UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of DUQUESNE LIGHT COMPANY OHIO EDISON COMPANY PENNSYLVANIA POWER COMPANY (Beaver Valley Power Station Unit No. 1)	))))))))	Docket No. 50-334

ORDER FOR MODIFICATION OF LICENSE

I.

Duquesne Light Company (DLC), Ohio Edison Company, and Pennsylvania Power Company (the licensees), are the holders of Facility Operating License No. DPR-66 which authorizes the operation of a nuclear power reactor known as Beaver Valley Power Station, Unit No. 1 (the facility) at steady state reactor power levels not in excess of 2652 thermal megawatts (rated power). The facility is a pressurized water reactor (PWR) located at the licensees' site in Beaver County, Pennsylvania.

II.

As a result of the operating license review of the North Anna Power Station, it appeared that the net positive suction head (NPSH) available to the containment recirculation spray (RS) and low head safety injection (LHSI) pumps might be insufficient for the post loss-of-coolant accident (LOCA) operation of the RS and LHSI systems. The NRC staff review of this matter for the North Anna Power Station is

ongoing. Beaver Valley Power Station Unit No. 1 (BVPS-1) is an operating plant with a design similar to that at North Anna.

To determine whether a similar problem existed at BVPS-1, we requested DLC to meet with us on August 19, 1977. As a result of this meeting and subsequent conversations with DLC, it was determined that in the event of a major LOCA, the vapor pressure of the water in the containment sump supplying the RS and LHSI pumps may be closer to the containment pressure than previously indicated. This is due to a number of original assumptions which have been determined to be inappropriate for analysis purposes. This situation would occur for only a short period of time following a loss-of-coolant accident and could result in inadequate NPSH at the RS and LHSI pumps. DLC advised us that the assumptions made in the original analysis were based on assuring maximum containment pressure. However, these assumptions are not conservative when determining the available NPSH for the RS and LHSI spray pumps. They indicated that more conservative assumptions for the NPSH analysis in the following areas must be made:

(a) mixing the emergency core cooling system (ECCS) water at the break to reduce the amount of energy to flash steam to the containment atmosphere and thereby increase the sump water temperature.

(b) flashing of the break effluent at the total containment pressure (pressure flash) to reduce the fraction of effluent which becomes steam and thereby increase the sump water temperature.

(c) 100 percent spray efficiency to maximize the heat removed from the containment atmosphere and thereby increase the sump temperature.

Items a through c above will result in a lower containment pressure and higher sump water vapor pressure. In addition to the above, minimizing initial containment pressure and using the coldest service water temperature also result in a more conservative NPSH calculation. It was determined that a lower calculated NPSH for the RS and LHSI pumps would exist at specific times during the recirculation phase of long term cooling at BVPS-1. This could result in either damaging of the pumps or reducing pump flow.

By a letter dated August 25, 1977, DLC informed us that the BVPS-1 had shutdown to perform routine maintenance work which would require approximately three weeks. DLC also stated that prior to startup of the plant, they would provide us with the details of a proposed interim design modification supported by analyses which would demonstrate the capability of the RS and LHSI systems to function as required.

At a meeting held on September 9, 1977, DLC submitted a report entitlted "Analysis and System Modification for Recirculation Spray and Low Head Safety Injection Pumps Net Positive Suction Head," which presented: (1) proposed interim modification of the RS and LHSI systems; (2) RS pump performance curves of the minimum NPSH required to prevent cavitation as a function of flow rate (the above cited curves are based on tests performed on August 22, 1977, with a North Anna RS pump, which is the same model as that installed at BVPS-1); (3) LHSI pump performance curves of the minimum NPSH required to prevent cavitation as a function of flow rate (these curves are based on tests performed on August 30, 1977, with a North Anna LHSI pump which is identical to those at BVPS-1. The test method and procedures were essentially identical to those used to test the RS pump at North Anna on August 22, 1977); and (4) the containment pressure transient response analyses and associated NPSH available to the RS and LHSI pumps. The calculated pressure in the containment and the temperature of the water that accumulates in the containment sumps are important parameters in determining the RS and LHSI pump operability following a LOCA, in regard to available NPSH. These terms, in combination with the pump static head and associated

line friction losses, establish the available NPSH during the transient. The required NPSH may be reduced by a reduction in the pump flow rate. Alternatively, the NPSH available at a given flow rate may be increased by the injection of cold water into the pump suction. The injection of cold water lowers the water temperature at the pump suction and, therefore, lowers the vapor pressure of the water entering the pump. DLC proposes to utilize both of the above methods to resolve this problem on an interim basis.

Recirculation Spray Pumps Located Inside Containment

Using the new modeling assumptions, a minimum available NPSH of greater than 11 feet is calculated for the two RS pumps located inside containment, except for a short time interval of about 10 to 20 minutes, depending on the break location and engineered safety feature equipment available. The initiation of the time interval varies from 350 seconds to 800 seconds after a postulated accident. This amount of available NPSH assures satisfactory pump operation. Sensitivity studies performed by DLC show that for a time interval of about 13 minutes, the available NPSH reaches a minimum of 8.3 feet during which the pump could potentially operate in a mild cavitating mode with a reduced flow rate of 3000 gpm. The design flow rate is

3600 gpm. The test results, as presented in the above cited topical report, demonstrate that the pump can be operated in a cavitating mode for periods of time well in excess of the 10 to 20 minute interval discussed above, at a lower efficiency, without damage to the pump. On this basis, DLC has not proposed any interim design modification to the RS pumps which are located inside the containment.

Recirculation Spray Pumps Located Outside Containment

For the two RS pumps located outside containment, the friction loss in the suction piping is substantially larger than that for the inside pump, and therefore results in a lower available NPSH. In order to assure an adequate amount of NPSH for the RS pumps located outside of the containment, DLC proposes to divert 250 gallons per minute (gpm) of cold quench spray (QS) water from each QS header to the sump area at that point where water is drawn to the outside RS pump suctions. The cold QS water injection will lower the water temperature at the pump suction, and therefore, lower the vapor pressure of the water entering the pump. This proposed modification will allow the pumps to perform as originally specified. No reduction in flow rate to increase the available NPSH is necessary.

Low Head Safety Injection Pumps

In order to assure an adequate amount of NPSH to the LHSI pumps, DLC proposes to limit the pump flow rate from 4200 gpm to approximately

3100 gpm during the recirculation phase assuming a single pump failure. The ability to throttle the LHSI pump flow rate was demonstrated by a test at Surry Power Station, Unit 2, on September 16, 1977, and reported in a September 19, 1977, letter by DLC. The low head portion of the ECCS system for Surry Unit 2 is similar to that at BVPS-1. However, the pump discharge valves at Surry Unit 2 are Darling valves with 10 second closure times, magnetic brakes on the motor operators, and a rated pressure differential of 1750 pounds per square inch (psi). The discharge valves at BVPS-1 are Crane valves and have 120 second closure times, a rated differential pressure of 200 psi and do not have magnetic brakes on the motor operators.

To assure that a pump flow rate of 3100 gpm is not exceeded in the event one pump fails, DLC will partially close both pump discharge valves to allow a flow rate of 2100 gpm per pump. Test results at Surry, Unit 2 indicated a valve opening of 25% allowed a flow rate of approximately 2100 gpm. Although the discharge valves at BVPS-1 have a different design than those tested at Surry Unit 2, it is expected that the flow characteristics versus valve opening would be similar. The BVPS-1 discharge valves will require a longer throttling time. However, the valves will be throttled just prior

to the recirculation stage of LHSI when time is no longer a critical parameter for maintaining adequate core cooling. Additionally, the slower operating speed of the BVPS-1 discharge valves should provide a finer adjustment capability. The rated valve differential pressure is greater than the pump differential pressure of 125 psi at 2100 gpm.

