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PLANT NAME: MONTICELLO

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NORTHERN STATES POWER COMPANY

MINNEAPOLIS, MINNESOTA 55401

October 31, 1977

Mr Victor Stello
Division of Operating Reactors
U S Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr Stello:

MONTICELLO NUCLEAR GENERATING PLANT
Docket No. 263 License No. DPR-22

Documentation of Basis for Continued Operation
Sequential SRV Actuations of Isolation Events

At the request of the NRC Staff, the Mark I Owners Group and General Electric representatives met with the NRC Staff October 27, 1977 to discuss potential influence on Mark I containments of SRV sequential actuations associated with isolation events. In that meeting General Electric presented a preliminary evaluation using most probable loads basis and short term program acceptance criteria for all operating plants.

At the conclusion of the October 27 meeting, Staff requested documentation of the basis for continued operation and requested consideration of commitments to operational procedures to reduce the probable incidence of SRV multiple-valve sequential actuations, said documentation to be submitted by November 1, 1977. Further, NRC Staff indicated an intent to formally request that a plant-unique assessment be provided within 60 to 90 days, with such assessment to be based on the conservative General Electric dynamic model prediction of sequential multiple-valve actuations, application of conservative factors for correlation of multiple and consecutive valve actuation effects, and use of the short term program acceptance criteria.

This submittal is believed to provide all of the requested information, including that which Staff indicated may be required within 60 to 90 days.

The Monticello plant has eight safety relief valves with all setpoints at approximately 1068 psig. All valves are by Target Rock. Each SRV discharge line has a recorded temperature monitor, a pressure switch monitor, a two inch vacuum breaker valve, and an eight inch vacuum breaker valve. All vacuum breaker setpoints are adjusted to be equal to or less than 0.2 psi. The pressure switch monitor setpoints are approximately 5 psig and provide input to the plant computer sequence-of-events monitor for specific discrimination of SRV actuations and closures.

Monticello Plant-Unique Transient Analysis

The purpose of using the transient analysis model was to predict the number of SRV's which might participate in multiple valve consecutive actuations for Monticello isolation events. The results of this analysis indicate that all eight SRV's will open and close in perfect unison for all initial and subsequent actuations, independent of the magnitude of demand for over-pressure relief capacity generated by the mass-energy transient of the isolation event.

In the Monticello case this is neither a prediction nor an analysis result. It is the consequence of model assumptions that valves of like nominal setpoint, specification and manufacture will perform with exactly identical characteristics for every actuation of every valve.

Qualification testing of Target Rock valves have demonstrated significant variations, within the limits of specified performance, for pilot actuation delay time and main disc stroke time. Because of the variability of and relation between these two characteristics, it is quite possible for the transient pressure to exceed the effective setpoint of all valves and have the pressure reduced below this level by the first-to-open valve, with no other valves actually actuating. Two isolation events from full rated power have occurred at Monticello. In both cases only a single valve opened for even the initial actuation when all valves were adjusted to the same nominal setpoint. From this experience we must conclude that single valve actuation is the typical characteristic, and that the all-valves, multiple actuation, resulting from the model assumptions is the remotely probable event.

Attachment C provides a summary of four isolation events which have occurred at Monticello since initial operation. For your understanding, Attachment C also includes a summary of relevant design changes and procedure changes since initial operation.

Although the transient analysis model grossly over-predicts consecutive multiple-valve actuation of all eight SRV's, compared to experience of single valve actuation, the eight valve consecutive actuation is used for purposes of conservatism as requested by the NRC Staff.

Justification for Continued Operation

Attachment "A" provides the basis for justification of continued operation of the Monticello plant in light of the potential influence of sequential multiple valve actuations. This is essentially the preliminary assessment for Monticello as presented by General Electric in the October 27, 1977 meeting with NRC Staff.

This assessment in our opinion is reasonable and conservative, and concludes that STP criteria is more than satisfied with limiting strength ratios of .24 for eight valve consecutive actuation. This assessment is especially conservative in light of actual operating experience that single valve actuation is typical of isolation from rated power.

