ATTACHMENT 3 TO NL-13-058

NUCLEAR SAFETY ADVISORY LETTER NSAL-11-5

Nuclear Safety Advisory Letter

Westinghouse

This is a notification of a recently identified potential safety issue pertaining to basic components supplied by Westinghouse. This information is being provided so that you can conduct a review of this issue to determine if any action is required.

1000 Westinghouse Drive, Cranberry Township, PA 16066

Subject: **Westinghouse LOCA Mass and Energy Release Calculation Issues**	Number: **NSAL-11-5**
Basic Component: Containment Mass and Energy Release Analysis	Date: 07/25/2011
Substantial Safety Hazard or Failure to Comply Pursuant to 10 CFR 21.21(a)	Yes ☐ No ☒ N/A ☐
Transfer of Information Pursuant to 10 CFR 21.21(b)	Yes ☐
Advisory Information Pursuant to 10 CFR 21.21(d)(2)	Yes ☐

SUMMARY

This Nuclear Safety Advisory Letter (NSAL) is applicable to loss-of-coolant accident (LOCA) mass and energy (M&E) release calculations performed for Westinghouse-designed pressurized water reactors (PWRs) utilizing the methodology documented in WCAP-10325-P-A and WCAP-8264-P-A, Revision 1 (References 1 and 2, respectively). Combustion Engineering NSSS designs and BWR designs are not affected by these issues.

The six issues listed below can potentially impact the plant specific LOCA M&E release calculation results which are used as input to the containment integrity response analyses. The six issues, which include generic errors that can impact the plant specific analyses differently, are:

1. The reactor vessel modeling did not include all the appropriate vessel metal mass available from the component drawings.
2. The reactor vessel modeling did not include all the appropriate vessel metal mass in the reactor vessel barrel/baffle region.
3. The reactor coolant pump (RCP) homologous curve input incorrectly included an absolute zero point coordinate.
4. The RCP homologous curve input incorrectly contained a sign error in a coordinate value.
5. The LOCA M&E release analysis initializes at a non-conservative (low) steam generator (SG) secondary pressure condition.
6. An error found in the EPITOME computer code (WCAP-10325-P-A methodology only) that is used to determine the M&E release rate during the long-term (i.e., post-reflood) SG depressurization phase of the LOCA transient.

Additional information, if required, may be obtained from Matt Cerrone (412) 374-6707

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These six issues can result in an increase in the LOCA M&E release to the containment. The increase in the LOCA M&E release associated with each of these issues affects the plant specific containment LOCA blowdown and post-blowdown transient conditions differently. The increase in the LOCA M&E release has the potential to affect the following analyses. The impact on these analyses is also discussed.

Long-term Containment Peak Pressure

Estimated containment pressure penalties for each issue are listed in Table 1. The WCAP-10325-P-A and WCAP-8264-P-A, Revision 1 methodology contains modeling and initial condition assumption conservatisms that result in a calculated peak pressure that is 6 psi higher than the peak pressure that would be determined from a more realistic analysis. This 6 psi would offset the resulting increase in the containment peak pressure (Pa) associated with these issues. Therefore, if a more realistic analysis were performed, Pa would not increase above the current value and there would be no impact on the 10CFR50, Appendix J, Type A, B, and C tests.

Containment Peak Temperature

As discussed above, if a more realistic analysis were performed, Pa would not increase above the current value due to these issues and the containment peak temperature would not be impacted. Temperature is a function of pressure; therefore, if pressure does not increase, temperature will not increase.

Containment Equipment Qualification

As discussed above, if a more realistic analysis were performed, Pa would not increase above the current value due to these issues and the containment peak temperature would not be impacted. Temperature is a function of pressure; therefore, if pressure does not increase, temperature will not increase. If the peak pressure and temperature are not impacted, then there would be no impact on long-term pressure and temperature.

Containment Sump Temperature

If a more realistic analysis were performed, the overall initial internal energy of the RCS would be lower and the active containment heat removal systems would be more efficient. This would result in a lower M&E release to the containment atmosphere and the sump and an increase in the energy removed from the containment. The result would be a lower sump temperature transient.