In addition to the provisions for throttling, the time of transfer will be delayed until an additional 10,000 gallons of water have been drawn into the containment from the refueling water storage tank (RWST). DLC proposes to increase the capacity of the RWST 17,000 gallons to 441,000 gallons to allow the delay in the transfer time. This time delay was selected to provide further assurance that adequate NPSH is available to support 3100 gpm flow without pump cavitation. Operation of the LHSI system during postulated accident conditions is affected by the proposed modification, since an additional 10,000 gallons of water from the RWST will be required for injection.

The proposed interim modifications assure that the LHSI pumps will be operable during long term core cooling following a LOCA by eliminating pump cavitation. The proposed modification does not cause LHSI flows to be less than the minimum flow rate required for emergency core cooling requirements in either the short term or the long term.

Effect of the System Modifications on Containment Peak Pressure and Containment Depressurization Time

Using the above containment spray flow rates which result from the proposed system modifications DLC performed a containment response analyses. The results show that the containment spray systems will function adequately. The peak containment pressure limit of 45 psia will not be exceeded and the pressure will return to subatmospheric conditions in less than 60 minutes, i.e., the depressurization time requirement for the design basis LOCA. The containment will remain in a negative pressure once it is brought to subatmospheric pressure.

Conclusion

Based on our review of the above cited topical report and on discussions with DLC, we find that in the unlikely event of a major LOCA, the containment spray and LHSI systems at BVPS-1 will operate satisfactorily to maintain adequate core cooling and assure that the containment design pressure is not exceeded and that the depressurization of time will remain under 60 minutes. We conclude that the continued operation of BVPS-1 with the proposed interim modifications is acceptable and will not pose an undue threat to the health and safety of the public.

However, we feel that operator action to partially close the LHSI pump discharge valves and the minor reduction in the inside RS pump performance for the 10 to 20 minute interval discussed above are acceptable solutions only for an interim period. Therefore, we will require DLC to propose a permanent solution and schedule of implementation by November 22, 1977. This permanent solution should provide that the containment spray and ECCS systems perform as originally designed without relying on the above operator action following a major LOCA.

Copies of the following documents are available for public inspection in the Commission's Public Document Room, 1717 H Street, N. W. Washington, D. C. 20555 and at the Beaver Area Memorial Library, 100 College Avenue, Beaver, Pennsylvania, (1) Letters from DLC dated August 20, 1977, August 25, 1977 September 8, 1977 and September 19, 1977, (2) Stone and Webster Report entitled "Analysis and System Modification for Recirculation Spray and Low Head Safety Injection Pumps Net Positive Suction Head", dated September 9, 1977, and (3) this Order for Modification of License, In the Matter of Duquesne Light Company, Ohio Edison Company, and Pennsylvania Power Company, Beaver Valley Power Station Unit No. 1, Docket No. 50-334.

III.

In view of the foregoing, and in accordance with provisions of the Atomic Energy Act of 1954, as amended, and the Commission's Rules and Regulations in 10 CFR Parts 2 and 50, IT IS ORDERED THAT Facility Operating License No. DPR-66 is hereby amended by adding the following new conditions:

1. Reactor operation shall be authorized only with the restrictions set forth below, until the permanent modifications are approved by the NRC and in place:
   a. With piping installed to divert 250 gpm of water from each quench spray header to the sump area at that point where water is drawn to the outside recirculation spray pump suctions.
   b. The volume of water in the RWST shall be maintained at equal to or greater than 441,000 gallons.
   c. Operating procedures shall be maintained which require that in the event of a loss of coolant accident necessitating use of the low head safety injection (LHSI) system, plant operators will throttle the discharge of each LHSI pump just prior to initiating the recirculation phase of core cooling. The discharge shall be throttled such that the flow shall not exceed 3100 gpm in the event of single pump operation.

2. DLC shall submit by November 22, 1977, a proposed permanent design modification and a schedule for its implementation. The proposed modification shall be based on detailed supportive analyses which include consideration of containment total pressure, containment vapor pressure, available NPSH, sump water level, and sump water temperature for a spectrum of break sizes and break locations. For each analysis, the following shall be specified: the energy release rates as a function of time throughout the blowdown, reflood, and post blowdown phases, all the containment evaluation parameters, and the recirculation spray heat exchanger characteristics.

FOR THE NUCLEAR REGULATORY COMMISSION

Edson G. Case

Edson G. Case, Acting Director
Office of Nuclear Reactor Regulation

Dated at Bethesda, Maryland
this September 30, 1977

3/11/79

[illegible], DW

Lynch } DLC
Cory
Hayes
Morigant } S&W
Grinecki
Moran
Healy

Pipe Stress

S&W refused to send calculations. They [illegible] [illegible] [illegible] DW [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

DW [illegible] to discuss [illegible] [illegible] [illegible] NRC.

3/1/79 meet w/ [illegible]; [illegible]

Will try to schedule a meeting [illegible] [illegible] in Bethesda [illegible] S&W [illegible] [illegible]. Otherwise may be necessary [illegible] [illegible] S&W [illegible] [illegible].

March 9, 1979

CHRONOLOGY OF DOR ACTION ON BEAVER VALLEY PIPE STRESS PROBLEM

The Engineering Branch received a LER, dated December 6, 1978, on Beaver Valley unit one which identified a design error in one piping system. The LER pointed out that corrective action had satisfactorily been completed. The I&E inspector, Don Beckman, contacted the project manager and requested to talk to a technical reviewer to get some assurance that this problem was solved and discuss some additional piping related matters. Project manager contacted Keith Wichman who assigned S. Hosford, EB to follow. He contacted D. Beckman several times during December and early January in a consulting capacity while I&E explored this concern with the Licensee and his vendor. The information available to DOR at this time, did not identify a problem but was sufficiently unclear and ambiguous that both EB and I&E reached the conclusion that more indepth review by the DOR staff would be required. DOR requested that all the available documentation be forwarded, and subsequently was received by the project manager for review around the end of January 1979. A formal TAC, 11431 was issued to EB on February 2, 1979, for this review. The EB staff internally reviewed the documentation which pointed out a difference in the results of two piping stress codes. EB's preliminary assessment was that the discrepancies in the Code results were probably due to a modeling error and limited to the systems identified, which had been corrected by a modification. Nevertheless we ~~We~~ contacted Beaver Valley and Stone & Webster on March 1, 1979, to get additional information on the differences in the Code results. Stone & Webster would not release any calculations to the staff but did agree to bring in the calculations and discuss the results with us. We agreed to this approach and Beaver Valley and Stone & Webster met with us on March 8, 1979. It first became apparent to us during that meeting that a problem exists in the intra modal ~~superposition~~ combination technique in ~~part of~~ the STOCK 2 subroutine of the ~~PIPESTRESS~~ PIPESTRESS Code. Having identified this, the potential for the generic concerns to other Beaver Valley piping systems and, ~~potentially~~ to other Stone & Webster plants was immediately brought to the attention of the line management of DOR up to the Division Director.

Contact: PM - Dave Wigginton
Lead Reviewer - Steve Hosford

in the PIPESTRESS Code

cc: A. Schwencer
D. Wigginton
V. Stello
D. Eisenhut
R. Vollmer
B. Grimes
V. Noonan
S. Hosford

The deficiency ~~[illegible]~~ identified in the STOCK 2 subroutine that was later discarded (i.e., algebraic intra modal component summation [illegible]) was not thought credible since [illegible] techniques are [illegible] independent [illegible] historically as far as the [illegible] had not been [illegible].

TO: (Name, office symbol, room number, building, Agency/Post) | Initials | Date

1. A. Schwencer 1/3
2. D. Wigginton
3.

4. ☑ YOU WERE CALLED BY— ☐ YOU WERE VISITED BY—

5. G. W. Moore

OF (Organization) BVPS

☐ PLEASE CALL → PHONE NO. CODE/EXT. 412-456-6523

☐ WILL CALL AGAIN ☐ IS WAITING TO SEE YOU

☐ RETURNED YOUR CALL ☐ WISHES AN APPOINTMENT

REMARKS

They initiated BV cooldown at 0900 pending satisfactory resolution of the seismic design question. Based of request by the onsite safety Committee & the (over)

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

FROM: (Name, org. symbol, Agency/Post) | Room No.—Bldg.

