	2	2	2
TDH (psi)	35.7	35.6	37.8	63.9	23.9	27.1	66.5	69.3	69.5	73.9	64.2	66.4
Total Flow	5598	5608	5606	10153	5304	5298	9989	9788	9787	9429	10110	9987
AC-1A	1860	1863	1863	2592	1354	1353	2551	2499	2499	2408	2582	2550
AC-1B	1848	1849	1849	2573	1344	1343	2531	2480	2480	2389	2562	2531
AC-1C	1892	1895	1894	2486	1298	1297	2446	2396	2396	2308	2475	2445
AC-1D	0	0	0	2502	1307	1306	2461	2412	2412	2323	2491	2461
AC-4A	2175	2158	2480	2403	1254	1885	2901	3387	36	43	2533	31
AC-4B	2197	2177	2505	2427	1267	1904	2930	3420	4784	5706	2558	4105
VA-1A	0	0	0	1106	577	0	0	0	0	0	1189	1374
VA-1B	0	0	0	1134	592	0	0	0	0	0	1221	1411
VA-8A	0	0	0	613	320	0	839	0	984	0	659	761
VA-8B	0	0	0	627	328	0	859	0	1007	0	675	780
AC-8	0	747	0	694	364	636	931	1132	1126	1395	0	0
CH-7	685	0	0	632	331	577	847	1030	1021	1266	708	840
SI-1A/B	14	12	16	12	6	10	15	19	18	23	14	17
SI-2A/B/C	52	47	61	44	23	40	59	72	71	88	54	64
SI-3A/B/C	19	18	22	16	9	16	22	26	28	34	21	25
VA-46A	64	64	73	59	31	56	82	100	96	120	63	73
VA-46B	65	64	73	60	31	56	83	101	97	121	64	74
CH-1A/B/C	15	15	18	15	6	12	18	21	21	27	17	21
RCP Lube	45	44	51	42	22	0	56	68	67	84	46	65
RCP Seal	88	87	101	82	43	0	110	133	132	164	90	107
CEDMs	58	57	66	54	28	0	72	88	87	108	60	71
WD-28A/B	30	29	34	32	17	26	39	46	57	68	34	49
SL-3	19	19	22	21	11	17	26	30	32	38	22	27
SL-8A/B	18	18	20	18	10	14	22	26	28	34	20	24
DW-46, SL-51	56	56	64	62	32	49	75	87	93	111	65	80

2

MODE	26	27	28	29								
No. Pumps	3	2	2	2								
TDH (psi)	92.4	75.8	80.6	68.3								
Total Flow	10795	9525	8855	10326								
AC-1A	2756	2432	2261	2637								
AC-1B	2735	2414	2244	2617								
AC-1C	2643	2332	2168	2528								
AC-1D	2660	2347	2182	2545								
AC-4A	61	54	65	2766								
AC-4B	61	54	65	2794								
VA-1A	2153	1899	2407	1327								
VA-1B	2211	1950	2471	1362								
VA-8A	1193	1053	1334	735								
VA-8B	1222	1078	1366	753								
AC-8	1464	1291	0	0								
CH-7	1328	1172	0	0								
SI-1A/B	24	21	30	16								
SI-2A/B/C	93	82	116	61								
SI-3A/B/C	35	31	44	23								
VA-46A	115	101	164	90								
VA-46B	116	102	0	0								
CH-1A/B/C	29	25	36	19								
RCP Lube	88	77	100	52								
RCP Seal	172	152	195	103								
CEDMs	113	100	129	68								
WD-28A/B	93	82	97	37								
SL-3	47	42	49	25								
SL-8A/B	42	37	44	22								
DW-46, SL-51	137	120	144	71								

Queenan, Peter

From: MOLZER, DOUGLAS S [dmolzer@oppd.com]
Sent: Friday, March 28, 2008 2:04 PM
To: Queenan, Peter
Cc: LIPPY, DONNA L; MATTHEWS, THOMAS C; GASPER, JAMES R
Subject: RE: OPPD SDC - 4 CCW Hx

Peter,

This is a follow-up to our earlier conversation. FlowServe has provided us verbal confirmation that the CCW limitation of 100 F based on LPSI pump seal temperatures may be overly conservative based on an inaccuracy in their assumed seal configuration. They have a high confidence level the previous limit of 120 F on CCW temperature should not be a problem. They agreed to send out a letter on Monday to confirm our conversation.

In the interim, our Design Manager requests the calculation you are working on (FC05694) be completed based on verbal confirmation. Please proceed with the completion of the Calculation based on a CCW limit of 120 F. I've provided an attached Excel spread sheet that lists the important input based on revision. Proceed on Revision 3 based on the attached inputs I've listed under the "Rev. 3" column. Please call if you have any questions. If the calculation cannot be completed by Monday please let us know, as we will need to inform the NRC we will not meet our commit date.

Thanks,

Doug Molzer
Nuclear Design Engineer
Fort Calhoun Nuclear Station
Ft. Calhoun, NE 68023
402-533-6678
dmolzer@oppd.com

From: Queenan, Peter [mailto:peter.queenan@shawgrp.com]
Sent: Thursday, March 27, 2008 4:18 PM
To: MOLZER, DOUGLAS S
Cc: Jacobs, Wesley
Subject: OPPD SDC - 4 CCW Hx

Doug – Using all 4 CCW heat exchangers doesn't help enough to get us there. And a higher CCW flow through the shells, doesn't help, it hurts.

> Counter intuitive as all get out, but increasing the CCW flow though the bank of 4 exchangers at a given duty actually raises the CCW cold temperature ! The higher flow does improve the heat transfer coefficient, and the average tube to shell temperature different does drop a hair. But since the temperature change is less with the higher flow, the inlet (CCW hot) temp drops and the outlet (CCW cold) rises.
>
> Another path that might work would be if the 100°F temperature could be raised by 1°F, to 101°F, the calculation works. Are the pump seals at issue somewhere where the ambient is low enough that un-insulated pipe or a passive fin cooler would buy 1°F ?

Peter Queenan, PE
Senior Engineering Specialist
Thermal Engineering Group
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Inputs to Calculation FC 5694 - Calculation of Minimum Reactor Coolant Time Usaing Shutdown Cooling System

	REV 0	REV 1	REV 2	REV 3 (IN PROGRESS)
LPSI Pumps #	2	2		2
LPSI Pumps Flow Total (RCS Flow) - gpm	3000	3000		3000
SDC HT EX #	1	1		1
SDC HT EX - Fouling	.0.001072	* 0.001	* 0.001	
CCW HT EX #	3	3		3
CCW HT EX - Fouling		* 0.0015	0.0015	
CCW Temp - Maximum (F)	120	120	120	120
CCW Pump #	2	2	2	2
CCW Pump Flow Total	8100	8100	8100	8100
CCW Heat Load (BTU/HR)	131.6 E6			Based on 2 hrs after shutdown
CCW Flow to SDC HT EX -throttled	1962	1962	As needed	As needed
CCW Flow to SDC HT EX -Unthrottled.	4246	4246	4246	4246
RW Pumps	2	2	2	
RW Pump Flow Total	7159	7159	7159	7159
RW Inlet Temp	90	90	90	90
RW Outlet Temp Limit	None	None	None	None
RCS Inlet Temp - Initial	300	300	350	350
Time to SDC - HRS	2.5	2.5	2	2

Shutdown Cooling Heat Exchanger

Heat transfer rate, clean	487		Btu/hr-F-sqft
Heat transfer rate, dirty	320		Btu/hr-F-sqft
Heat Transfer Area (ft2)	5020		
Number of U-tubes	514		
tube od, inch	0.75		
tube gage (BWG, inch)	18	0.049	
tube id, inch	0.652		
Tube flow area, ft^2	1.19175		(from tube number and id)
Shell Flow Area, ft^2	2.5904		(adjusted to give bet fit to data sheet velocities)
Shell film correction factor	0.09751		

Hx Design Point (Mode B)

	Q, gpm	W	Pt,i	Tt,i	Tt,o	Tt,ave	rho lb/ft^3	Cp Btu/lb-F	mu lb/ft-sec	k Btu/hr-ft-F	Vel	Re	Pr	h (Btu/hr-ft2-F)	Fouling, hr-ft^2-F/Btu	Udirty	Uclean	WCp	Cr	NTU	effectiveness	DT	to	Duty mmBtu/hr
																	0							
tube	3000	1,476,852	3.88918	140	114.93	127.47	61.38	0.9989	3.50E-04	0.372	5.609	53,484	3.3809	1554	0.0005			1,475,215	0.66	1.089	0.53330358	25.07	114.93	
metal						114.38			3.95E-04	8.775				2005		320.002	487.85							36.98
shell	4500	2,237,087	100	93	109.57	101.28	61.98	0.9977	4.52E-04	0.362	3.870	114,657	4.4774	1233	0.0005			2,231,873	1.5129	1.089	#N/A	16.57	109.57	
																320	487							37.1
																0.000810743	0.000814		0.0010716					
												-1.53E-08	-3.6E-06			2,066.65	2,057.66							
Mode A																								
tube	1500	741,518	2.9424	125	100.16	112.58	61.63	0.9983	4.02E-04	0.367	2.804	23,342	3.9442	839	0			740,278	0.66	1.067	0.52842214	24.84	100.16	
metal						99.40			4.61E-04	8.697				1988		157.280	313.22							18.39
shell	2250	1,121,755	95	78	94.43	86.21	62.16	0.9976	5.35E-04	0.356	1.935	48,566	5.3992	759	0.00316542			1,119,112	1.5117	1.067	#N/A	16.43	94.43	
																158.7	318.9							18.526
																0.001261508	0.001262		0.003165					
												5.7E-05	5.7E-05			1,271.19	1,271.19							
Mode C																								
tube	2250	1,079,449	15.696	212	158.65	185.33	59.81	1.0033	2.24E-04	0.387	4.206	61,051	2.0890	1483	0			1,083,007	0.75	0.815	0.45595948	53.35	158.65	
metal						150.11			2.89E-04	9.001				2057		175.878	440.88							57.78
shell	2937	1,455,601	95	95	134.77	114.88	61.79	0.9980	3.93E-04	0.368	2.526	85,650	3.8445	994	0.00341756			1,452,745	1.3414	0.815	#N/A	39.77	134.77	
																178.1	455.2							58.931
																0.000935297	0.000935		0.003418					
												7.1E-05	7.1E-05			1,857.22	1,858.06							
Mode D																								
tube	3400	1,599,745	33.5275	255	198.02	226.51	58.66	1.0093	1.75E-04	0.393	6.356	116,024	1.6139	2270	0			1,614,677	0.69	0.526	0.35611814	56.98	198.02	
metal						170.59			2.48E-04	9.124				2085		169.130	575.70							92.00
shell	4728	2,343,356	95	95	134.34	114.67	61.79	0.9980	3.94E-04	0.368	4.067	137,599	3.8534	1332	0.0041756			2,338,741	1.4484	0.526	#N/A	39.34	134.34	
																170.7	594.3							94.391
																0.000696222	0.000696		0.004176					
												5.4E-05	5.4E-05			2,493.60	2,493.52							

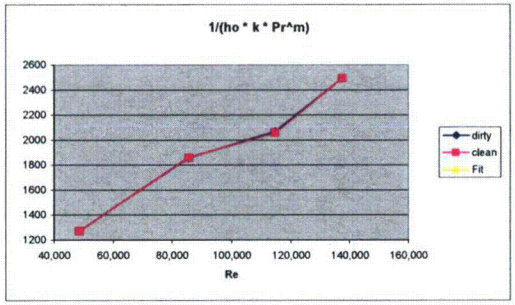
tube od, inch	0.75	
tube gage (BWG, inch)	18	0.049
tube id, inch	0.652	

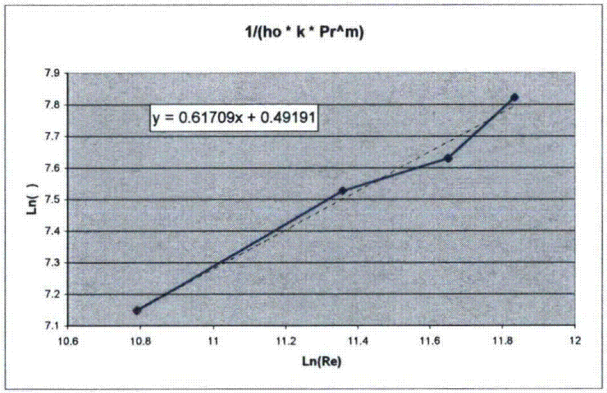
Re	dirty	clean	Ln(Re)	Ln(clean)
48,566	1,271	1,271	10.79068	7.14770788
85,650	1,857	1,858	11.35803	7.52729078
114,657	2,067	2,058	11.6497	7.62932323
137,599	2,494	2,494	11.8321	7.82145074

0.61709 0.49192

1.63545328

0.333





Effectiveness-Capacity Ratio-NTU for mix flow Hx

Capacity Ratio - WCp(tube) < WCp(shell)

NTU	0	0.2	0.4	0.6	0.8	1
0	0	0	0	0	0	0
0.5	0.393	0.378	0.364	0.350	0.337	0.324
1	0.632	0.593	0.557	0.523	0.492	0.462
1.5	0.777	0.718	0.664	0.613	0.567	0.524
2	0.865	0.792	0.723	0.661	0.603	0.552
2.5	0.918	0.835	0.757	0.685	0.620	0.562
3	0.950	0.861	0.775	0.697	0.626	0.564
3.5	0.970	0.876	0.785	0.701	0.627	0.561
4	0.982	0.884	0.789	0.702	0.624	0.556
4.5	0.989	0.889	0.791	0.700	0.620	0.551
5	0.993	0.892	0.790	0.697	0.615	0.544
5.5	0.996	0.893	0.789	0.693	0.609	0.538
6	0.998	0.893	0.787	0.689	0.604	0.532
6.5	0.999	0.893	0.785	0.685	0.599	0.526
7	0.999	0.892	0.782	0.680	0.593	0.520
7.5	0.999	0.892	0.780	0.676	0.588	0.515
8	1.000	0.891	0.777	0.672	0.583	0.510
8.5	1.000	0.890	0.774	0.668	0.578	0.505
9	1.000	0.889	0.771	0.664	0.573	0.500
9.5	1.000	0.888	0.769	0.660	0.569	0.496
10	1.000	0.887	0.766	0.656	0.564	0.492

Capacity Ratio - WCp(shell) < WCp(tube)

	0	0.2	0.4	0.6	0.8	1
0	0	0	0	0	0	0
0.5	0.393	0.378	0.364	0.350	0.337	0.324
1	0.632	0.593	0.557	0.523	0.492	0.462
1.5	0.777	0.718	0.664	0.613	0.567	0.524
2	0.865	0.791	0.723	0.661	0.603	0.552
2.5	0.918	0.833	0.757	0.685	0.620	0.562
3	0.950	0.857	0.775	0.697	0.626	0.564
3.5	0.970	0.870	0.785	0.701	0.627	0.561
4	0.982	0.876	0.789	0.702	0.624	0.556
4.5	0.989	0.878	0.791	0.700	0.620	0.551

18/8 Cr/Ni Steel (e.g. A249 TP304)

°F	Thermal Conductivity, Btu/hr/sqft/F
70	8.6
100	8.7
150	9
200	9.3
250	9.6
300	9.8
350	10.1
400	10.4
450	10.6
500	10.9
550	11.1
600	11.3
650	11.6
700	11.8
750	12
800	12.2
850	12.5
900	12.7
950	12.9
1000	13.2
1050	13.4
1100	13.6
1150	13.8
1200	14
1250	14.3
1300	14.5
1350	14.7
1400	14.9
1450	15.1
1500	15.3

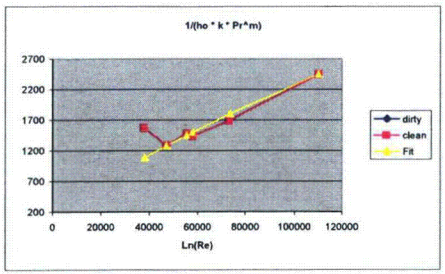
Component Cooling Water Heat Exchanger

Heat Transfer Area (ft2)	12400	effective
Number of tubes	2280	
No. of Passes	3	
tube od	0.75	
tube gage (BWG)	18	0.049
tube id	0.652	
Tube flow area, ft^2	1.76212	
Shell Flow Area, ft^2	1.74197	
Shell film correction factor	1.02130	

Tubes: 3/4", 18 BWG w. min wall, ST/STL - SA-249-TP-304 (OPPD Drawing File No. 18674, Whitlock Mfg Co. N o. L-26132-1
Flow arrangement, pure counterflow per draining Cramer and Lindell drawing FC-AC1B1, dated 7/26/99

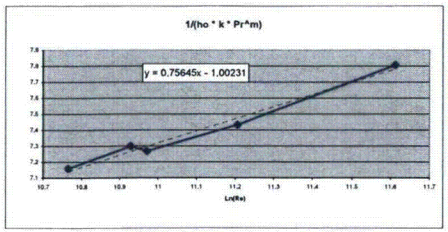
tube	0.333333
shell	0.333333

	Q, gpm	W	Pt,i	Tt,i	Tt,o	Tt,ave	rho lb/ft^3	Cp Btu/lb-F	mu lb/ft-sec	k Btu/hr-ft-F	Vel	Re	Pr	h (Btu/hr-ft2-F)	Fouling, hr-ft^2-F/Btu	Udirty	Uclean	WCp	Cr	NTU	effectiveness	DT	to	Duty mmBtu/hr
Hx Design Point (Mode E)																								
tube	2673	1,332,918	100	85	185.12	135.06	62.17	0.9989	3.27E-04	0.375	3.380	34,892	3.1407	1000	0			1,331,462	1.20	2.721		-100.12	185.12	
metal						157.46				9.045				2067		244.003	408.45							-133.30
shell	2283	1,109,178	100	239.8	119.91	179.85	60.57	1.0024	2.32E-04	0.386	2.920	110,479	2.1712	1228	0.00165			1,111,834	0.8350	2.721	0.775	-119.89	119.91	
																244	**408**							**134.00**
													-5.1E-08	-2.7E-06		0.0008146	0.0008172		0.00165					
																2,454.50	2,446.64							
Mode A																								
tube	1575	785,390	100	85	99.96	92.48	62.17	0.9976	4.97E-04	0.359	1.991	13,526	4.9820	523	0			783,494	1.02	2.820		-14.96	99.96	
metal						95.18				8.678				1983		174.966	237.22							-11.72
shell	1550	771,090	75	105.5	90.27	97.88	62.02	0.9977	4.68E-04	0.361	1.982	38,103	4.6634	661	0.0015			769,338	0.9819	2.820	0.743	-15.23	90.27	
																190.1	**266**							**12.00**
													4.6E-04	4.6E-04		0.001057	0.001056		0.00150					
																1,569.46	1,570.93							
Mode B																								
tube	3270	1,634,163	100	70	99.75	84.87	62.31	0.9976	5.43E-04	0.355	4.135	25,765	5.4952	896	0			1,630,306	1.14	2.056		-29.75	99.75	
metal						93.16			4.94E-04	8.670				1981		237.195	368.20							-48.50
shell	2885	1,434,171	95	118.4	84.50	101.45	61.98	0.9977	4.51E-04	0.362	3.690	73,637	4.4688	1078	0.0015			1,430,862	0.8777	2.056	0.700	-33.90	84.50	
																233.6	**359.6**							**48.18**
													-6.5E-05	-6.5E-05		0.0009926	0.0009927		0.00150					
																1,687.93	1,687.85							
Mode C																								
tube	2518	1,258,356	100	70	86.01	78.01	62.31	0.9978	5.91E-04	0.352	3.184	18,239	6.0346	695	0			1,255,608	1.15	2.312		-16.01	86.01	
metal						82.01			5.62E-04	8.629				1972		204.055	294.06							-20.11
shell	2200	1,096,865	95	95.2	76.82	86.01	62.16	0.9976	5.36E-04	0.356	2.814	47,375	5.4135	808	0.0015			1,094,283	0.8715	2.312	0.729	-18.38	76.82	
																203.7	**293.3**							**18.92**
													-8.6E-06	-8.8E-06		0.0012467	0.001247		0.00150					
																1,284.79	1,284.48							
Mode D																								
tube	2518	1,255,626	100	85	101.28	93.14	62.17	0.9976	4.94E-04	0.359	3.184	21,786	4.9410	764	0			1,252,598	1.15	2.443		-16.28	101.28	
metal						97.00			4.73E-04	8.686				1985		215.009	317.36							-20.40
shell	2200	1,093,785	95	110.2	91.51	100.85	61.99	0.9977	4.54E-04	0.362	2.814	55,804	4.5003	875	0.0015			1,091,251	0.8712	2.443	0.742	-18.69	91.51	
																215.5	**318.4**							**18.92**
													1.1E-05	1.0E-05		0.0011318	0.0011321		0.00150					
																1,477.97	1,477.53							
Mode F																								
tube	3333	1,662,034	100	85	109.93	97.47	62.17	0.9976	4.71E-04	0.361	4.214	30,250	4.6857	982	0			1,658,073	1.65	2.867		-24.93	109.93	
metal						105.42			4.33E-04	8.727				1994		231.626	354.95							-41.34
shell	2025	1,003,970	95	134	92.74	113.37	61.81	0.9980	3.99E-04	0.367	2.590	58,209	3.9076	874	0.0015			1,001,950	0.6043	2.867	0.842	-41.26	92.74	
																228.3	**347.2**							**39.488**
													-6.3E-05	-6.3E-05		0.001207	0.001207		0.00150					
																1,432.97	1,432.99							



Re

	dirty	clean		
38,103	1,569.46	1,570.93		
47,375	1,284.79	1,284.48	10.7658	7.158348
55,804	1,477.97	1,477.53	10.9296	7.298424
58,209	1,432.97	1,432.99	10.9718	7.267505
73,637	1,687.93	1,687.85	11.2069	7.431255
110,479	2,454.50	2,446.64	11.6126	7.80568
			0.75645	-0.99266
				0.37059

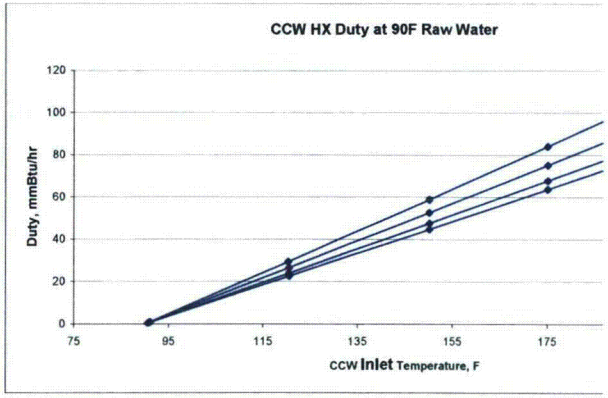


CCW Heat Exchanger Performance at Various Fouling Coefficients and CCW Inlet Temperatures with 90F River Water

River Water Temp	90	RW Flow, Total, gpm	7159	Shell Film Multiplier	1.0213
No CCW Hx	3	CCW Flow, total, gpm	8100	Shell Film Re power	0.75645
				Shell Film Pr power	0.333333333
				Fouling (total = tube side)	0.004

CCW - Based on Average Raw Water Flow

Case	Tube (River)				Shell (CCW)				Tube	Shell		Fouling (Total = Tube Side)		CCW HX tube side							CCW HX shell side					
	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o	h (Btu/hr-ft2-F)	h (Btu/hr-ft2-F)	kmetal		Udirty	W	WCp	Cr	NTU	ffectivenes	DT	Tt,o	W	WCp	Cr	NTU	ffectivenes	DTs
1A	2386.3	30	90	90.40	2700	90	90.50	90.15	719	966	8.658	0.0000	318.35	1,188,935	1,186,437	0.88	3.327	0.802	0.40	90.40	1,345,134	1,341,950	1.1311	3.327	0.729	0.35
1B	2386.3	30	90	114.64	2700	90	120.25	98.39	772	1066	8.729	0.0000	341.38	1,188,935	1,186,529	0.89	3.568	0.814	24.64	114.64	1,339,892	1,337,062	1.1269	3.568	0.742	21.86
1C	2386.3	30	90	139.48	2700	90	150.00	105.91	826	1159	8.816	0.0000	363.46	1,188,935	1,186,901	0.89	3.797	0.825	49.48	139.48	1,333,683	1,331,798	1.1221	3.797	0.752	44.09
1D	2386.3	30	90	160.71	2700	90	175.00	111.74	872	1233	8.897	0.0000	381.30	1,188,935	1,187,386	0.89	3.982	0.832	70.71	160.71	1,327,839	1,327,076	1.1176	3.982	0.761	63.26
1E	2386.3	30	90	182.19	2700	90	200.00	117.17	917	1302	8.982	0.0000	398.50	1,188,935	1,188,014	0.90	4.159	0.838	92.19	182.19	1,321,501	1,322,146	1.1129	4.159	0.768	82.83
2A	2386.3	30	90	90.72	2700	90	91.00	90.36	719	968	8.659	0.0015	215.63	1,188,935	1,186,436	0.88	2.254	0.720	0.72	90.72	1,345,046	1,341,861	1.1310	2.254	0.661	0.64
2B	2386.3	30	90	112.25	2700	90	120.50	100.75	767	1073	8.729	0.0015	225.55	1,188,935	1,186,507	0.89	2.357	0.730	22.25	112.25	1,339,490	1,336,709	1.1266	2.357	0.671	19.75
2C	2386.3	30	90	134.24	2700	90	150.00	110.55	815	1170	8.815	0.0015	234.61	1,188,935	1,186,804	0.89	2.451	0.737	44.24	134.24	1,332,841	1,331,107	1.1216	2.451	0.679	39.45
2D	2386.3	30	90	153.15	2700	90	175.00	118.46	856	1248	8.896	0.0015	241.70	1,188,935	1,187,198	0.90	2.524	0.743	63.15	153.15	1,326,485	1,326,007	1.1169	2.524	0.686	56.54
2E	2386.3	30	90	172.24	2700	90	200.00	126.04	896	1322	8.981	0.0015	248.30	1,188,935	1,187,707	0.90	2.592	0.748	82.24	172.24	1,319,552	1,320,670	1.1119	2.592	0.692	73.96
3A	2386.3	30	90	90.65	2700	90	91.00	90.42	719	968	8.659	0.0030	162.93	1,188,935	1,186,436	0.88	1.703	0.653	0.65	90.65	1,345,039	1,341,853	1.1310	1.703	0.604	0.58
3B	2386.3	30	90	110.15	2700	90	120.50	102.61	762	1077	8.729	0.0030	168.39	1,188,935	1,186,489	0.89	1.760	0.661	20.15	110.15	1,339,199	1,336,456	1.1264	1.760	0.612	17.89
3C	2386.3	30	90	130.00	2700	90	150.00	114.33	806	1180	8.814	0.0030	173.25	1,188,935	1,186,732	0.89	1.810	0.667	40.00	130.00	1,332,148	1,330,540	1.1212	1.810	0.619	35.67
3D	2386.3	30	90	147.03	2700	90	175.00	123.91	843	1261	8.895	0.0030	176.98	1,188,935	1,187,058	0.90	1.849	0.671	57.03	147.03	1,325,368	1,325,131	1.1163	1.849	0.625	51.09
3E	2386.3	30	90	164.20	2700	90	200.00	133.22	879	1337	8.979	0.0030	180.40	1,188,935	1,187,479	0.90	1.884	0.675	74.20	164.20	1,317,945	1,319,465	1.1111	1.884	0.630	66.78
4A	2386.3	30	90	90.61	2700	90	91.00	90.46	719	968	8.659	0.0040	140.10	1,188,935	1,186,436	0.88	1.464	0.615	0.61	90.61	1,345,035	1,341,849	1.1310	1.464	0.571	0.54
4B	2386.3	30	90	108.95	2700	90	120.50	103.68	760	1080	8.729	0.0040	144.06	1,188,935	1,186,480	0.89	1.506	0.621	18.95	108.95	1,339,033	1,336,311	1.1263	1.506	0.578	16.82
4C	2386.3	30	90	127.59	2700	90	150.00	116.47	800	1185	8.814	0.0040	147.54	1,188,935	1,186,694	0.89	1.542	0.626	37.59	127.59	1,331,750	1,330,216	1.1209	1.542	0.584	33.53
4D	2386.3	30	90	143.57	2700	90	175.00	127.00	835	1268	8.894	0.0040	150.19	1,188,935	1,186,984	0.90	1.569	0.630	53.57	143.57	1,324,728	1,324,632	1.1160	1.569	0.589	48.00
4E	2386.3	30	90	162.90	2700	90	205.00	139.30	876	1361	8.995	0.0040	153.06	1,188,935	1,187,444	0.90	1.598	0.634	72.90	162.90	1,315,408	1,317,591	1.1096	1.598	0.595	65.70



RW Flow, Total, gpm	7159
CCW Flow, total, gpm	8100

Case	Ts,o	Duty, per Hx	Tshell,in	Tshell,out	TD
1A	90.15	0.48	90.50	90.15	0.15
1B	98.39	29.23	120.25	98.39	8.39
1C	105.91	58.72	150.00	105.91	15.91
1D	111.74	83.95	175.00	111.74	21.74
1E	117.17	109.52	200.00	117.17	27.17
2A	90.36	0.85	91.00	90.36	0.36
2B	100.75	26.40	120.50	100.75	10.75
2C	110.55	52.51	150.00	110.55	20.55
2D	118.46	74.97	175.00	118.46	28.46
2E	126.04	97.67	200.00	126.04	36.04
3A	90.42	0.77	91.00	90.42	0.42
3B	102.61	23.90	120.50	102.61	12.61
3C	114.33	47.47	150.00	114.33	24.33
3D	123.91	67.70	175.00	123.91	33.91
3E	133.22	88.11	200.00	133.22	43.22
4A	90.46	0.73	91.00	90.46	0.46
4B	103.68	22.48	120.50	103.68	13.68
4C	116.47	44.61	150.00	116.47	26.47
4D	127.00	63.58	175.00	127.00	37.00
4E	139.30	86.56	205.00	139.30	49.30

CCW HX Ts,o

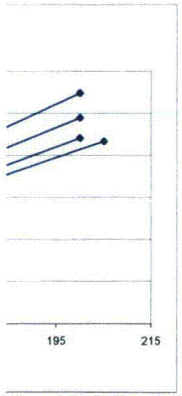
fouling	Duty, mmBtu/hr 1	20	40	60	86
0.0000	91.05	110.79	131.19	151.27	177.01
0.0015	91.17	113.17	135.93	158.37	187.18
0.0030	91.29	115.56	140.70	165.52	197.42
0.0040	91.37	117.16	143.89	170.30	204.27

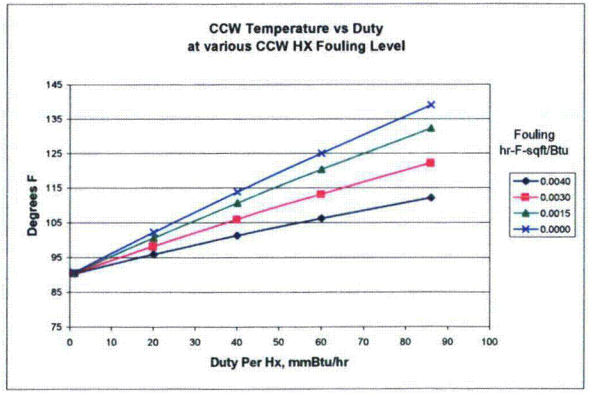
CCW HX shell outlet temperature

fouling	Duty, mmBtu/hr 1	20	40	60	86
0.0000	90.30	95.85	101.23	106.21	112.19
0.0015	90.42	98.22	105.95	113.24	122.19
0.0030	90.55	100.61	110.69	120.31	132.27
0.0040	90.63	102.20	113.85	125.04	139.01

Average CCW

90.68	103.32	116.21	128.74	144.60
90.80	105.70	120.94	135.81	154.69
90.92	108.09	125.69	142.92	164.85
91.00	109.68	128.87	147.67	171.64





Shutdown Cooling Temperature Transient with 90F River Water **SDC**

Hx Fouling = 0.001 hr-F-sqft/Btu, CCW Hx Fouling = 0.0015 hr-F-sqft/Btu

	Initial RC Temperature, F					350												SDC HX	CCW HX
	Initial Time					2					2754		Shell Film Multiplier					0.09751	
	RCS Temperature after 8 hours					152.35							Shell Film Re power					0.61709	
	Time after trip to 130F Primary Coolant Temp					22.00			Initial CCW to SDCHx		4246		Shell Film Pr power					0.333	
	Time after SDC initiation to 130F PC Temp					20.0			CCW Flow Step Temp		275		Fouling (total = tube side)					0.001	0.0015
	Decary heat equilibrium at 90F river temp					20.48												0.00418	0.004
										SDCHx									
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc			Tube					Shell				
hrs	hrs			mmBtu/hr			degF/hr		Q, gpm	Pi	Tt,i	Tt,o		Q, gpm	Pi	Ts,i	Ts,o		
2.00	0.1	54.966	18	1.5	-186.98	-112.51	-102.28		3000	315	350.00	213.15		4246	95	114.93	204.89		
2.10	0.10	54.107	18	1.5	-179.66	-106.06	-96.41		3000	315	339.77	208.87		4246	95	114.07	200.45		
2.20	0.10	53.300	18	1.5	-172.74	-99.94	-90.86		3000	315	330.13	204.79		4246	95	113.25	196.26		
2.30	0.10	52.540	18	1.5	-166.20	-94.16	-85.60		3000	315	321.04	200.91		4246	95	112.48	192.29		
2.40	0.10	51.822	18	1.5	-160.03	-88.70	-80.64		3000	315	312.48	197.23		4246	95	111.74	188.55		
2.50	0.10	51.143	18	1.5	-154.19	-83.55	-75.95		3000	315	304.42	193.73		4246	95	111.04	185.01		
2.60	0.10	50.500	18	1.5	-148.69	-78.69	-71.54		3000	315	296.82	190.41		4246	95	110.38	181.67		
2.70	0.10	49.888	18	1.5	-143.50	-74.11	-67.37		3000	315	289.67	187.26		4246	95	109.75	178.52		
2.80	0.10	49.305	18	1.5	-138.60	-69.80	-63.45		3000	315	282.93	184.28		4246	95	109.15	175.55		
2.90	0.10	48.749	18	1.5	-133.99	-65.74	-59.76		3000	315	276.59	181.46		4246	95	108.59	172.75		
3.00	0.10	48.218	18	1.5	-129.63	-61.92	-56.29		3000	315	270.61	178.78		4246	95	108.05	170.11		
3.10	0.10	47.710	18	1.5	-125.53	-58.32	-53.02		3000	315	264.98	176.25		4246	95	107.55	167.62		
3.20	0.10	47.223	18	1.5	-121.66	-54.94	-49.95		3000	315	259.68	173.86		4246	95	107.07	165.27		
3.30	0.10	46.756	18	1.5	-118.02	-51.76	-47.06		3000	315	254.69	171.59		4246	95	106.62	163.05		
3.40	0.10	46.307	18	1.5	-114.58	-48.78	-44.34		3000	315	249.98	169.44		4246	95	106.19	160.97		
3.50	0.11	45.875	18	1.5	-111.34	-45.97	-41.79		3000	315	245.54	167.41		4246	95	105.78	159.00		
3.61	0.11	45.434	18	1.5	-108.10	-43.16	-39.24		3000	315	241.10	165.37		4246	95	105.38	157.03		
3.72	0.12	44.984	18	1.5	-104.87	-40.38	-36.71		3000	315	236.68	163.32		4246	95	104.97	155.06		
3.84	0.13	44.527	18	1.5	-101.66	-37.63	-34.21		3000	315	232.29	161.29		4246	95	104.57	153.11		
3.97	0.14	44.059	18	1.5	-98.47	-34.91	-31.74		3000	315	227.93	159.26		4246	95	104.16	151.18		
4.10	0.15	43.581	18	1.5	-95.31	-32.23	-29.30		3000	315	223.60	157.24		4246	95	103.76	149.26		
4.25	0.16	43.091	18	1.5	-92.18	-29.59	-26.90		3000	315	219.32	155.23		4246	95	103.36	147.35		
4.41	0.17	42.587	18	1.5	-89.09	-27.00	-24.54		3000	315	215.08	153.24		4246	95	102.97	145.47		
4.58	0.19	42.068	18	1.5	-86.03	-24.46	-22.24		3000	315	210.89	151.26		4246	95	102.58	143.61		
4.76	0.20	41.530	18	1.5	-83.01	-21.98	-19.98		3000	315	206.76	149.30		4246	95	102.19	141.77		
4.96	0.20	40.982	18	1.5	-80.09	-19.61	-17.83		3000	315	202.77	147.39		4246	95	101.81	140.00		
5.16	0.20	40.462	0	1.5	-77.49	-35.53	-32.30		3000	315	199.20	145.69		4246	95	101.48	138.41		
5.36	0.20	39.968	0	1.5	-72.78	-31.31	-28.46		3000	315	192.74	142.59		4246	95	100.87	135.54		
5.56	0.15	39.498	0	1.5	-68.63	-27.63	-25.12		3000	315	187.05	139.84		4246	95	100.33	133.02		
5.72	0.18	39.150	0	1.5	-65.80	-25.15	-22.86		3000	315	183.16	137.95		4246	95	99.96	131.29		
5.89	0.20	38.769	0	1.5	-62.88	-22.61	-20.55		3000	315	179.14	136.00		4246	95	99.57	129.51		
6.09	0.20	38.355	0	1.5	-59.90	-20.05	-18.23		3000	315	175.05	134.00		4246	95	99.18	127.70		
6.29	0.20	37.957	0	1.5	-57.26	-17.80	-16.18		3000	315	171.41	132.21		4246	95	98.63	126.08		
6.49	0.20	37.575	0	1.5	-54.91	-15.83	-14.39		3000	315	168.17	130.62		4246	95	98.52	124.65		
6.69	0.20	37.208	0	1.5	-52.82	-14.11	-12.83		3000	315	165.29	129.20		4246	95	98.25	123.38		
6.89	0.20	36.856	0	1.5	-50.96	-12.61	-11.46		3000	315	162.73	127.93		4246	95	98.00	122.24		
7.09	0.20	36.517	0	1.5	-49.30	-11.29	-10.26		3000	315	160.43	126.79		4246	95	97.78	121.23		
7.29	0.20	36.190	0	1.5	-47.82	-10.13	-9.21		3000	315	158.38	125.77		4246	95	97.58	120.32		
7.49	0.49	35.875	0	1.5	-46.49	-9.11	-8.29		3000	315	156.54	124.85		4246	95	97.40	119.51		
7.98	0.54	35.153	0	1.5	-43.58	-6.92	-6.29		3000	315	152.50	122.83		4246	95	97.01	117.73		
8.52	0.60	34.413	0	1.5	-41.11	-5.20	-4.73		3000	315	149.09	121.12		4246	95	96.68	116.23		
9.13	0.79	33.661	0	1.5	-39.06	-3.90	-3.54		3000	315	146.23	119.68		4246	95	96.41	114.97		
9.92	1.06	32.765	0	1.5	-37.03	-2.77	-2.52		3000	315	143.42	118.26		4246	95	96.13	113.73		
10.98	1.41	31.710	0	1.5	-35.12	-1.91	-1.74		3000	315	140.75	116.91		4246	95	95.88	112.56		
12.39	1.99	30.495	0	1.5	-33.36	-1.37	-1.24		3000	315	138.30	115.67		4246	95	95.64	111.49		
14.37	2.00	29.065	0	1.5	-31.59	-1.03	-0.94		3000	315	135.83	114.41		4246	95	95.40	110.41		
16.37	2.00	27.867	0	1.5	-30.26	-0.89	-0.81		3000	315	133.96	113.46		4246	95	95.22	109.59		
18.37	2.00	26.849	0	1.5	-29.10	-0.75	-0.68		3000	315	132.35	112.64		4246	95	95.06	108.88		
20.37	2.00	25.968	0	1.5	-28.12	-0.66	-0.60		3000	315	130.98	111.94		4246	95	94.93	108.28		
22.37	2.00	25.194	0	1.5	-27.27	-0.58	-0.53		3000	315	129.79	111.32		4246	95	94.81	107.76		
24.37	2.00	24.507	0	1.5	-26.52	-0.52	-0.47		3000	315	128.73	110.79		4246	95	94.71	107.30		
26.37	2.00	23.890	0	1.5	-25.85	-0.46	-0.42		3000	315	127.80	110.30		4246	95	94.62	106.89		

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
2.00	281.58	55.59	1.0215	1.34E-04	0.396	5.609	126,869	1.2391	2211	159.91	61.00	1.0006	2.68E-04	0.382	3.652	179,432	2.5290	1416	9.430	371.70
2.10	274.32	55.95	1.0194	1.38E-04	0.396	5.609	123,654	1.2770	2192	157.26	61.05	1.0004	2.73E-04	0.381	3.652	176,030	2.5842	1407	9.399	370.26
2.20	267.46	56.29	1.0175	1.42E-04	0.396	5.609	120,558	1.3155	2173	154.76	61.10	1.0002	2.79E-04	0.380	3.652	172,822	2.6383	1399	9.370	368.84
2.30	260.98	56.60	1.0158	1.47E-04	0.396	5.609	117,589	1.3544	2155	152.39	61.14	1.0000	2.84E-04	0.380	3.652	169,798	2.6914	1390	9.342	367.45
2.40	254.85	56.89	1.0143	1.51E-04	0.396	5.609	114,749	1.3937	2136	150.14	61.19	0.9999	2.89E-04	0.379	3.652	166,949	2.7433	1383	9.316	366.09
2.50	249.07	57.15	1.0129	1.55E-04	0.396	5.609	112,038	1.4331	2118	148.02	61.23	0.9997	2.94E-04	0.379	3.652	164,268	2.7939	1375	9.291	364.77
2.60	243.62	57.40	1.0117	1.60E-04	0.395	5.609	109,456	1.4726	2100	146.02	61.27	0.9996	2.99E-04	0.378	3.652	161,745	2.8431	1368	9.269	363.49
2.70	238.47	57.62	1.0106	1.64E-04	0.395	5.609	107,001	1.5121	2082	144.13	61.30	0.9995	3.03E-04	0.377	3.652	159,371	2.8909	1361	9.248	362.25
2.80	233.61	57.83	1.0096	1.68E-04	0.394	5.609	104,670	1.5514	2064	142.35	61.33	0.9993	3.08E-04	0.377	3.652	157,139	2.9374	1354	9.228	361.05
2.90	229.02	58.03	1.0087	1.73E-04	0.394	5.609	102,459	1.5905	2048	140.67	61.36	0.9992	3.12E-04	0.376	3.652	155,039	2.9823	1348	9.209	359.89
3.00	224.70	58.21	1.0079	1.77E-04	0.394	5.609	100,365	1.6292	2031	139.08	61.39	0.9992	3.16E-04	0.376	3.652	153,064	3.0258	1342	9.191	358.77
3.10	220.62	58.37	1.0072	1.81E-04	0.393	5.609	98,382	1.6675	2016	137.58	61.42	0.9991	3.20E-04	0.375	3.652	151,206	3.0678	1337	9.175	357.69
3.20	216.77	58.53	1.0066	1.85E-04	0.393	5.609	96,507	1.7052	2000	136.17	61.44	0.9990	3.24E-04	0.375	3.652	149,460	3.1084	1331	9.159	356.65
3.30	213.14	58.67	1.0060	1.89E-04	0.392	5.609	94,734	1.7424	1986	134.84	61.47	0.9989	3.28E-04	0.375	3.652	147,817	3.1474	1326	9.144	355.65
3.40	209.71	58.80	1.0054	1.93E-04	0.392	5.609	93,059	1.7789	1972	133.58	61.49	0.9988	3.31E-04	0.374	3.652	146,271	3.1850	1322	9.130	354.69
3.50	206.47	58.93	1.0050	1.96E-04	0.391	5.609	91,475	1.8148	1958	132.39	61.51	0.9988	3.35E-04	0.374	3.652	144,816	3.2212	1317	9.117	353.77
3.61	203.23	59.05	1.0045	2.00E-04	0.391	5.609	89,887	1.8521	1944	131.20	61.53	0.9987	3.38E-04	0.373	3.652	143,363	3.2581	1313	9.103	352.83
3.72	200.00	59.17	1.0040	2.04E-04	0.390	5.609	88,302	1.8908	1930	130.02	61.55	0.9987	3.42E-04	0.373	3.652	141,918	3.2956	1308	9.090	351.87
3.84	196.79	59.29	1.0036	2.08E-04	0.390	5.609	86,726	1.9307	1916	128.84	61.57	0.9986	3.46E-04	0.373	3.652	140,485	3.3336	1303	9.077	350.91
3.97	193.59	59.40	1.0032	2.13E-04	0.389	5.609	85,160	1.9720	1902	127.67	61.59	0.9986	3.49E-04	0.372	3.652	139,067	3.3720	1299	9.064	349.94
4.10	190.42	59.52	1.0028	2.17E-04	0.389	5.609	83,605	2.0146	1887	126.51	61.61	0.9985	3.53E-04	0.372	3.652	137,663	3.4109	1294	9.051	348.96
4.25	187.28	59.63	1.0024	2.21E-04	0.388	5.609	82,064	2.0585	1873	125.36	61.63	0.9984	3.57E-04	0.371	3.652	136,275	3.4502	1290	9.038	347.97
4.41	184.16	59.74	1.0021	2.26E-04	0.388	5.609	80,538	2.1038	1858	124.22	61.65	0.9984	3.60E-04	0.371	3.652	134,904	3.4898	1285	9.025	346.98
4.58	181.08	59.84	1.0018	2.31E-04	0.387	5.609	79,030	2.1504	1843	123.09	61.66	0.9984	3.64E-04	0.371	3.652	133,553	3.5297	1281	9.013	345.98
4.76	178.03	59.94	1.0014	2.36E-04	0.386	5.609	77,542	2.1982	1829	121.98	61.68	0.9983	3.68E-04	0.370	3.652	132,223	3.5699	1276	9.000	344.97
4.96	175.08	60.04	1.0011	2.40E-04	0.386	5.609	76,104	2.2464	1814	120.90	61.70	0.9983	3.71E-04	0.370	3.652	130,939	3.6094	1272	8.987	343.98
5.16	172.45	60.13	1.0009	2.45E-04	0.385	5.609	74,822	2.2910	1801	119.94	61.71	0.9982	3.75E-04	0.370	3.652	129,797	3.6453	1268	8.975	343.08
5.36	167.67	60.28	1.0004	2.53E-04	0.384	5.609	72,501	2.3760	1777	118.20	61.74	0.9982	3.81E-04	0.369	3.652	127,734	3.7119	1261	8.953	341.41
5.56	163.44	60.41	1.0001	2.61E-04	0.383	5.609	70,458	2.4558	1755	116.67	61.76	0.9981	3.87E-04	0.368	3.652	125,923	3.7722	1255	8.934	339.90
5.72	160.56	60.50	0.9998	2.67E-04	0.382	5.609	69,066	2.5131	1740	115.62	61.78	0.9981	3.91E-04	0.368	3.652	124,690	3.8144	1251	8.921	338.85
5.89	157.57	60.59	0.9996	2.73E-04	0.382	5.609	67,630	2.5747	1724	114.54	61.80	0.9980	3.95E-04	0.368	3.652	123,421	3.8587	1246	8.908	337.75
6.09	154.53	60.68	0.9994	2.79E-04	0.381	5.609	66,170	2.6404	1708	113.44	61.81	0.9980	3.99E-04	0.367	3.652	122,132	3.9048	1242	8.895	336.61
6.29	151.81	60.76	0.9992	2.85E-04	0.380	5.609	64,872	2.7013	1693	112.46	61.83	0.9980	4.03E-04	0.367	3.652	120,987	3.9465	1238	8.883	335.57
6.49	149.39	60.82	0.9990	2.91E-04	0.379	5.609	63,721	2.7576	1680	111.59	61.84	0.9979	4.06E-04	0.366	3.652	119,973	3.9842	1234	8.872	334.64
6.69	147.24	60.88	0.9989	2.96E-04	0.379	5.609	62,700	2.8094	1668	110.81	61.85	0.9979	4.09E-04	0.366	3.652	119,074	4.0182	1231	8.863	333.80
6.89	145.33	60.94	0.9987	3.01E-04	0.378	5.609	61,792	2.8569	1658	110.12	61.86	0.9979	4.12E-04	0.366	3.652	118,274	4.0489	1228	8.855	333.05
7.09	143.61	60.98	0.9986	3.05E-04	0.378	5.609	60,981	2.9006	1648	109.50	61.87	0.9979	4.15E-04	0.366	3.652	117,562	4.0766	1225	8.848	332.36
7.29	142.08	61.03	0.9985	3.09E-04	0.377	5.609	60,257	2.9408	1639	108.95	61.88	0.9979	4.17E-04	0.365	3.652	116,925	4.1017	1223	8.841	331.74
7.49	140.70	61.06	0.9984	3.12E-04	0.377	5.609	59,608	2.9776	1632	108.46	61.88	0.9978	4.19E-04	0.365	3.652	116,354	4.1244	1221	8.835	331.18
7.98	137.67	61.14	0.9983	3.20E-04	0.376	5.609	58,189	3.0611	1614	107.37	61.90	0.9978	4.24E-04	0.365	3.652	115,107	4.1749	1216	8.823	329.94
8.52	135.10	61.21	0.9981	3.27E-04	0.375	5.609	56,992	3.1351	1599	106.45	61.91	0.9978	4.28E-04	0.364	3.652	114,056	4.2184	1212	8.812	328.87
9.13	132.96	61.26	0.9980	3.33E-04	0.374	5.609	55,996	3.1991	1587	105.69	61.92	0.9978	4.31E-04	0.364	3.652	113,181	4.2552	1209	8.804	327.97
9.92	130.84	61.31	0.9979	3.40E-04	0.374	5.609	55,015	3.2646	1574	104.93	61.93	0.9978	4.35E-04	0.364	3.652	112,319	4.2921	1206	8.795	327.07
10.98	128.83	61.36	0.9978	3.46E-04	0.373	5.609	54,090	3.3286	1563	104.22	61.94	0.9977	4.38E-04	0.363	3.652	111,507	4.3274	1203	8.787	326.20
12.39	126.99	61.41	0.9977	3.51E-04	0.372	5.609	53,241	3.3895	1552	103.56	61.95	0.9977	4.41E-04	0.363	3.652	110,761	4.3603	1200	8.780	325.39
14.37	125.12	61.45	0.9976	3.57E-04	0.372	5.609	52,388	3.4528	1540	102.90	61.96	0.9977	4.44E-04	0.363	3.652	110,013	4.3938	1197	8.773	324.57
16.37	123.71	61.48	0.9975	3.62E-04	0.371	5.609	51,743	3.5020	1532	102.40	61.97	0.9977	4.46E-04	0.363	3.652	109,447	4.4195	1195	8.768	323.94
18.37	122.49	61.51	0.9975	3.66E-04	0.371	5.609	51,188	3.5455	1524	101.97	61.97	0.9977	4.48E-04	0.363	3.652	108,959	4.4418	1193	8.763	323.39
20.37	121.46	61.53	0.9974	3.70E-04	0.371	5.609	50,719	3.5831	1518	101.60	61.98	0.9977	4.50E-04	0.362	3.652	108,547	4.4608	1191	8.759	322.93
22.37	120.56	61.55	0.9974	3.73E-04	0.370	5.609	50,310	3.6164	1513	101.29	61.98	0.9977	4.52E-04	0.362	3.652	108,188	4.4775	1190	8.756	322.52
24.37	119.76	61.57	0.9974	3.76E-04	0.370	5.609	49,950	3.6461	1508	101.01	61.98	0.9977	4.53E-04	0.362	3.652	107,872	4.4923	1189	8.753	322.16
26.37	119.05	61.59	0.9973	3.78E-04	0.370	5.609	49,630	3.6730	1503	100.76	61.99	0.9977	4.54E-04	0.362	3.652	107,591	4.5056	1188	8.750	321.83