Energy Loads to the Ultimate Heat Sink

If a more realistic analysis were performed, the energy transferred to the ultimate heat sink would be reduced as compared to the design basis analysis; therefore, the ultimate heat sink analyses would not be impacted.

This issue does not affect the LOCA ECCS analysis and does not fall within the reporting requirements of 10 CFR 50.46.

ISSUE DESCRIPTION

The LOCA M&E releases are conservatively generated and used as input to the containment integrity response analyses. Westinghouse has identified six issues that can potentially result in a non-conservative plant specific LOCA M&E release calculation:

1. Reactor Vessel Metal Mass – The reactor vessel model did not include all the appropriate vessel metal mass available from the component drawings. The discrepancy results in an inaccurate vessel metal mass that affects the amount of reactor vessel stored energy initially available in the M&E model. Containment pressure sensitivity studies were performed to evaluate the impact of

using a higher metal mass for the lower support plate in the vessel. The sensitivity studies showed no significant increase in the calculated peak containment pressure in either the blowdown or post-reflood phase of the LOCA event.

2. Missing Barrel/Baffle Region Metal Mass – The reactor vessel model did not include the appropriate amount of vessel metal mass in the reactor vessel barrel/baffle downcomer region. Differences were identified in the calculated metal mass and surface area input values between upflow and downflow barrel/baffle configurations, with more significant differences noted in plants that were converted to an upflow barrel/baffle configuration. Increases in the barrel/baffle metal mass impact the initial energy stored within the reactor vessel. Sensitivity studies showed no significant increase in the calculated peak containment pressure during the blowdown phase. However, the calculated peak containment pressure was found to increase during the post-reflood phase. For the downflow barrel/baffle design, the calculated post-reflood phase peak containment pressure increase was small, approximately 0.05 psi; but for the upflow barrel/baffle design, the increase was approximately 0.35 psi.

3. RCP Homologous Curve Zero Point – The RCP homologous curve inputs in certain plant specific analyses were found to incorrectly include an absolute zero coordinate data set when positive non-zero values were required. This error has an impact on the reflood portion of the long-term LOCA M&E release calculations. Sensitivity studies showed no significant increase in the calculated peak containment pressure during the blowdown phase. The calculated post-reflood phase peak containment pressure was found to increase by approximately 0.4 psi.

4. RCP Sign Error – A separate homologous curve input error was identified while performing the extent of condition for Item 3 above. A positive value for α/v was modeled in the input array in the reflood code for some plant specific LOCA M&E release analyses when it should have been negative. This error has an impact on the reflood portion of the long-term LOCA M&E release calculations. Sensitivity studies showed no significant increase in the calculated peak containment pressure in either the blowdown or post-blowdown phase of the LOCA event.

5. SG Pressure Error – The LOCA M&E release analysis was initialized at a non-conservative (low) SG secondary pressure value. This input value determines the initial SG secondary side temperature and pressure used in the LOCA M&E release calculations. The pressure at the exit of the SG outlet nozzle was incorrectly used as the SG secondary side pressure, as opposed to the correct, higher tube bundle pressure. The initial SG energy is underestimated; therefore, the correction results in an increase in the calculated LOCA M&E release. Sensitivity studies showed an approximate 0.1 psi increase in the calculated blowdown peak containment pressure and an approximate 0.4 psi increase in the calculated post-blowdown peak containment pressure.

6. An error was found in the EPITOME computer code which determines the M&E release (post-reflood) during the long-term SG depressurization phase of the LOCA transient. The error results in an underestimated energy release in the long-term, post-reflood phase of the transient. The impact of this single issue is expected to be less than 3.0 psi for most Westinghouse PWRs with dry and sub-atmospheric designs. However, since engineering safety features can vary considerably from plant to plant, the impact could be as much as 4.0 psi for some plants.

TECHNICAL EVALUATION

Short-term Sub-compartment Differential Pressure Analyses

The LOCA M&E release during a short-term sub-compartment differential pressure analysis lasts only 1 second to 3 seconds. The short-term LOCA break flow rate is dominated by the initial RCS pressure and RCS primary side fluid temperatures that are defined in the transient initial conditions. Analysis assumptions such as stored RCS metal energy and SG secondary pressure do not affect the calculation of the short-term LOCA M&E releases because of the duration of the transient. Therefore, none of the six issues previously described will have any impact the short-term LOCA M&E release input used in the short-term sub-compartment differential pressure analyses.

