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March 12, 1985

United States Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Mr. Harold R. Denton
Office of Nuclear Reactor Regulation

SUBJECT: Beaver Valley Power Station - Unit No. 2
Docket No. 50-412
Elimination of Arbitrary Intermediate Pipe Breaks

Gentlemen:

On February 5, 1985, Duquesne Light Company (DLC), along with other utilities, met with Westinghouse and the NRC to discuss future activity on Arbitrary Intermediate Pipe Breaks. At that meeting the NRC encouraged formal submittal on this issue for NRC approval. Enclosed for NRC staff review are the alternative pipe break criteria which we propose to apply to Beaver Valley Power Station Unit No. 2 (BVPS-2), which would obviate the need to postulate arbitrary intermediate pipe breaks.

Arbitrary intermediate pipe breaks are those break locations, which based on piping stress analysis results are below the stress and fatigue limits specified in Branch Technical Position (BTP) MEB 3-1, but which are arbitrarily selected as the two highest stress locations between the terminal ends of a piping system as required by the BTP. It has become apparent to both the NRC staff and the nuclear industry that this particular criterion requiring the postulation of arbitrary intermediate pipe breaks can be overly restrictive and result in an excessive number of pipe rupture protection devices which do not provide a compensating increase in the level of safety to the public. It is for this reason, as further explained and justified in detail in the enclosure to this letter, that DLC is pursuing the application of alternative pipe break criteria in the design of BVPS-2.

Attachment A provides a summary of the benefits derived from elimination of the arbitrary breaks. Attachment B provides the technical justification for the employment of the alternative pipe break criteria. Attachment C provides a list by piping system of the ASME Class 1, 2, and 3, and NNS piping intermediate break locations which are candidates to be eliminated. Attachment D gives systems information for these same piping systems. Attachments E, F, G, H, and I provide detailed descriptions of our provisions for minimizing stress corrosion cracking in high energy lines, minimizing the effects of thermal and vibration induced piping fatigue, minimizing steam and water hammer effects, environmental effects, and minimizing local stresses from welded attachments.

The percentage of the total potential benefits that can be realized by DLC for BVPS-2 becomes a matter of timing due to the advanced stage of

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design and construction. To make it possible for DLC to realize the maximum benefits afforded by this proposed change in the pipe break criteria, immediate attention by the NRC is requested with a favorable response to the proposed change in the pipe break criteria by April 30, 1985. Upon your concurrence, the FSAR will be appropriately revised in a future amendment.

DUQUESNE LIGHT COMPANY

By E. J. Woolever
E. J. Woolever
Vice President

RC/wjs
Attachment

cc: Mr. B. K. Singh, Project Manager (w/a)
Mr. G. Walton, NRC Resident Inspector (w/a)

COMMONWEALTH OF PENNSYLVANIA)
) SS:
COUNTY OF ALLEGHENY)

On this 12th day of March, 1985, before me, a Notary Public in and for said Commonwealth and County, personally appeared E. J. Woolever, who being duly sworn, deposed and said that (1) he is Vice President of Duquesne Light, (2) he is duly authorized to execute and file the foregoing Submittal on behalf of said Company, and (3) the statements set forth in the Submittal are true and correct to the best of his knowledge.

Anita Elaine Reiter
Notary Public

ANITA ELAINE REITER, NOTARY PUBLIC
ROBINSON TOWNSHIP, ALLEGHENY COUNTY
MY COMMISSION EXPIRES OCTOBER 20, 1986

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION UNIT 2

BENEFITS FOR ELIMINATION OF ARBITRARY INTERMEDIATE PIPE BREAKS

Duquense Light Company (DLC) has followed closely the recent activities of the Nuclear Regulatory Commission (NRC) staff and the nuclear industry related to the treatment of design basis pipe breaks in high energy piping systems. In particular, it is noted that the NRC staff has expressed an interest in the industry's proposal to modify the current pipe break criteria to eliminate from design consideration those intermediate breaks generally referred to as arbitrary intermediate breaks (i.e., those break locations which, based on stress analysis, are below the stress limits and/or the cumulative usage factors specified in the current NRC criteria) but are selected to provide a minimum of two breaks between terminal ends. Elimination of the arbitrary intermediate breaks offers considerable benefits due to the deletion of the associated pipe whip restraints and other provisions currently incorporated in plant designs to mitigate the effects of such breaks.

The break selection criteria currently employed by DLC for Beaver Valley Power Station Unit 2 (BVPS-2) is taken from NRC Branch Technical Positions ASB 3-1 and MEB 3-1. These documents require that pipe breaks be considered at terminal ends and at intermediate locations where stresses or cumulative usage factors exceed specified limits. If two intermediate locations cannot be determined based on the above (i.e., stresses and cumulative usage factors are below specified limits), then the two highest stress locations are selected.

DLC concurs with the nuclear industry in the belief that current knowledge and experience supports the conclusion that designing for the arbitrary intermediate breaks is not justified and that this requirement should be deleted. This conclusion is supported by extensive operating experience in over 80 operating U.S. plants and a number of similar plants overseas in which no piping failures have been known to occur that would suggest the need to design protective features to mitigate the dynamic effects of arbitrary intermediate breaks. Arbitrary intermediate breaks are often postulated at locations where stresses are well below the ASME Code allowables and within a few percent of the stress levels at other points in the same system. This results in complicated protective features being provided for specific break locations in the piping system that provide little to enhance overall plant safety.