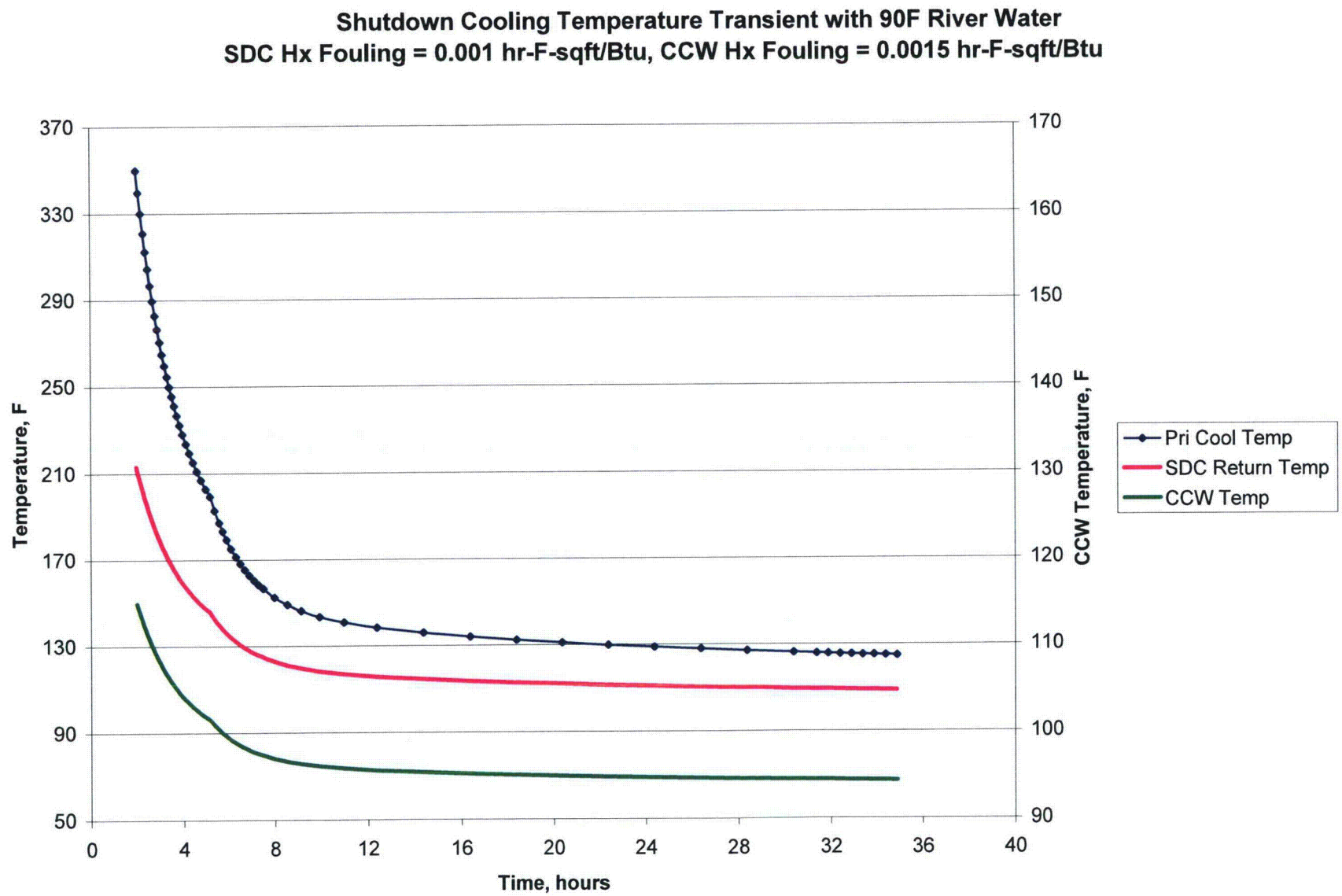
CCW HX Fouling 0

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate	Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX	CCW Temp
hrs	W	WCp	Cr	NTU	ffectivenes	DT	Tt,o	W	WCp	Cr	NTU	ffectivenes	DTs	Ts,o	Btu/hr			mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr	Ts,o
2.00	1,337,560	1,366,308	0.657	1.366	0.582	136.85	213.15	2,077,274	2,078,469	#N/A	#N/A	#N/A	89.96	204.89	186.98	213.15	204.89	7.358	194.33	8,100	3	64.78	114.93
2.10	1,346,390	1,372,463	0.660	1.354	0.580	130.91	208.87	2,079,081	2,079,847	#N/A	#N/A	#N/A	86.38	200.45	179.66	208.87	200.45	7.358	187.02	8,100	3	62.34	114.07
2.20	1,354,515	1,378,173	0.662	1.344	0.578	125.34	204.79	2,080,769	2,081,143	#N/A	#N/A	#N/A	83.00	196.26	172.74	204.79	196.26	7.358	180.10	8,100	3	60.03	113.25
2.30	1,361,998	1,383,476	0.664	1.333	0.576	120.14	200.91	2,082,345	2,082,361	#N/A	#N/A	#N/A	79.82	192.29	166.20	200.91	192.29	7.358	173.56	8,100	3	57.85	112.48
2.40	1,368,897	1,388,408	0.666	1.324	0.574	115.26	197.23	2,083,817	2,083,505	#N/A	#N/A	#N/A	76.81	188.55	160.03	197.23	188.55	7.358	167.38	8,100	3	55.79	111.74
2.50	1,375,264	1,392,998	0.668	1.315	0.572	110.69	193.73	2,085,190	2,084,579	#N/A	#N/A	#N/A	73.97	185.01	154.19	193.73	185.01	7.358	161.55	8,100	3	53.85	111.04
2.60	1,381,145	1,397,274	0.670	1.306	0.571	106.41	190.41	2,086,472	2,085,586	#N/A	#N/A	#N/A	71.29	181.67	148.69	190.41	181.67	7.358	156.05	8,100	3	52.02	110.38
2.70	1,386,582	1,401,260	0.672	1.298	0.569	102.41	187.26	2,087,669	2,086,531	#N/A	#N/A	#N/A	68.77	178.52	143.50	187.26	178.52	7.358	150.86	8,100	3	50.29	109.75
2.80	1,391,612	1,404,978	0.673	1.290	0.568	98.65	184.28	2,088,785	2,087,417	#N/A	#N/A	#N/A	66.40	175.55	138.60	184.28	175.55	7.358	145.96	8,100	3	48.65	109.15
2.90	1,396,270	1,408,448	0.674	1.283	0.566	95.13	181.46	2,089,828	2,088,248	#N/A	#N/A	#N/A	64.16	172.75	133.99	181.46	172.75	7.358	141.34	8,100	3	47.11	108.59
3.00	1,400,586	1,411,689	0.676	1.276	0.565	91.83	178.78	2,090,802	2,089,026	#N/A	#N/A	#N/A	62.05	170.11	129.63	178.78	170.11	7.358	136.99	8,100	3	45.66	108.05
3.10	1,404,589	1,414,716	0.677	1.269	0.564	88.73	176.25	2,091,711	2,089,756	#N/A	#N/A	#N/A	60.07	167.62	125.53	176.25	167.62	7.358	132.89	8,100	3	44.30	107.55
3.20	1,408,304	1,417,545	0.678	1.263	0.562	85.83	173.86	2,092,561	2,090,441	#N/A	#N/A	#N/A	58.20	165.27	121.66	173.86	165.27	7.358	129.02	8,100	3	43.01	107.07
3.30	1,411,755	1,420,190	0.679	1.257	0.561	83.10	171.59	2,093,355	2,091,083	#N/A	#N/A	#N/A	56.44	163.05	118.02	171.59	163.05	7.358	125.38	8,100	3	41.79	106.62
3.40	1,414,962	1,422,664	0.680	1.252	0.560	80.54	169.44	2,094,098	2,091,685	#N/A	#N/A	#N/A	54.78	160.97	114.58	169.44	160.97	7.358	121.94	8,100	3	40.65	106.19
3.50	1,417,948	1,424,981	0.681	1.246	0.559	78.14	167.41	2,094,793	2,092,250	#N/A	#N/A	#N/A	53.22	159.00	111.34	167.41	159.00	7.358	118.70	8,100	3	39.57	105.78
3.61	1,420,897	1,427,282	0.682	1.241	0.558	75.74	165.37	2,095,483	2,092,813	#N/A	#N/A	#N/A	51.65	157.03	108.10	165.37	157.03	7.358	115.46	8,100	3	38.49	105.38
3.72	1,423,797	1,429,558	0.683	1.236	0.557	73.35	163.32	2,096,166	2,093,372	#N/A	#N/A	#N/A	50.09	155.06	104.87	163.32	155.06	7.358	112.22	8,100	3	37.41	104.97
3.84	1,426,639	1,431,801	0.684	1.230	0.556	71.00	161.29	2,096,838	2,093,924	#N/A	#N/A	#N/A	48.55	153.11	101.66	161.29	153.11	7.358	109.01	8,100	3	36.34	104.57
3.97	1,429,421	1,434,009	0.685	1.225	0.555	68.67	159.26	2,097,500	2,094,469	#N/A	#N/A	#N/A	47.01	151.18	98.47	159.26	151.18	7.358	105.83	8,100	3	35.28	104.16
4.10	1,432,143	1,436,182	0.686	1.220	0.554	66.36	157.24	2,098,151	2,095,006	#N/A	#N/A	#N/A	45.49	149.26	95.31	157.24	149.26	7.358	102.67	8,100	3	34.22	103.76
4.25	1,434,803	1,438,316	0.686	1.214	0.553	64.09	155.23	2,098,791	2,095,537	#N/A	#N/A	#N/A	43.99	147.35	92.18	155.23	147.35	7.358	99.54	8,100	3	33.18	103.36
4.41	1,437,399	1,440,410	0.687	1.209	0.552	61.85	153.24	2,099,420	2,096,058	#N/A	#N/A	#N/A	42.50	145.47	89.09	153.24	145.47	7.358	96.44	8,100	3	32.15	102.97
4.58	1,439,929	1,442,461	0.688	1.204	0.551	59.64	151.26	2,100,035	2,096,572	#N/A	#N/A	#N/A	41.03	143.61	86.03	151.26	143.61	7.358	93.38	8,100	3	31.13	102.58
4.76	1,442,390	1,444,466	0.689	1.199	0.550	57.47	149.30	2,100,637	2,097,075	#N/A	#N/A	#N/A	39.58	141.77	83.01	149.30	141.77	7.358	90.37	8,100	3	30.12	102.19
4.96	1,444,736	1,446,386	0.690	1.194	0.549	55.37	147.39	2,101,215	2,097,560	#N/A	#N/A	#N/A	38.18	140.00	80.09	147.39	140.00	7.358	87.45	8,100	3	29.15	101.81
5.16	1,446,801	1,448,083	0.690	1.189	0.548	53.51	145.69	2,101,726	2,097,990	#N/A	#N/A	#N/A	36.93	138.41	77.49	145.69	138.41	7.358	84.85	8,100	3	28.28	101.48
5.36	1,450,473	1,451,118	0.691	1.181	0.546	50.15	142.59	2,102,642	2,098,765	#N/A	#N/A	#N/A	34.68	135.54	72.78	142.59	135.54	7.358	80.14	8,100	3	26.71	100.87
5.56	1,453,634	1,453,748	0.692	1.174	0.544	47.21	139.84	2,103,438	2,099,441	#N/A	#N/A	#N/A	32.69	133.02	68.63	139.84	133.02	7.358	75.99	8,100	3	25.33	100.33
5.72	1,455,753	1,455,519	0.693	1.169	0.543	45.21	137.95	2,103,976	2,099,901	#N/A	#N/A	#N/A	31.33	131.29	65.80	137.95	131.29	7.358	73.16	8,100	3	24.39	99.96
5.89	1,457,905	1,457,325	0.694	1.163	0.542	43.15	136.00	2,104,526	2,100,372	#N/A	#N/A	#N/A	29.94	129.51	62.88	136.00	129.51	7.358	70.23	8,100	3	23.41	99.57
6.09	1,460,060	1,459,141	0.695	1.158	0.541	41.05	134.00	2,105,081	2,100,850	#N/A	#N/A	#N/A	28.51	127.70	59.90	134.00	127.70	7.358	67.26	8,100	3	22.42	99.18
6.29	1,461,947	1,460,736	0.695	1.153	0.540	39.20	132.21	2,105,570	2,101,273	#N/A	#N/A	#N/A	27.25	126.08	57.26	132.21	126.08	7.358	64.61	8,100	3	21.54	98.83
6.49	1,463,596	1,462,136	0.696	1.149	0.539	37.55	130.62	2,106,001	2,101,646	#N/A	#N/A	#N/A	26.13	124.65	54.91	130.62	124.65	7.358	62.27	8,100	3	20.76	98.52
6.69	1,465,042	1,463,366	0.696	1.145	0.538	36.10	129.20	2,106,381	2,101,977	#N/A	#N/A	#N/A	25.13	123.38	52.82	129.20	123.38	7.358	60.18	8,100	3	20.06	98.25
6.89	1,466,315	1,464,451	0.697	1.142	0.538	34.80	127.93	2,106,717	2,102,271	#N/A	#N/A	#N/A	24.24	122.24	50.96	127.93	122.24	7.358	58.32	8,100	3	19.44	98.00
7.09	1,467,437	1,465,410	0.697	1.139	0.537	33.65	126.79	2,107,015	2,102,532	#N/A	#N/A	#N/A	23.45	121.23	49.30	126.79	121.23	7.358	56.66	8,100	3	18.89	97.78
7.29	1,468,431	1,466,261	0.697	1.136	0.536	32.61	125.77	2,107,281	2,102,765	#N/A	#N/A	#N/A	22.74	120.32	47.82	125.77	120.32	7.358	55.18	8,100	3	18.39	97.58
7.49	1,469,315	1,467,019	0.698	1.133	0.536	31.69	124.85	2,107,518	2,102,974	#N/A	#N/A	#N/A	22.11	119.51	46.49	124.85	119.51	7.358	53.85	8,100	3	17.95	97.40
7.98	1,471,221	1,468,658	0.698	1.128	0.535	29.67	122.83	2,108,033	2,103,429	#N/A	#N/A	#N/A	20.72	117.73	43.58	122.83	117.73	7.358	50.93	8,100	3	16.98	97.01
8.52	1,472,801	1,470,021	0.699	1.123	0.534	27.97	121.12	2,108,464	2,103,813	#N/A	#N/A	#N/A	19.54	116.23	41.11	121.12	116.23	7.358	48.47	8,100	3	16.16	96.68
9.13	1,474,097	1,471,141	0.699	1.119	0.533	26.55	119.68	2,108,820	2,104,131	#N/A	#N/A	#N/A	18.56	114.97	39.06	119.68	114.97	7.358	46.42	8,100	3	15.47	96.41
9.92	1,475,355	1,472,232	0.700	1.115	0.532	25.16	118.26	2,109,169	2,104,444	#N/A	#N/A	#N/A	17.60	113.73	37.03	118.26	113.73	7.358	44.39	8,100	3	14.80	96.13
10.98	1,476,524	1,473,249	0.700	1.112	0.531	23.84	116.91	2,109,497	2,104,738	#N/A	#N/A	#N/A	16.69	112.56	35.12	116.91	112.56	7.358	42.48	8,100	3	14.16	95.88
12.39	1,477,585	1,474,173	0.700	1.108	0.530	22.63	115.67	2,109,796	2,105,009	#N/A	#N/A	#N/A	15.85	111.49	33.36	115.67	111.49	7.358	40.72	8,100	3	13.57	95.64
14.37	1,478,635	1,475,091	0.701	1.105	0.530	21.42	114.41	2,110,094	2,105,279	#N/A	#N/A	#N/A	15.01	110.41	31.59	114.41	110.41	7.358	38.95	8,100	3	12.98	95.40
16.37	1,479,419	1,475,777	0.701	1.102	0.529	20.50	113.46	2,110,319	2,105,484	#N/A	#N/A	#N/A	14.37	109.59	30.26	113.46	109.59	7.358	37.61	8,100	3	12.54	95.22
18.37	1,480,088	1,476,364	0.701	1.100	0.529	19.71	112.64	2,110,512	2,105,660	#N/A	#N/A	#N/A	13.82	108.88	29.10	112.64	108.88	7.358	36.46	8,100	3	12.15	95.06
20.37	1,480,649	1,476,857	0.701	1.098	0.528	19.04	111.94	2,110,674	2,105,809	#N/A	#N/A	#N/A	13.36	108.28	28.12	111.94	108.28	7.358	35.48	8,100	3	11.83	94.93
22.37	1,481,134	1,477,283	0.701	1.096	0.528	18.46	111.32	2,110,815	2,105,939	#N/A	#N/A	#N/A	12.95	107.76	27.27	111.32	107.76	7.358	34.63	8,100	3	11.54	94.81
24.37	1,481,557	1,477,657	0.702	1.094	0.528	17.95	110.79	2,110,939	2,106,052	#N/A	#N/A	#N/A	12.59	107.30	26.52	110.79	107.30	7.358	33.88	8,100	3	11.29	94.71
26.37	1,481,932	1,477,987	0.702	1.093	0.527	17.49	110.30	2,111,049	2,106,154	#N/A	#N/A	#N/A	12.28	106.89	25.85	110.30	106.89	7.358	33.21	8,100	3	11.07	94.62

								SDCHx							
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell			
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o
28.37	2.00	23.333	0	1.5	-25.25	-0.42	-0.38	3000	315	126.95	109.87	4246	95	94.54	106.53
30.37	1.00	22.825	0	1.5	-24.71	-0.38	-0.35	3000	315	126.19	109.48	4246	95	94.46	106.19
31.37	0.50	22.587	0	1.5	-24.46	-0.37	-0.34	3000	315	125.84	109.30	4246	95	94.43	106.04
31.87	0.50	22.472	0	1.5	-24.34	-0.37	-0.33	3000	315	125.67	109.21	4246	95	94.41	105.97
32.37	0.50	22.359	0	1.5	-24.22	-0.36	-0.33	3000	315	125.50	109.13	4246	95	94.39	105.89
32.87	0.50	22.249	0	1.5	-24.10	-0.35	-0.32	3000	315	125.34	109.04	4246	95	94.38	105.82
33.37	0.50	22.141	0	1.5	-23.99	-0.35	-0.32	3000	315	125.18	108.96	4246	95	94.36	105.75
33.87	0.50	22.035	0	1.5	-23.88	-0.34	-0.31	3000	315	125.02	108.88	4246	95	94.35	105.68
34.37	0.50	21.931	0	1.5	-23.77	-0.34	-0.30	3000	315	124.86	108.80	4246	95	94.33	105.61
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55
34.87	0.00	21.829	0	1.5	-23.66	-0.33	-0.30	3000	315	124.71	108.72	4246	95	94.32	105.55

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
28.37	118.41	61.60	0.9973	3.80E-04	0.369	5.609	49,342	3.6975	1499	100.53	61.99	0.9977	4.55E-04	0.362	3.652	107,338	4.5176	1187	8.748	321.54
30.37	117.83	61.61	0.9973	3.83E-04	0.369	5.609	49,082	3.7200	1496	100.33	61.99	0.9977	4.56E-04	0.362	3.652	107,109	4.5285	1186	8.746	321.27
31.37	117.57	61.62	0.9973	3.84E-04	0.369	5.609	48,963	3.7303	1494	100.23	61.99	0.9977	4.57E-04	0.362	3.652	107,005	4.5335	1185	8.745	321.15
31.87	117.44	61.62	0.9973	3.84E-04	0.369	5.609	48,905	3.7353	1493	100.19	61.99	0.9977	4.57E-04	0.362	3.652	106,954	4.5359	1185	8.744	321.09
32.37	117.31	61.62	0.9973	3.84E-04	0.369	5.609	48,848	3.7403	1493	100.14	61.99	0.9977	4.57E-04	0.362	3.652	106,904	4.5383	1185	8.744	321.03
32.87	117.19	61.63	0.9973	3.85E-04	0.369	5.609	48,792	3.7452	1492	100.10	62.00	0.9977	4.57E-04	0.362	3.652	106,855	4.5406	1185	8.743	320.97
33.37	117.07	61.63	0.9973	3.85E-04	0.369	5.609	48,737	3.7500	1491	100.06	62.00	0.9977	4.58E-04	0.362	3.652	106,807	4.5429	1185	8.743	320.91
33.87	116.95	61.63	0.9973	3.86E-04	0.369	5.609	48,684	3.7547	1490	100.01	62.00	0.9977	4.58E-04	0.362	3.652	106,759	4.5452	1184	8.743	320.86
34.37	116.83	61.63	0.9972	3.86E-04	0.369	5.609	48,631	3.7594	1490	99.97	62.00	0.9977	4.58E-04	0.362	3.652	106,713	4.5474	1184	8.742	320.80
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75
34.87	116.71	61.64	0.9972	3.87E-04	0.369	5.609	48,579	3.7639	1489	99.93	62.00	0.9977	4.58E-04	0.362	3.652	106,667	4.5496	1184	8.742	320.75

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate			Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX		CCW Temp
hrs	W	WCp	Cr	NTU	ffectivenes	DT	Tt,o	W	WCp	Cr	NTU	ffectivenes	DTs	Ts,o	Btu/hr					mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr		Ts,o
28.37	1,482,267	1,478,283	0.702	1.092	0.527	17.08	109.87	2,111,148	2,106,245	#N/A	#N/A	#N/A	11.99	106.53	25.25	109.87	106.53			7.358	32.61	8,100	3	10.87		94.54
30.37	1,482,569	1,478,550	0.702	1.091	0.527	16.71	109.48	2,111,237	2,106,328	#N/A	#N/A	#N/A	11.73	106.19	24.71	109.48	106.19			7.358	32.07	8,100	3	10.69		94.46
31.37	1,482,706	1,478,671	0.702	1.090	0.527	16.54	109.30	2,111,278	2,106,365	#N/A	#N/A	#N/A	11.61	106.04	24.46	109.30	106.04			7.358	31.82	8,100	3	10.61		94.43
31.87	1,482,773	1,478,730	0.702	1.090	0.527	16.46	109.21	2,111,297	2,106,383	#N/A	#N/A	#N/A	11.56	105.97	24.34	109.21	105.97			7.358	31.70	8,100	3	10.57		94.41
32.37	1,482,838	1,478,788	0.702	1.090	0.526	16.38	109.13	2,111,317	2,106,401	#N/A	#N/A	#N/A	11.50	105.89	24.22	109.13	105.89			7.358	31.58	8,100	3	10.53		94.39
32.87	1,482,903	1,478,845	0.702	1.090	0.526	16.30	109.04	2,111,336	2,106,419	#N/A	#N/A	#N/A	11.44	105.82	24.10	109.04	105.82			7.358	31.46	8,100	3	10.49		94.38
33.37	1,482,966	1,478,901	0.702	1.089	0.526	16.22	108.96	2,111,355	2,106,436	#N/A	#N/A	#N/A	11.39	105.75	23.99	108.96	105.75			7.358	31.35	8,100	3	10.45		94.36
33.87	1,483,028	1,478,956	0.702	1.089	0.526	16.14	108.88	2,111,373	2,106,454	#N/A	#N/A	#N/A	11.33	105.68	23.88	108.88	105.68			7.358	31.23	8,100	3	10.41		94.35
34.37	1,483,088	1,479,009	0.702	1.089	0.526	16.07	108.80	2,111,391	2,106,470	#N/A	#N/A	#N/A	11.28	105.61	23.77	108.80	105.61			7.358	31.12	8,100	3	10.37		94.33
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32
34.87	1,483,148	1,479,062	0.702	1.089	0.526	15.99	108.72	2,111,409	2,106,487	#N/A	#N/A	#N/A	11.23	105.55	23.66	108.72	105.55			7.358	31.02	8,100	3	10.34		94.32


Shutdown Cooling Temperature Transient with 90F River Water
SDC Hx Fouling = 0.001 hr-F-sqft/Btu, CCW Hx Fouling = 0.0015 hr-F-sqft/Btu
Temperature, F
370
330
290
250
210
170
130
90
50
CCW Temperature, F
170
160
150
140
130
120
110
100
90
0
4
8
12
16
20
24
28
32
36
40
Time, hours
Pri Cool Temp
SDC Return Temp
CCW Temp

Shutdown Cooling Temperature Transient with 90F River Water **SDC**

Hx Fouling = 0. hr-F-sqft/Btu, CCW Hx Fouling = 0. hr-F-sqft/Btu

	Initial RC Temperature, F				350											SDC HX	CCW HX
	Initial Time				2					2754		Shell Film Multiplier				0.09751	
	RCS Temperature after 8 hours				140.93							Shell Film Re power				0.61709	
	Time after trip to 130F Primary Coolant Temp				13.73			Initial CCW to SDCHx		4246		Shell Film Pr power				0.333	
	Time after SDC initiation to 130F PC Temp				11.7			CCW Flow Step Temp		275		Fouling (total = tube side)				0	0
	Decary heat equilibrium at 90F river temp				12.28											0.00418	0.004
									SDCHx								
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell					
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o		
2.00	0.1	54.966	18	1.5	-214.20	-139.73	-127.03	3000	315	350.00	192.77	4246	95	109.46	212.54		
2.10	0.10	54.107	18	1.5	-204.01	-130.40	-118.55	3000	315	337.30	188.43	4246	95	108.68	206.78		
2.20	0.10	53.300	18	1.5	-194.43	-121.63	-110.58	3000	315	325.44	184.32	4246	95	107.94	201.36		
2.30	0.10	52.540	18	1.5	-185.45	-113.41	-103.10	3000	315	314.38	180.44	4246	95	107.23	196.27		
2.40	0.10	51.822	18	1.5	-177.03	-105.71	-96.10	3000	315	304.07	176.78	4246	95	106.56	191.51		
2.50	0.10	51.143	18	1.5	-169.15	-98.50	-89.55	3000	315	294.47	173.33	4246	95	105.93	187.05		
2.60	0.10	50.500	18	1.5	-161.78	-91.78	-83.43	3000	315	285.51	170.08	4246	95	105.34	182.87		
2.70	0.05	49.888	18	1.5	-154.89	-85.50	-77.73	3000	315	277.17	167.03	4246	95	104.78	178.97		
2.75	0.10	49.593	18	1.5	-151.68	-82.58	-75.08	3000	315	273.28	165.59	4246	95	104.51	177.15		
2.85	0.10	49.024	18	1.5	-145.46	-76.94	-69.94	3000	315	265.77	162.80	4246	95	104.00	173.63		
2.95	0.10	48.481	18	1.5	-139.66	-71.68	-65.16	3000	315	258.78	160.19	4246	95	103.52	170.34		
3.05	0.10	47.961	18	1.5	-134.24	-66.78	-60.71	3000	315	252.26	157.73	4246	95	103.07	167.27		
3.15	0.10	47.464	18	1.5	-129.19	-62.23	-56.57	3000	315	246.19	155.43	4246	95	102.64	164.41		
3.25	0.10	46.987	18	1.5	-124.47	-57.99	-52.72	3000	315	240.53	153.27	4246	95	102.24	161.73		
3.35	0.10	46.529	18	1.5	-120.08	-54.05	-49.13	3000	315	235.26	151.25	4246	95	101.87	159.23		
3.45	0.10	46.089	18	1.5	-115.97	-50.38	-45.80	3000	315	230.35	149.35	4246	95	101.52	156.91		
3.55	0.10	45.666	18	1.5	-112.14	-46.98	-42.71	3000	315	225.77	147.58	4246	95	101.19	154.73		
3.65	0.11	45.251	18	1.5	-108.51	-43.76	-39.78	3000	315	221.42	145.88	4246	95	100.87	152.67		
3.76	0.12	44.822	18	1.5	-104.87	-40.55	-36.86	3000	315	217.08	144.18	4246	95	100.56	150.60		
3.88	0.13	44.381	18	1.5	-101.26	-37.38	-33.98	3000	315	212.76	142.49	4246	95	100.24	148.55		
4.00	0.14	43.926	18	1.5	-97.68	-34.25	-31.14	3000	315	208.49	140.80	4246	95	99.93	146.52		
4.14	0.15	43.455	18	1.5	-94.14	-31.18	-28.35	3000	315	204.27	139.13	4246	95	99.62	144.51		
4.29	0.16	42.968	18	1.5	-90.64	-28.17	-25.61	3000	315	200.10	137.46	4246	95	99.31	142.52		
4.45	0.18	42.460	0	1.5	-87.19	-43.23	-39.30	3000	315	195.99	135.82	4246	95	99.00	140.56		
4.62	0.20	41.930	0	1.5	-81.38	-37.95	-34.50	3000	315	189.05	133.02	4246	95	98.48	137.25		
4.82	0.13	41.373	0	1.5	-75.73	-32.86	-29.87	3000	315	182.32	130.29	4246	95	97.97	134.04		
4.95	0.14	41.027	0	1.5	-72.54	-30.02	-27.29	3000	315	178.52	128.74	4246	95	97.68	132.22		
5.09	0.17	40.645	0	1.5	-69.23	-27.08	-24.62	3000	315	174.56	127.11	4246	95	97.38	130.33		
5.26	0.18	40.223	0	1.5	-65.78	-24.06	-21.87	3000	315	170.44	125.41	4246	95	97.06	128.37		
5.44	0.20	39.780	0	1.5	-62.42	-21.14	-19.22	3000	315	166.44	123.75	4246	95	96.75	126.46		
5.64	0.20	39.319	0	1.5	-59.21	-18.39	-16.72	3000	315	162.59	122.15	4246	95	96.46	124.62		
5.84	0.20	38.879	0	1.5	-56.41	-16.04	-14.58	3000	315	159.25	120.76	4246	95	96.20	123.03		
6.04	0.20	38.458	0	1.5	-53.98	-14.02	-12.75	3000	315	156.33	119.53	4246	95	95.97	121.64		
6.24	0.20	38.056	0	1.5	-51.85	-12.30	-11.18	3000	315	153.78	118.46	4246	95	95.77	120.43		
6.44	0.20	37.670	0	1.5	-49.99	-10.82	-9.83	3000	315	151.55	117.52	4246	95	95.60	119.36		
6.64	0.20	37.300	0	1.5	-48.35	-9.55	-8.68	3000	315	149.58	116.68	4246	95	95.44	118.43		
6.84	0.20	36.944	0	1.5	-46.90	-8.46	-7.69	3000	315	147.84	115.95	4246	95	95.31	117.60		
7.04	0.20	36.602	0	1.5	-45.62	-7.52	-6.83	3000	315	146.31	115.29	4246	95	95.19	116.87		
7.24	0.20	36.272	0	1.5	-44.48	-6.71	-6.10	3000	315	144.94	114.71	4246	95	95.08	116.22		
7.44	0.20	35.954	0	1.5	-43.47	-6.01	-5.47	3000	315	143.72	114.19	4246	95	94.98	115.64		
7.64	0.20	35.647	0	1.5	-42.56	-5.41	-4.92	3000	315	142.63	113.72	4246	95	94.90	115.12		
7.84	0.20	35.351	0	1.5	-41.74	-4.89	-4.44	3000	315	141.64	113.30	4246	95	94.82	114.65		
8.04	0.20	35.065	0	1.5	-41.00	-4.44	-4.03	3000	315	140.75	112.92	4246	95	94.75	114.23		
8.24	0.20	34.788	0	1.5	-40.33	-4.04	-3.68	3000	315	139.95	112.58	4246	95	94.69	113.85		
8.44	0.20	34.519	0	1.5	-39.72	-3.70	-3.36	3000	315	139.21	112.26	4246	95	94.63	113.50		
8.64	0.20	34.259	0	1.5	-39.16	-3.40	-3.09	3000	315	138.54	111.97	4246	95	94.57	113.18		
8.84	0.20	34.007	0	1.5	-38.65	-3.14	-2.86	3000	315	137.92	111.71	4246	95	94.53	112.89		
9.04	0.20	33.762	0	1.5	-38.17	-2.91	-2.65	3000	315	137.35	111.46	4246	95	94.48	112.62		
9.24	0.20	33.524	0	1.5	-37.73	-2.71	-2.46	3000	315	136.82	111.23	4246	95	94.44	112.36		
9.44	0.20	33.293	0	1.5	-37.33	-2.53	-2.30	3000	315	136.33	111.02	4246	95	94.40	112.13		
9.64	0.20	33.068	0	1.5	-36.94	-2.38	-2.16	3000	315	135.87	110.82	4246	95	94.36	111.91		
9.84	0.20	32.850	0	1.5	-36.59	-2.24	-2.03	3000	315	135.44	110.63	4246	95	94.33	111.71		

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
2.00	271.39	55.59	1.0185	1.40E-04	0.396	5.609	121,220	1.2931	2168	161.00	60.97	1.0007	2.66E-04	0.382	3.652	180,842	2.5068	1420	9.402	588.21
2.10	262.86	56.04	1.0163	1.45E-04	0.396	5.609	117,469	1.3428	2146	157.73	61.04	1.0004	2.72E-04	0.381	3.652	176,628	2.5743	1409	9.365	583.76
2.20	254.88	56.45	1.0143	1.51E-04	0.396	5.609	113,883	1.3935	2123	154.65	61.10	1.0002	2.79E-04	0.380	3.652	172,682	2.6407	1398	9.330	579.39
2.30	247.41	56.83	1.0125	1.57E-04	0.395	5.609	110,470	1.4449	2100	151.75	61.16	1.0000	2.85E-04	0.380	3.652	168,992	2.7059	1388	9.297	575.15
2.40	240.43	57.17	1.0110	1.62E-04	0.395	5.609	107,235	1.4968	2078	149.04	61.21	0.9998	2.91E-04	0.379	3.652	165,546	2.7695	1379	9.268	571.06
2.50	233.90	57.47	1.0097	1.68E-04	0.394	5.609	104,177	1.5490	2056	146.49	61.26	0.9996	2.97E-04	0.378	3.652	162,331	2.8315	1369	9.241	567.11
2.60	227.80	57.75	1.0085	1.74E-04	0.394	5.609	101,296	1.6013	2034	144.10	61.30	0.9995	3.03E-04	0.377	3.652	159,334	2.8917	1361	9.216	563.31
2.70	222.10	58.01	1.0075	1.79E-04	0.393	5.609	98,586	1.6534	2013	141.87	61.34	0.9993	3.09E-04	0.377	3.652	156,542	2.9500	1353	9.192	559.66
2.75	219.44	58.13	1.0070	1.82E-04	0.393	5.609	97,315	1.6789	2003	140.83	61.36	0.9993	3.12E-04	0.376	3.652	155,244	2.9779	1349	9.181	557.93
2.85	214.29	58.35	1.0062	1.87E-04	0.392	5.609	94,849	1.7304	1983	138.82	61.40	0.9991	3.17E-04	0.376	3.652	152,736	3.0332	1341	9.159	554.51
2.95	209.48	58.55	1.0054	1.93E-04	0.392	5.609	92,537	1.7814	1964	136.93	61.43	0.9990	3.22E-04	0.375	3.652	150,401	3.0864	1334	9.139	551.25
3.05	205.00	58.74	1.0047	1.98E-04	0.391	5.609	90,375	1.8316	1945	135.17	61.46	0.9989	3.27E-04	0.375	3.652	148,228	3.1376	1328	9.120	548.14
3.15	200.81	58.91	1.0042	2.03E-04	0.390	5.609	88,352	1.8809	1928	133.52	61.49	0.9988	3.32E-04	0.374	3.652	146,205	3.1866	1321	9.103	545.19
3.25	196.90	59.07	1.0036	2.08E-04	0.390	5.609	86,462	1.9292	1911	131.99	61.52	0.9988	3.36E-04	0.374	3.652	144,322	3.2337	1316	9.087	542.38
3.35	193.26	59.21	1.0032	2.13E-04	0.389	5.609	84,697	1.9764	1895	130.55	61.54	0.9987	3.40E-04	0.373	3.652	142,569	3.2786	1310	9.071	539.72
3.45	189.85	59.34	1.0028	2.18E-04	0.389	5.609	83,049	2.0224	1879	129.21	61.56	0.9986	3.44E-04	0.373	3.652	140,938	3.3215	1305	9.057	537.19
3.55	186.67	59.46	1.0024	2.22E-04	0.388	5.609	81,511	2.0671	1865	127.96	61.58	0.9986	3.48E-04	0.372	3.652	139,418	3.3624	1300	9.044	534.80
3.65	183.65	59.57	1.0020	2.27E-04	0.387	5.609	80,050	2.1113	1851	126.77	61.60	0.9985	3.52E-04	0.372	3.652	137,979	3.4021	1295	9.031	532.50
3.76	180.63	59.69	1.0017	2.31E-04	0.387	5.609	78,589	2.1572	1837	125.58	61.62	0.9985	3.56E-04	0.371	3.652	136,543	3.4425	1291	9.019	530.16
3.88	177.63	59.79	1.0014	2.36E-04	0.386	5.609	77,136	2.2047	1823	124.40	61.64	0.9984	3.60E-04	0.371	3.652	135,117	3.4836	1286	9.006	527.81
4.00	174.65	59.90	1.0011	2.41E-04	0.386	5.609	75,699	2.2536	1808	123.22	61.66	0.9984	3.64E-04	0.371	3.652	133,709	3.5251	1281	8.993	525.44
4.14	171.70	60.00	1.0008	2.46E-04	0.385	5.609	74,277	2.3040	1794	122.06	61.68	0.9983	3.67E-04	0.370	3.652	132,318	3.5669	1277	8.979	523.05
4.29	168.78	60.11	1.0005	2.51E-04	0.384	5.609	72,873	2.3557	1779	120.91	61.70	0.9983	3.71E-04	0.370	3.652	130,948	3.6092	1272	8.966	520.65
4.45	165.90	60.20	1.0003	2.57E-04	0.384	5.609	71,490	2.4088	1765	119.78	61.72	0.9982	3.75E-04	0.369	3.652	129,599	3.6516	1268	8.953	518.26
4.62	161.04	60.36	0.9999	2.66E-04	0.382	5.609	69,161	2.5033	1740	117.86	61.75	0.9981	3.82E-04	0.369	3.652	127,331	3.7252	1260	8.930	514.16
4.82	156.30	60.52	0.9995	2.76E-04	0.381	5.609	66,902	2.6017	1715	116.00	61.77	0.9981	3.89E-04	0.368	3.652	125,136	3.7990	1252	8.909	510.09
4.95	153.63	60.60	0.9993	2.81E-04	0.381	5.609	65,630	2.6603	1701	114.95	61.79	0.9980	3.93E-04	0.368	3.652	123,901	3.8418	1248	8.897	507.75
5.09	150.84	60.69	0.9991	2.88E-04	0.380	5.609	64,308	2.7237	1686	113.86	61.81	0.9980	3.97E-04	0.367	3.652	122,620	3.8872	1243	8.884	505.28
5.26	147.93	60.78	0.9989	2.94E-04	0.379	5.609	62,932	2.7927	1670	112.71	61.82	0.9980	4.02E-04	0.367	3.652	121,287	3.9355	1239	8.871	502.67
5.44	145.10	60.86	0.9987	3.01E-04	0.378	5.609	61,598	2.8628	1655	111.61	61.84	0.9979	4.06E-04	0.366	3.652	119,996	3.9834	1234	8.859	500.11
5.64	142.37	60.94	0.9985	3.08E-04	0.377	5.609	60,321	2.9329	1639	110.54	61.85	0.9979	4.11E-04	0.366	3.652	118,760	4.0302	1230	8.847	497.61
5.84	140.00	61.01	0.9984	3.14E-04	0.377	5.609	59,213	2.9964	1626	109.61	61.87	0.9979	4.14E-04	0.366	3.652	117,688	4.0717	1226	8.837	495.42
6.04	137.93	61.07	0.9983	3.19E-04	0.376	5.609	58,248	3.0537	1614	108.81	61.88	0.9979	4.18E-04	0.365	3.652	116,756	4.1084	1222	8.828	493.48
6.24	136.12	61.12	0.9982	3.24E-04	0.375	5.609	57,407	3.1053	1604	108.10	61.89	0.9978	4.21E-04	0.365	3.652	115,943	4.1409	1219	8.820	491.77
6.44	134.53	61.16	0.9981	3.29E-04	0.375	5.609	56,670	3.1519	1595	107.48	61.90	0.9978	4.23E-04	0.365	3.652	115,231	4.1698	1217	8.814	490.26
6.64	133.13	61.20	0.9980	3.33E-04	0.374	5.609	56,023	3.1939	1587	106.93	61.90	0.9978	4.26E-04	0.365	3.652	114,606	4.1955	1214	8.808	488.93
6.84	131.90	61.23	0.9979	3.36E-04	0.374	5.609	55,452	3.2317	1579	106.45	61.91	0.9978	4.28E-04	0.364	3.652	114,055	4.2184	1212	8.803	487.74
7.04	130.80	61.26	0.9979	3.40E-04	0.374	5.609	54,948	3.2658	1573	106.03	61.92	0.9978	4.30E-04	0.364	3.652	113,568	4.2388	1210	8.798	486.68
7.24	129.83	61.29	0.9978	3.43E-04	0.373	5.609	54,500	3.2967	1567	105.65	61.92	0.9978	4.31E-04	0.364	3.652	113,135	4.2571	1209	8.794	485.73
7.44	128.96	61.31	0.9978	3.45E-04	0.373	5.609	54,101	3.3247	1562	105.31	61.93	0.9978	4.33E-04	0.364	3.652	112,750	4.2736	1207	8.791	484.89
7.64	128.18	61.33	0.9977	3.48E-04	0.373	5.609	53,743	3.3502	1558	105.01	61.93	0.9978	4.34E-04	0.364	3.652	112,405	4.2884	1206	8.788	484.12
7.84	127.47	61.35	0.9977	3.50E-04	0.373	5.609	53,422	3.3733	1553	104.74	61.93	0.9978	4.36E-04	0.364	3.652	112,095	4.3018	1205	8.785	483.44
8.04	126.84	61.36	0.9977	3.52E-04	0.372	5.609	53,132	3.3945	1550	104.49	61.94	0.9977	4.37E-04	0.364	3.652	111,815	4.3139	1204	8.782	482.81
8.24	126.26	61.38	0.9977	3.54E-04	0.372	5.609	52,869	3.4139	1546	104.27	61.94	0.9977	4.38E-04	0.364	3.652	111,561	4.3250	1203	8.780	482.24
8.44	125.74	61.39	0.9976	3.55E-04	0.372	5.609	52,629	3.4318	1543	104.06	61.94	0.9977	4.39E-04	0.363	3.652	111,329	4.3352	1202	8.778	481.72
8.64	125.26	61.40	0.9976	3.57E-04	0.372	5.609	52,410	3.4482	1540	103.88	61.95	0.9977	4.39E-04	0.363	3.652	111,118	4.3445	1201	8.776	481.25
8.84	124.81	61.41	0.9976	3.58E-04	0.372	5.609	52,209	3.4635	1538	103.71	61.95	0.9977	4.40E-04	0.363	3.652	110,924	4.3531	1200	8.774	480.81
9.04	124.41	61.42	0.9976	3.60E-04	0.372	5.609	52,023	3.4777	1535	103.55	61.95	0.9977	4.41E-04	0.363	3.652	110,744	4.3610	1200	8.773	480.40
9.24	124.03	61.43	0.9976	3.61E-04	0.371	5.609	51,851	3.4910	1533	103.40	61.95	0.9977	4.42E-04	0.363	3.652	110,578	4.3684	1199	8.771	480.02
9.44	123.67	61.44	0.9975	3.62E-04	0.371	5.609	51,691	3.5034	1531	103.27	61.95	0.9977	4.42E-04	0.363	3.652	110,424	4.3753	1199	8.770	479.67
9.64	123.34	61.45	0.9975	3.63E-04	0.371	5.609	51,541	3.5150	1529	103.14	61.96	0.9977	4.43E-04	0.363	3.652	110,279	4.3818	1198	8.769	479.34
9.84	123.04	61.46	0.9975	3.64E-04	0.371	5.609	51,401	3.5260	1527	103.02	61.96	0.9977	4.43E-04	0.363	3.652	110,144	4.3879	1198	8.767	479.03