Phone No.

5041-102

OPTIONAL FORM 41 (Rev. 7-76)
Prescribed by GSA
FPMR (41 CFR) 101-11.206

☆U.S. GPO 1979-0-261-647 3304

Offsite review committee.

If you have any questions - call

RECEIVED BY	DATE	TIME
Judy	3/13	10:30

Oct. 13th 1978

A meeting was held at the site with the Station Superintendent, J.A. Wesling and J J Cheng and John Lynch of DCC ~~to~~ and J. Carmakey of Stone and Webster.

Additional information was provided that elaborated on original information. Station Superintendent requested that ~~a~~ even more specific information was required.

Oct. 23rd 1978.

Additional Information submitted

The Station Superintendent asked for additional clarification by telephone. He was informed that someone from S&W would be on the site during the following week.

Oct. 26 - J J Healy arrived at plant

During course of discussion it was identified that one SI line would be significantly overstressed.

The Station Superintendent made an immediate telephone notification to Region I

11/27 - Submitted ~~LER~~ Written LER, which included all available information

The information in [illegible]

~~[illegible]~~ JO by J J Clay 3/14/79.

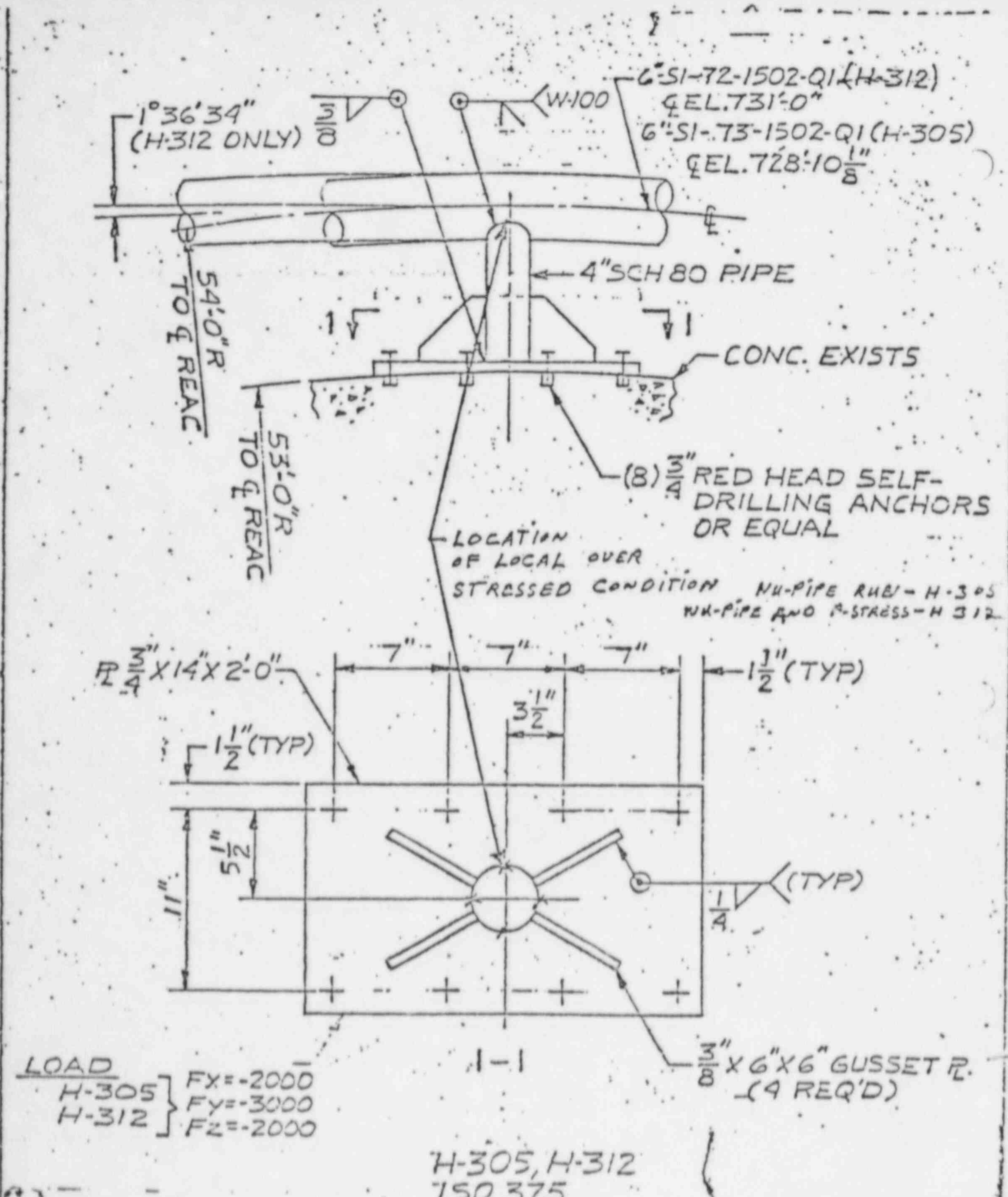
Initial notification to DLC was on 10/3/78 to J. A. Werling the Station Supt from J. Cermeskey and J J Healy of S&W.

Essence of statement was that S&W had discovered an error in the original stress analysis of some safety injection lines.

This error was discovered as a result of investigating the effect of the change of weight of each of 14 Safety injection system check valves and involved a misapplication of a "bend calculation method".

It was suggested that the use of this method was technically a deviation from the FSAR, but that no loss of safety function would have occurred. It was requested that this matter be brought to the attention of the Station Safety Committee ~~to determine reportability.~~

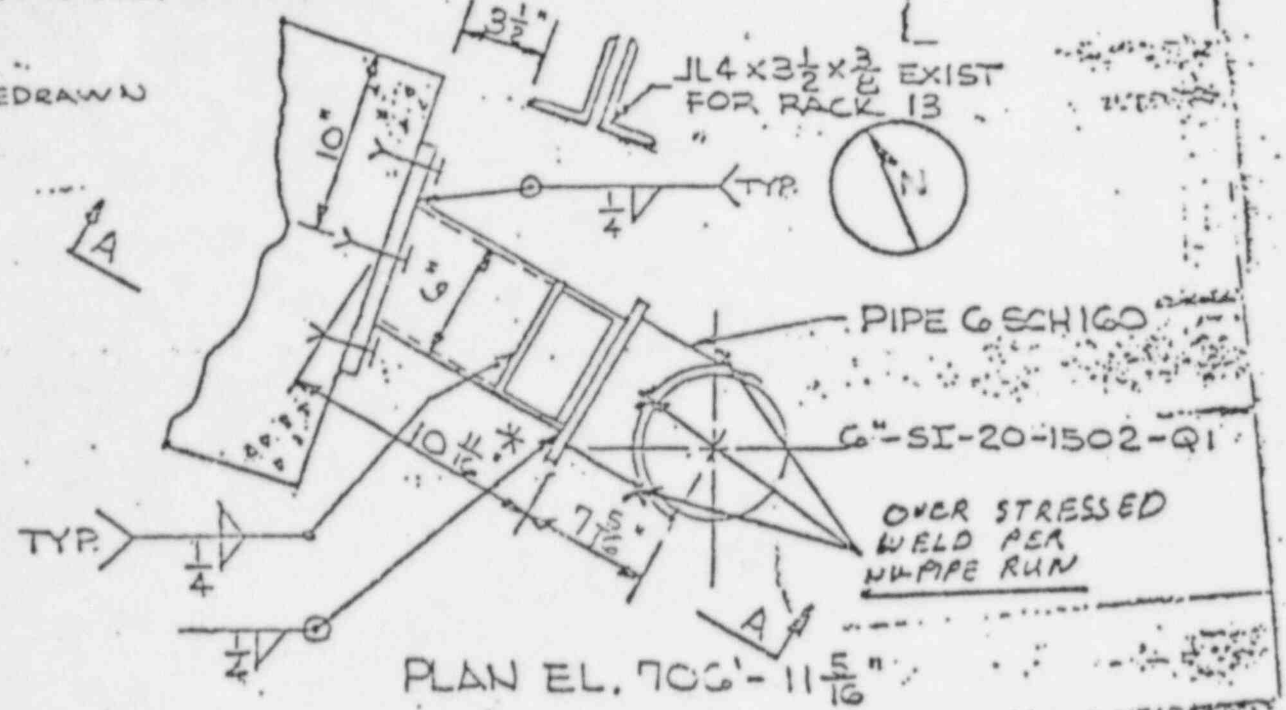
The Station Superintendent requested specifics on this matter to enable the performance of a proper review by the Safety Committee.



