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September 12, 2000

Re: Indian Point Unit No. 2
Docket No. 50-247
NL-00-116

Document Control Desk
US Nuclear Regulatory Commission
Mail Station P1-137
Washington, DC 20555-0001

Subject: Response to Request for Additional Information – Generic Letter 96-06, "Assurance of Equipment Operability and Condition Integrity During Design Basis Accident Conditions," for Indian Point Unit No. 2 (TAC No. M96822)

Reference: NRC Letter to Con Edison dated July 13, 2000

Pursuant to 10 CFR 50.54(f), this letter provides Consolidated Edison Company of New York, Inc.'s (Con Edison) response to the NRC staff's request for additional information dated July 13, 2000 relative to Generic Letter 96-06. The attachment to this letter responds to the specific requests for additional information.

No new regulatory commitments are being made by Con Edison in this correspondence.

Should you or your staff have any questions regarding this matter, please contact Mr. John F. McCann, Manager, Nuclear Safety and Licensing.

Sincerely,

A. Alan Blind

Subscribed and sworn to
before me this 12 day
of September 2000

Ersilia A. Amanna (Bowen)

ERSILIA A. AMANNA
Notary Public, State of New York
No. 01AM6038689
Qualified in Westchester County
Commission Expires March 20, 2002

Attachment

A072

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ATTACHMENT

Response to Request for Additional Information
Generic Letter 96-06

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
September 2000

Item 1

Provide the justification for selecting the loss-of-coolant accident with concurrent loss of offsite power (LOCA/LOOP) as limiting scenario versus the main steam line break with concurrent LOOP (MSLB/LOOP).

Response

CCWH occurs when the pumps restart following a LOOP, LOOP/LOCA or LOOP/MSLB. The LOOP causes column separation to occur in the FCU supply and discharge lines creating voids. When the pumps restart the water column on the pump side is accelerated toward the water column on the other side of the void. The water hammer is created when the columns meet and the void collapses.

The CCWH is dependent on impact velocity. The impact velocity is maximized by minimizing the void pressure. "LOOP only" creates the minimum void pressure and is bounding for this condition. LOOP/LOCA creates the maximum void pressure and is therefore bounded by both "LOOP only" and LOOP/MSLB. In this analysis the column closure velocity was calculated assuming zero void pressure.

Impact velocity is also dependent on void size. The void must be large enough that maximum water column velocity is achieved. Void sizes were calculated for both LOOP/LOCA and "LOOP only." The void size for LOOP/MSLB would be in-between that of LOOP/LOCA and "LOOP only" and therefore was not calculated. LOOP/LOCA's higher void pressure created the largest void. The void sizes for LOOP/LOCA and "LOOP only" were both large enough to insure that the maximum impact velocity was achieved for the zero back pressure case. Therefore the CCWH for this analysis bounds LOOP/LOCA, LOOP/MSLB and LOOP only.

CIWH may occur during LOOP/LOCA or LOOP/MSLB as the system drains down. CIWH is a result of stratified flow in long lengths of horizontal pipe where the upper strata is steam and the lower strata contains water that is sub-cooled. The CIWH occurs when the stratified flow turns to slug flow and a volume of steam is trapped between the water slug and the down stream water column. The sub-cooled water causes the trapped steam to condense leaving the void at very low pressure (the saturation pressure of the sub-cooled water). The steam pressure on the upstream side of the water slug pushes it into the void causing it to impact on the down stream water column. The result is a short duration water hammer (the water slugs are short compared to the water columns in CCWH).

The limiting scenario for CIWH is LOOP/LOCA. LOOP/LOCA will cause the water in the FCU to boil to the highest temperature. The higher the temperature of the boiling water in the FCU, the higher the steam pressure during drain down. The higher steam pressure will accelerate the water slug to a high impact velocity maximizing the CIWH.

The LOCA accident is more severe than MSLB for CIWH, even though higher containment temperatures are attained in the latter case. The reason why the LOCA is more severe, even at a lower temperature, is due to several heat transfer considerations.

