Copy to: Jay Lee 10E19

ESBU

Westinghouse
Energy
Systems
Business
Unit

NUCLEAR SAFETY ADVISORY LETTER

~~93-340~~

P21 93339

THIS IS A NOTIFICATION OF A RECENTLY IDENTIFIED POTENTIAL SAFETY ISSUE PERTAINING TO BASIC COMPONENTS SUPPLIED BY WESTINGHOUSE. THIS INFORMATION IS BEING PROVIDED TO YOU SO THAT A REVIEW OF THIS ISSUE CAN BE CONDUCTED BY YOU TO DETERMINE IF ANY ACTION IS REQUIRED.

P.O. Box 355, Pittsburgh, PA 15230-0355

Subject: Containment Spray System Issues	**Number:** NSAL-93-016
Basic Component: Please See Enclosed Letter	**Date:** 8-6-93
Plants: Please See Enclosed List	

Substantial Safety Hazard or Failure to Comply Pursuant to 10 CFR 21.21(a)	Yes ☐	No ☐
Transfer of Information Pursuant to 10 CFR 21.21(b)	Yes ☒	
Advisory Information Pursuant to 10 CFR 21.21(c)(2)	Yes ☐	

SUMMARY

Westinghouse has discovered two potential safety issues regarding the use of the Containment Spray System (CSS). One issue is that a Small Break LOCA (SBLOCA) may have higher offsite dose consequences than a Large Break LOCA (LBLOCA), since the CSS may not automatically actuate during the SBLOCA. In particular, the SBLOCA resulting in the highest peak clad temperature (PCT) is not expected in most plants to result in a containment pressure necessary to automatically actuate the CSS. Also, the core may release more activity during a SBLOCA than originally assumed. If the CSS is not actuated (automatically or manually) during the SBLOCA, then the utility should assess whether the SBLOCA is more limiting than the LBLOCA for the purpose of meeting 10CFR100. Westinghouse has determined that it has insufficient information to determine whether this issue presents a substantial safety hazard for your plant. Therefore, pursuant to the requirements of 10CFR21.21(b), Westinghouse is transferring the enclosed information to you so that you can determine whether this issue presents a substantial safety hazard. To assist you in your evaluation, Westinghouse has developed a methodology which you may wish to use to determine the applicability of this issue to your plant. This method is discussed later in this NSAL letter.

The second issue involves the time in which the sump solution pH should be adjusted to an acceptable pH level during a SBLOCA. Westinghouse has reviewed test data and past correspondence and has determined that the time in which the pH adjustment is made should be shorter than previously recommended. Westinghouse has clarified this guidance in this NSAL letter. However, Westinghouse cannot determine whether guidance is being followed. Therefore, Westinghouse has determined that it has insufficient information to determine whether this issue presents a Substantial Safety Hazard for your plant. Pursuant to the requirements of 10CFR21.21(b), Westinghouse is transferring the enclosed information to you so that you can determine whether this issue presents a substantial safety hazard.

Additional information, if required, may be obtained from the originator. Telephone 412-374-6460.

Originator: J. W. Fasnacht, Strategic Licensing Issues

H. A. Sepp, Manager, Strategic Licensing Issues

PLANT APPLICABILITY LIST

D.C. Cook 1
D.C. Cook 2
J.M. Farley 1
J.M. Farley 2
Byron 1
Byron 2
Braidwood 1
Braidwood 2
V.C. Summer 1
Zion 1
Zion 2
H.B. Robinson 2
Shearon Harris
Haddam Neck
W.B. McGuire 1
W.B. McGuire 2
Catawba 1
Catawba 2
Beaver Valley 1
Beaver Valley 2
Turkey Point 3
Turkey Point 4
Vogtle 1
Vogtle 2
Indian Point 2
Indian Point 3
Seabrook 1
Millstone 3
Prairie Island 1
Prairie Island 2
Diablo Canyon 1
Diablo Canyon 2
Trojan
Salem 1
Salem 2
R.E. Ginna
Wolf Creek
Callaway 1
Comanche Peak 1
Comanche Peak 2
South Texas 1
South Texas 2
Sequoyah 1
Sequoyah 2
Surry 1
Surry 2
North Anna 1
North Anna 2
Watts Bar 1
Watts Bar 2
Point Beach 1
Point Beach 2
Kewaunee
Maanshan 1
Maanshan 2
Napot Point
Fort Calhoun 1

CONTAINMENT SPRAY SYSTEM ISSUES

ISSUE DESCRIPTION

Issue 1: SBLOCA Radiological Consequence Analysis

This issue involves assumptions that were made in the Radiological Consequence analyses performed under 10CFR100. These assumptions may not bound the most limiting release scenario, and thus, there may be more limiting release scenarios which have not been analyzed.

