ENCLOSURE 3

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

SUPPORTING ENGINEERING EVALAUTIONS

EC 16090
(RELEVANT PORTIONS)

34 Pages Follow

Xcel Energy®

EC-0441 EC Closeout Package Report (Rev. 3)

Report Date: 06/11/2010

EC Number: 0000016090 Revision: 000

Engineering Change

EC Number :	0000016090	000	**Facility**	:	PI
Status/Date :	CLOSED	06/09/2010	**Type/Sub-type**	:	EVAL /

EC Title: TURBINE BUILDING FLOODING SDP: CL TURBINE BUILDING PIPE BREAK ANALYSIS

Mod Nbr:	**KW1:**	**KW2:**	**KW3:**	**KW4:**	**KW5:**

Master EC	:	**Work Group**	:	**Temporary**	:
Outage	:	**Alert Group**	: E-ME/CS DE	**Aprd Req. Dt.**	: 05/14/2010
WO Required	: N	**Image Addr**	:	**Exp Insvc Date**	:
Adv Wk Appvd	:	**Alt Ref.**	:	**Expires On**	:
Auto-Advance	:	**Priority**	:	**Auto-Asbuild**	:
Caveat Outst	:	**Resp Engr**	: N153927		

Units and Systems

Facility	Unit	System	System Description
PI	0	CL	COOLING WATER

Attributes

Attribute Name	Value	Updated By	Last Updated	Notes
SCRN NO	N/A	N153927	06/08/2010	No change is being performed. No 50.59 is required for this evaluation per FP-E-EVL-01
SIMULATOR				
SYSTEM HEALTH				
EVAL NO				
PORC DTE				
PRIORITY RANKING				

EC-0441 EC Closeout Package Report (Rev. 3)

Report Date: 06/11/2010

Topic Notes

Topic	Notes
DESCRIPTION	The purpose of this engineering evaluation is to provide the results and perform the owner's acceptance of Zachry's analysis 10-052, Rev B, "CL System HELB Break Analysis." This analysis is being performed in support of the Turbine Building Flooding Significance Determination Process. The analysis determines the flow rate through various sizes of postulated pipe breaks in the turbine building under conservative normal operating conditions. The flows and pressures in each CL header are monitored to determine if Low Header Pressure or High Flow annunciators will alarm in the control room. These annunciators would direct operators to investigate the cause of the high flow/ low header pressure and potentially isolate the break locations. The break locations analyzed in this evaluation are listed below: 1) 24-CL-67 2) 16-CL-67 3) 12-CL-67 4) 6-CL-67 5) 4-CL-68 The system was benchmarked based on flow and pressure readings obtained for March 21st 2010 to obtain a typical system alignment for evaluating each of the break cases. Each of these cases were performed with the #11 and #21 Cooling Water pumps running on there nominal pump curves. If the system pressures were low enough that the # 121 pump would receive a start signal the analysis was performed with three pumps in operation. If the three pump cases still resulted in system pressures below the start setpoint for the DDCLPs the analysis was re-performed with four pumps in operation. The likelihood of pipe breaks in these locations are being analyzed independently of this evaluation and may show that these locations are not susceptible to cracking or breaking. This evaluation is used to provide the best estimate of flows out of the listed pipe breaks, and as such suitable as a design basis analysis. The results indicate that a low header pressure alarm would be received for the 24" and 16" break cases in for the train with the break. A high header flow alarm would be received in the train with the break for the 24", 16", and 12" break cases. A summary of results from each of the cases is included in the attached spreadsheet in sharepoint.
JUSTIFICATION	See attached evaluation in sharepoint, Zachry Calculation 10-052B. * Zachry analysis 10-052, Rev B supports the site's Turbine Building Flooding Significance Determination Process and as such is not a calculation. Per FP-E-EVL-01 this EC-Eval does not require design verification because it is an owner's acceptance of a vendor produced analysis.
REVIEWER COMMENTS	***** Note: In the conclusion section of 10-052, Rev B a superscript 1 should have been included for scenario 3b to denote that the flow at FE-27185 exceeded the alarm setpoint of 18,000gpm. The flow at FE-27185 for scenario 3b was 21,657.70 gpm, which would result in a high flow alarm. ****** The QF-0528 comment form has been completed and is attached to Zachry analysis 10-052, Revision B. The QF-0547, "External Design Document Suitability Review Checklist" is scanned in Sharepoint.

Cross References

Affected Documents

Xcel Energy

EC-0441 EC Closeout Package Report (Rev. 3)

Report Date: 06/11/2010

Milestone

Milestone	Date	ID	Name	Req By
APPROVED BY	06/08/2010	N151816	Ford, Sean I	APPROVED
Notes:				
CLOSE	06/09/2010	LDWHIP01	Whipple, Linda D	CLOSED
Notes:				
PREPARED (EVL)	06/07/2010	N153927	Loeffler, Jason W	H/APPR
Notes:				

Document References

Facilty	Doc-Type	Sub-Type	Doc #	Sheet	Rev	Minor Rev	Date
PI	EC		0000016090		000		06/09/2010

Xcel Energy	**Design Review Comment Form**

Sheet 1 of 1

DOCUMENT NUMBER/ TITLE: 10-052: CL System HELB Break Analysis

REVISION: B DATE: 5/27/10

ITEM #	REVIEWER'S COMMENTS	PREPARER'S RESOLUTION	REVIEWER'S DISPOSITION
1	Reference 11 is listed as an email from Jeff Connors, when the email in Attachment P with the same date is from Jason Loeffler.	Comment incorporated.	Acceptable
2	In section 4.4 "Pumps" there is a sentence stating: "If a two pump scenario results in a condition... ...then the scenario will be repeated with a second pump operating." The sentence should be changed to say "...the scenario will be repeated with a third pump operating."	Comment incorporated.	Acceptable
3	The flagged condition section should be expanded for "Pressure below vapor pressure" to include a discussion of negative absolute pressures shown in the results, as this is not physically possible (indicating that section of pipe would not be receiving any flow).	Discussion regarding negative pressures added to Section 6.3.	Acceptable
4	In the 24" break case in which 4 pumps were in operation. The line supplying the 12 DDCLP jacket water heat exchanger should have been modeled as receiving flow. However, as this error results in a conservative predicted break flow, this condition is acceptable. This condition should be noted in the calculation.	Discussion added to last paragraph of Section 6.2.1.	Acceptable
Reviewer: Jason Loeffler Date: 5/27/10		Preparer:Michael Norwood Date: 5/28/10	

[signature] 6/1/2010

Xcel Energy	**External Design Document Suitability Review Checklist**

External Design Document Being Reviewed:Calculation

Title: **CL System HELB Break Analysis**

Number: 10-052 Rev: B Date: 5/28/10

This design document was received from:

Organization Name: Zachry Nuclear Engineering PO or DIA Reference: 16090

The purpose of the suitability review is to ensure that a calculation, analysis or other design document provided by an External Design Organization complies with the conditions of the purchase order and/or Design Interface Agreement (DIA) and is appropriate for its intended use. The suitability review does not serve as an independent verification. Independent verification of the design document supplied by the External Design Organization should be evident in the document, if required.