No further procedure changes are contemplated in light of procedures in effect since July 25, 1971 and as further revised January 6, 1977.

Plant-Unique Assessment and Action Plan

In the October 27, 1977 meeting with NRC Staff, Staff indicated a requirement for plant-unique assessment using multiple-valve consecutive actuations as predicted by the General Electric transient analysis model and more conservative correlations for multiple valves and consecutive actuations. The NSP assessment for Monticello on the request basis is presented in Attachment "B" with the summary and comparison to the General Electric preliminary assessment shown on the attachment "Summary".

Again, we conclude that the assumption of an 8 SRV multiple consecutive actuation is conservative in the extreme in light of operating experience that a single SRV is typical for even the initial actuation for a rated power isolation event.

The use of arithmetic sum of participation factors is conservative for evaluation of support structure loads because it assumes that both structural response and applied loads combine linearly in composite.

The use of peak stress of all runs and SRSS combination of participation factors is in itself a conservative method of evaluating shell stress; this is illustrated by the circumstance that the same approach bounds the three-valve test results where direct load participation might be expected to be more dominant than response participation.

Since for the extreme assumption of 8 valve sequential actuation all elements of the structure are well within STP acceptance criteria and also within a few percent of code allowable stresses, no structural modifications or procedure changes are warranted at this time.

Yours very truly,

L. O. Mayer

L O Mayer, PE
Manager of Nuclear Support Services

LOM/GHN/ak

cc: J G Keppler
G Charnoff
MPCA - Attn: J W Ferman

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY

MONTICELLO NUCLEAR GENERATING PLANT

Docket No. 50-263

License No. DPR-22

LETTER DATED October 31, 1977
RESPONDING TO NRC REQUESTS
FOR INFORMATION ON CONTAINMENT DESIGN

Northern States Power Company, a Minnesota corporation, by this letter dated October 31, 1977 hereby submits information in response to NRC requests for information concerning the Mark I Containment.

This request contains no restricted or other defense information.

NORTHERN STATES POWER COMPANY

By L J Wachter
L J Wachter
Vice President, Power Production
& System Operation

On this 31st day of October, 1977, before me a notary public in and for said County, personally appeared L J Wachter, Vice President, Power Production and System Operation, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company, that he knows the contents thereof and that to the best of his knowledge, information and belief, the statements made in it are true and that it is not interposed for delay.

Denise E. Halvorson

DENISE E. HALVORSON
NOTARY PUBLIC - MINNESOTA
HENNEPIN COUNTY
My Commission Expires Oct. 10, 1981

ATTACHMENT A

GE LOADS CALCULATION METHOD

A. TORUS SHELL PRINCIPAL STRESSES (MEMBRANE PLUS BENDING)

1. MONTICELLO AND PILGRIM TEST RESULTS

PLANT	MIDBAY 45° FROM BOTTOM SG #18	MIDBAY WATERLINE SG #15	MIDBAY WATERLINE SG #19
MONTICELLO ①	3531 PSI	2676 PSI	2287 PSI
PILGRIM ②	3730 PSI	2710 PSI	1860 PSI

REF. ① MONTI. TEST REPORT PG. 4.2-19, σ_1 MAX. (AVE. OF TEST 1 & 701)
② PRESENTATION BY NICK CEVA ON 10-5-77, PILGRIM QUICK LOOK RESULT.

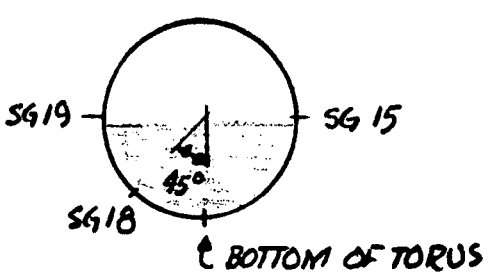
FROM PILGRIM PRESENTATION, S.G @ BOT. OF TORUS HAD A STRESS OF 4000psi

RATIO OF STRESS @ 45° TO STRESS @ BOTTOM:

RATIO = 4000/3730

RATIO = 1.072 USE 1.08

SINCE PILGRIM REPORTED STRESSES COMPARE WELL WITH MONTICELLO, DETERMINE THE STRESS AT THE BOTTOM OF MONTICELLO USING THE SAME RATIO AS DETERMINED AT PILGRIM.