In practice, consideration of these two arbitrary intermediate breaks is particularly difficult because the location of the high stress points may move several times as the seismic design and analysis of structures and piping develops. The industry recognizes that the revised MEB 3-1, which was included in the July 1981 revisions to the Standard Review Plan (NUREG-0800), provides criteria for not having to relocate intermediate break points when highest stress locations shift as a result of piping reanalysis. As a practical matter, however, these criteria provide little relief, since the burden

is on the designer to prove that not postulating breaks at relocated highest stress points does not degrade safety. This may require extensive additional analysis of break/target interactions for the relocated break points and could result in design, fabrication and installation of additional pipe whip restraints at the relocated break points, and elimination of previously installed restraints at abandoned break points. Early determination of exact break locations is quite important because of all the secondary effects of the pipe break to be considered.

The benefits to be realized from the elimination of the arbitrary intermediate break locations center primarily around the elimination of the associated pipe whip restraints and other structural provisions to mitigate the consequences of these breaks. While a substantial reduction in capital costs for these restraints and structures can be realized immediately, there are also significant operational benefits to be realized over the 40-year life of each plant. As identified in NUREG CR-2136, these effects are particularly in the areas of overall plant reliability and exposure of plant personnel to radiation when excessive pipe whip restraints are installed.

Access during plant operation for such activities as maintenance and inservice inspection is improved due to the elimination of congestion created by these restraints and the supporting structural steel, and in some cases due to the need to remove some restraints to gain access to welds. In addition to the decrease in maintenance effort, a significant reduction in man-rem exposure can be realized through fewer manhours spent in radiation areas. Also, the need to verify appropriate cold and hot clearances between pipes and restraints during initial heatup, which requires additional hold points during the startup phase, can be dispensed.

Recovery from unusual plant conditions would also be improved by elimination of this congestion. In the event of a radioactive release or spill inside the plant, decontamination operations would be much more effective if the complex shapes, represented by the structural frameworks supporting the restraints, were eliminated. This results in decreasing man-rem exposures associated with decontamination and restoration activities. Similarly, access for control of fires within these areas of the plant would be improved, especially under low visibility conditions. Substantial overall benefits in these areas would be realized by reducing the number of whip restraints required.

By design, whip restraints fit closely around the high energy piping with gaps typically being on the order of half an inch. These restraints and their supporting steel increase the heat loss to the surrounding environment significantly. Also, because thermal movement of the piping system during startup and shutdown could deform the piping insulation against the fixed whip restraint, the insulation must be cut back in these areas, creating convection gaps adjacent to the restraint, which also increases heat loss to the environment. This is a major contributor to the tendency of many containments to operate at temperatures near technical specification limits. The elimination of whip restraints associated with arbitrary intermediate breaks would assist in controlling the normal environmental temperatures and improving system operational efficiency.

For the above reasons, DLC requests NRC approval of the following for the application of alternative pipe break criteria which would eliminate the need to postulate arbitrary intermediate pipe breaks (i.e., those break locations which, based on stress analysis, are below the stress limits and the cumulative usage factors specified in the current NRC criteria, but are selected to provide a minimum of two breaks between terminal ends):

ASME Section III Piping Inside Containment

- Piping systems shall be designed to accommodate pipe breaks at terminal ends and locations where the stress or usage factor criteria of MEB 3-1 are exceeded. No arbitrary intermediate breaks will be postulated when the stress and/or usage factor criterion are not exceeded.

- For breaks that must be taken, the design will accommodate pipe whip, jet impingement, and compartment pressurization resulting from mechanistic treatment of the break. Current acceptable methods for limiting break opening, moderate and low energy exclusions, limited duration operation, etc. may still be applied.

- For flooding evaluation, environmental qualification of equipment, and structural design of areas traversed by high energy piping systems, breaks will continue to be postulated in accordance with the present project criteria (i.e., in each area traversed by the high energy piping system, non-mechanistic breaks are postulated at the location that results in the most severe environmental consequences). Therefore, elimination of the arbitrary intermediate breaks will not impact the flooding evaluation, environmental qualification program, or plant structural design.

ASME Section III and Seismically Designed Non-ASME Section III Piping Outside Containment

- Piping systems shall be designed to accommodate pipe breaks at terminal ends and locations where the stress criteria of MEB 3-1 are exceeded. No arbitrary intermediate breaks will be postulated when the stress criterion are not exceeded.

- For breaks that must be taken, the design will accommodate pipe whip and jet impingement effects resulting from mechanistic treatment of the break. Compartment pressurization and flooding effects from breaks postulated in accordance with MEB 3-1 will be accommodated in the design. Current acceptable methods for limiting break opening, moderate and low energy exclusions, limited duration operation, etc. may still be applied.

- For environmental qualification of equipment and structural design of areas traversed by high energy piping systems, breaks will continue to be postulated in accordance with the present project criteria (i.e., in each area traversed by the high energy piping system, non-mechanistic breaks are postulated at the location that results in the most severe environmental consequences). Therefore, elimination of the arbitrary intermediate breaks will not impact the environmental qualification program or plant structural design.

Application of the alternative pipe break criteria described above will not alter the commitment to quality in the design of safety related structures, systems, and components. The quality assurance program will continue to ensure safety related structures, systems, and components are designed, fabricated, erected, and tested to the quality standards commensurate with the safety function to be performed.

The piping systems being considered, including an estimate of the number of arbitrary intermediate breaks eliminated and a number of pipe rupture restraints and shields deleted, are detailed in Attachment C. Attachment D gives system information for these same piping systems. A total of 245 breaks are to be eliminated.