Heat transfer rates are a function of the following three factors:

1. The nature of the fluid
2. The temperature driving the heat transfer
3. The heat transfer coefficient

Each of these factors will be discussed.

1. When the LOCA occurs, the containment atmosphere becomes a mixture of air and water vapor. The temperature of this air water vapor mixture is the saturation temperature of the water vapor. The water vapor in the containment atmosphere will begin to condense when it comes in contact with any surface at a temperature less than the saturation temperature. The containment atmosphere in the MSLB case is air and superheated steam. The entire mixture has to cool to the saturation temperature before condensation can begin. Heat transfer during this cooling period will be by free convection around the FCU cooling tubes. Though the containment environment temperatures of the MSLB are slightly higher (for a short period of time) than those of the LOCA, the heat transfer rates are low during free convection.

   The range of typical heat transfer rates for condensing steam is 1000-20,000 BTU/(hr-ft^2-^{o}F). The range for heat transfer by free convection is 1-5 BTU/(hr-ft^2-^{o}F) [11]. This large difference indicates how much more effective condensing heat transfer is at raising the temperature of the water in the FCU.

2. The temperature driving force for condensing, where the latent heat of the steam is transferred from the steam to the Fan Cooling Unit (FCU) is the saturation temperature corresponding to the pressure of the steam. Since there is less steam in the containment atmosphere during the MSLB than in the LOCA accident, the pressure is lower and the saturation temperature is lower.

3. The heat transfer coefficient during condensing is proportional to its vapor to air ratio. Since the volume of liquid released during a LOCA is significantly greater than as a result of an MSLB, the heat transfer coefficient will be larger.

Since all conditions relating to heat release rate give lower rates for the MSLB accident, analysis of the LOCA is the worst case conditions.

The heat transfer analysis for IP2 predicted that the temperature of the water in the FCU would be approximately 174°F in 28 seconds. 28 seconds is the time of pump restart. The important point is that even with the high heat transfer film coefficients of the LOCA case, the FCU water temperature was much less than the LOCA containment of 260°F. Though the MSLB event may have a slightly higher containment temperature, the FCU water temperature would have been much less than that found for LOCA because of the order of magnitude lower film coefficients of MSLB.

Item 2

Con Ed assumed a sonic velocity of 2300 ft/sec, which is less than the 4500 ft/sec that is suggested in NUREG/CR-5220, "Diagnosis of Condensation-Induced Waterhammer," for bounding calculations. Provide a quantitative justification for the use of 2300 ft/sec.

Response

Consolidated Edison is a member of the EPRI Sponsored Waterhammer Utility Group to address GL96-06. This group has presented a Draft Technical Basis Report "Resolution of Generic Letter 96-06 Waterhammer Issues" TR-113594 to the ACRS for their review. The final report is expected to be issued in the Fall of 2000. This report will provide the industry techniques and references to address GL96-06 column closure and condensation-induced waterhammer. Item 2 will be addressed as part of that report.

Item 3

The Con Ed analyses were performed to compare predicted column closure waterhammer (CCWH) magnitudes with actual magnitudes that have been observed. Alternate valve line-ups were considered. However, sufficient information about the details of these analyses and tests, such as configurations, pressure measurement locations, and data scanning frequencies was not provided to allow an independent assessment by the staff. Provide these details.

Response

Column closure waterhammers have occurred in the service water supply and return lines of the containment Fan Cooler Units during performance testing of the Safety Injection System Electrical Load [ref 7].

Data monitoring of the IP2 FCU service water (SW) supply and return piping was performed during a Safety Injection System Electrical Load Test in May of 1997 [ref 2]. The test was performed with three pumps in operation and FCU 22 isolated. The objective of this evaluation was to collect field data related to waterhammer in the service water Containment Fan Cooler Unit (FCU) supply and return piping. Pressures that occurred during these tests were measured, post-test inspections of piping supports, were performed, and the piping was analytically evaluated.