Kamel Abdelmawla

2. SHELL STRESS MULTIPLE VALVE MULTIPLIER

MULTIPLIER FOR 8 VALVES (TEST BAY IS BAY D)

BAYS FROM BAY D	4	3	3	2	2	1	1	-
BAY ID	H	A	G	B	F	E	C	D
MULTIPLIER	.2	.4	.4	.4	.4	.75	.75	1.0

PARTICIPATION FACTORS DEVEL. BY GE BASED ON EXPECTED ATTENUATION

$$SRSS = \left[.2^2 + 4*.4^2 + 2*.75^2 + 1.0^2 \right]^{1/2} = 1.67$$

MULTIPLIER FOR 3 VALVES FROM TEST RESULTS

	SG-18	
TEST 1	3.4 ksi	BAY D
TEST 11	4.252 ksi	BAY CDE
TEST 15	5.218 ksi	BAY CDE

REF: MONTI TEST REPORT APPENDIX C

$$\text{MULTIPLIER} = \frac{(4.252 + 5.218).5}{3.4} = 1.39$$

3 VALVE SRSS $= \left[1.0 + 2*.75^2 \right]^{\frac{1}{2}}$

SRSS = 1.46

COMPARABLE TO MULTIP. FROM AVERAGE OF TESTS, THEREFORE USE SRSS FOR 8 VALVES

3. SUMMARY OF MULTIPLIERS

TO DETERMINE STRESS AT BOTTOM OF TORUS FROM SG 18 = 1.08
INCREASE FROM 1 VALVE TO 3 VALVES = 1.39
INCREASE FROM 1 VALVE TO 8 VALVES = 1.67

4. MONTICELLO CONSECUTIVE VALVE ACTUATION RESULTS

	SG 18
TEST 702	5.957 ksi
TEST 703	6.878 ksi
TEST 1602	9.066 ksi
TEST 1603	9.847 ksi

USE PEAK STRESS

REF. MONTI. TEST REPORT APPENDIX C

FROM TABLE 4.2-5 (PG 4.2-14)
HOT POP FACTOR FOR TEST 1603 = 2.69
THEREFORE VERY CONSERVATIVE, SINCE AVERAGE FACTOR = 1.91

5. MONTICELLO SHELL STRESSES PRESENTED BY GE

MEMBRANE PLUS BENDING STRESS (DOES NOT INCLUDE HYDRO)

1 SRV SHELL STRESS = 9847 (1.08) = 10635 PSI
- 1 SG18 TO BOTTOM
- PEAK HOT POP RESULTS FOR SG18 (TEST 1603)

3 SRV SHELL STRESS = 9847(1.08)(1.39) = 14780 PSI (GE REPORTED 13610 PSI IN ERROR)
- 3 VALVE FACTOR
- SG 18 TO BOTTOM
- PEAK HOT POP STRESS SG18

8 SRV SHELL STRESS = 9847(1.08)(1.67) = 17760 PSI
- 8 VALVE FACTOR
- SG 18 TO BOTTOM
- PEAK HOT POP STRESS

B. COLUMN LOADS

1. MULTIPLE VALVE FACTOR

	DISCHARGE IN BAY	O.S. COL. LOAD (MEASURED IN BAY D	PARTICIPATION FACTOR	
TEST 1	D	202.0[K]	1.0	Pg 4.2-23
TEST 2	C	84.5	0.42	
TEST 5	E	16.34	0.08	
TEST 3	B	19.6	0.10	
TEST 6	F	18.5	0.09	FROM DATA NOT INCLUDED IN REPORT
TEST 4	A	10.34	0.05	
USE TEST 4	G	10.34	0.05	
USE TEST 4	H	10.34	0.05	

