VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 14, 1978

Mr. Edson G. Case, Acting Director
Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Serial No. 069A/013178
PO&M/ALH:das
Docket Nos. 50-280
50-281
License Nos. DPR-32
DPR-37

Attention: Mr. Albert Schwencer, Chief
Operating Reactors Branch 1

Dear Mr. Case:

We submitted a letter to you on March 16, 1978 stating that certain information would be provided regarding our November 22, 1977 submittal for the permanent solution of the low head safety injection and recirculation spray pumps net positive suction head problems. We are still working with our A-E to provide responses to all of your requests. Responses to requests 1.0, 3.0, 9.0 and 12.0 are attached. We will continue to forward responses to the remainder of your requests as the information becomes available.

Very truly yours,

C. M. Stallings
Vice President - Power Supply
and Production Operations

Attachment

cc: Mr. J. P. O'Reilly

781070058

RESPONSES FOR NRC
REQUEST FOR ADDITIONAL INFORMATION
SURRY POWER STATION, UNITS 1 AND 2
DOCKET NOS. 50-280/281

Request 1.0

Describe and justify the analytical procedure used to conservatively determine the maximum containment second peak pressure and maximum containment third peak pressure, respectively, for a spectrum of postulated cold leg breaks.

Response

The analytical procedure used to conservatively determine the maximum containment second and third peak pressures is that portion of the LOCTIC computer program dealing with mass and energy release rates. A complete discussion of the method used for this calculation is presented in our response to question 8.0 and 8.1. Additional conservatism has been applied to this method to maximize second and third peak pressures as listed below.

The containment second peak pressure is maximized using the following assumptions:

1. Conservatively high mass and energy release rates calculated as indicated in response to questions 8.0 and 8.1

2. The Tagami condensing coefficient discussed in response to question 3.1 that underestimates condensing heat transfer

3. The maximum air partial pressure allowed by the technical specification with maximum initial dry bulb and dew point temperature. Maximum initial dry bulb temperature minimizes the effectiveness of the heat sinks, and maximum initial dew point maximizes the initial total pressure.

4. Use of Minimum ESF - Minimum ESF maximizes the release rates and minimizes quench spray flow.

The containment third peak pressure is maximized using the following assumptions:

1. Conservatively high mass and energy releases rates calculated as indicated in response to questions 8.0 and 8.1

2. The maximum air partial pressure allowed by the technical specification with the minimum allowable dry bulb temperature at 100 percent relative humidity. The minimum dry bulb temperature maximizes the containment air mass, and the 100 percent relative humidity assumption maximizes the inital total containment pressure.

3. Use of Minimum ESF - Table 8 of Reference 1-1 demonstrates that Minimum ESF is the single failure assumption the maximizes the third peak.

Reference

1-1 NPSH Report - Surry 1 & 2, forwarded to Mr. Edson G. Case, Acting Director of Nuclear Reactor Regulation, US NRC from Mr. C. M. Stallings, Vice President - Power Supply and Production Operations, VEPCO, dated November 22, 1977.

Request 3.0

For the case which results in the maximum containment second peak pressure and for the case which results in the maximum containment third peak pressure, provide the following information:

Request 3.1

A discussion of the conservatism in the heat transfer correlations used to calculate the heat transfer from the containment atmosphere to the passive heat sinks and vice versa:

Response

The heat transfer coefficient for condensation at surfaces inside the containment structure used in LOCTIC is the Tagami condensing coefficient (Reference 3-1) and is presented in the following table:

| MATERIAL | TIME | CONDENSING COEFFICIENT |
|---|---|---|
| Steel and painted concrete | During decompression | $h = hmax\ (t/tp)$ |
| | At end of decompression | $h = hmax = 75 \left(\frac{Q}{Vt_p}\right)^{0.60}$ |
| | After decompression | $h = hstag + (hmax - hstag)\ Y$ |