In this submittal we are providing additional technical information to justify further that request. Specific NRC concerns are addressed in the attachments as follows:

1. Technical justification for elimination of arbitrary intermediate breaks	Attachment B
2. Provisions for minimizing stress corrosion cracking in high energy lines	Attachment E
3. Provisions for minimizing the effects of thermal and vibration induced piping fatigue	Attachment F
4. Provisions for minimizing water/steam hammer effects	Attachment G
5. Environmental analysis	Attachment H
6. Provisions for minimizing local stresses from welded attachments	Attachment I

The application of the proposed criteria changes will result in the deletion of approximately 245 break locations, 105 pipe whip restraints, and 56 jet impingement shields in Classes 1, 2, and 3, and NNS piping. The breaks, restraints, and shields currently planned for elimination are listed in Attachent C. However, it should be noted that piping and system design is an iterative process and that postulated break locations could potentially move as the system design and analysis of structures and piping develops over the course of the design process and its potential for affecting postulated break locations, changes affecting high energy systems are continuously monitored and evaluated to determine the impact on break location. We propose to apply these alternative criteria to any potential break locations in the systems identified herein, provided the stresses at those locations are below the break selection threshold, and the operational concerns in Attachments F through I are adequately addressed.

Also, for those piping systems, or portions thereof, which are not included in this submittal, the existing guidelines in MEB 3-1 of the SRP (NUREG-0800) Revision 1 will be met. If other piping subsystems included in the systems

identified in Attachment D, but not specifically identified in this submittal, subsequently qualify for the conditions described herein, the implementation of the proposed elimination of the arbitrary intermediate break criteria may be used. If this criteria is to be applied to additional systems not included in Attachment D, those systems will be appropriately identified to the staff.

DLC has evaluated the potential cost savings and operational benefits that result from the elimination of arbitrary intermediate breaks. These benefits include $5-6 million savings in analysis, design, fabrication, and installation of associated pipe whip restraints, jet impingement barriers, and man-rem in dose reductions for BVPS-2 over its 40-year plant life. A summary of the benefits realized by the elimination of the arbitrary intermediate breaks is provided in Attachment A-1. The actual benefits that DLC will realize are expected to be higher than these due to the hidden factors and intangibles that are difficult to identify at this time. It is clear, however, that elimination of the arbitrary intermediate breaks is both safety effective and cost effective.

SUMMARY OF BENEFITS FROM THE ELIMINATION OF
ARBITRARY INTERMEDIATE PIPE BREAKS -
BEAVER VALLEY POWER STATION UNIT 2

Effect of Break Elimination	Cost Savings	Operational Benefits
Elimination of 162 Pipe Rupture Restraints (PRR) and Jet Shields	. Design, Fabrication and Installation Costs	. Potential improvement in performance of inservice inspection (ISI)
	. Dose Reduction Costs	. Dose reduction from improved personnel access during maintenance, ISI and recovery from unusual plant conditions, e.g., radioactive spills, fires, etc.
		. Improved capability to recover from unusual plant condition, e.g., decontamination following radioactive spills, access for fire fighting, etc.
		. Reduced system heat loss resulting from improved insulation design.
		. Dose reduction and improved construction schedule by eliminating the need to set and maintain PRR clearance gaps.
Elimination of Equipment Relocation	. Relocation Cost	. Improved system layout and design for future plant modifications.
Elimination of Evaluations Associated with the Dynamic Effects	. Jet Impingement Load and Pipe Whip Analyses Costs	
TOTAL SAVINGS	$5-6 Million	277 man-rem in dose reduction over the 40 year plant life.

ATTACHMENT A-1

TECHNICAL JUSTIFICATION FOR ELIMINATION OF ARBITRARY INTERMEDIATE BREAKS

The following items provide generic technical justification for the elimination of arbitrary intermediate pipe breaks and the associated pipe whip restraints for all piping other than Primary Loop.

1. The operating procedures and piping and system designs minimize the possibility of stress corrosion cracking, thermal and vibration induced fatigue, and water/steam hammer in these lines in which arbitrary pipe breaks are currently postulated. Detailed descriptions of the design provisions for these phenomena are provided in Attachments E, F, and G, respectively.

2. Welded attachments are analyzed for stress levels at every location to account for their contribution to the total stress. A survey of welded attachment locations indicates that very few are in close proximity to arbitrary intermediate breaks. For a further description, refer to Attachment I.

3. The pipe breaks and whip restraints being retained, i.e., terminal ends and intermediate points that exceed threshold limits, provide an adequate level of protection in areas containing high energy lines.

4. Pipe breaks are postulated to occur at locations where stresses are $\geq$ 80 percent of Code allowables (Class 2 and 3) or where the cumulative usage factor is 10 percent of the allowable (Class 1). The arbitrary breaks to be eliminated all exhibit stresses and usage factors below these conservatively low thresholds.

5. Pipe rupture is recognized in branch technical position MEB 3-1 as being a "rare event which may only occur under unanticipated conditions." The systems have been designed to preclude many operating transients identified in NUREG-0582. Those transients that remain have been analyzed and found acceptable. Consequently, the number of unanticipated transients has been significantly lowered.

6. Arbitrary intermediate breaks are only postulated to provide additional conservatism in the design. There is no technical basis for postulating these breaks. (See NUREG 1061 Volume 3)

7. Elimination of pipe whip restraints associated with the arbitrary breaks will facilitate in-service inspection, reduce heat losses from the piping, and eliminate the potential inadvertent restraints of piping during thermal growth and seismic motion.

8. Equipment environmental qualification (EQ) requirements will not be affected by the elimination of the arbitrary breaks. Breaks are postulated nonmechanistically for EQ purposes. For a further description, refer to Attachment H.

It is concluded that the elimination of arbitrary intermediate breaks is technically justified, based on the reasons stated above.