The measurements included pressure, flow, strain, and acceleration at selected locations in the system. Field data was obtained using pressure transducers and externally mounted strain gages, an accelerometer, and flow meters. The sensors were located on SW Supply Line No. 11c and SW Return Line No. 12c to FCU No. 24 (see figures 1 and 2). The water hammer analysis establishes that SW piping to FCU No. 24 is representative of all the SW supply and return lines of the other FCUs. Thus, the primary focus of the test was to measure and assess the effect of the resulting waterhammer in SW Supply Line 11c and SW Return Line 12c.

All equipment except the flow meters were wired directly into a data acquisition computer. The computer retrieved data at an acquisition rate of 4,000 times per second. The data was retrieved into the computer software package for final viewing and plotting.

The pressure transducer range was 0 to 1,000 psia, with an accuracy of $\pm$ 0.25% of full scale. The pressure transducer has a frequency response of 3KHz. This range, accuracy and response is sufficient to detect the pressure in the supply and return line due to waterhammer disturbances.

Bondable strain gages were attached to selected pipe supports on both the supply and return lines. An informational only (i.e. time of response) accelerometer was installed on a supply line.

Flow measurements were recorded with strap-on Panametric transducer type flowmeters, one located on the supply line (line 11c), and one on the return line (line 12c)

Air (non-condensable gas) in water reduces the sonic velocity of water when the air comes out of solution. Waterhammer pressure is directly proportional to sonic velocity. The LOOP will cause the dissolved air in the water to come out of solution and reduce waterhammer pressures. Therefore the maximum expected water hammer pressure would occur when the water contains a minimum of dissolved air. The tests occurred in late May of 1997. A survey of year round oxygen levels over a span of an approximate 21-year period for the Hudson River, north of the plant at Poughkeepsie, NY, show a reasonably consistent trend with a clear pattern. Oxygen levels reach a high during the winter months and a low during the summer months. Because the tests occurred in May, to be conservative the measured water hammer pressures were increased by 10% (based on figure 1-6 of ref. 6) to account for the higher river water air content in May compared to that expected in June and July.

Following a review of the data collected during the system electrical load safety injection tests and with consideration of the evaluation of this data it is apparent that a mild column closure waterhammer occurred on the supply lines, with a normal system response to pressurization of the return line. The peak column closure waterhammer (CCWH) magnitude, which occurred on the supply piping, was measured at approximately 35 psi. With consideration of the recommended 10% water hammer pressure margin for air content variability, the resulting peak waterhammer magnitude was measured/calculated to be approximately 40 psi.

The test configuration was analyzed (for comparison to the test results) by creating a hydraulic model of the FCU supply and discharge piping. FCU 24 has the longest supply and discharge piping and therefore the vapor cavity created in the supply and discharge line to FCU 24 will be the last cavities to close. The resistance in FCU 21, 23, and 25 is included in all cases. The resistance in FCU 24 is only included in the return side column closure case. In this manner the flowrate toward the voids at the FCU 24 supply and discharge line can be conservatively calculated.

The flowrates calculated in this manner are steady state flowrates but the problem is a transient. This is addressed by the method presented in section 6.8 of ref 10. This method determines the transient flowrate (velocity) at the point of impact based on the steady state flowrate, total line resistance and the ratio of the initial water column length to the total of the initial water column length and the void length.

The CCWH impact flowrate was found in this manner. The calculated flowrate for FCU 24 was 3536 gpm vs. the normal operating flow of 1500 gpm.

The hydraulic analysis concluded that the measured pressure pulses were very conservatively bounded by the analyzed pressure pulse magnitudes. The calculated

CCWH for the supply side was 250 psi and 204 on the return side [page 13 ref 1]. The measured pressure pulse was 35 psi.

Item 4

Plant-specific modeling, hand calculations, and spread sheets were used to evaluate drain-down and the potential for condensate-induced waterhammer to occur. Provide additional details about these calculations to allow an independent assessment of the work by the staff.

Response

A mathematical hydraulic model of the service water system was created using spread sheets and hand calculations. The hydraulic model consisted of sources, sinks, pump curves, flow paths (flow area), resistances and elevations of key locations. The model was based on drawings, specifications and measured pressures and flow rates. Steady state operation of the model was benchmarked against measured pressures and flow rates.