Long-term Containment Peak Pressure Analyses

The long-term containment peak pressure analyses are conservatively performed to confirm that the peak pressure is less than the containment design pressure value. The magnitude of the calculated peak containment pressure for a LOCA event depends upon the LOCA M&E release rates, the volume of the containment, and the energy absorption rates of the passive containment heat sinks and the active engineered safety features (fan coolers and containment spray). Depending upon the magnitude of the M&E releases, the containment volume, and the effectiveness of the containment heat removal systems, the time of the peak containment pressure can vary from the early blowdown phase (less than 30 seconds after event initiation) to the longer term post-reflood phase. The peak calculated pressure from the long-term LOCA containment peak pressure analysis (Pa) is contained in the Containment Leakage Rate Testing Program Specification for most plants. 10CFR50, Appendix J, Type A, B, and C tests are performed at the LOCA Pa.

Sensitivities were performed to estimate the cumulative impact of the six issues on the calculated peak containment pressure value. The estimated containment pressure increase for the double-ended hot leg (DEHL) break case is approximately 0.1 psi and the estimated containment pressure increase for the double-ended pump suction (DEPS) break case is between 3.0 and 4.0 psi. Table 1 identifies which of the six issues impacts each plant specific analysis and provides an estimated total impact on the containment peak pressure. While Westinghouse may not perform containment integrity analysis for all of the plants listed in Table 1, estimates of the peak containment pressure increase are provided based on similar plant sensitivities and engineering judgment.

Various changes to analysis input parameters can produce margin that may offset these estimated impacts. Therefore, plant-specific containment analyses are recommended to determine the actual impact on the calculated peak containment pressure.

Containment Peak Temperature Analyses

The containment peak temperature analyses are performed to confirm that the upper limit of the containment liner design temperature is not exceeded. The containment vapor temperature can be higher than the upper limit of the containment liner design temperature for a short period of time, since the thermal response time of the steel is much slower due to the surface heat transfer rate and conduction.

The containment peak temperature for a large break LOCA is calculated using the containment peak pressure LOCA M&E releases as an input; however, the containment model initial conditions are adjusted to calculate an upper bounding containment temperature response. The containment temperature will increase between 1.0°F and 1.5°F per psi increase in the steam partial pressure. Therefore, the total estimated increase in the containment peak temperature, considering all six LOCA M&E issues, is estimated to be less than 6°F.

Containment Equipment Qualification Analyses

Containment equipment qualification (EQ) analyses are performed to confirm that the equipment pressure and temperature test envelopes are not exceeded during the time period for which the equipment is required to perform its safety function. These analyses use the long-term LOCA containment integrity M&E releases as an input.

The six LOCA M&E issues listed above affect the calculated energy release rates during the first hour following a LOCA event. Typically, the margin between the calculated pressure and temperature conditions from those contained in the EQ pressure and temperature profiles is the greatest during the first few hours of the LOCA event. Exceeding the EQ pressure and temperature envelopes is typically a concern well beyond the first hour of a LOCA M&E release. Therefore, these six issues should have very little impact on the long-term EQ.

Containment Sump Temperature Analyses

Containment sump temperature analyses are performed to confirm the minimum net positive suction head available (NPSHa) for the emergency core cooling system (ECCS) recirculation and containment spray system (CSS) pumps is always greater than the required value (NPSHr). The NPSHa is the sum of the atmospheric pressure and static fluid heads, minus the sum of the velocity and vapor pressure heads. The NPSHa decreases as the pump flow rate and sump temperature increase.

The containment sump temperature response is calculated using the containment peak pressure LOCA M&E releases as an input; however, the energy released as steam is minimized in these analyses to maximize the calculated sump temperature. The sump temperature is expected to increase slightly due to the impact of these six issues.