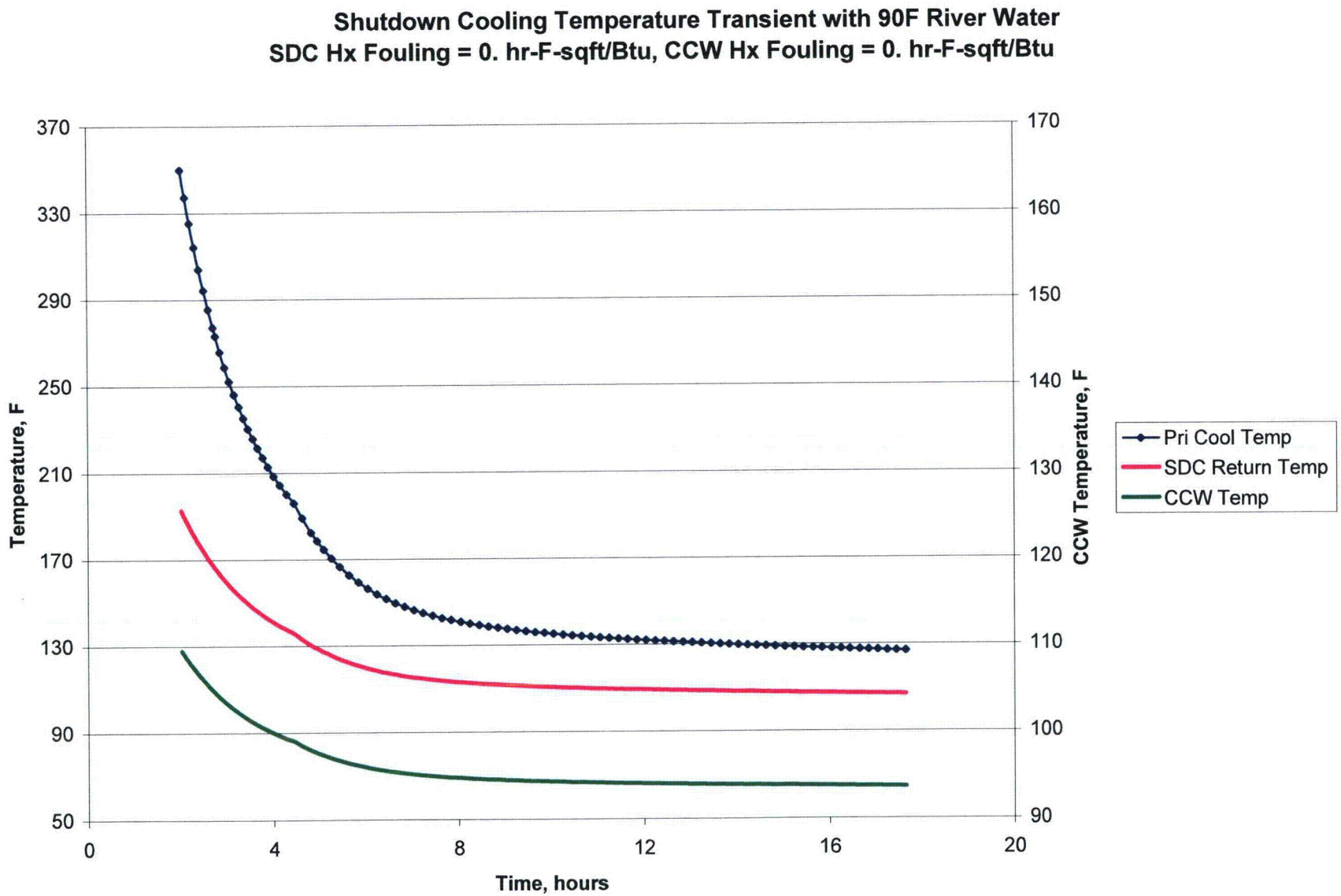
CCW HX Fouling 0

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate	Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX	CCW Temp
hrs	W	WCp	Cr	NTU	ffectivenes	DT	Tt,o	W	WCp	Cr	NTU	ffectivenes	DTs	Ts,o	Btu/hr			mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr	Ts,o
2.00	1,337,560	1,362,359	0.656	2.167	0.654	157.23	192.77	2,076,521	2,077,897	#N/A	#N/A	#N/A	103.08	212.54	214.20	192.77	212.54	7.358	221.56	8,100	3	73.85	109.46
2.10	1,348,494	1,370,412	0.659	2.138	0.651	148.87	188.43	2,078,765	2,079,605	#N/A	#N/A	#N/A	98.10	206.78	204.01	188.43	206.78	7.358	211.37	8,100	3	70.46	108.68
2.20	1,358,397	1,377,766	0.662	2.111	0.649	141.12	184.32	2,080,842	2,081,199	#N/A	#N/A	#N/A	93.42	201.36	194.43	184.32	201.36	7.358	201.79	8,100	3	67.26	107.94
2.30	1,367,378	1,384,494	0.665	2.085	0.647	133.95	180.44	2,082,763	2,082,685	#N/A	#N/A	#N/A	89.04	196.27	185.45	180.44	196.27	7.358	192.81	8,100	3	64.27	107.23
2.40	1,375,534	1,390,658	0.667	2.061	0.645	127.30	176.78	2,084,537	2,084,067	#N/A	#N/A	#N/A	84.94	191.51	177.03	176.78	191.51	7.358	184.39	8,100	3	61.46	106.56
2.50	1,382,949	1,396,311	0.670	2.039	0.643	121.14	173.33	2,086,175	2,085,352	#N/A	#N/A	#N/A	81.11	187.05	169.15	173.33	187.05	7.358	176.51	8,100	3	58.84	105.93
2.60	1,389,699	1,401,501	0.672	2.018	0.641	115.43	170.08	2,087,687	2,086,546	#N/A	#N/A	#N/A	77.53	182.87	161.78	170.08	182.87	7.358	169.13	8,100	3	56.38	105.34
2.70	1,395,848	1,406,270	0.674	1.998	0.639	110.14	167.03	2,089,082	2,087,653	#N/A	#N/A	#N/A	74.19	178.97	154.89	167.03	178.97	7.358	162.24	8,100	3	54.08	104.78
2.75	1,398,667	1,408,469	0.675	1.989	0.638	107.69	165.59	2,089,727	2,088,167	#N/A	#N/A	#N/A	72.64	177.15	151.68	165.59	177.15	7.358	159.03	8,100	3	53.01	104.51
2.85	1,404,031	1,412,678	0.676	1.970	0.637	102.97	162.80	2,090,963	2,089,155	#N/A	#N/A	#N/A	69.63	173.63	145.46	162.80	173.63	7.358	152.82	8,100	3	50.94	104.00
2.95	1,408,932	1,416,552	0.678	1.954	0.635	98.59	160.19	2,092,103	2,090,072	#N/A	#N/A	#N/A	66.82	170.34	139.66	160.19	170.34	7.358	147.02	8,100	3	49.01	103.52
3.05	1,413,413	1,420,119	0.679	1.938	0.634	94.53	157.73	2,093,157	2,090,922	#N/A	#N/A	#N/A	64.20	167.27	134.24	157.73	167.27	7.358	141.60	8,100	3	47.20	103.07
3.15	1,417,514	1,423,406	0.680	1.923	0.632	90.76	155.43	2,094,129	2,091,711	#N/A	#N/A	#N/A	61.76	164.41	129.19	155.43	164.41	7.358	136.55	8,100	3	45.52	102.64
3.25	1,421,272	1,426,436	0.682	1.909	0.631	87.26	153.27	2,095,028	2,092,442	#N/A	#N/A	#N/A	59.49	161.73	124.47	153.27	161.73	7.358	131.83	8,100	3	43.94	102.24
3.35	1,424,717	1,429,230	0.683	1.896	0.630	84.01	151.25	2,095,858	2,093,120	#N/A	#N/A	#N/A	57.37	159.23	120.08	151.25	159.23	7.358	127.43	8,100	3	42.48	101.87
3.45	1,427,879	1,431,808	0.684	1.883	0.629	81.00	149.35	2,096,626	2,093,749	#N/A	#N/A	#N/A	55.39	156.91	115.97	149.35	156.91	7.358	123.33	8,100	3	41.11	101.52
3.55	1,430,784	1,434,188	0.685	1.872	0.628	78.19	147.58	2,097,336	2,094,334	#N/A	#N/A	#N/A	53.55	154.73	112.14	147.58	154.73	7.358	119.50	8,100	3	39.83	101.19
3.65	1,433,502	1,436,424	0.686	1.861	0.627	75.54	145.88	2,098,005	2,094,885	#N/A	#N/A	#N/A	51.80	152.67	108.51	145.88	152.67	7.358	115.86	8,100	3	38.62	100.87
3.76	1,436,180	1,438,637	0.687	1.850	0.626	72.90	144.18	2,098,668	2,095,434	#N/A	#N/A	#N/A	50.05	150.60	104.87	144.18	150.60	7.358	112.23	8,100	3	37.41	100.56
3.88	1,438,804	1,440,815	0.687	1.839	0.625	70.28	142.49	2,099,322	2,095,977	#N/A	#N/A	#N/A	48.31	148.55	101.26	142.49	148.55	7.358	108.61	8,100	3	36.20	100.24
4.00	1,441,363	1,442,948	0.688	1.828	0.624	67.69	140.80	2,099,964	2,096,513	#N/A	#N/A	#N/A	46.59	146.52	97.68	140.80	146.52	7.358	105.04	8,100	3	35.01	99.93
4.14	1,443,857	1,445,034	0.689	1.817	0.622	65.14	139.13	2,100,594	2,097,039	#N/A	#N/A	#N/A	44.89	144.51	94.14	139.13	144.51	7.358	101.49	8,100	3	33.83	99.62
4.29	1,446,283	1,447,072	0.690	1.806	0.621	62.64	137.46	2,101,211	2,097,557	#N/A	#N/A	#N/A	43.21	142.52	90.64	137.46	142.52	7.358	98.00	8,100	3	32.67	99.31
4.45	1,448,639	1,449,058	0.691	1.795	0.620	60.17	135.82	2,101,815	2,098,065	#N/A	#N/A	#N/A	41.56	140.56	87.19	135.82	140.56	7.358	94.55	8,100	3	31.52	99.00
4.62	1,452,528	1,452,352	0.692	1.777	0.619	56.03	133.02	2,102,820	2,098,915	#N/A	#N/A	#N/A	38.77	137.25	81.38	133.02	137.25	7.358	88.73	8,100	3	29.58	98.48
4.82	1,456,206	1,455,485	0.693	1.759	0.617	52.03	130.29	2,103,782	2,099,735	#N/A	#N/A	#N/A	36.07	134.04	75.73	130.29	134.04	7.358	83.09	8,100	3	27.70	97.97
4.95	1,458,236	1,457,222	0.694	1.749	0.616	49.78	128.74	2,104,318	2,100,194	#N/A	#N/A	#N/A	34.54	132.22	72.54	128.74	132.22	7.358	79.90	8,100	3	26.63	97.68
5.09	1,460,314	1,459,005	0.695	1.739	0.615	47.45	127.11	2,104,871	2,100,669	#N/A	#N/A	#N/A	32.96	130.33	69.23	127.11	130.33	7.358	76.59	8,100	3	25.53	97.38
5.26	1,462,441	1,460,835	0.695	1.727	0.614	45.03	125.41	2,105,442	2,101,162	#N/A	#N/A	#N/A	31.31	128.37	65.78	125.41	128.37	7.358	73.14	8,100	3	24.38	97.06
5.44	1,464,471	1,462,587	0.696	1.717	0.613	42.68	123.75	2,105,991	2,101,638	#N/A	#N/A	#N/A	29.70	126.46	62.42	123.75	126.46	7.358	69.78	8,100	3	23.26	96.75
5.64	1,466,381	1,464,241	0.697	1.706	0.611	40.44	122.15	2,106,513	2,102,093	#N/A	#N/A	#N/A	28.17	124.62	59.21	122.15	124.62	7.358	66.57	8,100	3	22.19	96.46
5.84	1,468,014	1,465,658	0.697	1.697	0.610	38.49	120.76	2,106,962	2,102,486	#N/A	#N/A	#N/A	26.83	123.03	56.41	120.76	123.03	7.358	63.77	8,100	3	21.26	96.20
6.04	1,469,414	1,466,877	0.698	1.689	0.610	36.80	119.53	2,107,351	2,102,827	#N/A	#N/A	#N/A	25.67	121.64	53.98	119.53	121.64	7.358	61.34	8,100	3	20.45	95.97
6.24	1,470,621	1,467,929	0.698	1.682	0.609	35.32	118.46	2,107,688	2,103,125	#N/A	#N/A	#N/A	24.65	120.43	51.85	118.46	120.43	7.358	59.21	8,100	3	19.74	95.77
6.44	1,471,666	1,468,841	0.698	1.676	0.608	34.03	117.52	2,107,982	2,103,384	#N/A	#N/A	#N/A	23.76	119.36	49.99	117.52	119.36	7.358	57.34	8,100	3	19.11	95.60
6.64	1,472,574	1,469,636	0.699	1.670	0.608	32.90	116.68	2,108,239	2,103,612	#N/A	#N/A	#N/A	22.98	118.43	48.35	116.68	118.43	7.358	55.70	8,100	3	18.57	95.44
6.84	1,473,367	1,470,330	0.699	1.665	0.607	31.90	115.95	2,108,464	2,103,813	#N/A	#N/A	#N/A	22.29	117.60	46.90	115.95	117.60	7.358	54.26	8,100	3	18.09	95.31
7.04	1,474,064	1,470,941	0.699	1.661	0.607	31.01	115.29	2,108,663	2,103,990	#N/A	#N/A	#N/A	21.68	116.87	45.62	115.29	116.87	7.358	52.98	8,100	3	17.66	95.19
7.24	1,474,677	1,471,479	0.699	1.657	0.606	30.23	114.71	2,108,839	2,104,147	#N/A	#N/A	#N/A	21.14	116.22	44.48	114.71	116.22	7.358	51.84	8,100	3	17.28	95.08
7.44	1,475,220	1,471,957	0.700	1.654	0.606	29.53	114.19	2,108,995	2,104,287	#N/A	#N/A	#N/A	20.66	115.64	43.47	114.19	115.64	7.358	50.82	8,100	3	16.94	94.98
7.64	1,475,704	1,472,382	0.700	1.651	0.606	28.90	113.72	2,109,135	2,104,413	#N/A	#N/A	#N/A	20.22	115.12	42.56	113.72	115.12	7.358	49.92	8,100	3	16.64	94.90
7.84	1,476,136	1,472,763	0.700	1.648	0.605	28.34	113.30	2,109,260	2,104,525	#N/A	#N/A	#N/A	19.83	114.65	41.74	113.30	114.65	7.358	49.10	8,100	3	16.37	94.82
8.04	1,476,524	1,473,105	0.700	1.645	0.605	27.83	112.92	2,109,373	2,104,627	#N/A	#N/A	#N/A	19.48	114.23	41.00	112.92	114.23	7.358	48.36	8,100	3	16.12	94.75
8.24	1,476,875	1,473,414	0.700	1.643	0.605	27.37	112.58	2,109,475	2,104,719	#N/A	#N/A	#N/A	19.16	113.85	40.33	112.58	113.85	7.358	47.69	8,100	3	15.90	94.69
8.44	1,477,193	1,473,694	0.700	1.641	0.605	26.95	112.26	2,109,568	2,104,803	#N/A	#N/A	#N/A	18.87	113.50	39.72	112.26	113.50	7.358	47.08	8,100	3	15.69	94.63
8.64	1,477,482	1,473,950	0.700	1.639	0.604	26.57	111.97	2,109,653	2,104,879	#N/A	#N/A	#N/A	18.60	113.18	39.16	111.97	113.18	7.358	46.52	8,100	3	15.51	94.57
8.84	1,477,747	1,474,184	0.700	1.637	0.604	26.22	111.71	2,109,731	2,104,950	#N/A	#N/A	#N/A	18.36	112.89	38.65	111.71	112.89	7.358	46.01	8,100	3	15.34	94.53
9.04	1,477,991	1,474,400	0.700	1.636	0.604	25.89	111.46	2,109,802	2,105,015	#N/A	#N/A	#N/A	18.13	112.62	38.17	111.46	112.62	7.358	45.53	8,100	3	15.18	94.48
9.24	1,478,217	1,474,599	0.700	1.634	0.604	25.59	111.23	2,109,869	2,105,075	#N/A	#N/A	#N/A	17.93	112.36	37.73	111.23	112.36	7.358	45.09	8,100	3	15.03	94.44
9.44	1,478,426	1,474,784	0.701	1.633	0.604	25.31	111.02	2,109,930	2,105,131	#N/A	#N/A	#N/A	17.73	112.13	37.33	111.02	112.13	7.358	44.68	8,100	3	14.89	94.40
9.64	1,478,620	1,474,956	0.701	1.631	0.603	25.05	110.82	2,109,988	2,105,183	#N/A	#N/A	#N/A	17.55	111.91	36.94	110.82	111.91	7.358	44.30	8,100	3	14.77	94.36
9.84	1,478,802	1,475,117	0.701	1.630	0.603	24.80	110.63	2,110,042	2,105,232	#N/A	#N/A	#N/A	17.38	111.71	36.59	110.63	111.71	7.358	43.94	8,100	3	14.65	94.33

								SDCHx							
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell			
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o
10.04	0.20	32.637	0	1.5	-36.25	-2.11	-1.92	3000	315	135.03	110.46	4246	95	94.30	111.51
10.24	0.20	32.430	0	1.5	-35.93	-2.00	-1.82	3000	315	134.65	110.29	4246	95	94.27	111.33
10.44	0.20	32.228	0	1.5	-35.63	-1.90	-1.73	3000	315	134.28	110.14	4246	95	94.24	111.16
10.64	0.20	32.031	0	1.5	-35.34	-1.81	-1.65	3000	315	133.94	109.99	4246	95	94.21	111.00
10.84	0.20	31.839	0	1.5	-35.07	-1.73	-1.57	3000	315	133.61	109.84	4246	95	94.18	110.84
11.04	0.20	31.651	0	1.5	-34.81	-1.66	-1.51	3000	315	133.29	109.71	4246	95	94.16	110.69
11.24	0.20	31.468	0	1.5	-34.56	-1.59	-1.45	3000	315	132.99	109.58	4246	95	94.14	110.55
11.44	0.20	31.289	0	1.5	-34.32	-1.53	-1.39	3000	315	132.70	109.45	4246	95	94.11	110.41
11.64	0.20	31.115	0	1.5	-34.09	-1.47	-1.34	3000	315	132.42	109.33	4246	95	94.09	110.28
11.84	0.20	30.944	0	1.5	-33.87	-1.42	-1.29	3000	315	132.16	109.22	4246	95	94.07	110.15
12.04	0.20	30.777	0	1.5	-33.65	-1.38	-1.25	3000	315	131.90	109.10	4246	95	94.05	110.03
12.24	0.20	30.613	0	1.5	-33.45	-1.33	-1.21	3000	315	131.65	109.00	4246	95	94.03	109.91
12.44	0.20	30.454	0	1.5	-33.24	-1.29	-1.17	3000	315	131.40	108.89	4246	95	94.01	109.80
12.64	0.20	30.297	0	1.5	-33.05	-1.25	-1.14	3000	315	131.17	108.79	4246	95	93.99	109.69
12.84	0.20	30.144	0	1.5	-32.86	-1.22	-1.11	3000	315	130.94	108.69	4246	95	93.97	109.58
13.04	0.20	29.994	0	1.5	-32.68	-1.18	-1.08	3000	315	130.72	108.59	4246	95	93.96	109.47
13.24	0.20	29.847	0	1.5	-32.50	-1.15	-1.05	3000	315	130.50	108.50	4246	95	93.94	109.37
13.44	0.20	29.702	0	1.5	-32.33	-1.12	-1.02	3000	315	130.30	108.41	4246	95	93.92	109.27
13.64	0.20	29.561	0	1.5	-32.16	-1.10	-1.00	3000	315	130.09	108.32	4246	95	93.91	109.18
13.84	0.20	29.422	0	1.5	-31.99	-1.07	-0.97	3000	315	129.89	108.23	4246	95	93.89	109.08
14.04	0.20	29.286	0	1.5	-31.83	-1.05	-0.95	3000	315	129.70	108.15	4246	95	93.87	108.99
14.24	0.20	29.153	0	1.5	-31.67	-1.02	-0.93	3000	315	129.51	108.07	4246	95	93.86	108.90
14.44	0.20	29.022	0	1.5	-31.52	-1.00	-0.91	3000	315	129.32	107.98	4246	95	93.84	108.81
14.64	0.20	28.893	0	1.5	-31.37	-0.98	-0.89	3000	315	129.14	107.91	4246	95	93.83	108.73
14.84	0.20	28.767	0	1.5	-31.22	-0.96	-0.87	3000	315	128.96	107.83	4246	95	93.82	108.64
15.04	0.20	28.643	0	1.5	-31.08	-0.94	-0.85	3000	315	128.79	107.75	4246	95	93.80	108.56
15.24	0.20	28.521	0	1.5	-30.94	-0.92	-0.83	3000	315	128.62	107.68	4246	95	93.79	108.48
15.44	0.20	28.401	0	1.5	-30.80	-0.90	-0.82	3000	315	128.45	107.61	4246	95	93.77	108.40
15.64	0.20	28.283	0	1.5	-30.67	-0.88	-0.80	3000	315	128.29	107.53	4246	95	93.76	108.32
15.84	0.20	28.167	0	1.5	-30.53	-0.87	-0.79	3000	315	128.13	107.46	4246	95	93.75	108.25
16.04	0.20	28.053	0	1.5	-30.40	-0.85	-0.77	3000	315	127.97	107.40	4246	95	93.74	108.17
16.24	0.20	27.941	0	1.5	-30.28	-0.83	-0.76	3000	315	127.81	107.33	4246	95	93.72	108.10
16.44	0.20	27.831	0	1.5	-30.15	-0.82	-0.74	3000	315	127.66	107.26	4246	95	93.71	108.03
16.64	0.20	27.722	0	1.5	-30.03	-0.80	-0.73	3000	315	127.51	107.20	4246	95	93.70	107.96
16.84	0.20	27.616	0	1.5	-29.91	-0.79	-0.72	3000	315	127.37	107.13	4246	95	93.69	107.89
17.04	0.20	27.510	0	1.5	-29.79	-0.78	-0.71	3000	315	127.22	107.07	4246	95	93.68	107.82
17.24	0.20	27.407	0	1.5	-29.67	-0.76	-0.69	3000	315	127.08	107.01	4246	95	93.67	107.75
17.44	0.20	27.305	0	1.5	-29.56	-0.75	-0.68	3000	315	126.94	106.95	4246	95	93.65	107.69
17.64	0.20	27.205	0	1.5	-29.44	-0.74	-0.67	3000	315	126.81	106.89	4246	95	93.64	107.62

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
10.04	122.74	61.46	0.9975	3.65E-04	0.371	5.609	51,269	3.5364	1525	102.91	61.96	0.9977	4.44E-04	0.363	3.652	110,017	4.3936	1197	8.766	478.74
10.24	122.47	61.47	0.9975	3.66E-04	0.371	5.609	51,145	3.5463	1523	102.80	61.96	0.9977	4.44E-04	0.363	3.652	109,897	4.3990	1197	8.765	478.47
10.44	122.21	61.48	0.9975	3.67E-04	0.371	5.609	51,027	3.5557	1522	102.70	61.96	0.9977	4.45E-04	0.363	3.652	109,783	4.4042	1196	8.764	478.20
10.64	121.96	61.48	0.9975	3.68E-04	0.371	5.609	50,915	3.5647	1520	102.60	61.96	0.9977	4.45E-04	0.363	3.652	109,675	4.4091	1196	8.763	477.96
10.84	121.73	61.49	0.9975	3.69E-04	0.371	5.609	50,808	3.5733	1519	102.51	61.96	0.9977	4.46E-04	0.363	3.652	109,572	4.4138	1195	8.762	477.72
11.04	121.50	61.49	0.9974	3.70E-04	0.371	5.609	50,706	3.5815	1518	102.43	61.96	0.9977	4.46E-04	0.363	3.652	109,473	4.4182	1195	8.762	477.49
11.24	121.28	61.50	0.9974	3.70E-04	0.370	5.609	50,609	3.5894	1516	102.34	61.97	0.9977	4.47E-04	0.363	3.652	109,379	4.4225	1195	8.761	477.27
11.44	121.08	61.50	0.9974	3.71E-04	0.370	5.609	50,515	3.5970	1515	102.26	61.97	0.9977	4.47E-04	0.363	3.652	109,289	4.4267	1194	8.760	477.06
11.64	120.88	61.51	0.9974	3.72E-04	0.370	5.609	50,425	3.6044	1514	102.19	61.97	0.9977	4.47E-04	0.363	3.652	109,202	4.4306	1194	8.759	476.86
11.84	120.69	61.51	0.9974	3.72E-04	0.370	5.609	50,339	3.6115	1513	102.11	61.97	0.9977	4.48E-04	0.363	3.652	109,118	4.4345	1194	8.758	476.67
12.04	120.50	61.52	0.9974	3.73E-04	0.370	5.609	50,255	3.6184	1511	102.04	61.97	0.9977	4.48E-04	0.363	3.652	109,038	4.4382	1193	8.758	476.48
12.24	120.32	61.52	0.9974	3.74E-04	0.370	5.609	50,174	3.6251	1510	101.97	61.97	0.9977	4.48E-04	0.363	3.652	108,959	4.4418	1193	8.757	476.30
12.44	120.15	61.53	0.9974	3.74E-04	0.370	5.609	50,096	3.6316	1509	101.90	61.97	0.9977	4.49E-04	0.363	3.652	108,884	4.4452	1193	8.756	476.12
12.64	119.98	61.53	0.9974	3.75E-04	0.370	5.609	50,020	3.6379	1508	101.84	61.97	0.9977	4.49E-04	0.363	3.652	108,811	4.4486	1192	8.756	475.95
12.84	119.82	61.53	0.9974	3.75E-04	0.370	5.609	49,946	3.6441	1507	101.78	61.97	0.9977	4.49E-04	0.362	3.652	108,740	4.4519	1192	8.755	475.79
13.04	119.66	61.54	0.9974	3.76E-04	0.370	5.609	49,875	3.6500	1506	101.71	61.97	0.9977	4.50E-04	0.362	3.652	108,671	4.4551	1192	8.754	475.62
13.24	119.50	61.54	0.9974	3.77E-04	0.370	5.609	49,805	3.6559	1505	101.65	61.98	0.9977	4.50E-04	0.362	3.652	108,604	4.4582	1192	8.754	475.47
13.44	119.35	61.55	0.9974	3.77E-04	0.370	5.609	49,738	3.6616	1504	101.60	61.98	0.9977	4.50E-04	0.362	3.652	108,538	4.4612	1191	8.753	475.31
13.64	119.21	61.55	0.9973	3.78E-04	0.370	5.609	49,672	3.6672	1504	101.54	61.98	0.9977	4.50E-04	0.362	3.652	108,474	4.4642	1191	8.753	475.16
13.84	119.06	61.55	0.9973	3.78E-04	0.370	5.609	49,607	3.6726	1503	101.49	61.98	0.9977	4.51E-04	0.362	3.652	108,412	4.4671	1191	8.752	475.02
14.04	118.92	61.56	0.9973	3.79E-04	0.370	5.609	49,544	3.6779	1502	101.43	61.98	0.9977	4.51E-04	0.362	3.652	108,352	4.4699	1191	8.752	474.88
14.24	118.79	61.56	0.9973	3.79E-04	0.370	5.609	49,483	3.6832	1501	101.38	61.98	0.9977	4.51E-04	0.362	3.652	108,293	4.4726	1190	8.751	474.74
14.44	118.65	61.56	0.9973	3.80E-04	0.369	5.609	49,423	3.6883	1500	101.33	61.98	0.9977	4.51E-04	0.362	3.652	108,235	4.4753	1190	8.751	474.60
14.64	118.52	61.56	0.9973	3.80E-04	0.369	5.609	49,365	3.6933	1499	101.28	61.98	0.9977	4.52E-04	0.362	3.652	108,178	4.4780	1190	8.750	474.47
14.84	118.40	61.57	0.9973	3.81E-04	0.369	5.609	49,307	3.6982	1499	101.23	61.98	0.9977	4.52E-04	0.362	3.652	108,123	4.4806	1190	8.750	474.34
15.04	118.27	61.57	0.9973	3.81E-04	0.369	5.609	49,251	3.7030	1498	101.18	61.98	0.9977	4.52E-04	0.362	3.652	108,069	4.4831	1190	8.749	474.21
15.24	118.15	61.57	0.9973	3.81E-04	0.369	5.609	49,197	3.7077	1497	101.13	61.98	0.9977	4.52E-04	0.362	3.652	108,016	4.4856	1189	8.749	474.09
15.44	118.03	61.58	0.9973	3.82E-04	0.369	5.609	49,143	3.7124	1496	101.09	61.98	0.9977	4.53E-04	0.362	3.652	107,964	4.4880	1189	8.748	473.96
15.64	117.91	61.58	0.9973	3.82E-04	0.369	5.609	49,090	3.7170	1496	101.04	61.98	0.9977	4.53E-04	0.362	3.652	107,913	4.4904	1189	8.748	473.84
15.84	117.80	61.58	0.9973	3.83E-04	0.369	5.609	49,038	3.7214	1495	101.00	61.98	0.9977	4.53E-04	0.362	3.652	107,863	4.4928	1189	8.748	473.72
16.04	117.68	61.58	0.9973	3.83E-04	0.369	5.609	48,988	3.7259	1494	100.95	61.98	0.9977	4.53E-04	0.362	3.652	107,814	4.4951	1189	8.747	473.61
16.24	117.57	61.59	0.9973	3.83E-04	0.369	5.609	48,938	3.7302	1494	100.91	61.98	0.9977	4.53E-04	0.362	3.652	107,766	4.4973	1188	8.747	473.49
16.44	117.46	61.59	0.9973	3.84E-04	0.369	5.609	48,889	3.7345	1493	100.87	61.99	0.9977	4.54E-04	0.362	3.652	107,719	4.4995	1188	8.746	473.38
16.64	117.36	61.59	0.9973	3.84E-04	0.369	5.609	48,841	3.7386	1492	100.83	61.99	0.9977	4.54E-04	0.362	3.652	107,673	4.5017	1188	8.746	473.27
16.84	117.25	61.59	0.9973	3.85E-04	0.369	5.609	48,794	3.7428	1492	100.79	61.99	0.9977	4.54E-04	0.362	3.652	107,628	4.5039	1188	8.745	473.16
17.04	117.15	61.60	0.9973	3.85E-04	0.369	5.609	48,748	3.7468	1491	100.75	61.99	0.9977	4.54E-04	0.362	3.652	107,583	4.5060	1188	8.745	473.06
17.24	117.05	61.60	0.9973	3.85E-04	0.369	5.609	48,703	3.7508	1490	100.71	61.99	0.9977	4.54E-04	0.362	3.652	107,539	4.5080	1188	8.745	472.95
17.44	116.95	61.60	0.9973	3.86E-04	0.369	5.609	48,658	3.7548	1490	100.67	61.99	0.9977	4.55E-04	0.362	3.652	107,496	4.5101	1187	8.744	472.85
17.64	116.85	61.60	0.9973	3.86E-04	0.369	5.609	48,614	3.7587	1489	100.63	61.99	0.9977	4.55E-04	0.362	3.652	107,454	4.5121	1187	8.744	472.75

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate			Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX		CCW Temp
hrs	W	WCp	Cr	NTU	ffectivenes	DT	Tt,o	W	WCp	Cr	NTU	ffectivenes	DTs	Ts,o	Btu/hr					mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr		Ts,o
10.04	1,478,973	1,475,268	0.701	1.629	0.603	24.57	110.46	2,110,093	2,105,278	#N/A	#N/A	#N/A	17.22	111.51	36.25	110.46	111.51			7.358	43.61	8,100	3	14.54		94.30
10.24	1,479,134	1,475,411	0.701	1.628	0.603	24.35	110.29	2,110,140	2,105,321	#N/A	#N/A	#N/A	17.07	111.33	35.93	110.29	111.33			7.358	43.29	8,100	3	14.43		94.27
10.44	1,479,286	1,475,545	0.701	1.627	0.603	24.15	110.14	2,110,186	2,105,363	#N/A	#N/A	#N/A	16.92	111.16	35.63	110.14	111.16			7.358	42.99	8,100	3	14.33		94.24
10.64	1,479,430	1,475,673	0.701	1.626	0.603	23.95	109.99	2,110,228	2,105,402	#N/A	#N/A	#N/A	16.79	111.00	35.34	109.99	111.00			7.358	42.70	8,100	3	14.23		94.21
10.84	1,479,567	1,475,795	0.701	1.625	0.603	23.76	109.84	2,110,269	2,105,439	#N/A	#N/A	#N/A	16.66	110.84	35.07	109.84	110.84			7.358	42.43	8,100	3	14.14		94.18
11.04	1,479,698	1,475,911	0.701	1.624	0.603	23.58	109.71	2,110,308	2,105,474	#N/A	#N/A	#N/A	16.53	110.69	34.81	109.71	110.69			7.358	42.17	8,100	3	14.06		94.16
11.24	1,479,822	1,476,021	0.701	1.623	0.603	23.41	109.58	2,110,346	2,105,508	#N/A	#N/A	#N/A	16.41	110.55	34.56	109.58	110.55			7.358	41.92	8,100	3	13.97		94.14
11.44	1,479,942	1,476,127	0.701	1.622	0.602	23.25	109.45	2,110,381	2,105,541	#N/A	#N/A	#N/A	16.30	110.41	34.32	109.45	110.41			7.358	41.68	8,100	3	13.89		94.11
11.64	1,480,057	1,476,229	0.701	1.622	0.602	23.09	109.33	2,110,416	2,105,573	#N/A	#N/A	#N/A	16.19	110.28	34.09	109.33	110.28			7.358	41.45	8,100	3	13.82		94.09
11.84	1,480,167	1,476,327	0.701	1.621	0.602	22.94	109.22	2,110,449	2,105,603	#N/A	#N/A	#N/A	16.08	110.15	33.87	109.22	110.15			7.358	41.22	8,100	3	13.74		94.07
12.04	1,480,273	1,476,422	0.701	1.620	0.602	22.79	109.10	2,110,481	2,105,632	#N/A	#N/A	#N/A	15.98	110.03	33.65	109.10	110.03			7.358	41.01	8,100	3	13.67		94.05
12.24	1,480,376	1,476,513	0.701	1.619	0.602	22.65	109.00	2,110,511	2,105,660	#N/A	#N/A	#N/A	15.88	109.91	33.45	109.00	109.91			7.358	40.80	8,100	3	13.60		94.03
12.44	1,480,475	1,476,601	0.701	1.619	0.602	22.51	108.89	2,110,541	2,105,687	#N/A	#N/A	#N/A	15.79	109.80	33.24	108.89	109.80			7.358	40.60	8,100	3	13.53		94.01
12.64	1,480,571	1,476,686	0.701	1.618	0.602	22.38	108.79	2,110,570	2,105,714	#N/A	#N/A	#N/A	15.70	109.69	33.05	108.79	109.69			7.358	40.41	8,100	3	13.47		93.99
12.84	1,480,664	1,476,769	0.701	1.617	0.602	22.25	108.69	2,110,598	2,105,739	#N/A	#N/A	#N/A	15.61	109.58	32.86	108.69	109.58			7.358	40.22	8,100	3	13.41		93.97
13.04	1,480,754	1,476,849	0.701	1.617	0.602	22.13	108.59	2,110,625	2,105,764	#N/A	#N/A	#N/A	15.52	109.47	32.68	108.59	109.47			7.358	40.04	8,100	3	13.35		93.96
13.24	1,480,842	1,476,927	0.701	1.616	0.602	22.01	108.50	2,110,652	2,105,789	#N/A	#N/A	#N/A	15.43	109.37	32.50	108.50	109.37			7.358	39.86	8,100	3	13.29		93.94
13.44	1,480,927	1,477,003	0.701	1.615	0.602	21.89	108.41	2,110,678	2,105,812	#N/A	#N/A	#N/A	15.35	109.27	32.33	108.41	109.27			7.358	39.68	8,100	3	13.23		93.92
13.64	1,481,010	1,477,077	0.701	1.615	0.602	21.77	108.32	2,110,703	2,105,835	#N/A	#N/A	#N/A	15.27	109.18	32.16	108.32	109.18			7.358	39.52	8,100	3	13.17		93.91
13.84	1,481,091	1,477,149	0.701	1.614	0.602	21.66	108.23	2,110,727	2,105,858	#N/A	#N/A	#N/A	15.19	109.08	31.99	108.23	109.08			7.358	39.35	8,100	3	13.12		93.89
14.04	1,481,170	1,477,219	0.701	1.614	0.602	21.55	108.15	2,110,751	2,105,879	#N/A	#N/A	#N/A	15.12	108.99	31.83	108.15	108.99			7.358	39.19	8,100	3	13.06		93.87
14.24	1,481,246	1,477,287	0.701	1.613	0.601	21.44	108.07	2,110,774	2,105,901	#N/A	#N/A	#N/A	15.04	108.90	31.67	108.07	108.90			7.358	39.03	8,100	3	13.01		93.86
14.44	1,481,321	1,477,354	0.702	1.613	0.601	21.34	107.98	2,110,797	2,105,922	#N/A	#N/A	#N/A	14.97	108.81	31.52	107.98	108.81			7.358	38.88	8,100	3	12.96		93.84
14.64	1,481,395	1,477,419	0.702	1.612	0.601	21.23	107.91	2,110,819	2,105,942	#N/A	#N/A	#N/A	14.90	108.73	31.37	107.91	108.73			7.358	38.73	8,100	3	12.91		93.83
14.84	1,481,466	1,477,483	0.702	1.612	0.601	21.13	107.83	2,110,841	2,105,962	#N/A	#N/A	#N/A	14.83	108.64	31.22	107.83	108.64			7.358	38.58	8,100	3	12.86		93.82
15.04	1,481,536	1,477,545	0.702	1.611	0.601	21.03	107.75	2,110,862	2,105,982	#N/A	#N/A	#N/A	14.76	108.56	31.08	107.75	108.56			7.358	38.44	8,100	3	12.81		93.80
15.24	1,481,604	1,477,606	0.702	1.611	0.601	20.94	107.68	2,110,883	2,106,001	#N/A	#N/A	#N/A	14.69	108.48	30.94	107.68	108.48			7.358	38.30	8,100	3	12.77		93.79
15.44	1,481,671	1,477,666	0.702	1.610	0.601	20.84	107.61	2,110,903	2,106,019	#N/A	#N/A	#N/A	14.63	108.40	30.80	107.61	108.40			7.358	38.16	8,100	3	12.72		93.77
15.64	1,481,737	1,477,724	0.702	1.610	0.601	20.75	107.53	2,110,923	2,106,038	#N/A	#N/A	#N/A	14.56	108.32	30.67	107.53	108.32			7.358	38.02	8,100	3	12.67		93.76
15.84	1,481,801	1,477,782	0.702	1.609	0.601	20.66	107.46	2,110,943	2,106,056	#N/A	#N/A	#N/A	14.50	108.25	30.53	107.46	108.25			7.358	37.89	8,100	3	12.63		93.75
16.04	1,481,864	1,477,838	0.702	1.609	0.601	20.57	107.40	2,110,962	2,106,073	#N/A	#N/A	#N/A	14.44	108.17	30.40	107.40	108.17			7.358	37.76	8,100	3	12.59		93.74
16.24	1,481,925	1,477,893	0.702	1.608	0.601	20.49	107.33	2,110,980	2,106,091	#N/A	#N/A	#N/A	14.38	108.10	30.28	107.33	108.10			7.358	37.63	8,100	3	12.54		93.72
16.44	1,481,986	1,477,947	0.702	1.608	0.601	20.40	107.26	2,110,999	2,106,108	#N/A	#N/A	#N/A	14.32	108.03	30.15	107.26	108.03			7.358	37.51	8,100	3	12.50		93.71
16.64	1,482,045	1,478,000	0.702	1.607	0.601	20.32	107.20	2,111,017	2,106,124	#N/A	#N/A	#N/A	14.26	107.96	30.03	107.20	107.96			7.358	37.38	8,100	3	12.46		93.70
16.84	1,482,103	1,478,051	0.702	1.607	0.601	20.23	107.13	2,111,035	2,106,141	#N/A	#N/A	#N/A	14.20	107.89	29.91	107.13	107.89			7.358	37.26	8,100	3	12.42		93.69
17.04	1,482,160	1,478,102	0.702	1.607	0.601	20.15	107.07	2,111,052	2,106,157	#N/A	#N/A	#N/A	14.14	107.82	29.79	107.07	107.82			7.358	37.15	8,100	3	12.38		93.68
17.24	1,482,216	1,478,152	0.702	1.606	0.601	20.07	107.01	2,111,069	2,106,173	#N/A	#N/A	#N/A	14.09	107.75	29.67	107.01	107.75			7.358	37.03	8,100	3	12.34		93.67
17.44	1,482,271	1,478,202	0.702	1.606	0.601	19.99	106.95	2,111,086	2,106,188	#N/A	#N/A	#N/A	14.03	107.69	29.56	106.95	107.69			7.358	36.91	8,100	3	12.30		93.65
17.64	1,482,325	1,478,250	0.702	1.605	0.601	19.92	106.89	2,111,103	2,106,203	#N/A	#N/A	#N/A	13.98	107.62	29.44	106.89	107.62			7.358	36.80	8,100	3	12.27		93.64


Shutdown Cooling Temperature Transient with 90F River Water
SDC Hx Fouling = 0. hr-F-sqft/Btu, CCW Hx Fouling = 0. hr-F-sqft/Btu
Temperature, F
370
330
290
250
210
170
130
90
50
CCW Temperature, F
170
160
150
140
130
120
110
100
90
0
4
8
12
16
20
Time, hours
Pri Cool Temp
SDC Return Temp
CCW Temp

