SAFETY EVALUATION OF THE PROPOSED 140% MAIN STEAM LINE FLOW TRIP SETTING FOR THE VERMONT YANKEE NUCLEAR POWER STATION

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1. INTRODUCTION AND SUMMARY

It is proposed that the main steam line high flow isolation signal at the Vermont Yankee Nuclear Power Station be changed from 120% to 140% rated steam line flow. The basis for the selection of 140% as a requirement for the automatic isolation is that this setting permits the plant to continue to operate at full power with one of the four main steam lines isolated. This will improve plant operating characteristics and reduce unnecessary challenges to the system.

This document presents the safety analysis for the proposed technical specification change. It is shown that the setpoint change from 120% to 140% flow will not pose an unreviewed safety question.

2. SAFETY EVALUATION

I. Basis for Main Steam Line Flow Trip Setting

The 120% high steam flow isolation signal was originally established on the two steam line plants, Oyster Creek and Nine Mile Point. The basis for this setting was not due specifically to a safety limit, but was set high enough to avoid spurious trips during normal operation and yet low enough to minimize the consequences of main steam line (MSL) breaks of any size for a plant of that steam line configuration.

Vermont Yankee is a four steam line plant. The basis for the selection of the 140% of rated steam flow as a requirement for the automatic isolation is that this setting permits the plant to continue to operate at full power with one of the four main steam lines isolated (i.e., during required MSIV testing). This results in an average of 133% of rated steam flow in each of the remaining steam lines. To improve their operating characteristics and reduce unnecessary challenges to the system, most operating BWR/3 and 4's, and all requisition plants, have already incorporated the 140% setpoint into their technical specifications.

II. Radiological Consequences

A. Large Steam Line Leaks:

Large steam leaks (greater than 140% of rated flow) outside containment are detected by the main steam line flow restrictor differential pressure sensors. If flow exceeds the trip setting in any line, an isolation of all main steam lines will be initiated. The MSIVs will close in 3 to 5 seconds after receiving the isolation signal. One of the design basis accidents analyzed in the Vermont Yankee FSAR Section 14.6.5 is a guillotine break of one of the main steam lines. Choked flow

of the two phase blowdown is assumed to exist until MSIV closure, which is conservatively assumed to be 10.5 seconds following the break, resulting in the loss of 60,000 lbs of coolant. This break results in the bounding dose rate due to the two phase flow out of the break. The calculated dose at the site boundary is well below the limits of 10CFR100. For this event, the maximum flow rate in the broken line would be the maximum permitted by the flow limiting venturi, that is, about 200% of rated steam line flow. This is considerably higher than the proposed isolation valve trip setting of 140% rated flow. Therefore, changing the trip setting from 120% to 140% rated flow will not change the results of this design basis accident (DBA).

B. Small and Medium Steam Line Leaks:

Small and medium steam leaks in the main steam line (less than 140% of rated flow) are detected by the following:

1. Temperature sensors inside the steam tunnel which provide an alarm at 160°F and an isolation trip at 200°F.

2. Steam line flow sensors which provide steam line flow readings to the operators and isolation at the prescribed high-flow setpoint.

3. Area radiation monitors in the turbine building which provide alarms in the control room when exposed to high radiation.

An estimate was performed to represent the most bounding case for maximum amount of steam release from the MSL. It assumes that steam line flow increases to a value just under the high flow isolation setpoint, takes no credit for high temperature or high steam line flow trip, and assumes 10 minute operator

action time before isolation. For 120% and 140% steam line flow trip setpoints, the maximum mass losses would be 243,135 and 486,270 lbs, respectively. These mass losses were calculated assuming 120% and 140% flow, respectively, in all four steam lines simultaneously. This results in a very conservative, bounding value. Based on LOCA analysis with approved evaluation models for these small and intermediate breaks, steam is the only effluent released. Thus, the radiological dose is still much less than the design basis accident in the FSAR and well below the 10CFR100 limit.