RESULTS FROM MONTI. TEST DATA

MULTIPLE VALVE TEST RESULTS

TEST	BAYS	OS. COL LOAD
11	CDE	304 K
15	CDE	215 K

MONTI TEST RESULTS, PG. 4.2-23

TEST 1 BAY D OS COL LOAD = 202.0

3 VALVE MULTIPLIER = $\frac{.5(215+304)}{202} = 1.28$

SRSS OF PARTICIPATION FACTORS = $\left[1.0^2 + .42^2 + .08^2\right]^{\frac{1}{2}} = 1.09$

RATIO OF SRSS TO TEST RESULTS = 1.28/1.09 = 1.17

8 VALVE MULTIPLIER:

SRSS OF PARTICIPATION FACTORS = $\left[1.0^2 + .42^2 + .08^2 + .10^2 + .09^2 + 3*.05^2\right]^{\frac{1}{2}} = 1.1$

8 VALVE MULTIPLIER = 1.1 (1.17) = 1.29

↳ TEST RESULT CORRELATION FACTOR

2. CONSECUTIVE VALVE FACTOR

	TEST	O.S COL LOAD
COLD	#1	202 K
HOT	702	316 K
HOT	703	348 K
HOT	1602	360 K
HOT	1603	380 K

REF. MONTI. TEST RESULTS PG 4.2-23

FACTOR = $\frac{.25(316+348+360+380)}{202} = 1.74$

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3. SUMMARY OF MULTIPLIERS

COLD POP TO HOT POP (2ND ACTUATION) = 1.74
INCREASE FROM 1 VALVE TO 3 VALVES = 1.28
INCREASE FROM 1 VALVE TO 8 VALVES = 1.29
PLANT UNIQUE MULTIPLIER = 1.01 → ACCOUNTS FOR DIFFER. BETWEEN TEST PRESSURE AND VALVE SET POINT AND BENEFIT FROM ΔP

4. STRENGTH RATIOS (S.R.)

O.S. COL DL = 164^K
SEISMIC = 15^K } AT MAX. SUBMERGENCE
SHELL CONN. CAPACITY = 2820^K

1 SRV LOAD = 202 (1.74)(1.01) = 355^K
ℓ HOT POP FACTOR
ℓ SINGLE COLD

3 SRV LOAD = 202 (1.74)(1.28)(1.01) = 454^K
ℓ 3 VALVE MULTIPLIER
ℓ HOT POP

8 SRV LOAD = 202 (1.74)(1.29)(1.01) = 458^K
ℓ 8 VALVE MULTIPLIER
ℓ HOT

		GE REPORTED
S.R. 1 SRV =	(355+164+15)/2820 = 0.19	.20
S.R. 3 SRV =	(454+164+15)/2820 = 0.22	.23
S.R 8 SRV =	(458+164+15)/2820 = 0.23	.24

ATTACHMENT B

CONSERVATIVE LOADS CALC. METHOD BY NSP

A. COLUMN LOADS

1. MULTIPLE VALVE FACTOR (8 VALVES)

TEST NO.	BAY	OS COL LOAD MEAS. IN BAY D	
1	D	202.0 K	PG 4.2-23
2	C	84.5	
5	E	16.34	
3	B	19.6	
6	F	18.5	FROM DATA NOT INCLUDED IN MONTI REPORT
4	A	10.34	
USE 4	G	10.34	
USE 4	H	10.34	
	TOTAL =	372 K	

FACTOR = 372/202 = 1.84 ASSUMES NO PARTICIPATION FACTORS BUT USES DIRECT ADDITION OF LOADS

(GE FACTOR = 1.29)

2. CONSECUTIVE VALVE FACTOR (HOT POP) MONT. REPORT PG 4.2-23

	TEST	O.S COL.	IS COL.	OS COL. FAC.	IS COL. FAC.
COLD	1	202 K	154 K	-	-
HOT	702	316	264	1.56	1.71
HOT	703	348	297	1.72	1.93
HOT	1602	360	301	1.78	1.95
HOT	1603	380	339	1.88	2.20