Void locations and sizes during LOOP and LOOP/LOCA were determined from the basic Bernoulli equation written between points of the hydraulic model.

For the LOOP only condition, the hydraulic model was "broken or separated" at the high point elevation. One point for the supply side and one point for the discharge side. These points were assumed to be a constant pressure boundary condition. The pressure was set to the vapor pressure of the service water at this location prior to the LOOP.

The Bernoulli equation was then written between the nodes of the hydraulic model. The Bernoulli equations then formed a system of equations and unknowns that could be solved with the spread sheet. The solution yielded the flow rate at the void. Knowing the flow rate and a specified time step the void length (volume) increase is determined. Previously a table of void volume versus elevation was determined. This allows for the determination of void elevation as a function of time.

For the LOOP/LOCA case the hydraulic model differs from the LOOP only case because the boundary pressure of the void varies with time. The void pressure is set to the saturation pressure of the heated water in the FCU. The temperature of the water in the FCU is found in a separate calculation (explained below). The void pressure is then taken as the saturation pressure corresponding to the FCU water temperature. The hydraulic drain down solution then follows as explained above. The increased void pressure in the FCU due to the LOCA results in greater voids for the LOOP/LOCA case.

The FCU water temperature vs. time for the LOCA case was found in the following manner. The water in the FCU was considered a lumped mass that was heated by the LOCA containment peak temperature. The heat transfer coefficient on the outside surface of the FCU tubes was taken to be that of condensing steam. The heat transfer coefficient on the inside surface was assumed to be that of forced convection. This resulted in high heat transfer to the FCU water and a resulting conservatively high water temperature. The water

in the FCU was then conservatively assumed to be water vapor at the calculated temperature and corresponding saturation pressure.

The following equation was used to determine the condensation induced water hammer (CIWH) pressure.

$$\Delta P_{CIWH} = 0.707 \times C_{sonic} \times \sqrt{\Delta P \times \rho \times (\frac{\alpha}{1-\alpha})}$$

Where:

C_{sonic} = The sonic velocity
ΔP = The pressure difference across the water slug. This is taken to be equal to the void pressure as calculated for the LOCA condition in the explanation above. The upstream side of the water slug is assumed to be at the void pressure and the down stream side of the slug is conservatively assumed to be at zero pressure.
α = 0.35 This is the void fraction.

The calculated CIWH pressure pulse used in the structural analysis is 210 psi and 15 msec.

The following criteria was used to determine what piping was susceptible to CIWH per [ref 9]:

- Near horizontal (i.e., neglect vertical pipes)
- Sub-cooling greater than 36°F
- L/D > 24

It was assumed that during drain down, horizontal pipes did not run full. Horizontal pipes are expected to drain in a stratified manner as opposed to being "piston driven" from one end (as would be the case for the draining of a vertical pipe).

For evaluation of sub-cooling margin, it was assumed that sub-cooling is greater than 36°F for all of the horizontal piping except the piping associated with FCU 22. The FCU 22 discharge piping exited from the bottom of the FCU, therefore the discharge piping allowed it to drain completely. As a result the heat transfer coefficient on the inside surface of the FCU tubes is free convection to water vapor, a very poor conductor. The escaped water would not be heated by the FCU coils. Therefore it did not heat to the high temperatures the other FCUs did in the LOOP/LOCA case.

Item 5

A steam void-to-water ratio of 0.35 was used in the condensate-induced waterhammer analysis. Provide a quantitative evaluation (based on experimental data or deterministic calculations) to justify the use of this ratio value.

Response

Consolidated Edison is a member of the EPRI Sponsored Waterhammer Utility Group to address GL96-06. This group has presented a Draft Technical Basis Report "Resolution of Generic Letter 96-06 Waterhammer Issues" TR-113594 to the ACRS for their review. The final report is expected to be issued in the Fall of 2000. This report will provide the industry techniques and references to address GL96-06 column closure and condensation induced waterhammer. Item 5 will be addressed as part of that report.

Item 6

A structural analysis of the fan cooler unit (FCU) pressure retaining components, FCU supply and return piping, and associated support system, was performed. Provide additional details about the analysis to allow an independent assessment by the staff.