The reviewer should use the criteria below as a guide to assess the overall quality, completeness and usefulness of the design document. The reviewer is not required to check calculations in detail.

REVIEW

		Reviewed	N/A
1.	Design inputs correspond to those that were transmitted to the External Design Organization.	☒	☐
2.	Assumptions are described and reasonable.	☒	☐
3.	Applicable codes, standards and regulations are identified and met.	☐	☒
4.	Applicable construction and operating experience is considered.	☐	☒
5.	Applicable structure(s), system(s), and component(s) are listed.	☒	☐
6.	Formulae and equations are documented. Unusual symbols are defined.	☒	☐
7.	Acceptance criteria are identified, adequate and satisfied.	☒	☐
8.	Results are reasonable compared to inputs.	☒	☐
9.	Source documents are referenced.	☒	☐
10.	The document is appropriate for its intended use.	☒	☐
11.	The document complies with the terms of the Purchase Order and/or DIA.	☒	☐
12.	Inputs, assumptions, outputs, etc. which could affect plant operation are enforced by adequate procedural controls. List any affected procedures.	☐	☒
13.	Plant impact has been identified and either implemented or controlled. (e.g., For piping analyses, the piping and support database is updated or a tracking item has been initiated.)	☐	☒
14.	Design and Operational Margin have been considered and documented.	☐	☒

Completed by: Jason Loeffler [signature] Date: 6/2/2010

Case	Number of Pumps	Break Flow	A Low Hdr Press Alarm (PS-16001)	Header Pressure B (PS-16008)	A High Flow Alarm (FE-27185)	B High Flow Alarm (FE-27186)	3rd Pump Start (121 MDCLP) PS-16259 (121 Start Signal)	4th Pump Start (12 DDCLP) PS-16002 (12 Start Signal)	PS-16009 (22 Start Signal)
		[gpm]	< 89.7 psia	< 89.7 psia	>18,000 gpm	>18,000 gpm	<94.7 psia	< 89.7 psia	<89.7 psia
Case 1a: 24" Break (2 Pumps)	2	35000	36.4	54.4	29000	12000	49.9	52.3	53.6
Case 1b: 24" Break (3 Pumps)	3	46000	44.1	75.5	37000	16000	72.8	72.7	77.3
Case 1c: 24" Break (4 Pumps)	4	53000	50.3	90.5	43000	18000	89.9	89.6	93.7
Case 2a: 16" Break (2 Pumps)	2	28000	62.9	75.3	25000	11000	70.8	73.4	74.2
Case 2b: 16" Break (3 Pumps)	3	33000	80.4	98.8	29000	14000	95.4	96.7	99.3
Case 3a: 12" Break (2 Pumps)	2	18000	91.3	98.7	20000	10000	93.8	96.6	97
Case 3b: 12" Break (3 Pumps)	3	20000	108.5	118	22000	11000	113.6	115.7	117
Case 4: 6" Break (2 Pumps)	2	8000	121.3	124	13000	8000	118.5	121.5	121.6
Case 5: 4" Break (2 Pumps)	2	3000	131.8	132.9	10000	7000	127.2	130.2	130.3

Note: All flows rounded to the nearest 1000GPM. All Pressures rounded to the nearest 0.1 PSI.

Alarm Received/Pump Start Signa
No Alarm Received/No Pump Start Signal
Pump Already Running

ZACHRY NUCLEAR ENGINEERING, INC.
CALCULATION TITLE SHEET

CLIENT: Xcel Energy

PROJECT: CL System PROTO-FLO Analysis

CALCULATION TITLE: CL SYSTEM HELB BREAK ANALYSIS

CALCULATION NO.: 10-052

JOB NO.: 150PIS/051828

COMPUTER CODE & VERSION (if applicable): PROTO-FLO V4.60

ZACHRY NUCLEAR ENGINEERING, INC. PROPERTY CODE (if applicable): 000520

QA CLASSIFICATION: Non-Safety Related

REV	TOTAL NO. OF PAGES	ORIGINATOR/DATE	VERIFIER/DATE	APPROVAL/DATE
A	1106	5/12/10 Michael A. Norwood	5/12/10 Scott M. Ingalls	5/12/10 Christopher M. D'Angelo
B	1539	6/1/10 Michael A. Norwood	Scott M. Ingalls 6/1/10	6/1/10 Christopher M. D'Angelo

REVISION HISTORY

Revision	Revision Description
A	Original Issue
B	System Re-Benchmarked and HELB cases re-performed with new guidance. The calculation body has been revised in its entirety. All Attachments revised.

ZACHRY NUCLEAR ENGINEERING, INC. GROTON, CONNECTICUT	CALC NO. 10-052	REV B	PAGE iii OF v
	ORIGINATOR Michael A. Norwood		DATE 5/28/2010
	VERIFIED BY Scott M. Ingalls		JOB NO. 051828
CLIENT Xcel Energy	PROJECT CL System PROTO-FLO Analysis		
TITLE CL System HELB Break Analysis			

CALCULATION VERIFICATION FORM

1. VERIFICATION METHOD:

	Yes	N/A
A. Approach Checked	☒	
B. Logic Checked	☒	
C. Arithmetic Checked	☒*	☐
D. Alternate Method (Provide documentation)	☐*	☒
E. Other	☐*	☒

*Describe below.

2. EXTENT OF VERIFICATION:

Complete calculation (including attachments /appendices) has been reviewed to determine impact of revision on un-revised areas.

A. IDV of Complete calculation (including attachments/appendices). ☒

B. IDV of revised areas of Calculation only. ☐

C. Other (describe below): ☐

3. DOCUMENTATION OF VERIFICATION

A. IDV documentation as attachment with Calc ☒

B. IDV documentation forwarded to QA ☐

C. IDV documentation is this form and any continuation pages only. ☐

Errors Detected

See Attachment N

Error Resolution

See Attachment N

*Verification Method:

All arithmetic within the body was checked by hand. Model inputs were verified against the design inputs and references. Default difference reports were used to verify model configuration changes.

Other Comments

QA Software used was run on a benchmarked computer.

Extra References Used

None

(Attach extra sheets if needed (Use Form P030114))

THE APPROACH, LOGIC, AND METHODOLOGY OF THE CALCULATION IS ACCEPTABLE. THE **GUIDELINES DEFINED IN PARA. 7.5.4** (AS APPLICABLE) OF P 3-1 HAVE BEEN MET. THE OVERALL CALCULATION IS FOUND TO BE VALID AND CONCLUSIONS TO BE CORRECT AND REASONABLE:

IDV Signature: [signature] Printed Name: Scott M. Ingalls Date: 6/1/10

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C	Zachry Nuclear Engineering, Inc. Calculation 10-052, Revision B – CL System Operation, Benchmarking	190
D	Zachry Nuclear Engineering, Inc. Calculation 10-052, Revision B – CL System Operation for a HELB Break Event, Scenario 1a, Full Break of 24-CL-67 (2 Pumps)	142
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Total number of pages in Attachments 1512

Complete Calculation (total number of pages) 1539

1.0 PURPOSE

This calculation documents the flow, pressure, and temperature distribution in the Prairie Island Nuclear Generating Plant (PINGP) Cooling Water (CL) System during postulated High Energy Line Break (HELB) events that result in a pipe break in the CL System.