Specifically, 10CFR100 requires each licensee to evaluate the radiological consequences associated with a fission product release that is ". . . based upon a major accident . . . that would result in potential hazards not exceeded by those from any accident considered credible." Currently, it is assumed that the most limiting accident for the fission product release is a Large Break LOCA (LBLOCA) with core melt. During a LBLOCA with core melt, the amount of fuel damage is maximized, but credit is taken for the Containment Spray System (CSS) removal of iodines from the containment vapor space. During a credible Small Break LOCA (SBLOCA), the amount of fuel damage is lower than for a LBLOCA, but since containment pressure is not expected to reach the setpoint at which CSS is actuated, credit for automatic CSS operation cannot be assumed. Recently, it has been determined that the amount of fuel damage during a SBLOCA can be much higher than the small amount previously assumed. Therefore, the SBLOCA may have higher off site radiological consequences than a LBLOCA.

Issue 2: Long-term Sump pH Control During a SBLOCA

The second issue involves the pH requirements of the long-term sump solution following a SBLOCA. In general, the pH of the sump solution should be raised into the range of 7 to 9.5 in order to maximize the retention of iodine in solution and minimize the potential for chloride induced stress corrosion cracking of stainless steel components. Many plants rely on the CSS to deliver an alkaline chemical (usually sodium hydroxide) to the containment sump for long-term pH control. During a SBLOCA, the CSS may not automatically actuate, and the operator may need to take action to add a sufficient quantity of an alkaline chemical to adjust the sump pH. This action must be completed before the safety-related components experience stress corrosion cracking. The previously recommended time limit, (which is to adjust the sump pH to an acceptable level within 48 hours from the start of the LOCA) may not be adequate to minimize or preclude chloride induced stress corrosion cracking.

TECHNICAL EVALUATION

Issue 1: SBLOCA Radiological Consequence Analysis

Westinghouse has performed an evaluation to assess whether a SBLOCA, without CSS actuation, has higher off site dose consequences than a LBLOCA. As a result of this evaluation, it can be shown that the LBLOCA still has higher off site dose consequences, under certain conditions and assumptions. However, it should be noted that some of the conditions and assumptions may not be applicable to your plant specific licensing basis. Therefore, you should carefully review the analysis conditions and assumptions to assess the applicability to your plant specific licensing basis.

The following discussion is provided to identify a "representative" analysis that you may wish to use to assess this issue. The purpose of the analysis is to calculate the off site dose consequences associated with a "representative" SBLOCA. The following are some of the inputs and assumptions used for the analysis.

INPUTS AND ASSUMPTIONS

1. The rod burst percentage is assumed to be 100% of the core, and the release is assumed to occur at time zero. This assumption is selected to bound all possible rod burst occurrences. This assumption is made even though it has been shown that the actual rod burst percentage is likely to be lower, depending upon plant specific design. Plant design factors which would lower the amount of rod burst include, but are not limited to: peak clad temperature during SBLOCA, fuel design features, and precision used in the rod burst calculation.

2. The break size is small enough so that the CSS is not automatically actuated. Please note that the potential use of the CSS to mitigate the off site dose consequences of the SBLOCA is discussed in the Recommendations section of this letter. It is believed that if the operator initiates CSS during the SBLOCA, within a sufficient amount of time after the accident has started, then the LBLOCA will still be the bounding analysis for the purposes of meeting 10CFR100. However, if the plant decides to initiate the CSS during a SBLOCA, then the plant must assure that the initiation of the CSS is considered in the 10CFR50.46 analysis. (See "Recommendations" for details.)