Response

A review of all five supply and return lines inside containment was performed. The supply and return lines run parallel to each other and therefore have the same general configuration. However the FCUs are spaced about the containment and therefore the FCU farthest from the supply and discharge header will have the longest lines. Based on this review, service water supply line 11c to FCU 24 was concluded to have the longest straight pipe runs and would therefore be subject to the largest water hammer loads. Supply line 11c was therefore chosen for the dynamic structural analysis to determine its ability to withstand the applied loadings, maintain the integrity of the pressure boundary, and ensure the function of the piping to pass flow.

The piping system was coded in the ADLPIPE computer code and the waterhammer event was evaluated as a time history dynamic analysis. The technique used to qualify the waterhammer is based on determination of the piping system response to known time dependent forces to calculate resulting stresses and loadings. The response of the piping system is computed by normal mode superposition technique. The ADLPIPE analytical model of the piping system was coded in accordance with the plant isometrics drawing.

The support modeling and stiffness values used for the evaluation were evaluated based on the pipe support configuration drawings. In general, the support stiffness values were enveloped to typical generic values based on support type.

The thermal displacements at each of the fan coolers were reviewed and determined not to be significant in magnitude for inclusion in the piping model. In general, such movements will be within reasonably anticipated gaps at the pipe supports.

All containment/fan cooler supports and nozzles were reviewed to determine appropriate nozzle stiffness values. In general, the resulting stiffnesses were rounded up to enveloping numbers.

The loading for the piping model consists of pipe and content weight.

The FCU tubing hoop stress was evaluated for waterhammer pressure. Stresses were calculated on the tube/tubesheet junction by applying unbalanced waterhammer loads to the FCU tubing.

Upon review of the CIWH and CCWH pressure pulses, it was determined that the CCWH pressure pulse would produce the limiting water hammer loads. CCWH is limiting because of its greater duration and higher pressure. The CCWH pressure pulse used in the

structural dynamic analysis is a 290 psi 100 msec triangular pulse. This was a preliminary pressure pulse. The final hydraulic analysis determined a 250 psi pulse and test data confirmed the duration of 100 msec. The pressure pulse was transmitted through the piping system at a sonic velocity of 2300 ft/sec and the unbalanced loads at each change in direction were applied to the structural model in a dynamic manner.

The piping stresses were evaluated in accordance with the requirements of the IP2 UFSAR, and the resulting piping stresses meet an equivalent Upset Load Category Limit applicable for IP2. IP2 was licensed to meet stress limits for loadings as specified in Table 1.11-2 of the UFSAR. Current day load categories (i.e., Normal, Upset, Emergency/Faulted) or ASME Service levels (i.e., A, B, C/D) are not listed in the UFSAR. As such, corresponding equivalent Upset and Faulted load case is IP2 Table 1.11-2, Load Combination 2 and 3, respectively.

The pipe support system was evaluated in accordance with equivalent IP2 Faulted Load Category Limits. All supports were found to be acceptable to this criteria. As such it is concluded that the FCU piping and supports are operable and capable of performing their function in the event of the postulated LOOP, LOOP/LOCA and LOOP/MSLB condition and meet the requirements of the IP2 UFSAR.

Item 7

Con Ed's two-phase flow analysis concluded that flow could be reduced by as much as 50 percent and yet enough heat would still be removed to satisfy accident assumptions (assuming no fouling of the FCU tubes). Provide sufficient details about this analysis, including justification for assuming clean tubes as the worst-case condition, to allow an independent assessment to be completed by the staff.

Response

An analysis was performed to show that design flowrates could be reduced by two phase flow and still provide design heat removal. If flashing occurs in the service water system, flow may be reduced. Two phase flow increases frictional losses and creates the potential for choked flow conditions [ref 4, 5]. Indian Point Unit 2 was evaluated for flow limitation at (1) restrictions upstream of coolers, (2) the coolers themselves, and (3) restrictions downstream of the coolers. Two conditions were considered. The first was clean or un-fouled FCU coiling coils. The second was fouled FCU cooling coils.