This calculation is non-safety related and is not intended to support design basis analysis.

2.0 BACKGROUND

Revision A of this calculation documents the HELB break analysis performed per client's instructions submitted via Reference 1 as authorized by Reference 2. Revision B of this calculation documents the HELB break analysis performed per client's instructions submitted via References 7, 8, 9, 10, and 11 as authorized by Reference 2.

The development of the PROTO-FLO model for the PINGP CL is documented in Reference 3. System response to a seismic event resulting in a HELB is documented in Reference 4 and Reference 5. Those calculations will serve as the basis for the analysis herein. Minor modifications will be required to the CL system model in order to analyze a new break location and to accurately reflect recent test data. This calculation models pipe break scenarios similar to those found in Reference 4 and Reference 5, but with different benchmarking and with slightly different system alignments than are found in Reference 4 and Reference 5.

Revision A of this calculation used Case 1 of the Reference 4 model as a baseline, with changes applied to the baseline case as documented in the Design Inputs and Analysis sections of Revision A. Revision B of this calculation uses Case 1 from Revision A of this calculation as a baseline case with modifications listed in the Design Inputs and Analysis sections of this calculation.

3.0 APPROACH

The PROTO-FLO model used for Revision B of this calculation is based on the model used in Revision A of this calculation, using Case 1 with the modifications listed in the Design Inputs and Analysis sections of this calculation. Five distinct operating scenarios will be considered:

1. Full break of 24-CL-67
   a. with two CL system pumps operating
   b. with three CL system pumps operating
   c. with four CL system pumps operating
2. Full break of 16-CL-67
   a. with two CL system pumps operating
   b. with three CL system pumps operating
3. Full break of 12-CL-67

   a. with two CL system pumps operating
   b. with three CL system pumps operating
4. Full break of 6-CL-67 with two CL system pumps operating
5. Full break of 4-CL-68 with two CL system pumps operating

Instrument uncertainty is not considered in this calculation consistent with the guidance in Attachment P, and all reported values are nominal values.

4.0 DESIGN INPUTS

Based on the client instructions provided in References 1, 7, 8, 9, 10, and 11 the design inputs for this calculation are as follows:

4.1 System Alignment

The baseline system alignment shall be based on the model from Revision A of this calculation, 10-052A.DBD dated 5/06/2010, Case Alignment 1 (Unit 1 Power / Unit 2 Power).

4.2 Benchmarking

In Revision A of this calculation the model was benchmarked to test data provided in Reference 1. In Revision B of this calculation the model was benchmarked to test data provided in References 7, 8, 9, 10, and 11.

The system alignment was established as described in References 7, 8, 9, 10, and 11. System valves were throttled using balancing parameters to establish flow rates provided in the DITs and flow rates calculated in Attachment M. Valve positions were set to DIT values when provided. Some flow paths did not include a known flow rate or valve position; an initial benchmarking run was used as a baseline from which the flow rates in such flow paths were decreased by a uniform percentage until the sum of the Train A and Train B header flows (model pipes 43 and 55, respectively) were equal to the sum of the DIT flow rates for the Train A and Train B headers. The flow rates were uniformly decreased by either using balancing parameters to throttle valves in the flow paths, or by reducing flows into and out of nodes, as appropriate.

Benchmark results are described in Section 6.1.

4.3 Valves

4.3.1 The following valve positions were changed as part of Revision A of this calculation:

The following valves were shut to isolate CL flow to the AFW pumps for all revision A cases:

- MV-32025 (AFW Pump 11)
- MV-32026 (AFW Pump 21)
- MV-32027 (AFW Pump 12)
- MV-32030 (AFW Pump 22)

The following valves were shut to isolate CL flow to the Containment Fan Coil Units for all cases:

- CV-39401 (FCU 11/13 Supply)
- CV-39411 (FCU 11/13 Return)
- CV-39403 (FCU 12/14 Supply)
- CV-39409 (FCU 12/14 Return)
- CV-39415 (FCU 21/23 Supply)
- CV-39423 (FCU 21/23 Return)
- CV-39413 (FCU 22/24 Supply)
- CV-39421 (FCU 22/24 Return)

The following valves were opened to supply CL flow to the ZX chillers (model heat exchangers 11CHLDWTRCND and 12 CHLDWTRCND:

- CL-114-001
- CV-39450
- CV-39451

The following valves were shut to isolate CL flow to 11CCHX and 21CCHX for all cases:

- CV-31381
- CV-31383
- MV-32145
- MV-32160

The following valves were opened to supply CL flow to 12CCHX and 22CCHX:

- MV-32146
- MV-32161

4.3.2 The following valve positions were changed as part of benchmarking Revision B of this calculation

The following valves were opened to supply CL flow to the Containment Fan Coil Units:

- CV-39401 (FCU 11/13 Supply)
- CV-39411 (FCU 11/13 Return)
- CV-39403 (FCU 12/14 Supply)
- CV-39409 (FCU 12/14 Return)
- CV-39415 (FCU 21/23 Supply)
- CV-39423 (FCU 21/23 Return)
- CV-39413 (FCU 22/24 Supply)
- CV-39421 (FCU 22/24 Return)

The following valves were throttled to control CL flow to the Containment Fan Coil Units and their valve curves were set to 'Standard Gate':

- 1CW-012-001 (Pipe 263, #11CFCU), 783.38 gpm
- 1CW-012-002 (Pipe 281, #13CFCU), 984.61 gpm
- 1CW-012-003 (Pipe 479, #12CFCU), 807.25 gpm
- 1CW-012-004 (Pipe 497, #14CFCU), 981.33 gpm
- 2CL-012-001 (Pipe 217, #21CFCU), 648.87 gpm
- 2CL-012-002 (Pipe 234, #23CFCU), 773.63 gpm
- 2CL-012-003 (Pipe 543, #22CFCU), 778.16 gpm
- 2CL-012-004 (Pipe 519, #24CFCU), 668.72 gpm

The following valves were throttled to control CL flow to the Bus Duct Coolers:

- 1CW-087-007 (Pipe 122, 11GBDCLR), 53 gpm
- 2CL-087-007 (Pipe 387, 21GBDCLR), 57 gpm

The following valves were closed to isolate CL flow to Station AC #124 and Station AA #124:

- SV-37082
- CV-39191

The following valves were opened to supply CL flow to Station AC #125 and Station AA #125:

- SV-37083
- CV-39190

The following valve was closed to isolate CL flow to the ZX chiller (model heat exchanger 12 CHLDWTRCND):

- CV-39451

The following valve was balanced to supply CL flow to the ZX chiller (model heat exchanger 11 CHLDWTRCND) :

- CV-39450 (Pipe 349) 3500 gpm. It is noted that Reference 8 requested the valve be throttled to allow 3500 gpm and also requested a sensitivity study with CV-39450 100% open; however, in Reference 9 it was requested that further analysis use the results with CV-39450 throttled to 3500 gpm instead of the 100% open scenario.