AVE. IS & OS COL FACTOR = $(1.56+1.72+1.78+1.88+1.71+1.93+1.95+2.20)/8 = 1.84 = \bar{X}$

STD. DEVIATION: $\sigma = \sqrt{\frac{\Sigma(X_i - \bar{X})^2}{6}} = 0.18$

AVE. CONSECUTIVE VALVE FACTOR + 1 STD DEVIATION = 1.84 + 0.18 = 2.02

CONSECUTIVE VALVE FACTOR = 2.02 (GE FACTOR = 1.74)

3. PLANT UNIQUE FACTOR

FOR MONTICELLO = 1.01 PER GE ACCOUNTS FOR INCREASE DUE TO DIFFERENCE IN TEST PRESSURE (985) TO VALVE SET POINT (1066) AND DECREASE IN LOAD DUE TO ΔP

4. SUMMARY OF MULTIPLIERS

MULTIPLIER	NSP	GE
8 VALVE CASE	1.84	1.29
HOT POP	2.02	1.74
PLANT UNIQUE	1.01	1.01

5. LOADS

1 SRV COLD OS COL = 202 K (TEST #1 PAGE 4.2-23 OF MONTI REPORT)
IS COL = 154 K

8 SRV HOT OS COL = 202(1.84)(2.02)(1.01) = 758 K (GE USED 533 K)
IS COL = 154(1.84)(2.02)(1.01) = 578 K

DEAD LOAD: IS COL = 164 K OS COL = 192 K
SEISMIC: IS COL = 15 K OS COL = 21 K

AT MAX SUBMERGENCE, NUTECH REPORT NSP-01-168 PG 13

TOTAL LOAD: (8 SRV HOT)

IS COL = 164 + 15 + 578 = 757 K
OS COL = 192 + 21 + 758 = 971 K

6. STRENGTH RATIOS (8 VALVE HOT POP)

COMPONENT	LOAD	CODE ALLOWABLE	ULTIMATE CAPACITY	STRENGTH RATIO CODE	STRENGTH RATIO ULTIMATE
IS SHELL CONN.	757^k	940^k	2820^k	0.81	MEETS CODE
IS COLUMN	757^k	1123^k	3140^k	0.67	MEETS CODE
IS PIN	757^k	993^k	2960^k	0.76	MEETS CODE
OS SHELL CONN.	971^k	940^k	2820^k	1.03	0.34
OS COLUMN	971^k	1189^k	3288^k	0.82	MEETS CODE
OS PIN	971^k	993^k	2960^k	0.98	MEETS CODE

ALL COMPONENTS MEET CODE FOR 8 VALVE, 2ND ACTUATION EXCEPT FOR OS SHELL CONN. WHICH IS 3% OVER. STP ULTIMATE STRENGTH RATIO = 0.34 < 0.5

B. TORUS SHELL STRESSES

1. FACTOR FOR STRESS AT BOTTOM OF TORUS

REF: PILGRIM TEST REPORT TR-2682

RATIO OF STRESS @ 45° TO BOTTOM R18 @ 45° R17 @ BOTTOM

	GAGE R18	GAGE R17	RATIO
TEST # 1	3288 PSI	4893 PSI	1.49
TEST # 2	2318 PSI	3234 PSI	1.40

[TEST REPORT DOES NOT CONFIRM EARLIER PRESENTATION VALUES USED BY GE]

USE WORSE CASE FACTOR = 1.49 (GE FACTOR = 1.08)

2. FACTOR FOR MULTIPLE VALVE EFFECT

REFER: APPENDIX C OF MONT. TEST REPORT

TEST	DISCHARGE BAY	STRESS (SG 18)
1	D	3.400 KSI
2	C	3.972
3	B	0.746
4	A	1.768
5	E	0.215
6	F	1.679
USE 4	G	1.768
USE 4	H	1.768

SRSS OF CDE: $[\overline{3.4}^2 + \overline{3.972}^2 + \overline{0.215}^2]$

(3 VALVE) SRSS = 5.23 KSI

3 VALVE TEST	STRESS
#11	4.252 KSI
#15	5.218 KSI

∴ SRSS BOUNDS TEST RESULTS

FROM ABOVE IT APPEARS THAT STRESS IS MORE A FUNCTION OF STRUCTURAL RESPONSE THAN LOAD. CONSERVATIVE ASSUMPTION WOULD BE TO USE SRSS OF RESPONSES.