Upstream of the coolers and in the coolers themselves, no flow limiting condition was found. For the un-fouled case the region downstream of the cooler was found to have two-phase flow. The flow was reduced to approximately 3900 gpm total or 780 gpm per cooler (normal flow is 1500 gpm per cooler and 1740 gpm following LOCA) due to flashing across the FCUs throttling valves, for the first case of clean cooling coils. Each of these regions are described below.

(1) Upstream of the coolers the water is not significantly heated. There are also no significant flow restrictions upstream of the coolers. The water will not flash upstream of the coolers after starting of the service water pumps.

(2) Water entering the tubes from the supply side following pump restart will flash to steam since the tubes may be voided and the tubes will be near containment temperature. The two-phase flow downstream of the advancing water will cause increased resistance in the cooler. The water pressure will increase, though, to accommodate the increased resistance and continually displace steam in the cooler as the tubes are filled. If a choked steam flow condition exists in the tubes, the water pressure will increase and compress the steam void. The water will progress through the tubes as steaming occurs at the leading edge of the water. The progression of water through the tubes will not be significantly affected by steam formation in the tubes.

(3) The significant resistance in the piping downstream of the coolers prior to the 18" header are the 10" SWN-44, 1B through 5B, butterfly valves. These valves are in their "throttle" positions when hot water reaches them. System and local pressures in the piping downstream of the valves may drop below the saturation point upon restart of the pumps, and two phase flow may occur in the piping between theses valves and the 24" header.

Flow limitations as a result of two-phase flow conditions will occur in the service water system following a LOOP with concurrent LOCA assuming un-fouled FCU coils. However, even at the reduced flow, analysis of the FCUs has shown that they are capable of removing sufficient heat to meet design basis conditions. However, for these reduced flows (3,900 gpm) and the design containment temperature of 260°F and a service water inlet temperature of 95°F, a heat removal rate of approximately 62×10^6 BTU/hr is calculated for a clean FCU. This is greater than the 61×10^6 BTU/hr required by reference 3.

This analysis is conservative because it assumes that the header is at atmospheric pressure. In reality, the header will be pressurized above atmospheric pressure as the pumps try to push the two-phase mixture out. Therefore a more realistic higher header pressure would reduce the two-phase flow resistance and increase the expected flow.

For the case of fouled FCU tubes, no reduction in service water flow is expected. This is because the heat transfer calculations for the FCU indicate that outlet water temperature will be approximately at the FCU design temperature of 174°F. The corresponding saturation pressure is below the minimum system pressure during LOCA conditions with two pumps in operation. Therefore, flashing will not occur and there will be no two-phase flow.

Because two phase flow does not occur for the case of fouled FCU coils the un-fouled condition is limiting.

References:

1.0 "Containment Fan Cooler Response to a Simultaneous LOCA & LOOP Event". Altran Corporation Technical Report 96233-TR-01 Rev 1. Prepared for Consolidated Edison Company of New York, Inc. Indian Point Unit 2 Nuclear Power Station. August 1997.

2.0 "Monitoring of a Service Water FCU Supply & Return Line during a System Electrical Load Safety Injection Test", Altran Corporation Technical Report No.97143-TR-01 Revision 0, August, 1997, prepared for Consolidated Edison Company of New York, Inc. Indian Point Unit 2.

3.0 PMXR-8901, Indian Point Unit 2 Fan Cooler Unit Performance Service-Water Inlet Temperature of 95°F, September, 96.

4.0 Moody, F.J., Introduction to Unsteady Thermofluid Mechanics, J. Wiley & Sons, 1990, pg. 142.

5.0 Incropera, F.P., and D.P. DeWitt, Introduction to Heat Transfer, Second Edition, J. Wiley & Sons, 1990, pp. 380-381.

6.0 E.B. Wylie, V.L. Streeter with Lisheng Suo, Fluid Transients in Systems, Prentice-Hall, Inc. Englewood Cliffs, NJ, 1993.

