ENCLOSURE 3

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Robert G. Byram
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Director of Nuclear Reactor Regulation
Attention: Mr. C. L. Miller, Project Director
Project Directorate I-2
Division of Reactor Projects
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
RESPONSE TO 10/20/93 RAI ON SPENT
FUEL POOL COOLING SYSTEM
PLA-4044 FILES R41-2/[illegible]

Docket Nos. 50-387
and 50-388

Reference: NRC letter, J.W. Shea to R.G. Byram, dated October 20, 1993.

Dear Mr. Miller:

Enclosed please find PP&L's complete response to your request for additional information on the effects of a loss of spent fuel pool cooling event following a loss of coolant accident. Questions should be directed to Mr. R.R. Sgarro at (215) 774-7914.

Very truly yours,

R. G. Byram

Enclosure

cc: NRC Document Control Desk (original)
NRC Region I
Mr. G. S. Barber, NRC Sr. Resident Inspector - SSES
Mr. R. J. Clark, NRC Sr. Project Manager - Rockville
Mr. J. W. Shea, NRC Project Manager - Rockville

PP&L RESPONSE TO

NRC REQUEST FOR ADDITIONAL INFORMATION

ON THE

EFFECTS OF A LOSS OF SPENT FUEL POOL COOLING

FOLLOWING A LOSS OF COOLANT ACCIDENT

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 AND 2

DOCKET NOS. 50-387 AND 50-388

NOVEMBER 1, 1993

INTRODUCTION

This document responds to the October 20, 1993 NRC Request for Additional Information (RAI) on the Effects of a Loss of Spent Fuel Pool (SFP) Cooling Event Following a Loss of Coolant Accident. In this request, the NRC identifies the need for additional information on the ability of the SFP cooling related systems to withstand hydrodynamic loads, and the ability of the RHR system to operate in the SFP cooling mode without experiencing NPSH problems.[1] Specifically, the RAI makes the following requests:

1. With regard to the effect of hydrodynamic loads on SFP cooling related systems, please provide:

    a) A summary of the design criteria for piping and hangers in SFP cooling related systems.

    b) A summary of the loads (static, deadweight, etc.) that were considered in the design analysis of the piping and hangers in SFP cooling related systems.

    c) Summarize the results of any additional analyses of the SFP cooling related systems that considered the effect of LOCA hydrodynamic loads on these systems.

2. With regard to the use of RHR in the SFP cooling mode, provide:

    a) A description of the pre-operational tests including system lineups and initial conditions.

    b) Copies of the relevant pre-operational test data sheets showing results for the RHR Fuel Pool Cooling mode.

PP&L RESPONSES

1. Effect of Hydrodynamic Loads on SFP Cooling Related Systems

The RAI identifies concerns with regard to the ability of the SFP cooling related systems to withstand LOCA induced hydrodynamic loads. The LOCA dynamic loads in the reactor building which affect SFP cooling related piping result from pressure loads at the suppression pool boundary solely caused by steam condensation at the downcomer exits during a LOCA

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[1] SFP COOLING RELATED SYSTEMS REFER TO THE NORMAL SFP COOLING SYSTEM AND NON-SAFETY RELATED SERVICE WATER. THE CONDENSATE CONNECTIONS TO THE SFP COOLING PUMPS ARE NOT REQUIRED TO SUPPORT PUMP OPERATION AND ARE PROVIDED AS AN ALTERNATE MEANS OF ADDING WATER TO THE SFP SYSTEM.

blowdown (i.e., condensation oscillation and chugging). The "pool swell" phase of the LOCA, where the non-condensibles are displaced to the wetwell causing a portion of the suppression pool water volume to be lifted, does not produce dynamic loads in the reactor building. The accelerations ("g" levels) throughout the reactor building resulting from the LOCA hydrodynamic loads are approximately 2 to 3 times less than the levels associated with an earthquake (Safe Shutdown Earthquake (SSE)). A typical comparison of peak spectral acceleration values is 0.6 g's for hydrodynamic loads (LOCA) versus 2.0 g's for an earthquake (SSE).