$$SRSS = [\overline{3.4}^2 + \overline{3.972}^2 + \overline{.746}^2 + \overline{1.768}^2 + \overline{.215}^2 + \overline{1.679}^2 + \overline{1.768}^2 + \overline{1.768}^2]^{\frac{1}{2}} = 6.34 \text{ KSI}$$

FACTOR = 6.34/3.4 = 1.86 (GE FACTOR: 1.67)

3. CONSECUTIVE VALVE ACTUATION

USE PEAK STRESS FROM 4 TESTS (702, 703, 1602, 1603)

FOR SG 18 σ_i = 9.847 KSI (APPENDIX C OF TEST REPORT TEST 1603)

4. PLANT UNIQUE FACTOR

FACTOR = 1.01 PER GE — ACCOUNTS FOR INCR. DUE TO TEST PRESS. VARIATION AND ΔP

5. STRESS DUE TO HYDROSTATIC LOAD

DEPTH OF WATER = 11.96 AT MAX SUBMERGENCE
PRESSURE = .43 (11.96) = 5.14 PSI

RADIUS = 166"
THICKNESS = .584

$\sigma = PR/t = 5.14(166)/.584 = 1461$ PSI

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6. 8 VALVE 2ND POP SHELL STRESS

FACTOR FOR STRESS FROM SG18 TO BOTTOM	= 1.49	(GE FACTOR = 1.08)
MULTIPLE VALVE FACTOR (8 VALVES)	= 1.86	(GE FACTOR = 1.67)
PLANT UNIQUE FACTOR	= 1.01	(GE FACTOR = 1.01)
CONSECUTIVE ACTUACTION STRESS	= 9847 PSI	(GE SAME)
HYDROSTATIC HEAD STRESS	= 1461 PSI	(GE NOT USED)

STRESS @ BOT. = $9847(1.49)(1.86)(1.01) + 1461 = 29020$ PSI
EXTREME FIBER STRESS
MEMBRANE PLUS BENDING

CODE ALLOW: MEMBRANE = 19.3 KSI
MEM. + BEND = $1.5(19.3) = 28.95$ KSI

STP ULT. CRITERIA: $2S_y$ or S_u WHICH EVER LESS

$2S_y = 2(38) = 76 > 70$ ∴ USE 70

STRENGTH RATIO:
CODE = 29/28.95 = 1.01 1% OVER CODE
STP = 29/70 = .41 < .5

- WORST CASE SHELL STRESS AT BOTTOM OF TORUS LESS THAN 1% OVER CODE.
- ULTIMATE STRENGTH RATIO < .5

NOTE: TEST SERIES 16 CAUSED THE SHELL TO BOTTOM OUT ON THE BAY EARTHQUAKE TIE CAUSING SIGNIFICANTLY HIGHER EXTREME FIBER STRESSES IN SHELL AT GAGE 18

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STATE OF STRESS IN SHELL AT OTHER THAN SG 18

CLEAN SHELL AREAS:
- SG 18 @ 45° MIDBAY
- SG 19 @ WATER LINE MIDBAY
- SG 15 @ WATER LINE MIDBAY

NEAR RING GIRDER
- SG 22 @ WATER LINE

AT EQ TIE
- SG 17 SIDE OF EQ TIE
- SG 57 END OF EQ TIE

REFERENCE TABLE 4.2-3 OF MONTI REPORT

GAGE	REF. STRESS	TCN	PEAK STRESS	
18	2.86 KSI	2.44	6.98 KSI	CLEAN SHELL
19	1.64	3.39	5.56 KSI	CLEAN SHELL
15	2.27	2.64	5.99 KSI	CLEAN SHELL
22	3.09	1.65	5.10 KSI	AT DISCONTINUITY
17	4.05	2.05	8.30 KSI	AT DISCONTINUITY
57	5.99	1.89	11.13 KSI	AT DISCONTINUITY

RATIO OF SG 57/SG 18 = 11.13/6.98 = 1.59

- FROM GAGES 19 AND 15, THE CONCLUSIONS BASED ON SG 18 ARE STILL VALID FOR THE CLEAN SHELL AREAS
- FROM GAGES 22, 17 AND 57, THE CONCLUSIONS BASED OF SG 18 ARE ALSO VALID FOR SHELL STRESS AT MAJOR DISCONTINUITIES SUCH AS THE EARTHQUAKE TIE AND THE RING GIRDER. CODE ALLOWABLE EXTREME FIBER STRESS FOR AREAS AT DISCONTINUITIES IS $3S_m$ (TWICE THE CLEAN SHELL ALLOWABLE OF $1.5S_m$).