Where:

| | | |
|---|---|---|
| $h$ | = | Tagami heat transfer coefficient, Btu/hr-sq ft-F |
| $t$ | = | time after rupture of primary system, sec |
| $t_p$ | = | time at end of decompression, sec |
| $Q$ | = | energy released to containment during decompression, Btu |
| $V$ | = | containment free volume, cu ft |
| hstag | = | 2 + 50x, Btu/hr - sq ft - F |
| $x$ | = | steam/air mass ratio |
| $Y$ | = | $EXP\ \{-0.05\ (t-t_p)\}$ |

The use of the Tagami condensing coefficient is very conservative, as exhibited in Figure 3.1-1. The measured pressure transient was obtained from Test 3 of the Simulated Design Basis Accident tests of the Carolinas Virginia Tube Reactor Containment (Reference 3-2). The CONTEMPT best estimate calculation using the Uchida condensing coefficient generates a peak pressure 45 percent greater than the measured peak. The use of the Tagami condensing coefficient would yield a similar result.

Better agreement with the data is achieved using the TAEH average coefficient to calculate the condensing heat transfer. Figure 3B of Reference 3-2 indicates that the TAEH average coefficient is four times the Uchida value at the time of peak pressure.

If the heat sink surface temperature is greater than the dew point temperature, convective heat transfer to the containment atmosphere is calculated using a conservatively high constant heat transfer coefficient value of 1.8 Btu/hr-ft$^2$F. It is conservative to overestimate heat transfer to the containment atmosphere. This reversal occurs as the containment atmosphere is depressuring and approaching atmospheric pressure. The heat transfer is considered as natural convection to air because of the mass energy releases to the containment are relatively small at the time (decay heat boil-off).

Kreith(Reference 3-3) recommends, for convection from vertical plates in the turbulent region (Grashoff number greater than $10^{10}$):

$$h = \frac{k}{L} 0.021 \, (Gr \; Pr)^{2/5}$$

Where:

| | | |
|---|---|---|
| L | = | height of heat sink |
| h | = | convective heat transfer coefficient |
| k | = | thermal conductivity |
| Gr | = | Grashoff number |
| Pr | = | Prandtl number |

McAdams (Reference 3-4) recommends, for free convection from vertical plates for Gr greater than $10^9$, the correlation

$$Nu = 0.13 \, (Gr \; Pr)^{1/3}$$

The properties are evaluated at the mean film temperature. The Grashoff number is proportional to the temperature difference between the heat sink and the containment atmosphere and also is proportional to the height of the sink cubed.

Figures 3.1-2 and 3.1-3 present sensitivity of the convective heat transfer coefficient to the heat sink containment atmosphere temperature difference and the heat sink height, respectively. The curves demonstrate that, for very conservative bounding values, the calculated heat transfer coefficient is about one-half of the value used in LOCTIC (1.8 Btu/hr-ft$^2$F).

References

3-1 Takashi Tagami, "Interim Report on Safety Assessments and Facilities Establishment Project in Japan for Period Ending June, 1965 (No. 1), February 28, 1966, Section IV.

3-2 Schmitt, R.C., et al, "Simulated Design Basis Accident Tests of the Carolinas Virginia Tube Reactor Containment - Final Report." IN-1403, December 1970.

3-3 Kreith, F., Principles of Heat Transfer, International Textbook Company (1966).

3-4 McAdam, W. H., Heat Transmission, McGraw Hill (1954).