The following valves were opened to supply CL flow to 21CCHX:

- CV-31383 (Pipe 320) flow set to 345.49 gpm
- MV-32160

The following valves were closed to isolate CL flow to 22CCHX:

- MV-32161

The following valve was balanced to supply flow to 12CCHX:

- CV-31411 (Pipe 578) flow set to 218.56 gpm

The following valves were opened to supply CL flow to 121CNTRLCHLR:

- CV-31769, 7.62% open

The following valves were closed to isolate CL flow to 122CNTRLCHLR:

- CV-31785

The following valve was closed to isolate CL flow to the Filtered Water supply:

- CL-048-003

The following valve was closed to isolate CL flow to CompCoolUC#11:

- SV-33551

The following valve was opened to supply CL flow to CompClgPmp#12:

- SV-33590

As a part of the benchmarking effort, balancing parameters were used to throttle the following valves as described in Section 4.2:

Pipe	Flow Rate	Valve
86	233.748	CV-31784
95	185.889	1CW-002-002
103	334.007	1CW-030-001
129	1422.12	1CW-032-001
178	345.967	1CW-027-002
185	196.565	1CW-002-001
360	188.153	2CL-002-002
368	334.025	2CL-030-001
394	1377.95	2CL-032-001
443	345.758	2CL-027-002
450	193.078	2CL-002-001
614	60.3524	CW-017-001
645	47.1309	CW-017-004
646	25.5387	2CL-099B-002
655	36.2374	CL-099B-002
669	15.3687	CV-39427
691	7.99041	2CL-099B-003
707	44.6684	CV-39444
742	42.1224	CV-39441
790	183	2CL-099C-001
849	124.062	CL-046-003
863	110.985	2CL-046-003
946	137.186	CL-099C-001
972	19.4775	CP-034-001

For completeness, the following check valves were initially assumed as open. If there is reverse flow in these lines, PROTO-FLO will automatically close the valves to isolate the reverse flow:

- 1CW-031-001
- 2CL-031-001

Scenarios 1b, 1c, 2b and 3b each had the following check valve open to allow for flow in the discharge line of pump CLWP-121:

- 1CL-043-003

Scenario 1c had the following check valve open to allow for flow in the discharge line of pump CLWP-012:

- 1CL-043-002

Travel stop settings were added for the valves are as follows:

- CV-31383, 26.42%
- CV-31384, 26.13%
- CV-31381, 26.34%
- CV-31411, 26.1%
- CV-31360, 53%
- CV-31361, 53%

4.3.3 The following valve positions were changed after benchmarking as part of establishing HELB cases as part of Revision B of this calculation:

The following valves are modeled as flow control valves so their flow rates in the HELB scenarios are equal to their benchmarking flow rates:

- CV-31769, 270.65 gpm (model heat exchanger 121CNTRLCHLR)
- CV-31784, 233.73 gpm (model heat exchanger LABSERVCHL)
- CV-31383, 345.49 gpm (model heat exchanger 21CCHX)
- CV-31411, 218.56 gpm (model heat exchanger 12CCHX)

Balancing parameters were used to throttle the following valves so their flow rates in the HELB scenarios are equal to their benchmarking flow rates:

- 2CL-032-001, 1377.93 gpm (Unit 2 Generator Hydrogen Coolers)
- 1CW-032-001, 1422.20 gpm (Unit 1 Generator Hydrogen Coolers)

The following valve was closed to isolate CL flow to the ZX chiller (model heat exchanger 11 CHLDWTRCND):

- CV-39450

4.4 Pumps

The benchmark case and each HELB scenario was performed with two pumps running:

- CLWP-011 operating on pump curve titled "#11 CL Pump Design Curve"
- CLWP-021 operating on pump curve titled "#21 CL Pump Design Curve"

If a two pump scenario results in a condition where the pressure at the pump header pressure switch PS-16259 is less than 80 psig (94.7 psia), then that scenario will be repeated with a third pump operating. The three pumps are as follows:

- CLWP-011 operating on pump curve titled "#11 CL Pump Design Curve"
- CLWP-021 operating on pump curve titled "#21 CL Pump Design Curve"

- CLWP-121 operating on the new pump curve "#121 SP 1106C 100% Curve"

If a three pump scenario results in a condition where the pressures at the pump header pressure switches PS-16002 and PS-16009 are less than 75 psig (89.7 psia), then that scenario will be repeated with a fourth pump operating. The four pumps are as follows:

- CLWP-011 operating on pump curve titled "#11 CL Design Curve"
- CLWP-012 operating on the new pump curve "#12 SP 1106A 100% Curve"
- CLWP-021 operating on pump curve titled "#21 CL Design Curve"
- CLWP-121 operating on the new pump curve "#121 SP 1106C 100% Curve"

The pump header pressure switches PS-16259, PS-16002 and PS-16009 are at model nodes 008, 009, and 007, respectively. The difference between the height of pressure instruments and the height of the model nodes was input into the model as shown below:

Pressure Instrument	Pressure Instrument elevation (ft)	Node Name	Node Elevation (ft)	Δ Between Instrument and Node (ft)
PS-16259	702.25	008	702.25	0
PS-16002	695.27	009	688.5	6.77
PS-16009	695.27	007	688.5	6.77

Note 1: Reference 10

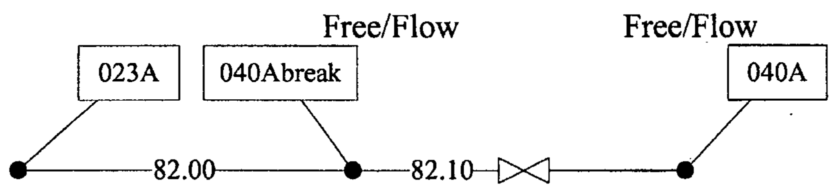
4.5 New Pipes

In Revision A of this calculation the following CL System model pipe was segmented in order to analyze the postulated pipe break:

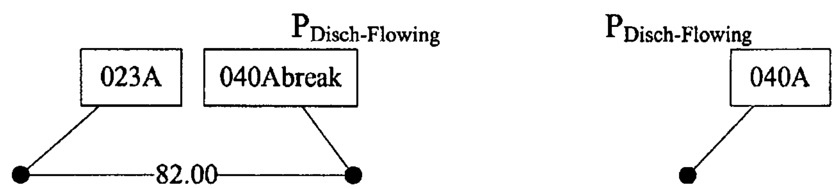
- Pipe 82.00 (from Node 023A to 040A) was segmented into Pipes 82.00 and 82.10. New node 040Abreak was added.

