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MANGAN, C. V. Niagara Mohawk Power Corp.
RECIP. NAME RECIPIENT AFFILIATION
ADENSAM, E. G. BWR Project Directorate 3

SUBJECT: Forwards calculation, "Max Allowable Leakage Through Main Steam Valve Under Field Test Condition," in support of 860806 request to change Tech Spec Table 3.6.1.2-1 re main steam isolation valve leak rate.

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NIAGARA MOHAWK POWER CORPORATION/300 ERIE BOULEVARD WEST, SYRACUSE, N.Y. 13202/TELEPHONE (315) 474-1511

August 21, 1986
(NMP2L 0835)

Ms. Elinor G. Adensam, Director
BWR Project Directorate No. 3
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Washington, DC 20555

Dear Ms. Adensam:

Re: Nine Mile Point Unit 2
Docket No. 50-410

This letter provides a copy of the calculation to support our requested change to Technical Specification Table 3.6.1.2-1 for Nine Mile Point Unit 2. Our letter dated August 6, 1986 provided the requested change regarding the allowable Main Steam Isolation Valve leak rate.

The calculation, "Maximum Allowable Leakage Through the Main Steam Valve Under the Field Test Condition", by Stone and Webster Engineering Corporation, is provided in the enclosure of this letter.

Very truly yours,

CVMangan

C. V. Mangan
Senior Vice President

LL/CVM:ar
1974G
Enclosure

xc: W. A. Cook, NRC Resident Inspector
Project File (2)

3001
1/1

ENCLOSURE

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

✓✓

5010.64 (FRONT)

CLIENT & PROJECT	PAGE 1 OF 10
Niagara Mohawk Power Corp./Nine Mile Point Unit 2	

CALCULATION TITLE (Indicative of the Objective):	QA CATEGORY (✓)
MAXIMUM ALLOWABLE LEAKAGE THROUGH THE MAIN STEAM VALVE UNDER THE FIELD TEST CONDITION	☒ I - NUCLEAR SAFETY RELATED ☐ II ☐ III ☐ ____ OTHER

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
12177	ES	217	—	26N

*APPROVALS - SIGNATURE & DATE			REV. NO. OR NEW CALC NO.	SUPERSEDES *CALC. NO OR REV. NO.	CONFIRMATION *REQUIRED (✓)	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
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STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

5010 65

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OBJECTIVE

THE ALLOWABLE LEAKAGE THROUGH THE MAIN STEAM VALVE UNDER THE SPECIFIED TEST CONDITION (AS SHOWN IN FIG. 1) IS 6 SCFH.* HOWEVER, THE FIELD TEST SET UP IS ARRANGED AS SHOWN IN FIG. 2. THE OBJECTIVE OF THIS CALCULATION IS TO DETERMINE THE NEW ALLOWABLE LEAKAGE RATE UNDER THE FIELD TEST CONDITION.