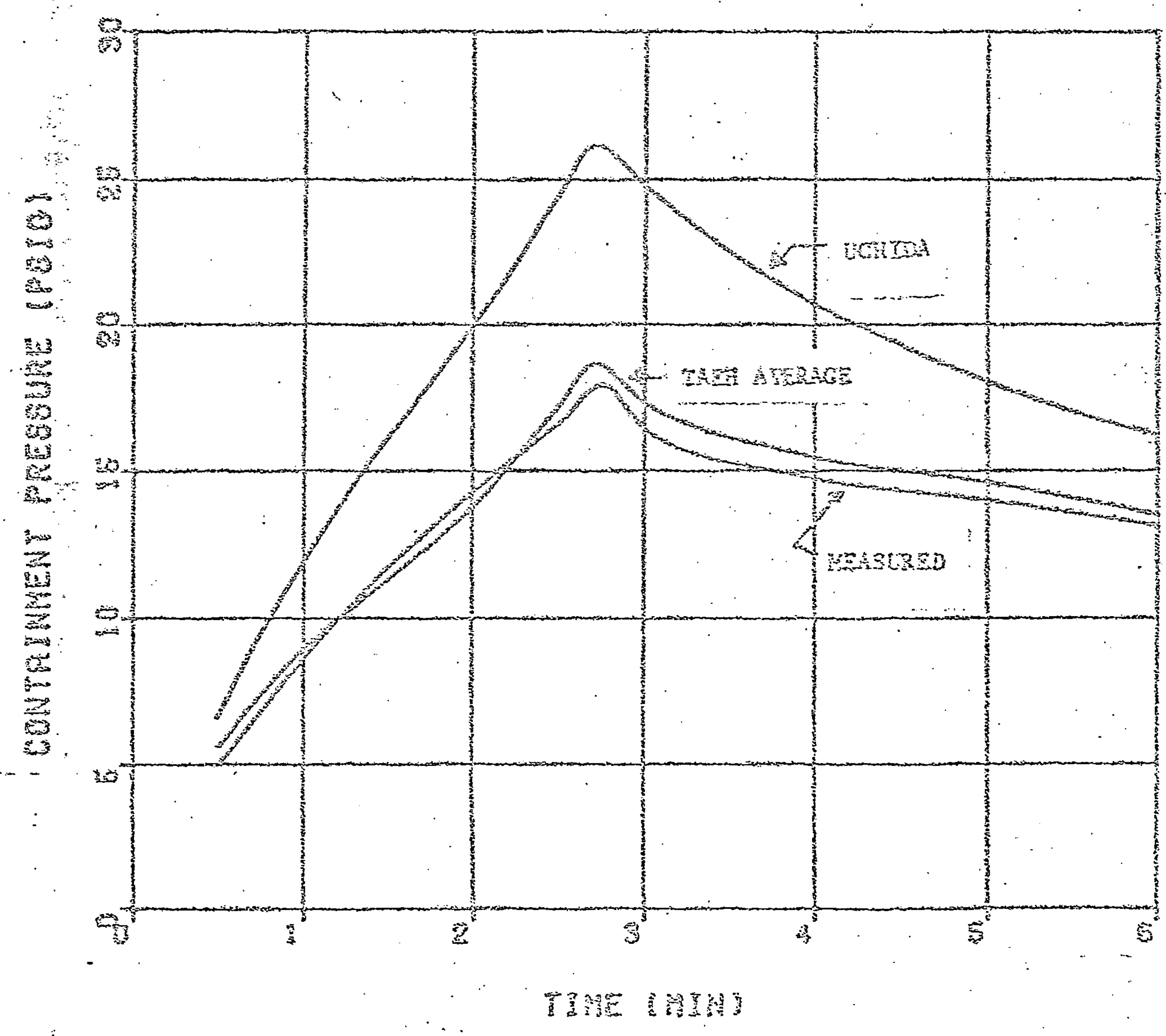



FIGURE 3.1-1

STEAM TEST 3

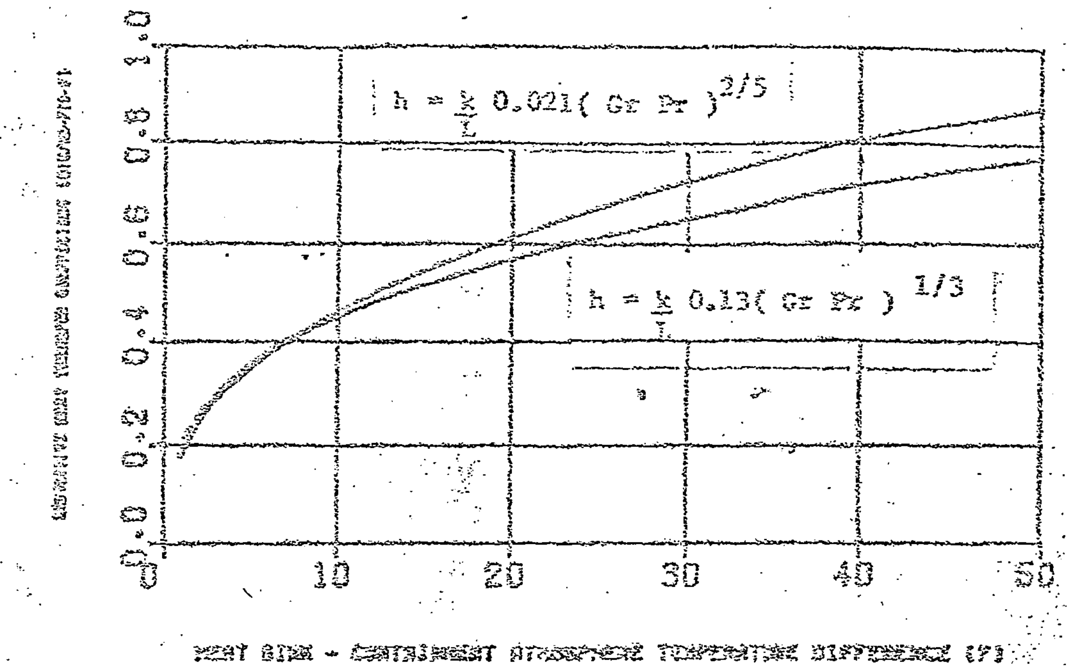



FIGURE 3.1-2

CONVECTIVE HEAT TRANSFER COEFFICIENT

SENSITIVITY TO TEMPERATURE DIFFERENCE

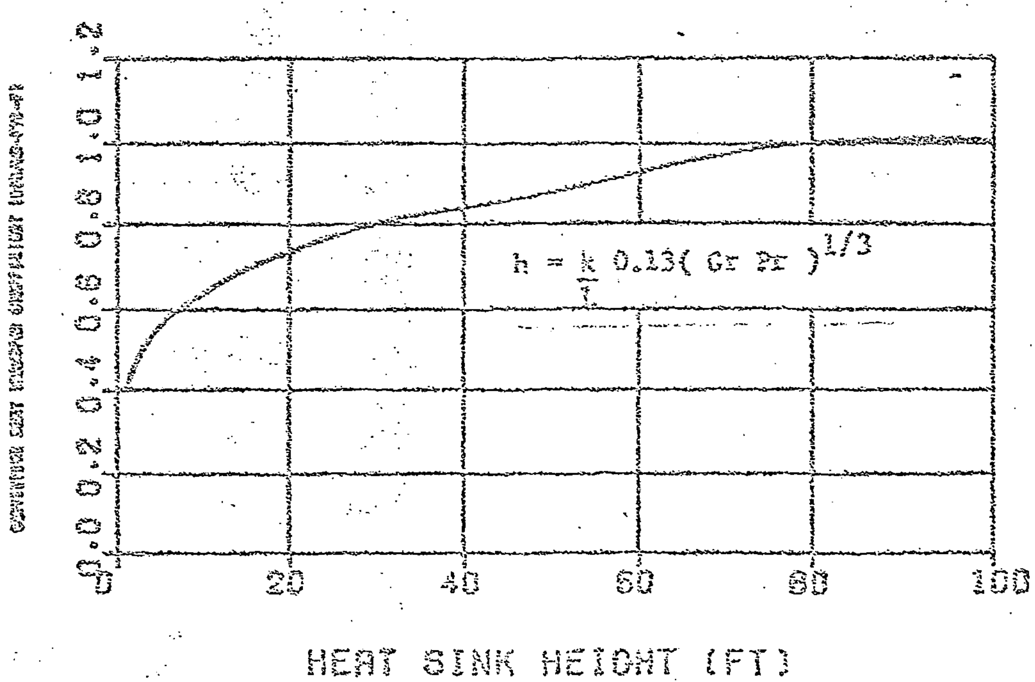



FIGURE 3.1-3

CONVECTIVE HEAT TRANSFER COEFFICIENT

SENSITIVITY TO HEAT SINK HEIGHT FOR

Request 9.0

Provide a detailed schematic drawing to show the modifications of the containment recirculation spray system.

