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DUANE ARNOLD ENERGY CENTER
PLANT UNIQUE ANALYSIS REPORT
VOLUME 5
SAFETY RELIEF VALVE DISCHARGE
LINE PIPING ANALYSIS

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EFFECTIVE PAGE(S)	REV	PREPARED	ACCURACY CHECK	CRITERIA CHECK
5-2.92	0	SL	TAB	JWAK-
5-2.93		SL		
5-2.94		JDS		
5-2.95				
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5-2.97				
5-2.98		JDS	TAB	
5-2.99		TAB	JDS	
5-2.100		SL	TAB	
5-2.101		SL		
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5-2.131				
5-2.132	0	JDS	TAB	JWAK-

EFFECTIVE PAGE(S)	REV	PREPARED	ACCURACY CHECK	CRITERIA CHECK
5-2.133	0	FEP	TAB	JWAK-
5-2.134		JDS		
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5-2.138		JDS		
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5-2.140		FEP		
5-2.141		SL		
5-2.142		SL	TAB	
5-2.143		SL	FEP	
5-2.144		TAB	FEP	
5-2.145		TAB	JDS	
5-2.146		SL	TAB	
5-2.147		SL	TAB	
5-3.1	0	TAB	JDS	JWAK-
5-2.88	1	WJS	JWAK-	JWAK-
5-2.90	1			
5-2.92	1			
5-2.96	1			
5-2.138	1			
5-2.143	1	WJS	JWAK-	JWAK-

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NOTES FOR TABLE 5-2.2-25

(1) SEE SECTION 5-2.2.1 FOR DEFINITION OF INDIVIDUAL LOADS.

(2) ONLY GOVERNING MARK I LOAD COMBINATIONS FROM TABLE 5-2.2-28 AND GOVERNING NON-MARK I LOAD COMBINATIONS ARE CONSIDERED HERE.

(3) SEE SECTION 5-2.2.3 FOR COMBINATION OF DYNAMIC LOADS.

(4) STRESS RANGE ANALYSIS IS NOT REQUIRED.

(5) LOAD RV1B IS USED IF LARGER THAN RV1A.

(6) LOCA AND SSE LOADS ARE COMBINED BY THE SRSS METHOD. IF THE COMBINATION OF LOCA AND SSE LOADS IS LESS THAN LOCA LOADS ADDED ABSOLUTELY WITH OBE, THE COMBINATION OF LOCA LOADS ADDED ABSOLUTELY WITH OBE IS USED.

(7) FOR THE DBA CONDITION, SRV DISCHARGE LOADS NEED NOT BE COMBINED WITH CO LOADS.

(8) WHEN THE COMBINATION OF EITHER TE2 AND THAM2 OR TE1 AND THAM1A OR TE2 AND THAM2A IS GREATER THAN THE COMBINATION OF TE1 AND THAM1, THE MAXIMUM COMBINATION IS USED.

Table 5-2.2-26

BASIS FOR GOVERNING LOAD COMBINATIONS-

MSL, SRVDL PIPING AND SRV OUTLET FLANGES

EVENT COMBINATION NUMBER (1)	GOVERNING LOAD COMBINATIONS (2)	DISCUSSION	EVENT COMBINATION GOVERNING BASIS
1	B-2	SECONDARY STRESS BOUNDED BY EVENT COMBINATION NUMBER 3.	(3b)
2	N/A	BOUNDED BY EVENT COMBINATION NUMBER 3.	(3a)
3	A-3, C-1	N/A	N/A
4,5,10	N/A	BOUNDED BY EVENT COMBINATION NUMBER 11.	(3b)
6,8,12, 14,20	N/A	BOUNDED BY EVENT COMBINATION NUMBER 15.	(3a)
7,9,13,17 21,23,27	N/A	BOUNDED BY EVENT COMBINATION NUMBER 15.	(3b)
11	C-2, C-3	N/A	N/A
15	A-4, D-2, D-3	N/A	N/A
16,19,22	N/A	BOUNDED BY EVENT COMBINATION NUMBER 25.	(3b)
18,24	N/A	BOUNDED BY EVENT COMBINATION NUMBER 25.	(3a)
25	A-4, D-4	N/A	N/A
26	A-5, D-1	N/A	N/A

NOTES FOR TABLE 5-2.2-26

(1) EVENT COMBINATION NUMBERS REFER TO THE NUMBERS USED IN TABLE 5-2.2-21.

(2) GOVERNING LOAD COMBINATIONS ARE LISTED IN TABLE 5-2.2-23.