Various changes to analysis input parameters can produce margin that may offset the sump temperature increase (i.e., reducing the as-analyzed RWST temperature to the Technical Specification limit, reducing the accumulator temperature to measured values plus uncertainty, etc.). For this reason, plant-specific containment analyses are recommended to determine the actual impact on the calculated NPSHa.

Ultimate Heat Sink Analyses

Analyses are performed to determine the energy load on the ultimate heat sink. The six LOCA M&E issues listed above can affect the calculated energy release rates during the first hour following a LOCA event. The energy in the containment atmosphere and the containment sump is eventually transferred to the plant's ultimate heat sink. Typically, the loads on the ultimate heat sink are the highest shortly after the transfer to sump recirculation. The increase in the peak calculated temperature for the ultimate heat sink is not expected to be significant; however, the duration of the temperature increase may be longer than currently analyzed. For this reason, plant specific containment analyses are recommended to determine the actual impact on the ultimate heat sink analyses.

SAFETY SIGNIFICANCE

Westinghouse has assessed this deviation relative to 10CFR Part21 and determined that it would not result in a substantial safety hazard even if left uncorrected. This conclusion was based on inherent conservatism in the Westinghouse LOCA M&E analysis methodology, WCAP-10325-P-A and WCAP-8264-P-A, Revision 1 (References 1 and 2, respectively), that are sufficient to offset the impact of the identified errors.

The Westinghouse LOCA M&E analysis methodology is based on non-mechanistic assumptions that maximize the M&E release rates during the first hour. These assumptions generate very limiting blowdown and post-blowdown peak containment pressure conditions that are extremely conservative. The non-mechanistic methodology assumptions are part of the approved methodology and these conservatisms were not considered in the substantial safety hazard assessment; however, they are discussed since they represent additional conservatism.

The post-blowdown LOCA M&E releases, when calculated with a more mechanistic LOCA analysis code like WCOBRA-TRAC, are significantly lower than those calculated using the WCAP-10325 methodology. As a result, the calculated post-blowdown containment pressure for the large dry and sub-atmospheric containment designs would be significantly reduced if the more accurate LOCA M&E releases were used.

Additionally, because of the lower energy release rate, the time of ice bed melt-out in the ice condenser containment design would be extended. This would result in a potentially lower sump temperature and peak containment pressure, since the residual heat removal system would be able to remove energy from the containment sump over a longer period of time.

Separate from the non-mechanistic assumptions are inherent input, initial condition, and model conservatisms, which are sufficient to offset the impact of the identified errors for all plants. Section 5.1 of WCAP-10325-P-A documents the conservatisms that are inherent in the methodology. These conservatisms include modeling aspects and initial conditions assumptions that result in a peak calculated containment pressure that is a minimum of 6 psi higher than what would be calculated with "more realistic" input values. These inherent conservatisms also apply to the methodology described in WCAP-8264-P-A, Revision 1. If these more realistic input values were applied to the WCAP-10325-P-A or WCAP-8264-P-A, Revision 1 LOCA M&E release calculation methodology, a similar reduction in the calculated peak containment pressure would be observed. The input, initial condition and model assumption conservatisms include:

- Core power and primary side fluid temperatures apply an uncertainty.
- The RCS system volume used in M&E release calculation has an additional 1.4% for uncertainty and 1.6% of the system volume is added for thermal expansion.
- Steam generator parameters are skewed to maximize available energy. These assumptions are based on full power, maximum Tavg (with applied uncertainty), 0% SG tube plugging (assuming no fouling), maximum SG level plus uncertainty with an additional 10% increase in secondary mass.
- Decay heat is maximized and a two sigma uncertainty has been applied to ensure conservatism.
- Core stored energy is maximized by assuming the conditions at the most limiting time in life and maximum core fluid temperatures.
- The moisture carryover fraction correlation used in the reflood transient for a DEPS break was developed for ECCS type applications for a DECL break. At the beginning of the reflood phase in an M&E energy release transient for a DEPS break, the initial core temperature is greatly reduced compared to a DECL for a peak clad temperature analysis. This core temperature reduction would greatly reduce the carryover fraction for a DEPS case by as much as 50%. In turn, the releases to the containment would be reduced.