ATTACHMENT C
POSTULATED ARBITRARY INTERMEDIATE BREAKS (AIBs)
- BREAKS/PROTECTION DEVICES ELIMINATED -

Piping System****	Location*	NPS	Safety Class	Estimated Number Deleted		
				AIBs	RESTRAINTS	SHIELDS
Auxiliary Steam System	OC	10	NNS			
	OC	8	NNS			
	OC	6	NNS			
	OC	4	NNS	43	9	8
	OC	3	NNS			
	OC	2	NNS			
	OC	1½	NNS			
Steam Generator Blowdown	IC	3	2			
	IC	2½	2	6	2	2
	IC	2	2			
	OC	3	2	3	3	2
	OC	2½	2			
	OC	3	NNS			
	OC	1½	NNS	11	5	4
Chemical and Volume Control						
a. Charging flowpath downstream of Regen. Heat Exchanger (including	IC	3	2	1	0	0
Aux. Spray)	IC	2	2	2	0	0
b. Charging flowpath between containment Penetration and Regen. Heat Exchanger	IC	3	2	6	1	5
c. Normal letdown flowpath upstream	IC	2	1			
of Regen. Heat Exchanger	IC	2	2			
d. Normal letdown between Regen.	IC	3	2	20	2	5
Heat Exchanger and letdown orifices	IC	2	2			
e. Normal letdown from letdown orifices to containment penetration	IC	2	2			

ATTACHMENT C
POSTULATED ARBITRARY INTERMEDIATE BREAKS (AIBs)
- BREAKS/PROTECTION DEVICES ELIMINATED -

Piping System	Location*	NPS	Safety Class	Estimated Number Deleted		
				AIBs	RESTRAINTS	SHIELDS
f. Seal Water Injection to RCPs	IC	2	1	8	2	0
	IC	1½	1			
	IC	2	2			
				2	1	0
g. Seal water return from RCPs No. 1 Seal Bypass	IC	2	2			
h. Loop fill between RCPB isolation valves	IC	2	1	11	3	0
i. Excess letdown between RCPB isolation valves	IC	2	1	2	1	0
j. Normal letdown between containment penetration and Nonregen. Heat Exchanger	OC	2	2	16	3	1
k. Normal letdown downstream of Nonregen. Heat Exchanger	OC	2	2			
l. Charging/Seal water injection lines from charging pumps to containment penetrations	OC	4	2			
	OC	3	2			
	OC	2	2	40	7	3
	OC	1½	2			
Auxiliary Feedwater into Main Feedwater lines	IC	4	2	4	0	0
Main Feedwater						
a. Piping between containment penetration and steam generators	IC	16	2	6	18	3
b. Piping outboard of break exclusion zone	OC	16	NNS	2	6	0
	OC	6	NNS			

ATTACHMENT C
POSTULATED ARBITRARY INTERMEDIATE BREAKS (AIBs)
- BREAKS/PROTECTION DEVICES ELIMINATED -

Piping System	Location*	NPS	Safety Class	Estimated Number Deleted		
				AIBs	RESTRAINTS	SHIELDS
Gaseous Nitrogen System	OC	1½	NNS	8	3	3
Main Steam Piping						
a. Piping between containment penetration and steam generators	IC	32	2	6	7	3
b. Piping outboard of break exclusion zone	OC	32	NNS	6	21	0
Reactor Coolant System						
a. Pressurizer Spray lines	IC	6 4 1½	1 1 1	12	4	4
b. 8 in. Bypass line including branch connections	IC	8 2	1 1	6	3	9
c. Pressurizer Safety and Power-Operated Relief Valve Inlet lines	IC	6 3	1 1	3	1	1
Residual Heat Removal						
a. Piping from RCS loop connection to second RCPB isolation valve	IC	12	1	1	0	0
b. Piping connected to accum. injection line (loops 22 & 23)	IC	10	1			

ATTACHMENT C
POSTULATED ARBITRARY INTERMEDIATE BREAKS (AIBs)
- BREAKS/PROTECTION DEVICES ELIMINATED -

Piping System	Location*	NPS	Safety Class	Estimated Number Deleted AIBs	RESTRAINTS	SHIELDS
Safety Injection System (SIS)						
a. SIS lines normally connected to HHSI pumps	OC	4 3	2 2	8	3	3
b. Low/High Head Pump Injection lines from RCS loop connection to second RCPB isolation valve	IC	6 3 2	1 1 1	**	**	**
c. Piping from RCS loop connection to accumulator tanks	IC	12 2	2 2	1 6	0 0	0 0
TOTALS	--	--	--	245	105	56

*Location code

OC: lines located outside containment structure
IC: lines located inside containment structure

**Stress and break locations not available

***NPS: Nominal Pipe Size

****Includes branch connections although not specifically identified

ATTACHMENT D
POSTULATED ARBITRARY INTERMEDIATE BREAKS (AIBs)
- SYSTEMS SUMMARY -

Piping System****	Sys. FSAR Sec. No.	NPS	Safety Class	Pipe Class[1]	Pipe Material[2]	Operating Temperature(°F)
Auxiliary Steam System	10.4.10	10	NNS	151	CS	360
		8	NNS	151	CS	360
		6	NNS	151	CS	360
		4	NNS	151, 601	CS	360
		3	NNS	151	CS	360
		2	NNS	151	CS	360
		1½	NNS	151	CS	360
Steam Generator Blowdown	10.4.8	3	2	1502	SS	547
		2½	2	1502	SS	547
		2	2	601	CS	547
		3	NNS	901	CS	547
		1½	NNS	901	CS	390
Chemical and Volume Control	9.3.4					
a. Charging flowpath downstream of Regen. Heat Exchanger (including Auxiliary Spray)		3	1	1502	SS	495
		3	2	1502	SS	495
		2	2	1502	SS	130
b. Charging flowpath between containment Penetration and Regen. Heat Exchanger		3	2	1502	SS	130
c. Normal letdown flowpath upstream of Regen. Heat Exchanger		2	1	1502	SS	549
		2	2	1502	SS	549
d. Normal letdown between Regen. Heat Exchanger and letdown orifices		3	2	1502	SS	287
		2	2	1502	SS	
e. Normal letdown from letdown orifices to containment penetration		2	2	602	SS	287
f. Seal Water Injection to RCPs		2	1	1502	SS	130
		1½	1	1502	SS	130
		2	2	1502	SS	130