Shutdown Cooling Temperature Transient with 90F River Water **SDC**

Hx Fouling = 0.00418 hr-F-sqft/Btu, CCW Hx Fouling = 0.0015 hr-F-sqft/Btu

	Initial RC Temperature, F				350												SDC HX	CCW HX	
	Initial Time				2					2754		Shell Film Multiplier					0.09751		
	RCS Temperature after 8 hours				213.20							Shell Film Re power					0.61709		
	Time after trip to 130F Primary Coolant Temp				73.21			Initial CCW to SDCHx		4246		Shell Film Pr power					0.333		
	Time after SDC initiation to 130F PC Temp				71.21			CCW Flow Step Temp		275		Fouling (total = tube side)					0.00418	0.0015	
	Decary heat equilibrium at 90F river temp				64.37												0.00418	0.004	
									SDCHx										
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell							
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o				
2.00	0.1	54.966	18	1.5	-132.55	-58.08	-52.80	3000	315	350.00	253.61	4246	95	108.410	171.88				
2.10	0.10	54.107	18	1.5	-129.83	-56.22	-51.11	3000	315	344.72	250.50	4246	95	108.08	170.23				
2.20	0.10	53.300	18	1.5	-127.20	-54.40	-49.45	3000	315	339.61	247.47	4246	95	107.75	168.63				
2.30	0.10	52.540	18	1.5	-124.65	-52.61	-47.83	3000	315	334.66	244.54	4246	95	107.44	167.08				
2.40	0.10	51.822	18	1.5	-122.18	-50.86	-46.24	3000	315	329.88	241.70	4246	95	107.13	165.58				
2.50	0.10	51.143	18	1.5	-119.80	-49.15	-44.69	3000	315	325.26	238.95	4246	95	106.84	164.13				
2.60	0.10	50.500	18	1.5	-117.49	-47.49	-43.17	3000	315	320.79	236.28	4246	95	106.55	162.73				
2.70	0.10	49.888	18	1.5	-115.26	-45.87	-41.70	3000	315	316.47	233.69	4246	95	106.27	161.38				
2.80	0.10	49.305	18	1.5	-113.11	-44.30	-40.28	3000	315	312.30	231.19	4246	95	106.00	160.07				
2.90	0.10	48.749	18	1.5	-111.03	-42.78	-38.89	3000	315	308.27	228.78	4246	95	105.74	158.81				
3.00	0.10	48.218	18	1.5	-109.02	-41.30	-37.55	3000	315	304.38	226.43	4246	95	105.49	157.59				
3.10	0.10	47.710	18	1.5	-107.08	-39.87	-36.24	3000	315	300.63	224.17	4246	95	105.25	156.41				
3.20	0.10	47.223	18	1.5	-105.20	-38.48	-34.98	3000	315	297.01	221.98	4246	95	105.01	155.27				
3.30	0.10	46.756	18	1.5	-103.40	-37.14	-33.76	3000	315	293.51	219.86	4246	95	104.78	154.17				
3.40	0.10	46.307	18	1.5	-101.65	-35.84	-32.58	3000	315	290.13	217.82	4246	95	104.56	153.11				
3.50	0.15	45.876	18	1.5	-99.97	-34.59	-31.45	3000	315	286.87	215.84	4246	95	104.35	152.09				
3.65	0.15	45.266	18	1.5	-97.56	-32.79	-29.81	3000	315	282.22	213.01	4246	95	104.05	150.62				
3.80	0.16	44.667	18	1.5	-95.19	-31.03	-28.20	3000	315	277.64	210.22	4246	95	103.75	149.18				
3.96	0.17	44.080	18	1.5	-92.87	-29.29	-26.63	3000	315	273.16	207.48	4246	95	103.45	147.77				
4.13	0.18	43.493	18	1.5	-90.56	-27.57	-25.06	3000	315	268.69	204.75	4246	95	103.16	146.37				
4.31	0.19	42.906	18	1.5	-88.27	-25.86	-23.51	3000	315	264.25	202.02	4246	95	102.86	144.97				
4.49	0.20	42.319	18	1.5	-85.98	-24.16	-21.97	3000	315	259.83	199.31	4246	95	102.57	143.58				
4.69	0.21	41.729	18	1.5	-83.72	-22.49	-20.44	3000	315	255.45	196.61	4246	95	102.28	142.20				
4.91	0.23	41.136	18	1.5	-81.47	-20.83	-18.94	3000	315	251.10	193.93	4246	95	101.99	140.84				
5.13	0.24	40.537	18	1.5	-79.24	-19.20	-17.46	3000	315	246.79	191.26	4246	95	101.70	139.48				
5.38	0.26	39.932	18	1.5	-77.04	-17.60	-16.00	3000	315	242.52	188.61	4246	95	101.42	138.14				
5.64	0.29	39.319	18	1.5	-74.85	-16.03	-14.58	3000	315	238.30	185.99	4246	95	101.14	136.81				
5.93	0.31	38.695	18	1.5	-72.70	-14.50	-13.18	3000	315	234.12	183.39	4246	95	100.86	135.49				
6.24	0.34	38.058	18	1.5	-70.57	-13.01	-11.83	3000	315	230.00	180.82	4246	95	100.58	134.20				
6.58	0.38	37.406	18	1.5	-68.48	-11.57	-10.52	3000	315	225.95	178.29	4246	95	100.31	132.92				
6.96	0.42	36.735	18	1.5	-66.42	-10.18	-9.26	3000	315	221.96	175.79	4246	95	100.04	131.67				
7.39	0.48	36.042	18	1.5	-64.40	-8.86	-8.05	3000	315	218.04	173.34	4246	95	99.77	130.44				
7.86	0.54	35.323	18	1.5	-62.43	-7.60	-6.91	3000	315	214.22	170.93	4246	95	99.51	129.23				
8.40	0.62	34.573	18	1.5	-60.50	-6.43	-5.85	3000	315	210.48	168.58	4246	95	99.26	128.06				
9.02	0.72	33.786	18	1.5	-58.63	-5.35	-4.86	3000	315	206.85	166.30	4246	95	99.01	126.92				
9.75	0.86	32.954	18	1.5	-56.82	-4.37	-3.97	3000	315	203.34	164.08	4246	95	98.78	125.82				
10.60	1.03	32.071	0	1.5	-55.08	-21.50	-19.55	3000	315	199.94	161.93	4246	95	98.54	124.75				
11.63	1.26	31.126	0	1.5	-44.81	-12.18	-11.07	3000	315	179.94	149.20	4246	95	97.18	118.48				
12.89	0.26	30.109	0	1.5	-37.68	-6.07	-5.52	3000	315	166.00	140.26	4246	95	96.22	114.12				
13.14	0.45	29.917	0	1.5	-36.95	-5.53	-5.03	3000	315	164.58	139.34	4246	95	96.12	113.68				
13.60	0.91	29.593	0	1.5	-35.79	-4.70	-4.27	3000	315	162.31	137.88	4246	95	95.97	112.97				
14.50	0.99	28.982	0	1.5	-33.82	-3.34	-3.03	3000	315	158.44	135.38	4246	95	95.70	111.77				
15.50	1.17	28.368	0	1.5	-32.28	-2.42	-2.20	3000	315	155.42	133.43	4246	95	95.49	110.83				
16.67	1.65	27.709	0	1.5	-30.98	-1.77	-1.61	3000	315	152.85	131.76	4246	95	95.31	110.03				
18.32	2.28	26.877	0	1.5	-29.63	-1.25	-1.14	3000	315	150.20	130.05	4246	95	95.13	109.20				
20.59	3.11	25.879	0	1.5	-28.31	-0.93	-0.85	3000	315	147.61	128.36	4246	95	94.95	108.40				
23.70	4.39	24.729	0	1.5	-26.97	-0.74	-0.68	3000	315	144.97	126.64	4246	95	94.77	107.58				
28.09	5.00	23.408	0	1.5	-25.47	-0.56	-0.51	3000	315	142.00	124.71	4246	95	94.56	106.66				
33.09	5.00	22.201	0	1.5	-24.18	-0.48	-0.43	3000	315	139.45	123.05	4246	95	94.39	105.87				
38.09	6.00	21.215	0	1.5	-23.08	-0.37	-0.33	3000	315	137.28	121.63	4246	95	94.24	105.20				
44.09	6.56	20.236	0	1.5	-22.07	-0.34	-0.30	3000	315	135.28	120.32	4246	95	94.10	104.58				
50.65	10.35	19.349	0	1.5	-21.06	-0.21	-0.19	3000	315	133.28	119.01	4246	95	93.96	103.96				

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
2.00	301.81	55.59	1.0281	1.23E-04	0.396	5.609	138,149	1.1470	2291	140.14	61.37	0.9992	3.13E-04	0.376	3.652	154,386	2.9966	1346	9.432	169.81
2.10	297.61	55.78	1.0266	1.25E-04	0.396	5.609	136,269	1.1647	2281	139.15	61.39	0.9992	3.16E-04	0.376	3.652	153,153	3.0238	1343	9.416	169.67
2.20	293.54	55.96	1.0253	1.27E-04	0.396	5.609	134,429	1.1824	2271	138.19	61.41	0.9991	3.19E-04	0.376	3.652	151,961	3.0507	1339	9.400	169.53
2.30	289.60	56.13	1.0240	1.29E-04	0.396	5.609	132,629	1.2003	2261	137.26	61.42	0.9990	3.21E-04	0.375	3.652	150,808	3.0770	1336	9.385	169.38
2.40	285.79	56.30	1.0228	1.31E-04	0.396	5.609	130,871	1.2184	2251	136.36	61.44	0.9990	3.24E-04	0.375	3.652	149,694	3.1029	1332	9.370	169.24
2.50	282.10	56.46	1.0217	1.33E-04	0.396	5.609	129,157	1.2365	2241	135.49	61.46	0.9989	3.26E-04	0.375	3.652	148,618	3.1283	1329	9.356	169.10
2.60	278.53	56.61	1.0206	1.35E-04	0.396	5.609	127,486	1.2547	2231	134.64	61.47	0.9989	3.28E-04	0.374	3.652	147,579	3.1532	1326	9.342	168.96
2.70	275.08	56.76	1.0196	1.37E-04	0.396	5.609	125,859	1.2729	2221	133.83	61.48	0.9989	3.31E-04	0.374	3.652	146,576	3.1775	1323	9.328	168.83
2.80	271.75	56.90	1.0186	1.40E-04	0.396	5.609	124,277	1.2911	2211	133.04	61.50	0.9988	3.33E-04	0.374	3.652	145,609	3.2014	1320	9.315	168.69
2.90	268.52	57.03	1.0178	1.42E-04	0.396	5.609	122,739	1.3093	2201	132.28	61.51	0.9988	3.35E-04	0.374	3.652	144,675	3.2247	1317	9.303	168.56
3.00	265.41	57.16	1.0169	1.44E-04	0.396	5.609	121,245	1.3275	2191	131.54	61.52	0.9987	3.37E-04	0.373	3.652	143,775	3.2476	1314	9.291	168.43
3.10	262.40	57.28	1.0161	1.46E-04	0.396	5.609	119,795	1.3456	2182	130.83	61.54	0.9987	3.39E-04	0.373	3.652	142,906	3.2699	1311	9.280	168.31
3.20	259.49	57.39	1.0154	1.48E-04	0.396	5.609	118,389	1.3637	2172	130.14	61.55	0.9987	3.42E-04	0.373	3.652	142,069	3.2916	1308	9.269	168.18
3.30	256.69	57.50	1.0147	1.50E-04	0.396	5.609	117,025	1.3817	2163	129.48	61.56	0.9986	3.44E-04	0.373	3.652	141,262	3.3129	1306	9.258	168.06
3.40	253.97	57.61	1.0140	1.52E-04	0.396	5.609	115,703	1.3995	2154	128.84	61.57	0.9986	3.46E-04	0.373	3.652	140,483	3.3337	1303	9.248	167.94
3.50	251.36	57.71	1.0134	1.54E-04	0.396	5.609	114,422	1.4172	2145	128.22	61.58	0.9986	3.47E-04	0.372	3.652	139,732	3.3539	1301	9.239	167.82
3.65	247.61	57.86	1.0126	1.57E-04	0.395	5.609	112,584	1.4435	2132	127.33	61.59	0.9985	3.50E-04	0.372	3.652	138,661	3.3832	1298	9.225	167.65
3.80	243.93	57.99	1.0117	1.60E-04	0.395	5.609	110,771	1.4703	2118	126.46	61.61	0.9985	3.53E-04	0.372	3.652	137,610	3.4124	1294	9.211	167.48
3.96	240.32	58.13	1.0110	1.63E-04	0.395	5.609	108,985	1.4977	2105	125.61	61.62	0.9985	3.56E-04	0.372	3.652	136,581	3.4414	1291	9.198	167.31
4.13	236.72	58.26	1.0102	1.66E-04	0.395	5.609	107,199	1.5260	2092	124.76	61.64	0.9984	3.58E-04	0.371	3.652	135,558	3.4708	1287	9.184	167.14
4.31	233.13	58.39	1.0095	1.69E-04	0.394	5.609	105,417	1.5554	2078	123.92	61.65	0.9984	3.61E-04	0.371	3.652	134,542	3.5004	1284	9.171	166.96
4.49	229.57	58.52	1.0088	1.72E-04	0.394	5.609	103,642	1.5857	2064	123.08	61.66	0.9984	3.64E-04	0.371	3.652	133,534	3.5303	1281	9.158	166.78
4.69	226.03	58.65	1.0082	1.75E-04	0.394	5.609	101,874	1.6171	2050	122.24	61.68	0.9983	3.67E-04	0.370	3.652	132,535	3.5604	1277	9.145	166.60
4.91	222.51	58.77	1.0075	1.79E-04	0.393	5.609	100,116	1.6495	2036	121.41	61.69	0.9983	3.70E-04	0.370	3.652	131,546	3.5906	1274	9.132	166.42
5.13	219.03	58.89	1.0069	1.82E-04	0.393	5.609	98,369	1.6829	2022	120.59	61.70	0.9982	3.73E-04	0.370	3.652	130,566	3.6211	1271	9.119	166.23
5.38	215.57	59.01	1.0064	1.86E-04	0.393	5.609	96,636	1.7174	2007	119.78	61.72	0.9982	3.75E-04	0.369	3.652	129,598	3.6516	1268	9.106	166.04
5.64	212.14	59.13	1.0058	1.90E-04	0.392	5.609	94,919	1.7528	1993	118.97	61.73	0.9982	3.78E-04	0.369	3.652	128,642	3.6823	1264	9.093	165.85
5.93	208.76	59.24	1.0053	1.94E-04	0.392	5.609	93,221	1.7893	1978	118.17	61.74	0.9982	3.81E-04	0.369	3.652	127,698	3.7130	1261	9.081	165.66
6.24	205.41	59.35	1.0048	1.98E-04	0.391	5.609	91,544	1.8268	1964	117.39	61.75	0.9981	3.84E-04	0.369	3.652	126,769	3.7438	1258	9.068	165.47
6.58	202.12	59.46	1.0043	2.02E-04	0.391	5.609	89,891	1.8653	1949	116.61	61.76	0.9981	3.87E-04	0.368	3.652	125,856	3.7745	1255	9.056	165.28
6.96	198.87	59.56	1.0039	2.06E-04	0.390	5.609	88,265	1.9046	1934	115.85	61.78	0.9981	3.90E-04	0.368	3.652	124,960	3.8051	1252	9.044	165.08
7.39	195.69	59.66	1.0035	2.10E-04	0.390	5.609	86,671	1.9447	1920	115.11	61.79	0.9980	3.93E-04	0.368	3.652	124,082	3.8355	1249	9.032	164.89
7.86	192.58	59.76	1.0031	2.14E-04	0.389	5.609	85,112	1.9855	1905	114.37	61.80	0.9980	3.95E-04	0.367	3.652	123,226	3.8656	1245	9.021	164.70
8.40	189.53	59.85	1.0027	2.18E-04	0.389	5.609	83,592	2.0268	1891	113.66	61.81	0.9980	3.98E-04	0.367	3.652	122,392	3.8954	1243	9.010	164.50
9.02	186.57	59.94	1.0024	2.22E-04	0.388	5.609	82,116	2.0686	1877	112.97	61.82	0.9980	4.01E-04	0.367	3.652	121,583	3.9247	1240	8.998	164.31
9.75	183.71	60.03	1.0020	2.27E-04	0.387	5.609	80,686	2.1105	1863	112.30	61.83	0.9980	4.03E-04	0.367	3.652	120,800	3.9534	1237	8.987	164.12
10.60	180.93	60.11	1.0017	2.31E-04	0.387	5.609	79,307	2.1526	1849	111.65	61.84	0.9979	4.06E-04	0.366	3.652	120,045	3.9815	1234	8.975	163.94
11.63	164.57	60.57	1.0002	2.59E-04	0.383	5.609	71,231	2.4341	1766	107.83	61.89	0.9978	4.22E-04	0.365	3.652	115,633	4.1534	1218	8.909	162.77
12.89	153.13	60.87	0.9993	2.82E-04	0.380	5.609	65,665	2.6714	1704	105.17	61.93	0.9978	4.34E-04	0.364	3.652	112,592	4.2803	1207	8.864	161.88
13.14	151.96	60.90	0.9992	2.85E-04	0.380	5.609	65,103	2.6978	1698	104.90	61.93	0.9978	4.35E-04	0.364	3.652	112,284	4.2936	1206	8.859	161.79
13.60	150.09	60.95	0.9991	2.89E-04	0.380	5.609	64,203	2.7411	1687	104.47	61.94	0.9977	4.37E-04	0.364	3.652	111,792	4.3149	1204	8.852	161.63
14.50	146.91	61.02	0.9988	2.97E-04	0.379	5.609	62,674	2.8176	1669	103.73	61.95	0.9977	4.40E-04	0.363	3.652	110,954	4.3517	1201	8.840	161.37
15.50	144.43	61.08	0.9987	3.03E-04	0.378	5.609	61,489	2.8798	1655	103.16	61.96	0.9977	4.43E-04	0.363	3.652	110,304	4.3807	1198	8.831	161.16
16.67	142.31	61.13	0.9985	3.08E-04	0.377	5.609	60,481	2.9346	1643	102.67	61.96	0.9977	4.45E-04	0.363	3.652	109,751	4.4056	1196	8.823	160.98
18.32	140.12	61.19	0.9984	3.14E-04	0.377	5.609	59,446	2.9931	1631	102.17	61.97	0.9977	4.47E-04	0.363	3.652	109,182	4.4315	1194	8.815	160.78
20.59	137.99	61.24	0.9983	3.19E-04	0.376	5.609	58,435	3.0522	1618	101.68	61.97	0.9977	4.50E-04	0.362	3.652	108,627	4.4571	1192	8.807	160.59
23.70	135.80	61.28	0.9982	3.25E-04	0.375	5.609	57,409	3.1145	1605	101.17	61.98	0.9977	4.52E-04	0.362	3.652	108,062	4.4834	1190	8.799	160.40
28.09	133.35	61.34	0.9980	3.32E-04	0.375	5.609	56,260	3.1872	1591	100.61	61.99	0.9977	4.55E-04	0.362	3.652	107,429	4.5133	1187	8.790	160.17
33.09	131.25	61.39	0.9979	3.38E-04	0.374	5.609	55,278	3.2518	1579	100.13	61.99	0.9977	4.57E-04	0.362	3.652	106,886	4.5391	1185	8.782	159.98
38.09	129.46	61.42	0.9978	3.44E-04	0.373	5.609	54,445	3.3086	1568	99.72	62.00	0.9977	4.59E-04	0.362	3.652	106,426	4.5613	1183	8.776	159.81
44.09	127.80	61.46	0.9977	3.49E-04	0.373	5.609	53,679	3.3625	1558	99.34	62.00	0.9977	4.61E-04	0.361	3.652	106,002	4.5819	1182	8.770	159.65
50.65	126.15	61.49	0.9977	3.54E-04	0.372	5.609	52,915	3.4178	1548	98.96	62.01	0.9977	4.63E-04	0.361	3.652	105,579	4.6026	1180	8.765	159.49

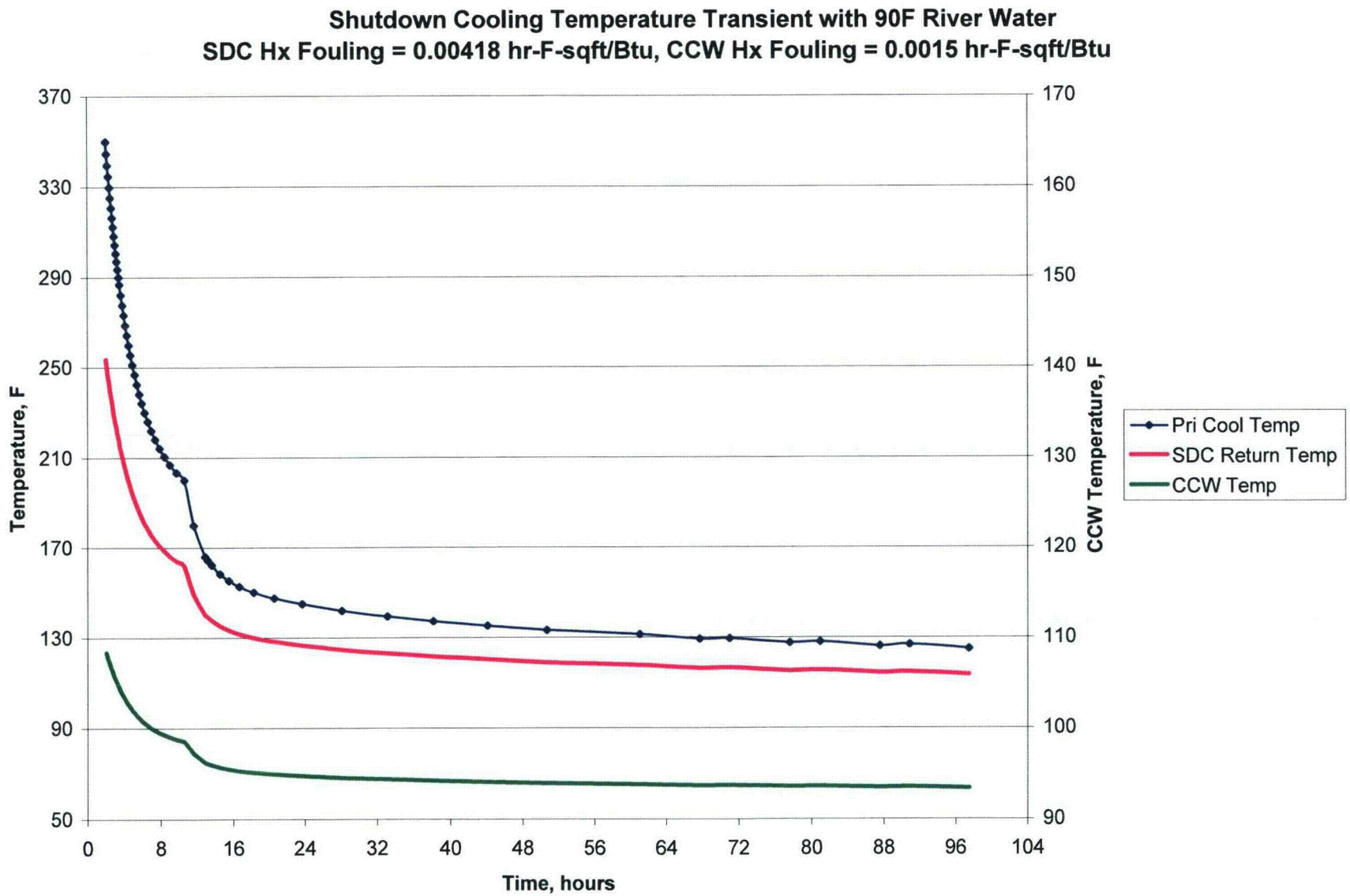
CCW HX Fouling 0

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate	Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX	CCW Temp
hrs	W	WCp	Cr	NTU	ffectivenes	DT	Tt,o	W	WCp	Cr	NTU	ffectivenes	DTs	Ts,o	Btu/hr			mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr	Ts,o
2.00	1,337,560	1,375,146	0.658	0.620	0.399	96.39	253.61	2,090,150	2,088,505	#N/A	#N/A	#N/A	63.47	171.88	132.55	253.61	171.88	7.358	139.91	8,100	3	46.64	108.41
2.10	1,342,146	1,377,907	0.660	0.618	0.398	94.22	250.50	2,090,758	2,088,991	#N/A	#N/A	#N/A	62.15	170.23	129.83	250.50	170.23	7.358	137.19	8,100	3	45.73	108.08
2.20	1,346,529	1,380,565	0.661	0.616	0.397	92.13	247.47	2,091,343	2,089,460	#N/A	#N/A	#N/A	60.88	168.63	127.20	247.47	168.63	7.358	134.56	8,100	3	44.85	107.75
2.30	1,350,719	1,383,126	0.662	0.615	0.397	90.12	244.54	2,091,906	2,089,913	#N/A	#N/A	#N/A	59.64	167.08	124.65	244.54	167.08	7.358	132.01	8,100	3	44.00	107.44
2.40	1,354,723	1,385,591	0.663	0.613	0.396	88.18	241.70	2,092,447	2,090,349	#N/A	#N/A	#N/A	58.45	165.58	122.18	241.70	165.58	7.358	129.54	8,100	3	43.18	107.13
2.50	1,358,549	1,387,963	0.664	0.612	0.395	86.31	238.95	2,092,968	2,090,770	#N/A	#N/A	#N/A	57.30	164.13	119.80	238.95	164.13	7.358	127.16	8,100	3	42.39	106.84
2.60	1,362,206	1,390,248	0.665	0.610	0.394	84.51	236.28	2,093,470	2,091,175	#N/A	#N/A	#N/A	56.18	162.73	117.49	236.28	162.73	7.358	124.85	8,100	3	41.62	106.55
2.70	1,365,702	1,392,447	0.666	0.609	0.394	82.78	233.69	2,093,951	2,091,566	#N/A	#N/A	#N/A	55.11	161.38	115.26	233.69	161.38	7.358	122.62	8,100	3	40.87	106.27
2.80	1,369,044	1,394,563	0.667	0.607	0.393	81.11	231.19	2,094,415	2,091,942	#N/A	#N/A	#N/A	54.07	160.07	113.11	231.19	160.07	7.358	120.47	8,100	3	40.16	106.00
2.90	1,372,238	1,396,601	0.667	0.606	0.393	79.50	228.78	2,094,860	2,092,305	#N/A	#N/A	#N/A	53.06	158.81	111.03	228.78	158.81	7.358	118.38	8,100	3	39.46	105.74
3.00	1,375,292	1,398,562	0.668	0.605	0.392	77.95	226.43	2,095,288	2,092,654	#N/A	#N/A	#N/A	52.10	157.59	109.02	226.43	157.59	7.358	116.38	8,100	3	38.79	105.49
3.10	1,378,213	1,400,450	0.669	0.603	0.391	76.46	224.17	2,095,699	2,092,990	#N/A	#N/A	#N/A	51.16	156.41	107.08	224.17	156.41	7.358	114.44	8,100	3	38.15	105.25
3.20	1,381,007	1,402,267	0.670	0.602	0.391	75.02	221.98	2,096,094	2,093,313	#N/A	#N/A	#N/A	50.26	155.27	105.20	221.98	155.27	7.358	112.56	8,100	3	37.52	105.01
3.30	1,383,679	1,404,016	0.671	0.601	0.390	73.64	219.86	2,096,474	2,093,625	#N/A	#N/A	#N/A	49.39	154.17	103.40	219.86	154.17	7.358	110.75	8,100	3	36.92	104.78
3.40	1,386,235	1,405,700	0.671	0.600	0.390	72.31	217.82	2,096,839	2,093,924	#N/A	#N/A	#N/A	48.55	153.11	101.65	217.82	153.11	7.358	109.01	8,100	3	36.34	104.56
3.50	1,388,682	1,407,322	0.672	0.599	0.389	71.03	215.84	2,097,190	2,094,213	#N/A	#N/A	#N/A	47.73	152.09	99.97	215.84	152.09	7.358	107.32	8,100	3	35.77	104.35
3.65	1,392,143	1,409,632	0.673	0.597	0.388	69.21	213.01	2,097,689	2,094,624	#N/A	#N/A	#N/A	46.58	150.62	97.56	213.01	150.62	7.358	104.92	8,100	3	34.97	104.05
3.80	1,395,502	1,411,894	0.674	0.595	0.388	67.42	210.22	2,098,176	2,095,027	#N/A	#N/A	#N/A	45.44	149.18	95.19	210.22	149.18	7.358	102.55	8,100	3	34.18	103.75
3.96	1,398,757	1,414,104	0.675	0.594	0.387	65.68	207.48	2,098,651	2,095,420	#N/A	#N/A	#N/A	44.32	147.77	92.87	207.48	147.77	7.358	100.23	8,100	3	33.41	103.45
4.13	1,401,960	1,416,298	0.676	0.592	0.386	63.94	204.75	2,099,120	2,095,810	#N/A	#N/A	#N/A	43.21	146.37	90.56	204.75	146.37	7.358	97.92	8,100	3	32.64	103.16
4.31	1,405,109	1,418,474	0.677	0.591	0.386	62.23	202.02	2,099,585	2,096,196	#N/A	#N/A	#N/A	42.11	144.97	88.27	202.02	144.97	7.358	95.62	8,100	3	31.87	102.86
4.49	1,408,199	1,420,627	0.678	0.589	0.385	60.52	199.31	2,100,044	2,096,579	#N/A	#N/A	#N/A	41.01	143.58	85.98	199.31	143.58	7.358	93.34	8,100	3	31.11	102.57
4.69	1,411,230	1,422,758	0.678	0.588	0.384	58.84	196.61	2,100,496	2,096,957	#N/A	#N/A	#N/A	39.92	142.20	83.72	196.61	142.20	7.358	91.08	8,100	3	30.36	102.28
4.91	1,414,202	1,424,864	0.679	0.586	0.383	57.18	193.93	2,100,943	2,097,331	#N/A	#N/A	#N/A	38.84	140.84	81.47	193.93	140.84	7.358	88.83	8,100	3	29.61	101.99
5.13	1,417,112	1,426,944	0.680	0.585	0.383	55.53	191.26	2,101,382	2,097,701	#N/A	#N/A	#N/A	37.78	139.48	79.24	191.26	139.48	7.358	86.60	8,100	3	28.87	101.70
5.38	1,419,958	1,428,996	0.681	0.583	0.382	53.91	188.61	2,101,815	2,098,065	#N/A	#N/A	#N/A	36.72	138.14	77.04	188.61	138.14	7.358	84.39	8,100	3	28.13	101.42
5.64	1,422,740	1,431,019	0.682	0.582	0.381	52.31	185.99	2,102,240	2,098,424	#N/A	#N/A	#N/A	35.67	136.81	74.85	185.99	136.81	7.358	82.21	8,100	3	27.40	101.14
5.93	1,425,455	1,433,008	0.683	0.580	0.381	50.73	183.39	2,102,658	2,098,778	#N/A	#N/A	#N/A	34.64	135.49	72.70	183.39	135.49	7.358	80.05	8,100	3	26.68	100.86
6.24	1,428,100	1,434,963	0.684	0.579	0.380	49.18	180.82	2,103,067	2,099,125	#N/A	#N/A	#N/A	33.62	134.20	70.57	180.82	134.20	7.358	77.93	8,100	3	25.98	100.58
6.58	1,430,673	1,436,878	0.684	0.577	0.379	47.66	178.29	2,103,467	2,099,466	#N/A	#N/A	#N/A	32.62	132.92	68.48	178.29	132.92	7.358	75.83	8,100	3	25.28	100.31
6.96	1,433,171	1,438,752	0.685	0.576	0.379	46.16	175.79	2,103,858	2,099,800	#N/A	#N/A	#N/A	31.63	131.67	66.42	175.79	131.67	7.358	73.78	8,100	3	24.59	100.04
7.39	1,435,590	1,440,581	0.686	0.575	0.378	44.70	173.34	2,104,240	2,100,126	#N/A	#N/A	#N/A	30.66	130.44	64.40	173.34	130.44	7.358	71.76	8,100	3	23.92	99.77
7.86	1,437,926	1,442,360	0.687	0.573	0.377	43.28	170.93	2,104,610	2,100,444	#N/A	#N/A	#N/A	29.72	129.23	62.43	170.93	129.23	7.358	69.78	8,100	3	23.26	99.51
8.40	1,440,177	1,444,085	0.687	0.572	0.377	41.90	168.58	2,104,969	2,100,753	#N/A	#N/A	#N/A	28.80	128.06	60.50	168.58	128.06	7.358	67.86	8,100	3	22.62	99.26
9.02	1,442,337	1,445,751	0.688	0.571	0.376	40.56	166.30	2,105,316	2,101,053	#N/A	#N/A	#N/A	27.91	126.92	58.63	166.30	126.92	7.358	65.99	8,100	3	22.00	99.01
9.75	1,444,404	1,447,356	0.689	0.569	0.375	39.26	164.08	2,105,650	2,101,342	#N/A	#N/A	#N/A	27.04	125.82	56.82	164.08	125.82	7.358	64.18	8,100	3	21.39	98.78
10.60	1,446,376	1,448,897	0.689	0.568	0.375	38.01	161.93	2,105,970	2,101,620	#N/A	#N/A	#N/A	26.21	124.75	55.08	161.93	124.75	7.358	62.43	8,100	3	20.81	98.54
11.63	1,457,482	1,457,735	0.693	0.561	0.371	30.74	149.20	2,107,816	2,103,237	#N/A	#N/A	#N/A	21.30	118.48	44.81	149.20	118.48	7.358	52.16	8,100	3	17.39	97.18
12.89	1,464,689	1,463,616	0.696	0.555	0.369	25.74	140.26	2,109,059	2,104,345	#N/A	#N/A	#N/A	17.90	114.12	37.68	140.26	114.12	7.358	45.03	8,100	3	15.01	96.22
13.14	1,465,397	1,464,200	0.696	0.555	0.369	25.24	139.34	2,109,184	2,104,457	#N/A	#N/A	#N/A	17.56	113.68	36.95	139.34	113.68	7.358	44.31	8,100	3	14.77	96.12
13.60	1,466,520	1,465,128	0.696	0.554	0.368	24.43	137.88	2,109,382	2,104,635	#N/A	#N/A	#N/A	17.01	112.97	35.79	137.88	112.97	7.358	43.15	8,100	3	14.38	95.97
14.50	1,468,406	1,466,692	0.697	0.552	0.368	23.06	135.38	2,109,718	2,104,939	#N/A	#N/A	#N/A	16.07	111.77	33.82	135.38	111.77	7.358	41.18	8,100	3	13.73	95.70
15.50	1,469,847	1,467,893	0.697	0.551	0.367	21.99	133.43	2,109,978	2,105,174	#N/A	#N/A	#N/A	15.34	110.83	32.28	133.43	110.83	7.358	39.64	8,100	3	13.21	95.49
16.67	1,471,058	1,468,905	0.698	0.550	0.367	21.09	131.76	2,110,198	2,105,374	#N/A	#N/A	#N/A	14.71	110.03	30.98	131.76	110.03	7.358	38.33	8,100	3	12.78	95.31
18.32	1,472,288	1,469,936	0.698	0.549	0.366	20.16	130.05	2,110,423	2,105,580	#N/A	#N/A	#N/A	14.07	109.20	29.63	130.05	109.20	7.358	36.99	8,100	3	12.33	95.13
20.59	1,473,474	1,470,935	0.699	0.548	0.366	19.25	128.36	2,110,643	2,105,780	#N/A	#N/A	#N/A	13.45	108.40	28.31	128.36	108.40	7.358	35.67	8,100	3	11.89	94.95
23.70	1,474,666	1,471,940	0.699	0.547	0.365	18.32	126.64	2,110,865	2,105,984	#N/A	#N/A	#N/A	12.81	107.58	26.97	126.64	107.58	7.358	34.33	8,100	3	11.44	94.77
28.09	1,475,981	1,473,053	0.699	0.546	0.364	17.29	124.71	2,111,113	2,106,212	#N/A	#N/A	#N/A	12.09	106.66	25.47	124.71	106.66	7.358	32.83	8,100	3	10.94	94.56
33.09	1,477,090	1,473,996	0.700	0.545	0.364	16.40	123.05	2,111,324	2,106,408	#N/A	#N/A	#N/A	11.48	105.87	24.18	123.05	105.87	7.358	31.54	8,100	3	10.51	94.39
38.09	1,478,021	1,474,789	0.700	0.544	0.364	15.65	121.63	2,111,503	2,106,574	#N/A	#N/A	#N/A	10.96	105.20	23.08	121.63	105.20	7.358	30.44	8,100	3	10.15	94.24
44.09	1,478,867	1,475,512	0.700	0.543	0.363	14.96	120.32	2,111,667	2,106,726	#N/A	#N/A	#N/A	10.48	104.58	22.07	120.32	104.58	7.358	29.43	8,100	3	9.81	94.10
50.65	1,479,702	1,476,227	0.701	0.542	0.363	14.27	119.01	2,111,830	2,106,879	#N/A	#N/A	#N/A	10.00	103.96	21.06	119.01	103.96	7.358	28.42	8,100	3	9.47	93.96

								SDCHx							
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell			
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o
61.00	6.64	18.221	0	1.5	-20.05	-0.33	-0.30	3000	315	131.28	117.70	4246	95	93.82	103.34
67.64	3.32	17.623	0	1.5	-19.05	0.08	0.07	3000	315	129.28	116.39	4246	95	93.68	102.72
70.95	6.64	17.353	0	1.5	-19.16	-0.31	-0.28	3000	315	129.52	116.55	4246	95	93.70	102.80
77.59	3.32	16.859	0	1.5	-18.22	0.14	0.13	3000	315	127.64	115.31	4246	95	93.57	102.22
80.91	6.64	16.632	0	1.5	-18.43	-0.30	-0.27	3000	315	128.06	115.59	4246	95	93.60	102.35
87.54	3.32	16.214	0	1.5	-17.52	0.19	0.17	3000	315	126.26	114.41	4246	95	93.48	101.79
90.86	6.64	16.020	0	1.5	-17.81	-0.29	-0.27	3000	315	126.83	114.78	4246	95	93.52	101.97
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42
97.50	0.00	15.660	0	1.5	-16.93	0.23	0.21	3000	315	125.07	113.63	4246	95	93.39	101.42

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
61.00	124.49	61.53	0.9976	3.60E-04	0.372	5.609	52,154	3.4747	1538	98.58	62.01	0.9977	4.65E-04	0.361	3.652	105,156	4.6235	1178	8.759	159.33
67.64	122.84	61.56	0.9975	3.65E-04	0.371	5.609	51,395	3.5331	1528	98.20	62.02	0.9976	4.67E-04	0.361	3.652	104,735	4.6445	1177	8.754	159.16
70.95	123.03	61.56	0.9975	3.64E-04	0.371	5.609	51,484	3.5262	1529	98.25	62.02	0.9976	4.67E-04	0.361	3.652	104,784	4.6420	1177	8.754	159.18
77.59	121.48	61.59	0.9974	3.70E-04	0.371	5.609	50,774	3.5824	1519	97.89	62.02	0.9976	4.68E-04	0.361	3.652	104,389	4.6618	1175	8.749	159.03
80.91	121.83	61.58	0.9975	3.68E-04	0.371	5.609	50,934	3.5696	1521	97.97	62.02	0.9976	4.68E-04	0.361	3.652	104,478	4.6574	1176	8.750	159.06
87.54	120.33	61.61	0.9974	3.74E-04	0.370	5.609	50,253	3.6247	1512	97.63	62.03	0.9976	4.70E-04	0.361	3.652	104,099	4.6765	1174	8.745	158.91
90.86	120.81	61.60	0.9974	3.72E-04	0.370	5.609	50,469	3.6070	1515	97.74	62.02	0.9976	4.69E-04	0.361	3.652	104,220	4.6704	1174	8.747	158.96
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81
97.50	119.35	61.63	0.9974	3.77E-04	0.370	5.609	49,806	3.6617	1506	97.41	62.03	0.9976	4.71E-04	0.361	3.652	103,850	4.6892	1173	8.742	158.81

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate			Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX		CCW Temp
hrs	W	WCp	Cr	NTU	ffectivenes	DT	Tt,o	W	WCp	Cr	NTU	ffectivenes	DTs	Ts,o	Btu/hr					mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr		Ts,o
61.00	1,480,526	1,476,934	0.701	0.542	0.362	13.58	117.70	2,111,992	2,107,030	#N/A	#N/A	#N/A	9.52	103.34	20.05	117.70	103.34			7.358	27.41	8,100	3	9.14		93.82
67.64	1,481,338	1,477,633	0.701	0.541	0.362	12.89	116.39	2,112,153	2,107,182	#N/A	#N/A	#N/A	9.04	102.72	19.05	116.39	102.72			7.358	26.40	8,100	3	8.80		93.68
70.95	1,481,242	1,477,551	0.701	0.541	0.362	12.97	116.55	2,112,134	2,107,164	#N/A	#N/A	#N/A	9.09	102.80	19.16	116.55	102.80			7.358	26.52	8,100	3	8.84		93.70
77.59	1,481,995	1,478,201	0.701	0.540	0.362	12.33	115.31	2,112,285	2,107,306	#N/A	#N/A	#N/A	8.65	102.22	18.22	115.31	102.22			7.358	25.58	8,100	3	8.53		93.57
80.91	1,481,827	1,478,055	0.701	0.540	0.362	12.47	115.59	2,112,251	2,107,274	#N/A	#N/A	#N/A	8.75	102.35	18.43	115.59	102.35			7.358	25.79	8,100	3	8.60		93.60
87.54	1,482,542	1,478,674	0.702	0.539	0.362	11.85	114.41	2,112,396	2,107,410	#N/A	#N/A	#N/A	8.32	101.79	17.52	114.41	101.79			7.358	24.88	8,100	3	8.29		93.48
90.86	1,482,316	1,478,478	0.702	0.540	0.362	12.05	114.78	2,112,350	2,107,367	#N/A	#N/A	#N/A	8.45	101.97	17.81	114.78	101.97			7.358	25.17	8,100	3	8.39		93.52
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39
97.50	1,483,008	1,479,078	0.702	0.539	0.361	11.44	113.63	2,112,491	2,107,500	#N/A	#N/A	#N/A	8.03	101.43	16.93	113.63	101.42			7.358	24.29	8,100	3	8.10		93.39


Shutdown Cooling Temperature Transient with 90F River Water
SDC Hx Fouling = 0.00418 hr-F-sqft/Btu, CCW Hx Fouling = 0.0015 hr-F-sqft/Btu
Temperature, F
370
330
290
250
210
170
130
90
50
CCW Temperature, F
170
160
150
140
130
120
110
100
90
0
8
16
24
32
40
48
56
64
72
80
88
96
104
Time, hours
Pri Cool Temp
SDC Return Temp
CCW Temp

Shutdown Cooling Temperature Transient with 90F River Water **SDC Hx**

Fouling = 0.001 hr-F-sqft/Btu, CCW Hx Fouling = 0.004 hr-F-sqft/Btu

	Initial RC Temperature, F				350												SDC HX	CCW HX
	Initial Time				2					2754		Shell Film Multiplier					0.09751	
	RCS Temperature after 8 hours				157.97							Shell Film Re power					0.61709	
	Time after trip to 130F Primary Coolant Temp				26.41764		Initial CCW to SDCHx			4246		Shell Film Pr power					0.333	
	Time after SDC initiation to 130F PC Temp				24.4		CCW Flow Step Temp			275		Fouling (total = tube side)					0.001	0.004
	Decary heat equilibrium at 90F river temp				24.75		CCW Flow Step flow			4246							0.00418	0.004
								SDCHx										
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell						
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o			
2.00	0.1	54.966	18	1.5	-178.49	-104.02	-94.57	3000	315	350.00	219.49	4246	95	126.11	212.19			
2.10	0.10	54.107	18	1.5	-172.02	-98.41	-89.46	3000	315	340.54	215.28	4246	95	124.92	207.82			
2.20	0.20	53.300	18	1.5	-165.87	-93.07	-84.61	3000	315	331.60	211.26	4246	95	123.80	203.68			
2.40	0.20	51.822	18	1.5	-154.20	-82.88	-75.34	3000	315	314.68	203.59	4246	95	121.64	195.81			
2.60	0.20	50.500	18	1.5	-143.76	-73.76	-67.06	3000	315	299.61	196.66	4246	95	119.71	188.78			
2.80	0.20	49.305	18	1.5	-134.45	-65.64	-59.68	3000	315	286.19	190.42	4246	95	117.97	182.50			
3.00	0.20	48.218	18	1.5	-126.14	-58.42	-53.11	3000	315	274.26	184.82	4246	95	116.41	176.90			
3.20	0.20	47.223	18	1.5	-118.74	-52.01	-47.29	3000	315	263.64	179.78	4246	95	115.01	171.90			
3.40	0.20	46.307	18	1.5	-112.14	-46.33	-42.12	3000	315	254.18	175.26	4246	95	113.76	167.45			
3.60	0.20	45.460	18	1.5	-106.25	-41.29	-37.54	3000	315	245.76	171.21	4246	95	112.64	163.49			
3.80	0.20	44.673	18	1.5	-101.01	-36.84	-33.49	3000	315	238.25	167.57	4246	95	111.63	159.95			
4.00	0.20	43.939	18	1.5	-96.33	-32.89	-29.90	3000	315	231.55	164.30	4246	95	110.73	156.79			
4.20	0.20	43.252	18	1.5	-92.15	-29.40	-26.73	3000	315	225.57	161.38	4246	95	109.93	153.97			
4.40	0.20	42.606	18	1.5	-88.42	-26.31	-23.92	3000	315	220.23	158.75	4246	95	109.21	151.45			
4.60	0.20	41.999	18	1.5	-85.07	-23.58	-21.43	3000	315	215.44	156.38	4246	95	108.56	149.19			
4.80	0.20	41.425	18	1.5	-82.08	-21.16	-19.23	3000	315	211.16	154.26	4246	95	107.98	147.17			
5.00	0.20	40.883	18	1.5	-79.40	-19.01	-17.28	3000	315	207.31	152.34	4246	95	107.46	145.36			
5.20	0.20	40.368	18	1.5	-76.98	-17.12	-15.56	3000	315	203.85	150.62	4246	95	106.99	143.73			
5.40	0.20	39.879	18	1.5	-74.81	-15.43	-14.03	3000	315	200.74	149.06	4246	95	106.57	142.26			
5.60	0.20	39.413	0	1.5	-72.85	-31.94	-29.04	3000	315	197.93	147.65	4246	95	106.18	140.94			
5.80	0.20	38.969	0	1.5	-68.81	-28.34	-25.76	3000	315	192.13	144.73	4246	95	105.39	138.20			
6.00	0.20	38.544	0	1.5	-65.22	-25.17	-22.88	3000	315	186.97	142.12	4246	95	104.69	135.78			
6.20	0.20	38.138	0	1.5	-62.03	-22.39	-20.36	3000	315	182.40	139.79	4246	95	104.06	133.62			
6.40	0.20	37.749	0	1.5	-59.20	-19.95	-18.14	3000	315	178.33	137.72	4246	95	103.50	131.71			
6.60	0.20	37.375	0	1.5	-56.68	-17.81	-16.19	3000	315	174.70	135.86	4246	95	103.00	130.00			
6.80	0.20	37.017	0	1.5	-54.43	-15.92	-14.47	3000	315	171.46	134.20	4246	95	102.56	128.48			
7.00	0.20	36.672	0	1.5	-52.43	-14.26	-12.96	3000	315	168.57	132.71	4246	95	102.16	127.12			
7.20	0.20	36.339	0	1.5	-50.63	-12.79	-11.63	3000	315	165.97	131.37	4246	95	101.80	125.91			
7.40	0.20	36.019	0	1.5	-49.02	-11.50	-10.46	3000	315	163.65	130.17	4246	95	101.48	124.82			
7.60	0.20	35.710	0	1.5	-47.57	-10.36	-9.42	3000	315	161.56	129.08	4246	95	101.20	123.84			
7.80	0.21	35.412	0	1.5	-46.27	-9.36	-8.51	3000	315	159.67	128.11	4246	95	100.94	122.95			
8.01	0.24	35.104	0	1.5	-45.01	-8.41	-7.65	3000	315	157.86	127.16	4246	95	100.69	122.10			
8.25	0.27	34.774	0	1.5	-43.76	-7.49	-6.80	3000	315	156.04	126.21	4246	95	100.43	121.25			
8.52	0.30	34.418	0	1.5	-42.50	-6.59	-5.99	3000	315	154.22	125.27	4246	95	100.18	120.40			
8.82	0.35	34.030	0	1.5	-41.25	-5.72	-5.20	3000	315	152.40	124.32	4246	95	99.93	119.55			
9.17	0.41	33.606	0	1.5	-40.00	-4.89	-4.45	3000	315	150.58	123.36	4246	95	99.68	118.70			
9.58	0.49	33.136	0	1.5	-38.75	-4.11	-3.74	3000	315	148.76	122.41	4246	95	99.43	117.86			
10.07	0.50	32.610	0	1.5	-37.49	-3.38	-3.08	3000	315	146.95	121.46	4246	95	99.18	117.01			
10.57	0.50	32.103	0	1.5	-36.44	-2.83	-2.58	3000	315	145.41	120.65	4246	95	98.97	116.29			
11.07	0.50	31.627	0	1.5	-35.55	-2.42	-2.20	3000	315	144.12	119.97	4246	95	98.79	115.69			
11.57	0.50	31.179	0	1.5	-34.79	-2.12	-1.92	3000	315	143.02	119.39	4246	95	98.64	115.18			
12.07	0.50	30.755	0	1.5	-34.13	-1.88	-1.71	3000	315	142.06	118.88	4246	95	98.50	114.73			
12.57	0.50	30.355	0	1.5	-33.55	-1.69	-1.54	3000	315	141.20	118.43	4246	95	98.39	114.33			
13.07	0.50	29.974	0	1.5	-33.02	-1.55	-1.41	3000	315	140.43	118.02	4246	95	98.28	113.97			
13.57	0.50	29.613	0	1.5	-32.54	-1.43	-1.30	3000	315	139.73	117.65	4246	95	98.18	113.65			
14.07	0.50	29.269	0	1.5	-32.09	-1.33	-1.21	3000	315	139.08	117.31	4246	95	98.09	113.35			
14.57	0.50	28.940	0	1.5	-31.68	-1.24	-1.13	3000	315	138.48	116.99	4246	95	98.01	113.07			
15.07	0.50	28.627	0	1.5	-31.30	-1.17	-1.06	3000	315	137.91	116.69	4246	95	97.93	112.80			
15.57	0.50	28.326	0	1.5	-30.93	-1.11	-1.00	3000	315	137.38	116.41	4246	95	97.86	112.56			
16.07	0.50	28.038	0	1.5	-30.59	-1.05	-0.95	3000	315	136.88	116.14	4246	95	97.79	112.32			
16.57	0.50	27.762	0	1.5	-30.26	-1.00	-0.91	3000	315	136.40	115.89	4246	95	97.72	112.10			
17.07	0.50	27.497	0	1.5	-29.95	-0.95	-0.87	3000	315	135.95	115.65	4246	95	97.66	111.89			