1. The Monticello Plant initially had four safety relief valves discharging to the torus and four conventional safety valves. SRV discharge lines terminated in the suppression pool as vertical straight pipe near the torus wall with no discharge device.

2. July 25, 1971-Operating procedures were issued to require operator to take manual control of SRV following isolation and blow down to 950 psig, with pressure to be maintained between 1000 and 950 psig by manual blowdown as necessary.

3. January, 1972-SRV discharge lines were extended to torus center line and rams head discharge devices installed.

4 July 25, 1972-Installed SRV discharge pressure switches with 5 psig setpoints and inputs to computer sequence of events monitor.

5. April, 1974-Replaced the four conventional safety valves with four SRV's. SRV discharge line additions installed with rams heads and pressure switch monitors.

6. January 6, 1977-Operating procedures revised to require operator to take manual control of SRV following isolation and blowdown to 800 psig. Pressure to be maintained between 1000 and 800 psig by manual blowdown as necessary. Specified sequence of blowdown so all SRV's would be actuated once before re-activating first SRV. (Sequence of SRV lifts based on history of SRV actuations, i.e., 1st valve specified for torus bay previously experiencing fewest actuations.)

7. October 1977-Added 8-inch vacuum breakers to all SRV discharge lines. Installed three prototype SRV discharge "T-Quenchers".

EVENT #1
Date: May 20, 1971
Power Level: 75%
Initiating Event: Startup test STP 11, Initiated by tripping RCIS relays with opening of test switch.
Sequence of Events:
1. MSIV closure at 1318.
2. Rx pressure peaks at 1069 psig, approximately six seconds after initiation.
3. No automatic lift on initial pressure peak.
4. "D" safety relief valve manually operated to reduce Rx pressure. Actual number of manual lifts cannot be determined but only one is suspected.

EVENT #2
Date: May 24, 1971
Power Level: 100%
Initiating Event: Oscillations in the steam line flow signal had initiated the high steam flow isolation of Group I.
Sequence of Events:
1. MSIV closure at 2146.
2. Auto lift of "D" safety relief valve (1085 Rx pressure peak)
3. Rx pressure reduced to 976 psig.
4. Manual lift of "D" safety relief valve at 1035 psig approximately 4 minutes after initial lift.
5. Rx pressure reduced to 995 psig.
6. MSIV's opened.

EVENT #3
Date: July 14, 1971
Power Level: 91%
Initiating Event: Pressure transmitter was valved in service following routine calibration, a pressure surge occurred in the instrument sensing line. The surge tripped the main steam line high flow switches connected to the same line causing a group I isolation.
Sequence of Events:
1. MSIV closure at 1348.
2. SRV opens Rx press 1060 psig peak.
3. Rx press drops to 995 psig.
4. SRV opens Rx press 1090 psig peak, 1352*.
5. Rx press drops to 1025.
6. SRV opens Rx press 1095 psig peak, 1353*.
7. Rx press drops to 1015.
8. SRV opens Rx press 1095 psig peak, 1355*.
9. Rx press drops to 1040 psig.
10. SRV opens Rx press 1090 psig peak, 1357*.
11. Rx press drops to 1035 psig.
12. SRV opens Rx press 1090 psig peak, ~1358*.
13. Rx press drops to 1030 psig.
14. SRV opens Rx press peak 1090 psig, ~1359*.
15. Rx press drops to 1030 psig.
16. SRV opens Rx press peak 1092 psig, ~1401*.
17. Rx press drops to 1025 psig.
18. SRV opens Rx press peak 1095 psig, ~1402*.
19. Rx press drops to 1018 psig.