This pipe was segmented as directed by Reference 1. The new segment (82.10) has no hydraulic resistance and a dummy valve. This is to give the ability to model a guillotine pipe break by closing the dummy valve and setting the associated nodes as pressure discharge flowing nodes with static pressures of 14.7 psia (See Figure below for Pipe 82.00). Exit losses are not included in the pipe sections as a separate loss because exit losses are included when a node is modeled as a pressure discharge flowing node.

It is noted that Reference 1 describes this break as being in Pipe 82 between MV-32021 and Node 040A. After reviewing the model and the piping isometric provided in Reference 1, it was determined that the break location is in Pipe 82 between MV-32031 and Node 040A.



Valve Open



Valve Shut

The Pipe Section Data Report for the new pipe segments is included in Attachment B. The updated PROTO-FLO model is also provided on the optical disk included in Attachment B.

4.6 Node Elevations

Some break nodes are modeled as flow or free rather than pressure discharge flowing because the static pressure in that part of the system is lower than atmospheric during HELB conditions; modeling a node in that part of the system as pressure discharge flowing would result in the erroneous calculation of flow into the break. The model elevation of select break nodes and nodes adjacent to those break nodes is reported below, to aide in the qualitative justification that those nodes be modeled as free or flow as found in Sections 6.2.1, 6.2.2, 6.2.3, and 6.2.4.

- Node 044A1, 705.1 ft
- Node 044A, 705.5 ft
- Node 075A1, 705.37 ft
- FD PMP UC 01, 704.56 ft
- Node 145A1, 708.5 ft
- Node 145A, 708.5 ft

4.7 Miscellaneous K

Prior to re-benchmarking the model in Revision B of this calculation, the miscellaneous K added in Revision A of this calculation was removed. Specifically, a miscellaneous k of 46 was removed from pipe 43 and a miscellaneous k of 847 was removed from pipe 345.

As part of model benchmarking in Revision B of this calculation the following miscellaneous K was either added or removed to allow the modeled discharge pressures of the CFCUs to match benchmark data:

- Pipe 43.00, from 46 to 0
- Pipe 216.00, from 24.5875 to 0
- Pipe 223.00, from 111.82 to 100
- Pipe 226.00, from 111.82 to 100
- Pipe 232.00, from 0 to 470
- Pipe 233.00, from 15.251 to 0
- Pipe 234.00, from 31.823 to 0
- Pipe 253.00, from 0 to 325
- Pipe 279.00, from 0 to 45
- Pipe 299.00, from 0 to 30
- Pipe 345.00, from 847 to 0
- Pipe 476.00, from 72.616 to 0
- Pipe 478.00, from 24.5875 to 0
- Pipe 496.00, from 15.251 to 0
- Pipe 518.00, from 10.5933 to 0
- Pipe 519.00, from 14.308 to 0
- Pipe 530.00, from 111.82 to 75
- Pipe 531.00, from 111.82 to 75
- Pipe 532.00, from 111.82 to 75
- Pipe 534.00, from 111.82 to 75
- Pipe 541.00, from 0 to 300
- Pipe 542.00, from 41.736 to 0
- Pipe 549.00, from 111.82 to 65
- Pipe 550.00, from 111.82 to 65
- Pipe 551.00, from 111.82 to 65
- Pipe 553.00, from 111.82 to 65
- Pipe 559.00, from 0 to 180

4.8 Low Supply Header Pressure Alarms

PS-16001 and PS-16008 are adjacent to model nodes 022A and 022B, respectively. These low pressure alarms have setpoints of 75 psig per Reference 10. The difference between the height of pressure instruments and the height of the model nodes is used in conjunction with the density of water at 85F to determine the model node pressure corresponding to a pressure instrument pressure of 75 psig, as shown below:

Pressure Instrument/ Associated Node[2]	PS-16001/ Node 022A	PS-16008/ Node 022B
Pressure Instrument Elevation[2]	701 ft	701 ft
Node Elevation[3]	686.5 ft	686.5 ft
Elevation Delta	14.5 ft	14.5 ft
Pressure delta [1]	6.26 psi	6.26 psi
Nodal Pressure Corresponding to a Pressure Instrument pressure of 75 psig	95.96 psia/ 81.26 psig	95.96 psia/ 81.26 psig

Note 1: Based on a water temperature of 85F and a corresponding water density of 62.168 lbm/ft^3.
Note 2: Reference 10
Note 3: Model Database.

4.9 High Supply Header Flow Alarms

FE-27185 and FE-27186 are high flow alarms in model pipes 43 and 55, respectively. These high flow alarms have setpoints of 18,000 gpm per Reference 10.

4.10 CCHX Flow Rates

The flow rates to 12CCHX and 21CCHX are calculated in Attachment M based on inputs provided in Reference 8.

4.11 Boundary Conditions

The bay elevation is 679.26 feet Reference 9 and the bay temperature is 45.81 per Reference 11. It is noted that bay and river elevations were provided in the Reference 11 email, but those values are superseded by the values that were later provided in the Reference 9 DIT.

The following nodal flows were developed as part of the benchmarking effort as described in Section 4.2:

Node	Flow Rate	Components
Node 051A, 043A	9.274995	Turbine EH #11, 12 Reservoir Oil Coolers
Node 061A, 318A	6.956246	Heater Drain Pump #11, 12, 13 Motor Cooling Coils
Node 213A, 218A	4.637497	121 Process Steam Cond. Return Heat Exch.
Node 051B, 124 Sta A/C 09	9.274995	Turbine EH #21, 22 Reservoir Oil Coolers
Node 061B, 318B	6.956246	Heater Drain Pump #21, 22, 23 Motor Cooling Coils

5.0 ASSUMPTIONS

None

6.0 ANALYSIS

6.1 Benchmarking

The system was benchmarked to test data provided in Reference 7, 8, 9, 10, and 11. Case Alignment 1 (Unit 1 Power / Unit 2 Power) was used as the benchmark alignment, with the system configuration as described in Section 4.0. Many individual component flows and pressures were not included in the benchmark data; therefore, valves were balanced for components with unknown flows or valve positions, in order to uniformly reduce the flow to each modeled component by a proportional amount. The benchmark results are as follows:

Data Point	Test Data	Benchmarking Results	Delta	% Delta
Flow at FE-27185 (Pipe 43) (gpm)	8,550[1]	9088.10	538.10	6.29
Pressure at PS-16001 (psig)	111.25[1]	131.19-6.26 psi[4] -14.7 = 110.23	-1.02	-0.92
Flow at FE-27186 (Pipe 55) (gpm)	8,550[1]	7971.23	-578.77	-6.77
Pressure at PS-16008 (psig)	111.25[1]	131.65-6.26 psi[4] -14.7 = 110.69	-0.56	-0.50
Sum of Train A and Train B Header Flows (Pipe 43 and Pipe 55) (gpm)	17,100	17,059.33	-40.67	-0.24
Pressure at Pump Discharge (Node 001D) (psig)	130[1]	139.50-14.7=124.80	-5.20	-4.00
Pressure at Pump Discharge (Node 005D) (psig)	130[1]	139.47-14.7=124.77	-5.23	-4.02
Pressure Differential Across Strainer #11 (Nodes 014A and 015A) (psid)	1[1]	127.35-126.36=0.99	-0.01	-1.00
Pressure Differential Across Strainer #12 (Nodes 012A and 013A) (psid)	1[1]	127.27-126.20=1.07	0.07	7.00