Since the conservatisms in the LOCA M&E release calculation methodology offset the estimated penalties due to the combined effect of the errors, it was determined that a substantial safety hazard does not exist. Appendix A contains information that can be used as input to an Operability Determination.

Additional margin in plant specific LOCA M&E analysis input values have been identified to offset the penalties associated with these six issues. Analysis inputs where margin may be available are listed below.

- Crediting a lower maximum Tavg within the analyzed limits
- Reduce the maximum initial accumulator temperature
- Utilizing a maximum steam pressure that is lower than current analysis, yet bounding for plant operation
- Reduce the maximum refueling water storage tank (RWST)temperature
- Revised drain down times for the RWST (which would delay the switchover to cold leg recirculation)
- More accurate accounting of SG secondary side metal mass above the water level
- Credit for extraction steam to run the turbine driven AFW pumps and valves
- Plant specific valve closure characteristics for the main feedwater isolation valve closure time
- Revised safety injection flow rates

The following changes to the containment model inputs may also be used to offset the penalty due to the six LOCA M&E issues and increase the plant specific analysis margin:

- Lower the initial containment pressure
- Identify ice mass margin (ice condenser plants)
- Increase the containment spray flow
- Improve the containment fan cooler performance
- Increase the containment volume provided for the containment integrity analysis
- Increase the containment heat sink mass

Depending on the magnitude of the analysis input change for a particular plant, the benefits obtained from the above items can be 0.1 psi to 0.5 psi for individual changes and combinations of several of these input changes have shown that the impact of the errors can be offset.

AFFECTED PLANTS LIST

The affected plants and the estimated impact on the containment peak pressure values are listed in Table 1.

NRC AWARENESS

Westinghouse had a telephone conference call with the U.S. Nuclear Regulatory Commission (NRC) regarding some of these LOCA M&E release issues and stated that the margins that are contained in the WCAP-10325-P-A (Reference 1) methodology were the basis for the no substantial safety hazard determination.

RECOMMENDED ACTIONS

1. Determine the estimated impact by adding the estimated penalties provided in Table 1 to the current licensing basis analysis of record calculated containment LOCA blowdown and post-blowdown peak pressure result values. Add any other known containment pressure penalties that may have been determined from plant specific evaluations.
2. Determine the impact of the errors (from information provide in the Technical Evaluation and Table 1) on the containment peak pressure and containment peak temperature/EQ. A plant

specific analysis can be performed to determine these impacts, in addition to the potential sump temperature and ultimate heat sink input impacts.

3. Determine the available margin that may exist between the current analysis input assumptions versus actual plant conditions that can be used to offset the estimated penalty.
4. Revise the affected analyses as required based on revised analysis input assumptions to address these issues to offset the penalty.
5. If it is ultimately determined that sufficient offsetting margin cannot be identified, an alternative approach may be considered such as a more realistic analysis methodology.

REFERENCES

1. WCAP-10325-P-A, "Westinghouse LOCA Mass and Energy Release Model for Containment Design-March 1979 Version," May 1983 (Proprietary), WCAP-10326-A (Non-Proprietary)
2. WCAP-8264-P-A, Revision 1, "Topical Report - Westinghouse Mass and Energy Release Data for Containment Design," August 1975.