3. The offsite thyroid dose acceptance criterion is specified in 10CFR100 as 300 rem. This criterion is selected even though a lower dose acceptance criterion has been recommended by ANSI/ANS-51.1-1983 which states that the appropriate acceptance criteria for a SBLOCA should be 25% of the 10CFR100 guidelines, or 75 rem. It should be noted that ANSI/ANS-51.1 has not been incorporated into the radiological licensing basis of most plants and the NRC Standard Review Plan does not identify any dose acceptance criteria specifically for the SBLOCA.

4. The amount of activity accumulated in the fuel clad gap is assumed to be 2% of the iodines and 2% of the noble gases accumulated in the core at the end of core life. This assumption differs from the assumption of a 10% gap fraction recommended by the NRC in Regulatory Guide 1.77 for the rod ejection accident. It is believed that the 2% is a bounding and conservative value and that the 10% value is excessively conservative, since the total core is being considered in the analysis. Likewise, the core melt activity release assumed for the LBLOCA (see Regulatory Guide 1.4) is also excessively conservative since the core is predicted to experience rod bursts and a small amount of melting. If a core melt is assumed, the calculated doses (see page 4) would increase by a factor of 12.5 based on the ratio of the Regulatory Guide 1.4 release (25% of the core activity) and the assumed gap release (2% of core activity).

5. Half of the iodine activity released from the fuel reaches the containment atmosphere and half is retained in the reactor coolant system.

6. Credit is taken for the deposition removal of airborne iodine on the containment surfaces. The deposition removal process is recognized by the NRC in Section 6.5.2 of the Standard Review Plan. This deposition removal process is not part of the licensing basis for most plants. The removal of airborne iodine from the containment atmosphere is accomplished by deposition onto containment surfaces by using a removal coefficient of 2 hr^{-1}. Based on eight specific plant analyses, this value is less than would be expected.

7. The design basis containment leak rate is assumed to be 0.1% per day.

8. The core power level is assumed to be 3565 MWt.

9. The assumed atmospheric dispersion factors are provided below. It is believed that these factors bound most of the operating plants.

	Time	Dispersion Factor
Site Boundary	(0-2 hours)	1.0E-03 sec/m^3
Low Population Zone	(0-8 hours)	1.5E-04 sec/m^3
	(8-24 hours)	1.0E-04 sec/m^3
	(24-96 hours)	5.0E-05 sec/m^3
	(96-720 hours)	2.0E-05 sec/m^3

RESULTS

Using the inputs and assumptions listed above, the following results are obtained.

	Containment Leakage	Secondary Side Releases	Total
Site Boundary	20.7 rem	1.6 rem	22.3 rem
Low Population Zone			
(0-8 hr)	4.59 rem	2.34 rem	
(8-24 hr)	1.10 rem	—	
(24-96 hr)	1.14 rem	—	
(96-720 hr)	1.24 rem	—	
	8.07 rem	2.34 rem	10.4 rem

The total dose at the site boundary is 22.3 rem. The total dose at the low population zone boundary is 10.4 rem. These doses are well below the 10CFR100 guideline of 300 rem and are bounded by the LBLOCA doses that would be determined for this representative plant.

SENSITIVITY ANALYSIS

Due to the wide array of inputs and assumptions, it is difficult to perform a rigorous sensitivity evaluation for the analysis. However, it is possible to make several observations regarding the impact that changes in certain analysis assumptions would have on the analysis results. First, assumption #4 above indicates that the assumed gap fraction is 2%. If the gap fraction is assumed to be 10%, then the offsite dose will increase by a factor of 5 (10%/2%). As a result, the corresponding doses will be about 112 rem for the site boundary and 52 rem for the low population zone.

Second, assumption #6 above indicates that a credit is taken for the removal of airborne iodine by deposition on containment surfaces. Without this credit for deposition, there is no depletion of the airborne iodine and the corresponding dose will be about 73 rem at the site boundary and 110 rem[a] at the low population zone.

Third, if you assume that the gap fraction is 10% (see assumption #4) and also do not take credit for deposition removal, then the corresponding doses will be outside of the 300 rem limit for this sample case. The dose at the site boundary will be about 365 rem, and 550 rem[b] at the low population zone.