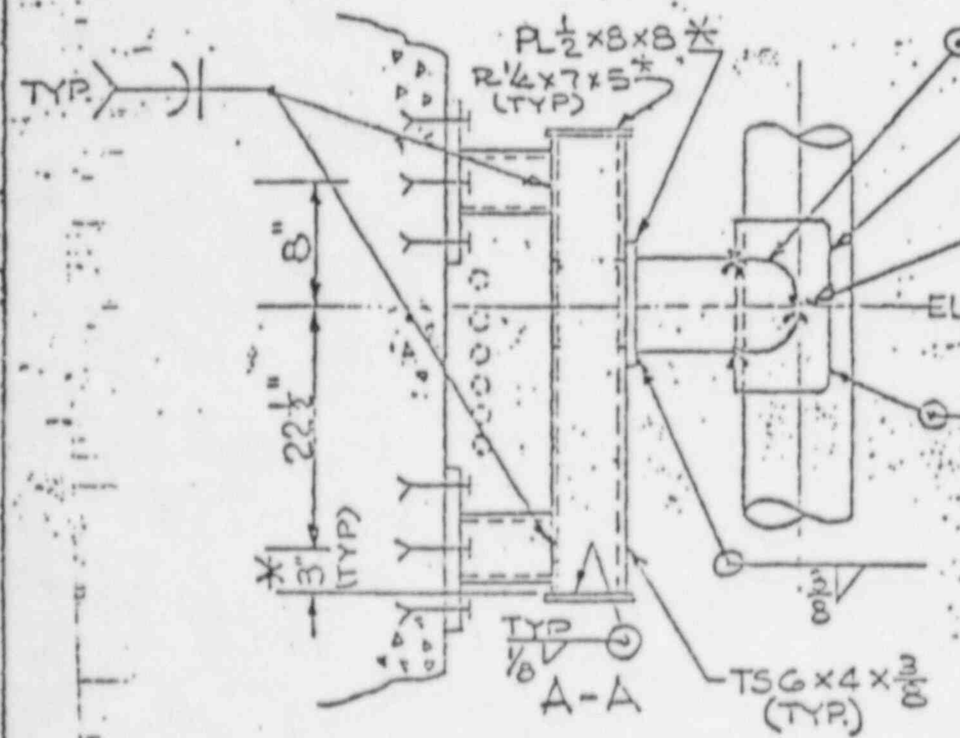
POWER INDUSTRY GROUP		TITLE: HANGER - H-305 AND 312	SCALE: NONE
CHECKED			DATE:
CORRECT			
APPROVED	[signature]		SKETCH NUMBER: FIG II B - III B
REVISIONS	② ③ ④ ⑤		

DUQUESNE LIGHT CO.
BEAVER VALLEY UNIT 1

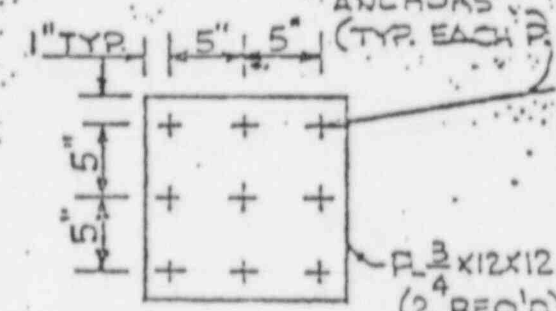
REV. 3: REDRAWN



PLAN EL. 706'-11 5/16"



A-A



TYP. BASE PL. DETAIL

NOTE: FOR LOCATION PLAN
SEE

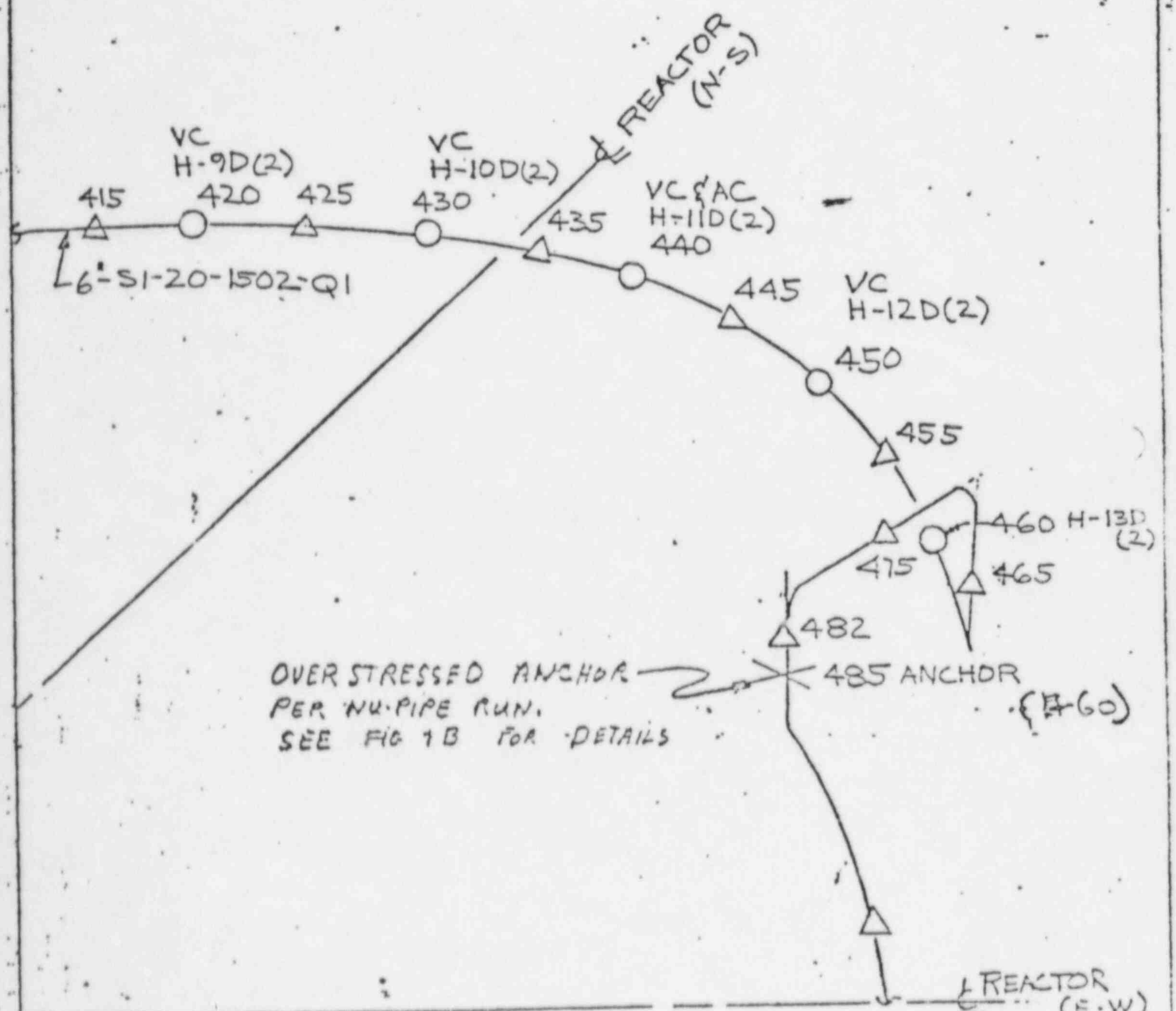
DESIGN LD.