Response

See Figure 9.0-1 " Recirculation Spray Pump NPSH Modification"

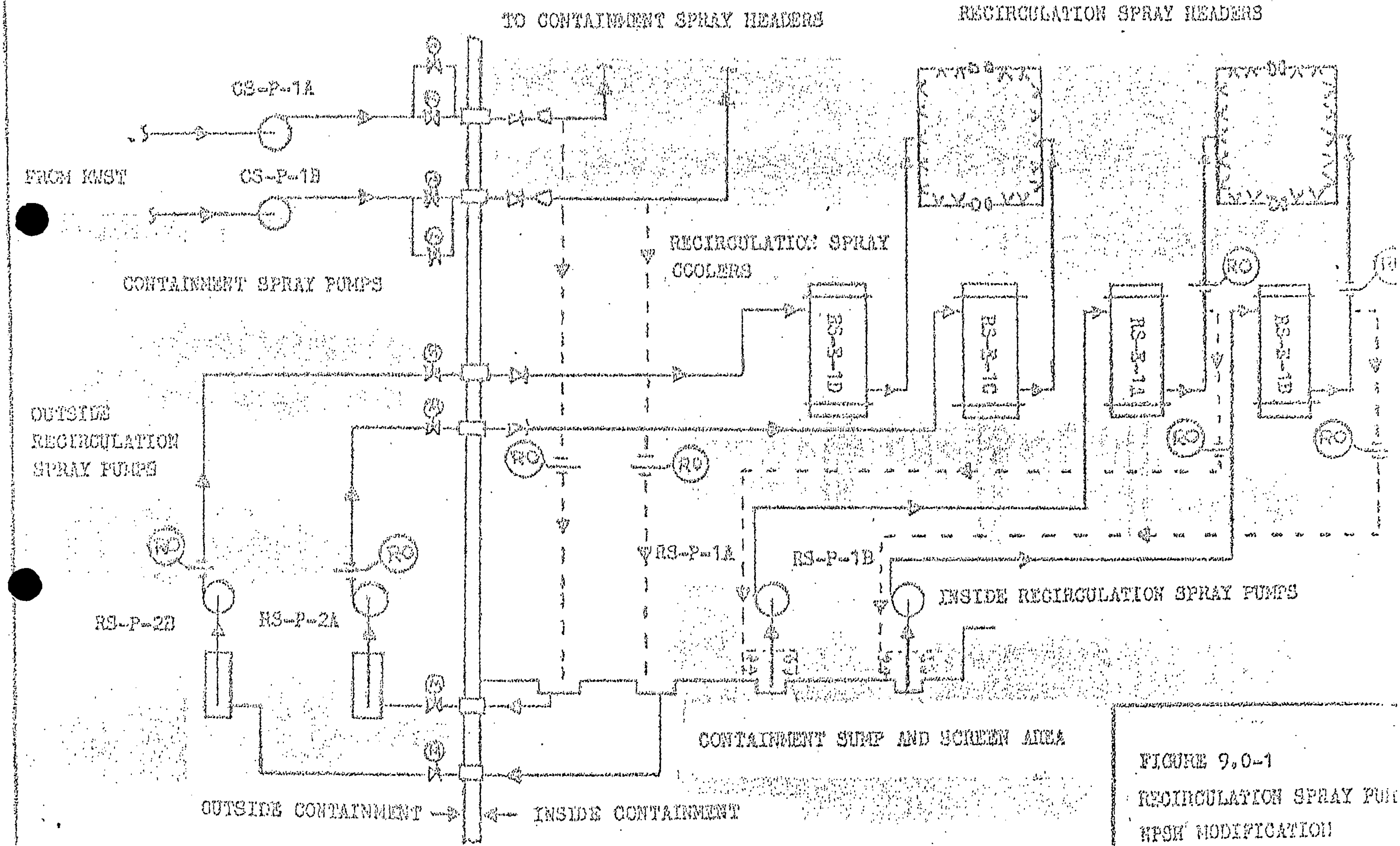



FIGURE 9.0-1
RECIRCULATION SPRAY PUM
NPSH MODIFICATION
SURRY 1 & 2

Request 12.0

Submit all cavitating venturi sizing calculations. Describe the flow tests to be performed to verify both the system pressure drop and flow rate with the cavitating venturi installed.

Response

Sizing of the venturis depends on the desired flow, the corresponding inlet pressure to the venturis and the lowest water temperature. The cavitating venturis were sized for the minimum single pump runout flow condition during the injection phase. The temperature of the injected water from the RWST is 40 F to 45 F.

The minimum required runout flow value of 3,249 gpm was selected based upon discussions with Westinghouse concerning the ECCS analysis. The inlet pressure was determined for an empty RWST. This means that the inlet pressure and hence the flow rates passed by the venturi will be higher for any other RWST level. Thus, a single pump runout flow will be always be higher than the minimum required value of 3,249 gpm.

The inlet pressure to the venturi during the injection phase is a function of the atmospheric pressure, the elevation difference between the RWST and the venturis, piping system friction pressure loss, and the total dynamic head of the pump. The friction loss and the pump head are flow dependent. The system friction loss was found using as-built piping drawings and the results of the preoperational tests which were performed with the LHSI pumps installed in the system. The pump head was found from the vendor's certified head flow curve developed from the shop tests. The results are given in Table 12.0-1.