TABLE 1: LIST OF AFFECTED PLANTS

Plant List	Containment Scope	Reactor Vessel Metal	RCP Input	SG Pressure	Barrel Baffle		EPITOME	Estimated Peak Pressure Increase (psi)	
								DEHL	DEPS
Almaraz 1 & 2(8)	Westinghouse	□		□	□	Upflow	□	0.1	3.85
A.W. Vogtle 1 & 2(1)	Westinghouse	□		□	□	Upflow	□	0.1	3.1
Angra 1(1)	Westinghouse	□		□	□	Downflow	□	0.1	0.1
AP1000®* PWR	Westinghouse					Upflow	N/A	0(5)	0(5)(7)
Asco 1 & 2(8)	No Scope	□			□	Upflow	□	0	3.45
Beaver Valley 1 & 2	No Scope	□	□sign	□	□	Upflow	□	0.1	3.75
Braidwood 1 & Byron 1	Westinghouse					Upflow		0(5)	0(5)
Braidwood 2 & Byron 2	Westinghouse					Upflow		0(5)	0(5)
Callaway 1	No Scope	□		□	□	Upflow	□	0.1	3.75
Comanche Peak 1 & 2	Westinghouse	□		□	□	Upflow	□	0.1	2.45(6)
Diablo Canyon 1(1)	Westinghouse	□		□	□	Downflow	□	0.1	3.1
Diablo Canyon 2(1)	Westinghouse	□		□	□	Upflow	□	0.1	0.07(6)
Donald C. Cook 1 & 2(2)	Westinghouse	□		□	□	Downflow	□	0	2.8
H.B. Robinson 2	Westinghouse	□	□0 point		□	Downflow	□	0	3.0(6)
Indian Point 2	Westinghouse	□		□	□	Downflow	□	0.1	3.45
Indian Point 3	Westinghouse	□		□	□	Downflow	□	0.1	3.45
Joseph Farley 1 & 2	No Scope	□		□	□	Upflow	□	0.1	3.75
Kewaunee	Westinghouse	□		□	□	Downflow	□	0.1	3.45
Kori 1(1)	Westinghouse	□	□0 point	□	□	Upflow	□	0.1	3.1
Kori 2	No Scope	□		□	□	Upflow	□	0.1	3.75
Kori 3 & 4	No Scope	□		□	□	Upflow	□	0.1	3.75
Krsko(8)	No Scope	□			□	Downflow	□	0	3.15
Maanshan 1 & 2	No Scope	□		□	□	Upflow	□	0.1	3.75
Millstone 3	No Scope	□		□	□	Upflow	N/A	0.1	0.75
North Anna 1	No Scope	□		□	□	Upflow	N/A	0.1	0.75
North Anna 2	No Scope	□		□	□	Downflow	N/A	0.1	0.45
Point Beach 1 & 2(1) (4)	Westinghouse					Upflow		0(5)	0(5)

TABLE 1: LIST OF AFFECTED PLANTS									
Plant List	Containment Scope	Reactor Vessel Metal	RCP Input	SG Pressure	Barrel Baffle		EPITOME	Estimated Peak Pressure Increase (psi) DEHL	DEPS
Prairie Island 1 & 2(4)	Westinghouse	[ ]		[ ]	[ ]	Downflow	[ ]	0.1	3.45
R.E. Ginna	Westinghouse	[ ]		[ ]	[ ]	Downflow	[ ]	0.1	3.45
Ringhals 3(8)	Westinghouse	[ ]		[ ]	[ ]	Downflow	[ ]	0.0	0.5
Salem 1	Westinghouse	[ ]		[ ]	[ ]	Downflow	[ ]	0.1	3.45
Salem 2	Westinghouse	[ ]		[ ]	[ ]	Downflow	[ ]	0.1	2.8(6)
Seabrook 1	No Scope	[ ]	[ ]sign	[ ]	[ ]	Upflow	[ ]	0.1	3.75
Sequoyah 1 & 2(2)	Westinghouse	[ ]		[ ]	[ ]	Downflow	[ ]	0	2.8
Shearon Harris 1	No Scope					Upflow		0(5)	0(5)
South Texas 1 & 2	No Scope	[ ]		[ ]	[ ]	Upflow	[ ]	0.1	3.75
Surry 1 & 2	No Scope	[ ]		[ ]	[ ]	Downflow	N/A	0.1	0.45
Turkey Point 3&4 (AOR) (4)	Westinghouse	[ ]	[ ]0 point	[ ]	[ ]	Downflow	[ ]	0.1	4.3
Vandellos II(8)	No Scope	[ ]			[ ]	Upflow	[ ]	0	3.45
V.C. Summer	No Scope	[ ]	[ ]sign	[ ]	[ ]	Upflow	[ ]	0.1	3.75
Watts Bar 1(2)	Westinghouse	[ ]		[ ]	[ ]	Upflow	[ ]	0	2.8
Watts Bar 2(2)	Westinghouse					Upflow		0	0(5)
Wolf Creek(3)	No Scope	[ ]		[ ]	[ ]	Upflow	N/A	N/A	N/A
Yonggwang 1 & 2	No Scope	[ ]		[ ]	[ ]	Upflow	[ ]	0.1	3.75