The bounding estimate described above does not take credit for the high temperature sensors in the steam tunnel. In reality, these sensors would further limit the mass loss due to a leak in the steam tunnel. At the request of Vermont Yankee Power Corporation, an analysis was performed to determine a best estimate for mass loss under these conditions.

An analysis was performed to develop a set of break curves, showing tunnel temperature as a function of time after break, for several break flow rates. This set is shown in Figure 1. Using Figure 1, the total mass losses prior to isolation were obtained for the following cases: (a) 160°F alarm sensing time plus 10 minute operator action, and (b) 200°F sensing time plus five second tech spec MSIV closure time. These mass losses are presented in Tables 1 and 2.

Combined the results of cases (a) and (b) above, a bounding mass loss curve was developed for the MSL break inside the steam tunnel and shown in Figure 2. Comparison of Tables 1 and 2 indicates that for break flows greater than 1.8% of rated steam line flow the 200°F automatic trip occurs well before the 160°F alarm plus 10 minute operator action. For conservatism, the bounding mass loss curve accounts for 10 minute operator

action after the 160°F alarm for break flows less than 20 lb/sec (5% rated steam line flow).

Based on this bounding curve, the maximum mass loss prior to isolation on high steam tunnel temperature would be 12,360 lbs which is far less than the mass losses determined in the previously discussed analyses. In conclusion, for small and intermediate breaks in the steam tunnel, the temperature sensors will effectively limit the mass loss, independent of the high flow isolation setpoint.

III. Conclusions

Changing the Technical Specifications high flow setting from 120% to 140% rated steam line flow will not affect the radiation dose reported in the FSAR nor will it pose undue risk to public health. It will, however, improve the plant operating characteristics and reduce unnecessary challenges to the system.

TABLE 1

MASS LOSS (lb) IN STEAM TUNNEL AS DETERMINED BY 160% TEMPERATURE SENSOR LIMIT*

BREAK FLOW (lb/sec)	(%)+	SENSOR TRIGGER TIME (sec) (REACH 160°F)	ACTION TIME (sec) (add 10 min)	MASS LOSS (lb)
6	(1.3)	280	880	5280
8	(1.8)	181	781	6248
16	(3.6)	32	632	10112
20	(4.4)	18	618	12360
30	(6.7)	8.6	608.6	18258
45	(10.0)	4.9	604.9	27221
60	(13.3)	3.4	603.4	36204
80	(17.8)	2.3	602.3	48184
160	(35.6)	1.0	601.0	96160

*Time to reach 160°F in tunnel plus 10 minutes operation action time
+Percent of each steam line rated flow

TABLE 2

MASS LOSS (lb) IN TUNNEL AS
DETERMINED BY 200°F TEMPERATURE SENSOR LIMIT*

BREAK FLOW (lb/sec)	(%)+	SENSOR TRIGGER TIME (sec) (REACH 200°F)	ACTION TIME (sec) (add 5 sec)	MASS LOSS (lb)
8	(1.8)	501	506	4048.0
16	(3.6)	172.5	177.5	2840.0
20	(4.4)	106.5	111.5	2230.0
30	(6.7)	44	49	1470.0
45	(10.0)	20.3	25.3	1138.5
60	(13.3)	12.9	17.9	1074.0
80	(17.8)	8.7	13.7	1096.0
160	(35.6)	3.8	8.8	1408.0
300	(67.0)	1.9	6.9	2070.0
440	(98.0)	1.3	6.3	2772.0

*Time to reach 200°F in tunnel for automatic trip plus 5 seconds
+Percent of each steam line rated flow