$F_x = -5672$ # $M_x = \pm 10599$ '#

$F_y = -1959$ # $M_y = -7956$ '#

$F_z = \pm 3723$ # $M_z = \pm 7526$ '#

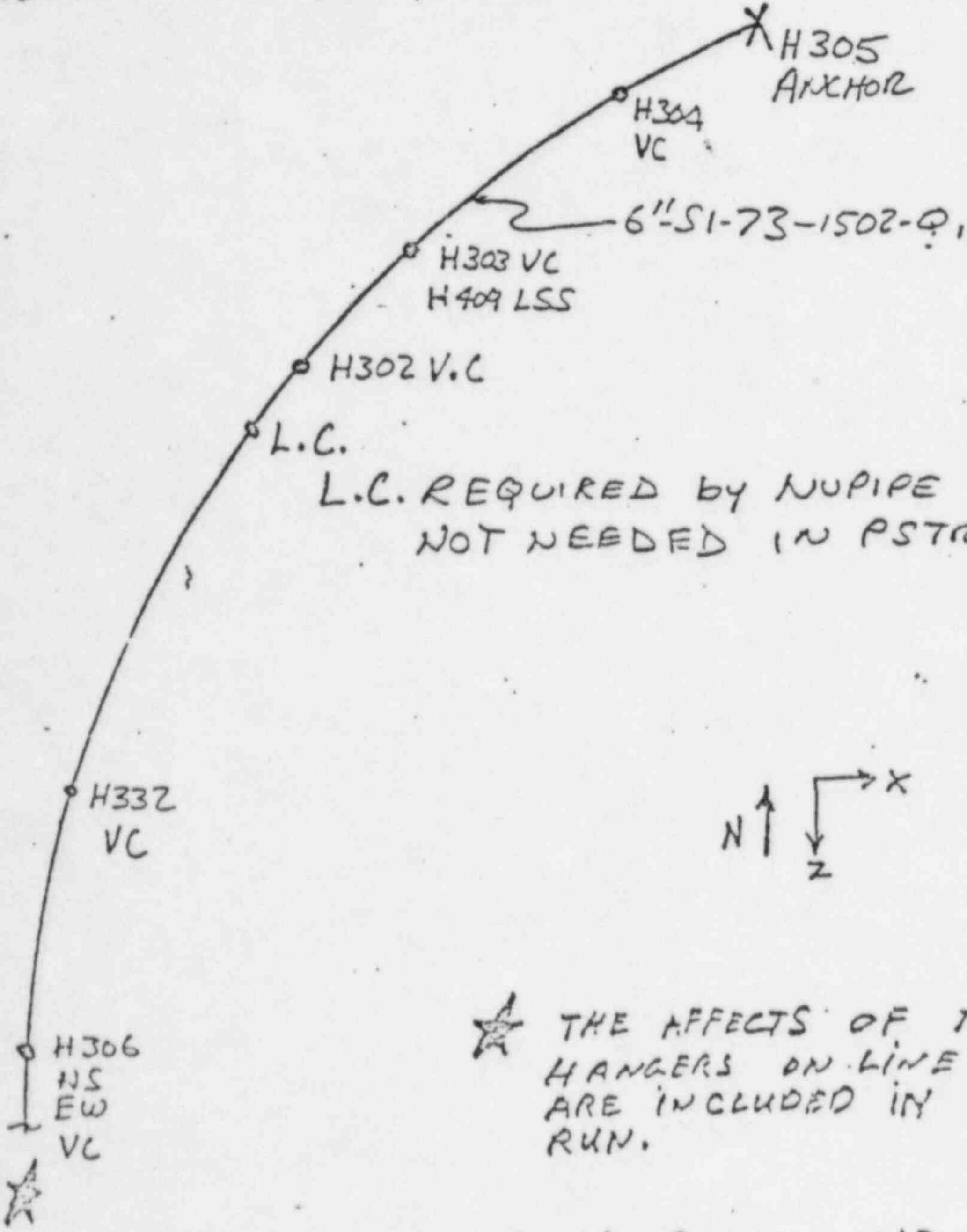
POWER INDUSTRY GROUP		TITLE	SCALE: NONE
CHECKED		FIGURE 1B	DATE: 12-1-78
CORRECT			SKETCH NUMBER
APPROVED		ANCHOR - H-60	FIG. 1B
REVISIONS	② ③ ④ ⑤		



POWER INDUSTRY GROUP		TITLE H-60 HANGER-LOCATION LINE 6"-SI-20-			SCALE: NONE DATE: 12-1-78
CHECKED					
CORRECT					SKETCH NUMBER
APPROVED	[signature]				FIG -1A
REVISIONS	②	③	④	⑤	

PREPARER/DATE F. Boroni 12/1/78	REVIEWER/CHECKER/DATE Gary L Harper 12/4/78	INDEPENDENT REVIEWER/DATE K.R. Moriarty 12/4/78
SUBJECT/TITLE PITRUST RESULTS H305 (6"-S1-73-1502-Q1)		QA CATEGORY/CODE CLASS CAT I CLASS 2

	ALLOWABLE @180°F (PSI)	NUPIPE RUN AS BUILT (PSI)	NUPIPE RUN, W/NEW RESTR.	PSTRESS RUN AS BUILT	PSTRESS RUN, W/RES ON 6-S1-72
DLOAD+SLP	$1.0S_h$ = 16600	9583	9945	10385	10231
DLOAD+SLP+OBET	$1.5S_h$ = 24900	206238	18268	29899	19488
DLOAD+SLP+OBET+THERM.	$3.0S_h$ = 49800	236994	40949	56439	46755
DLOAD+SLP+DBET	$1.8S_h$ = 29880	218689	21463	32884	20776



L.C. REQUIRED by NUPIPE RUN
NOT NEEDED IN PSTRESS RUN

☆ THE AFFECTS OF THE TWO NEW HANGERS ON LINE 6"-S1-72 [FIG III A] ARE INCLUDED IN P-STRESS ACCEPTANCE RUN.

FIG II A

RESULTS BASED ON: STRESS RUNS # (R028[illegible], R028803, R0288066)

PI-TRUST RUN # R02880[illegible]

The model Run in NU-PIPE and in PSTRESS are geometrically similar; however, the mass distribution and support stiffness are different. Further, the method of force summation (intra-modal) is different between PSTRESS and NUPIPE. NUPIPE utilizes more conservative techniques for intra-modal combinations of generalized loadings. These newer techniques arose following establishment of BV1 design criteria out of AEC (now NRC) urgings combined with increasing industry experience with seismic design. appears incorrect

In December 1974, the USNRC published Regulatory Guide 1.92, applicable to facilities docketed after April 1975, which required the use of the more conservative combinations.

The P-STRESS methods used were accepted dynamic analysis techniques for Beaver Valley I generation plants, and is the basis for all computerized Category 1 pipe stress analysis done for Beaver Valley Unit 1.

Figure IA gives the hanger location and peak local stress vs. allowable resulting from the NU-PIPE Model for line 6" SI-20.

Figure IB is a sketch of the hangers-pipe (SI-A-60/6"SI-20) interface showing the overstressed area. The table attached to this sketch identifies the differences in the hanger attachment loads resulting from the two different computer models. Based on the above the Safety Injection line 6"-SI-20' is acceptable as designed.

Figure IIA&B gives the most highly stressed hanger, location and stresses resulting from the NU-PIPE and P-STRESS runs on 6"SI-73. Based on this data, 6"-SI-73 is acceptable as design.