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
2.00	284.74	55.59	1.0225	1.32E-04	0.396	5.609	128,630	1.2234	2224	169.15	60.80	1.0014	2.50E-04	0.384	3.652	191,412	2.3514	1447	9.468	374.47
2.10	277.91	55.93	1.0204	1.36E-04	0.396	5.609	125,596	1.2579	2206	166.37	60.86	1.0011	2.55E-04	0.383	3.652	187,797	2.4024	1438	9.439	373.09
2.20	271.43	56.24	1.0186	1.40E-04	0.396	5.609	122,669	1.2929	2189	163.74	60.92	1.0009	2.60E-04	0.383	3.652	184,378	2.4527	1429	9.411	371.73
2.40	259.13	56.82	1.0153	1.48E-04	0.396	5.609	116,997	1.3660	2153	158.73	61.02	1.0005	2.70E-04	0.381	3.652	177,912	2.5534	1412	9.356	369.01
2.60	248.13	57.31	1.0127	1.56E-04	0.395	5.609	111,814	1.4398	2118	154.24	61.11	1.0001	2.80E-04	0.380	3.652	172,164	2.6497	1397	9.308	366.42
2.80	238.31	57.73	1.0106	1.64E-04	0.395	5.609	107,113	1.5134	2084	150.23	61.19	0.9999	2.89E-04	0.379	3.652	167,063	2.7412	1383	9.266	363.99
3.00	229.54	58.10	1.0088	1.72E-04	0.394	5.609	102,870	1.5860	2052	146.65	61.25	0.9996	2.97E-04	0.378	3.652	162,537	2.8275	1370	9.229	361.72
3.20	221.71	58.41	1.0074	1.80E-04	0.393	5.609	99,054	1.6571	2022	143.46	61.31	0.9994	3.05E-04	0.377	3.652	158,522	2.9084	1358	9.195	359.60
3.40	214.72	58.68	1.0062	1.87E-04	0.392	5.609	95,632	1.7260	1994	140.60	61.36	0.9992	3.12E-04	0.376	3.652	154,961	2.9840	1348	9.166	357.64
3.60	208.48	58.92	1.0053	1.94E-04	0.392	5.609	92,568	1.7924	1968	138.06	61.41	0.9991	3.19E-04	0.376	3.652	151,800	3.0543	1339	9.140	355.84
3.80	202.91	59.13	1.0044	2.01E-04	0.391	5.609	89,827	1.8559	1944	135.79	61.45	0.9990	3.25E-04	0.375	3.652	148,993	3.1194	1330	9.116	354.17
4.00	197.93	59.31	1.0038	2.07E-04	0.390	5.609	87,376	1.9164	1923	133.76	61.49	0.9989	3.31E-04	0.374	3.652	146,497	3.1795	1322	9.095	352.65
4.20	193.47	59.47	1.0032	2.13E-04	0.389	5.609	85,183	1.9736	1902	131.95	61.52	0.9988	3.36E-04	0.374	3.652	144,277	3.2348	1315	9.076	351.25
4.40	189.49	59.60	1.0027	2.18E-04	0.389	5.609	83,222	2.0275	1884	130.33	61.54	0.9987	3.41E-04	0.373	3.652	142,298	3.2857	1309	9.059	349.97
4.60	185.91	59.73	1.0023	2.23E-04	0.388	5.609	81,466	2.0781	1867	128.88	61.57	0.9986	3.45E-04	0.373	3.652	140,532	3.3323	1304	9.044	348.81
4.80	182.71	59.83	1.0019	2.28E-04	0.387	5.609	79,892	2.1255	1852	127.58	61.59	0.9986	3.49E-04	0.372	3.652	138,954	3.3751	1299	9.031	347.74
5.00	179.82	59.93	1.0016	2.33E-04	0.387	5.609	78,480	2.1698	1838	126.41	61.61	0.9985	3.53E-04	0.372	3.652	137,542	3.4143	1294	9.019	346.77
5.20	177.23	60.01	1.0014	2.37E-04	0.386	5.609	77,212	2.2111	1826	125.36	61.63	0.9984	3.57E-04	0.371	3.652	136,276	3.4501	1290	9.008	345.88
5.40	174.90	60.09	1.0011	2.41E-04	0.386	5.609	76,070	2.2494	1814	124.41	61.64	0.9984	3.60E-04	0.371	3.652	135,139	3.4830	1286	8.998	345.07
5.60	172.79	60.16	1.0009	2.44E-04	0.385	5.609	75,042	2.2851	1804	123.56	61.66	0.9984	3.62E-04	0.371	3.652	134,115	3.5130	1283	8.988	344.33
5.80	168.43	60.29	1.0005	2.52E-04	0.384	5.609	72,916	2.3621	1782	121.80	61.68	0.9983	3.68E-04	0.370	3.652	132,004	3.5765	1276	8.968	342.76
6.00	164.55	60.41	1.0002	2.59E-04	0.383	5.609	71,033	2.4345	1762	120.23	61.71	0.9982	3.74E-04	0.370	3.652	130,138	3.6345	1269	8.950	341.33
6.20	161.09	60.52	0.9999	2.66E-04	0.382	5.609	69,363	2.5022	1744	118.84	61.73	0.9982	3.79E-04	0.369	3.652	128,488	3.6873	1264	8.934	340.04
6.40	158.02	60.61	0.9996	2.72E-04	0.382	5.609	67,881	2.5653	1727	117.60	61.75	0.9981	3.83E-04	0.369	3.652	127,025	3.7353	1259	8.920	338.88
6.60	155.28	60.69	0.9994	2.78E-04	0.381	5.609	66,563	2.6239	1713	116.50	61.77	0.9981	3.87E-04	0.368	3.652	125,725	3.7789	1254	8.907	337.82
6.80	152.83	60.76	0.9992	2.83E-04	0.380	5.609	65,389	2.6782	1700	115.52	61.78	0.9981	3.91E-04	0.368	3.652	124,570	3.8186	1250	8.896	336.86
7.00	150.64	60.82	0.9991	2.88E-04	0.380	5.609	64,341	2.7284	1688	114.64	61.79	0.9980	3.94E-04	0.368	3.652	123,539	3.8546	1247	8.886	335.99
7.20	148.67	60.87	0.9990	2.93E-04	0.379	5.609	63,405	2.7748	1677	113.86	61.81	0.9980	3.97E-04	0.367	3.652	122,619	3.8872	1243	8.877	335.21
7.40	146.91	60.92	0.9988	2.97E-04	0.379	5.609	62,566	2.8176	1667	113.15	61.82	0.9980	4.00E-04	0.367	3.652	121,795	3.9170	1240	8.869	334.49
7.60	145.32	60.96	0.9987	3.01E-04	0.378	5.609	61,813	2.8571	1658	112.52	61.82	0.9980	4.03E-04	0.367	3.652	121,056	3.9440	1238	8.862	333.85
7.80	143.89	61.00	0.9986	3.04E-04	0.378	5.609	61,136	2.8935	1650	111.95	61.83	0.9979	4.05E-04	0.367	3.652	120,391	3.9686	1235	8.856	333.26
8.01	142.51	61.04	0.9985	3.08E-04	0.377	5.609	60,483	2.9294	1642	111.39	61.84	0.9979	4.07E-04	0.366	3.652	119,751	3.9926	1233	8.850	332.69
8.25	141.13	61.07	0.9985	3.11E-04	0.377	5.609	59,831	2.9660	1634	110.84	61.85	0.9979	4.09E-04	0.366	3.652	119,112	4.0167	1231	8.844	332.11
8.52	139.74	61.11	0.9984	3.15E-04	0.377	5.609	59,181	3.0035	1627	110.29	61.86	0.9979	4.12E-04	0.366	3.652	118,474	4.0412	1229	8.838	331.53
8.82	138.36	61.14	0.9983	3.18E-04	0.376	5.609	58,531	3.0417	1619	109.74	61.86	0.9979	4.14E-04	0.366	3.652	117,837	4.0658	1226	8.832	330.94
9.17	136.97	61.18	0.9982	3.22E-04	0.376	5.609	57,883	3.0809	1611	109.19	61.87	0.9979	4.16E-04	0.365	3.652	117,202	4.0907	1224	8.826	330.35
9.58	135.59	61.21	0.9981	3.26E-04	0.375	5.609	57,235	3.1209	1603	108.64	61.88	0.9978	4.18E-04	0.365	3.652	116,568	4.1159	1222	8.820	329.76
10.07	134.20	61.25	0.9981	3.30E-04	0.375	5.609	56,589	3.1617	1595	108.09	61.89	0.9978	4.21E-04	0.365	3.652	115,936	4.1412	1219	8.815	329.16
10.57	133.03	61.28	0.9980	3.33E-04	0.374	5.609	56,043	3.1971	1588	107.63	61.89	0.9978	4.23E-04	0.365	3.652	115,401	4.1629	1217	8.810	328.65
11.07	132.04	61.30	0.9979	3.36E-04	0.374	5.609	55,587	3.2271	1582	107.24	61.90	0.9978	4.25E-04	0.365	3.652	114,955	4.1811	1216	8.806	328.22
11.57	131.20	61.32	0.9979	3.39E-04	0.374	5.609	55,197	3.2533	1577	106.91	61.90	0.9978	4.26E-04	0.365	3.652	114,573	4.1969	1214	8.802	327.85
12.07	130.47	61.34	0.9979	3.41E-04	0.374	5.609	54,857	3.2763	1573	106.62	61.91	0.9978	4.27E-04	0.364	3.652	114,241	4.2107	1213	8.799	327.52
12.57	129.82	61.35	0.9978	3.43E-04	0.373	5.609	54,556	3.2971	1569	106.36	61.91	0.9978	4.28E-04	0.364	3.652	113,946	4.2230	1212	8.796	327.23
13.07	129.23	61.37	0.9978	3.44E-04	0.373	5.609	54,284	3.3160	1565	106.13	61.92	0.9978	4.29E-04	0.364	3.652	113,680	4.2341	1211	8.794	326.97
13.57	128.69	61.38	0.9978	3.46E-04	0.373	5.609	54,037	3.3334	1562	105.91	61.92	0.9978	4.30E-04	0.364	3.652	113,438	4.2443	1210	8.792	326.73
14.07	128.19	61.39	0.9978	3.48E-04	0.373	5.609	53,809	3.3496	1559	105.72	61.92	0.9978	4.31E-04	0.364	3.652	113,214	4.2538	1209	8.790	326.51
14.57	127.73	61.40	0.9977	3.49E-04	0.373	5.609	53,597	3.3647	1556	105.54	61.92	0.9978	4.32E-04	0.364	3.652	113,007	4.2626	1208	8.788	326.30
15.07	127.30	61.41	0.9977	3.50E-04	0.373	5.609	53,398	3.3790	1554	105.37	61.93	0.9978	4.33E-04	0.364	3.652	112,813	4.2709	1208	8.786	326.11
15.57	126.90	61.42	0.9977	3.52E-04	0.372	5.609	53,212	3.3926	1551	105.21	61.93	0.9978	4.33E-04	0.364	3.652	112,630	4.2787	1207	8.785	325.92
16.07	126.51	61.43	0.9977	3.53E-04	0.372	5.609	53,035	3.4055	1549	105.06	61.93	0.9978	4.34E-04	0.364	3.652	112,458	4.2861	1206	8.783	325.75
16.57	126.15	61.44	0.9977	3.54E-04	0.372	5.609	52,868	3.4178	1547	104.91	61.93	0.9978	4.35E-04	0.364	3.652	112,294	4.2932	1206	8.782	325.58
17.07	125.80	61.45	0.9976	3.55E-04	0.372	5.609	52,708	3.4296	1545	104.77	61.93	0.9978	4.35E-04	0.364	3.652	112,138	4.2999	1205	8.780	325.43

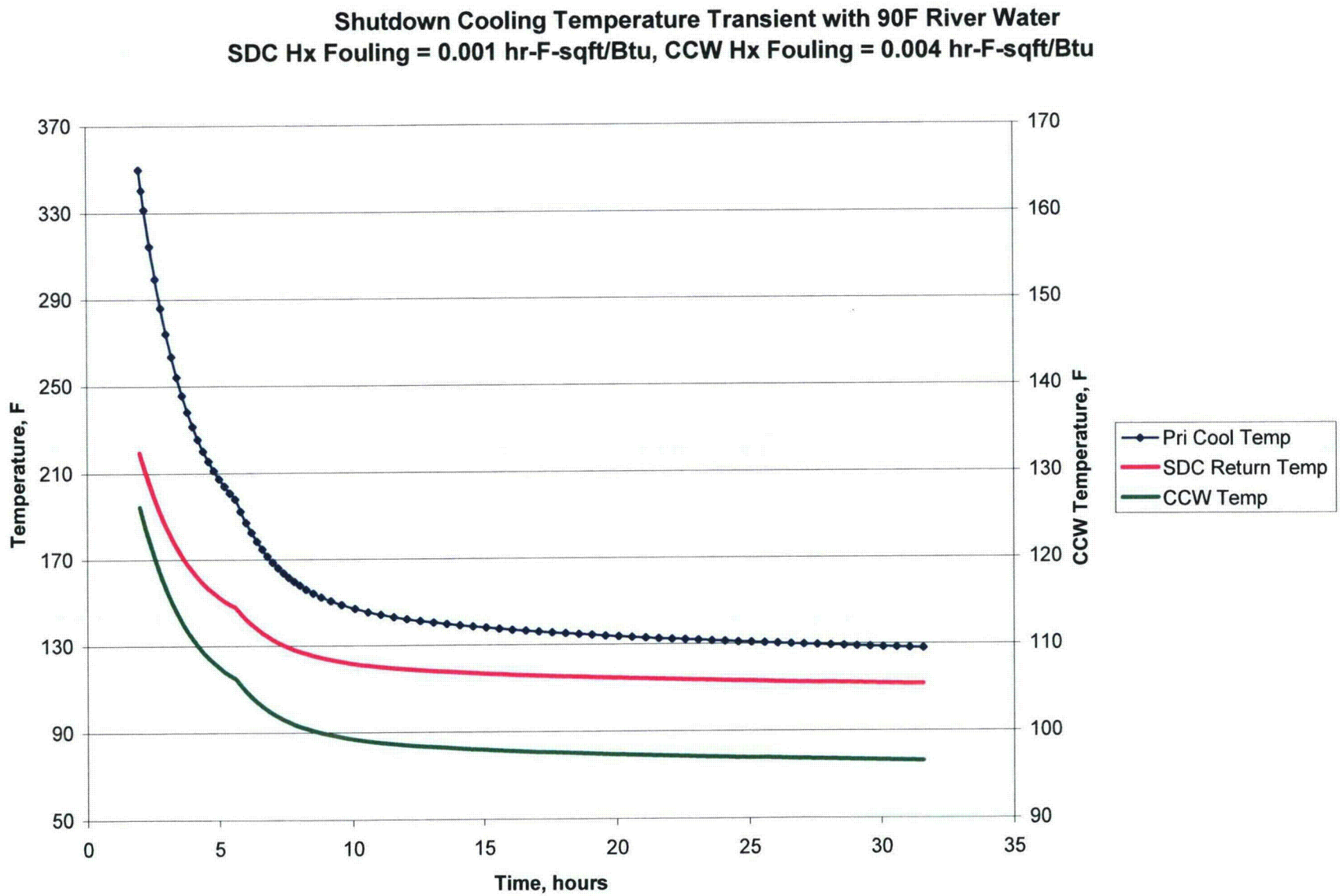
CCW HX Fouling 0

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate	Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX	CCW Temp
hrs	W	WCp	Cr	NTU	effectivenes	DT	Tt,o	W	WCp	Cr	NTU	effectivenes	DTs	Ts,o	Btu/hr			mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr	Ts,o
2.00	1,337,560	1,367,602	0.660	1.375	0.583	130.51	219.49	2,070,777	2,073,598	#N/A	#N/A	#N/A	86.08	212.19	178.49	219.49	212.19	7.358	185.85	8,100	3	61.95	126.11
2.10	1,345,732	1,373,188	0.662	1.364	0.581	125.27	215.28	2,072,759	2,075,070	#N/A	#N/A	#N/A	82.90	207.82	172.02	215.28	207.82	7.358	179.37	8,100	3	59.79	124.92
2.20	1,353,291	1,378,397	0.664	1.354	0.579	120.34	211.26	2,074,617	2,076,461	#N/A	#N/A	#N/A	79.88	203.68	165.87	211.26	203.68	7.358	173.23	8,100	3	57.74	123.80
2.40	1,367,145	1,388,068	0.668	1.335	0.576	111.09	203.59	2,078,084	2,079,085	#N/A	#N/A	#N/A	74.17	195.81	154.20	203.59	195.81	7.358	161.56	8,100	3	53.85	121.64
2.60	1,379,004	1,396,491	0.671	1.317	0.572	102.95	196.66	2,081,113	2,081,408	#N/A	#N/A	#N/A	69.07	188.78	143.76	196.66	188.78	7.358	151.12	8,100	3	50.37	119.71
2.80	1,389,188	1,403,848	0.674	1.302	0.569	95.77	190.42	2,083,759	2,083,460	#N/A	#N/A	#N/A	64.53	182.50	134.45	190.42	182.50	7.358	141.81	8,100	3	47.27	117.97
3.00	1,397,960	1,410,289	0.676	1.288	0.567	89.44	184.82	2,086,071	2,085,271	#N/A	#N/A	#N/A	60.49	176.90	126.14	184.82	176.90	7.358	133.50	8,100	3	44.50	116.41
3.20	1,405,538	1,415,937	0.678	1.275	0.564	83.86	179.78	2,088,094	2,086,868	#N/A	#N/A	#N/A	56.90	171.90	118.74	179.78	171.90	7.358	126.09	8,100	3	42.03	115.01
3.40	1,412,102	1,420,897	0.680	1.264	0.562	78.92	175.26	2,089,867	2,088,278	#N/A	#N/A	#N/A	53.70	167.45	112.14	175.26	167.45	7.358	119.50	8,100	3	39.83	113.76
3.60	1,417,805	1,425,259	0.682	1.253	0.560	74.55	171.21	2,091,421	2,089,523	#N/A	#N/A	#N/A	50.85	163.49	106.25	171.21	163.49	7.358	113.61	8,100	3	37.87	112.64
3.80	1,422,772	1,429,100	0.684	1.244	0.558	70.68	167.57	2,092,787	2,090,623	#N/A	#N/A	#N/A	48.32	159.95	101.01	167.57	159.95	7.358	108.37	8,100	3	36.12	111.63
4.00	1,427,111	1,432,489	0.685	1.236	0.557	67.25	164.30	2,093,989	2,091,597	#N/A	#N/A	#N/A	46.06	156.79	96.33	164.30	156.79	7.358	103.69	8,100	3	34.56	110.73
4.20	1,430,909	1,435,481	0.686	1.228	0.555	64.20	161.38	2,095,049	2,092,459	#N/A	#N/A	#N/A	44.04	153.97	92.15	161.38	153.97	7.358	99.51	8,100	3	33.17	109.93
4.40	1,434,245	1,438,129	0.687	1.222	0.554	61.48	158.75	2,095,986	2,093,225	#N/A	#N/A	#N/A	42.24	151.45	88.42	158.75	151.45	7.358	95.77	8,100	3	31.92	109.21
4.60	1,437,181	1,440,475	0.688	1.216	0.553	59.06	156.38	2,096,816	2,093,906	#N/A	#N/A	#N/A	40.63	149.19	85.07	156.38	149.19	7.358	92.43	8,100	3	30.81	108.56
4.80	1,439,773	1,442,558	0.689	1.210	0.551	56.90	154.26	2,097,552	2,094,512	#N/A	#N/A	#N/A	39.19	147.17	82.08	154.26	147.17	7.358	89.44	8,100	3	29.81	107.98
5.00	1,442,067	1,444,411	0.689	1.205	0.551	54.97	152.34	2,098,207	2,095,053	#N/A	#N/A	#N/A	37.90	145.36	79.40	152.34	145.36	7.358	86.75	8,100	3	28.92	107.46
5.20	1,444,102	1,446,062	0.690	1.201	0.550	53.24	150.62	2,098,791	2,095,536	#N/A	#N/A	#N/A	36.74	143.73	76.98	150.62	143.73	7.358	84.34	8,100	3	28.11	106.99
5.40	1,445,913	1,447,538	0.691	1.197	0.549	51.68	149.06	2,099,312	2,095,969	#N/A	#N/A	#N/A	35.69	142.26	74.81	149.06	142.26	7.358	82.17	8,100	3	27.39	106.57
5.60	1,447,528	1,448,859	0.691	1.193	0.548	50.28	147.65	2,099,779	2,096,358	#N/A	#N/A	#N/A	34.75	140.94	72.85	147.65	140.94	7.358	80.21	8,100	3	26.74	106.18
5.80	1,450,818	1,451,562	0.692	1.185	0.547	47.40	144.73	2,100,736	2,097,158	#N/A	#N/A	#N/A	32.81	138.20	68.81	144.73	138.20	7.358	76.16	8,100	3	25.39	105.39
6.00	1,453,675	1,453,925	0.693	1.179	0.545	44.86	142.12	2,101,574	2,097,862	#N/A	#N/A	#N/A	31.09	135.78	65.22	142.12	135.78	7.358	72.57	8,100	3	24.19	104.69
6.20	1,456,164	1,455,994	0.694	1.172	0.544	42.60	139.79	2,102,308	2,098,482	#N/A	#N/A	#N/A	29.56	133.62	62.03	139.79	133.62	7.358	69.39	8,100	3	23.13	104.06
6.40	1,458,339	1,457,810	0.695	1.167	0.543	40.61	137.72	2,102,955	2,099,030	#N/A	#N/A	#N/A	28.20	131.71	59.20	137.72	131.71	7.358	66.56	8,100	3	22.19	103.50
6.60	1,460,245	1,459,408	0.695	1.162	0.542	38.84	135.86	2,103,524	2,099,515	#N/A	#N/A	#N/A	27.00	130.00	56.68	135.86	130.00	7.358	64.04	8,100	3	21.35	103.00
6.80	1,461,920	1,460,817	0.696	1.158	0.541	37.26	134.20	2,104,028	2,099,945	#N/A	#N/A	#N/A	25.92	128.48	54.43	134.20	128.48	7.358	61.79	8,100	3	20.60	102.56
7.00	1,463,396	1,462,063	0.696	1.154	0.540	35.86	132.71	2,104,475	2,100,328	#N/A	#N/A	#N/A	24.96	127.12	52.43	132.71	127.12	7.358	59.79	8,100	3	19.93	102.16
7.20	1,464,702	1,463,167	0.697	1.150	0.539	34.60	131.37	2,104,871	2,100,669	#N/A	#N/A	#N/A	24.10	125.91	50.63	131.37	125.91	7.358	57.99	8,100	3	19.33	101.80
7.40	1,465,859	1,464,149	0.697	1.147	0.539	33.48	130.17	2,105,225	2,100,974	#N/A	#N/A	#N/A	23.33	124.82	49.02	130.17	124.82	7.358	56.38	8,100	3	18.79	101.48
7.60	1,466,889	1,465,024	0.697	1.144	0.538	32.47	129.08	2,105,541	2,101,247	#N/A	#N/A	#N/A	22.64	123.84	47.57	129.08	123.84	7.358	54.93	8,100	3	18.31	101.20
7.80	1,467,807	1,465,805	0.698	1.141	0.537	31.57	128.11	2,105,823	2,101,492	#N/A	#N/A	#N/A	22.02	122.95	46.27	128.11	122.95	7.358	53.63	8,100	3	17.88	100.94
8.01	1,468,685	1,466,554	0.698	1.139	0.537	30.69	127.16	2,106,095	2,101,728	#N/A	#N/A	#N/A	21.42	122.10	45.01	127.16	122.10	7.358	52.37	8,100	3	17.46	100.69
8.25	1,469,555	1,467,297	0.698	1.136	0.536	29.82	126.21	2,106,365	2,101,963	#N/A	#N/A	#N/A	20.82	121.25	43.76	126.21	121.25	7.358	51.12	8,100	3	17.04	100.43
8.52	1,470,416	1,468,034	0.698	1.134	0.536	28.95	125.27	2,106,633	2,102,198	#N/A	#N/A	#N/A	20.22	120.40	42.50	125.27	120.40	7.358	49.86	8,100	3	16.62	100.18
8.82	1,471,269	1,468,764	0.699	1.131	0.535	28.09	124.32	2,106,900	2,102,431	#N/A	#N/A	#N/A	19.62	119.55	41.25	124.32	119.55	7.358	48.61	8,100	3	16.20	99.93
9.17	1,472,113	1,469,489	0.699	1.129	0.535	27.22	123.36	2,107,165	2,102,664	#N/A	#N/A	#N/A	19.02	118.70	40.00	123.36	118.70	7.358	47.36	8,100	3	15.79	99.68
9.58	1,472,948	1,470,208	0.699	1.126	0.534	26.35	122.41	2,107,429	2,102,896	#N/A	#N/A	#N/A	18.42	117.86	38.75	122.41	117.86	7.358	46.10	8,100	3	15.37	99.43
10.07	1,473,775	1,470,920	0.699	1.123	0.534	25.49	121.46	2,107,691	2,103,127	#N/A	#N/A	#N/A	17.83	117.01	37.49	121.46	117.01	7.358	44.85	8,100	3	14.95	99.18
10.57	1,474,468	1,471,517	0.700	1.121	0.533	24.76	120.65	2,107,912	2,103,322	#N/A	#N/A	#N/A	17.32	116.29	36.44	120.65	116.29	7.358	43.79	8,100	3	14.60	98.97
11.07	1,475,043	1,472,014	0.700	1.119	0.533	24.15	119.97	2,108,095	2,103,485	#N/A	#N/A	#N/A	16.90	115.69	35.55	119.97	115.69	7.358	42.91	8,100	3	14.30	98.79
11.57	1,475,532	1,472,437	0.700	1.118	0.532	23.63	119.39	2,108,252	2,103,624	#N/A	#N/A	#N/A	16.54	115.18	34.79	119.39	115.18	7.358	42.15	8,100	3	14.05	98.64
12.07	1,475,955	1,472,803	0.700	1.116	0.532	23.18	118.88	2,108,388	2,103,745	#N/A	#N/A	#N/A	16.23	114.73	34.13	118.88	114.73	7.358	41.49	8,100	3	13.83	98.50
12.57	1,476,329	1,473,127	0.700	1.115	0.532	22.77	118.43	2,108,509	2,103,853	#N/A	#N/A	#N/A	15.95	114.33	33.55	118.43	114.33	7.358	40.91	8,100	3	13.64	98.39
13.07	1,476,665	1,473,418	0.700	1.114	0.532	22.41	118.02	2,108,617	2,103,949	#N/A	#N/A	#N/A	15.69	113.97	33.02	118.02	113.97	7.358	40.38	8,100	3	13.46	98.28
13.57	1,476,970	1,473,683	0.700	1.113	0.531	22.08	117.65	2,108,716	2,104,037	#N/A	#N/A	#N/A	15.46	113.65	32.54	117.65	113.65	7.358	39.90	8,100	3	13.30	98.18
14.07	1,477,250	1,473,926	0.700	1.112	0.531	21.77	117.31	2,108,807	2,104,119	#N/A	#N/A	#N/A	15.25	113.35	32.09	117.31	113.35	7.358	39.45	8,100	3	13.15	98.09
14.57	1,477,509	1,474,151	0.701	1.111	0.531	21.49	116.99	2,108,891	2,104,194	#N/A	#N/A	#N/A	15.06	113.07	31.68	116.99	113.07	7.358	39.04	8,100	3	13.01	98.01
15.07	1,477,750	1,474,361	0.701	1.110	0.531	21.23	116.69	2,108,970	2,104,265	#N/A	#N/A	#N/A	14.87	112.80	31.30	116.69	112.80	7.358	38.65	8,100	3	12.88	97.93
15.57	1,477,977	1,474,558	0.701	1.110	0.531	20.98	116.41	2,109,044	2,104,331	#N/A	#N/A	#N/A	14.70	112.56	30.93	116.41	112.56	7.358	38.29	8,100	3	12.76	97.86
16.07	1,478,191	1,474,744	0.701	1.109	0.531	20.74	116.14	2,109,113	2,104,393	#N/A	#N/A	#N/A	14.54	112.32	30.59	116.14	112.32	7.358	37.95	8,100	3	12.65	97.79
16.57	1,478,393	1,474,921	0.701	1.108	0.530	20.52	115.89	2,109,180	2,104,453	#N/A	#N/A	#N/A	14.38	112.10	30.26	115.89	112.10	7.358	37.62	8,100	3	12.54	97.72
17.07	1,478,585	1,475,088	0.701	1.107	0.530	20.30	115.65	2,109,242	2,104,509	#N/A	#N/A	#N/A	14.23	111.89	29.95	115.65	111.89	7.358	37.31	8,100	3	12.44	97.66

								SDCHx							
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell			
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o
17.57	0.50	27.242	0	1.5	-29.65	-0.91	-0.83	3000	315	135.52	115.42	4246	95	97.60	111.69
18.07	0.50	26.996	0	1.5	-29.37	-0.87	-0.80	3000	315	135.10	115.20	4246	95	97.54	111.50
18.57	0.50	26.759	0	1.5	-29.10	-0.84	-0.76	3000	315	134.71	114.98	4246	95	97.49	111.31
19.07	0.50	26.530	0	1.5	-28.84	-0.81	-0.73	3000	315	134.32	114.78	4246	95	97.43	111.14
19.57	0.50	26.309	0	1.5	-28.59	-0.78	-0.71	3000	315	133.96	114.59	4246	95	97.38	110.97
20.07	0.50	26.095	0	1.5	-28.34	-0.75	-0.68	3000	315	133.60	114.40	4246	95	97.33	110.80
20.57	0.50	25.889	0	1.5	-28.11	-0.72	-0.66	3000	315	133.26	114.22	4246	95	97.29	110.64
21.07	0.50	25.689	0	1.5	-27.89	-0.70	-0.64	3000	315	132.93	114.04	4246	95	97.24	110.49
21.57	0.50	25.495	0	1.5	-27.67	-0.68	-0.61	3000	315	132.62	113.87	4246	95	97.20	110.34
22.07	0.50	25.307	0	1.5	-27.46	-0.65	-0.59	3000	315	132.31	113.71	4246	95	97.16	110.20
22.57	0.50	25.124	0	1.5	-27.26	-0.63	-0.58	3000	315	132.01	113.55	4246	95	97.11	110.06
23.07	0.50	24.947	0	1.5	-27.06	-0.61	-0.56	3000	315	131.72	113.40	4246	95	97.07	109.93
23.57	0.50	24.775	0	1.5	-26.87	-0.60	-0.54	3000	315	131.44	113.25	4246	95	97.04	109.80
24.07	0.50	24.607	0	1.5	-26.69	-0.58	-0.53	3000	315	131.17	113.10	4246	95	97.00	109.68
24.57	0.50	24.444	0	1.5	-26.51	-0.56	-0.51	3000	315	130.91	112.96	4246	95	96.96	109.55
25.07	0.50	24.286	0	1.5	-26.33	-0.55	-0.50	3000	315	130.66	112.83	4246	95	96.93	109.44
25.57	0.50	24.131	0	1.5	-26.16	-0.53	-0.48	3000	315	130.41	112.69	4246	95	96.89	109.32
26.07	0.50	23.981	0	1.5	-26.00	-0.52	-0.47	3000	315	130.17	112.57	4246	95	96.86	109.21
26.57	0.50	23.834	0	1.5	-25.84	-0.50	-0.46	3000	315	129.93	112.44	4246	95	96.83	109.10
27.07	0.50	23.691	0	1.5	-25.68	-0.49	-0.45	3000	315	129.70	112.32	4246	95	96.79	108.99
27.57	0.50	23.551	0	1.5	-25.53	-0.48	-0.43	3000	315	129.48	112.20	4246	95	96.76	108.89
28.07	0.50	23.415	0	1.5	-25.38	-0.47	-0.42	3000	315	129.26	112.08	4246	95	96.73	108.79
28.57	0.50	23.282	0	1.5	-25.24	-0.46	-0.41	3000	315	129.05	111.97	4246	95	96.70	108.69
29.07	0.50	23.152	0	1.5	-25.10	-0.44	-0.40	3000	315	128.84	111.86	4246	95	96.68	108.60
29.57	0.50	23.024	0	1.5	-24.96	-0.43	-0.39	3000	315	128.64	111.75	4246	95	96.65	108.50
30.07	0.50	22.900	0	1.5	-24.82	-0.42	-0.39	3000	315	128.44	111.65	4246	95	96.62	108.41
30.57	0.50	22.778	0	1.5	-24.69	-0.41	-0.38	3000	315	128.25	111.54	4246	95	96.59	108.32
31.07	0.50	22.659	0	1.5	-24.56	-0.41	-0.37	3000	315	128.06	111.44	4246	95	96.57	108.23
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15
31.57	0.00	22.543	0	1.5	-24.44	-0.40	-0.36	3000	315	127.88	111.34	4246	95	96.54	108.15

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
17.57	125.47	61.46	0.9976	3.56E-04	0.372	5.609	52,556	3.4410	1543	104.64	61.94	0.9978	4.36E-04	0.364	3.652	111,990	4.3063	1205	8.779	325.28
18.07	125.15	61.46	0.9976	3.57E-04	0.372	5.609	52,411	3.4519	1541	104.52	61.94	0.9978	4.37E-04	0.364	3.652	111,848	4.3125	1204	8.778	325.13
18.57	124.84	61.47	0.9976	3.58E-04	0.372	5.609	52,272	3.4624	1539	104.40	61.94	0.9977	4.37E-04	0.364	3.652	111,712	4.3184	1203	8.776	324.99
19.07	124.55	61.48	0.9976	3.59E-04	0.372	5.609	52,138	3.4726	1537	104.28	61.94	0.9977	4.38E-04	0.364	3.652	111,581	4.3242	1203	8.775	324.86
19.57	124.27	61.48	0.9976	3.60E-04	0.371	5.609	52,010	3.4824	1535	104.17	61.94	0.9977	4.38E-04	0.363	3.652	111,455	4.3297	1203	8.774	324.73
20.07	124.00	61.49	0.9976	3.61E-04	0.371	5.609	51,886	3.4919	1534	104.07	61.94	0.9977	4.39E-04	0.363	3.652	111,334	4.3350	1202	8.773	324.61
20.57	123.74	61.49	0.9975	3.62E-04	0.371	5.609	51,767	3.5010	1532	103.97	61.94	0.9977	4.39E-04	0.363	3.652	111,218	4.3401	1202	8.772	324.49
21.07	123.49	61.50	0.9975	3.63E-04	0.371	5.609	51,652	3.5099	1531	103.87	61.95	0.9977	4.40E-04	0.363	3.652	111,105	4.3450	1201	8.771	324.37
21.57	123.24	61.51	0.9975	3.64E-04	0.371	5.609	51,541	3.5186	1529	103.77	61.95	0.9977	4.40E-04	0.363	3.652	110,997	4.3498	1201	8.770	324.26
22.07	123.01	61.51	0.9975	3.64E-04	0.371	5.609	51,434	3.5270	1528	103.68	61.95	0.9977	4.40E-04	0.363	3.652	110,892	4.3545	1200	8.769	324.15
22.57	122.78	61.52	0.9975	3.65E-04	0.371	5.609	51,330	3.5351	1526	103.59	61.95	0.9977	4.41E-04	0.363	3.652	110,791	4.3590	1200	8.768	324.04
23.07	122.56	61.52	0.9975	3.66E-04	0.371	5.609	51,230	3.5430	1525	103.50	61.95	0.9977	4.41E-04	0.363	3.652	110,692	4.3634	1200	8.767	323.94
23.57	122.35	61.53	0.9975	3.67E-04	0.371	5.609	51,132	3.5508	1524	103.42	61.95	0.9977	4.42E-04	0.363	3.652	110,597	4.3676	1199	8.767	323.84
24.07	122.14	61.53	0.9975	3.67E-04	0.371	5.609	51,038	3.5583	1522	103.34	61.95	0.9977	4.42E-04	0.363	3.652	110,505	4.3717	1199	8.766	323.75
24.57	121.94	61.53	0.9975	3.68E-04	0.371	5.609	50,946	3.5656	1521	103.26	61.95	0.9977	4.42E-04	0.363	3.652	110,415	4.3757	1199	8.765	323.65
25.07	121.74	61.54	0.9975	3.69E-04	0.371	5.609	50,857	3.5727	1520	103.18	61.96	0.9977	4.43E-04	0.363	3.652	110,328	4.3796	1198	8.764	323.56
25.57	121.55	61.54	0.9974	3.69E-04	0.371	5.609	50,771	3.5797	1519	103.11	61.96	0.9977	4.43E-04	0.363	3.652	110,243	4.3834	1198	8.764	323.47
26.07	121.37	61.55	0.9974	3.70E-04	0.370	5.609	50,687	3.5864	1518	103.03	61.96	0.9977	4.43E-04	0.363	3.652	110,161	4.3871	1198	8.763	323.39
26.57	121.19	61.55	0.9974	3.71E-04	0.370	5.609	50,605	3.5931	1517	102.96	61.96	0.9977	4.44E-04	0.363	3.652	110,081	4.3907	1197	8.762	323.30
27.07	121.01	61.56	0.9974	3.71E-04	0.370	5.609	50,525	3.5995	1516	102.89	61.96	0.9977	4.44E-04	0.363	3.652	110,003	4.3942	1197	8.761	323.22
27.57	120.84	61.56	0.9974	3.72E-04	0.370	5.609	50,448	3.6059	1515	102.83	61.96	0.9977	4.44E-04	0.363	3.652	109,927	4.3976	1197	8.761	323.14
28.07	120.67	61.56	0.9974	3.72E-04	0.370	5.609	50,372	3.6120	1513	102.76	61.96	0.9977	4.45E-04	0.363	3.652	109,854	4.4010	1196	8.760	323.06
28.57	120.51	61.57	0.9974	3.73E-04	0.370	5.609	50,298	3.6181	1512	102.70	61.96	0.9977	4.45E-04	0.363	3.652	109,781	4.4042	1196	8.760	322.99
29.07	120.35	61.57	0.9974	3.74E-04	0.370	5.609	50,226	3.6240	1512	102.64	61.96	0.9977	4.45E-04	0.363	3.652	109,711	4.4074	1196	8.759	322.91
29.57	120.20	61.57	0.9974	3.74E-04	0.370	5.609	50,156	3.6298	1511	102.58	61.96	0.9977	4.46E-04	0.363	3.652	109,643	4.4105	1196	8.758	322.84
30.07	120.04	61.58	0.9974	3.75E-04	0.370	5.609	50,088	3.6355	1510	102.52	61.96	0.9977	4.46E-04	0.363	3.652	109,576	4.4136	1195	8.758	322.77
30.57	119.90	61.58	0.9974	3.75E-04	0.370	5.609	50,021	3.6410	1509	102.46	61.96	0.9977	4.46E-04	0.363	3.652	109,510	4.4166	1195	8.757	322.70
31.07	119.75	61.58	0.9974	3.76E-04	0.370	5.609	49,956	3.6465	1508	102.40	61.97	0.9977	4.46E-04	0.363	3.652	109,446	4.4195	1195	8.757	322.63
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56
31.57	119.61	61.59	0.9974	3.76E-04	0.370	5.609	49,892	3.6518	1507	102.35	61.97	0.9977	4.47E-04	0.363	3.652	109,384	4.4223	1195	8.756	322.56

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate			Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX		CCW Temp
hrs	W	WCp	Cr	NTU	effectivenes	DT	Tt,o	W	WCp	Cr	NTU	effectivenes	DTs	Ts,o	Btu/hr					mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr		Ts,o
17.57	1,478,768	1,475,247	0.701	1.107	0.530	20.10	115.42	2,109,302	2,104,563	#N/A	#N/A	#N/A	14.09	111.69	29.65	115.42	111.69			7.358	37.01	8,100	3	12.34		97.60
18.07	1,478,942	1,475,399	0.701	1.106	0.530	19.91	115.20	2,109,360	2,104,615	#N/A	#N/A	#N/A	13.96	111.50	29.37	115.20	111.50			7.358	36.73	8,100	3	12.24		97.54
18.57	1,479,109	1,475,544	0.701	1.106	0.530	19.72	114.98	2,109,415	2,104,664	#N/A	#N/A	#N/A	13.83	111.31	29.10	114.98	111.31			7.358	36.46	8,100	3	12.15		97.49
19.07	1,479,269	1,475,684	0.701	1.105	0.530	19.54	114.78	2,109,467	2,104,712	#N/A	#N/A	#N/A	13.70	111.14	28.84	114.78	111.14			7.358	36.20	8,100	3	12.07		97.43
19.57	1,479,422	1,475,817	0.701	1.105	0.530	19.37	114.59	2,109,518	2,104,757	#N/A	#N/A	#N/A	13.58	110.97	28.59	114.59	110.97			7.358	35.94	8,100	3	11.98		97.38
20.07	1,479,569	1,475,946	0.701	1.104	0.530	19.20	114.40	2,109,566	2,104,801	#N/A	#N/A	#N/A	13.47	110.80	28.34	114.40	110.80			7.358	35.70	8,100	3	11.90		97.33
20.57	1,479,710	1,476,069	0.701	1.104	0.529	19.05	114.22	2,109,613	2,104,843	#N/A	#N/A	#N/A	13.36	110.64	28.11	114.22	110.64			7.358	35.47	8,100	3	11.82		97.29
21.07	1,479,846	1,476,188	0.701	1.103	0.529	18.89	114.04	2,109,658	2,104,884	#N/A	#N/A	#N/A	13.25	110.49	27.89	114.04	110.49			7.358	35.25	8,100	3	11.75		97.24
21.57	1,479,977	1,476,303	0.701	1.103	0.529	18.74	113.87	2,109,701	2,104,923	#N/A	#N/A	#N/A	13.15	110.34	27.67	113.87	110.34			7.358	35.03	8,100	3	11.68		97.20
22.07	1,480,104	1,476,414	0.701	1.102	0.529	18.60	113.71	2,109,743	2,104,961	#N/A	#N/A	#N/A	13.05	110.20	27.46	113.71	110.20			7.358	34.82	8,100	3	11.61		97.16
22.57	1,480,226	1,476,521	0.701	1.102	0.529	18.46	113.55	2,109,784	2,104,998	#N/A	#N/A	#N/A	12.95	110.06	27.26	113.55	110.06			7.358	34.62	8,100	3	11.54		97.11
23.07	1,480,345	1,476,624	0.701	1.101	0.529	18.33	113.40	2,109,823	2,105,034	#N/A	#N/A	#N/A	12.86	109.93	27.06	113.40	109.93			7.358	34.42	8,100	3	11.47		97.07
23.57	1,480,459	1,476,725	0.702	1.101	0.529	18.20	113.25	2,109,861	2,105,068	#N/A	#N/A	#N/A	12.76	109.80	26.87	113.25	109.80			7.358	34.23	8,100	3	11.41		97.04
24.07	1,480,570	1,476,822	0.702	1.100	0.529	18.07	113.10	2,109,898	2,105,101	#N/A	#N/A	#N/A	12.68	109.68	26.69	113.10	109.68			7.358	34.04	8,100	3	11.35		97.00
24.57	1,480,677	1,476,916	0.702	1.100	0.529	17.95	112.96	2,109,934	2,105,134	#N/A	#N/A	#N/A	12.59	109.55	26.51	112.96	109.55			7.358	33.86	8,100	3	11.29		96.96
25.07	1,480,781	1,477,007	0.702	1.100	0.529	17.83	112.83	2,109,969	2,105,165	#N/A	#N/A	#N/A	12.51	109.44	26.33	112.83	109.44			7.358	33.69	8,100	3	11.23		96.93
25.57	1,480,882	1,477,095	0.702	1.099	0.528	17.71	112.69	2,110,002	2,105,196	#N/A	#N/A	#N/A	12.43	109.32	26.16	112.69	109.32			7.358	33.52	8,100	3	11.17		96.89
26.07	1,480,980	1,477,181	0.702	1.099	0.528	17.60	112.57	2,110,035	2,105,226	#N/A	#N/A	#N/A	12.35	109.21	26.00	112.57	109.21			7.358	33.36	8,100	3	11.12		96.86
26.57	1,481,075	1,477,265	0.702	1.099	0.528	17.49	112.44	2,110,067	2,105,255	#N/A	#N/A	#N/A	12.27	109.10	25.84	112.44	109.10			7.358	33.20	8,100	3	11.07		96.83
27.07	1,481,168	1,477,346	0.702	1.098	0.528	17.38	112.32	2,110,098	2,105,283	#N/A	#N/A	#N/A	12.20	108.99	25.68	112.32	108.99			7.358	33.04	8,100	3	11.01		96.79
27.57	1,481,258	1,477,425	0.702	1.098	0.528	17.28	112.20	2,110,128	2,105,310	#N/A	#N/A	#N/A	12.13	108.89	25.53	112.20	108.89			7.358	32.89	8,100	3	10.96		96.76
28.07	1,481,346	1,477,502	0.702	1.098	0.528	17.18	112.08	2,110,157	2,105,337	#N/A	#N/A	#N/A	12.06	108.79	25.38	112.08	108.79			7.358	32.74	8,100	3	10.91		96.73
28.57	1,481,431	1,477,577	0.702	1.097	0.528	17.08	111.97	2,110,186	2,105,363	#N/A	#N/A	#N/A	11.99	108.69	25.24	111.97	108.69			7.358	32.59	8,100	3	10.86		96.70
29.07	1,481,514	1,477,650	0.702	1.097	0.528	16.98	111.86	2,110,214	2,105,388	#N/A	#N/A	#N/A	11.92	108.60	25.10	111.86	108.60			7.358	32.45	8,100	3	10.82		96.68
29.57	1,481,595	1,477,721	0.702	1.097	0.528	16.89	111.75	2,110,241	2,105,413	#N/A	#N/A	#N/A	11.85	108.50	24.96	111.75	108.50			7.358	32.32	8,100	3	10.77		96.65
30.07	1,481,674	1,477,791	0.702	1.096	0.528	16.80	111.65	2,110,268	2,105,437	#N/A	#N/A	#N/A	11.79	108.41	24.82	111.65	108.41			7.358	32.18	8,100	3	10.73		96.62
30.57	1,481,751	1,477,858	0.702	1.096	0.528	16.71	111.54	2,110,294	2,105,461	#N/A	#N/A	#N/A	11.73	108.32	24.69	111.54	108.32			7.358	32.05	8,100	3	10.68		96.59
31.07	1,481,826	1,477,925	0.702	1.096	0.528	16.62	111.44	2,110,319	2,105,484	#N/A	#N/A	#N/A	11.67	108.23	24.56	111.44	108.23			7.358	31.92	8,100	3	10.64		96.57
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54
31.57	1,481,900	1,477,989	0.702	1.096	0.528	16.54	111.34	2,110,344	2,105,507	#N/A	#N/A	#N/A	11.61	108.15	24.44	111.34	108.15			7.358	31.80	8,100	3	10.60		96.54