(a) The 110 rem value is based on a summation of doses from the following time intervals:
[(0-8 hours : 40.4 rem), (8-24 hours : 22.1 rem),
(24-96 hours : 22.8 rem), (96-720 hours : 24.6 rem)]

(b) The 550 rem value is based on a summation of doses from the following time intervals:
[(0-8 hours : 202 rem), (8-24 hours : 111 rem),
(24-96 hours : 114 rem), (96-720 hours : 123.0 rem)]

USE OF RESULTS TO ASSESS APPLICABILITY OF THE ISSUE TO PLANT SPECIFIC PARAMETERS

The first concern in the determination of the applicability of the sample SBLOCA dose analysis is whether the assumptions used are ones that are consistent with the plant licensing basis. Also, since most plants have no defined licensing basis for the SBLOCA dose analysis, the assumptions should be ones for which the licensee is willing to take credit. There are only a few operating plants which have a time-dependent deposition removal model (assumption #6) in their licensing basis analysis for the LBLOCA; however, there is no apparent reason why this approach could not be used for the SBLOCA analysis for all plants. Relative to the assumption of a two percent gap fraction (assumption #4), there are a number of older plants that use calculated gap fractions that are near this value (with different values determined for each nuclide, some of which are far below the two percent value). Most plants have a ten percent gap fraction in their licensing basis, and the use of the two percent value would be a departure from past practice. The use of the two percent gap fraction is still conservative for an event involving the total core.

After verifying and selecting the appropriate assumptions, the site specific doses can be estimated as follows. First, evaluate whether it is appropriate to take credit for a 2 percent gap fraction and/or deposition on containment surfaces. Afterwards, select the dose results from the sample analysis that are appropriate for the assumptions. Then, use the following equation to assess your plant specific doses.

$$(PSD) = \left[\frac{(PSCLR)}{.1\%^{(b)}}\right]\left[\frac{PSCPL}{3565MWt^{(c)}}\right]\left[\sum_{t=1}^{n} (AD)_t^{(a)} \frac{(PSADF)_t}{(AADF)_t}\right]$$

Definition of Variables

PSD = Plant Specific Dose (Site boundary or low population zone, depending on which is more limiting)

PSCLR = Plant Specific Containment Leak Rate Percent

PSCPL = Plant Specific Core Power Level (MWt)

$(AD)_t$ = Analysis Dose (rem)

$(PSADF)_t$ = Plant Specific Atmospheric Dispersion Factor (sec/m^3)

$(AADF)_t$ = Analysis Atmospheric Dispersion Factor (sec/m^3), see page 3

n = number of time intervals. For a Site Boundary Dose, n = 1 for the time interval (0-2 hours). For the Low Population Zone, n = 4 for the four time intervals (0-8 hr), (8-24 hr), (24-96 hr) and (96-720 hr)

Notes for Equation

(a) This value(s) will depend on the plant specific licensing bases. After defining the assumptions, obtain this value(s) from the results and sensitivity analysis on page 4.

(b) See assumption #7, page 3.

(c) See assumption #8, page 3.

The resultant value will provide a determination of whether the doses will exceed the acceptance criteria.

Issue 2: Long-term Sump pH Control During a SBLOCA

Many plants rely on a CSS to deliver an alkaline chemical to the containment sump for long-term pH control during an accident. During a SBLOCA, the CSS may not automatically actuate and the operator may take action to add a sufficient quantity of an alkaline chemical to adjust the sump pH within acceptable limits. In the past, the Westinghouse Standard Information Package has indicated that the sump pH be adjusted to a pH of 8 within 48 hours of the accident. The pH adjustment is needed to mitigate stress corrosion cracking of the stainless steel components which are part of the emergency core cooling system (ECCS).

Westinghouse has re-evaluated this recommendation in light of test data. It has been determined that the SIP should be changed to more accurately reflect this test data. The SIP should be changed to recommend that the sump pH be adjusted to a pH greater than 7 as soon as possible, but within 8 hours of a LOCA.

SAFETY SIGNIFICANCE

Issue 1: SBLOCA Radiological Consequence Analysis

The safety significance of this issue is that if the analysis assumptions for the sample case SBLOCA dose analysis are not acceptable to the licensee or to the NRC, it is possible that the thyroid doses for this accident might exceed the current limiting design basis dose analysis (LBLOCA with core melt). If this is the case, the plant would be viewed as operating in an unanalyzed condition.