(1) Blowdown peak limited
(2) Ice condenser containment, no blowdown peak
(3) WCAP-8264-P-A, Rev. 1 analysis methodology
(4) Recent EPU analyses are NOT impacted
(5) Current licensed configuration recently reanalyzed for all issues so no penalty applies
(6) Reflects internal evaluation impact
(7) Double-ended cold leg break
(8) Reflects a separate impact from steam generators without any tube fouling

Appendix A: Information to be Used as Input to an Operability Determination

Long-term Containment Peak Pressure Design Basis Analyses

The post-blowdown LOCA M&E releases, when calculated with a more mechanistic LOCA analysis code like WCOBRA-TRAC, are significantly lower than those calculated using the WCAP-10325 methodology. As a result, the calculated post-blowdown containment pressure for the large dry and sub-atmospheric containment designs would be significantly reduced if the more accurate LOCA M&E releases were used.

Additionally, because of the lower energy release rate, the time of ice bed melt out in the ice condenser containment design would be extended. This would result in a potentially lower sump temperature and peak containment pressure, since the residual heat removal system would be able to remove energy from the containment sump over a longer period of time.

Separate from the non-mechanistic assumptions are inherent input, initial condition, and model conservatisms, which are sufficient to offset the impact of the identified errors for all plants. Section 5.1 of WCAP-10325-P-A documents the conservatisms that are inherent in the methodology. These conservatisms include modeling aspects and initial conditions assumptions that result in a peak calculated containment pressure that is a minimum of 6 psi higher than what would be calculated with "more realistic" input values. These inherent conservatisms also apply to the methodology described in WCAP-8264-P-A, Revision 1. If these more realistic input values were applied to the WCAP-10325-P-A or WCAP-8264-P-A, Revision 1 LOCA M&E release calculation methodology, a similar reduction in the calculated peak containment pressure would be observed. The input, initial condition and model assumption conservatisms include:

- Core power and primary side fluid temperatures apply an uncertainty.
- The RCS system volume used in M&E release calculation has an additional 1.4% for uncertainty and 1.6% of the system volume is added for thermal expansion.
- Steam generator parameters are skewed to maximize available energy. These assumptions are based on full power, maximum Tavg (with applied uncertainty), 0% SG tube plugging (assuming no fouling), maximum SG level plus uncertainty with an additional 10% increase in secondary mass.
- Decay heat is maximized and a two sigma uncertainty has been applied to ensure conservatism.
- Core stored energy is maximized by assuming the conditions at the most limiting time in life and maximum core fluid temperatures.
- The moisture carryover fraction correlation used in the reflood transient for a double-ended pump suction (DEPS) break was developed for ECCS type applications for a double-ended cold leg (DECL) break. At the beginning of the reflood phase in an M&E energy release transient for a DEPS break, the initial core temperature is greatly reduced compared to a DECL for a peak clad temperature analysis. This core temperature reduction would greatly reduce the carryover fraction for a DEPS case by as much as 50%. In turn, the releases to the containment would be reduced.

Since the conservatisms in the LOCA M&E release calculation methodology offset the estimated penalties due to the combined effect of the errors, it was determined that a substantial safety hazard does not exist. As discussed above, the WCAP-10325-P-A and WCAP-8264-P-A, Revision 1 methodology contains modeling and initial condition assumption conservatisms that result in a calculated peak pressure that is 6 psi higher than the peak pressure that would be determined from a more realistic analysis. This 6 psi would offset the resulting increase in the contaiment peak pressure (Pa) associated with these issues. Therefore, if a more realistic analysis were performed, Pa would not increase above the current value, and there would be no impact on the 10CFR50, Appendix J, Type A, B, and C tests.

Discussion of Potential Impacts on other Design Basis Analyses and Evaluations that use the LOCA M&E Releases as an Input

Containment Peak Temperature Analyses

The containment peak temperature analyses are performed to confirm that the upper limit of the containment liner design temperature is not exceeded. The containment vapor temperature can be higher than the upper limit of the containment liner design temperature for a short period of time, since the thermal response time of the steel is much slower due to the surface heat transfer rate and conduction.