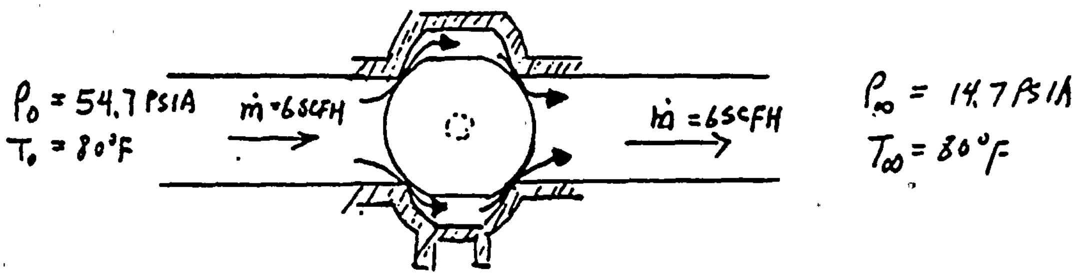
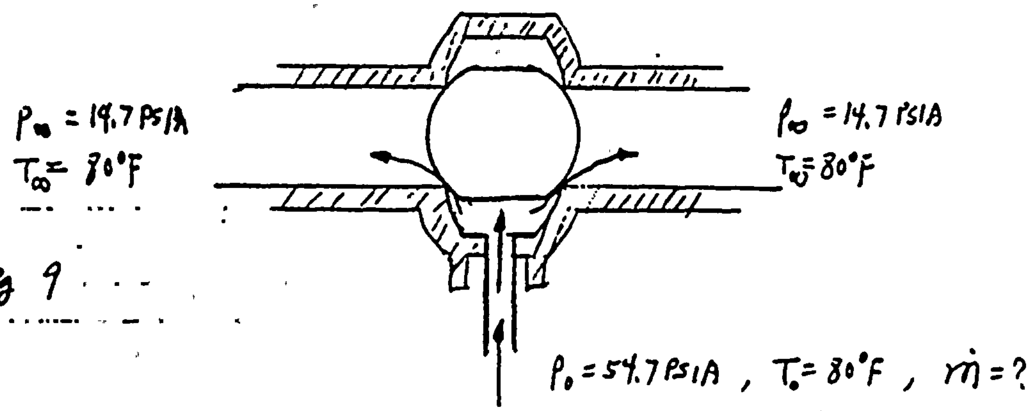


FIGURE 1.: PREFERRED TEST ARRANGEMENT



* REF 3 Pg 9

FIGURE 2: FIELD TEST ARRANGEMENT

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RESULT

THE ALLOWABLE LEAKAGE UNDER FIELD TEST CONDITION IS 14.86 SCFH.

ASSUMPTIONS

1. FLOW THROUGH VALVE SEAL IS ISENTROPIC.
2. TEMPERATURE AT STAGE 1 EQUAL TO AMBIENT TEMPERATURE OF 80°F
3. OTHER SPECIFIC ASSUMPTIONS STATED IN BODY OF THE CALC.
4. STP CONDITIONS DEFINED HERE ARE P = 14.7 PSIA, T = 68°F.

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REFERENCES

1. "THE THERMAL-HYDRAULICS OF A BOILING WATER REACTOR" R. T. LAHEY, JR & F. J. MOODY. PUBLISHED BY AMERICAN NUCLEAR SOCIETY.

2. "THE DYNAMICS AND THERMODYNAMICS OF COMPRESSIBLE FLUID FLOW" A. H. SHAPIRO.

3. CALCULATION 12177-ES-177-3 "SECONDARY CONTAINMENT BYPASS LEAKAGE"

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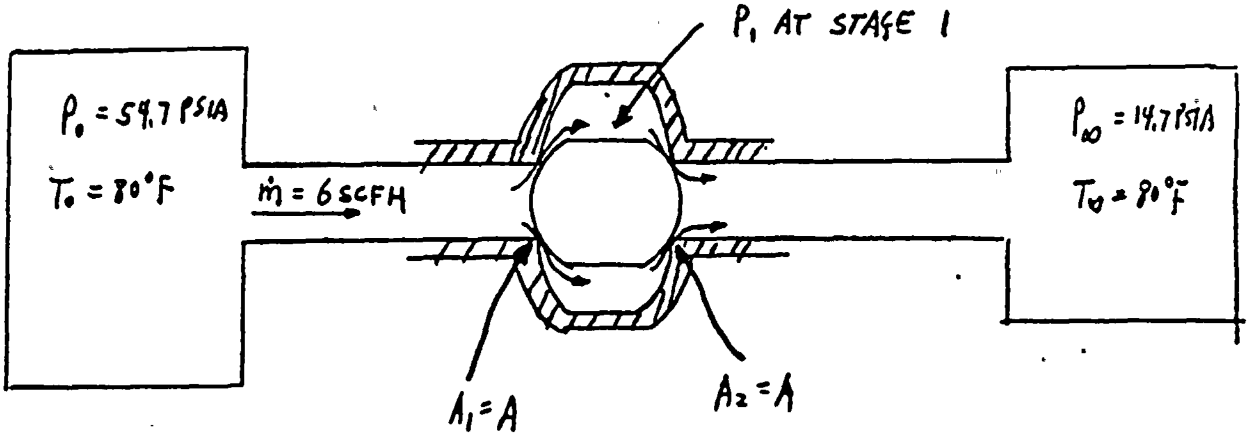
CALCULATION