7.0 Consolidated Edison Indian Point Station Test Analysis Performance Procedure PT-14, "Safety Injection System Electrical Load Test", Revision 14.

8.0 "Structural Dynamic Analysis of Service Water Containment Fan Cooler Line 11C Subjected to Waterhammer Loading", Altran Corporation Technical Report No.96233-TR-02 Revision 0, February, 1997, prepared for Consolidated Edison Company of New York, Inc. Indian Point Unit 2.

9.0 NUREG/CR-6519, "Screening Reactor Steam/Water Piping Systems for Water Hammer", prepared by P. Griffith, 1997.

10.0 "Water Hammer Handbook for Nuclear Plant Engineers and Operators". EPRI TR-106438 2856-03 Final Report May 1996 prepared by the Electric Power Research Institute, Palo Alto California.

11.0 F. Kreith, PRINCIPLES OF HEAT TRANSFER, Scranton Pa., International Textbook Co., 1965, 2nd ed., 4th printing.

12.0 "Diagnosis of Condensation-Induced Waterhammer, Volume 1, Methods and Background", NUREG-CR-5220, 1988.

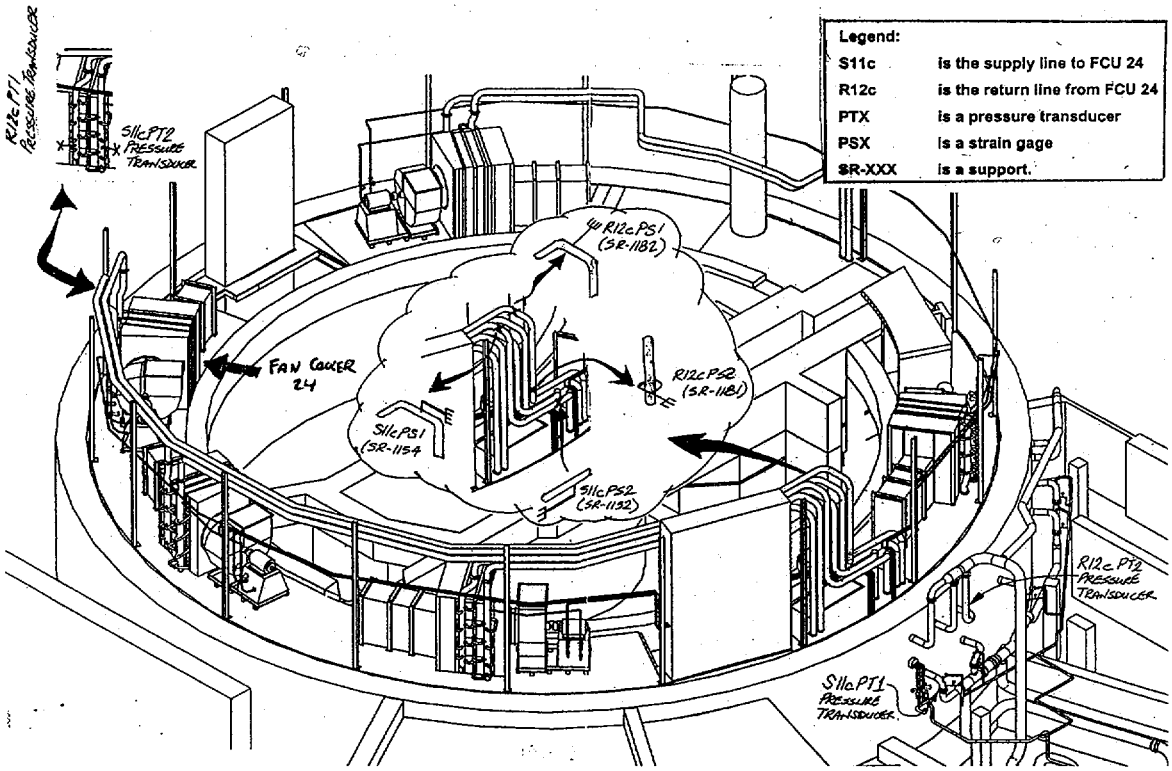
Legend:
S11c is the supply line to FCU 24
R12c is the return line from FCU 24
PTX is a pressure transducer
PSX is a strain gage
SR-XXX is a support.
R12c PT1 PRESSURE TRANSDUCER
S11c PT2 PRESSURE TRANSDUCER
FAN COOLER 24
R12c PS1 (SR-1182)
R12c PS2 (SR-1181)
S11c PS1 (SR-1154)
S11c PS2 (SR-1152)
R12c PT2 PRESSURE TRANSDUCER
S11c PT1 PRESSURE TRANSDUCER