ATTACHMENT D
POSTULATED ARBITRARY INTERMEDIATE BREAKS (AIBs)
- SYSTEMS SUMMARY -

Piping System	Sys. FSAR Sec. No.	NPS	Safety Class	Pipe Class[1]	Pipe Material[2]	Operating Temperature(°F)
g. Seal water return from RCPs No. 1 Seal Bypass		2	2	1502	SS	
h. Loop fill between RCPB isolation valves		2	1	1502	SS	65-104
i. Excess letdown between RCPB isolation valves		2	1	1502	SS	85-105***
j. Normal letdown between containment penetration and Nonregen. Heat Exchanger		2	2	602	SS	287
k. Normal letdown downstream of Nonregen. Heat Exchanger		2	2	602	SS	115
l. Charging/Seal water injection lines from charging pumps to containment penetrations		4	2	1502	SS	130
		3	2	1502	SS	130
		2	2	1502	SS	130
		1½	2	1502	SS	130
Auxiliary Feedwater into Main Feedwater lines	10.4.9	4	2	601	CS	443
Main Feedwater						
a. Piping between containment penetration and steam generators	10.4.7	16	2	601	CS	443

ATTACHMENT D
POSTULATED ARBITRARY INTERMEDIATE BREAKS (AIBs)
- SYSTEMS SUMMARY -

Piping System	Sys. FSAR Sec. No.	NPS	Safety Class	Pipe Class[1]	Pipe Material[2]	Operating Temperature(°F)
b. Piping outboard of break exclusion zone		16	NNS	901	CS	443
		6	NNS	901	CS	443
Gaseous Nitrogen System	9.5.9					
a. Normally connected to main steam system		1½	NNS	601	CS	547
b. In other areas		1½	NNS	151,601	CS	65-104
Main Steam Piping	10.3					
a. Piping between containment penetration and steam generators		32	2	601	CS	547
b. Piping outboard of break exclusion zone		32	NNS	601	CS	547
Reactor Coolant System	5.3					
a. Pressurizer Spray lines		6	1	1502	SS	542-656
		4	1	1502	SS	542-656
		1½	1	1502	SS	85-105
b. 8 in. Bypass line including branch connections		8	1	2501R#	SS	542
		2		1502	SS	542
c. Pressurizer Safety and Power-Operated Relief Valve Inlet lines		6	1	1502	SS	400/656*
		3	1	1502	SS	400/656*

ATTACHMENT D
POSTULATED ARBITRARY INTERMEDIATE BREAKS (AIBs)
- SYSTEMS SUMMARY -

Piping System	Sys. FSAR Sec. No.	NPS	Safety Class	Pipe Class[1]	Pipe Material[2]	Operating Temperature(°F)
Residual Heat Removal	5.4.7					
a. Piping from RCS loop connection to second RCPB isolation valve		12	1	1502	SS	610**
b. Piping connected to accum. injection line (loops 22 & 23)		10	1	1502	SS	85-105**
Safety Injection System (SIS)	6.3					
a. SIS lines normally connected to HHSI pumps		4 3	2 2	1502	SS	130
b. Low/High Head Pump Injection lines from RCS loop connection to second RCPB isolation valve		6 3 2	1 1 1	1502 1502 1502	SS SS SS	610-Hot leg conn. 542-Cold leg conn.
c. Piping from RCS loop connection to accumulator tanks		12 12 2	1 2 2	1502 602, 1502 602	SS SS SS	542 85-105 85-105

*Water solid loop seal maintained at 400°F
**Excludes temperatures for RHR system operation
***Line can see loop temperature conditions during heatup or when normal letdown path inoperable.
****Includes branch connections although not specifically identified.

1. Pipe Classes: 150-151 Lb Carbon Steel Piping
601-600 Lb Carbon Steel Piping
602-600 Lb Type 304 Stainless Steel Piping
901-900 Lb Carbon Steel Piping
1502-1500 Lb Type 316 Stainless Steel Piping
2501R#-1500 Lb Type 316 Stainless Steel Piping

2. Material: CS-Carbon Steel SA/A106, Gr. B or C
SS-Stainless Steel: Class 602 is SA/A376 or 312, Type 304. Class 1502 is SA/A376 or 312, Type 316. Class 2501R# is SA376 Type 316.

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION UNIT 2

PROTECTION OF HIGH ENERGY LINES
FROM STRESS CORROSION CRACKING

Stainless Steel Lines:

All high energy piping at BVPS-2 made with stainless steel is made of alloy Type 304 or Type 316. High carbon grades Type 304H and Type 316H are not used. The piping material was furnished in the solution annealed condition and fabricated using forming and welding practices which limited the degree of sensitization consistent with Regulatory Guide 1.44 recommendations.

While the controls used to minimize sensitization alone do not prevent the possibility of stress corrosion, experience and tests have shown that by maintaining a high degree of cleanliness and controls on fluid chemistry that stress corrosion will not occur under these conditions.