- LEAKAGE AREA OF THE VALUE



ASSUME FLOW LEAKED THROUGH THE 1st SEAL EXPANDED FULLY AT STAGE 1 WITH A PRESSURE OF P_1 BEFORE LEAKING THROUGH THE SECOND SEAL. THE LEAKAGE AREA IN THE SEALS ARE ASUMED TO BE EQUAL. THE PRESSURE AT STAGE 1, P_1 CAN BE CALCULATED BASED ON THE FOLLOWING EXPRESSION(S):

$$\dot{m} = A\left\{2g_c\left(\frac{K}{K-1}\right)P_0 \rho_0\left[\left(\frac{P_1}{P_0}\right)^{2/K} - \left(\frac{P_1}{P_0}\right)^{\frac{K+1}{K}}\right]\right\}^{1/2} \quad \text{—— (1)}$$

(REF 1 EQN 9.37)
Pg 347

IF $\frac{P_1}{P_0} > 0.5283$

AND $$\dot{m} = 0.532\,A\,\frac{P_0}{\sqrt{T_0}} \quad \text{—— (2)}$$ (REF 2 EQN 4.18)

IF $\frac{P_1}{P_0} \leq 0.5283$

BASED ON THE PRESSURES, $P_0 = 54.7$ PSIA & $P_\infty = 14.7$ PSIA, IT APPEARS THAT 4 POSSIBILITIES CAN EXIST:

① CHOKE AT 1st AND 2nd SEALS

② CHOKE AT 1st SEAL, UNCHOKE AT 2nd SEAL

③ UNCHOKE AT 1st AND 2nd SEALS.

④ UNCHOKE AT 1st SEAL AND CHOKE AT 2nd SEAL

FOR CONDITION ① & ② WITH CHOKE AT 1st SEAL, THEN

$P_1 = P_0(.5283) = 28.9$ PSIA OR LOWER

WHICH WILL NOT SATISFY CONTINUITY WHEN CALCULATING FLOW RATE ... THUS CONDITION ① & ② CAN'T EXIST.

CONDITION ③ CAN NOT EXIST BECAUSE PRESSURE DROP IS LARGE ENOUGH TO CALL FOR CHOKE AT LEAST IN ONE LOCATION.

THUS APPLYING EQNS (1) & (2) FOR CONDITION ④ YEILDS:

$$\dot{m} = A \left\{ 2 g_c \left(\frac{k}{k-1}\right) P_0 \gamma_0 \left[\left(\frac{P_1}{P_0}\right)^{2/k} - \left(\frac{P_1}{P_0}\right)^{k+1/k} \right] \right\}^{1/2} \quad \text{——— (3)}$$

$$\& \quad \dot{m} = A\,(0.532)\,\frac{P_1}{\sqrt{T_1}} \quad \text{——— (4)}$$

THE PARAMETERS ARE:

$g_c = 32.2$ lbm-FT/lbf-SEC^2 $\qquad \dot{m} = 6\ \text{SCFH} = \frac{14.7(144)}{53.3(68+460)}\ 6/3600$

$K = 1.4$ FOR AIR $\qquad = 1.2536\text{E-}4$ lbm/SEC

$P_0 = 54.7$ PSIA

$$\gamma_0 = \frac{P_0}{RT_0} = \frac{54.7\ (144)}{53.3\ (80+460)} = 0.27367$$

$T_1 = T_\infty = 80°F$ (ASSUME $T_1 = T_\infty = 80°F$)