Shutdown Cooling Temperature Transient with 90F River Water
SDC Hx Fouling = 0.001 hr-F-sqft/Btu, CCW Hx Fouling = 0.004 hr-F-sqft/Btu
Temperature, F
CCW Temperature, F
Time, hours
370
330
290
250
210
170
130
90
50
170
160
150
140
130
120
110
100
90
0
5
10
15
20
25
30
35
Pri Cool Temp
SDC Return Temp
CCW Temp

Shutdown Cooling Temperature Transient with 90F River Water **SDC**

Hx Fouling = 0.00418 hr-F-sqft/Btu, CCW Hx Fouling = 0.004 hr-F-sqft/Btu

	Initial RC Temperature, F					350												SDC HX	CCW HX
	Initial Time					2						2754			Shell Film Multiplier			0.09751	
	RCS Temperature after 8 hours					217.28									Shell Film Re power			0.61709	
	Time after trip to 130F Primary Coolant Temp					#NUM!			Initial CCW to SDCHx			4246			Shell Film Pr power			0.333	
	Time after SDC initiation to 130F PC Temp					#NUM!			CCW Flow Step Temp			275			Fouling (total = tube side)			0.00418	0.004
	Decary heat equilibrium at 90F river temp					74.85												0.00418	0.004
										SDCHx									
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc			Tube					Shell				
hrs	hrs	mmBtu/hr					degF/hr		Q, gpm	Pi	Tt,i	Tt,o		Q, gpm	Pi	Ts,i	Ts,o		
2.00	0.1	54.966	18	1.5	-128.171	-53.70	-48.82		3000	315	350.00	256.85		4246	95	116.79	178.27		
2.10	0.10	54.107	18	1.5	-125.734	-52.13	-47.39		3000	315	345.12	253.90		4246	95	116.33	176.62		
2.20	0.10	53.300	18	1.5	-123.368	-50.57	-45.97		3000	315	340.38	251.04		4246	95	115.88	175.03		
2.30	0.10	52.540	18	1.5	-121.071	-49.03	-44.57		3000	315	335.78	248.25		4246	95	115.45	173.48		
2.40	0.10	51.822	18	1.5	-118.843	-47.52	-43.20		3000	315	331.32	245.55		4246	95	115.03	171.98		
2.50	0.10	51.143	18	1.5	-116.683	-46.04	-41.85		3000	315	327.00	242.92		4246	95	114.62	170.52		
2.60	0.10	50.500	18	1.5	-114.589	-44.59	-40.54		3000	315	322.82	240.37		4246	95	114.22	169.11		
2.70	0.10	49.888	18	1.5	-112.561	-43.17	-39.25		3000	315	318.77	237.89		4246	95	113.84	167.74		
2.80	0.10	49.305	18	1.5	-110.596	-41.79	-37.99		3000	315	314.84	235.49		4246	95	113.46	166.41		
2.90	0.10	48.749	18	1.5	-108.694	-40.44	-36.77		3000	315	311.04	233.16		4246	95	113.10	165.13		
3.00	0.20	48.218	18	1.5	-106.853	-39.13	-35.58		3000	315	307.36	230.91		4246	95	112.75	163.89		
3.20	0.40	47.223	18	1.5	-103.288	-36.57	-33.24		3000	315	300.25	226.53		4246	95	112.07	161.49		
3.60	0.50	45.460	18	1.5	-96.627	-31.67	-28.79		3000	315	286.95	218.31		4246	95	110.79	156.99		
4.10	0.50	43.590	18	1.5	-89.414	-26.32	-23.93		3000	315	272.56	209.36		4246	95	109.40	152.12		
4.60	0.50	41.999	18	1.5	-83.418	-21.92	-19.93		3000	315	260.59	201.87		4246	95	108.24	148.07		
5.10	0.50	40.622	18	1.5	-78.428	-18.31	-16.64		3000	315	250.63	195.61		4246	95	107.27	144.70		
5.60	0.50	39.413	18	1.5	-74.262	-15.35	-13.95		3000	315	242.31	190.35		4246	95	106.46	141.89		
6.10	0.50	38.339	18	1.5	-70.770	-12.93	-11.76		3000	315	235.33	185.93		4246	95	105.78	139.53		
6.60	0.50	37.375	18	1.5	-67.830	-10.95	-9.96		3000	315	229.45	182.20		4246	95	105.20	137.54		
7.10	0.50	36.504	18	1.5	-65.341	-9.34	-8.49		3000	315	224.48	179.03		4246	95	104.71	135.86		
7.60	0.50	35.710	18	1.5	-63.220	-8.01	-7.28		3000	315	220.23	176.32		4246	95	104.29	134.43		
8.10	0.50	34.983	18	1.5	-61.402	-6.92	-6.29		3000	315	216.59	173.99		4246	95	103.94	133.20		
8.60	0.50	34.312	18	1.5	-59.832	-6.02	-5.47		3000	315	213.45	171.98		4246	95	103.63	132.13		
9.10	0.50	33.692	18	1.5	-58.466	-5.27	-4.80		3000	315	210.71	170.22		4246	95	103.36	131.21		
9.60	0.50	33.114	18	1.5	-57.270	-4.66	-4.23		3000	315	208.31	168.68		4246	95	103.12	130.40		
10.10	0.50	32.576	18	1.5	-56.215	-4.14	-3.76		3000	315	206.20	167.32		4246	95	102.91	129.69		
10.60	0.54	32.071	18	1.5	-55.277	-3.71	-3.37		3000	315	204.31	166.11		4246	95	102.73	129.05		
11.14	0.60	31.561	18	1.5	-54.370	-3.31	-3.01		3000	315	202.50	164.94		4246	95	102.55	128.44		
11.74	0.68	31.027	18	1.5	-53.464	-2.94	-2.67		3000	315	200.68	163.77		4246	95	102.37	127.82		
12.42	0.50	30.467	0	1.5	-52.558	-20.59	-18.72		3000	315	198.86	162.60		4246	95	102.19	127.21		
12.92	0.50	30.081	0	1.5	-47.900	-16.32	-14.84		3000	315	189.50	156.55		4246	95	101.26	124.06		
13.42	0.50	29.714	0	1.5	-44.214	-13.00	-11.82		3000	315	182.08	151.73		4246	95	100.53	121.56		
13.92	0.50	29.365	0	1.5	-41.282	-10.42	-9.47		3000	315	176.17	147.89		4246	95	99.94	119.57		
14.42	0.50	29.033	0	1.5	-38.936	-8.40	-7.64		3000	315	171.44	144.80		4246	95	99.47	117.98		
14.92	0.50	28.715	0	1.5	-37.046	-6.83	-6.21		3000	315	167.62	142.30		4246	95	99.09	116.70		
15.42	0.50	28.411	0	1.5	-35.510	-5.60	-5.09		3000	315	164.51	140.26		4246	95	98.78	115.66		
15.92	0.50	28.119	0	1.5	-34.253	-4.63	-4.21		3000	315	161.97	138.59		4246	95	98.53	114.81		
16.42	0.52	27.840	0	1.5	-33.213	-3.87	-3.52		3000	315	159.86	137.21		4246	95	98.32	114.10		
16.94	0.61	27.563	0	1.5	-32.316	-3.25	-2.96		3000	315	158.04	136.01		4246	95	98.14	113.50		
17.56	0.75	27.247	0	1.5	-31.420	-2.67	-2.43		3000	315	156.23	134.82		4246	95	97.96	112.89		
18.30	0.93	26.882	0	1.5	-30.524	-2.14	-1.95		3000	315	154.41	133.62		4246	95	97.77	112.28		
19.24	1.19	26.454	0	1.5	-29.628	-1.67	-1.52		3000	315	152.59	132.42		4246	95	97.59	111.67		
20.43	1.55	25.944	0	1.5	-28.733	-1.29	-1.17		3000	315	150.77	131.22		4246	95	97.41	111.06		
21.98	2.00	25.338	0	1.5	-27.839	-1.00	-0.91		3000	315	148.95	130.02		4246	95	97.23	110.46		
23.98	2.00	24.636	0	1.5	-26.945	-0.81	-0.74		3000	315	147.13	128.82		4246	95	97.05	109.85		
25.98	2.00	24.006	0	1.5	-26.222	-0.72	-0.65		3000	315	145.66	127.84		4246	95	96.90	109.36		
27.98	2.00	23.438	0	1.5	-25.583	-0.65	-0.59		3000	315	144.36	126.98		4246	95	96.77	108.93		
29.98	2.00	22.921	0	1.5	-25.008	-0.59	-0.53		3000	315	143.19	126.21		4246	95	96.66	108.54		
31.98	2.00	22.448	0	1.5	-24.485	-0.54	-0.49		3000	315	142.12	125.50		4246	95	96.55	108.18		
33.98	2.00	22.012	0	1.5	-24.006	-0.49	-0.45		3000	315	141.15	124.85		4246	95	96.45	107.86		
35.98	2.00	21.609	0	1.5	-23.566	-0.46	-0.42		3000	315	140.25	124.26		4246	95	96.37	107.56		
37.98	2.00	21.235	0	1.5	-23.159	-0.42	-0.39		3000	315	139.42	123.71		4246	95	96.28	107.28		

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
2.00	303.42	55.59	1.0287	1.22E-04	0.396	5.609	139,053	1.1405	2297	147.53	61.24	0.9997	2.95E-04	0.378	3.652	163,640	2.8060	1373	9.459	170.31
2.10	299.51	55.76	1.0273	1.24E-04	0.396	5.609	137,300	1.1566	2288	146.48	61.26	0.9996	2.98E-04	0.378	3.652	162,315	2.8318	1369	9.444	170.18
2.20	295.71	55.93	1.0260	1.26E-04	0.396	5.609	135,580	1.1729	2279	145.46	61.28	0.9995	3.00E-04	0.378	3.652	161,030	2.8573	1366	9.429	170.04
2.30	292.02	56.09	1.0248	1.28E-04	0.396	5.609	133,895	1.1893	2269	144.46	61.29	0.9995	3.02E-04	0.377	3.652	159,785	2.8825	1362	9.415	169.90
2.40	288.44	56.25	1.0236	1.30E-04	0.396	5.609	132,246	1.2058	2260	143.50	61.31	0.9994	3.05E-04	0.377	3.652	158,579	2.9073	1359	9.401	169.76
2.50	284.96	56.40	1.0225	1.32E-04	0.396	5.609	130,634	1.2224	2251	142.57	61.33	0.9994	3.07E-04	0.377	3.652	157,412	2.9316	1355	9.387	169.63
2.60	281.59	56.54	1.0215	1.34E-04	0.396	5.609	129,060	1.2390	2241	141.66	61.35	0.9993	3.09E-04	0.377	3.652	156,282	2.9556	1352	9.373	169.50
2.70	278.33	56.68	1.0205	1.35E-04	0.396	5.609	127,524	1.2557	2232	140.79	61.36	0.9993	3.12E-04	0.376	3.652	155,188	2.9791	1349	9.360	169.37
2.80	275.17	56.81	1.0196	1.37E-04	0.396	5.609	126,028	1.2724	2223	139.94	61.38	0.9992	3.14E-04	0.376	3.652	154,131	3.0022	1346	9.348	169.24
2.90	272.10	56.94	1.0187	1.39E-04	0.396	5.609	124,569	1.2891	2213	139.12	61.39	0.9992	3.16E-04	0.376	3.652	153,109	3.0248	1342	9.336	169.11
3.00	269.14	57.06	1.0179	1.41E-04	0.396	5.609	123,150	1.3058	2204	138.32	61.41	0.9991	3.18E-04	0.376	3.652	152,121	3.0470	1340	9.324	168.99
3.20	263.39	57.29	1.0164	1.45E-04	0.396	5.609	120,382	1.3396	2186	136.78	61.43	0.9990	3.22E-04	0.375	3.652	150,211	3.0908	1334	9.301	168.74
3.60	252.63	57.71	1.0137	1.53E-04	0.396	5.609	115,140	1.4086	2150	133.89	61.48	0.9989	3.31E-04	0.374	3.652	146,656	3.1756	1323	9.260	168.25
4.10	240.96	58.15	1.0111	1.62E-04	0.395	5.609	109,380	1.4927	2109	130.76	61.54	0.9987	3.40E-04	0.373	3.652	142,826	3.2719	1311	9.215	167.70
4.60	231.23	58.50	1.0091	1.71E-04	0.394	5.609	104,537	1.5714	2072	128.16	61.58	0.9986	3.48E-04	0.372	3.652	139,659	3.3559	1301	9.178	167.20
5.10	223.12	58.79	1.0076	1.78E-04	0.393	5.609	100,477	1.6438	2040	125.99	61.62	0.9985	3.54E-04	0.372	3.652	137,034	3.4286	1292	9.147	166.77
5.60	216.33	59.02	1.0065	1.85E-04	0.393	5.609	97,071	1.7096	2011	124.17	61.65	0.9984	3.60E-04	0.371	3.652	134,851	3.4914	1285	9.122	166.40
6.10	210.63	59.21	1.0056	1.92E-04	0.392	5.609	94,209	1.7689	1987	122.65	61.67	0.9983	3.65E-04	0.370	3.652	133,028	3.5455	1279	9.100	166.07
6.60	205.83	59.36	1.0049	1.97E-04	0.391	5.609	91,794	1.8221	1966	121.37	61.69	0.9983	3.70E-04	0.370	3.652	131,496	3.5921	1274	9.082	165.79
7.10	201.75	59.49	1.0043	2.02E-04	0.391	5.609	89,747	1.8696	1948	120.29	61.71	0.9982	3.74E-04	0.370	3.652	130,203	3.6325	1270	9.066	165.54
7.60	198.28	59.60	1.0038	2.06E-04	0.390	5.609	88,003	1.9120	1932	119.36	61.72	0.9982	3.77E-04	0.369	3.652	129,103	3.6674	1266	9.053	165.32
8.10	195.29	59.70	1.0034	2.10E-04	0.390	5.609	86,506	1.9498	1918	118.57	61.73	0.9982	3.80E-04	0.369	3.652	128,162	3.6979	1263	9.042	165.14
8.60	192.71	59.78	1.0031	2.14E-04	0.389	5.609	85,214	1.9837	1906	117.88	61.74	0.9981	3.82E-04	0.369	3.652	127,350	3.7245	1260	9.032	164.97
9.10	190.47	59.85	1.0028	2.17E-04	0.389	5.609	84,090	2.0140	1896	117.28	61.75	0.9981	3.84E-04	0.369	3.652	126,645	3.7479	1257	9.023	164.82
9.60	188.50	59.91	1.0026	2.20E-04	0.388	5.609	83,106	2.0413	1886	116.76	61.76	0.9981	3.86E-04	0.368	3.652	126,029	3.7687	1255	9.016	164.70
10.10	186.76	59.96	1.0024	2.22E-04	0.388	5.609	82,238	2.0659	1878	116.30	61.77	0.9981	3.88E-04	0.368	3.652	125,485	3.7871	1253	9.009	164.58
10.60	185.21	60.00	1.0022	2.24E-04	0.388	5.609	81,466	2.0883	1870	115.89	61.78	0.9981	3.90E-04	0.368	3.652	125,003	3.8036	1252	9.003	164.48
11.14	183.72	60.05	1.0020	2.27E-04	0.387	5.609	80,721	2.1103	1863	115.49	61.78	0.9981	3.91E-04	0.368	3.652	124,537	3.8197	1250	8.997	164.37
11.74	182.22	60.09	1.0019	2.29E-04	0.387	5.609	79,977	2.1328	1856	115.10	61.79	0.9980	3.93E-04	0.368	3.652	124,071	3.8359	1248	8.991	164.27
12.42	180.73	60.13	1.0017	2.31E-04	0.387	5.609	79,232	2.1557	1848	114.70	61.79	0.9980	3.94E-04	0.368	3.652	123,606	3.8522	1247	8.985	164.17
12.92	173.02	60.35	1.0009	2.44E-04	0.385	5.609	75,411	2.2811	1810	112.66	61.82	0.9980	4.02E-04	0.367	3.652	121,222	3.9379	1238	8.953	163.62
13.42	166.91	60.52	1.0004	2.55E-04	0.384	5.609	72,396	2.3900	1778	111.04	61.85	0.9979	4.09E-04	0.366	3.652	119,343	4.0080	1232	8.927	163.16
13.92	162.03	60.65	1.0000	2.64E-04	0.383	5.609	70,005	2.4836	1752	109.76	61.86	0.9979	4.14E-04	0.366	3.652	117,854	4.0652	1226	8.907	162.78
14.42	158.12	60.76	0.9996	2.72E-04	0.382	5.609	68,097	2.5633	1731	108.73	61.88	0.9979	4.18E-04	0.365	3.652	116,665	4.1120	1222	8.891	162.47
14.92	154.96	60.84	0.9994	2.79E-04	0.381	5.609	66,563	2.6309	1714	107.90	61.89	0.9978	4.22E-04	0.365	3.652	115,709	4.1504	1218	8.878	162.22
15.42	152.39	60.90	0.9992	2.84E-04	0.380	5.609	65,321	2.6882	1700	107.22	61.90	0.9978	4.25E-04	0.365	3.652	114,934	4.1820	1216	8.868	162.00
15.92	150.28	60.95	0.9991	2.89E-04	0.380	5.609	64,305	2.7367	1688	106.67	61.91	0.9978	4.27E-04	0.364	3.652	114,300	4.2082	1213	8.860	161.83
16.42	148.54	61.00	0.9989	2.93E-04	0.379	5.609	63,466	2.7781	1679	106.21	61.91	0.9978	4.29E-04	0.364	3.652	113,777	4.2300	1211	8.853	161.68
16.94	147.03	61.03	0.9988	2.96E-04	0.379	5.609	62,743	2.8146	1670	105.82	61.92	0.9978	4.31E-04	0.364	3.652	113,326	4.2491	1210	8.847	161.55
17.56	145.52	61.07	0.9987	3.00E-04	0.378	5.609	62,022	2.8520	1662	105.42	61.92	0.9978	4.32E-04	0.364	3.652	112,876	4.2682	1208	8.841	161.42
18.30	144.01	61.10	0.9986	3.04E-04	0.378	5.609	61,302	2.8903	1653	105.03	61.93	0.9978	4.34E-04	0.364	3.652	112,426	4.2875	1206	8.835	161.29
19.24	142.50	61.14	0.9985	3.08E-04	0.377	5.609	60,584	2.9294	1645	104.63	61.94	0.9978	4.36E-04	0.364	3.652	111,977	4.3069	1204	8.829	161.15
20.43	141.00	61.18	0.9985	3.11E-04	0.377	5.609	59,868	2.9695	1636	104.24	61.94	0.9977	4.38E-04	0.363	3.652	111,529	4.3264	1203	8.823	161.02
21.98	139.49	61.21	0.9984	3.15E-04	0.376	5.609	59,153	3.0105	1627	103.84	61.95	0.9977	4.40E-04	0.363	3.652	111,081	4.3461	1201	8.818	160.88
23.98	137.98	61.24	0.9983	3.19E-04	0.376	5.609	58,439	3.0524	1618	103.45	61.95	0.9977	4.41E-04	0.363	3.652	110,634	4.3659	1199	8.812	160.74
25.98	136.75	61.27	0.9982	3.23E-04	0.376	5.609	57,863	3.0871	1611	103.13	61.96	0.9977	4.43E-04	0.363	3.652	110,273	4.3821	1198	8.807	160.63
27.98	135.67	61.30	0.9981	3.26E-04	0.375	5.609	57,354	3.1184	1605	102.85	61.96	0.9977	4.44E-04	0.363	3.652	109,954	4.3964	1197	8.803	160.53
29.98	134.70	61.32	0.9981	3.28E-04	0.375	5.609	56,897	3.1470	1599	102.60	61.96	0.9977	4.45E-04	0.363	3.652	109,667	4.4094	1196	8.800	160.44
31.98	133.81	61.34	0.9980	3.31E-04	0.375	5.609	56,481	3.1734	1594	102.37	61.97	0.9977	4.47E-04	0.363	3.652	109,407	4.4213	1195	8.796	160.35
33.98	133.00	61.35	0.9980	3.33E-04	0.374	5.609	56,102	3.1979	1589	102.16	61.97	0.9977	4.47E-04	0.363	3.652	109,168	4.4322	1194	8.793	160.28
35.98	132.25	61.37	0.9980	3.35E-04	0.374	5.609	55,753	3.2207	1585	101.96	61.97	0.9977	4.48E-04	0.363	3.652	108,949	4.4422	1193	8.791	160.21
37.98	131.56	61.39	0.9979	3.37E-04	0.374	5.609	55,431	3.2421	1581	101.78	61.97	0.9977	4.49E-04	0.362	3.652	108,747	4.4516	1192	8.788	160.14

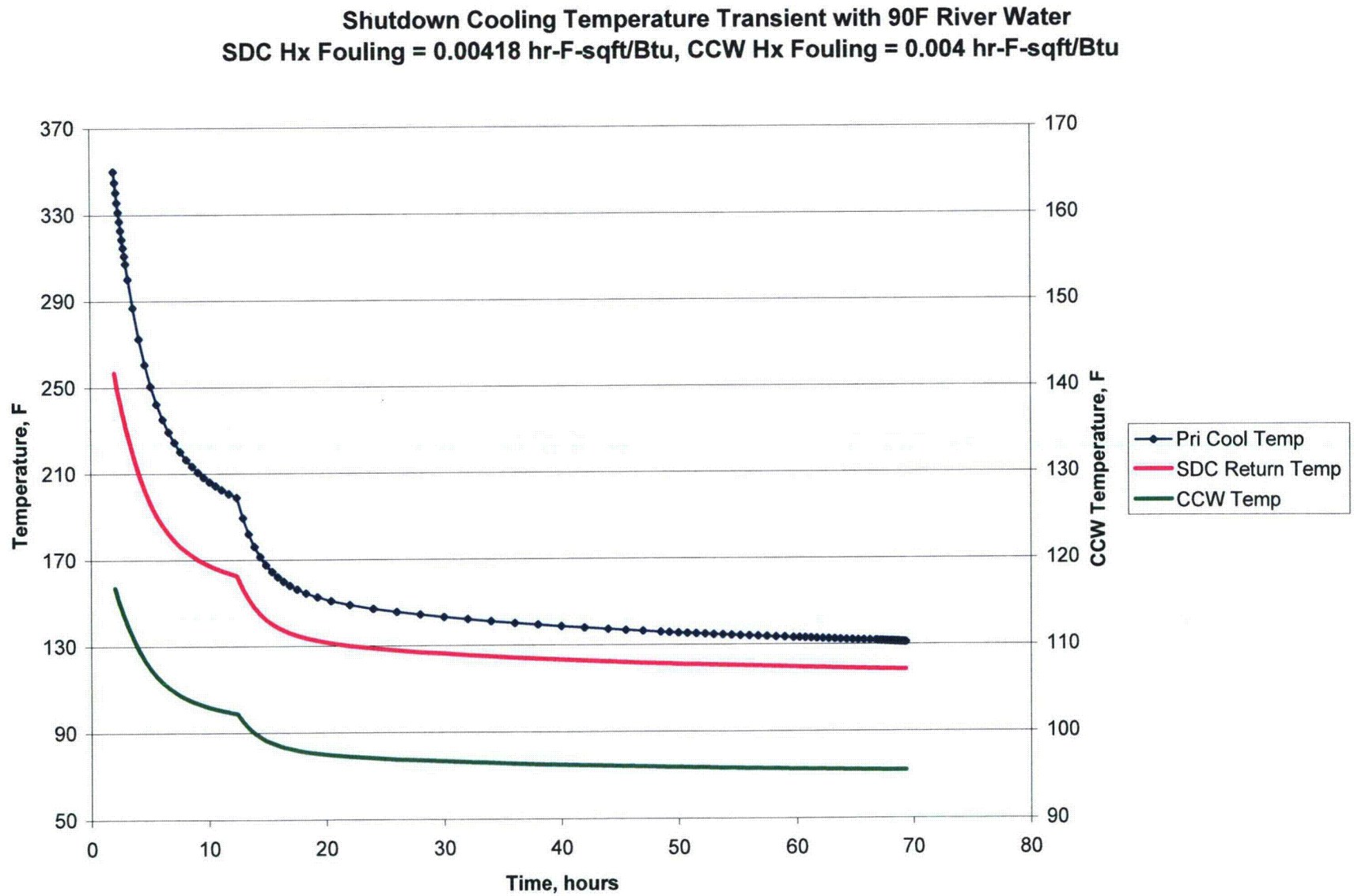
CCW HX Fouling 0.004

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate	Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX	CCW Temp
hrs	W	WCp	Cr	NTU	effectivenes	DT	Tt,o	W	WCp	Cr	NTU	effectivenes	DTs	Ts,o	Btu/hr			mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr	Ts,o
2.00	1,337,560	1,375,913	0.660	0.621	0.399	93.15	256.85	2,085,510	2,084,830	#N/A	#N/A	#N/A	61.48	178.27	128.17	256.85	178.27	7.358	135.53	8,100	3	45.18	116.79
2.10	1,341,802	1,378,432	0.661	0.620	0.399	91.22	253.90	2,086,183	2,085,359	#N/A	#N/A	#N/A	60.29	176.62	125.73	253.90	176.62	7.358	133.09	8,100	3	44.36	116.33
2.20	1,345,872	1,380,865	0.662	0.618	0.398	89.34	251.04	2,086,833	2,085,871	#N/A	#N/A	#N/A	59.14	175.03	123.37	251.04	175.03	7.358	130.73	8,100	3	43.58	115.88
2.30	1,349,776	1,383,217	0.663	0.617	0.397	87.53	248.25	2,087,461	2,086,367	#N/A	#N/A	#N/A	58.03	173.48	121.07	248.25	173.48	7.358	128.43	8,100	3	42.81	115.45
2.40	1,353,519	1,385,488	0.664	0.615	0.397	85.78	245.55	2,088,066	2,086,846	#N/A	#N/A	#N/A	56.95	171.98	118.84	245.55	171.98	7.358	126.20	8,100	3	42.07	115.03
2.50	1,357,108	1,387,681	0.665	0.614	0.396	84.08	242.92	2,088,649	2,087,309	#N/A	#N/A	#N/A	55.90	170.52	116.68	242.92	170.52	7.358	124.04	8,100	3	41.35	114.62
2.60	1,360,549	1,389,798	0.666	0.612	0.395	82.45	240.37	2,089,212	2,087,756	#N/A	#N/A	#N/A	54.89	169.11	114.59	240.37	169.11	7.358	121.95	8,100	3	40.65	114.22
2.70	1,363,849	1,391,843	0.667	0.611	0.395	80.87	237.89	2,089,754	2,088,188	#N/A	#N/A	#N/A	53.90	167.74	112.56	237.89	167.74	7.358	119.92	8,100	3	39.97	113.84
2.80	1,367,013	1,393,816	0.667	0.610	0.394	79.35	235.49	2,090,276	2,088,606	#N/A	#N/A	#N/A	52.95	166.41	110.60	235.49	166.41	7.358	117.95	8,100	3	39.32	113.46
2.90	1,370,046	1,395,720	0.668	0.608	0.393	77.88	233.16	2,090,780	2,089,008	#N/A	#N/A	#N/A	52.03	165.13	108.69	233.16	165.13	7.358	116.05	8,100	3	38.68	113.10
3.00	1,372,954	1,397,558	0.669	0.607	0.393	76.46	230.91	2,091,264	2,089,397	#N/A	#N/A	#N/A	51.14	163.89	106.85	230.91	163.89	7.358	114.21	8,100	3	38.07	112.75
3.20	1,378,508	1,401,102	0.670	0.605	0.392	73.72	226.53	2,092,196	2,090,146	#N/A	#N/A	#N/A	49.42	161.49	103.29	226.53	161.49	7.358	110.65	8,100	3	36.88	112.07
3.60	1,388,622	1,407,677	0.673	0.600	0.390	68.64	218.31	2,093,913	2,091,535	#N/A	#N/A	#N/A	46.20	156.99	96.63	218.31	156.99	7.358	103.98	8,100	3	34.66	110.79
4.10	1,399,188	1,414,729	0.676	0.595	0.387	63.20	209.36	2,095,737	2,093,021	#N/A	#N/A	#N/A	42.72	152.12	89.41	209.36	152.12	7.358	96.77	8,100	3	32.26	109.40
4.60	1,407,669	1,420,539	0.678	0.591	0.385	58.72	201.87	2,097,224	2,094,241	#N/A	#N/A	#N/A	39.83	148.07	83.42	201.87	148.07	7.358	90.78	8,100	3	30.26	108.24
5.10	1,414,522	1,425,337	0.680	0.587	0.384	55.02	195.61	2,098,442	2,095,247	#N/A	#N/A	#N/A	37.43	144.70	78.43	195.61	144.70	7.358	85.79	8,100	3	28.60	107.27
5.60	1,420,099	1,429,315	0.682	0.584	0.382	51.96	190.35	2,099,444	2,096,079	#N/A	#N/A	#N/A	35.43	141.89	74.26	190.35	141.89	7.358	81.62	8,100	3	27.21	106.46
6.10	1,424,672	1,432,627	0.683	0.582	0.381	49.40	185.93	2,100,274	2,096,771	#N/A	#N/A	#N/A	33.75	139.53	70.77	185.93	139.53	7.358	78.13	8,100	3	26.04	105.78
6.60	1,428,450	1,435,400	0.684	0.580	0.380	47.26	182.20	2,100,965	2,097,350	#N/A	#N/A	#N/A	32.34	137.54	67.83	182.20	137.54	7.358	75.19	8,100	3	25.06	105.20
7.10	1,431,598	1,437,734	0.685	0.578	0.379	45.45	179.03	2,101,545	2,097,838	#N/A	#N/A	#N/A	31.15	135.86	65.34	179.03	135.86	7.358	72.70	8,100	3	24.23	104.71
7.60	1,434,241	1,439,712	0.686	0.576	0.379	43.91	176.32	2,102,035	2,098,251	#N/A	#N/A	#N/A	30.13	134.43	63.22	176.32	134.43	7.358	70.58	8,100	3	23.53	104.29
8.10	1,436,481	1,441,401	0.687	0.575	0.378	42.60	173.99	2,102,453	2,098,604	#N/A	#N/A	#N/A	29.26	133.20	61.40	173.99	133.20	7.358	68.76	8,100	3	22.92	103.94
8.60	1,438,393	1,442,852	0.687	0.574	0.378	41.47	171.98	2,102,811	2,098,908	#N/A	#N/A	#N/A	28.51	132.13	59.83	171.98	132.13	7.358	67.19	8,100	3	22.40	103.63
9.10	1,440,041	1,444,109	0.688	0.573	0.377	40.49	170.22	2,103,121	2,099,172	#N/A	#N/A	#N/A	27.85	131.21	58.47	170.22	131.21	7.358	65.82	8,100	3	21.94	103.36
9.60	1,441,472	1,445,206	0.688	0.572	0.377	39.63	168.68	2,103,392	2,099,402	#N/A	#N/A	#N/A	27.28	130.40	57.27	168.68	130.40	7.358	64.63	8,100	3	21.54	103.12
10.10	1,442,725	1,446,171	0.689	0.571	0.376	38.87	167.32	2,103,629	2,099,605	#N/A	#N/A	#N/A	26.77	129.69	56.21	167.32	129.69	7.358	63.57	8,100	3	21.19	102.91
10.60	1,443,832	1,447,026	0.689	0.571	0.376	38.20	166.11	2,103,840	2,099,784	#N/A	#N/A	#N/A	26.32	129.05	55.28	166.11	129.05	7.358	62.63	8,100	3	20.88	102.73
11.14	1,444,894	1,447,849	0.689	0.570	0.376	37.55	164.94	2,104,042	2,099,958	#N/A	#N/A	#N/A	25.89	128.44	54.37	164.94	128.44	7.358	61.73	8,100	3	20.58	102.55
11.74	1,445,949	1,448,670	0.690	0.569	0.375	36.91	163.77	2,104,244	2,100,131	#N/A	#N/A	#N/A	25.46	127.82	53.46	163.77	127.82	7.358	60.82	8,100	3	20.27	102.37
12.42	1,446,997	1,449,488	0.690	0.569	0.375	36.26	162.60	2,104,446	2,100,303	#N/A	#N/A	#N/A	25.02	127.21	52.56	162.60	127.21	7.358	59.92	8,100	3	19.97	102.19
12.92	1,452,282	1,453,649	0.692	0.565	0.373	32.95	156.55	2,105,470	2,101,186	#N/A	#N/A	#N/A	22.80	124.06	47.90	156.55	124.06	7.358	55.26	8,100	3	18.42	101.26
13.42	1,456,334	1,456,884	0.693	0.562	0.372	30.35	151.73	2,106,267	2,101,878	#N/A	#N/A	#N/A	21.04	121.56	44.21	151.73	121.56	7.358	51.57	8,100	3	17.19	100.53
13.92	1,459,474	1,459,415	0.694	0.560	0.371	28.29	147.89	2,106,893	2,102,425	#N/A	#N/A	#N/A	19.64	119.57	41.28	147.89	119.57	7.358	48.64	8,100	3	16.21	99.94
14.42	1,461,931	1,461,412	0.695	0.558	0.370	26.64	144.80	2,107,389	2,102,860	#N/A	#N/A	#N/A	18.52	117.98	38.94	144.80	117.98	7.358	46.29	8,100	3	15.43	99.47
14.92	1,463,876	1,463,001	0.696	0.557	0.370	25.32	142.30	2,107,785	2,103,210	#N/A	#N/A	#N/A	17.61	116.70	37.05	142.30	116.70	7.358	44.40	8,100	3	14.80	99.09
15.42	1,465,430	1,464,278	0.696	0.555	0.369	24.25	140.26	2,108,104	2,103,493	#N/A	#N/A	#N/A	16.88	115.66	35.51	140.26	115.66	7.358	42.87	8,100	3	14.29	98.78
15.92	1,466,688	1,465,314	0.697	0.554	0.368	23.38	138.59	2,108,364	2,103,724	#N/A	#N/A	#N/A	16.28	114.81	34.25	138.59	114.81	7.358	41.61	8,100	3	13.87	98.53
16.42	1,467,716	1,466,164	0.697	0.554	0.368	22.65	137.21	2,108,578	2,103,914	#N/A	#N/A	#N/A	15.79	114.10	33.21	137.21	114.10	7.358	40.57	8,100	3	13.52	98.32
16.94	1,468,594	1,466,893	0.697	0.553	0.368	22.03	136.01	2,108,761	2,104,078	#N/A	#N/A	#N/A	15.36	113.50	32.32	136.01	113.50	7.358	39.67	8,100	3	13.22	98.14
17.56	1,469,465	1,467,616	0.697	0.552	0.367	21.41	134.82	2,108,944	2,104,242	#N/A	#N/A	#N/A	14.93	112.89	31.42	134.82	112.89	7.358	38.78	8,100	3	12.93	97.96
18.30	1,470,327	1,468,333	0.698	0.551	0.367	20.79	133.62	2,109,126	2,104,405	#N/A	#N/A	#N/A	14.50	112.28	30.52	133.62	112.28	7.358	37.88	8,100	3	12.63	97.77
19.24	1,471,181	1,469,046	0.698	0.551	0.367	20.17	132.42	2,109,308	2,104,568	#N/A	#N/A	#N/A	14.08	111.67	29.63	132.42	111.67	7.358	36.99	8,100	3	12.33	97.59
20.43	1,472,026	1,469,752	0.698	0.550	0.366	19.55	131.22	2,109,488	2,104,731	#N/A	#N/A	#N/A	13.65	111.06	28.73	131.22	111.06	7.358	36.09	8,100	3	12.03	97.41
21.98	1,472,862	1,470,453	0.699	0.549	0.366	18.93	130.02	2,109,668	2,104,893	#N/A	#N/A	#N/A	13.23	110.46	27.84	130.02	110.46	7.358	35.20	8,100	3	11.73	97.23
23.98	1,473,690	1,471,149	0.699	0.549	0.366	18.32	128.82	2,109,846	2,105,054	#N/A	#N/A	#N/A	12.80	109.85	26.95	128.82	109.85	7.358	34.30	8,100	3	11.43	97.05
25.98	1,474,354	1,471,707	0.699	0.548	0.365	17.82	127.84	2,109,990	2,105,185	#N/A	#N/A	#N/A	12.46	109.36	26.22	127.84	109.36	7.358	33.58	8,100	3	11.19	96.90
27.98	1,474,936	1,472,198	0.699	0.547	0.365	17.38	126.98	2,110,117	2,105,301	#N/A	#N/A	#N/A	12.15	108.93	25.58	126.98	108.93	7.358	32.94	8,100	3	10.98	96.77
29.98	1,475,456	1,472,638	0.699	0.547	0.365	16.98	126.21	2,110,231	2,105,404	#N/A	#N/A	#N/A	11.88	108.54	25.01	126.21	108.54	7.358	32.37	8,100	3	10.79	96.66
31.98	1,475,926	1,473,035	0.700	0.546	0.365	16.62	125.50	2,110,335	2,105,499	#N/A	#N/A	#N/A	11.63	108.18	24.48	125.50	108.18	7.358	31.84	8,100	3	10.61	96.55
33.98	1,476,354	1,473,397	0.700	0.546	0.365	16.29	124.85	2,110,429	2,105,585	#N/A	#N/A	#N/A	11.40	107.86	24.01	124.85	107.86	7.358	31.36	8,100	3	10.45	96.45
35.98	1,476,745	1,473,729	0.700	0.546	0.364	15.99	124.26	2,110,516	2,105,664	#N/A	#N/A	#N/A	11.19	107.56	23.57	124.26	107.56	7.358	30.92	8,100	3	10.31	96.37
37.98	1,477,105	1,474,034	0.700	0.545	0.364	15.71	123.71	2,110,595	2,105,737	#N/A	#N/A	#N/A	11.00	107.28	23.16	123.71	107.28	7.358	30.52	8,100	3	10.17	96.28

								SDCHx							
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell			
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o
39.98	2.00	20.886	0	1.5	-22.781	-0.40	-0.36	3000	315	138.65	123.19	4246	95	96.21	107.02
41.98	2.00	20.559	0	1.5	-22.429	-0.37	-0.34	3000	315	137.93	122.72	4246	95	96.13	106.79
43.98	1.50	20.252	0	1.5	-22.100	-0.35	-0.32	3000	315	137.25	122.27	4246	95	96.07	106.56
45.48	1.50	20.034	0	1.5	-21.868	-0.33	-0.30	3000	315	136.78	121.95	4246	95	96.02	106.40
46.98	1.50	19.825	0	1.5	-21.645	-0.32	-0.29	3000	315	136.32	121.65	4246	95	95.97	106.25
48.48	0.75	19.625	0	1.5	-21.432	-0.31	-0.28	3000	315	135.89	121.36	4246	95	95.93	106.11
49.23	0.75	19.528	0	1.5	-21.329	-0.30	-0.27	3000	315	135.68	121.22	4246	95	95.91	106.04
49.98	0.75	19.433	0	1.5	-21.229	-0.30	-0.27	3000	315	135.47	121.09	4246	95	95.89	105.97
50.73	0.75	19.339	0	1.5	-21.130	-0.29	-0.26	3000	315	135.27	120.95	4246	95	95.87	105.90
51.48	0.75	19.248	0	1.5	-21.033	-0.29	-0.26	3000	315	135.07	120.82	4246	95	95.85	105.84
52.23	0.75	19.158	0	1.5	-20.938	-0.28	-0.25	3000	315	134.88	120.69	4246	95	95.83	105.77
52.98	0.75	19.070	0	1.5	-20.845	-0.27	-0.25	3000	315	134.69	120.56	4246	95	95.81	105.71
53.73	0.75	18.984	0	1.5	-20.753	-0.27	-0.25	3000	315	134.50	120.44	4246	95	95.79	105.65
54.48	0.75	18.899	0	1.5	-20.664	-0.26	-0.24	3000	315	134.32	120.32	4246	95	95.78	105.59
55.23	0.75	18.816	0	1.5	-20.575	-0.26	-0.24	3000	315	134.14	120.20	4246	95	95.76	105.53
55.98	0.75	18.734	0	1.5	-20.489	-0.26	-0.23	3000	315	133.96	120.08	4246	95	95.74	105.47
56.73	0.75	18.653	0	1.5	-20.404	-0.25	-0.23	3000	315	133.78	119.96	4246	95	95.72	105.41
57.48	0.75	18.574	0	1.5	-20.321	-0.25	-0.22	3000	315	133.61	119.85	4246	95	95.71	105.35
58.23	0.75	18.497	0	1.5	-20.239	-0.24	-0.22	3000	315	133.45	119.74	4246	95	95.69	105.30
58.98	0.75	18.421	0	1.5	-20.159	-0.24	-0.22	3000	315	133.28	119.63	4246	95	95.67	105.24
59.73	0.50	18.345	0	1.5	-20.080	-0.23	-0.21	3000	315	133.12	119.52	4246	95	95.66	105.19
60.23	0.50	18.296	0	1.5	-20.029	-0.23	-0.21	3000	315	133.01	119.45	4246	95	95.65	105.15
60.73	0.50	18.247	0	1.5	-19.978	-0.23	-0.21	3000	315	132.91	119.38	4246	95	95.64	105.12
61.23	0.50	18.199	0	1.5	-19.928	-0.23	-0.21	3000	315	132.80	119.31	4246	95	95.63	105.08
61.73	0.50	18.151	0	1.5	-19.878	-0.23	-0.21	3000	315	132.70	119.24	4246	95	95.62	105.05
62.23	0.50	18.104	0	1.5	-19.829	-0.23	-0.20	3000	315	132.59	119.18	4246	95	95.61	105.02
62.73	0.50	18.057	0	1.5	-19.781	-0.22	-0.20	3000	315	132.49	119.11	4246	95	95.60	104.98
63.23	0.50	18.011	0	1.5	-19.734	-0.22	-0.20	3000	315	132.39	119.05	4246	95	95.59	104.95
63.73	0.50	17.965	0	1.5	-19.688	-0.22	-0.20	3000	315	132.29	118.98	4246	95	95.58	104.92
64.23	0.50	17.920	0	1.5	-19.643	-0.22	-0.20	3000	315	132.19	118.92	4246	95	95.57	104.89
64.73	0.50	17.875	0	1.5	-19.599	-0.22	-0.20	3000	315	132.09	118.86	4246	95	95.56	104.86
65.23	0.50	17.831	0	1.5	-19.556	-0.23	-0.20	3000	315	131.98	118.80	4246	95	95.55	104.83
65.73	0.50	17.787	0	1.5	-19.515	-0.23	-0.21	3000	315	131.88	118.74	4246	95	95.54	104.80
66.23	0.50	17.743	0	1.5	-19.475	-0.23	-0.21	3000	315	131.78	118.69	4246	95	95.53	104.77
66.73	0.20	17.700	0	1.5	-19.438	-0.24	-0.22	3000	315	131.67	118.63	4246	95	95.53	104.74
66.93	0.20	17.683	0	1.5	-19.424	-0.24	-0.22	3000	315	131.63	118.61	4246	95	95.52	104.73
67.13	0.20	17.666	0	1.5	-19.411	-0.24	-0.22	3000	315	131.59	118.59	4246	95	95.52	104.72
67.33	0.20	17.649	0	1.5	-19.398	-0.25	-0.23	3000	315	131.54	118.57	4246	95	95.52	104.71
67.53	0.20	17.632	0	1.5	-19.385	-0.25	-0.23	3000	315	131.50	118.55	4246	95	95.51	104.70
67.73	0.20	17.615	0	1.5	-19.374	-0.26	-0.23	3000	315	131.45	118.53	4246	95	95.51	104.68
67.93	0.10	17.599	0	1.5	-19.363	-0.26	-0.24	3000	315	131.40	118.52	4246	95	95.51	104.67
68.03	0.10	17.590	0	1.5	-19.358	-0.27	-0.24	3000	315	131.38	118.51	4246	95	95.51	104.67
68.13	0.10	17.582	0	1.5	-19.353	-0.27	-0.25	3000	315	131.35	118.50	4246	95	95.51	104.67
68.23	0.10	17.574	0	1.5	-19.348	-0.27	-0.25	3000	315	131.33	118.49	4246	95	95.51	104.66
68.33	0.10	17.565	0	1.5	-19.344	-0.28	-0.25	3000	315	131.31	118.49	4246	95	95.51	104.66
68.43	0.10	17.557	0	1.5	-19.340	-0.28	-0.26	3000	315	131.28	118.48	4246	95	95.51	104.65
68.53	0.10	17.549	0	1.5	-19.336	-0.29	-0.26	3000	315	131.25	118.47	4246	95	95.50	104.65
68.63	0.10	17.540	0	1.5	-19.333	-0.29	-0.27	3000	315	131.23	118.46	4246	95	95.50	104.64
68.73	0.10	17.532	0	1.5	-19.329	-0.30	-0.27	3000	315	131.20	118.46	4246	95	95.50	104.64
68.83	0.10	17.524	0	1.5	-19.326	-0.30	-0.27	3000	315	131.17	118.45	4246	95	95.50	104.63
68.93	0.10	17.516	0	1.5	-19.324	-0.31	-0.28	3000	315	131.15	118.45	4246	95	95.50	104.63
69.03	0.10	17.508	0	1.5	-19.321	-0.31	-0.29	3000	315	131.12	118.44	4246	95	95.50	104.62
69.13	0.10	17.499	0	1.5	-19.319	-0.32	-0.29	3000	315	131.09	118.43	4246	95	95.50	104.62
69.23	0.10	17.491	0	1.5	-19.318	-0.33	-0.30	3000	315	131.06	118.43	4246	95	95.50	104.62
69.33	0.10	17.483	0	1.5	-19.317	-0.33	-0.30	3000	315	131.03	118.43	4246	95	95.50	104.61

