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Subject: AP1000 Response to Request for Open Item (SRP 3)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 5. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following proposed Open Item(s):

RAI-TR09-008

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

D. O. Lindgren /FOR

Robert Sisk, Manager
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/Enclosure

1. Response to Request for Additional Information on SRP Section 3

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NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 3

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR09-008
Revision: 5

Question:
In TR-9, starting on p. 4, Westinghouse presents a justification for reducing the design external pressure from 2.9 psid to 0.9 psid, and states that "the extreme conservatism in the above analyses was reduced and an estimate of the external pressure was provided in the response to DSER Open Item 3.8.2.1-1." The staff reviewed the AP1000 SER and could not establish that this reduction has been specifically reviewed and accepted by the staff. The staff also reviewed AP1000 DCD, Rev. 15, and found that the design external pressure is specified to be 2.9 psid on page 3.8-1. Since there is no evidence that the reduction in design external pressure has been reviewed and accepted by the appropriate staff reviewers, and a determination of acceptability cannot be made by staff structural reviewers, Westinghouse must use the design external pressure of record (i.e., 2.9 psid) in demonstrating the adequacy of the containment penetration designs. Therefore, the staff requests the applicant to

- Demonstrate the design adequacy of the containment penetrations for a design external pressure of 2.9 psid.
- Confirm the design adequacy of the steel containment vessel (other than penetrations) for a design external pressure of 2.9 psid.

Revision 2

According to Westinghouse, the "inadvertent actuation of the containment coolers" event controls both the minimum service temperature and the external pressure loading for the steel containment shell. The Containment Performance reviewers must evaluate the hypothetical scenario, and either agree or disagree with Westinghouse's predicted minimum containment shell temperature, and the predicted external pressure loading. The structures and materials reviewers cannot resolve their technical issues until the "inadvertent actuation of the containment coolers" event is resolved. Refer to RAI-SRP 6.2.1.1-SPCV-07. A teleconference took place between W and staff reviewers responsible for structures, materials, and containment performance, in order to clarify for W what the issues are, related to each review area. W has an action to address these issues.

Revision 3

Resolution of RAI-TR09-008 is tied to the resolution of RAI-SRP6.2.1.1-SPCV-07. Explain inconsistencies in DCD Section 3.8.2.6, Table 3.8.3-1, and Tech Spec Bases B 3.6.4.

Revision 5

10 CFR 50, Appendix A, General Design Criterion (GDC) 50, requires that nuclear power plant containment structures be designed with a sufficient margin of safety to accommodate appropriate design loads. Per the guidance in SRP 3.8.2 II.3 (acceptance criteria), the structural staff has reviewed the Revision 4 response to RAI TR09-08, and requires additional clarifications. Please address the following:

a. In Table 1, the results show a trend of higher external pressure as the outside temperature goes up. However, the analysis is limited to ≤ 19 degrees F, for which the external pressure is 0.98 psi. The staff requests the technical basis for limiting the analysis to 19 degrees F for the outside temperature.

b. After reviewing the RAI response and the proposed revision to DCD Table 3.8.2-1, it is not clear what temperature gradient/external pressure combination is used in the Service Level A load combination notated by footnotes 3 and 5. Describe in detail the pressure and temperature condition used in this Service Level A load combination, and the technical basis for concluding it is the worst case. Include this information in DCD 3.8.2 and TR-09. Revise the DCD Table 3.8.2-1 footnotes to reference the DCD 3.8.2 section that describes this loading condition.

c. The staff noted a number of inconsistencies between proposed DCD Table 3.8.2-1 and the latest TR-09 Table 2-4, both of which identify the applicable load combinations for design of the containment structure. Please make these tables consistent, or provide the technical basis for the inconsistencies.

d. The maximum external pressure is no longer listed as 0.9 psi in the proposed revision to DCD Table 3.8.2-1. For consistency, ensure that all references to the 0.9 psi external pressure in both the DCD and TR-09 are appropriately revised.

Westinghouse Response:

For consistency with Figure 6.2.1.1-11, the words 'at one hour' were deleted from the text in section 6.2.1.1.4 of the DCD, Revision 16. This change and all other DCD changes shown below were incorporated in Revision 5 of APP-GW-GLR-134 (Technical Report 134).

