8604324

Safety Balance for

Elimination of Pressurizer Surge Line

Break Protective Devices

South Texas Project

Units 1 and 2

Safety Balance for the Elimination of Pressurizer Surge Line Pipe Break Protective Devices

I. Introduction

This report presents a safety balance evaluation of the consequences of eliminating the protective devices currently employed in the design of the South Texas Project Units 1 and 2 (STP) to mitigate dynamic effects associated with postulated breaks in the pressurizer surge line. This assessment uses methods suggested in the "Leak Before Break Value-Impact Analysis" attached to the Nuclear Regulatory Commission's (NRC) Generic Letter 84-04 (Reference 1). Plant specific data and the generic data developed in Reference 1, and other public documents are used to perform the safety balance evaluation for STP. The evaluation is performed in terms of public health and occupational accident risk avoidance attributable to the protection provided for dynamic effects associated with postulated breaks in the pressurizer surge line versus the reduction in Occupational Radiation Exposure (ORE) resulting from a decision not to provide such protection.

The man-rem savings is presented in tabular form and listed as nominal, lower and upper values. These represent the range of values expected at STP; however, there are conservatisms included in the analysis of the ORE which tend to lower the estimated man-rem savings over the entire range of values. These are explained as follows:

A. The man-rem savings associated with not installing jet impingement barriers independent of the pipe whip restraints are not included in this analysis. The elimination f jet impingement barriers and associated supporting structures will result in increased work efficiency due to improved access for maintenance and inservice inspection. These factors are not considered in this analysis. Only man-rem savings associated with not installing pipe whip restraints are analyzed.

B. Conservatively low estimates of man-rem exposures are used when calculating the total exposure due to the removal and reinstallation of pipe whip restraints for access to perform inservice inspection (ISI) of the pressurizer surge line. It is assumed that it takes two persons, one shift, to remove each pipe whip restraint and another one shift for reinstallation. The STP expected exposure rates in the vicinity of the pressurizer surge line are in the range of 0.02 to 0.2 rem/hr. This corresponds to an expected dose of between 0.64 and 6.4 man-rem per restraint per ISI. The 0.5, 4 and 15 man-rem per restraint per ISI values used in this analysis represent low, expected, and upper bound estimates of the radiation exposure.

C. Increased work efficiency due to improved access for maintenance (based on fewer interferences with the pipe whip restraints and supporting structural members) was not considered in this evaluation. The reduction in interferences allows platform location to be optimized to increase efficiency.

II. Safety Balance Assessment Summary and Conclusions

A summary of the results of the safety balance is shown below. The nominal dose estimates support the request to not require consideration of the dynamic effects of pipe breaks in the STP pressurizer Surge line.

Value (man-rem)	Nominal Estimate	Lower Estimate	Upper Estimate
Public Health (a)	-0.2	0	-4
Occupational Exposure (Accidental) (a)	-0.1	0	-2.7
Occupational Exposure (Operational)			
Inservice Inspection	24	3	90
Total Quantified Value	24	3	83

(a) The estimates shown here use negative values to represent a decrease in man-rem savings. The upper and lower estimates are transposed from values presented in Section III.A.

III. Development of Safety Balance

A. Risk Avoidance Attributable to Protection from Dynamic Effects Associated with Pipe Breaks

1. Public Health

Dose estimates derived in Reference 1 for reactor coolant system (RCS) main loop failures are conservative and bound the results calculated for the STP pressurizer surge line for the following reasons.

a. The consequences of pressurizer surge line failures are enveloped by RCS main loop failures since the break area is smaller.

b. Reference 1 assumed a uniform population density of 340 people per square-mile around the reactor site and a 50-mile release radius model. The expected average population density at the STP site is 182 people per square mile in the year 2000. A total of 97.7 percent of that population is expected to live between 10 to 50 miles away from the plant. The corresponding numbers for the year 2030 are 273 people per square mile and 97.3 percent (Reference 3, Section 2.2).

c. Based on the significantly lower population density around STP, the off-site doses calculated in Reference 1 envelope the STP RCS main loop failure doses. (The STP whole body population dose to 50 miles is 10.5 man-rem per Ref. 3). The increased population density at the end of plant life does not significantly change the population doses and is still well within the bounds of Reference 1. The nominal estimate of added risk to public health for plants that use a two-loop configuration was estimated to be 0.006 man-rem/plant year (py) for breaks outside the reactor cavity in Reference 1. For the STP pressurizer surge line, this number is halved to reflect the single pipe. This results in a nominal risk of:

$$\text{Risk} = 1/2 \times 0.0006 = 0.003 \text{ man-rem/py}$$

Upper estimate risk calculations are made using procedures similar to those of the nominal estimates. The number calculated in Reference 1 is similarly adjusted for the pressurizer surge line. The upper estimate is:

$$\text{Risk} = 1/2/ \times 0.1 \text{ man-rem/py} = 0.05 \text{ man-rem/py}$$

The lower estimate is assumed to be 0.