The venturi performance characteristics are then submitted to the manufacturer who determines the physical characteristics of the venturi. A shop test to "prove" the sizing of the venturi is then conducted in the manufacturer's test loop.

After installation in the plant a performance test will be conducted using one LHSI pump in the recirculation mode. The maximum flow passed by the cavitating venturis depends on the inlet pressure. Since the venturis are located close to the three branch flow split, each will have the same inlet pressure. Hence, only one of the three branches to the reactor coolant system will be tested. The flow path and instrumentation is shown in Fig. 12.0-1, "Installed Cavitating venturi Performance Test." As shown in the drawing, the safety injection branch line will be cut and temporary piping will be routed back to the containment sump. A throttle valve will be utilized in the temporary piping to vary the downstream pressure.

The parameters that will be measured are the sump water level, the pump flow, the pump discharge pressure, the venturi inlet pressure, the pressure downstream of the temporary throttle valve, and the temperature of the water.

With one LHSI pump running, the throttle valve will be opened in steps until a constant flow is reached. The valve will then be opened further to show that the maximum flow passed by the venturi for a constant inlet pressure does not increase with decreasing downstream pressure.

The installed cavitating venturi performance will be acceptable if the measured maximum flow rate and corresponding venturi inlet pressure are within the respective ranges predicted for the test conditions. The predicted ranges depend upon conservatively high and low values for the system friction pressure loss and for the total dynamic head of the pump.