Data Point	Test Data	Benchmarking Results	Delta	% Delta
Pressure Differential Across Strainer #21 (Nodes 014B and 015B) (psid)	2 to 3[1]	127.54-126.73=0.81	-1.19 to -2.19	-59.5 to -73.00
Pressure Differential Across Strainer #22 (Nodes 012B and 013B) (psid)	1[1]	127.39-126.57=0.82	-0.18	-18.00
Flow to 11 FCU (Pipe 263) (gpm)	783.38[1]	783.31	-0.07	-0.01
Pressure at 11 FCU Outlet (Node #11FCU Out) (psig)	55.43[1]	69.27-14.7=54.57	-0.86	-1.55
Flow to 12 FCU (Pipe 479) (gpm)	807.25[1]	807.17	-0.08	-0.01
Pressure at 12 FCU Outlet (Node #12 CFCU Out) (psig)	58.98[1]	76.11-14.7=61.41	2.43	4.12
Flow to 13 FCU (Pipe 281) (gpm)	984.61[1]	984.54	-0.07	-0.01
Pressure at 13 FCU Outlet (Node #13 CFCU Out) (psig)	55.66[1]	70.53-14.7=55.83	0.17	0.31
Flow to 14 FCU (Pipe 497) (gpm)	981.33[1]	981.26	-0.07	-0.01
Pressure at 14 FCU Outlet (Node #14 CFCU Out) (psig)	60.20[1]	76.80-14.7=62.10	1.90	3.16

Data Point	Test Data	Benchmarking Results	Delta	% Delta
Flow to 21 FCU (Pipe 217) (gpm)	648.87[1]	648.82	-0.05	-0.01
Pressure at 21 FCU Outlet (Node #21 CFCU Out) (psig)	72.73[1]	86.98-14.7=72.28	-0.45	-0.62
Flow to 22 FCU (Pipe 543) (gpm)	778.16[1]	778.09	-0.07	-0.01
Pressure at 22 FCU Outlet (Node #22 CFCU Out) (psig)	59.38[1]	72.67-14.7=57.97	-1.41	-2.37
Flow to 23 FCU (Pipe 234) (gpm)	773.63[1]	773.57	-0.06	-0.01
Pressure at 23 FCU Outlet (Node #23 CFCU Out) (psig)	72.27[1]	86.49-14.7=71.79	-0.48	-0.66
Flow to 24 FCU (Pipe 519) (gpm)	668.72[1]	668.66	-0.06	-0.01
Pressure at 24 FCU Outlet (Node #24 CFCU Out) (psig)	66.27[1]	79.68-14.7=64.98	-1.29	-1.95
Flow to GBDCLR11 (Pipe 122) (gpm)	53[2]	53.00	0.00	0.00
Flow to GBDCLR21 (Pipe 387) (gpm)	57[2]	57.00	0.00	0.00
Flow to 21CCHX (Pipe 320) (gpm)	345.49[2, 3]	345.49	0.00	0.00
Flow to 12CCHX (Pipe 578) (gpm)	218.56[2, 3]	218.56	0.00	0.00

Note 1: Reference 7

Note 2: Reference 8

Note 3: Attachment M

Note 4: See Section 4.8 for discussion of nodal pressure vs. pressure instrument pressure.

The resultant PROTO-FLO output reports for the benchmarking case are provided in Attachment C.

6.2 HELB Scenarios

Scenarios 1 through 5 defined in References 1, 7, 8, 9, 10, and 11 are modeled as described in the following subsections. The temperature convergence tolerance was set to zero to aide in model convergence of the scenarios, resulting in fluid temperatures in each pipe section being held at a constant temperature for each scenario.

6.2.1 Scenario #1 – Full Break of 24-CL-67 with Two Pumps Operating

Scenario #1 represents a full break of pipe 24-CL-67. The system configuration is as described in Section 4.0. The break location for this scenario is just downstream of the penetration at wall column 8 and upstream of the 3" line to the Administration Building Air Conditioner. A guillotine break was modeled by closing the dummy valve "Pipe82Break" and setting node 040Abreak as a pressure discharge flowing node with a static pressure of 14.7 psia. Node 040A remained modeled as a flow or free node to prevent the erroneous modeling of water flowing into the break; this is evident because the Node Summary report in Attachment D shows Node 040A has a static pressure of 9.28 psia, which is below atmospheric pressure. It is concluded that modeling Node 040A as a flow or free node is appropriate because it will prevent the modeling of flow into the break.

The resultant PROTO-FLO output reports for this scenario with three pumps running are provided in Attachment D. As shown therein, the pressure at pressure switch PS-16259 is 49.926 psia (35.226 psig), which is less than the 94.7 psia required to start the 3rd CL pump. The 3rd CL pump will start, therefore this analysis is repeated with three pumps in operation. These results are included in Attachment E. The results of the analysis with three CL pumps show that the pressure at pressure switches PS-16002 and PS-16009 are 72.714 psia (58.014 psig) and 77.328 psia (62.628 psig), which is less than the 89.7 psia required to start the 4th CL pump. The 4th CL pump will start, therefore this analysis is repeated with four pumps in operation. These results are included in Attachment F.

It is noted in comment 4 of Attachment O that the line supplying the 12DDCLP jacket water cooler (model heat exchanger CLPDJC12) should have been receiving flow in the 24-inch break case with four pumps running, Case 1c. The only four-pump break case from Reference 4 was reviewed, a 6-inch break scenario, and the CL flow for CLPDJC12 was found to be 368.65 gpm (Reference 4, page 40 of Attachment G). This flow is very small when compared to the break flow of 52,555.13 gpm and combined header flow of 60,337.00 gpm, therefore the impact on the results due to CLPDJC12 not being in the flowpath is considered negligible. The omission of CLPDJC12 from the flowpath results in a conservatively higher break flow.

6.2.2 Scenario #2 – Full Break of 16-CL-67 with Two Pumps Operating

Scenario #2 represents a full break of pipe 16-CL-67. The system configuration is as described in Section 4.0. The break location for this scenario is downstream of the pipe anchor. A guillotine break was modeled by closing the dummy valve "Pipe88Break" and setting node 050A1 as a pressure discharge flowing node with a static pressure of 14.7 psia. Node 044A1 remained modeled as a flow or free node to prevent the erroneous modeling of water flowing into the break; this is evident because the Node Summary report in Attachment G shows Node 044A, which is also in pipe 88.2, is 0.4 feet higher than Node 044A1, and has a static pressure of 11.75 psia. The pressure at Node 044A1 will be 11.75+(0.4 ft * 62.168 lbm/ft^3/144 in^2/ft^2) = 11.92 psia, which is below atmospheric pressure. It is concluded that modeling Node 044A1 as a flow or free node is appropriate because it will prevent the modeling of flow into the break.