The containment peak temperature for a large break LOCA is calculated using the containment peak pressure LOCA M&E releases as an input; however, the containment model initial conditions are adjusted to calculate an upper bounding containment temperature response. The containment temperature will increase between 1.0°F and 1.5°F per psi increase in the steam partial pressure. Therefore, the total estimated increase in the containment peak temperature, considering all six LOCA M&E issues, is estimated to be less than 6°F. EQ programs typically include approximately a 15°F peak temperature margin as discussed in IEEE Std 323-2003, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations." Typically, the overall limiting containment temperature is associated with a MSLB during the early portion of the profile (i.e., approximately the first 10 to 20 minutes) and the LOCA transient is limiting for the remainder of the profile (i.e., approximately 30 to 120 days).

As discussed above, if a more realistic analysis were performed, Pa would not increase above the current value due to these issues, and the containment peak temperature would not be impacted. Temperature is a function of pressure; therefore, if pressure does not increase, temperature will not increase.

Containment Equipment Qualification Analyses

Containment equipment qualification (EQ) analyses are performed to confirm that the equipment pressure and temperature test envelopes are not exceeded during the time period for which the equipment is required to perform its safety function. These analyses use the long-term LOCA containment integrity M&E releases as an input.

The six LOCA M&E issues listed above affect the calculated energy release rates during the first hour following a LOCA event. Typically, the margin between the calculated pressure and temperature conditions from those contained in the EQ pressure and temperature profiles is the greatest during the first few hours of the LOCA event. Typically, the limiting short-term containment conditions from an EQ standpoint are associated with a MSLB. Exceeding the EQ pressure and temperature envelopes is typically a concern well beyond the first hour of a LOCA M&E release. Therefore, these six issues should have very little impact on the long-term EQ.

As discussed above, if a more realistic analysis were performed, Pa would not increase above the current value due to these issues, and the containment peak temperature would not be impacted. Temperature is a function of pressure; therefore, if pressure does not increase, temperature will not increase. If the peak pressure and temperature are not impacted, then there would be no impact on long-term pressure and temperature.

Containment Sump Temperature Analyses

Containment sump temperature analyses are performed to confirm the minimum net positive suction head available (NPSHa) for the emergency core cooling system (ECCS) recirculation and containment spray system (CSS) pumps is always greater than the required value (NPSHr). The NPSHa is the sum of the atmospheric pressure and static fluid heads, minus the sum of the head losses and vapor pressure heads. In general, the NPSHa decreases as the pump flow rate and sump temperature increase due to the corresponding increases in head loss and vapor pressure, respectively. However, in accordance with USNRC Regulatory Guide 1.1, the NPSHA is calculated assuming the atmpshperic pressure and vapor pressure are equal. This calculational technique results in a slight increase in NPSHA as sump temperature increases due to reduced friction losses.

The containment sump temperature response is calculated using the containment peak pressure LOCA M&E releases as an input; however, the energy released as steam is minimized in these analyses to maximize the calculated sump temperature. The sump temperature is expected to increase slightly due to the impact of these six issues.

If a more realistic analysis were performed, the overall initial internal energy of the RCS would be lower and the active containment heat removal systems would be more efficient. This would result in a lower mass and energy release to the containment atmosphere and the sump and an increase in the energy removed from the containment. The result would be a lower sump temperature transient.

Ultimate Heat Sink Analyses

Analyses are performed to determine the energy load on the ultimate heat sink. The six LOCA M&E issues listed above can affect the calculated energy release rates during the first hour following a LOCA event. The energy in the containment atmosphere and the containment sump is eventually transferred to the plant's ultimate heat sink. Typically, the loads on the ultimate heat sink are the highest shortly after the transfer to sump recirculation. The increase in the peak calculated temperature for the ultimate heat sink is not expected to be significant; however, the duration of the temperature increase may be longer than currently analyzed.

If a more realistic analysis were performed, the energy transferred to the ultimate heat sink would be reduced as compared to the design basis analysis; therefore, the ultimate heat sink analyses would not be impacted.