Issue 2: Long-term Sump pH Control During a SBLOCA

The safety significance is that during a SBLOCA, the operator may need to place the plant ECCS on cold leg recirculation to mitigate the accident effects. As a result, the ECCS components must be able to perform their intended design functions. To help assure that these components are able to perform their intended design functions, it is necessary to assure that the sump pH is properly adjusted to mitigate stress corrosion cracking of the stainless steel parts of these components. If the sump pH is not properly adjusted, then the ECCS components may not be able to perform their intended design function. This condition would be outside a variety of plant licensing bases, including, but not limited to, the Plant Technical Specifications and 10CFR50 Appendix A, General Design Criteria 35, Emergency Core Cooling.

NRC AWARENESS/REPORTABILITY CONSIDERATION

The NRC has not been notified of these issues. Westinghouse has determined that it has insufficient information to determine whether this issue presents a substantial safety hazard for your plant. Therefore, pursuant to the requirements of 10CFR21.21(b), Westinghouse is transferring this information to the licensees so that they can determine whether this issue presents a substantial safety hazard for their plants.

RECOMMENDATIONS

Issue 1: SBLOCA Radiological Consequence Analysis

In making the 10CFR21 assessment, you may wish to consider the following:

1. Affected licensees should consider actuating the CSS during the SBLOCA if high radiation levels, indicative of substantial fuel damage, are detected inside containment. The CSS is highly effective in removing airborne iodine from the containment atmosphere. Use of the CSS in the appropriate manner should mitigate the SBLOCA so that it is not more limiting than the LBLOCA for the purpose of meeting 10CFR100. The time of CSS actuation and the duration of CSS operation will depend on the plant specific design features.

   Also, it should be noted that the use of the CSS during a SBLOCA may impact the plant specific analysis performed pursuant to 10CFR50.46. While early initiation of spray during a small break LOCA would reduce offsite dose, if the initiation is too early, switchover of the ECCS to cold leg recirculation could occur during the core uncovery period of the accident. This would result in a period of reduced SI flows leading to higher calculated Peak Cladding Temperatures (PCT) for the SBLOCA event. Therefore, if the plant EOPs are to be modified to require the operator to start the CSS in the event of an SBLOCA, this action should be restricted to occur no earlier than 30 minutes into the transient, as measured from the "S" signal time. In this manner, the rapid drain down of the RWST by the CSS should not occur prior to the onset of core recovery for the SBLOCA event, and the PCT should not be affected.

2. Assuming that item #1 is not pursued, it should be determined whether the SBLOCA, without CSS actuation, is more limiting than the LBLOCA for the purpose of meeting the 10CFR100 requirements. Consideration of the results of the analysis presented in the "Technical Evaluation" section of this letter will help assess the applicability of this issue to a specific plant. However, note that this analysis is provided only to help you assess the applicability of this issue. You should ultimately verify whether the issue is applicable by performing a plant specific calculation, as required.

Issue 2: <u>Long-term Sump pH Control During a SBLOCA</u>

1. Review the plant specific design features and operating procedures to assure that the sump pH is adjusted to a pH of 7 within 8 hours following a SBLOCA. This adjustment will help to mitigate the potential stress corrosion cracking of ECCS components. One way to perform this adjustment is to actuate the CSS during the SBLOCA, if the CSS is used to deliver an alkaline chemical for sump pH adjustment. However, it should be noted that the use of the CSS during a SBLOCA may impact the plant specific analysis performed pursuant to 10CFR50.46. While early initiation of spray during a small break LOCA would inject chemicals to raise the sump pH, if the initiation is too early, switchover of the ECCS to cold leg recirculation could occur during the core uncovery period of the accident. This would result in a period of reduced SI flows leading to higher calculated Peak Cladding Temperatures (PCT) for the SBLOCA event. Therefore, if the plant EOPs are to be modified to require the operator to start the CSS in the event of an SBLOCA, this action should be restricted to occur no earlier than 30 minutes into the transient, as measured from the "S" signal time. In this manner, the rapid drain down of the RWST by the CSS should not occur prior to the onset of core recovery for the SBLOCA event, and the PCT should not be affected. Alternatively, you may wish to consider the use of an alternate pH adjusting system such as TSP (Trisodium Phosphate) passive basket system to adjust the sump pH within acceptable limits, following the accident.