EQUATE (3) & (4) YIELDS:

$$.532\,\frac{P_1\ 144}{\sqrt{80+460}} = \left\{2(32.2)\left(\frac{1.4}{.4}\right)(54.7)(144)(.27367)\left[\left(\frac{P_1}{54.7}\right)^{2/1.4} - \left(\frac{P_1}{54.7}\right)^{2.4/1.4}\right]\right\}^{1/2}$$

OR

$$P_1\ 3.2967 = 697.052 \left[\left(\frac{P_1}{54.7}\right)^{2/1.4} - \left(\frac{P_1}{54.7}\right)^{2.4/1.4}\right]^{1/2}$$

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SOLVE FOR P_1 USING TRIAL & ERROR AND OBTAINED:

$$P_1 = 44.177 \text{ PSIA}$$

THEN:

$$A = \dot{m}\sqrt{T_1} \Big/ (0.532)\, P_1$$

$$= 1.2536\text{E-}4 \sqrt{80+460} \Big/ (0.532)\, 44.177\,(144)$$

$$= 8.6078\text{E-}7 \text{ FT}^2 = .0800 \text{ mm}^2 \equiv .3191 \text{ mm } \phi$$

- ALLOWABLE LEAKAGE RATE UNDER FIELD TEST CONDITION.

SUBSTITUTE EQN (2) WITH $P_0 = 54.7$ PSIA, $T_0 = 80°F$,

$$A_T = 2A = 2(8.6078\text{E-}7) = 1.7216\text{E-}6 \text{ FT}^2 ;$$

AND YIELD:

$$\dot{m} = 0.532\,(1.7216\text{E-}6)(54.7)(144) \Big/ \sqrt{80+460}$$

$$= 3.1045\text{E-}4 \text{ lbm/sec}$$

$$= \left(3.1045\text{E-}4 \frac{\text{lbm}}{\text{sec}}\right)\left[\frac{(53.3)(68+460)}{144\,(14.7)} \frac{\text{FT}^3}{\text{lbm}}\right]\left(3600 \frac{\text{sec}}{\text{HR}}\right)$$

$$= 14.86 \text{ SCFH}$$

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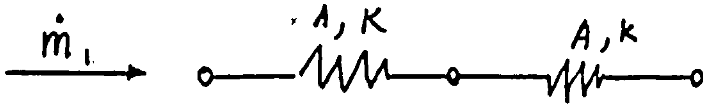
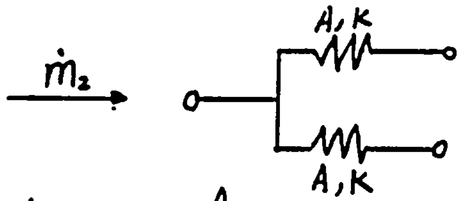
SENSITIVITY STUDY TO DETERMINE THE ALLOWABLE LEAKAGE RATE WHEN INCOMPRESSIBLE FLOW IS CONSIDERED



FLOW RATE FOR THE ABOVE SETUP IS

$\dot{m}_1 \propto \frac{A}{\sqrt{2K}}$ USING DARCY'S EXPRESSION

FLOW RATE FOR THE FIELD SET UP IS



$\dot{m}_2 \propto 2\frac{A}{\sqrt{K}}$

COMPARE $\dot{m}_1$ & $\dot{m}_2$ YIELD

$$\frac{\dot{m}_2}{\dot{m}_1} = \frac{2A}{\sqrt{K}} \Big/ \frac{A}{\sqrt{2K}} = 2\sqrt{2} = 2.828$$

THE ALLOWABLE LEAKAGE UNDER INCOMPRESSIBLE FLOW ASSUMPTION IS

$\dot{m} = 6\ \text{SCFH}\ (2.828) = 16.97\ \text{SCFH}$