The September 1992 report (Attachment 15 to the Part 21 report) referenced in the RAI was an independent assessment of the concerns ultimately raised in the Part 21 report. It was performed at the request of the Manager of Nuclear Engineering. Attachment 1 provides a timeline for the activities performed by PP&L relative to the effect of hydrodynamic loads on SFP cooling related systems. The September 1992 report does note that the SFP cooling related piping is not designed for hydrodynamic loads and therefore, could be susceptible to a loss of integrity. The report goes on to state (as noted in the RAI) that long-term failure of the SFP cooling system will be assumed in order to evaluate a worst case condition. No calculations or structural evaluations were performed by the author of the report in making this assumption. It should be noted that in PP&L's first internal report on the contractors' concern (NE-092-002, Attachment 30 to the Part 21), the engineers assigned to resolution of the issue also recognized the potential for hydrodynamic loads to compromise the integrity of SFP cooling related piping.

The SFP cooling piping is located in the reactor building on el. 749'-0" and above. It is an ASME Section III, Class 3 / ANSI B31.1, non-safety related, and non-seismically designed system, except for the portion that interfaces with the RHR Fuel Pool Cooling mode. That portion of piping is ASME Section III, Class 3 and Seismic Category I design. The SFP cooling system is supported primarily by spring cans / rigid hangers and is analyzed by computer for deadweight and thermal loads. The normal service water system is primarily of non-seismic design and is an ANSI B31.1, non-safety related system.[2] The portions located in the reactor building are located on el. 719'-0" and above. The service water system is mainly supported for deadweight only in accordance with AE field installation criteria. No piping stress calculations were performed since the system has a low design temperature and is non-ASME/non-safety related.

As part of the NE-092-002 report, PP&L piping engineers developed a qualitative assessment of the ability of SFP cooling related piping to withstand LOCA hydrodynamic loads. This assessment was based on engineering judgement and considerable experience with similar structural issues. The principal element of this judgement was the magnitude of the load increase (≈25% over deadweight) produced by hydrodynamic loads as compared to the reserve capacity that would be expected to be available in the supports. The maximum horizontal and vertical accelerations resulting from hydrodynamic loads are 0.9 g's and 0.5 g's respectively.

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[2] SOME PORTIONS OF THE NORMAL SERVICE WATER SYSTEM ARE DESIGNED FOR SEISMIC AND HYDRODYNAMIC LOADS.

The frequencies associated with these accelerations are ≥ 20 Hz, while the frequencies for earthquake loads are ≤ 10 Hz. The natural frequencies of the piping systems and structures involved are typically in the ≤ 10 Hz. range so that the high frequency hydrodynamic loads will have a minimal impact on pipe displacement (≤ 1/16" is expected). The ability of the supports to accommodate this load increase combined with the minimal displacements indicates that the increase in pipe stress will be minimal.

Recent calculations to determine the impact of hydrodynamic loads on the SFP cooling system indicate that the increase due to hydrodynamic loads is ≈500 psi, and the total pipe stress is ≈3,000 psi (faulted allowable = 36,000 psi). For normal service water, the increase due to hydrodynamic loads is ≈1530 psi and the total pipe stress is ≈5,200 psi (faulted allowable = 28,800 psi). The support and nozzle loads for the SFP cooling heat exchangers and pumps were determined to be within allowable values. The recent calculations also determined that the pipe displacements due to hydrodynamic loads are ≤ 0.080".

Therefore, even though the systems are not designed for hydrodynamic loads, PP&L expects the normal SFPC and its support systems (e.g., non-safety related service water) to remain functional post-LOCA. This expectation, along with the recognition that other cooling systems may be required, has been noted in all of PP&L's communications to the NRC on the loss of SFP cooling issue. PP&L has always considered that it may not be possible to restore cooling to the SFP using the normal systems. Should this occur, the RHR system or the opposite unit's systems (RHR and normal SFPC) could be used to cool both SFPs. Thus, SFP cooling would be achieved.

The calculations and assessments that support the above conclusions are available for NRC staff review, if desired, at PP&L's corporate engineering offices.