Table 12.0-1

CAVITATING VENTURI SIZING

I) Design Flow

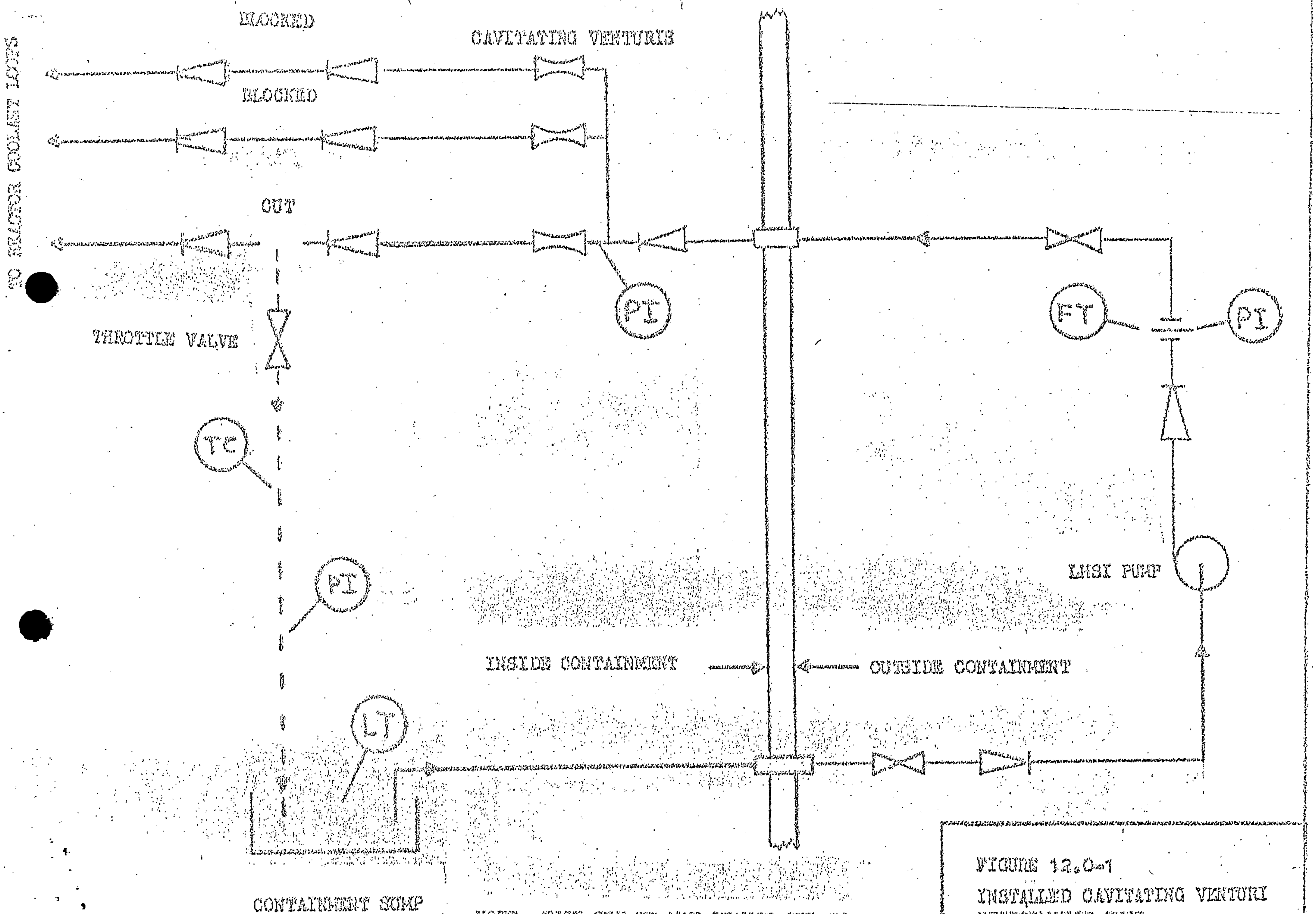
| | |
|---|---|
| Total Flow | 3249 gpm |
| Flow per venturi (1/3 Total) | 1083 gpm |

II) Design Vapor Pressure

| | |
|---|---|
| For RWST at 40-45F | 0.3 ft |

III) Design Inlet Pressure

| | | |
|---|---|---|
| A) | Atmospheric pressure | 33.9 ft |
| B) | Friction loss at design flow | 88.7 ft |
| C) | Pump head at design flow | 226.0 ft |
| D) | Elevation of RWST above venturis | 42.8 ft |
| E) | Inlet pressure (A+B+C+D) | 214.0 ft |




NOTE: TEST SET-UP MAY CHANGE DUE TO STATION AVAILABILITY

FIGURE 12.0-1
INSTALLED CAVITATING VENTURI PERFORMANCE TEST
SURRY 1 & 2