The description of the external pressure analysis in DCD subsection 6.2.1.1.4 will be revised as shown below. ~~This analysis concludes that the limiting case containment pressure transient is an inadvertent actuation of active containment cooling during extreme cold ambient conditions.~~

The limiting external pressure and associated thermal transient is considered conservatively as a normal event and is evaluated against ASME Service Level A criteria. It is also conservatively evaluated in combination with the safe shutdown earthquake occurring at the time of minimum pressure against ASME Service Level D criteria.

The external pressure analysis in DCD subsection 6.2.1.1.4 would permit a reduction in the design external pressure for the containment vessel from 2.9 psid to 0.9 psid. Westinghouse does not intend to change the design of the containment vessel and will retain the 2.9 psid as the design external pressure. ~~which is evaluated against ASME design conditions. Westinghouse will also retain the specification requiring evaluation of the combination of the 2.9 psid design external pressure and the safe shutdown earthquake.~~

The containment vessel, including the penetrations, is designed for a design external pressure of 2.9 psid. The design external pressure is the second "design" case in DCD Table 3.8.2-1 and also shown as "Des2" in Table 2-4 of this report~~. The design external pressure plus SSE is considered in the first Service Level D case in DCD Table 3.8.2-1 and also shown as "D1" in Table 2-4 of this report. The lower external pressure of 0.9 psid is only used as part of the "inadvertent actuation of active containment cooling during extreme cold ambient conditions" event (cases A1 and D2 in Table 2-4).~~

Response Revision 3

To determine parameters and loading conditions for the structural evaluation of the containment pressure vessel shell for external pressure loading conditions, postulated accident scenarios are evaluated. These scenarios typically postulated a rapid temperature reduction in the containment atmosphere. These postulated accidents were defined in DCD Subsection 6.2.1.1. DCD Section 6.2 considers containment performance requirements and analyses. The placement of information about the external pressure transients in Subsection 6.2.1.1 has caused confusion in the review of Section 6.2. The resolution of RAI-SRP6.2.1.1-SPCV-07 is dependent on the removal of information on the external pressure analyses from Section 6.2.

Information on the external pressure analyses is added to DCD Subsection 3.8.2, as shown below, to replace information removed from Subsection 6.2.1.1. The service metal temperature in Subsection 3.8.2.6 is corrected. Conforming changes to Note 3 to Table 3.8.2-1 and Technical Specification Bases for B 3.6.4 are also shown below.

No additional changes to TR09 (APP-GW-GLR-005) are included in Revision 3 of this response

Response Revision 4

In Revision 2 of the response to RAI-SRP6.2.1.1-SPCV-07 Westinghouse has proposed revision of Subsection 6.2.1.1.4 to be similar to what was provided in DCD Revision 15 to support the Design Certification. This revised text supports the use of a value of 2.9 psi for a design external pressure. This design external pressure is used in a design pressure load combination that does not include a thermal load. The design external pressure is a bounding pressure determined using a scenario that is nonmechanistic with respect to credible temperature conditions.

To evaluate loading combinations that include external pressure and thermal load a more credible external pressure is used. These loading combinations are used to evaluate Service Level A and Service Level D limits. Additional information on the development of the Service Level load combinations is provided in the DCD in Subsection 3.8.2 as shown below.

Westinghouse completed WGOTHIC runs of inadvertent actuation of the containment fan coolers, inadvertent actuation of the PCS, and Loss of AC (LOAC) transients. The inadvertent fan cooler cases were run at external ambient temperatures of -40°F, -30°F, -10°F, 0°F, and 19°F to determine the differential pressure across the containment shell. The inadvertent PCS cases were run with external temperatures of 33°F, 40°F, 70°F.The LOAC cases were run at -40°F and 19°F.

The analyses combine an initializing case to determine the initial containment atmospheric temperature with the appropriate fault condition transient into a single run.