The resultant PROTO-FLO output reports for this scenario with three pumps running are provided in Attachment G. As shown therein, the pressure at pressure switch PS-16259 is 70.781 psia (56.081 psig), which is less than the 94.7 psia required to start the 3rd CL pump. The 3rd CL pump will start, therefore this analysis is repeated with three pumps in operation. These results are included in Attachment H. The results of the analysis with three CL pumps show that the pressure at pressure switches PS-16002 and PS-16009 are 99.680 psia (84.980 psig) and 99.252 psia (84.552 psig), which is greater than the 89.7 psia required to start the 4th CL pump. The 4th CL pump will not start, therefore this analysis is not repeated with four pumps in operation.

6.2.3 Scenario #3 – Full Break of 12-CL-67 with Two Pumps Operating

Scenario #3 represents a full break of pipe 12-CL-67. The system configuration is as described in Section 4.0. The break location for this scenario is just downstream of the 90° elbow just prior to where the line containing valve CL-99C-1 taps in. A guillotine break was modeled by closing the dummy valve "Pipe174Break" and setting nodes 058A1 as pressure discharge flowing nodes with static pressures of 14.7 psia. Node 075A1 remained modeled as a flow or free node to prevent the erroneous modeling of water flowing into the break; this is evident because the Node Summary report in Attachment I shows Node FD PMP UC 01, which is the node closest to Node 075A1 without being isolated from it and also in the flow path, is lower than Node 075A1 and has a static pressure of 13.34 psia. The pressure at Node 075A1 will be less than 13.34 psia, which is below atmospheric pressure. It is concluded that modeling Node 075A1 as a flow or free node is appropriate because it will prevent the modeling of flow into the break.

The resultant PROTO-FLO output reports for this scenario with two pumps running are provided in Attachment I. As shown therein, the pressures pressure switch PS-16259 is 93.813 psia (79.113 psig), which is less than the 94.7 psia required to start the 3rd CL pump. The 3rd CL pump will start, therefore this analysis is repeated three pumps in operation. These results are included in Attachment J. The results of the analysis with three CL pumps show that the pressures pressure switches PS-16002 and PS-16009 are 115.705 psia (101.005 psig) and 117.017 psia (102.317 psig), which is greater than the 89.7 psia required to start the 4th CL pump. The 4th CL pump will not start, therefore this analysis is not repeated with four pumps in operation.

6.2.4 Scenario #4 – Full Break of 6-CL-67 with Two Pumps Operating

Scenario #4 represents a full break of pipe 6-CL-67. The system configuration is as described in Section 4.0. The break location for this scenario is just downstream of where this line taps off the capped 16 inch header. A guillotine break was modeled by closing the dummy valve "Pipe091Break" and setting node 111A1 as a pressure discharge flowing node with static pressures of 14.7 psia. Node 145A1 remained modeled as a flow or free node to prevent the erroneous modeling of water flowing into the break; this is evident because the Node Summary report in Attachment K shows Node 145A, which is the same elevation as Node 145A1, has a static pressure of 11.67 psia. The pressure at Node 044A will also be 11.67 psia, which is below atmospheric pressure. It is concluded that modeling Node 145A1 as a flow or free node is appropriate because it will prevent the modeling of flow into the break.

The resultant PROTO-FLO output reports are provided in Attachment K. As shown therein, the pressure at pressure switch PS-16259 is 118.487 psia (103.787 psig), which is greater than the 94.7 psia required to start the 3rd CL pump. The 3rd CL pump will not start, therefore this analysis is not repeated with three pumps in operation.

6.2.5 Scenario #5 – Full Break of 4-CL-68 with Two Pumps Operating

Scenario #5 represents a full break of pipe 4-CL-68. The system configuration is as described in Section 4.0 for two pumps running. The break location for this scenario is just downstream of the turbine building wall penetration and upstream of check valve CW-31-1. A guillotine break was modeled by closing the dummy valve "Pipe184Break" and setting nodes 026A1 and 079A1 as pressure discharge flowing nodes with static pressures of 14.7 psia.

The resultant PROTO-FLO output reports are provided in Attachment L. As shown therein, the pressure at pressure switch PS-16259 is 127.237 psia (112.537 psig), which is greater than the 94.7 psia required to start the 3rd CL pump. The 3rd CL pump will not start, therefore this analysis is not repeated with three pumps in operation.

6.3 Flagged Conditions

The calculation summary reports in Attachments C through I contain flagged conditions. Typical flagged conditions include

- "Closed due to Reverse Flow Thru Check Valve CW-047-001", which is an indication that the PROTO-FLO model detected reverse flow in a pipe containing a check valve and closed the check valve accordingly.

- "Control Valve Position 21.04% Full Open", which is a notification of the status of control valves in the model.
- "DP > 50% of Inlet Pressure Cavitation Flow Possible", which is an indication that there is potential for cavitation if, for example, the entire pressure drop exists in a single component such as a valve or orifice.
- "Pressure below vapor pressure (0.90 < 1.40)", which indicates the fluid will flash to vapor. This flagged condition is typically corrected by taking measures such as throttling downstream valves, however for the purposes of this calculation it is conservative to maximize component flow thus decreasing header pressure and maximizing the potential to start the fourth pump, which will in turn increase break flow. The sum of the flows through flow paths with cavitating nodes is listed below. It is noted that the greatest summation of cavitating flows is less than 1% of either the total system flow or the break flow for most break scenarios, indicating that the impact of the cavitating flows on the break flows and header pressures is negligible. For Scenarios 1a and 1b the cavitating flows are significant compared to the total flow, indicating the system will experience a significant amount of flashing until the 4th CL pump is started.

Scenario	Representative Pipe in Cavitating Flowpaths	Total Flow Through Cavitating Flowpaths (gpm)
1a: Full Break of 24-CL-67 (2 pumps)	84, 103, 303, 312, 563, 707	1737.29
1b: Full Break of 24-CL-67 (3 pumps)	84, 103, 303, 707	1012.35
1c: Full Break of 24-CL-67 (4 pumps)	84, 103, 707	52.36
2a: Full Break of 16-CL-67 (2 pumps)	103, 707	31.35
2b: Full Break of 16-CL-67 (3 pumps)	103, 707	36.13
3a: Full Break of 12-CL-67(2 pumps)	707	36.85
3b: Full Break of 12-CL-67(3 pumps)	707	41.08
4: Full Break of 6-CL-67 (2 pumps)	707	43.72
5: Full Break of 4-CL-68 (2 pumps)	707	45.79

It is noted that some node pressures are reported as being negative; this typically occurs at nodes that are high in the system because PROTO-FLO models water as having a saturated liquid density even if the water is below vapor pressure. In reality if water drops below vapor pressure as it rises in a pipe then a portion of water will flash to vapor and the density will decrease, resulting in pressures at higher nodes that are not as low as reported in PROTO-FLO. The added hydraulic resistance of a two-phase mixture is expected to cause a decrease in flow rate of fluid in pipes associated with nodes that are below vapor pressure, but that increase will have a negligible impact on total system performance for Scenario 1c through Scenario 5; the majority of flowpaths with the added two-phase resistance in Scenarios 1a and 1b will return to single-phase flow when the fourth pump is started.