* Estimates made from measuring Rx press chart.

NOTE: It appears that the least the "A", "B" and "C" valves lifted during this event based on discharge pipe temperature recorder indications. We cannot tell which one lifted at a given time from the available information.

EVENT #4
Date: November 6, 1973
Power Level: 99.5%
Initiating Event: Inadvertant trip of a main steam line high flow sensor during routine instrument surveillance resulted in a Group I isolation.

Sequence of Events:

1. MSIV closure at 1338:47.62.
2. Rx pressure peaks at 1065.
3. "C" safety relief valve auto opens at 1338:51.82.
4. "C" SRV closes at 1339:11.03 at Rx press. of 970.
5. "D" SRV manually opened at 1341:08.47, Rx press 1035.
6. "D" SRV closed at 1341:20.46, Rx press 975.
7. "D" SRV manually opened at 1341:43.84, Rx press ~1024.
8. "D" SRV closed at 1341:56.16, Rx press ~970.
9. "D" SRV manually opened at 1342:20.48, Rx press ~1024.
10. "D" SRV closed at 1342:33.73, Rx press ~966.
11. "D" SRV manually opened at 1343:13.41, Rx press ~1024.
12. "D" SRV closed at 1343:25.75, Rx press ~966.
13. "D" SRV manually opened at 1344:24.10, Rx press ~1028.
14. "D" SRV closed at 1344.37.70, Rx press ~964.
15. "D" SRV manually opened at 1345:38.69, Rx press ~1028.
16. "D" SRV closed at 1345:51.52, Rx press ~965.
17. "D" SRV manually opened at 1347:10.93, Rx press ~1043.
18. "D" SRV closed at 1347:27.54, Rx press ~910.

NOTE: These lift times are accurate times as indicated by the sequence of events recorder.

Project SRV 2ND ACTUATION File No.
Owner NORTHERN STATES POWER
Client NORTHERN STATES POWER

SUMMARY

FACTOR	GE (SECT. A)	NSP (SECT. B)
SHELL STRESS SG 18 TO BOT.	1.08	1.49
SHELL STRESS 8 VALVE MULT.	1.67	1.86
SHELL STRESS 2ND POP	9.847 KSI	9.847 KSI
COL. LOAD 8 VALVE MULT.	1.29	1.84
COL. LOAD 2ND POP	1.74	2.02
PLANT UNIQUE FACTOR	1.01	1.01
SHELL STRESS INCR. DUE TO DEAD LOAD	NO	YES
SHELL STRESS @ TORUS BOT.	17760 PSI	29020 PSI
MAXIMUM STRENGTH RATIO FOR SUPPORT STRUCTURE	0.23	0.34

- TORUS SUPPORT : WITH NSP MORE CONSERVATIVE ASSUMPTIONS ALL SUPPORT COMPONENTS WITHIN CODE ALLOW. EXCEPT O.S. COLUMN TO SHELL CONNECTION WHICH IS 3% OVER CODE. STP ULTIMATE STRENGTH RATIO = 0.34 < 0.50
- TORUS SHELL : WITH NSP MORE CONSERVATIVE ASSUMPTIONS SHELL STRESS AT BOTTOM OF TORUS (EXTREME FIBER MEMBRANE PLUS BENDING) LESS THAN 1% OVER CODE ALLOW. STP ULTIMATE STRENGTH RATIO = 0.41 < 0.5
  AN EVALUATION OF SHELL STRESS NEAR RING GIRDER AND EARTHQUAKE TIE SHOW THAT CONCLUSIONS REACHED FOR SG 18 ARE CONSERVATIVE

- ACCEPTANCE CRITERIA

  SHELL SA-516 Gr 70 $S_y = 38$ ksi $S_u = 70$ ksi $S_m = 19.3$ ksi
  CODE ALLOW:
  PRIMARY MEMBRANE + PRIMARY BENDING = $1.5 S_m$ (28.95 ksi)
  STP ULTIMATE : SR < 0.5 ULT. FOR SHELL = S_u (70 KSI)

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