Fig. IIIA&B gives the most highly stressed hanger, location and stresses resulting from the NU-PIPE and P-STRESS runs for line 6"SI-72. Based on this data modification to hanger VC-LC-H306A (Fig. IV) and the addition of hanger LSS-H (Fig. V) is required to be added to line 6"SI-72.

We believe that the remainder of the containment annulus piping is acceptable based on the fact that the pipe stress analysis section has completed a review of seismic piping shown on the RP-3 series drawings (annulus piping). The review was limited to piping 2½" O.D. to 6" O.D. because of the possibility that these sizes may have been analyzed by the 'chart' method. The attached tabulation (Table I) contains all the seismic lines falling between 2½" & 6". This tabulation contains 103 seismic lines of which 55 were reviewed and found acceptable.

A large portion of this piping was analyzed during the "as-built review" using computer program P-STRESS. P-STRESS results are available for all or portions of 48 of the tabulated lines and are acceptable.

REPORT

APPARENT OVERSTRESS

BEAVER VALLEY I

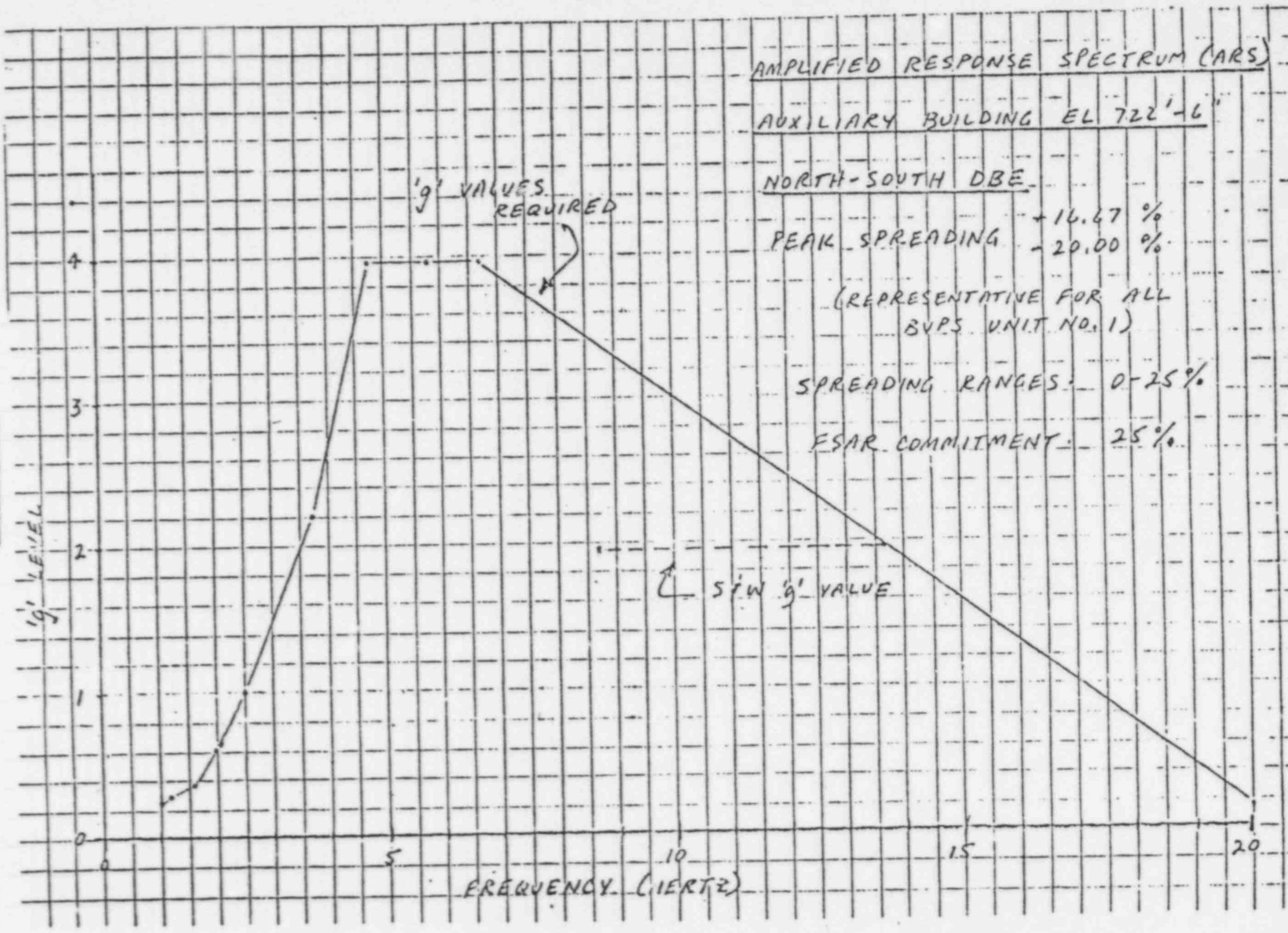
SAFETY INJECTION LINES

Approved G.L. Harper

G.L. Harper

Approved J.M. Cumiskey

J.M. Cumiskey



AMPLIFIED RESPONSE SPECTRUM (ARS)
AUXILIARY BUILDING EL 722'-6"
NORTH-SOUTH DBE
PEAK SPREADING + 16.67 % - 20.00 %
(REPRESENTATIVE FOR ALL BVPS UNIT NO. 1)
SPREADING RANGES: 0-25%
FSAR COMMITMENT: 25%
'g' VALUES REQUIRED
S/W 'g' VALUE
'g' LEVEL
FREQUENCY (HERTZ)
0
1
2
3
4
0
5
10
15
20

FIGURE 1a

6.0 SPREADING OF AMPLIFIED RESPONSE SPECTRA (continued)

± 25 per cent." However, this statement appears to be with respect to general amplified response spectra which would be applied to equipment and components, and not specifically applied to piping. The quotation in the FSAR Appendix B applies specifically to piping.

The conclusion is that the amplified response spectra used in the design and analysis of Beaver Valley Power Station Unit No. 1 piping do not appear to conform to the FSAR.

5.0 FSAR COMMITMENTS CONCERNING SUMMARY OF X, Y, AND Z COMPONENTS FOR EACH MODE PRODUCED BY TWO OR THREE DIMENSIONAL EARTHQUAKE (continued)

the statement in the AEC SER corresponds exactly with the way NUPIPE handles results, which resulted in much greater results than the PSTRESS method on Safety Injection Piping. (See History of Events relating to 6" Safety Injection Piping.) This would indicate that results generated by NUPIPE or ADLPIPE are in accordance with the methods stated in the AEC SER. The difference in technique resulted in a factor of 10 difference in stress in the LHSI system inside containment.

5.0 FSAR COMMITMENTS CONCERNING SUMMARY OF X, Y, AND Z COMPONENTS FOR EACH MODE PRODUCED BY TWO OR THREE DIMENSIONAL EARTHQUAKE (continued)

combining results for each mode. Furthermore, the NRC had been made to believe that one or more modes which are closely spaced in frequency and parallel in mode shape are added absolutely.

Actually, Stone & Webster has computed algebraic sums of the multidirectional components of three simultaneous earthquakes. This method may be more or less conservative (depending upon number signs) than the method outlined in the FSAR; whether it is more or less conservative is undetermined without detailed analysis on a case by case basis.

A hypothetical example is in order:

Given three earthquakes (X, Y, Z) resulting in three force responses (x, y, z):

"X" Earthquake			"Y" Earthquake			"Z" Earthquake		
Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz
3	-2	-1	-1	4	2	-1	-2	-3

Yield different resultant forces by the NRC and Stone & Webster methods:

5.0 FSAR COMMITMENTS CONCERNING SUMMARY OF X, Y, AND Z COMPONENTS FOR EACH MODE PRODUCED BY TWO OR THREE DIMENSIONAL EARTHQUAKE

Reproduced below are sections of the Beaver Valley Power Station Unit No. 1 FSAR, with comments:

"B.2 Stone & Webster Equipment.