7.0 CONCLUSION

Flow out of the break for each scenario is as follows:

Scenario	Pipe Feeding Break (gpm)	Pipe Back-Flowing to Break (gpm)	Total Break Flow (gpm)
1a: Full Break of 24-CL-67 (2 pumps)	Pipe 82.00 = 35,074.58	N/A	35,074.58
1b: Full Break of 24-CL-67 (3 pumps)	Pipe 82.00 = 45,615.45	N/A	45,615.45
1c: Full Break of 24-CL-67 (4 pumps)	Pipe 82.00 = 52,555.13	N/A	52,555.13
2a: Full Break of 16-CL-67 (2 pumps)	Pipe 88.00 = 27,714.10	N/A	27,714.10
2b: Full Break of 16-CL-67 (3 pumps)	Pipe 88.00 = 33,269.46	N/A	33,269.46
3a: Full Break of 12-CL-67 (2 pumps)	Pipe 174.00 = 18,062.92	N/A	18,062.92
3b: Full Break of 12-CL-67 (3 pumps)	Pipe 174.00 = 20,222.06	N/A	20,222.06
4: Full Break of 6-CL-67 (2 pumps)	Pipe 91.00 = 7,779.57	N/A	7,779.57
5: Full Break of 4-CL-68 (2 pumps)	Pipe 184.00 = 2857.36	Pipe 184.20 = 54.20[1]	2911.56

Note 1: The flow is reported in Attachment L as –54.20 because water is flowing backwards in the pipe and out the break.

The readings of the header flow instruments, which alarm at a high flow of 18,000 gpm, are as follows:

Scenario	FE-27185 (gpm)	FE-27186 (gpm)
1a: Full Break of 24-CL-67 (2 pumps)	28,922.36[1]	12,339.98
1b: Full Break of 24-CL-67 (3 pumps)	37,118.63[1]	15,663.69
1c: Full Break of 24-CL-67 (4 pumps)	42,836.96[1]	17,500.02
2a: Full Break of 16-CL-67 (2 pumps)	24,633.31[1]	11,412.66
2b: Full Break of 16-CL-67 (3 pumps)	29,200.46[1]	13,512.19
3a: Full Break of 12-CL-67 (2 pumps)	19,708.18[1]	9,991.68
3b: Full Break of 12-CL-67 (3 pumps)	21,657.70	11,088.10
4: Full Break of 6-CL-67 (2 pumps)	12,870.31	7649.12
5: Full Break of 4-CL-68 (2 pumps)	9,674.50	6964.14

Note 1: Value is above the high header flow alarm setpoint.

The reading of the header pressure alarm instruments, which alarm at a low pressure of 95.96 psia at model Nodes 022A and 022B as noted in Section 4.8, are as follows:

Scenario	PS-16001 (psia)	PS-16008 (psia)
1a: Full Break of 24-CL-67 (2 pumps)	36.39[1]	54.44[1]
1b: Full Break of 24-CL-67 (3 pumps)	44.11[1]	75.53[1]
1c: Full Break of 24-CL-67 (4 pumps)	50.29[1]	90.45[1]
2a: Full Break of 16-CL-67 (2 pumps)	62.90[1]	75.32[1]
2b: Full Break of 16-CL-67 (3 pumps)	80.41[1]	98.84
3a: Full Break of 12-CL-67 (2 pumps)	91.27[1]	98.68
3b: Full Break of 12-CL-67 (3 pumps)	108.45	117.95
4: Full Break of 6-CL-67 (2 pumps)	121.34	124.04
5: Full Break of 4-CL-68 (2 pumps)	131.83	132.94

Note 1: Value is below the low header pressure alarm setpoint.

The model used for this analysis, 10-052B.DBD (Size 4,714 KB, dated 5/24/2010 10:09 PM EDST) is included on the optical disk provided in Attachment B. It is noted that the 'Model Version' field of the 'System Description' tab of the model describes this model as 10-052A, and the text '10-052A' also appears on the first page of the Calculation Summary reports. This model would be more accurately described as 10-052B, however this discrepancy is non-technical and does not affect the results of the model or the conclusions of the calculation. The resultant CL system conditions are provided in Attachments C through L.

8.0 REFERENCES

1. Xcel Energy Design Input Transmittal 16090 dated April 30, 2010, DIT No. 01, "Turbine Building Flooding SDP: CL Turbine Building Pipe Break Analysis." (Included in Attachment A)

   DIT References and Attachments

   1.1. Xcel Energy Drawing X-HIAW-106-124, Revision C

   1.2. Proto-Power Calc 04-109D

   1.3. Proto-Power Calc 09-045A

2. Xcel Energy Contract 1757 Release 22 dated December 23, 2009, "Zachry Cooling Water System PROTO-FLO Analysis."

3. Proto-Power Calculation 07-013, Revision A, "Revision F of PINGP CL System Model Database."

4. Proto-Power Calculation 09-045, Revision A, "HELB Break Analysis of the CL System."

5. Proto-Power Calculation 04-109 Revision D, " SEISMIC - FAILURE OF A SINGLE PIPE "

6. Proto-Power Corporation User Documentation for Thermal-Hydraulic Modeling Software PROTO-FLO – Steady State Module, UD-93948-01, Version 4.6

7. Xcel Energy Design Input Transmittal 16090 dated May 17, 2010, DIT No. 02, "Turbine Building Flooding SDP: CL Turbine Building Pipe Break Analysis." (Included in Attachment A)

8. Xcel Energy Design Input Transmittal 16090 dated May 18, 2010, DIT No. 03, "Turbine Building Flooding SDP: CL Turbine Building Pipe Break Analysis." (Included in Attachment A)

9. Xcel Energy Design Input Transmittal 16090 dated May 19, 2010, DIT No. 04, "Turbine Building Flooding SDP: CL Turbine Building Pipe Break Analysis." (Included in Attachment A)

10. Xcel Energy Design Input Transmittal 16090 dated May 23, 2010, DIT No. 05, "Turbine Building Flooding SDP: CL Turbine Building Pipe Break Analysis." (Included in Attachment A)

11. Email from Jason Loeffler, 5/17/2010, 1:55 PM EST (Included in Attachment P)

12. Email from Rick Rohrer, 5/6/2010, 7:11 PM EST (Included in Attachment P)