The fluid chemistry requirements specified for the Reactor Coolant System (RCS) are provided in FSAR Table 5.2-5 (Attachment E-1). The strict limitations on halogens and oxygen have proven to be effective in preventing stress corrosion cracking. Makeup water to the RCS and the remaining secondary side safety related high energy lines, with the exception of steam generator blowdown, are subject to the same strict halogen requirements. These strict controls have proven to be effective in preventing stress corrosion cracking in these systems which operate at lower temperatures than the RCS. The steam generator blowdown system chemistry is controlled by the feedwater system conditions described below, thus preventing stress corrosion cracking. The steam generator blowdown system is continuously monitored to ensure correct water chemistry is maintained. Caustic stress corrosion is prevented because of the lack of additives that can generate caustics.

Stress corrosion cracking initiated from the outside surfaces of the piping is prevented by the use of strict cleaning procedures followed by swipe testing to ensure low chloride and fluoride levels and the use of thermal insulation supplied in accordance with the recommendations of Regulatory Guide 1.36.

Carbon Steel Lines:

Carbon steel high energy piping are protected from stress corrosion cracking due to the water chemistry controls specified in FSAR Table 10.4-13 (Attachment E-2). All-volatile chemistry treatment in the feedwater system maintains oxygen concentration and pH within desired levels. The feedwater system is also continuously monitored to ensure correct water chemistry. No caustic is present in this environment, precluding the possibility of caustic stress corrosion cracking of the carbon steels.

TABLE 5.2-5

REACTOR COOLANT CHEMISTRY SPECIFICATION

Electrical conductivity	Determined by the concentration of boric acid and alkali present. Expected range is <1 to 40 μMhos/cm at 25°C.
Solution pH	Determined by the concentration of boric acid and alkali present. Expected values range between 4.2 (high boric acid concentration) and 10.5 (low boric acid concentration) at 25°C.
Oxygen(1)	0.005 ppm, maximum
Chloride(2)	0.15 ppm, maximum
Fluoride(2)	0.15 ppm, maximum
Hydrogen(3)	25-50 cc (STP)/kg H_2O
Suspended solids(4)	1.0 ppm, maximum
pH control agent (Li7OH)(5)	0.7-2.2 ppm as Li
Boric acid	Variable from 0-4000 ppm as B
Silica(6)	0.2 ppm, maximum
Aluminum(6)	0.05 ppm, maximum
Calcium(6)	0.05 ppm, maximum
Magnesium6	0.05 ppm, maximum

NOTES:

1. Oxygen concentration must be controlled to less than 0.1 ppm in the reactor coolant at temperatures above 180°F by scavenging with hydrazine or by maintaining the proper hydrogen concentration. During power operation with the specified hydrogen concentration maintained in the coolant, the residual oxygen concentration must not exceed 0.005 ppm.
2. Halogen concentrations must be maintained below the specified values at all times regardless of system temperature.

TABLE 5.2-5 (Cont)

NOTES: (Cont)

3. Hydrogen must be maintained in the reactor coolant for all plant operations with nuclear power above 1 MWt. The normal operating range should be 30-40 cc/kg H_2O.
4. Solids concentration determined by filtration through filter having 0.45 micron pore size.
5. The specified limits for lithium hydroxide must be established for prestart-up testing prior to heatup beyond 150°F. During cold hydrostatic testing and hot functional testing, in the absence of boric acid, the reactor coolant limits for lithium hydroxide must be maintained to provide inhibition of halogen stress corrosion cracking. Upon plant restart, the lithium hydroxide limits should be established at 180°F.
6. These limits are included as recommended standards for monitoring coolant purity. Establishing coolant purity within the limits shown for the species is judged desirable with the current data base to minimize fuel clad crud deposition which affects the corrosion resistance and heat transfer of the clad.

TABLE 10.4-13

STEAM GENERATOR STEAM SIDE AND FEEDWATER CHEMISTRY SPECIFICATIONS

	Cold Hydro/ Cold Wet Layup	Hot Functional/ Hot Shutdown/ Hot Standby		Start-up From Hot Standby				Normal Power Operation			
	Blowdown	Blowdown		Feedwater		Blowdown		Feedwater		Blowdown	
Chemistry Parameter	Control	Control	Expected	Expected	Control	Control	Expected	Expected	Control	Control	Expected
pH @ 25°C	10.0 - 10.5	8.8 - 9.2	8.8 - 9.2	8.8 - 10.0	NA	8.5 - 10.0	8.5 - 10.0	8.8 - 9.2	NA	8.5 - 9.0	8.5 - 9.0
Free hydroxide as ppm $CaCO_3$	ND	0.15	<0.15	NA	NA	0.15	<0.15	NA	NA	0.15	<0.15
Cation conductivity mhos/cm @ 25°C	NA	2.0	<2.0	NA	NA	7	<7	NA	NA	2.0	<2.0
Total conductivity mhos/cm @ 25°C	NA	NA	NA	NA	NA	NA	NA	≤4	NA	NA	NA
Sodium, ppm	NA	NA	<0.1	NA	NA	NA	<0.5	NA	NA	NA	<0.1
Chloride, ppm	<0.5	NA	<0.15	NA	NA	NA	<0.5	NA	NA	NA	<0.15
NH_3, ppm	As pH requires	NA	≤0.5	NA	NA	NA	<10.0	≤0.5	NA	NA	≤0.25
Hydrazine, ppm	75 - 150	NA	NA	$[O_2]$ + 0.005	$[O_2]$ + 0.005	NA	NA	$[O_2]$ + 0.005	$[O_2]$ + 0.005	NA	NA
Dissolved oxygen, ppb	<100	NA	<5	<100	<100	NA	<5	<5	<5	NA	<5
SiO_2, ppm	NA	NA	<1.0	NA	NA	NA	<5	NA	NA	NA	<1.0
Fe, ppb	NA	NA	NA	<100	NA	NA	NA	<10	NA	NA	NA
Cu, ppb	NA	NA	NA	<50	NA	NA	NA	<5	NA	NA	NA
Suspended solids, ppm	NA	NA	<1	NA	NA	NA	NA	NA	NA	NA	<1.0
Blowdown rate, gpm/SG	NA	NA	As required	NA	NA	Maximum	Maximum	NA	NA	As required to maintain control parameters	<1.0