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
39.98	130.92	61.40	0.9979	3.39E-04	0.374	5.609	55,132	3.2621	1577	101.62	61.98	0.9977	4.50E-04	0.362	3.652	108,559	4.4603	1191	8.786	160.08
41.98	130.32	61.41	0.9979	3.41E-04	0.374	5.609	54,853	3.2810	1573	101.46	61.98	0.9977	4.51E-04	0.362	3.652	108,384	4.4684	1191	8.784	160.02
43.98	129.76	61.42	0.9978	3.43E-04	0.373	5.609	54,593	3.2988	1570	101.31	61.98	0.9977	4.51E-04	0.362	3.652	108,220	4.4760	1190	8.782	159.97
45.48	129.37	61.43	0.9978	3.44E-04	0.373	5.609	54,410	3.3115	1567	101.21	61.98	0.9977	4.52E-04	0.362	3.652	108,105	4.4814	1190	8.780	159.93
46.98	128.99	61.44	0.9978	3.45E-04	0.373	5.609	54,234	3.3237	1565	101.11	61.98	0.9977	4.52E-04	0.362	3.652	107,994	4.4866	1189	8.779	159.89
48.48	128.62	61.45	0.9978	3.46E-04	0.373	5.609	54,065	3.3355	1563	101.02	61.98	0.9977	4.53E-04	0.362	3.652	107,888	4.4916	1189	8.778	159.86
49.23	128.45	61.45	0.9978	3.47E-04	0.373	5.609	53,985	3.3412	1562	100.97	61.98	0.9977	4.53E-04	0.362	3.652	107,837	4.4940	1189	8.777	159.84
49.98	128.28	61.46	0.9978	3.47E-04	0.373	5.609	53,905	3.3468	1561	100.93	61.98	0.9977	4.53E-04	0.362	3.652	107,787	4.4963	1188	8.776	159.82
50.73	128.11	61.46	0.9977	3.48E-04	0.373	5.609	53,828	3.3523	1560	100.89	61.99	0.9977	4.54E-04	0.362	3.652	107,738	4.4986	1188	8.776	159.80
51.48	127.95	61.46	0.9977	3.48E-04	0.373	5.609	53,751	3.3577	1559	100.84	61.99	0.9977	4.54E-04	0.362	3.652	107,690	4.5009	1188	8.775	159.79
52.23	127.78	61.47	0.9977	3.49E-04	0.373	5.609	53,676	3.3630	1558	100.80	61.99	0.9977	4.54E-04	0.362	3.652	107,643	4.5031	1188	8.775	159.77
52.98	127.62	61.47	0.9977	3.49E-04	0.373	5.609	53,603	3.3683	1557	100.76	61.99	0.9977	4.54E-04	0.362	3.652	107,597	4.5053	1188	8.774	159.76
53.73	127.47	61.47	0.9977	3.50E-04	0.373	5.609	53,531	3.3735	1556	100.72	61.99	0.9977	4.54E-04	0.362	3.652	107,551	4.5075	1188	8.773	159.74
54.48	127.32	61.48	0.9977	3.50E-04	0.373	5.609	53,460	3.3786	1555	100.68	61.99	0.9977	4.55E-04	0.362	3.652	107,507	4.5096	1187	8.773	159.73
55.23	127.17	61.48	0.9977	3.51E-04	0.372	5.609	53,391	3.3836	1554	100.64	61.99	0.9977	4.55E-04	0.362	3.652	107,463	4.5116	1187	8.772	159.71
55.98	127.02	61.48	0.9977	3.51E-04	0.372	5.609	53,322	3.3885	1553	100.60	61.99	0.9977	4.55E-04	0.362	3.652	107,420	4.5137	1187	8.772	159.70
56.73	126.87	61.49	0.9977	3.52E-04	0.372	5.609	53,255	3.3933	1552	100.57	61.99	0.9977	4.55E-04	0.362	3.652	107,378	4.5157	1187	8.771	159.68
57.48	126.73	61.49	0.9977	3.52E-04	0.372	5.609	53,190	3.3981	1552	100.53	61.99	0.9977	4.55E-04	0.362	3.652	107,336	4.5176	1187	8.771	159.67
58.23	126.59	61.49	0.9977	3.53E-04	0.372	5.609	53,125	3.4028	1551	100.49	61.99	0.9977	4.55E-04	0.362	3.652	107,296	4.5196	1187	8.770	159.65
58.98	126.45	61.49	0.9977	3.53E-04	0.372	5.609	53,062	3.4074	1550	100.46	61.99	0.9977	4.56E-04	0.362	3.652	107,256	4.5215	1186	8.770	159.64
59.73	126.32	61.50	0.9977	3.54E-04	0.372	5.609	52,999	3.4120	1549	100.42	61.99	0.9977	4.56E-04	0.362	3.652	107,217	4.5233	1186	8.769	159.63
60.23	126.23	61.50	0.9977	3.54E-04	0.372	5.609	52,958	3.4150	1548	100.40	61.99	0.9977	4.56E-04	0.362	3.652	107,191	4.5246	1186	8.769	159.62
60.73	126.14	61.50	0.9977	3.54E-04	0.372	5.609	52,918	3.4180	1548	100.38	61.99	0.9977	4.56E-04	0.362	3.652	107,165	4.5258	1186	8.769	159.61
61.23	126.05	61.50	0.9976	3.54E-04	0.372	5.609	52,878	3.4210	1547	100.35	61.99	0.9977	4.56E-04	0.362	3.652	107,140	4.5270	1186	8.768	159.60
61.73	125.97	61.50	0.9976	3.55E-04	0.372	5.609	52,838	3.4239	1547	100.33	61.99	0.9977	4.56E-04	0.362	3.652	107,115	4.5282	1186	8.768	159.59
62.23	125.88	61.51	0.9976	3.55E-04	0.372	5.609	52,798	3.4268	1546	100.31	61.99	0.9977	4.56E-04	0.362	3.652	107,091	4.5293	1186	8.768	159.58
62.73	125.80	61.51	0.9976	3.55E-04	0.372	5.609	52,761	3.4295	1546	100.29	61.99	0.9977	4.56E-04	0.362	3.652	107,066	4.5305	1186	8.768	159.58
63.23	125.72	61.51	0.9976	3.56E-04	0.372	5.609	52,723	3.4324	1545	100.27	61.99	0.9977	4.57E-04	0.362	3.652	107,042	4.5317	1186	8.767	159.57
63.73	125.64	61.51	0.9976	3.56E-04	0.372	5.609	52,685	3.4352	1545	100.25	61.99	0.9977	4.57E-04	0.362	3.652	107,018	4.5328	1185	8.767	159.56
64.23	125.55	61.51	0.9976	3.56E-04	0.372	5.609	52,647	3.4380	1544	100.22	61.99	0.9977	4.57E-04	0.362	3.652	106,995	4.5339	1185	8.767	159.55
64.73	125.47	61.51	0.9976	3.56E-04	0.372	5.609	52,610	3.4408	1544	100.20	61.99	0.9977	4.57E-04	0.362	3.652	106,971	4.5351	1185	8.766	159.54
65.23	125.39	61.52	0.9976	3.57E-04	0.372	5.609	52,573	3.4436	1543	100.18	61.99	0.9977	4.57E-04	0.362	3.652	106,948	4.5362	1185	8.766	159.53
65.73	125.31	61.52	0.9976	3.57E-04	0.372	5.609	52,536	3.4463	1543	100.17	61.99	0.9977	4.57E-04	0.362	3.652	106,932	4.5369	1185	8.766	159.53
66.23	125.23	61.52	0.9976	3.57E-04	0.372	5.609	52,499	3.4491	1542	100.15	61.99	0.9977	4.57E-04	0.362	3.652	106,911	4.5379	1185	8.766	159.52
66.73	125.15	61.52	0.9976	3.57E-04	0.372	5.609	52,463	3.4518	1542	100.13	61.99	0.9977	4.57E-04	0.362	3.652	106,891	4.5389	1185	8.765	159.51
66.93	125.12	61.52	0.9976	3.57E-04	0.372	5.609	52,448	3.4529	1542	100.12	61.99	0.9977	4.57E-04	0.362	3.652	106,883	4.5393	1185	8.765	159.51
67.13	125.09	61.52	0.9976	3.58E-04	0.372	5.609	52,434	3.4540	1542	100.12	61.99	0.9977	4.57E-04	0.362	3.652	106,875	4.5397	1185	8.765	159.51
67.33	125.06	61.52	0.9976	3.58E-04	0.372	5.609	52,419	3.4551	1541	100.11	62.00	0.9977	4.57E-04	0.362	3.652	106,868	4.5400	1185	8.765	159.50
67.53	125.02	61.52	0.9976	3.58E-04	0.372	5.609	52,405	3.4562	1541	100.10	62.00	0.9977	4.57E-04	0.362	3.652	106,860	4.5404	1185	8.765	159.50
67.73	124.99	61.53	0.9976	3.58E-04	0.372	5.609	52,390	3.4573	1541	100.10	62.00	0.9977	4.57E-04	0.362	3.652	106,853	4.5407	1185	8.765	159.50
67.93	124.96	61.53	0.9976	3.58E-04	0.372	5.609	52,375	3.4584	1541	100.09	62.00	0.9977	4.57E-04	0.362	3.652	106,846	4.5410	1185	8.765	159.49
68.03	124.94	61.53	0.9976	3.58E-04	0.372	5.609	52,368	3.4590	1541	100.09	62.00	0.9977	4.57E-04	0.362	3.652	106,843	4.5412	1185	8.765	159.49
68.13	124.93	61.53	0.9976	3.58E-04	0.372	5.609	52,360	3.4596	1541	100.09	62.00	0.9977	4.57E-04	0.362	3.652	106,840	4.5414	1185	8.765	159.49
68.23	124.91	61.53	0.9976	3.58E-04	0.372	5.609	52,353	3.4601	1541	100.08	62.00	0.9977	4.57E-04	0.362	3.652	106,837	4.5415	1185	8.764	159.49
68.33	124.90	61.53	0.9976	3.58E-04	0.372	5.609	52,346	3.4607	1540	100.08	62.00	0.9977	4.57E-04	0.362	3.652	106,833	4.5417	1185	8.764	159.49
68.43	124.88	61.53	0.9976	3.58E-04	0.372	5.609	52,338	3.4612	1540	100.08	62.00	0.9977	4.57E-04	0.362	3.652	106,830	4.5418	1185	8.764	159.49
68.53	124.86	61.53	0.9976	3.58E-04	0.372	5.609	52,331	3.4618	1540	100.08	62.00	0.9977	4.58E-04	0.362	3.652	106,827	4.5420	1185	8.764	159.48
68.63	124.85	61.53	0.9976	3.58E-04	0.372	5.609	52,323	3.4624	1540	100.07	62.00	0.9977	4.58E-04	0.362	3.652	106,824	4.5421	1185	8.764	159.48
68.73	124.83	61.53	0.9976	3.58E-04	0.372	5.609	52,316	3.4630	1540	100.07	62.00	0.9977	4.58E-04	0.362	3.652	106,822	4.5422	1185	8.764	159.48
68.83	124.81	61.53	0.9976	3.58E-04	0.372	5.609	52,308	3.4635	1540	100.07	62.00	0.9977	4.58E-04	0.362	3.652	106,819	4.5424	1185	8.764	159.48
68.93	124.80	61.53	0.9976	3.59E-04	0.372	5.609	52,301	3.4641	1540	100.07	62.00	0.9977	4.58E-04	0.362	3.652	106,816	4.5425	1185	8.764	159.48
69.03	124.78	61.53	0.9976	3.59E-04	0.372	5.609	52,293	3.4647	1540	100.06	62.00	0.9977	4.58E-04	0.362	3.652	106,814	4.5426	1185	8.764	159.48
69.13	124.76	61.53	0.9976	3.59E-04	0.372	5.609	52,285	3.4653	1540	100.06	62.00	0.9977	4.58E-04	0.362	3.652	106,811	4.5427	1185	8.764	159.48
69.23	124.75	61.53	0.9976	3.59E-04	0.372	5.609	52,278	3.4659	1540	100.06	62.00	0.9977	4.58E-04	0.362	3.652	106,809	4.5428	1185	8.764	159.47
69.33	124.73	61.53	0.9976	3.59E-04	0.372	5.609	52,270	3.4665	1539	100.06	62.00	0.9977	4.58E-04	0.362	3.652	106,806	4.5430	1185	8.764	159.47

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate		Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX		CCW Temp
hrs	W	WCp	Cr	NTU	effectivenes	DT	Tt,o	W	WCp	Cr	NTU	effectivenes	DTs	Ts,o	Btu/hr				mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr		Ts,o
39.98	1,477,437	1,474,316	0.700	0.545	0.364	15.45	123.19	2,110,669	2,105,805	#N/A	#N/A	#N/A	10.82	107.02	22.78	123.19	107.02		7.358	30.14	8,100	3	10.05		96.21
41.98	1,477,745	1,474,579	0.700	0.545	0.364	15.21	122.72	2,110,738	2,105,868	#N/A	#N/A	#N/A	10.65	106.79	22.43	122.72	106.79		7.358	29.79	8,100	3	9.93		96.13
43.98	1,478,033	1,474,823	0.700	0.544	0.364	14.98	122.27	2,110,803	2,105,927	#N/A	#N/A	#N/A	10.49	106.56	22.10	122.27	106.56		7.358	29.46	8,100	3	9.82		96.07
45.48	1,478,234	1,474,995	0.700	0.544	0.364	14.83	121.95	2,110,848	2,105,969	#N/A	#N/A	#N/A	10.38	106.40	21.87	121.95	106.40		7.358	29.23	8,100	3	9.74		96.02
46.98	1,478,427	1,475,159	0.700	0.544	0.364	14.67	121.65	2,110,891	2,106,009	#N/A	#N/A	#N/A	10.28	106.25	21.65	121.65	106.25		7.358	29.00	8,100	3	9.67		95.97
48.48	1,478,612	1,475,316	0.701	0.544	0.364	14.53	121.36	2,110,933	2,106,047	#N/A	#N/A	#N/A	10.18	106.11	21.43	121.36	106.11		7.358	28.79	8,100	3	9.60		95.93
49.23	1,478,700	1,475,392	0.701	0.544	0.364	14.46	121.22	2,110,953	2,106,065	#N/A	#N/A	#N/A	10.13	106.04	21.33	121.22	106.04		7.358	28.69	8,100	3	9.56		95.91
49.98	1,478,787	1,475,466	0.701	0.544	0.363	14.39	121.09	2,110,972	2,106,083	#N/A	#N/A	#N/A	10.08	105.97	21.23	121.09	105.97		7.358	28.59	8,100	3	9.53		95.89
50.73	1,478,872	1,475,538	0.701	0.544	0.363	14.32	120.95	2,110,991	2,106,101	#N/A	#N/A	#N/A	10.03	105.90	21.13	120.95	105.90		7.358	28.49	8,100	3	9.50		95.87
51.48	1,478,955	1,475,609	0.701	0.544	0.363	14.25	120.82	2,111,010	2,106,118	#N/A	#N/A	#N/A	9.99	105.84	21.03	120.82	105.84		7.358	28.39	8,100	3	9.46		95.85
52.23	1,479,036	1,475,679	0.701	0.544	0.363	14.19	120.69	2,111,029	2,106,135	#N/A	#N/A	#N/A	9.94	105.77	20.94	120.69	105.77		7.358	28.30	8,100	3	9.43		95.83
52.98	1,479,116	1,475,747	0.701	0.543	0.363	14.12	120.56	2,111,047	2,106,152	#N/A	#N/A	#N/A	9.90	105.71	20.84	120.56	105.71		7.358	28.20	8,100	3	9.40		95.81
53.73	1,479,195	1,475,814	0.701	0.543	0.363	14.06	120.44	2,111,065	2,106,168	#N/A	#N/A	#N/A	9.85	105.65	20.75	120.44	105.65		7.358	28.11	8,100	3	9.37		95.79
54.48	1,479,271	1,475,880	0.701	0.543	0.363	14.00	120.32	2,111,082	2,106,184	#N/A	#N/A	#N/A	9.81	105.59	20.66	120.32	105.59		7.358	28.02	8,100	3	9.34		95.77
55.23	1,479,347	1,475,944	0.701	0.543	0.363	13.94	120.20	2,111,099	2,106,200	#N/A	#N/A	#N/A	9.77	105.53	20.58	120.20	105.53		7.358	27.93	8,100	3	9.31		95.76
55.98	1,479,421	1,476,007	0.701	0.543	0.363	13.88	120.08	2,111,116	2,106,216	#N/A	#N/A	#N/A	9.73	105.47	20.49	120.08	105.47		7.358	27.85	8,100	3	9.28		95.74
56.73	1,479,493	1,476,069	0.701	0.543	0.363	13.82	119.96	2,111,132	2,106,231	#N/A	#N/A	#N/A	9.69	105.41	20.40	119.96	105.41		7.358	27.76	8,100	3	9.25		95.72
57.48	1,479,564	1,476,130	0.701	0.543	0.363	13.77	119.85	2,111,148	2,106,246	#N/A	#N/A	#N/A	9.65	105.35	20.32	119.85	105.35		7.358	27.68	8,100	3	9.23		95.71
58.23	1,479,634	1,476,190	0.701	0.543	0.363	13.71	119.74	2,111,164	2,106,260	#N/A	#N/A	#N/A	9.61	105.30	20.24	119.74	105.30		7.358	27.60	8,100	3	9.20		95.69
58.98	1,479,702	1,476,248	0.701	0.543	0.363	13.65	119.63	2,111,180	2,106,275	#N/A	#N/A	#N/A	9.57	105.24	20.16	119.63	105.24		7.358	27.52	8,100	3	9.17		95.67
59.73	1,479,770	1,476,306	0.701	0.543	0.363	13.60	119.52	2,111,195	2,106,289	#N/A	#N/A	#N/A	9.53	105.19	20.08	119.52	105.19		7.358	27.44	8,100	3	9.15		95.66
60.23	1,479,814	1,476,344	0.701	0.543	0.363	13.56	119.45	2,111,205	2,106,298	#N/A	#N/A	#N/A	9.51	105.15	20.03	119.45	105.15		7.358	27.38	8,100	3	9.13		95.65
60.73	1,479,858	1,476,381	0.701	0.543	0.363	13.53	119.38	2,111,215	2,106,307	#N/A	#N/A	#N/A	9.48	105.12	19.97	119.38	105.12		7.358	27.33	8,100	3	9.11		95.63
61.23	1,479,901	1,476,418	0.701	0.543	0.363	13.49	119.31	2,111,225	2,106,316	#N/A	#N/A	#N/A	9.46	105.08	19.92	119.31	105.08		7.358	27.28	8,100	3	9.09		95.62
61.73	1,479,944	1,476,455	0.701	0.543	0.363	13.46	119.24	2,111,235	2,106,325	#N/A	#N/A	#N/A	9.43	105.05	19.87	119.24	105.05		7.358	27.23	8,100	3	9.08		95.61
62.23	1,479,986	1,476,491	0.701	0.543	0.363	13.42	119.17	2,111,244	2,106,334	#N/A	#N/A	#N/A	9.41	105.02	19.82	119.18	105.02		7.358	27.18	8,100	3	9.06		95.60
62.73	1,480,029	1,476,528	0.701	0.543	0.363	13.39	119.10	2,111,254	2,106,343	#N/A	#N/A	#N/A	9.39	104.98	19.77	119.10	104.98		7.358	27.13	8,100	3	9.04		95.59
63.23	1,480,071	1,476,564	0.701	0.542	0.363	13.36	119.03	2,111,263	2,106,352	#N/A	#N/A	#N/A	9.36	104.95	19.72	119.03	104.95		7.358	27.08	8,100	3	9.03		95.58
63.73	1,480,112	1,476,600	0.701	0.542	0.363	13.32	118.97	2,111,272	2,106,360	#N/A	#N/A	#N/A	9.34	104.92	19.67	118.97	104.92		7.358	27.03	8,100	3	9.01		95.57
64.23	1,480,154	1,476,636	0.701	0.542	0.363	13.29	118.90	2,111,282	2,106,369	#N/A	#N/A	#N/A	9.32	104.88	19.62	118.90	104.89		7.358	26.98	8,100	3	8.99		95.56
64.73	1,480,196	1,476,672	0.701	0.542	0.363	13.25	118.83	2,111,291	2,106,377	#N/A	#N/A	#N/A	9.29	104.85	19.57	118.83	104.86		7.358	26.93	8,100	3	8.98		95.55
65.23	1,480,238	1,476,708	0.701	0.542	0.363	13.22	118.76	2,111,300	2,106,386	#N/A	#N/A	#N/A	9.27	104.82	19.52	118.76	104.83		7.358	26.88	8,100	3	8.96		95.54
65.73	1,480,280	1,476,744	0.701	0.542	0.363	13.18	118.70	2,111,306	2,106,391	#N/A	#N/A	#N/A	9.24	104.78	19.47	118.70	104.78		7.358	26.83	8,100	3	8.94		95.53
66.23	1,480,322	1,476,781	0.701	0.542	0.363	13.15	118.63	2,111,314	2,106,399	#N/A	#N/A	#N/A	9.22	104.75	19.42	118.63	104.75		7.358	26.78	8,100	3	8.93		95.52
66.73	1,480,365	1,476,819	0.701	0.542	0.363	13.11	118.56	2,111,322	2,106,406	#N/A	#N/A	#N/A	9.19	104.72	19.37	118.56	104.72		7.358	26.72	8,100	3	8.91		95.51
66.93	1,480,383	1,476,834	0.701	0.542	0.363	13.10	118.53	2,111,325	2,106,409	#N/A	#N/A	#N/A	9.18	104.71	19.34	118.53	104.71		7.358	26.70	8,100	3	8.90		95.51
67.13	1,480,401	1,476,850	0.701	0.542	0.363	13.08	118.50	2,111,328	2,106,412	#N/A	#N/A	#N/A	9.17	104.69	19.32	118.50	104.69		7.358	26.68	8,100	3	8.89		95.50
67.33	1,480,419	1,476,866	0.701	0.542	0.363	13.07	118.47	2,111,331	2,106,414	#N/A	#N/A	#N/A	9.16	104.68	19.30	118.47	104.68		7.358	26.66	8,100	3	8.89		95.50
67.53	1,480,438	1,476,882	0.701	0.542	0.363	13.05	118.44	2,111,334	2,106,417	#N/A	#N/A	#N/A	9.15	104.67	19.28	118.44	104.67		7.358	26.63	8,100	3	8.88		95.49
67.73	1,480,457	1,476,899	0.701	0.542	0.363	13.04	118.41	2,111,337	2,106,420	#N/A	#N/A	#N/A	9.14	104.65	19.25	118.41	104.65		7.358	26.61	8,100	3	8.87		95.49
67.93	1,480,476	1,476,916	0.701	0.542	0.363	13.02	118.38	2,111,339	2,106,422	#N/A	#N/A	#N/A	9.13	104.64	19.23	118.38	104.64		7.358	26.59	8,100	3	8.86		95.48
68.03	1,480,486	1,476,925	0.701	0.542	0.363	13.01	118.37	2,111,341	2,106,423	#N/A	#N/A	#N/A	9.12	104.63	19.22	118.37	104.63		7.358	26.57	8,100	3	8.86		95.48
68.13	1,480,496	1,476,933	0.701	0.542	0.363	13.00	118.35	2,111,342	2,106,425	#N/A	#N/A	#N/A	9.12	104.62	19.20	118.35	104.62		7.358	26.56	8,100	3	8.85		95.48
68.23	1,480,506	1,476,942	0.701	0.542	0.363	12.99	118.34	2,111,343	2,106,426	#N/A	#N/A	#N/A	9.11	104.62	19.19	118.34	104.62		7.358	26.55	8,100	3	8.85		95.47
68.33	1,480,516	1,476,951	0.701	0.542	0.363	12.98	118.32	2,111,344	2,106,427	#N/A	#N/A	#N/A	9.10	104.61	19.18	118.32	104.61		7.358	26.54	8,100	3	8.85		95.47
68.43	1,480,526	1,476,961	0.701	0.542	0.363	12.98	118.30	2,111,346	2,106,428	#N/A	#N/A	#N/A	9.10	104.60	19.16	118.30	104.60		7.358	26.52	8,100	3	8.84		95.47
68.53	1,480,537	1,476,970	0.701	0.542	0.363	12.97	118.29	2,111,347	2,106,429	#N/A	#N/A	#N/A	9.09	104.60	19.15	118.29	104.60		7.358	26.51	8,100	3	8.84		95.47
68.63	1,480,547	1,476,980	0.701	0.542	0.363	12.96	118.27	2,111,348	2,106,430	#N/A	#N/A	#N/A	9.08	104.59	19.14	118.27	104.59		7.358	26.49	8,100	3	8.83		95.46
68.73	1,480,558	1,476,989	0.701	0.542	0.363	12.95	118.25	2,111,349	2,106,431	#N/A	#N/A	#N/A	9.08	104.58	19.12	118.25	104.58		7.358	26.48	8,100	3	8.83		95.46
68.83	1,480,569	1,476,999	0.701	0.542	0.363	12.94	118.24	2,111,350	2,106,432	#N/A	#N/A	#N/A	9.07	104.57	19.11	118.24	104.57		7.358	26.47	8,100	3	8.82		95.46
68.93	1,480,580	1,477,009	0.701	0.542	0.363	12.93	118.22	2,111,351	2,106,433	#N/A	#N/A	#N/A	9.06	104.57	19.09	118.22	104.57		7.358	26.45	8,100	3	8.82		95.46
69.03	1,480,592	1,477,019	0.701	0.542	0.363	12.92	118.20	2,111,352	2,106,434	#N/A	#N/A	#N/A	9.06	104.56	19.08	118.20	104.56		7.358	26.44	8,100	3	8.81		95.45
69.13	1,480,604	1,477,030	0.701	0.542	0.363	12.91	118.18	2,111,353	2,106,435	#N/A	#N/A	#N/A	9.05	104.55	19.06	118.18	104.55		7.358	26.42	8,100	3	8.81		95.45
69.23	1,480,615	1,477,041	0.701	0.542	0.363	12.90	118.16	2,111,354	2,106,436	#N/A	#N/A	#N/A	9.04	104.54	19.05	118.16	104.54		7.358	26.41	8,100	3	8.80		95.45
69.33	1,480,628	1,477,051	0.701	0.542	0.363	12.89	118.15	2,111,355	2,106,437	#N/A	#N/A	#N/A	9.04	104.54	19.03	118.15	104.54		7.358	26.39	8,100	3	8.80		95.44


Shutdown Cooling Temperature Transient with 90F River Water
SDC Hx Fouling = 0.00418 hr-F-sqft/Btu, CCW Hx Fouling = 0.004 hr-F-sqft/Btu
Temperature, F
CCW Temperature, F
Time, hours
370
330
290
250
210
170
130
90
50
170
160
150
140
130
120
110
100
90
0
10
20
30
40
50
60
70
80
Pri Cool Temp
SDC Return Temp
CCW Temp

Shutdown Cooling Temperature Transient with 90F River Water **SDC**

Hx Fouling = 0. hr-F-sqft/Btu, CCW Hx Fouling = 0.004 hr-F-sqft/Btu

	Initial RC Temperature, F				350											SDC HX	CCW HX
	Initial Time				2				2754		Shell Film Multiplier					0.09751	
	RCS Temperature after 8 hours				146.83						Shell Film Re power					0.61709	
	Time after trip to 130F Primary Coolant Temp				18.55		Initial CCW to SDCHx		4246		Shell Film Pr power					0.333	
	Time after SDC initiation to 130F PC Temp				16.5		CCW Flow Step Temp		275		Fouling (total = tube side)					0	0.004
	Decary heat equilibrium at 90F river temp				17.14											0.00418	0.004
								SDCHx									
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell					
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o		
2.00	0.1	54.966	18	1.5	-196.968	-122.50	-111.36	3000	315	350.00	205.68	4246	95	129.46	224.64		
2.10	0.10	54.107	18	1.5	-188.703	-115.10	-104.63	3000	315	338.86	201.29	4246	95	127.96	219.07		
2.20	0.10	53.300	18	1.5	-180.894	-108.09	-98.27	3000	315	328.40	197.12	4246	95	126.55	213.80		
2.30	0.10	52.540	18	1.5	-173.523	-101.48	-92.26	3000	315	318.57	193.18	4246	95	125.20	208.84		
2.40	0.10	51.822	18	1.5	-166.574	-95.25	-86.59	3000	315	309.35	189.44	4246	95	123.93	204.15		
2.50	0.10	51.143	18	1.5	-160.028	-89.38	-81.26	3000	315	300.69	185.90	4246	95	122.72	199.74		
2.60	0.10	50.500	18	1.5	-153.865	-83.87	-76.24	3000	315	292.56	182.56	4246	95	121.58	195.59		
2.70	0.10	49.888	18	1.5	-148.068	-78.68	-71.53	3000	315	284.94	179.41	4246	95	120.51	191.68		
2.80	0.10	49.305	18	1.5	-142.616	-73.81	-67.10	3000	315	277.79	176.43	4246	95	119.49	188.00		
2.90	0.10	48.749	18	1.5	-137.490	-69.24	-62.95	3000	315	271.08	173.62	4246	95	118.54	184.55		
3.00	0.10	48.218	18	1.5	-132.673	-64.96	-59.05	3000	315	264.78	170.97	4246	95	117.63	181.30		
3.10	0.10	47.710	18	1.5	-128.154	-60.94	-55.40	3000	315	258.88	168.46	4246	95	116.79	178.25		
3.20	0.10	47.223	18	1.5	-123.908	-57.19	-51.99	3000	315	253.34	166.10	4246	95	115.99	175.39		
3.30	0.10	46.756	18	1.5	-119.919	-53.66	-48.78	3000	315	248.14	163.87	4246	95	115.23	172.70		
3.40	0.10	46.307	18	1.5	-116.172	-50.36	-45.79	3000	315	243.26	161.77	4246	95	114.52	170.17		
3.50	0.10	45.876	18	1.5	-112.651	-47.28	-42.98	3000	315	238.68	159.80	4246	95	113.85	167.80		
3.60	0.10	45.460	18	1.5	-109.344	-44.38	-40.35	3000	315	234.38	157.94	4246	95	113.22	165.57		
3.70	0.10	45.059	18	1.5	-106.237	-41.68	-37.89	3000	315	230.35	156.18	4246	95	112.63	163.47		
3.80	0.10	44.673	18	1.5	-103.317	-39.14	-35.59	3000	315	226.56	154.53	4246	95	112.07	161.50		
3.90	0.10	44.300	18	1.5	-100.574	-36.77	-33.43	3000	315	223.00	152.97	4246	95	111.55	159.65		
4.00	0.10	43.939	18	1.5	-97.995	-34.56	-31.41	3000	315	219.66	151.50	4246	95	111.05	157.91		
4.10	0.20	43.590	18	1.5	-95.571	-32.48	-29.53	3000	315	216.52	150.12	4246	95	110.59	156.28		
4.30	0.40	42.924	18	1.5	-91.013	-28.59	-25.99	3000	315	210.61	147.51	4246	95	109.71	153.20		
4.70	0.50	41.708	18	1.5	-82.984	-21.78	-19.80	3000	315	200.21	142.88	4246	95	108.16	147.78		
5.20	0.50	40.368	0	1.5	-75.337	-33.47	-30.43	3000	315	190.32	138.43	4246	95	106.67	142.62		
5.70	0.50	39.188	0	1.5	-63.589	-22.90	-20.82	3000	315	175.10	131.52	4246	95	104.37	134.67		
6.20	0.50	38.138	0	1.5	-55.562	-15.92	-14.48	3000	315	164.69	126.73	4246	95	102.78	129.24		
6.70	0.50	37.194	0	1.5	-49.990	-11.30	-10.27	3000	315	157.45	123.37	4246	95	101.68	125.47		
7.20	0.50	36.339	0	1.5	-46.043	-8.20	-7.46	3000	315	152.32	120.97	4246	95	100.89	122.80		
7.70	0.50	35.560	0	1.5	-43.180	-6.12	-5.56	3000	315	148.59	119.22	4246	95	100.32	120.86		
8.20	0.50	34.844	0	1.5	-41.046	-4.70	-4.27	3000	315	145.81	117.91	4246	95	99.89	119.41		
8.70	0.54	34.184	0	1.5	-39.408	-3.72	-3.39	3000	315	143.67	116.90	4246	95	99.56	118.30		
9.24	0.67	33.529	0	1.5	-38.015	-2.99	-2.71	3000	315	141.85	116.04	4246	95	99.28	117.36		
9.91	0.85	32.779	0	1.5	-36.624	-2.34	-2.13	3000	315	140.04	115.18	4246	95	99.00	116.42		
10.76	1.10	31.916	0	1.5	-35.233	-1.82	-1.65	3000	315	138.22	114.32	4246	95	98.72	115.47		
11.86	1.41	30.928	0	1.5	-33.844	-1.42	-1.29	3000	315	136.40	113.45	4246	95	98.44	114.53		
13.27	1.77	29.824	0	1.5	-32.455	-1.13	-1.03	3000	315	134.58	112.59	4246	95	98.16	113.59		
15.04	2.00	28.643	0	1.5	-31.067	-0.92	-0.84	3000	315	132.76	111.72	4246	95	97.88	112.65		
17.04	2.00	27.511	0	1.5	-29.786	-0.77	-0.70	3000	315	131.08	110.91	4246	95	97.63	111.78		
19.04	2.00	26.542	0	1.5	-28.712	-0.67	-0.61	3000	315	129.67	110.24	4246	95	97.41	111.05		
21.04	2.00	25.699	0	1.5	-27.784	-0.59	-0.53	3000	315	128.46	109.65	4246	95	97.22	110.42		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87		

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
2.00	277.84	55.59	1.0204	1.36E-04	0.396	5.609	124,795	1.2583	2195	177.05	60.63	1.0021	2.37E-04	0.386	3.652	201,779	2.2160	1472	9.471	600.55
2.10	270.08	55.99	1.0182	1.41E-04	0.396	5.609	121,360	1.3005	2175	173.52	60.71	1.0018	2.43E-04	0.385	3.652	197,131	2.2748	1461	9.437	596.35
2.20	262.76	56.35	1.0162	1.45E-04	0.396	5.609	118,062	1.3434	2155	170.17	60.78	1.0015	2.49E-04	0.384	3.652	192,755	2.3330	1450	9.404	592.22
2.30	255.87	56.69	1.0145	1.50E-04	0.396	5.609	114,908	1.3869	2135	167.02	60.85	1.0012	2.54E-04	0.383	3.652	188,638	2.3904	1440	9.372	588.18
2.40	249.39	56.99	1.0130	1.55E-04	0.396	5.609	111,900	1.4309	2114	164.04	60.91	1.0009	2.60E-04	0.383	3.652	184,769	2.4468	1430	9.342	584.25
2.50	243.30	57.27	1.0116	1.60E-04	0.395	5.609	109,041	1.4750	2094	161.23	60.97	1.0007	2.65E-04	0.382	3.652	181,136	2.5022	1421	9.314	580.45
2.60	237.56	57.53	1.0104	1.65E-04	0.395	5.609	106,327	1.5193	2075	158.58	61.02	1.0005	2.71E-04	0.381	3.652	177,728	2.5563	1412	9.288	576.78
2.70	232.17	57.77	1.0093	1.70E-04	0.394	5.609	103,758	1.5634	2056	156.09	61.07	1.0003	2.76E-04	0.381	3.652	174,531	2.6092	1403	9.265	573.25
2.80	227.11	57.99	1.0084	1.74E-04	0.394	5.609	101,329	1.6074	2037	153.75	61.12	1.0001	2.81E-04	0.380	3.652	171,534	2.6607	1395	9.243	569.86
2.90	222.35	58.19	1.0075	1.79E-04	0.393	5.609	99,036	1.6510	2019	151.54	61.16	0.9999	2.86E-04	0.379	3.652	168,725	2.7107	1387	9.222	566.60
3.00	217.87	58.38	1.0067	1.84E-04	0.393	5.609	96,873	1.6942	2002	149.47	61.20	0.9998	2.90E-04	0.379	3.652	166,093	2.7592	1380	9.202	563.47
3.10	213.67	58.55	1.0061	1.88E-04	0.392	5.609	94,833	1.7369	1985	147.52	61.24	0.9997	2.95E-04	0.378	3.652	163,631	2.8061	1373	9.184	560.48
3.20	209.72	58.71	1.0054	1.93E-04	0.392	5.609	92,913	1.7789	1969	145.69	61.27	0.9996	2.99E-04	0.378	3.652	161,323	2.8515	1367	9.166	557.62
3.30	206.00	58.86	1.0049	1.97E-04	0.391	5.609	91,105	1.8201	1954	143.97	61.30	0.9994	3.04E-04	0.377	3.652	159,162	2.8953	1360	9.150	554.88
3.40	202.52	58.99	1.0044	2.01E-04	0.391	5.609	89,405	1.8605	1939	142.35	61.33	0.9993	3.08E-04	0.377	3.652	157,136	2.9374	1354	9.135	552.27
3.50	199.24	59.12	1.0039	2.05E-04	0.390	5.609	87,806	1.9001	1925	140.83	61.36	0.9993	3.12E-04	0.376	3.652	155,237	2.9780	1349	9.120	549.79
3.60	196.16	59.23	1.0035	2.09E-04	0.390	5.609	86,303	1.9387	1911	139.40	61.39	0.9992	3.15E-04	0.376	3.652	153,458	3.0171	1344	9.107	547.42
3.70	193.26	59.34	1.0032	2.13E-04	0.389	5.609	84,890	1.9763	1898	138.05	61.41	0.9991	3.19E-04	0.376	3.652	151,790	3.0545	1339	9.094	545.17
3.80	190.54	59.44	1.0028	2.17E-04	0.389	5.609	83,562	2.0129	1886	136.79	61.43	0.9990	3.22E-04	0.375	3.652	150,227	3.0905	1334	9.082	543.02
3.90	187.98	59.53	1.0025	2.20E-04	0.388	5.609	82,314	2.0485	1874	135.60	61.45	0.9990	3.26E-04	0.375	3.652	148,760	3.1249	1329	9.071	540.99
4.00	185.58	59.62	1.0023	2.24E-04	0.388	5.609	81,141	2.0830	1863	134.48	61.47	0.9989	3.29E-04	0.374	3.652	147,385	3.1578	1325	9.060	539.05
4.10	183.32	59.70	1.0020	2.27E-04	0.387	5.609	80,039	2.1163	1852	133.43	61.49	0.9988	3.32E-04	0.374	3.652	146,094	3.1894	1321	9.050	537.21
4.30	179.06	59.85	1.0015	2.34E-04	0.387	5.609	77,966	2.1819	1832	131.46	61.53	0.9987	3.38E-04	0.373	3.652	143,673	3.2502	1314	9.032	533.70
4.70	171.55	60.10	1.0008	2.46E-04	0.385	5.609	74,319	2.3066	1795	127.97	61.58	0.9986	3.48E-04	0.372	3.652	139,430	3.3621	1300	8.998	527.35
5.20	164.37	60.34	1.0002	2.59E-04	0.383	5.609	70,853	2.4378	1759	124.64	61.64	0.9984	3.59E-04	0.371	3.652	135,414	3.4750	1287	8.964	521.06
5.70	153.31	60.68	0.9993	2.82E-04	0.380	5.609	65,549	2.6674	1701	119.52	61.72	0.9982	3.76E-04	0.369	3.652	129,294	3.6613	1267	8.910	510.98
6.20	145.71	60.90	0.9988	3.00E-04	0.378	5.609	61,943	2.8473	1659	116.01	61.77	0.9981	3.89E-04	0.368	3.652	125,150	3.7986	1252	8.875	503.79
6.70	140.41	61.04	0.9984	3.13E-04	0.377	5.609	59,450	2.9853	1629	113.57	61.81	0.9980	3.98E-04	0.367	3.652	122,290	3.8990	1242	8.850	498.64
7.20	136.65	61.15	0.9982	3.23E-04	0.376	5.609	57,690	3.0902	1608	111.85	61.83	0.9979	4.05E-04	0.366	3.652	120,274	3.9729	1235	8.833	494.92
7.70	133.91	61.22	0.9980	3.31E-04	0.375	5.609	56,417	3.1705	1592	110.59	61.85	0.9979	4.10E-04	0.366	3.652	118,817	4.0280	1230	8.821	492.18
8.20	131.86	61.27	0.9979	3.37E-04	0.374	5.609	55,470	3.2328	1580	109.65	61.87	0.9979	4.14E-04	0.366	3.652	117,734	4.0699	1226	8.812	490.11
8.70	130.29	61.31	0.9979	3.41E-04	0.374	5.609	54,744	3.2820	1571	108.93	61.88	0.9979	4.17E-04	0.365	3.652	116,904	4.1025	1223	8.805	488.50
9.24	128.95	61.34	0.9978	3.45E-04	0.373	5.609	54,128	3.3250	1563	108.32	61.88	0.9978	4.20E-04	0.365	3.652	116,199	4.1306	1220	8.800	487.13
9.91	127.61	61.38	0.9977	3.50E-04	0.373	5.609	53,512	3.3688	1555	107.71	61.89	0.9978	4.22E-04	0.365	3.652	115,496	4.1590	1218	8.794	485.75
10.76	126.27	61.41	0.9977	3.54E-04	0.372	5.609	52,898	3.4137	1547	107.10	61.90	0.9978	4.25E-04	0.365	3.652	114,794	4.1877	1215	8.788	484.36
11.86	124.93	61.44	0.9976	3.58E-04	0.372	5.609	52,286	3.4596	1539	106.49	61.91	0.9978	4.28E-04	0.364	3.652	114,094	4.2168	1212	8.783	482.96
13.27	123.58	61.47	0.9975	3.63E-04	0.371	5.609	51,674	3.5065	1531	105.88	61.92	0.9978	4.30E-04	0.364	3.652	113,396	4.2461	1210	8.777	481.56
15.04	122.24	61.50	0.9975	3.67E-04	0.371	5.609	51,064	3.5546	1523	105.27	61.93	0.9978	4.33E-04	0.364	3.652	112,699	4.2758	1207	8.771	480.14
17.04	121.00	61.53	0.9974	3.71E-04	0.370	5.609	50,501	3.6000	1515	104.70	61.93	0.9978	4.36E-04	0.364	3.652	112,056	4.3035	1205	8.766	478.82
19.04	119.96	61.56	0.9974	3.75E-04	0.370	5.609	50,030	3.6388	1509	104.23	61.94	0.9977	4.38E-04	0.363	3.652	111,518	4.3269	1203	8.762	477.71
21.04	119.05	61.58	0.9973	3.78E-04	0.370	5.609	49,623	3.6729	1503	103.82	61.95	0.9977	4.40E-04	0.363	3.652	111,054	4.3473	1201	8.759	476.75
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91

