ATTACHMENT 2 TO BECO LTR. 2.97.042

PILGRIM CALCULATION M-734

CALCULATION COVER SHEET

PILGRIM NUCLEAR POWER STATION

SHEET 1 OF 6

INCLUDING ATTACHMENTS

CALC. NO. M-734	REV. 0	FILE NO.	SR ☒ NSR ☐	RTYPE B4.01
Subject: RHR and Core Spray Pump Suction Strainer Debris Head Loss NPSH Evaluation			Preliminary Calc. ☐	
Discipline Division Manager: T.F. White			Finalization Due Date:	
Approval/s/: Thomas White J.		Date: 4/11/97	Final Calc. ☒	

Independent Reviewer: G.E. O'Connor /s/ G.E. O'Connor Statement Attached ☒

Page(s)	By: P.D. Harizi	Date	Ch'k'd P.J. Doody	Date	Agreed
See Note	/s/ P.D. Harizi	04-08-97	/s/ Patrick J. Doody	4/10/97	✓

A. Statement of Problem
B. Summary of Results and Recommendations
C. Method of Solution
D. Input Data and Assumptions
E. Calculations / Analyses
F. References
G. List of Attachments

Attachment 1 = 1 Pgs

Total Pages Sections A to G = 5 Pgs Total Pages Attachments 1 = 1 Pgs

This design analysis ☐ DOES, ☒ DOES NOT require revision to affected design documents.
Affected Design Documents:
A PDC ☐ IS, ☒ IS NOT Required.
A Safety Evaluation ☒ IS, ☐ IS NOT Required. Refer to SE-3088.
This design analysis ☐ DOES, ☒ DOES NOT affect the piping analysis index (PAI). If the PAI is affected, initiate a revision to Calculation M561.

Minor revisions made on pages _____ of this calculation. See next revision.

Replaces Calc. No.	Voided By Calc. No. _____ ☐ Or Attached Memo

A. Statement of Problem

It is necessary to calculate the head loss due to LOCA-generated debris on the suction strainers for the RHR and Core Spray pumps. The debris is a postulated value for the bounding accident condition that displaces the largest volume of fiberglass pipe insulation. The head loss is then compared to the minimum available margin for LOCA debris on the suction strainers.

B. Summary of Results and Recommendations

The postulated volume of LOCA-generated debris from [Ref. 1] is 23 ft^3. Applying the entire volume to one strainer with 2 RHR and 1 Core Spray pump operating at maximum flow, the head loss due solely to the debris is less than 0.01 ft. The minimum available margin for LOCA debris for the limiting Core Spray pump is greater than 2 ft based on only the containment pressure available prior to the accident (0.5 psig) and is equal to 0.9 feet assuming zero positive pressure following a DBA-LOCA [Ref. 4]. Therefore, there is adequate NPSH margin to accommodate the postulated debris loading without affecting pump performance.

C. Method of Solution

The postulated volume of LOCA-generated debris was taken from the [Ref. 1] analysis which was performed in accordance with Regulatory Guide 1.82 Rev. 1 [Ref. 2]. The total volume of insulation displaced is applied uniformly to one strainer along with blockage of 5% of the screen area by fabric. The head loss due to the debris is calculated using the correlation given in NUREG-0897 Rev. 1 [Ref. 3] for low density fiberglass. The head loss is then compared with the available margin for LOCA debris given in Calculation M-662 [Ref. 4].

D. Input Data and Assumptions

1. The RHR and Core Spray pumps are operating at their maximum flow rates.

2. The greatest head loss occurs when 2 RHR pumps and 1 Core Spray pump are operating on one suction strainer.

3. The minimum available margin for LOCA debris $NPSH_M$ is taken from [Ref. 4] for the original FSAR Design Basis LOCA case of 166°F peak suppression pool temperature with a 65°F heat sink [Ref. 6].

4. The LOCA debris volume from [Ref. 1] is based on Regulatory Guide 1.82 Rev. 1 [Ref. 2].

E. Calculations / Analyses

The GE Report [Ref. 1] determined that the maximum volume of shredded fiberglass debris generated from a bounding line break inside primary containment is 23 ft^3.

The following maximum pump flow rates will be used:

RHR	=	5,100 gpm	x 2	=	10,200 gpm
Core Spray	=	4,400 gpm	x 1	=	4,400 gpm
		Total Flow		=	14,600 gpm

The "strainer flow velocity" is defined as follows:

$$V = \frac{(Q \times 1/7.4805 \times 1/60)}{A} \qquad \text{(ft/sec)} \qquad \text{Eq. 1}$$

where: A = 636 ft^2 (see Note 1)
Q = 14,600 gpm (see Note 2)

1. For the calculation of strainer velocity, the strainer is assumed to have 5% of surface area completely blocked by fiberglass fabric in addition to insulation debris [Ref. 1]. The strainer wetted surface area of perforated plate is 670 ft^2 [Ref. 5]. This yields a strainer net area of (670)*(0.95) = 636 ft^2.