Multiplying each of the risk calculations by the number of years of expected plant life (2 plants x 40 yr = 80 py) results in an STP public risk increase of:

	Total Added Risk (man-rem)
Nominal Estimate	0.24
Upper Estimate	4.0
Lower Estimate	0

The nominal estimate from Reference 1 of the total increase in core melt frequency for not providing protection against dynamic effects associated with pipe breaks is used and adjusted in a similar manner for the STP pressurizer surge line.

Core melt frequency increase = $1/2 \times 1 \times 10^{-7} = 0.5 \times 10^{-7}$

The upper estimate of core melt frequency increase of 2×10^{-6}/py (Reference 1) is similarly adjusted for the STP pressurizer surge line. A lower estimate of 0 is used for STP. In summary, core melt frequency increase estimates are as follows:

	Increase in Core Melt Frequency (events/py)
Nominal Estimate	0.5×10^{-7}
Upper Estimate	1×10^{-6}
Lower Estimate	0

Probabilistic analysis of the potential for increased risk to the public health due to the increase in core melt frequency demonstrates that there is no credible increase in the risk to public health. Because of the uncertainties in the core melt frequency estimates (References 6 and 7), the increase in core melt frequency is not statistically significant enough to establish a credible difference in the core melt frequency and hence the estimated added risks to public health.

2. Occupational Exposure Accidental

The increased occupational exposure from accidents is estimated to be the product of the change in total core melt frequency and the occupational exposure likely to occur in the event of a major accident. The nominal change in core melt frequency was estimated as 0.5×10^{-7} events/py. The occupational exposure in the event of a major accident has two components. The first is the "immediate" exposure to the personnel onsite during the span of the event and the time necessary to achieve short term control. The second is the longer term exposure associated with the cleanup and recovery from the accident.

The total avoided occupational exposure is calculated as follows:

$$D_{TOA} = NTD_{OA}$$
$$D_{OA} \equiv P(D_{IO} = D_{LTO})$$

Where

D_{TOA} = Total avoided

N = Number of affected facilities = 2

T = Average plant lifetime = 40 yrs.

D_{OA} = Avoided occupational dose per reactor year

P = Change in core melt frequency

D_{IO} = "Immediate" occupational exposure

D_{LTO} = Long-term occupational exposure

Results of the calculations are shown below. Uncertainties are conservatively propagated by the use of extremes (e.g., upper bound D_{IO} + upper bound D_{LT}).

	Increase in Core Melt Frequency (events/ Plant-yr) P	Immediate Occupational Exposure (man-rem/ event) D_{IO}	Long Term [(a)] Occupational Exposure (man-rem/ event) D_{LTO}	Total Avoided Occupational (man-rem) D_{TOA}
Nominal Estimate	0.5×10^{-7}	1×10^{3}	2×10^{4}	0.1
Upper Estimate	1×10^{-6}	4×10^{3}	3×10^{4}	2.7
Lower Estimate	0	0	1×10^{4}	0

(a) Based on cleanup and decommissioning estimates contained in Reference 2.

B. Reduction in Occupational Radiation Exposure (ORE) Resulting from a Decision Not to Protect Against the Dynamic Effects Associated with Pipe Breaks

1. Occupational Exposure - Operational

a. Inservice Inspection (ISI)

Review of the STP design indicates that the pressurizer surge line pipe whip restraints allow insufficient access to three surge line welds for performing ISI. Interferences posed by these pipe whip restraints require partial restraint removal during ISI. A minimum of 25% of the welds have to be inspected every 10 years. It is assumed that it takes two persons, one shift, to remove each pipe whip restraint and another shift for reinstallation. The STP expected exposure rates in the vicinity of the pressurizer surge line are in the range of 0.02 to 0.2 rem/hr. This corresponds to an expected dose rate of between 0.64 and 6.4 man-rem per restraint per ISI. Since in the STP design there are three pipe whip restraints per unit which require removal, the nominal reduction in ORE for not installing these pipe whip restraints is estimated as follows:

$$\text{Reduction in ORE} = 0.25 \times 2 \text{ units} \times 3 \frac{\text{restraints}}{\text{unit}} \times 4 \frac{\text{man-rem}}{\text{ISI, restraint}} \times 4 \frac{\text{ISI}}{\text{Plant life}}$$

$$= 24 \text{ man-rem}$$

The upper estimate is based on a 15 man-rem dose per ISI per restraint. The lower estimate is based on a value of 0.5 man-rem per ISI per restraint. In summary, the reduction in ORE is as follows:

	Occupational Radiation Exposure (man-rem)
Nominal Estimate	24
Upper Estimate	90
Lower Estimate	3

IV. References

1. U. S. NRC Generic Letter 84-04 "Safety Evaluation of Westinghouse Topical Reports Dealing with Elimination of Postulated Pipe Breaks in PWR Primary Main Loops" dated February 1, 1984.

2. NUREG/CR-2601, "Technology, Safety and Costs of Decommissioning Reference Light Water Reactors Following Postulated Accidents," November 1982.

3. STP Environmental Report, section 2.2 and 7.1

4. STP FSAR, section 12.4

5. NUREG 0933, "A Prioritization of Generic Safety Issues," 3/31/83

6. Wash 1400 (NUREG-75/014) "Reactor Safety Study," October 1975

7. German Risk Study, NRC Translation 729, May 1980