"B.2.1 Analyses and Design Criteria of Seismic Class I and Seismic Class II Piping

"B.2.1.1 General analytical procedure. The modal analysis technique computes the peak inertial responses for all significant participating modes, which are then combined by the method of square root of sum of squares (SRSS) at each mass node."

Note the description above of computation of peak inertial responses, stating that combination of modal responses is by the square root of the sum of the squares.

"Question 3.15.2

"... the criteria for combining modal responses (shears, moments, stresses, deflections, and/or accelerations) when modal frequencies are closely spaced and a response spectrum modal analysis method is used."

"Response

"The square root of the sum of the squares (SRSS) method, employed in the combination of maximum modal responses, was supplemented by a search of closely spaced modal responses and an evaluation of their effect on the maximum structural response. The evaluation incorporated:

4.0 COMMITMENTS MADE IN FSAR APPENDIX B AND NON-COMPUTER ANALYZED PIPING (continued)

4.2 Comment 2

"Calculations" done on small bore piping consist of sketches of piping, about two-thirds of which have a statement that the constraint location is seismically adeuqate, with a statement of natural frequency. The basis of the natural frequency is often not stated. In several instances, the natural frequency stated is known to be unrealistically high, which is nonconservative.

The remaining one-third of the audited design documents have no statement of seismic adequacy and no natural frequency included. Of roughly fifty (50) piping design "calculations," not one stress calculation is performed.

4.3 Comment 3

In eleven (11) piping designs of thirty-three (33) examined in some detail, valves, elbows, etc. are left unconstrained in such a manner as to cause what appears to be inadequate design (i.e., see H74 discussion). The fact that valves, elbows, etc.

4.0 COMMITMENTS MADE IN FSAR APPENDIX B AND NON-COMPUTER ANALYZED PIPING

The sections of the FSAR under discussion are reproduced below with comments after each section.

"B.2.1.9 Simplified Seismic Analysis of Small Size Seismic Class I Piping

"Piping systems designed to ANSI-B31.1 pressure piping code with diameters of 6 inch NPS and below, are subjected to analyses using acceleration values from the amplified response spectra. The length of span between supports is selected such that the fundamental frequency is removed from the resonant band of the amplified response spectra as specified in Section B.1.5.

"The basic approach to the design of small-bore seismic Class I piping is to make the system relatively rigid whenever engineering design criteria dictate.

"The spacing between pipe constraints is determined so that fundamental frequency of piping section will always be greater than 1.5 f where f = peak resonant frequency of structure, as determined from applicable amplified response spectrum.

"Inertial loads ("g" factor), from OBE and DBE, are conservatively set at one-half peak acceleration of OBE and DBE using this predetermined span. The deadweight stresses are multiplied by the applicable "g" factor in X, Y, and Z directions as specified, which is set at one-half peak acceleration, or 0.5 g minimum; this produces seismic stress induced by OBE and DBE respectively in all three directions. The seismic stress calculation is based upon equations in paragraph 119.6.4 of Reference 1. [B 31.1] The "g" factor for the X, Y, and Z directions is specified explicitly for each problem.

3.0 SAFETY INJECTION PIPING SIX [6] INCH (continued)

June 12, 1975. H39B was modeled as an anchor in this analysis.

An interoffice correspondence was sent from P. Piraino to H. Moscow and G. Harper, with a copy to C. Fonseca, on June 20, 1975, transmitting revised comment sheets for Iso 265 and Iso 266. This revised comment sheet indicated that H39B should be an anchor instead of a vertical support.

C. A. Fonseca had the responsibility to incorporate these changes by E&DCR: however, no E&DCR was generated incorporating a change to H39B.

H39B is installed as a vertical constraint. E&DCR P-1083c is an E&DCR requesting changes to five (5) pipe restraint sketches to reflect as-built conditions. H39B was not installed exactly as its sketch indicated. Mr. Bob Cashi stated that the as-built designs were acceptable in this E&DCR. However, this E&DCR was never signed by C. Fonseca or the Project Engineer, and not one person was put on distribution.

3.0 SAFETY INJECTION PIPING SIX [6] INCH (continued)

two (2) vertical and East-West restraints and no North-South restraints. The significant difference is that the MSK and original design drawing indicate a lateral and vertical constraint on the bypass, but instead a vertical, East-West restraint was installed on the pipe in which FCV CH-122 is located. MSK-110D8-2 and ~~the~~ original design and the as-built condition do not conform to the directive outlined in FSAR Appendix B for non-computer analyzed pipe. An extremely high stress was determined under North-South earthquake condition by ADLPIPE for the as-built configuration.

This illustrates an inadequate original piping design which was installed essentially as originally designed. There may have been an intermediate change in design, but the MSK which would indicate this is unclear. The intermediate change, if it existed, appears no better than the original design. The valve assembly design does not appear to conform to the letter or intent of the FSAR (paragraph B.2.1.9).

3.0 SAFETY INJECTION PIPING (SIX [6] INCH) (continued)

foot of their design location, the discrepancy is not reported to the pipe stress personnel for disposition.

This is a situation which may result in unacceptable as-built configurations (i.e., movement of a restraint near a concentrated weight may affect pipe stress levels, constraint load and load distribution in both dead weight and seismic conditions).

Under thermal growth conditions, movement of a restraint near an elbow to a position too close to an elbow may result in excessive pipe stress and restraint loads, due to the lack of sufficient pipe to absorb an imposed deflection caused by thermal growth. Flexibility of a cantilever end increases with the cube of length, indicating that a small length change may cause a large change in load and stress.

3.0 <u>SAFETY INJECTION PIPING (SIX [6] INCH)</u> (continued)

The original design of this piping system was with MOV-SI-667 A & B constrained by snubbers in the "Z" direction. No indication is made of which direction is the "Z" direction, but per Gary Harper of Stone & Webster, it is understood among Engineering Mechanics personnel to be North. RP10X has a detail of the manner in which snubbers are to be attached to motor operators.

As originally designed, 3" SI-60 on Iso 272 had a lack of restraint in the North-South direction at a portion of the pipe between SI-TK-2 and MOV-SI-867A.

This situation was corrected in E&DCR sequence such that H-3-7B-4 was modified to provide North-South restraint. The support table indicates this restraint, however, to be a vertical and East-West restraint only. J. M. Cumiskey indicated that the Support Table is not a controlling document but an index. The design sketch was properly updated, referencing appropriate E&DCR's. E&DCR 1085-B and 11700-AZ-10A-18-1 indicate that this restraint is to be a North-South restraint.

3.0 SAFETY INJECTION PIPING (SIX [6] INCH) (continued)

of analysis that was made on LHSI piping. The overstress condition of the piping is attributable to the fact that the hand and chart method is sometimes unconservative, particularly with increasing pipe sizes, per Mr. Cumiskey.

During the audit, it was determined that the engineering justification of the 6" LHSI line inside containment was considerably more detailed than any other engineering justification performed in accordance with the hand and chart method which was reviewed during the audit. (See Section 2.0 of this report.)

Therefore, the implication is that other piping systems may have undetermined overstress conditions due to the inadequacy of engineering justification noted previously.

3.1.2 The Stone & Webster report on the overstress condition of LHSI piping states that one of the salient reasons why differences exist

3.0 SAFETY INJECTION PIPING (SIX [6] INCH)

3.1 During Beaver Valley Power Station Unit No. 1 design change involving the safety injection system inside containment, two 6" check valves, which were originally installed, were weighed before reinstallation. Their weight was determined to be 450 pounds, although the weight shown on the vendor (Velan) drawing is 225 pounds. A Stone & Webster letter dated February 17, 1978, to Westinghouse addressed this discrepancy and requested a check for validity of valve weights indicated on drawings for all Westinghouse-supplied valves. Westinghouse responded by a letter of May 30, 1978, stating that subsequent valve order for 6" check valves from Velan list a weight of 450 pounds, and that there are fourteen (14) such check valves at Beaver Valley Power Station Unit No. 1 supplied by Westinghouse. Westinghouse also indicated that the only other valves manufactured by Velan for Beaver Valley Power Station Unit No. 1 supplied by Westinghouse are three (3) 12" MOV's. Westinghouse stated that the Velan-supplied weights of these 12" MOV's appeared to be "seemingly about the correct weight."