2. Ability to Use RHR in SFP Cooling Mode

The RAI indicates that it may not be possible to use RHR in the SFP cooling mode, based on a letter prepared by the PP&L Manager of the Nuclear Safety Assessment Group (NSAG) (Attachment 16 to the Part 21 report). This letter was also the basis for the concerns raised in NE-092-002 regarding the use of RHR in the SFP cooling mode of operation. However, discussions with (past and present) NSAG personnel indicate that the statements in the letter were based on the recollection of an individual involved in the RHR test program rather than actual test records. In writing the letter of 9/9/92 (Attachment 16 to the Part 21 report), the Manager of NSAG misinterpreted the individual and assumed he was referring to the pre-operational test. The individual was actually referring to the flush of the SFP cooling system using RHR in the SFP cooling mode, where a maximum flow of ≈2,000 gpm was attained without running the Skimmer surge tank dry. The system flush was performed prior to the individual joining NSAG in June of 1981. The actual pre-operational tests were performed on 8/23/82 (Unit 1) and 7/21/84 (Unit 2). During the pre-operational tests, the personnel recognized the need to raise water level in the SFP in order to support the higher flowrate of the RHR pumps (≈5,700 gpm vs. ≈1,800 gpm for SFP cooling). With level raised prior to starting the RHR pumps, the test was successfully performed at the higher flowrate required for the RHR Fuel Pool Cooling Mode without running the Skimmer Surge Tank dry.

A document review performed subsequent to the Part 21 report found the original test results (Pre-operational Test Nos. P49.1 for Unit 1 and P249.1 for Unit 2) which demonstrated the acceptability of this mode of RHR. The test results show that each unit was capable of achieving at least 5,700 gpm for the Fuel Pool Cooling mode of RHR. A description of the system line-ups and initial conditions for the pre-operational tests is provided in Attachment 2 of this document. The test results data sheets are provided in Attachment 3 of this document.

A calculation (M-RHR-039, revision 0, dated 5-17-93) performed to assess this mode of operation agrees well with the results of the pre-operational test data. The calculation shows that at the SFP level used for the successful test (≈8" above the skimmer weir) a flowrate of ≈5,700 gpm can be sustained; while at the normal water level (≈2" above the skimmer weir) a flowrate of only 2,000 gpm can be sustained. The need to pre-fill the SFP to 8" above the weir was added to the procedures for using this mode of RHR as part of the procedure enhancements discussed in PP&L's August 16, 1993 submittal. A review of RHR system calculations indicates that significant NPSH would be available to the RHR pumps in the SFP Cooling mode of operation.

The pre-operational test procedures, system line-ups, initial conditions, and results are available for NRC staff review, if desired, at Susquehanna SES.

SUMMARY

PP&L believes that the above responses answer the questions raised in the October 20, 1993 RAI on the loss of SFP cooling issue. PP&L has assessed the SFP cooling related piping with regard to hydrodynamic loads and has concluded that this piping should remain functional post-LOCA. PP&L has recognized that the normal SFP cooling system could be lost for various reasons and has determined that other systems can be used to cool the SFP. Among these systems is the RHR SFP Cooling mode, which has been proven by pre-operational testing and verified by calculation to be capable of providing long term cooling to the SFP.

ATTACHMENT 1

FUEL POOL COOLING ISSUE
TIMELINE FOR ACTIONS RELATIVE TO HYDRODYNAMIC LOADS

≈ 8/1/92: K. Brinckman is assigned by George Jones (Manager Nuclear Engineering) to perform an independent assessment of the concerns raised by the contractors in their Engineering Discrepancy Report (EDR G20020).

8/27/92: PLI-72267, memo from G. Jones to G. Miller (Supervisor Engineering Technology) providing instruction to accelerate the schedule for evaluating the concerns raised in EDR G20020 and organize a dedicated response team .

8/31/92: PLI-72297, memo from G. Miller responding to G. Jones memo PLI-72267. This memo initiates work on NE-092-002, which ultimately provides PP&L's initial formal evaluation of the concerns.