A humidity of 25% and 10% were analyzed for the -40°F and 0°F inadvertent fan cooler cases. A humidity of 25% was analyzed for the -30°F and -10°F cases. From sensitivity runs made during the development of the calculation it was determined the lower the humidity in containment the higher the containment temperature was allowed to rise prior to transient initiation. This makes sense as the specific heat of water vapor is 0.48 Btu/lbm-°F whereas the specific heat of air is ~ 0.24 Btu/lbm-°F. The higher the containment temperature the greater the calculated external pressure at transient initiation as this will result in the greatest ΔT. From sensitivity runs made at the cold conditions even at 100% and 50% humidity containment equilibrated to 25% and 10% humidity respectively. These values were used to minimize humidity in the various transients analyzed to maximize the calculated magnitude of external pressure. Table 1 depicts the results of the inadvertent fan cooler cases:

Table 1: Results of the Inadvertent Fan Cooler Cases

External Temp. (°F)	Humidity (%)	Min. Service Metal Temp (°F)	Calculated Ext. Pressure (psid)
-40	25	7.18	-0.59
-40	10	7.76	-0.70
-30	25	-0.61	-0.53
External Temp. (°F)	Humidity (%)	Min. Service Metal Temp (°F)	Calculated Ext. Pressure (psid)
-10	25	7.5	-0.54
0	25	17.5	-0.55
0	10	18.1	-0.79
19	10	33.75	-0.98

Table 2 depicts the results of the Loss of AC power cases. Based on the sensitivities to external pressure identified in the inadvertent fan cooler cases the LOAC cases were run at -40°F and 19°F as these were the most limiting cases identified for external pressure and minimum service metal temperature. The cases conservatively used 25% and 10% internal humidity to maximize the magnitude of the calculated external pressure.

Table 2: Results of the LOAC cases

External Temp. (°F)	Humidity (%)	Min. Service Metal Temp (°F)	Calculated Ext. Pressure (psid)
-40	25	4.16	-0.57
19	10	37.71	-0.58

Table 3 depicts the inadvertent PCS cases. The minimum service metal temperatures were not depicted for these cases since the minimum service metal temperature could not be challenged for these transients.

Table 3: Results of the Inadvertent PCS Cases

External Temp. (°F)	Humidity (%)	Min. Service Metal Temp (°F)	Calculated Ext. Pressure (psid)
40	10	N/A	-0.42
33	10	N/A	-0.37
70	10	N/A	-0.44

The scenario described in DCD Rev. 17 Subsection 6.2.1.1.4 to validate the external design pressure was also run to verify that the calculated pressure differential is less than 2.9 psid.

In the DCD revisions shown below the differentiation between the design external pressure and the more credible external pressure used for Service Level A and D load combinations is explained. How this more credible value of external pressure is determined is also explained.

In the revisions for Table 3.8.2-1 shown below, the reference to footnote (4) for the second design load combination is deleted. Footnote (4) identifies the thermal load at 70°F. This load is taken to mean a zero thermal load. Not including a thermal load in this load combination is consistent with the standard practice for vessel design to not include a thermal load for a design load combination. Typically the design load combinations include deadweight, pressure and design mechanical loads. The Standard Review Plan (SRP) for 3.8.2 does not include a design condition load combination that includes external pressure. The inclusion of this second design load combination provides for an evaluation beyond what is recommended by the SRP for 3.8.2.

In the revisions for Table 3.8.2-1 shown below two of the loading combinations are eliminated. For both the Service Level A and Service Level D combinations a case that includes a combination with the design external pressure and the thermal load at 70°F (footnote 4) was previously included. The thermal load at 70°is taken as a zero thermal load. These load combinations are not appropriate for the Service Level A and D load combinations and have been deleted. The load combinations that remain include cases with external pressure and a thermal load for both Service Level A and Service Level D. These cases are consistent with the guidance in Regulatory Guide 1.57 and the SRP for 3.8.2.

The footnote (4) remains for the load combination which includes the tornado load since tornados are not expected during extreme cold temperature conditions.

The footnote (6) for Table 3.8.2-1, which identifies the minimum metal service temperature, is deleted from the table since this information is included in the DCD text and there is no entry in the table that refers to footnote (6).