ATTACHMENT E-2

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION UNIT 2

PROVISIONS FOR MINIMIZING THE EFFECTS OF
THERMAL AND VIBRATION INDUCED PIPING FATIGUE

I. GENERAL FATIGURE DESIGN CONSIDERATIONS

For Class 1 lines, fatigue considerations are addressed by the cumulative usage factor (CUF). In order to ensure that piping will not fail due to fatigue, the ASME Code has set the CUF limit at 1.0. By definition, all arbitrary intermediate break locations have CUFs below 0.1.

For Class 2 and 3 lines, fatigue is considered in the allowable stress range check for thermal expansion stresses. This stress is included in the total stress value used to determine postulated break locations. All arbitrary break locations exhibit stresses less than 80 percent of the code allowables. If the number of thermal cycles is expected to be greater than 7,000, then the allowable stresses are further reduced by an amount dependent on the number of cycles.

II. VIBRATION DESIGN CONSIDERATIONS

BVPS-2 piping systems are designed and supported to minimize transient and steady state vibrations.

Vibration levels are observed or measured during preoperational testing for both steady state and transient vibration conditions. The program used to monitor these conditions is described below.

Steady-State Vibrations:

Visual observations are used for judging acceptability of steady-state vibration. Visual observations may be aided by hand-held instruments (e.g., vibrometers) when considered appropriate by engineers experienced in piping design.

A screening velocity or displacement will be established for use with hand-held instrument results. If the measurement indicates that the velocity or displacement limit is exceeded, the measured values are reconciled with the respective analyses by considering the specific piping configuration, velocity or displacement amplitude measured, stress indices, and the endurance strength of the material properly accounting for high cycle effects. If system modifications are required, the applicable ASME design calculations are reconciled to assure acceptable system characteristics for all applicable design conditions.

The maximum alternating stress intensity will be used to establish the acceptance stress criteria for steady state vibrations.

Transient Vibrations:

Transient vibration conditions are subjected to visual and instrumented observations. When instrumented observations are taken, the acceptance criteria are based on the applicable fluid system transient analysis (stress, deflection, etc.) results. Instrumented observations are considered acceptable if they are within the transient analysis results acceptance criteria, the results are reconciled with the design analysis. When system modifications are required to achieve acceptable levels of transient vibration, the ASME design calculations are reviewed and modified as necessary to assure acceptable system characteristics.

III. THERMAL DESIGN CONSIDERATIONS

During normal operation, mixing (backflow from the steam generator into the feedwater line) of hot water in the steam generator with the lower temperature feedwater is localized to the area of the feedwater inlet nozzle. This is accomplished by both the piping arrangement and the main and bypass feedwater control valves.

The feedwater piping is arranged with a downward 90 degree elbow welded to the steam generator inlet nozzle coupled with a vertical run of pipe. A thermal protective liner extending from the nozzle back through the 90 degree elbow will minimize thermally induced cyclic stresses on the nozzle and inlet piping.

Flow surges due to main and bypass feedwater control valve modulation have been minimized due to control valve design (trim/flow coefficient design) coupled with a valve positioner which adds to control valve stability.

Mixing is further reduced by the presence of inverted "J" tubes located on the top of the feedwater ring in the steam generator.

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION UNIT 2

PROVISIONS FOR MINIMIZING
STEAM/WATER HAMMER EFFECTS

Systems within Westinghouse scope of supply are not in general susceptible to water hammer. The reactor coolant, chemical and volume control and residual heat removal systems have been specifically designed to preclude water hammer. Operating experience at other plants with Westinghouse systems have verified this design approach.

Westinghouse has conducted a number of investigations into the causes and consequences of water hammer events. The results of these investigations have been reported to Westinghouse operating plant customers and have been reflected in design interface requirements to the BOP designer for plants under construction, to assure that water hammer events initiated in the secondary systems do not compromise the performance of the Westinghouse-supplied safety-related systems and components.

In general, the approaches taken, individually or in combination, to address water hammer concerns were to prevent/minimize water hammer effects through system design features/operating procedures. Potential water hammer sources to be considered were based on industry experience and the concerns presented in NUREG-0582 "Water Hammer in Nuclear Power Plants." The following discusses in more detail the potential water hammer sources, if any, that were considered in the design of the subject systems and the actions taken to minimize and prevent water hammer effects.

Reactor Coolant System (RCS):

There is a very low potential for water hammer in the subcooled water solid portions of RCS since these portions of RCS are designed to preclude void formation.

Safety Injection System (SIS):

As discussed below, it is considered unlikely that water hammer induced pipe ruptures could occur in the Safety Injection System.

The low temperature SIS lines, which are normally water solid, have a very low probability of steam void formation. Proper initial fill and venting ensures that low and high head safety injection system piping remains filled. In addition, the head of water provided by the RWST provides a continuous mechanism for ensuring that the low head safety injection system lines remain full.

For the SIS lines, which are part of the Residual Heat Removal System return flowpath, operating procedures for RHRS minimize the potential for water hammer in these lines.

For the SIS lines, which are part of the Reactor Coolant Pressure Boundary to the first isolation valve, there is a very low potential for water hammer as indicated in the above RCS discussion.

Residual Heat Removal System (RHRS):

Portions of the RHRS piping is high energy because it is normally pressurized by RCS or SIS during normal plant operating conditions. As discussed below, it is unlikely that water hammer induced pipe ruptures could occur in the Residual Heat Removal System.