9/01/92: PLI-72288, memo transmitting K. Brinckman's independent review to G. Jones. This report provides the first formal identification of the possibility of hydrodynamic loads affecting Fuel Pool Cooling and Service Water piping.

9/23/92: First Draft of NE-092-002 is issued for review. This draft acknowledges the potential for hydrodynamic loads to disable Fuel Pool Cooling and service Water piping under design basis assumptions. No evaluation of the ability of the piping to withstand these loads has been made at this point since the event can be mitigated without use of the Fuel Pool Cooling system under "realistic" assumptions.

10/21/92: "Engineering Assessment of Fuel Pool Cooling Piping EDR-G20020" is completed by piping personnel assigned to the evaluation team. This assessment concludes that the piping of concern should be expected to remain functional after being subjected to hydrodynamic loads. This assessment is included in the final draft of NE-092-002 and ultimately is included in the Revision 0 of NE-092-002.

10/27/92: Final draft of NE-092-002 is issued for review. Included in this review is K. Brinckman (independent review author). He does not provide any comments disputing the assessment of the piping for hydrodynamic loads.

10/29/92: NE-092-002 is issued and transmitted to G. Jones by memo PLI-72763. This report notes that the Fuel Pool Cooling and Service Water piping should be expected to remain functional after being subjected to hydrodynamic loads. It also notes that if the Fuel Pool Cooling system was disabled, other actions could be taken to mitigate the event.

FUEL POOL COOLING ISSUE
PRE-OPERATIONAL TEST DESCRIPTION

Both Unit 1 and 2 RHR Systems were operated/tested in the Fuel Pool Cooling Assist Mode in accordance with their respective Preoperational Tests during initial plant startup.

Unit 1 was tested in accordance with P49.1, section 7.4.6 on 8/23/82, and Unit 2 was tested in accordance with P249.1A, section 7.4.6 on 7/21/84. A summary of test results are shown on Attachment 3.

Both pre-ops lined up RHR and Fuel Pool Cooling in accordance with their appropriate Operational Procedures at that time, (OP-49-001 Rev. 0 and OP-249-001 Rev. 1, respectively).

Typical preoperational test, lineup is as follows, in accordance with OP-49/249-003, (ref. attached diagram)