2. Total flow through one strainer is based on 2 RHR and 1 Core Spray pump operating simultaneously.

$$V = \frac{(14{,}600 \times 1/7.4805 \times 1/60)}{636}$$

V = 0.0511 ft/sec

The debris bed is assumed to be uniformly deposited to the following depth:

$$t = \frac{Volume\left(ft^3\right)}{A\left(ft^2\right)} \quad \text{(ft)} \qquad \text{Eq. 2}$$

$$t = \frac{23\ ft^3}{636\ ft^2}$$

$$t = 0.0362 \text{ ft}$$

From NUREG-0897 Rev. 1 [Ref. 3], the correlation equation for the head loss due to low density fiberglass insulation is:

$$h_{DEBRIS} = 68.3(V)^{1.79} * (t)^{1.07} \quad \text{(ft)} \qquad \text{Eq. 3}$$

$$h_{DEBRIS} = 68.3(0.0511)^{1.79} * (0.0362)^{1.07}$$

$$h_{DEBRIS} = 0.0096 \text{ ft}$$

From Calculation M-662, Table 5 [Ref. 4], the minimum available margin for LOCA debris for the limiting Core Spray pump is:

$NPSH_M = 2.15$ ft @ 0.5 psig Wetwell Pressure
$NPSH_M = 0.96$ ft @ 0.0 psig Wetwell Pressure

This 2.15 ft NPSH margin is very conservatively based on only the containment pressure available prior to the accident while the 0.96 ft margin is based on zero positive pressure following a DBA-LOCA . Therefore, there is adequate NPSH margin to accommodate the postulated debris without affecting pump performance.

F. References

1. GE Report GE-NE-B13-01805-11 "Effects of Fiberglass Insulation Debris on Pilgrim ECCS Pump Performance" January 1996, SUDDS/RF # 96-02.
2. Regulatory Guide 1.82 Rev. 1, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident", U.S. Nuclear Regulatory Commission, November, 1985.
3. NUREG-0897, Rev. 1 "Containment Emergency Sump Performance", U.S. Nuclear Regulatory Commission, October 1985.
4. BECo Calculation M-662 Rev. E2 "RHR and Core Spray Pump NPSH and Suction Pressure Drop".
5. Pilgrim ECCS Suction Strainer Data Sheet per Specification M-618.
6. FSAR Section 14.5.3 "Loss of Coolant Accident".

G. List of Attachments

Attachment 1 = Independent Verification Statement Record (1 page)

Calculation - Independent Verification Statement Record

Calculation # M-734, Revision # 0 has been independently verified by the following method(s), as noted below:

Mark each item yes, no or not applicable (N/A) and initial each item checked by you.

Design Review [X] including verification that:

- YES Design inputs were correctly selected and included in the calculation.
- YES Assumptions are adequately described and are reasonable.
- YES Input or assumptions requiring confirmation are identified, and if any exist, the calculation has been identified as "Preliminary" and a "Finalization Due Date" has been specified.
- YES Design requirements from applicable codes, standards and regulatory documents are identified and reflected in the design.
- YES Applicable construction and operating experience was considered in the design.
- YES The calculation number has been properly obtained and entered.
- YES An appropriate design method or computer code was used.
- YES A mathematical check has been performed.
- YES The output is reasonable compared to the input.

Alternate Calculation [ ] including verification of asterisked items noted above. The alternate calculation (pages) is attached.

Qualification Testing [ ] for design feature including verification of asterisked items noted above and the following:

- The test was performed in accordance with written test procedures.
- Most adverse design conditions were used in the test.
- Scaling laws were established and verified and error analyses were performed, if applicable.
- Test acceptance criteria were clearly related to the design calculation.
- Test results (documented in) were reviewed by the calculation Preparer or other cognizant engineer.

Independent Reviewer Comments: No Comments

/S/ M. E. O'Connor 4/10/97
Independent Reviewer /Date

Preparer concurrence with findings and comment resolution /S/ P. D. Hariji 4-10-97
Preparer or Other Cognizant Engineer

Note: Exhibit 3.06-B (Sheet 3 of 3) may to used for additional comments by IV as a part of the Independent Verification for calculations.