2.0 SUMMARY AND CONCLUSIONS

In many instances, it appears that many piping designs and analyses, as well as actual procedures, used by piping design personnel are not in conformance with the Beaver Valley Power Station Unit No. 1 FSAR and with the Safety Evaluation Report (SER). The techniques used by Stone & Webster were often less conservative; in the case of LHSI piping inside containment, the techniques used result in stress levels which are one-tenth of the stress which results from the technique outlined in the SER. The techniques outlined in the SER are essentially the same as those used by NUPIPE and ADLPIPE computer codes.

Certain techniques outlined in the FSAR for small bore piping are unconservative for Beaver Valley (and possibly for Beaver Valley only) because of the shapes of the amplified response spectra. Also, the manner in which amplified response spectra peaks were spread does not appear to be in conformance with the FSAR. The method used in developing amplified response spectra is less conservative.

In several instances, piping reviewed during the audit appeared to be of poor original design. In those piping

AUDIT REPORT
PIPING DESIGN AND ANALYSIS

I N D E X

Please provide a response to the above concerns and the balance of the report by March 1, 1979. (Note: In the report, please consider the word "audit" to mean "report.")

If you have any questions, please contact J. J. Lynch.

Very truly yours,

H. A. VAN WASSEN
Project Manager

JJL/mr

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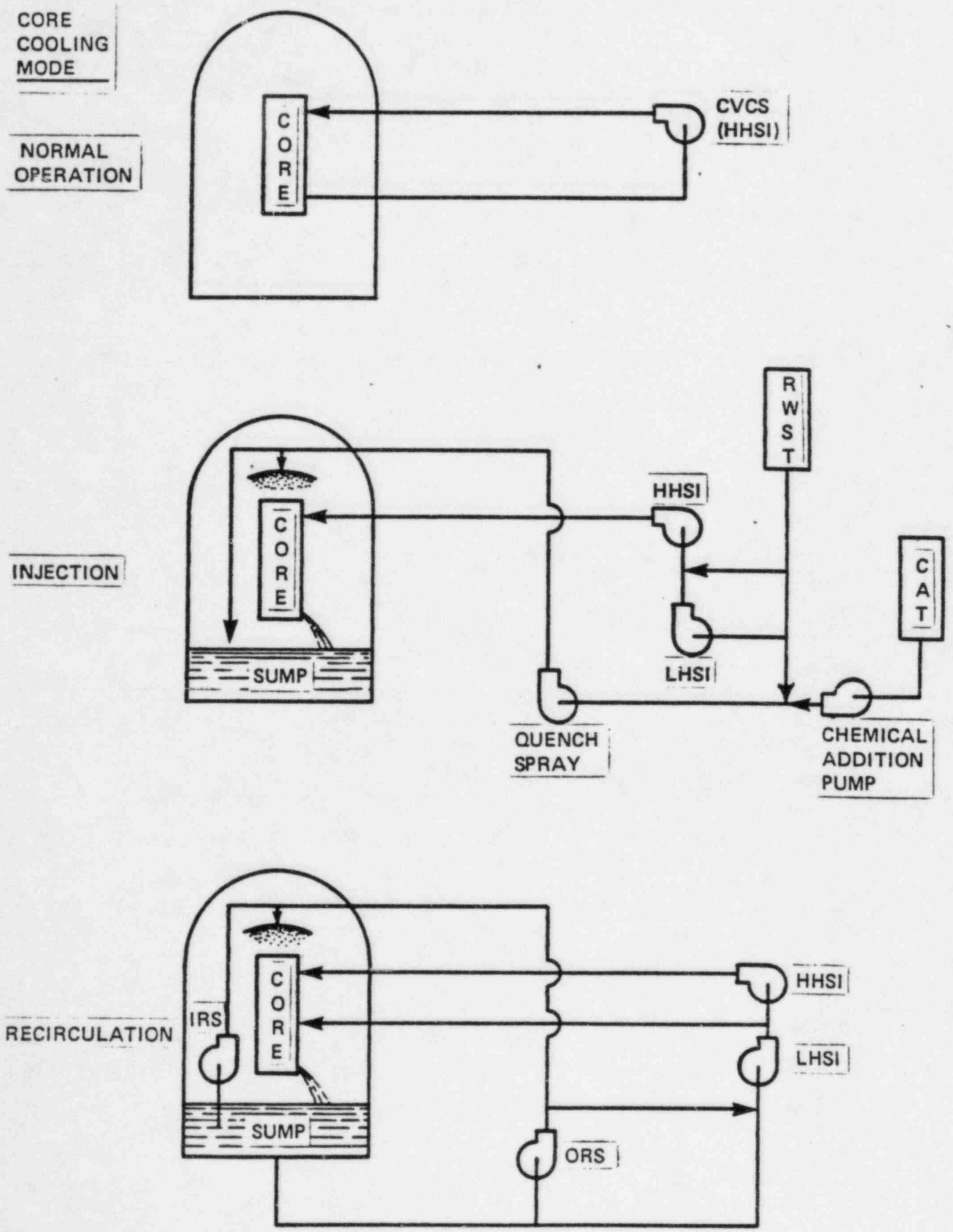
EMERGENCY CORE COOLING SYSTEM

BEAVER VALLEY #1

AUTO TRANSFER - PUMP ALIGNMENT - NPSH



DEFINITIONS TO ACCOMPANY SIMPLIFIED ECCS SCHEMATIC

FOR BEAVER VALLEY 1

Chemical and Volume Control System (CVCS) or Charging Pumps

Circulates reactor coolant at high pressures through chemical and gases clean-up systems. Maintains control of the reactor coolant volume in the reactor system. (Same pump as High Head Safety Injection)

High Head Safety Injection Pump (HHSI)

Provides (or injects) cool and highly borated water to the reactor upon Safety Injection System (SIS) actuation. Used while cooldown of reactor is at high pressures. HHSI pump draws water from RWST, LHSI, or containment sump depending upon size of break and available paths.

Refueling Water Storage Tank (RWST)

Normally stores water used during refueling operations. In emergencies provides initial cool water to reduce temperature of reactor core and pressure/temperature in containment building.

Low Head Safety Injection Pump (LHSI)

Provides large volumes of water at low pressures during accidents to boost the water available at the HHSI pump suction for large breaks (boost not needed for small breaks) and replaces the HHSI pump when the reactor coolant pressure is reduced to a level allowing the LHSI to cool the core directly. In normal operation, transfer RWST water for refueling.

Chemical Addition Tank (CAT)

Provides concentrated caustic solution to containment sprays during containment depressurization which acts to raise pH of containment sump and trap Iodine gases in the sump water. Depressurization of containment and trapping Iodine in the sump water reduces the likelihood of radioactive leaks to the atmosphere.

Chemical Addition Pumps

Provides positive transfer of caustic to suction of Quench Spray Pumps.

Quench Spray Pumps

Provides cool RWST water and caustic solution to containment sprays for depressurization and Iodine removal from the air and for the NPSH problem resolution, provides cool water to the containment sump/pump intakes for the IRS and ORS pumps.

Inside Recirculation System Pumps (IRS)

Located inside containment, provides long term cooling of the sump water and long term cooling and depressurization of the containment.

Outside Recirculation System Pumps (ORS)

Located outside containment so that they could be repaired (if necessary), provides redundant long term cooling of the sump water and long term cooling and depressurization of the containment. Due to pump alignment problem on LHSI, now cross connected to LHSI and can provide long term cooling of core should one LHSI fail.