(3) EVENT COMBINATION GOVERNING BASIS:

A. THE GOVERNING EVENT COMBINATION CONTAINS SSE LOADS WHICH BOUND OBE LOADS.

B. THE GOVERNING EVENT COMBINATION CONTAINS MORE LOADS, WHILE THE ALLOWABLE LIMITS ARE THE SAME.

Table 5-2.2-27

BASIS FOR GOVERNING LOAD COMBINATIONS-
MSL AND SRVDL PIPING SUPPORTS

EVENT COMBINATION NUMBER (1)	GOVERNING LOAD COMBINATIONS (2)	DISCUSSION	EVENT COMBINATION GOVERNING BASIS
1	SB-1	N/A	N/A
2	N/A	BOUNDED BY EVENT COMBINATION NUMBER 3.	(3a)
3	SC-1	N/A	N/A
4,5,10	N/A	BOUNDED BY EVENT COMBINATION NUMBER 11.	(3b)
6,8,12, 14,20,26	N/A	BOUNDED BY EVENT COMBINATION NUMBER 15.	(3a)
7,9,13,17 21,23,27	N/A	BOUNDED BY EVENT COMBINATION NUMBER 15.	(3b)
11	SC-2, SC-3	N/A	N/A
15	SD-1, SD-2	N/A	N/A
16,19,22	N/A	BOUNDED BY EVENT COMBINATION NUMBER 25.	(3b)
18,24	N/A	BOUNDED BY EVENT COMBINATION NUMBER 25.	(3a)
25	SD-3	N/A	N/A
26	SD-4	N/A	N/A

NOTES FOR TABLE 5-2.2-27

(1) EVENT COMBINATION NUMBERS REFER TO THE NUMBERS USED IN TABLE 5-2.2-21.

(2) GOVERNING LOADS COMBINATIONS ARE LISTED IN TABLE 5-2.2-24.

(3) EVENT COMBINATION GOVERNING BASIS:

A. THE GOVERNING EVENT COMBINATION CONTAINS SSE LOADS WHICH BOUND OBE LOADS.

B. THE GOVERNING EVENT COMBINATION CONTAINS MORE LOADS, WHILE THE ALLOWABLE LIMITS ARE THE SAME.

Table 5-2.2-28

BASIS FOR GOVERNING LOAD COMBINATIONS-SRVDL-VL PENETRATION

EVENT COMBINATION NUMBER (1)	GOVERNING LOAD COMBINATIONS (2)	DISCUSSION	EVENT COMBINATION GOVERNING BASIS
1,2,4,5,6, 8,10,11,12	N/A	BOUNDED BY EVENT COMBINATION NUMBER 14	(3b)
3,7,9,13	N/A	BOUNDED BY EVENT COMBINATION NUMBER 15	(3b)
14	SB-1,SB-2	N/A	N/A
15	SC-3,SC-4	N/A	N/A
16	N/A	BOUNDED BY EVENT COMBINATION NUMBER 18	(3b)
17	N/A	BOUNDED BY EVENT COMBINATION NUMBER 20	(3b)
18	SB-3	N/A	N/A
19,22	N/A	BOUNDED BY EVENT COMBINATION NUMBER 25	(3b)
20	SB-4	N/A	N/A
21,23	N/A	BOUNDED BY EVENT COMBINATION NUMBER 27	(3b)
24	N/A	BOUNDED BY EVENT COMBINATION NUMBER 25	(3a)
25	SC-1	N/A	N/A
26	N/A	BOUNDED BY EVENT COMBINATION NUMBER 27	(3a)
27	SC-2	N/A	N/A

5-2.3 Analysis Acceptance Criteria

The acceptance criteria defined in NUREG-0661 on which the SRVDL piping analysis is based are discussed in Section 1-3.2. In general, the acceptance criteria follow the rules contained in the ASME Code, Section III, Division 1, 1977 Edition with Addenda up to and including the 1978 Winter Addenda for Class 2 piping and piping supports (Reference 7). These criteria are equivalent to those of the 1977 Edition with Addenda up to and including the Summer 1977 Addenda with respect to the requirements of NUREG-0661. The corresponding service level limits, allowable stresses, and fatigue requirements are also consistent with the requirements of the ASME Code and NUREG-0661. The following paragraphs provide a summary of the acceptance criteria used in the analysis of the SRVDL piping.

The MSL, SRVDL piping, and T-quencher are analyzed in accordance with the requirements for Class 2 piping systems contained in Subsection NC of the ASME Code. Tables 5-2.3-1 and 5-2.3-2 list the applicable ASME Code equations and stress limits for each of the governing load combinations for piping and T-quenchers.

The MSL and SRVDL piping supports are analyzed in accordance with requirements for Class 2 piping supports as provided in Subsection NF of the ASME Code. The applicable stress limits for support structures are based on the service level assignments listed for the governing piping support load combinations. Table 5-2.3-3 provides the allowable load limits for snubber and strut support components.