Figure 1

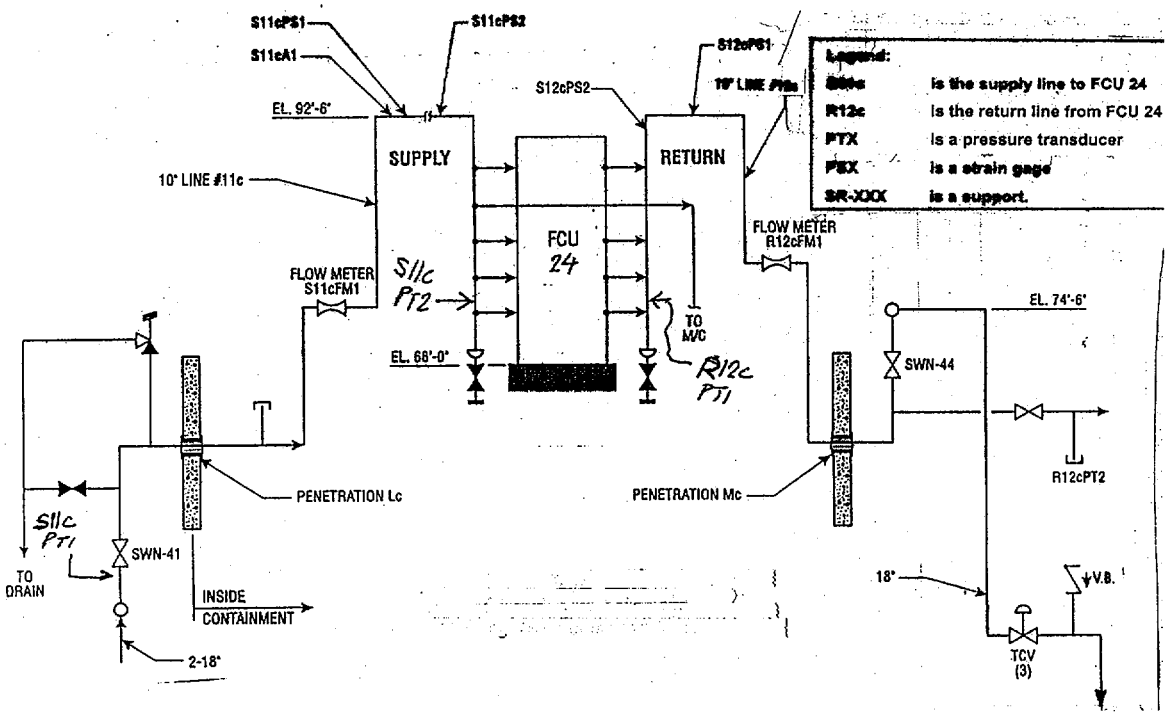
S11cPS1
S11cA1
S11cPS2
S12cPS1
S12cPS2
EL. 92'-6"
SUPPLY
RETURN
10" LINE #11c
FCU
24
FLOW METER
S11cFM1
S11c
PT2
TO
M/C
R12c
PT1
FLOW METER
R12cFM1
EL. 74'-6"
EL. 68'-0"
SWN-44
R12cPT2
PENETRATION Lc
PENETRATION Mc
S11c
PT1
SWN-41
TO
DRAIN
INSIDE
CONTAINMENT
2-18"
18"
V.B.
TCV
(3)
Legend:
is the supply line to FCU 24
R12c
is the return line from FCU 24
PTX
is a pressure transducer
PSX
is a strain gage
SR-XXX
is a support.

Figure 2