When RHRS is not operating, the normally pressurized portions of the system are water solid and are either at a low temperature or subcooled.

When RHRS is operating (i.e., the short operational period), valve closure times and operating procedures minimize the potential for water hammer. Proper fill and venting will initially ensure that air does not become trapped in any part of the RHRS during start-up. Additionally, just prior to RHRS initiation, the RHRS will be cross-connected with the CVCS (via 2RHS*MOV750A, and B and 2CHS*HCV142). The valves are shown on FSAR Figures 5.4-4 and 9.3-24, respectively. This action utilizes the pressure head in the CVCS to collapse any voids (should they remain) prior to opening the RHRS suction (2RHS*MOV701A and B and 2RHS*MOV702A and B) valves from the RCS.

Steam Generator Blowdown (SGB):

Fluid flow in the SGB lines is normally two-phase flow from the steam generators to the feedwater injection taps downstream of the containment isolation valves outside containment. There is very little probability of water hammer occurring in this portion of piping because of the very low percent quality (approximately 10 percent).

Because of the greater susceptibility for water slugging to occur in the SGB lines outboard of the contaiment isolation valves, a connection from the feedwater system was provided to inject feedwater into the blowdown flow. This will subcool the blowdown flow and prevent water slugging.

In addition to the above, operating procedures provide precautions to prevent thermal shock and water hammer of system components while starting up the system or when changing loads.

Auxiliary Steam Systems (ASS):

The potential for water hammer has been minimized by means of operating procedures (e.g., warming up lines prior to continuous operation to remove any existing condensation), sloping of piping to eliminate pockets of condensate and providing drains/steam traps to continuously remove any condensate accumulating during heat-up and operation.

Gaseous Nitrogen System (GNS):

There are no potential water hammers in gaseous lines once the system is vented and charged with nitrogen. The GNS lines normally connected to

MSS lines are part of the MSS pressure boundary (i.e., to the first normally closed isolation valve off MSS line).

Chemical and Volume Control (CVCS):

The low temperature CVCS lines, which are normally water solid, have a very small probability of steam void formation. Accordingly, no water hammer would be expected. In addition, for those lines which are part of the charging flowpath, operating procedures should prevent any water hammer effects associated with the starting of a charging pump.

In the high temperature CVCS lines system design, a pressure regulating valve downstream of the letdown restriction orifices prevents flashing and maintains water solid conditions during normal plant operation so water hammer would ot be expected. Valve interlocks, as well as operating procedures, have been provided to prevent flashing when starting up or securing the letdown flowpath.

Main Feedwater System (FWS):

The potential for water hammer in the FWS caused by rapid condensation of a steam bubble in the steam generator feedring (NUREG-0582, Item A-8) has been minimizing by incorporation of the following features:

1. The steam generator feedring is provided with J-tubes to prevent drainage of water during low steam generator water level.
2. The feedwater piping connections of the steam generators are made with a 90 degree elbow arrangement which does not present a horizontal pipe run immediately upstream of the feedwater nozzles. This configuration should prevent formation of steam pockets under low steam generator water level conditions and minimize the volume of water external to the steam generator which could pocket a steam bubble. This piping arrangement follows Westinghouse design guidelines.

Industry experience has shown that the above design features have minimized, if not eliminated this type of water hammer. During start-up testing at BVPS-2, tests will be conducted to demonstrate the effectiveness of this design.

In addition, the main feedwater control valves, supplied by W have been subjected to extensive design considerations and iterations to ensure the valve size and trim is compatible with the remainder of the feedwater system design. To ensure feedwater flow control at low power levels (approximately 15 percent), a bypass control valve is provided around each main feedwater control valve.

Auxiliary Feedwater System (AFWS):

The AFWS does not operate during normal operation. The majority of the AFWS is moderate energy as only that portion which is part of the FWS up to the isolation valve in containment is considered high energy. Thus, for this 4-inch section of piping, the discussion for the FWS regarding water hammer applies.

Operating procedures (e.g., filling and venting procedures) minimize the potential for water hammer associated with pump starting.

Main Steam System (MSS):

The potential of water hammer in the MSS caused by water entrained in steam lines has been minimized due to the piping arrangement. MSS piping is sloped to eliminate pockets where condensate could collect, and condensate is continuously removed via the steam drains system.

Heating up the MSS lines downstream of the main steam isolation valves (MSIV) prior to opening the MSIVs is accomplished using the 2-inch bypass line. This removes any condensate which may have accumulated in the lines prior to opening the MSIV's.

Operating procedures identify specific actions to minimize/prevent water hammer.

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION UNIT 2

ELIMINATION OF ARBITRARY INTERMEDIATE BREAKS
ENVIRONMENTAL ANALYSIS

There will be no change in the results of Beaver Valley Power Station Unit 2 environmental analysis due to elimination of arbitrary intermediate breaks. The break postulation for environmental effects, as indicated in FSAR Section 3.6B.1.3.4.3, is performed independently of break postulation for dynamic (i.e., whip/jet) effects. When postulating breaks for environmental effects, a break is assumed to occur nonmechanistically anywhere along the piping run. The break location chosen for purposes of equipment qualification is the one which causes the worst environmental effect on safety-related equipment.

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION UNIT 2

PROVISIONS FOR MINIMIZING LOCAL STRESSES
FROM WELDED ATTACHMENTS

All of the arbitrary intermediate break locations to be eliminated have been reviewed, and it has been determined that in only six cases are welded attachments close to the postulated breaks. In each of these cases, the attachment stresses have been appropriately added to the arbitrary break point stresses and the resultant stresses were less than the break postulation stress limit.