The acceptance criteria for the safety relief valve outlet flanges are specified in terms of maximum allowable moments. Table 5-2.3-4 lists the allowable moments for the SRV outlet flanges.

The acceptance criteria for the SRVDL vacuum breakers is based on limiting the calculated stresses in the valve body and extended structure below Service Level B limits.

Table 5-2.3-5 lists the allowable stress limits for the T-quencher and elbow support beam and connecting brackets. The welds are evaluated according to code requirements of the supporting structure. The local effects on the vent line penetration are analyzed in accordance with requirements for Class MC components as provided in Subsection NE of the ASME Code. Table 5-2.3-6 lists the allowable stress limits for the SRVDL-VL penetration.

5-2.5 Analysis Results

The analytical results for the SRVDL piping evaluation are summarized in this section.

Table 5-2.5-1 presents the maximum piping stresses resulting from governing load combinations for the highest stressed locations on the MSL and on each SRV discharge line (both drywell and wetwell). The maximum stresses for each service level are listed, along with the associated ASME Code equations and allowable stress values.

Tables 5-2.5-2 and 5-2.5-3 contain the maximum snubber reaction loads for the governing load combinations. Maximum loads from six SRV discharge lines are presented for various rated snubbers and are grouped by service levels with appropriate allowables.

Table 5-2.5-4 lists maximum resultant loads in the rigid struts. Strut loads and strut ratings are provided for each service level.

Table 5-2.5-5 provides the maximum resultant moments of the six SRV outlet flanges. The maximum moments

are also listed for each service level along with the allowable flange moments.

Table 5-2.5-6 shows the maximum T-quencher arm stresses resulting from ASME Code piping equations for the controlling load combinations.

Calculated stresses in the SRVDL vacuum breaker are all within Service Level B limits, thus demonstrating operability.

Table 5-2.5-7 shows the maximum stresses for the T-quencher support beam, and elbow support beam and connecting brackets for each of the governing loads.

Table 5-2.5-8 shows the maximum stresses for the SRVDL-VL penetration nozzle, insert plates and local vent line shell.

In summary, the results show that the design of the SRV discharge line piping system, including the SRV discharge line-vent line penetration is adequate for the loads and load combinations, according to the acceptance criteria limits specified in NUREG-0661 (Reference 1) and the PUAAG (Reference 5).

Table 5-2.5-4

ANALYSIS RESULTS FOR SRVDL PIPING STRUT LOADS

SRV LINE NUMBER	RATING (kips)	(4) LEVEL B (kips)	(4) LEVEL C (kips)	(4) LEVEL D (kips)	(5) LOAD RANGE (kips)
GBC-6	15.1	11.2	16.0	16.8	22.4
GBC-6	26.5	12.1	14.5	16.2 (2)	24.2
GBC-6	15.0	7.4	8.1	8.1	14.8 (3)
GBC-7	26.5	16.6	21.6	19.8 (2)	33.2
GBC-7	15.0	5.3	7.3	6.3	10.6 (3)
GBC-8	28.0	13.0	15.5	16.8	26.0
GBC-8	26.5	10.7	12.6	14.4 (2)	21.4
GBC-8	15.0	6.0	7.7	8.3	12.0 (3)
GBC-9	26.5	20.5	20.9	20.9 (2)	41.0
GBC-9	15.0	4.2	5.1	5.4	8.4 (3)
GBC-10	26.5	20.9	22.2	22.2 (2)	41.8
GBC-10	15.0	7.2	9.0	5.4	14.4 (3)
GBC-11	26.5	14.9	15.7	13.1 (2)	29.8
GBC-11	15.0	6.2	7.2	7.4	12.4 (3)
ALLOWABLE LOAD (1) (kips)		1.0 x RATING	1.33 x RATING	1.88 x RATING	2.0 X RATED LOAD

(1) THE SUPPORTING DRYWELL FLOOR STEEL OR VENTLINE SHELL IS DESIGNED TO MEET THE ALLOWABLE LOADS AS A MINIMUM.

(2) ALLOWABLE LOAD IS 1.55 X RATED LOAD.

(3) ALLOWABLE LOAD IS 1.5 X RATED LOAD.

(4) INCLUDES SECONDARY LOADS.

(5) LOAD RANGE WAS TAKEN AS TWICE LEVEL B LOAD.

Table 5-2.5-5

ANALYSIS RESULTS FOR SRV OUTLET FLANGE MOMENTS

SERVICE LEVEL	OUTLET FLANGE MOMENT (in-kips) (1)
LEVEL A	319.0
LEVEL B	403.8
LEVEL C	658.3
LEVEL D	912.7
SECONDARY	716.4

(1) VALUE SHOWN REPRESENTS MAXIMUM MOMENT FOR ANY SRV LINE

(2) SEE TABLE 5-2.3-4 FOR ALLOWABLE MOMENTS