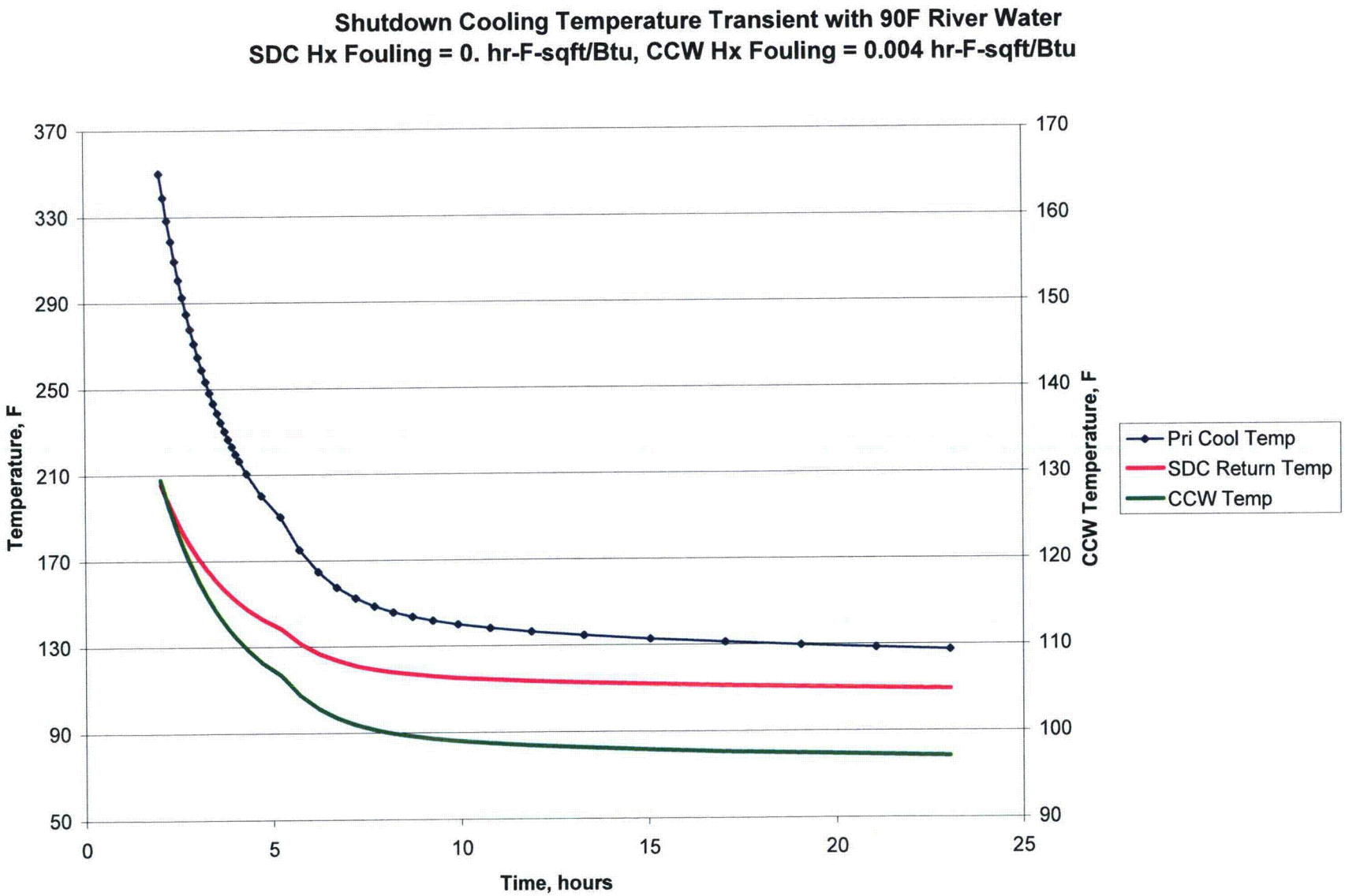
CCW HX Fouling 0.004

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate	Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX	CCW Temp
hrs	W	WCp	Cr	NTU	effectivenes	DT	Tt,o	W	WCp	Cr	NTU	effectivenes	DTs	Ts,o	Btu/hr			mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr	Ts,o
2.00	1,337,560	1,364,823	0.660	2.209	0.654	144.32	205.68	2,064,989	2,069,372	#N/A	#N/A	#N/A	95.18	224.64	196.97	205.68	224.64	7.358	204.33	8,100	3	68.11	129.46
2.10	1,347,164	1,371,652	0.662	2.183	0.652	137.57	201.29	2,067,602	2,071,266	#N/A	#N/A	#N/A	91.11	219.07	188.70	201.29	219.07	7.358	196.06	8,100	3	65.35	127.96
2.20	1,355,952	1,377,956	0.665	2.157	0.650	131.28	197.12	2,070,036	2,073,051	#N/A	#N/A	#N/A	87.26	213.80	180.89	197.12	213.80	7.358	188.25	8,100	3	62.75	126.55
2.30	1,364,004	1,383,782	0.667	2.134	0.648	125.40	193.18	2,072,300	2,074,728	#N/A	#N/A	#N/A	83.64	208.84	173.52	193.18	208.84	7.358	180.88	8,100	3	60.29	125.20
2.40	1,371,389	1,389,173	0.669	2.111	0.647	119.91	189.44	2,074,405	2,076,302	#N/A	#N/A	#N/A	80.23	204.15	166.57	189.44	204.15	7.358	173.93	8,100	3	57.98	123.93
2.50	1,378,168	1,394,166	0.671	2.090	0.645	114.78	185.90	2,076,363	2,077,778	#N/A	#N/A	#N/A	77.02	199.74	160.03	185.90	199.74	7.358	167.39	8,100	3	55.80	122.72
2.60	1,384,396	1,398,794	0.673	2.070	0.643	110.00	182.56	2,078,182	2,079,160	#N/A	#N/A	#N/A	74.00	195.59	153.87	182.56	195.59	7.358	161.22	8,100	3	53.74	121.58
2.70	1,390,124	1,403,086	0.674	2.051	0.642	105.53	179.41	2,079,872	2,080,453	#N/A	#N/A	#N/A	71.17	191.68	148.07	179.41	191.68	7.358	155.43	8,100	3	51.81	120.51
2.80	1,395,397	1,407,070	0.676	2.033	0.640	101.36	176.43	2,081,442	2,081,662	#N/A	#N/A	#N/A	68.51	188.00	142.62	176.43	188.00	7.358	149.97	8,100	3	49.99	119.49
2.90	1,400,254	1,410,770	0.677	2.016	0.639	97.46	173.62	2,082,901	2,082,792	#N/A	#N/A	#N/A	66.01	184.55	137.49	173.62	184.55	7.358	144.85	8,100	3	48.28	118.54
3.00	1,404,732	1,414,207	0.679	2.000	0.638	93.81	170.97	2,084,257	2,083,848	#N/A	#N/A	#N/A	63.67	181.30	132.67	170.97	181.30	7.358	140.03	8,100	3	46.68	117.63
3.10	1,408,864	1,417,401	0.680	1.985	0.636	90.41	168.46	2,085,515	2,084,834	#N/A	#N/A	#N/A	61.47	178.25	128.15	168.46	178.25	7.358	135.51	8,100	3	45.17	116.79
3.20	1,412,680	1,420,371	0.681	1.971	0.635	87.24	166.10	2,086,685	2,085,754	#N/A	#N/A	#N/A	59.41	175.39	123.91	166.10	175.39	7.358	131.27	8,100	3	43.76	115.99
3.30	1,416,207	1,423,134	0.682	1.957	0.634	84.26	163.87	2,087,774	2,086,614	#N/A	#N/A	#N/A	57.47	172.70	119.92	163.87	172.70	7.358	127.28	8,100	3	42.43	115.23
3.40	1,419,470	1,425,705	0.683	1.945	0.633	81.48	161.77	2,088,787	2,087,418	#N/A	#N/A	#N/A	55.65	170.17	116.17	161.77	170.17	7.358	123.53	8,100	3	41.18	114.52
3.50	1,422,490	1,428,099	0.684	1.933	0.632	78.88	159.80	2,089,730	2,088,169	#N/A	#N/A	#N/A	53.95	167.80	112.65	159.80	167.80	7.358	120.01	8,100	3	40.00	113.85
3.60	1,425,287	1,430,328	0.685	1.921	0.631	76.45	157.94	2,090,608	2,088,871	#N/A	#N/A	#N/A	52.35	165.57	109.34	157.94	165.57	7.358	116.70	8,100	3	38.90	113.22
3.70	1,427,881	1,432,405	0.686	1.911	0.630	74.17	156.18	2,091,426	2,089,527	#N/A	#N/A	#N/A	50.84	163.47	106.24	156.18	163.47	7.358	113.59	8,100	3	37.86	112.63
3.80	1,430,287	1,434,341	0.686	1.901	0.629	72.03	154.53	2,092,188	2,090,140	#N/A	#N/A	#N/A	49.43	161.50	103.32	154.53	161.50	7.358	110.68	8,100	3	36.89	112.07
3.90	1,432,521	1,436,146	0.687	1.891	0.628	70.03	152.97	2,092,900	2,090,714	#N/A	#N/A	#N/A	48.10	159.65	100.57	152.97	159.65	7.358	107.93	8,100	3	35.98	111.55
4.00	1,434,596	1,437,830	0.688	1.882	0.628	68.15	151.50	2,093,563	2,091,251	#N/A	#N/A	#N/A	46.86	157.91	98.00	151.50	157.91	7.358	105.35	8,100	3	35.12	111.05
4.10	1,436,526	1,439,401	0.688	1.874	0.627	66.40	150.12	2,094,183	2,091,754	#N/A	#N/A	#N/A	45.69	156.28	95.57	150.12	156.28	7.358	102.93	8,100	3	34.31	110.59
4.30	1,440,100	1,442,326	0.689	1.858	0.625	63.10	147.51	2,095,336	2,092,693	#N/A	#N/A	#N/A	43.49	153.20	91.01	147.51	153.20	7.358	98.37	8,100	3	32.79	109.71
4.70	1,446,217	1,447,375	0.691	1.829	0.623	57.33	142.88	2,097,331	2,094,329	#N/A	#N/A	#N/A	39.62	147.78	82.98	142.88	147.78	7.358	90.34	8,100	3	30.11	108.16
5.20	1,451,829	1,452,057	0.693	1.801	0.620	51.88	138.43	2,099,187	2,095,865	#N/A	#N/A	#N/A	35.95	142.62	75.34	138.43	142.62	7.358	82.69	8,100	3	27.56	106.67
5.70	1,460,034	1,458,984	0.695	1.758	0.616	43.58	131.52	2,101,950	2,098,179	#N/A	#N/A	#N/A	30.31	134.67	63.59	131.52	134.67	7.358	70.95	8,100	3	23.65	104.37
6.20	1,465,341	1,463,515	0.697	1.728	0.613	37.96	126.73	2,103,776	2,099,730	#N/A	#N/A	#N/A	26.46	129.24	55.56	126.73	129.24	7.358	62.92	8,100	3	20.97	102.78
6.70	1,468,877	1,466,557	0.698	1.707	0.611	34.09	123.37	2,105,013	2,100,791	#N/A	#N/A	#N/A	23.80	125.47	49.99	123.37	125.47	7.358	57.35	8,100	3	19.12	101.68
7.20	1,471,306	1,468,656	0.699	1.692	0.610	31.35	120.97	2,105,873	2,101,535	#N/A	#N/A	#N/A	21.91	122.80	46.04	120.97	122.80	7.358	53.40	8,100	3	17.80	100.89
7.70	1,473,027	1,470,149	0.699	1.681	0.608	29.37	119.22	2,106,489	2,102,071	#N/A	#N/A	#N/A	20.54	120.86	43.18	119.22	120.86	7.358	50.54	8,100	3	16.85	100.32
8.20	1,474,287	1,471,246	0.700	1.672	0.608	27.90	117.91	2,106,943	2,102,469	#N/A	#N/A	#N/A	19.52	119.41	41.05	117.91	119.41	7.358	48.40	8,100	3	16.13	99.89
8.70	1,475,242	1,472,078	0.700	1.666	0.607	26.77	116.90	2,107,289	2,102,773	#N/A	#N/A	#N/A	18.74	118.30	39.41	116.90	118.30	7.358	46.77	8,100	3	15.59	99.56
9.24	1,476,044	1,472,778	0.700	1.660	0.606	25.81	116.04	2,107,582	2,103,031	#N/A	#N/A	#N/A	18.08	117.36	38.02	116.04	117.36	7.358	45.37	8,100	3	15.12	99.28
9.91	1,476,837	1,473,471	0.701	1.655	0.606	24.86	115.18	2,107,872	2,103,288	#N/A	#N/A	#N/A	17.41	116.42	36.62	115.18	116.42	7.358	43.98	8,100	3	14.66	99.00
10.76	1,477,620	1,474,158	0.701	1.649	0.605	23.90	114.32	2,108,161	2,103,544	#N/A	#N/A	#N/A	16.75	115.47	35.23	114.32	115.47	7.358	42.59	8,100	3	14.20	98.72
11.86	1,478,395	1,474,838	0.701	1.644	0.605	22.95	113.45	2,108,448	2,103,799	#N/A	#N/A	#N/A	16.09	114.53	33.84	113.45	114.53	7.358	41.20	8,100	3	13.73	98.44
13.27	1,479,160	1,475,511	0.701	1.638	0.604	22.00	112.59	2,108,733	2,104,053	#N/A	#N/A	#N/A	15.42	113.59	32.45	112.59	113.59	7.358	39.81	8,100	3	13.27	98.16
15.04	1,479,916	1,476,176	0.702	1.633	0.603	21.05	111.72	2,109,016	2,104,306	#N/A	#N/A	#N/A	14.76	112.65	31.07	111.72	112.65	7.358	38.43	8,100	3	12.81	97.88
17.04	1,480,607	1,476,786	0.702	1.628	0.603	20.17	110.91	2,109,276	2,104,539	#N/A	#N/A	#N/A	14.15	111.78	29.79	110.91	111.78	7.358	37.14	8,100	3	12.38	97.63
19.04	1,481,179	1,477,291	0.702	1.623	0.602	19.44	110.24	2,109,492	2,104,734	#N/A	#N/A	#N/A	13.64	111.05	28.71	110.24	111.05	7.358	36.07	8,100	3	12.02	97.41
21.04	1,481,669	1,477,725	0.702	1.620	0.602	18.80	109.65	2,109,679	2,104,903	#N/A	#N/A	#N/A	13.20	110.42	27.78	109.65	110.42	7.358	35.14	8,100	3	11.71	97.22
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87	7.358	34.33	8,100	3	11.44	97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87	7.358	34.33	8,100	3	11.44	97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87	7.358	34.33	8,100	3	11.44	97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87	7.358	34.33	8,100	3	11.44	97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87	7.358	34.33	8,100	3	11.44	97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87	7.358	34.33	8,100	3	11.44	97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87	7.358	34.33	8,100	3	11.44	97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87	7.358	34.33	8,100	3	11.44	97.06

								SDCHx							
Time	Step	Q(D)	P(pp)	P(lp)	Psdc	Total Q	dTrc	Tube				Shell			
hrs	hrs	mmBtu/hr					degF/hr	Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87
23.04	0.00	24.956	0	1.5	-26.975	-0.52	-0.47	3000	315	127.39	109.14	4246	95	97.06	109.87

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91
23.04	118.27	61.59	0.9973	3.81E-04	0.369	5.609	49,268	3.7031	1498	103.46	61.95	0.9977	4.41E-04	0.363	3.652	110,649	4.3653	1199	8.755	475.91

Time	SDC HX tube side							SDC HX shell side							SDC Duty	Tt,o Iterate	Ts,o Iterate			Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX		CCW Temp
hrs	W	WCp	Cr	NTU	ffectivenes	DT	Tt,o	W	WCp	Cr	NTU	ffectivenes	DTs	Ts,o	Btu/hr					mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr		Ts,o
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06
23.04	1,482,094	1,478,101	0.702	1.616	0.602	18.25	109.14	2,109,840	2,105,049	#N/A	#N/A	#N/A	12.81	109.87	26.97	109.14	109.87			7.358	34.33	8,100	3	11.44		97.06


Shutdown Cooling Temperature Transient with 90F River Water
SDC Hx Fouling = 0. hr-F-sqft/Btu, CCW Hx Fouling = 0.004 hr-F-sqft/Btu
Temperature, F
370
330
290
250
210
170
130
90
50
CCW Temperature, F
170
160
150
140
130
120
110
100
90
0
5
10
15
20
25
Time, hours
Pri Cool Temp
SDC Return Temp
CCW Temp

Shutdown Cooling Temperature Transient with 90F River Water **SDC**

Hx Fouling = 0.00418 hr-F-sqft/Btu, CCW Hx Fouling = 0.0015 hr-F-sqft/Btu

							SDC HX	CCW HX
Initial RC Temperature, F	350							
Initial Time	2		2754		Shell Film Multiplier		0.09751	
RCS Temperature after 8 hours	180.13				Shell Film Re power		0.61709	
Time after trip to 130F Primary Coolant Temp	14.95	Initial CCW to SDCHx	4246		Shell Film Pr power		0.333	
Time after SDC initiation to 130F PC Temp	13.0	CCW Flow Step Temp	275		Fouling (total = tube side)		0.00418	0.0015
Decary heat equilibrium at 90F river temp	0.00	2 HX Temp	225				0.00418	0.004

Time	Step	Q(D)	P(pp)	Psdc	Total Q	dTrc	No SDC Hx	SDCHx (per exchanger) Tube				Shell			
hrs	hrs	mmBtu/hr				degF/hr		Q, gpm	Pi	Tt,i	Tt,o	Q, gpm	Pi	Ts,i	Ts,o
2.00	0.1	54.966	19.5	-132.55	-58.08	-52.80	1	3000	315	350.00	253.61	4246	95	108.410	171.88
2.10	0.10	54.107	19.5	-129.83	-56.22	-51.11	1	3000	315	344.72	250.50	4246	95	108.08	170.23
2.20	0.10	53.300	19.5	-127.20	-54.40	-49.45	1	3000	315	339.61	247.47	4246	95	107.75	168.63
2.30	0.10	52.540	19.5	-124.65	-52.61	-47.83	1	3000	315	334.66	244.54	4246	95	107.44	167.08
2.40	0.10	51.822	19.5	-122.18	-50.86	-46.24	1	3000	315	329.88	241.70	4246	95	107.13	165.58
2.50	0.10	51.143	19.5	-119.80	-49.15	-44.69	1	3000	315	325.26	238.95	4246	95	106.84	164.13
2.60	0.10	50.500	19.5	-117.49	-47.49	-43.17	1	3000	315	320.79	236.28	4246	95	106.55	162.73
2.70	0.10	49.888	19.5	-115.26	-45.87	-41.70	1	3000	315	316.47	233.69	4246	95	106.27	161.38
2.80	0.10	49.305	19.5	-113.11	-44.30	-40.28	1	3000	315	312.30	231.19	4246	95	106.00	160.07
2.90	0.10	48.749	19.5	-111.03	-42.78	-38.89	1	3000	315	308.27	228.78	4246	95	105.74	158.81
3.00	0.10	48.218	19.5	-109.02	-41.30	-37.55	1	3000	315	304.38	226.43	4246	95	105.49	157.59
3.10	0.10	47.710	19.5	-107.08	-39.87	-36.24	1	3000	315	300.63	224.17	4246	95	105.25	156.41
3.20	0.10	47.223	19.5	-105.20	-38.48	-34.98	1	3000	315	297.01	221.98	4246	95	105.01	155.27
3.30	0.10	46.756	19.5	-103.40	-37.14	-33.76	1	3000	315	293.51	219.86	4246	95	104.78	154.17
3.40	0.10	46.307	19.5	-101.65	-35.84	-32.58	1	3000	315	290.13	217.82	4246	95	104.56	153.11
3.50	0.10	45.876	19.5	-99.97	-34.59	-31.45	1	3000	315	286.87	215.84	4246	95	104.35	152.09
3.60	0.10	45.460	19.5	-98.34	-33.38	-30.35	1	3000	315	283.73	213.93	4246	95	104.15	151.10
3.70	0.10	45.059	19.5	-96.77	-32.21	-29.28	1	3000	315	280.69	212.08	4246	95	103.95	150.14
3.80	0.10	44.673	19.5	-95.26	-31.08	-28.26	1	3000	315	277.77	210.30	4246	95	103.75	149.22
3.90	0.10	44.300	19.5	-93.79	-30.00	-27.27	1	3000	315	274.94	208.57	4246	95	103.57	148.33
4.00	0.10	43.939	19.5	-92.38	-28.95	-26.31	1	3000	315	272.21	206.90	4246	95	103.39	147.48
4.10	0.10	43.590	19.5	-91.02	-27.93	-25.39	1	3000	315	269.58	205.29	4246	95	103.22	146.65
4.20	0.10	43.252	19.5	-89.71	-26.96	-24.51	1	3000	315	267.04	203.74	4246	95	103.05	145.85
4.30	0.10	42.924	19.5	-88.44	-26.02	-23.65	1	3000	315	264.59	202.23	4246	95	102.89	145.08
4.40	0.10	42.606	19.5	-87.22	-25.11	-22.83	1	3000	315	262.23	200.78	4246	95	102.73	144.33
4.50	0.10	42.298	19.5	-86.04	-24.24	-22.04	1	3000	315	259.94	199.38	4246	95	102.58	143.62
4.60	0.10	41.999	19.5	-84.90	-23.40	-21.27	1	3000	315	257.74	198.02	4246	95	102.43	142.92
4.70	0.10	41.708	19.5	-83.80	-22.59	-20.54	1	3000	315	255.61	196.71	4246	95	102.29	142.25
4.80	0.10	41.425	19.5	-82.74	-21.81	-19.83	1	3000	315	253.56	195.44	4246	95	102.15	141.61
4.90	0.10	41.148	19.5	-81.70	-21.06	-19.14	1	3000	315	251.56	194.21	4246	95	102.02	140.98
5.01	0.11	40.869	19.5	-80.67	-20.30	-18.46	1	3000	315	249.56	192.97	4246	95	101.89	140.35
5.11	0.11	40.587	19.5	-79.64	-19.55	-17.77	1	3000	315	247.56	191.73	4246	95	101.75	139.72
5.23	0.12	40.302	19.5	-78.60	-18.80	-17.09	1	3000	315	245.56	190.49	4246	95	101.62	139.09
5.34	0.12	40.015	19.5	-77.57	-18.06	-16.41	1	3000	315	243.56	189.26	4246	95	101.49	138.46
5.47	0.13	39.725	19.5	-76.54	-17.31	-15.74	1	3000	315	241.56	188.01	4246	95	101.35	137.83
5.59	0.13	39.431	19.5	-75.50	-16.57	-15.07	1	3000	315	239.56	186.77	4246	95	101.22	137.20
5.72	0.14	39.133	19.5	-74.47	-15.84	-14.40	1	3000	315	237.56	185.53	4246	95	101.09	136.57
5.86	0.15	38.831	19.5	-73.44	-15.11	-13.73	1	3000	315	235.56	184.29	4246	95	100.95	135.94
6.01	0.15	38.525	19.5	-72.41	-14.38	-13.07	1	3000	315	233.56	183.04	4246	95	100.82	135.32
6.16	0.16	38.213	19.5	-71.37	-13.66	-12.42	1	3000	315	231.56	181.79	4246	95	100.68	134.69
6.32	0.17	37.896	19.5	-70.34	-12.94	-11.77	1	3000	315	229.56	180.55	4246	95	100.55	134.06
6.49	0.18	37.572	19.5	-69.31	-12.24	-11.12	1	3000	315	227.56	179.30	4246	95	100.41	133.43
6.67	0.19	37.242	19.5	-68.28	-11.53	-10.48	1	3000	315	225.56	178.05	4246	95	100.28	132.80
6.86	0.10	36.905	19.5	-53.77	-51.14	-46.49	2	2000	315	223.56	167.43	3254	95	105.31	138.76
6.96	0.10	36.733	19.5	-51.86	-47.48	-43.16	2	2000	315	218.91	164.87	3254	95	104.82	137.08
7.06	0.10	36.564	19.5	-50.08	-44.09	-40.08	2	2000	315	214.59	162.48	3254	95	104.38	135.52
7.16	0.10	36.398	19.5	-48.43	-40.96	-37.23	2	2000	315	210.58	160.26	3254	95	103.96	134.07
7.26	0.10	36.236	19.5	-46.90	-38.06	-34.60	2	2000	315	206.86	158.18	3254	95	103.57	132.72
7.36	0.10	36.076	19.5	-45.47	-35.37	-32.15	2	2000	315	203.40	156.25	3254	95	103.21	131.47
7.46	0.10	35.919	19.5	-44.15	-32.88	-29.89	2	2000	315	200.19	154.46	3254	95	102.87	130.31
7.56	0.10	35.765	1.5	-42.92	-48.58	-44.16	2	2000	315	197.20	152.78	3254	95	102.55	129.22
7.66	0.10	35.614	1.5	-41.11	-45.10	-41.00	2	2000	315	192.78	150.30	3254	95	102.09	127.63

Time	Tube									Shell										
hrs	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	Tt,ave	rho	Cp	mu	k	Vel	Re	Pr	h (Btu/hr-ft2-F)	kmetal	Udirty
2.00	301.81	55.59	1.0281	1.23E-04	0.396	5.609	138,149	1.1470	2291	140.14	61.37	0.9992	3.13E-04	0.376	3.652	154,386	2.9966	1346	9.432	169.81
2.10	297.61	55.78	1.0266	1.25E-04	0.396	5.609	136,269	1.1647	2281	139.15	61.39	0.9992	3.16E-04	0.376	3.652	153,153	3.0238	1343	9.416	169.67
2.20	293.54	55.96	1.0253	1.27E-04	0.396	5.609	134,429	1.1824	2271	138.19	61.41	0.9991	3.19E-04	0.376	3.652	151,961	3.0507	1339	9.400	169.53
2.30	289.60	56.13	1.0240	1.29E-04	0.396	5.609	132,629	1.2003	2261	137.26	61.42	0.9990	3.21E-04	0.375	3.652	150,808	3.0770	1336	9.385	169.38
2.40	285.79	56.30	1.0228	1.31E-04	0.396	5.609	130,871	1.2184	2251	136.36	61.44	0.9990	3.24E-04	0.375	3.652	149,694	3.1029	1332	9.370	169.24
2.50	282.10	56.46	1.0217	1.33E-04	0.396	5.609	129,157	1.2365	2241	135.49	61.46	0.9989	3.26E-04	0.375	3.652	148,618	3.1283	1329	9.356	169.10
2.60	278.53	56.61	1.0206	1.35E-04	0.396	5.609	127,486	1.2547	2231	134.64	61.47	0.9989	3.28E-04	0.374	3.652	147,579	3.1532	1326	9.342	168.96
2.70	275.08	56.76	1.0196	1.37E-04	0.396	5.609	125,859	1.2729	2221	133.83	61.48	0.9989	3.31E-04	0.374	3.652	146,576	3.1775	1323	9.328	168.83
2.80	271.75	56.90	1.0186	1.40E-04	0.396	5.609	124,277	1.2911	2211	133.04	61.50	0.9988	3.33E-04	0.374	3.652	145,609	3.2014	1320	9.315	168.69
2.90	268.52	57.03	1.0178	1.42E-04	0.396	5.609	122,739	1.3093	2201	132.28	61.51	0.9988	3.35E-04	0.374	3.652	144,675	3.2247	1317	9.303	168.56
3.00	265.41	57.16	1.0169	1.44E-04	0.396	5.609	121,245	1.3275	2191	131.54	61.52	0.9987	3.37E-04	0.373	3.652	143,775	3.2476	1314	9.291	168.43
3.10	262.40	57.28	1.0161	1.46E-04	0.396	5.609	119,795	1.3456	2182	130.83	61.54	0.9987	3.39E-04	0.373	3.652	142,906	3.2699	1311	9.280	168.31
3.20	259.49	57.39	1.0154	1.48E-04	0.396	5.609	118,389	1.3637	2172	130.14	61.55	0.9987	3.42E-04	0.373	3.652	142,069	3.2916	1308	9.269	168.18
3.30	256.69	57.50	1.0147	1.50E-04	0.396	5.609	117,025	1.3817	2163	129.48	61.56	0.9986	3.44E-04	0.373	3.652	141,262	3.3129	1306	9.258	168.06
3.40	253.97	57.61	1.0140	1.52E-04	0.396	5.609	115,703	1.3995	2154	128.84	61.57	0.9986	3.46E-04	0.373	3.652	140,483	3.3337	1303	9.248	167.94
3.50	251.36	57.71	1.0134	1.54E-04	0.396	5.609	114,422	1.4172	2145	128.22	61.58	0.9986	3.47E-04	0.372	3.652	139,732	3.3539	1301	9.239	167.82
3.60	248.83	57.81	1.0128	1.56E-04	0.396	5.609	113,182	1.4348	2136	127.62	61.59	0.9986	3.49E-04	0.372	3.652	139,009	3.3736	1299	9.229	167.71
3.70	246.39	57.90	1.0123	1.58E-04	0.395	5.609	111,982	1.4523	2127	127.04	61.60	0.9985	3.51E-04	0.372	3.652	138,311	3.3929	1296	9.220	167.60
3.80	244.03	57.99	1.0118	1.59E-04	0.395	5.609	110,820	1.4696	2119	126.49	61.61	0.9985	3.53E-04	0.372	3.652	137,638	3.4116	1294	9.212	167.49
3.90	241.75	58.08	1.0113	1.61E-04	0.395	5.609	109,695	1.4867	2111	125.95	61.62	0.9985	3.55E-04	0.372	3.652	136,990	3.4298	1292	9.203	167.38
4.00	239.56	58.16	1.0108	1.63E-04	0.395	5.609	108,608	1.5036	2102	125.43	61.63	0.9985	3.56E-04	0.371	3.652	136,365	3.4476	1290	9.195	167.28
4.10	237.44	58.24	1.0104	1.65E-04	0.395	5.609	107,556	1.5203	2095	124.93	61.63	0.9984	3.58E-04	0.371	3.652	135,762	3.4649	1288	9.187	167.17
4.20	235.39	58.31	1.0100	1.67E-04	0.395	5.609	106,539	1.5368	2087	124.45	61.64	0.9984	3.59E-04	0.371	3.652	135,181	3.4817	1286	9.180	167.07
4.30	233.41	58.38	1.0096	1.69E-04	0.394	5.609	105,556	1.5531	2079	123.98	61.65	0.9984	3.61E-04	0.371	3.652	134,620	3.4981	1284	9.172	166.98
4.40	231.50	58.45	1.0092	1.70E-04	0.394	5.609	104,605	1.5691	2072	123.53	61.66	0.9984	3.63E-04	0.371	3.652	134,080	3.5140	1283	9.165	166.88
4.50	229.66	58.52	1.0088	1.72E-04	0.394	5.609	103,686	1.5850	2065	123.10	61.66	0.9984	3.64E-04	0.371	3.652	133,559	3.5295	1281	9.158	166.79
4.60	227.88	58.58	1.0085	1.74E-04	0.394	5.609	102,797	1.6006	2058	122.68	61.67	0.9983	3.65E-04	0.370	3.652	133,056	3.5446	1279	9.152	166.70
4.70	226.16	58.64	1.0082	1.75E-04	0.394	5.609	101,939	1.6159	2051	122.27	61.68	0.9983	3.67E-04	0.370	3.652	132,572	3.5592	1278	9.145	166.61
4.80	224.50	58.70	1.0079	1.77E-04	0.394	5.609	101,109	1.6310	2044	121.88	61.68	0.9983	3.68E-04	0.370	3.652	132,104	3.5735	1276	9.139	166.52
4.90	222.88	58.76	1.0076	1.79E-04	0.393	5.609	100,300	1.6460	2038	121.50	61.69	0.9983	3.69E-04	0.370	3.652	131,649	3.5874	1274	9.133	166.44
5.01	221.26	58.82	1.0073	1.80E-04	0.393	5.609	99,490	1.6613	2031	121.12	61.69	0.9983	3.71E-04	0.370	3.652	131,194	3.6015	1273	9.127	166.35
5.11	219.65	58.87	1.0070	1.82E-04	0.393	5.609	98,680	1.6769	2024	120.74	61.70	0.9983	3.72E-04	0.370	3.652	130,740	3.6156	1271	9.121	166.26
5.23	218.03	58.93	1.0068	1.83E-04	0.393	5.609	97,868	1.6927	2018	120.36	61.71	0.9982	3.73E-04	0.370	3.652	130,286	3.6299	1270	9.115	166.18
5.34	216.41	58.98	1.0065	1.85E-04	0.393	5.609	97,057	1.7089	2011	119.97	61.71	0.9982	3.75E-04	0.370	3.652	129,833	3.6442	1268	9.109	166.09
5.47	214.79	59.04	1.0062	1.87E-04	0.392	5.609	96,244	1.7253	2004	119.59	61.72	0.9982	3.76E-04	0.369	3.652	129,380	3.6586	1267	9.103	166.00
5.59	213.16	59.09	1.0060	1.89E-04	0.392	5.609	95,432	1.7421	1997	119.21	61.72	0.9982	3.77E-04	0.369	3.652	128,927	3.6731	1265	9.097	165.91
5.72	211.54	59.15	1.0057	1.90E-04	0.392	5.609	94,618	1.7592	1990	118.83	61.73	0.9982	3.79E-04	0.369	3.652	128,474	3.6877	1264	9.091	165.82
5.86	209.92	59.20	1.0055	1.92E-04	0.392	5.609	93,805	1.7766	1983	118.45	61.74	0.9982	3.80E-04	0.369	3.652	128,022	3.7024	1262	9.085	165.73
6.01	208.30	59.25	1.0052	1.94E-04	0.392	5.609	92,991	1.7944	1976	118.07	61.74	0.9982	3.82E-04	0.369	3.652	127,571	3.7172	1261	9.079	165.64
6.16	206.68	59.31	1.0050	1.96E-04	0.391	5.609	92,176	1.8125	1969	117.68	61.75	0.9981	3.83E-04	0.369	3.652	127,120	3.7322	1259	9.073	165.54
6.32	205.05	59.36	1.0048	1.98E-04	0.391	5.609	91,362	1.8310	1962	117.30	61.75	0.9981	3.84E-04	0.369	3.652	126,669	3.7472	1258	9.067	165.45
6.49	203.43	59.41	1.0045	2.00E-04	0.391	5.609	90,547	1.8498	1955	116.92	61.76	0.9981	3.86E-04	0.368	3.652	126,219	3.7623	1256	9.061	165.35
6.67	201.80	59.47	1.0043	2.02E-04	0.391	5.609	89,732	1.8690	1947	116.54	61.77	0.9981	3.87E-04	0.368	3.652	125,769	3.7775	1254	9.055	165.26
6.86	195.50	59.52	1.0035	2.10E-04	0.390	3.739	57,572	1.9472	1384	122.04	61.68	0.9983	3.68E-04	0.370	2.799	101,382	3.5679	1083	9.053	155.83
6.96	191.89	59.64	1.0030	2.15E-04	0.389	3.739	56,380	1.9947	1372	120.95	61.70	0.9983	3.71E-04	0.370	2.799	100,393	3.6076	1080	9.039	155.56
7.06	188.54	59.75	1.0026	2.20E-04	0.388	3.739	55,273	2.0407	1361	119.95	61.71	0.9982	3.75E-04	0.370	2.799	99,476	3.6451	1076	9.025	155.30
7.16	185.42	59.85	1.0022	2.24E-04	0.388	3.739	54,245	2.0853	1350	119.01	61.73	0.9982	3.78E-04	0.369	2.799	98,626	3.6806	1073	9.013	155.05
7.26	182.52	59.94	1.0019	2.29E-04	0.387	3.739	53,291	2.1283	1340	118.15	61.74	0.9982	3.81E-04	0.369	2.799	97,838	3.7142	1070	9.002	154.82
7.36	179.83	60.03	1.0016	2.33E-04	0.387	3.739	52,404	2.1698	1331	117.34	61.75	0.9981	3.84E-04	0.369	2.799	97,107	3.7458	1067	8.991	154.60
7.46	177.32	60.10	1.0014	2.37E-04	0.386	3.739	51,582	2.2096	1322	116.59	61.76	0.9981	3.87E-04	0.368	2.799	96,428	3.7756	1065	8.980	154.40
7.56	174.99	60.17	1.0011	2.41E-04	0.386	3.739	50,817	2.2479	1313	115.89	61.78	0.9981	3.90E-04	0.368	2.799	95,798	3.8036	1062	8.970	154.20
7.66	171.54	60.28	1.0008	2.46E-04	0.385	3.739	49,689	2.3067	1301	114.86	61.79	0.9980	3.94E-04	0.368	2.799	94,869	3.8457	1059	8.955	153.90

CCW HX Fouling 0.0015

Time	SDC HX tube side							SDC HX shell side							SDC Duty (per Hx)	Tt,o Iterate	Ts,o Iterate	Qccw, other	CCW Duty	Total CCW Flow	# CCW Hx	CCW Duty per HX		CCW Temp
hrs	W	WCp	Cr	NTU	effectivenes	DT	Tt,o	W	WCp	Cr	NTU	effectivenes	DTs	Ts,o	Btu/hr			mmBtu/hr	mmBtu/hr	gpm		mmBtu/hr		Ts,o
2.00	1,337,560	1,375,146	0.658	0.620	0.399	96.39	253.61	########	2,088,505	#N/A	#N/A	#N/A	63.47	171.88	132.55	253.61	171.88	7.358	139.91	8,100	3	46.64	12	108.41
2.10	1,342,146	1,377,907	0.660	0.618	0.398	94.22	250.50	########	2,088,991	#N/A	#N/A	#N/A	62.15	170.23	129.83	250.50	170.23	7.358	137.19	8,100	3	45.73	13	108.08
2.20	1,346,529	1,380,565	0.661	0.616	0.397	92.13	247.47	########	2,089,460	#N/A	#N/A	#N/A	60.88	168.63	127.20	247.47	168.63	7.358	134.56	8,100	3	44.85	14	107.75
2.30	1,350,719	1,383,126	0.662	0.615	0.397	90.12	244.54	########	2,089,913	#N/A	#N/A	#N/A	59.64	167.08	124.65	244.54	167.08	7.358	132.01	8,100	3	44.00	15	107.44
2.40	1,354,723	1,385,591	0.663	0.613	0.396	88.18	241.70	########	2,090,349	#N/A	#N/A	#N/A	58.45	165.58	122.18	241.70	165.58	7.358	129.54	8,100	3	43.18	16	107.13
2.50	1,358,549	1,387,963	0.664	0.612	0.395	86.31	238.95	########	2,090,770	#N/A	#N/A	#N/A	57.30	164.13	119.80	238.95	164.13	7.358	127.16	8,100	3	42.39	17	106.84
2.60	1,362,206	1,390,248	0.665	0.610	0.394	84.51	236.28	########	2,091,175	#N/A	#N/A	#N/A	56.18	162.73	117.49	236.28	162.73	7.358	124.85	8,100	3	41.62	18	106.55
2.70	1,365,702	1,392,447	0.666	0.609	0.394	82.78	233.69	########	2,091,566	#N/A	#N/A	#N/A	55.11	161.38	115.26	233.69	161.38	7.358	122.62	8,100	3	40.87	19	106.27
2.80	1,369,044	1,394,563	0.667	0.607	0.393	81.11	231.19	########	2,091,942	#N/A	#N/A	#N/A	54.07	160.07	113.11	231.19	160.07	7.358	120.47	8,100	3	40.16	20	106.00
2.90	1,372,238	1,396,601	0.667	0.606	0.393	79.50	228.78	########	2,092,305	#N/A	#N/A	#N/A	53.06	158.81	111.03	228.78	158.81	7.358	118.38	8,100	3	39.46	21	105.74
3.00	1,375,292	1,398,562	0.668	0.605	0.392	77.95	226.43	########	2,092,654	#N/A	#N/A	#N/A	52.10	157.59	109.02	226.43	157.59	7.358	116.38	8,100	3	38.79	22	105.49
3.10	1,378,213	1,400,450	0.669	0.603	0.391	76.46	224.17	########	2,092,990	#N/A	#N/A	#N/A	51.16	156.41	107.08	224.17	156.41	7.358	114.44	8,100	3	38.15	23	105.25
3.20	1,381,007	1,402,267	0.670	0.602	0.391	75.02	221.98	########	2,093,313	#N/A	#N/A	#N/A	50.26	155.27	105.20	221.98	155.27	7.358	112.56	8,100	3	37.52	24	105.01
3.30	1,383,679	1,404,016	0.671	0.601	0.390	73.64	219.86	########	2,093,625	#N/A	#N/A	#N/A	49.39	154.17	103.40	219.86	154.17	7.358	110.75	8,100	3	36.92	25	104.78
3.40	1,386,235	1,405,700	0.671	0.600	0.390	72.31	217.82	########	2,093,924	#N/A	#N/A	#N/A	48.55	153.11	101.65	217.82	153.11	7.358	109.01	8,100	3	36.34	26	104.56
3.50	1,388,682	1,407,322	0.672	0.599	0.389	71.03	215.84	########	2,094,213	#N/A	#N/A	#N/A	47.73	152.09	99.97	215.84	152.09	7.358	107.32	8,100	3	35.77	27	104.35
3.60	1,391,024	1,408,883	0.673	0.598	0.389	69.80	213.93	########	2,094,491	#N/A	#N/A	#N/A	46.95	151.10	98.34	213.93	151.10	7.358	105.70	8,100	3	35.23	28	104.15
3.70	1,393,265	1,410,386	0.673	0.597	0.388	68.61	212.08	########	2,094,758	#N/A	#N/A	#N/A	46.20	150.14	96.77	212.08	150.14	7.358	104.13	8,100	3	34.71	29	103.95
3.80	1,395,412	1,411,833	0.674	0.596	0.388	67.47	210.30	########	2,095,016	#N/A	#N/A	#N/A	45.47	149.22	95.26	210.30	149.22	7.358	102.61	8,100	3	34.20	30	103.75
3.90	1,397,468	1,413,227	0.674	0.595	0.387	66.37	208.57	########	2,095,264	#N/A	#N/A	#N/A	44.77	148.33	93.79	208.57	148.33	7.358	101.15	8,100	3	33.72	31	103.57
4.00	1,399,437	1,414,569	0.675	0.594	0.387	65.31	206.90	########	2,095,502	#N/A	#N/A	#N/A	44.09	147.48	92.38	206.90	147.48	7.358	99.74	8,100	3	33.25	32	103.39
4.10	1,401,324	1,415,861	0.676	0.593	0.386	64.29	205.29	########	2,095,732	#N/A	#N/A	#N/A	43.43	146.65	91.02	205.29	146.65	7.358	98.38	8,100	3	32.79	33	103.22
4.20	1,403,133	1,417,106	0.676	0.592	0.386	63.31	203.74	########	2,095,953	#N/A	#N/A	#N/A	42.80	145.85	89.71	203.74	145.85	7.358	97.07	8,100	3	32.36	34	103.05
4.30	1,404,866	1,418,305	0.677	0.591	0.386	62.36	202.23	########	2,096,166	#N/A	#N/A	#N/A	42.19	145.08	88.44	202.23	145.08	7.358	95.80	8,100	3	31.93	35	102.89
4.40	1,406,529	1,419,461	0.677	0.590	0.385	61.45	200.78	########	2,096,372	#N/A	#N/A	#N/A	41.61	144.33	87.22	200.78	144.33	7.358	94.58	8,100	3	31.53	36	102.73
4.50	1,408,123	1,420,574	0.678	0.589	0.385	60.57	199.38	########	2,096,569	#N/A	#N/A	#N/A	41.04	143.62	86.04	199.38	143.62	7.358	93.40	8,100	3	31.13	37	102.58
4.60	1,409,652	1,421,646	0.678	0.589	0.385	59.72	198.02	########	2,096,760	#N/A	#N/A	#N/A	40.49	142.92	84.90	198.02	142.92	7.358	92.26	8,100	3	30.75	38	102.43
4.70	1,411,120	1,422,680	0.678	0.588	0.384	58.90	196.71	########	2,096,943	#N/A	#N/A	#N/A	39.96	142.25	83.80	196.71	142.25	7.358	91.16	8,100	3	30.39	39	102.29
4.80	1,412,529	1,423,676	0.679	0.587	0.384	58.12	195.44	########	2,097,120	#N/A	#N/A	#N/A	39.45	141.61	82.74	195.44	141.61	7.358	90.10	8,100	3	30.03	40	102.15
4.90	1,413,893	1,424,644	0.679	0.586	0.384	57.35	194.21	########	2,097,292	#N/A	#N/A	#N/A	38.96	140.98	81.70	194.21	140.98	7.358	89.06	8,100	3	29.69	41	102.02
5.01	1,415,249	1,425,610	0.680	0.586	0.383	56.59	192.97	########	2,097,464	#N/A	#N/A	#N/A	38.46	140.35	80.67	192.97	140.35	7.358	88.03	8,100	3	29.34	42	101.89
5.11	1,416,597	1,426,575	0.680	0.585	0.383	55.82	191.73	########	2,097,635	#N/A	#N/A	#N/A	37.97	139.72	79.64	191.73	139.72	7.358	87.00	8,100	3	29.00	43	101.75
5.23	1,417,938	1,427,538	0.680	0.584	0.383	55.06	190.49	########	2,097,806	#N/A	#N/A	#N/A	37.47	139.09	78.60	190.49	139.09	7.358	85.96	8,100	3	28.65	44	101.62
5.34	1,419,271	1,428,499	0.681	0.584	0.382	54.30	189.26	########	2,097,977	#N/A	#N/A	#N/A	36.97	138.46	77.57	189.26	138.46	7.358	84.93	8,100	3	28.31	45	101.49
5.47	1,420,597	1,429,459	0.681	0.583	0.382	53.54	188.01	########	2,098,147	#N/A	#N/A	#N/A	36.48	137.83	76.54	188.01	137.83	7.358	83.90	8,100	3	27.97	46	101.35
5.59	1,421,914	1,430,416	0.682	0.582	0.382	52.78	186.77	########	2,098,317	#N/A	#N/A	#N/A	35.98	137.20	75.50	186.77	137.20	7.358	82.86	8,100	3	27.62	47	101.22
5.72	1,423,224	1,431,372	0.682	0.582	0.381	52.03	185.53	########	2,098,487	#N/A	#N/A	#N/A	35.49	136.57	74.47	185.53	136.57	7.358	81.83	8,100	3	27.28	48	101.09
5.86	1,424,526	1,432,325	0.682	0.581	0.381	51.27	184.29	########	2,098,657	#N/A	#N/A	#N/A	34.99	135.94	73.44	184.29	135.94	7.358	80.80	8,100	3	26.93	49	100.95
6.01	1,425,820	1,433,277	0.683	0.580	0.381	50.52	183.04	########	2,098,826	#N/A	#N/A	#N/A	34.50	135.32	72.41	183.04	135.32	7.358	79.76	8,100	3	26.59	50	100.82
6.16	1,427,106	1,434,226	0.683	0.579	0.380	49.76	181.79	########	2,098,994	#N/A	#N/A	#N/A	34.00	134.69	71.37	181.79	134.69	7.358	78.73	8,100	3	26.24	51	100.68
6.32	1,428,385	1,435,174	0.684	0.579	0.380	49.01	180.55	########	2,099,163	#N/A	#N/A	#N/A	33.51	134.06	70.34	180.55	134.06	7.358	77.70	8,100	3	25.90	52	100.55
6.49	1,429,655	1,436,119	0.684	0.578	0.380	48.26	179.30	########	2,099,331	#N/A	#N/A	#N/A	33.01	133.43	69.31	179.30	133.43	7.358	76.67	8,100	3	25.56	53	100.41
6.67	1,430,918	1,437,061	0.684	0.577	0.379	47.51	178.05	########	2,099,499	#N/A	#N/A	#N/A	32.52	132.80	68.28	178.05	132.80	7.358	75.63	8,100	3	25.21	54	100.28
6.86	954,782	958,077	0.596	0.816	0.475	56.12	167.43	########	1,607,113	#N/A	#N/A	#N/A	33.46	138.76	53.77	167.43	138.76	7.358	114.90	8,100	3	38.30	55	105.31
6.96	956,705	959,574	0.597	0.814	0.474	54.04	164.87	########	1,607,487	#N/A	#N/A	#N/A	32.26	137.08	51.86	164.87	137.08	7.358	111.07	8,100	3	37.02	56	104.82
7.06	958,465	960,953	0.598	0.811	0.473	52.11	162.48	########	1,607,832	#N/A	#N/A	#N/A	31.15	135.52	50.08	162.48	135.52	7.358	107.51	8,100	3	35.84	57	104.38
7.16	960,077	962,224	0.598	0.809	0.472	50.33	160.26	########	1,608,151	#N/A	#N/A	#N/A	30.11	134.07	48.43	160.26	134.07	7.358	104.21	8,100	3	34.74	58	103.96
7.26	961,555	963,395	0.599	0.807	0.471	48.68	158.18	########	1,608,447	#N/A	#N/A	#N/A	29.16	132.72	46.90	158.18	132.72	7.358	101.15	8,100	3	33.72	59	103.57
7.36	962,910	964,476	0.600	0.805	0.471	47.15	156.25	########	1,608,720	#N/A	#N/A	#N/A	28.27	131.47	45.47	156.25	131.47	7.358	98.30	8,100	3	32.77	60	103.21
7.46	964,155	965,473	0.600	0.803	0.470	45.73	154.46	########	1,608,973	#N/A	#N/A	#N/A	27.44	130.31	44.15	154.46	130.31	7.358	95.66	8,100	3	31.89	61	102.87
7.56	965,300	966,393	0.601	0.801	0.469	44.41	152.78	########	1,609,208	#N/A	#N/A	#N/A	26.67	129.22	42.92	152.78	129.22	7.358	93.20	8,100	3	31.07	62	102.55
7.66	966,967	967,741	0.601	0.798	0.468	42.48	150.30	########	1,609,554	#N/A	#N/A	#N/A	25.54	127.63	41.11	150.30	127.63	7.358	89.57	8,100	3	29.86	63	102.09