Prerequisites

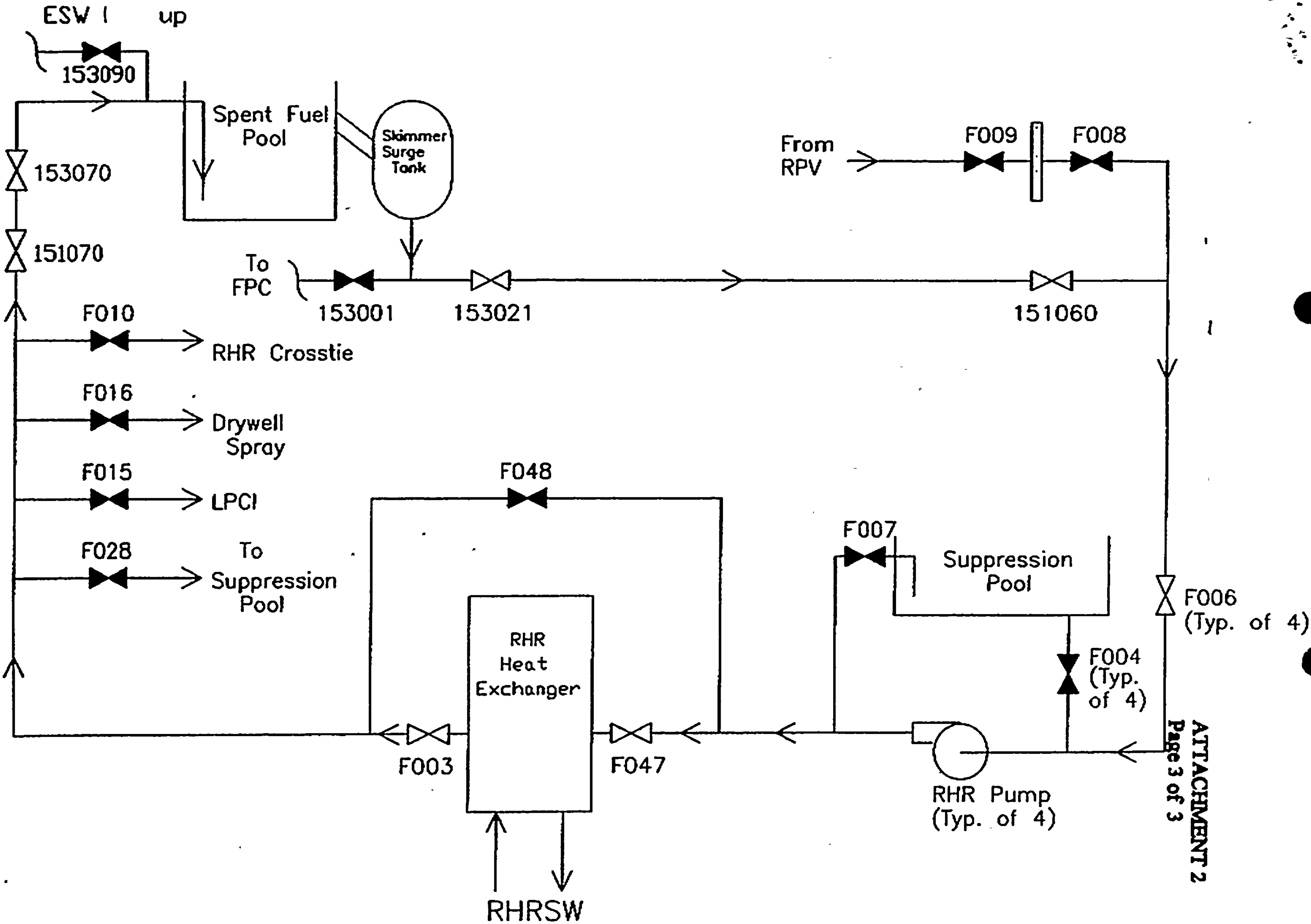
- RHR is in standby alignment
- RHRSW and ESW are available
- Fuel Pool Cooling is shutdown

Lineup

- RHR minimum flow valve (F007) interlock is defeated to prevent inadvertent dumping of Fuel Pool water into the Suppression Pool
- Fuel Pool (FP) Skimmer Surge Tank to Fuel Pool Pump valve, 153001 is closed
- FP Skimmer Surge Tank to RHR valve, 153021 is opened
- FP to RHR valve 151060 is opened
- The 2 normal RHR Suppression Pool suction valves (F004), for the loop to be used, are closed

- The appropriate RHR Shutdown Cooling suction valve (F006), for the pump to be used, is opened
- RHR to Fuel Pool valve 151070 is opened
- RHR Heat Exchanger valves, F003, F048 are open and after pump is started, the F048 will be throttled for desired cooling
- RHR Heat Exchanger inlet valve (F047) is closed
- Ensure adequate Fuel Pool level (makeup via condensate transfer or Emergency Service Water (ESW))
- Check system filled and vented
- Start pump and throttle flow between 1500 - 6000 gpm as desired (1500 gpm is needed for min flow pump protection)

In summary, the RHR Fuel Pool Cooling Assist mode of operation has been successfully tested on both units. Procedure inadequacies were discovered and subsequently corrected.



Typical Lineup of
RHR Fuel Pool Assist

ATTACHMENT 3

FUEL POOL COOLING ISSUE
PRE-OPERATIONAL TEST RESULTS SUMMARY*

	Unit 1		Unit 2
Acceptance Criteria (gpm)		6000 +0, -500	
Actual Flow (gpm)	5800		5700
Suction Pressure (psig)	30		34
Discharge Pressure (psig)	325		325
Fuel Pool Level	> 22 ft.		10" below lip of curb
Fuel Pool Temperature (°F)	58°		76°
NPSH (calculated) (feet)	34.75**		43.52

* Results obtained from P49.1, and P249.1A section 7.4.6.1, data sheet 7.4.6.1 .

** Revised calc, upon checking calc, found it to be in error in P49.1A initially recorded as 70.71 ft.