FIGURE 1. TUNNEL TEMPERATURE INCREASE PROFILES

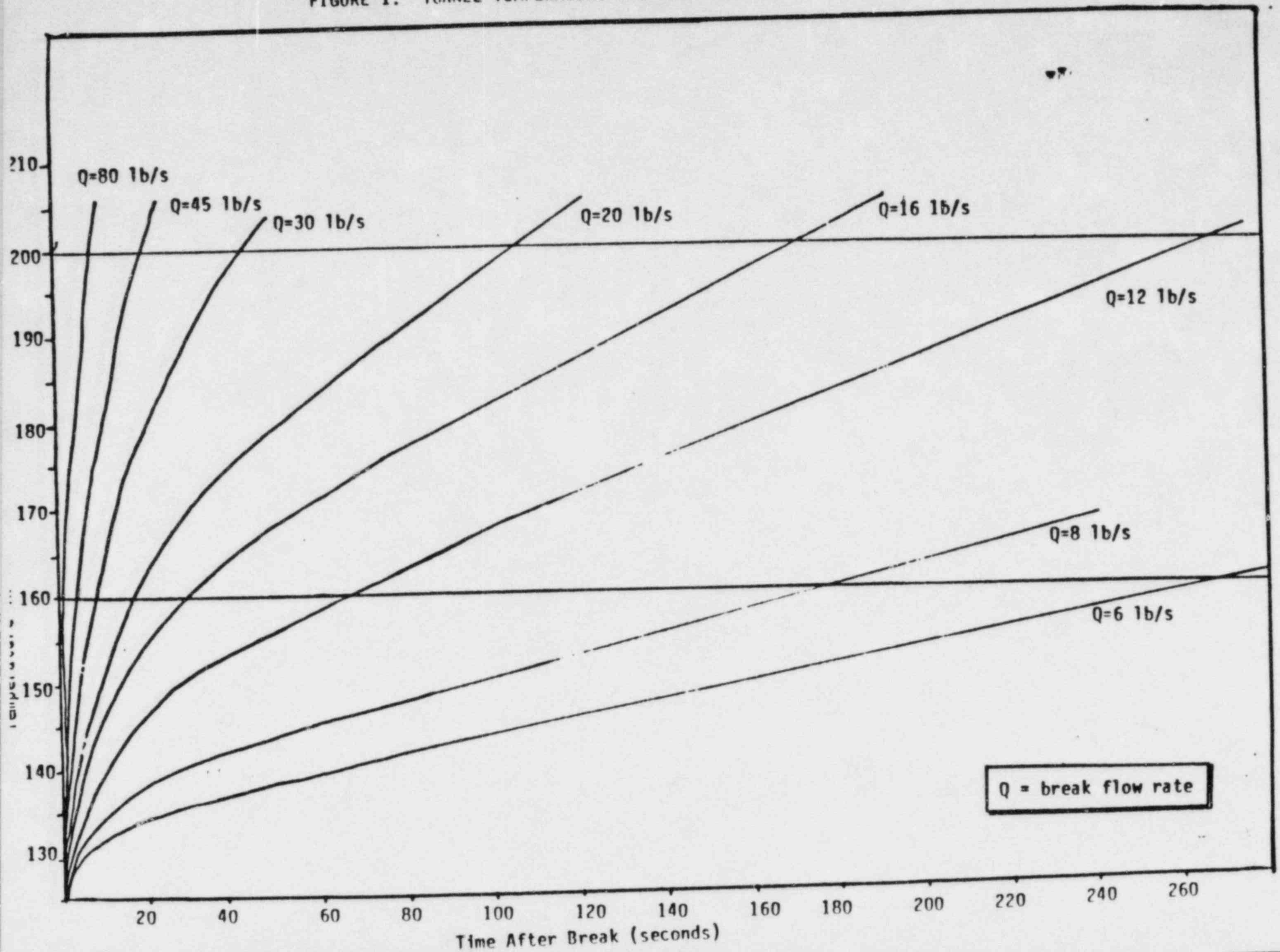

FIGURE 2. BOUNDING MASS LOSS CURVE (Steam Tunnel Temperature Sensors)