Response Revision 5

a. The explanation of results found in APP-MV50-Z0C-039 Rev. 0 clearly explains this. The pressure excursions are proportional to the temperature change in containment resulting from the various transients. For conservatism the inadvertent fan cooler transients were performed assuming the fan coolers were off to maximize the internal containment temperature prior to transient initiation. In reality the fan coolers will be running at all times, so an inadvertent actuation is not really a credible event but was analyzed at the staff's request. Additionally, the AP1000 Tech Specs State that if Containment Temperature is greater than 120 F then the plant can't operate. So, the 19 F case represents the case with the maximum containment internal temperature coupled with the minimum outside temperatures which maximizes the heat transfer gradient to the outside which results in the greatest containment internal temperature reduction at transient initiation.

At higher external temperatures the fan coolers would have to be running prior to transient initiation, which would result in a lower containment initial temperature which would result in a smaller pressure excursion magnitude. Remember the fan cooler performances ramp from 40 F to max at 120 F. Starting the transient at a lower containment temperature would result in less heat removal due to the reduced performance of the fan coolers.

b. The external pressure to be analyzed in Service Level A1 is 0.9 psid combined with the thermal gradient based on an outside air temperature of -40°F. When the outside air temperature is -40°F, the metal temperature of the CV exposed to the cold air is -18.5°F. The metal temperature of the CV not exposed to outside air temperature will be 70°F, with a step change taking place at the location of the external stiffener at E.L. 131'-9".

Based upon the results of analyzing several credible initiating events, it was determined that an external pressure of 0.9 psid combined with this thermal gradient provide the highest stress intensities in the CV. Because of this, these will be the pressure and temperature to be analyzed with the ASME Service Limits.

See DCD revision section of the RAI Response for DCD markup.

c. Once this RAI Response is accepted by the NRC, TR-09 will be updated to reflect the proposed DCD Table 3.8.2-1. See Technical Report Revision Section of this RAI Response for changes to TR-09.

d. Once this RAI Response is accepted by the NRC, TR-09 will be updated to reflect the proposed DCD Table 3.8.2-1. See Technical Report Revision Section of this RAI Response for changes to TR-09.

Design Control Document (DCD) Revision: (thru Revision 5)

Note: Due to the complexity of the combined responses' changes, a "changes accepted" version of the markup is also attached.

Revise Subsection 3.8.2.4.1.1 as follows:

3.8.2.4.1.1 Axisymmetric Shell Analyses

The containment vessel is modelled as an axisymmetric shell and analyzed using the ANSYS computer program. A model used for static analyses is shown in Figure 3.8.2-6.

Dynamic analyses of the axisymmetric model, which is similar to that shown in Figure 3.8.2-6, are performed to obtain frequencies and mode shapes. These are used to confirm the adequacy of the containment vessel stick model as described in subsection 3.7.2.3.2. Stress analyses are performed for each of the following loads:

Dead load
Internal pressure
Seismic
Polar crane wheel loads
Wind loads
Thermal loads

The seismic analysis performed envelope all soil conditions. The seismic analysis is discussed in Section 3.7. The torsional moments, which include the effects of the eccentric masses, are increased to account for accidental torsion and are evaluated in a separate calculation.

The results of these load cases are factored and combined in accordance with the load combinations identified in Table 3.8.2-1. These results are used to evaluate the general shell away from local penetrations and attachments, that is, for areas of the shell represented by the axisymmetric geometry. The results for the polar crane wheel loads are also used to establish local shell stiffnesses for inclusion in the containment vessel stick model described in subsection 3.7.2.3. The results of the analyses and evaluations are included in the containment vessel design report.

Design of the containment shell is primarily controlled by the internal pressure of 59 psig. The meridional and circumferential stresses for the internal pressure case are shown in Figure 3.8.2-5. The most highly stressed regions for this load case are the portions of the shell away from the hoop stiffeners and the knuckle region of the top head. In these regions the stress intensity is close to the allowable for the design condition.

Table 3.8.2-1 includes a second design load combination to address external pressure. For the design external pressure load combination a conservatively large magnitude of 2.9 psi differential pressure is used. This design external pressure is validated by assuming that the containment is operating at the maximum temperature, 120°F, with 100% relative humidity, and experiences a step change to the minimum operating temperature, 50°F. The assumptions used to validate the 2.9 psi differential pressure are discussed in Subsection 6.2.1.1.4. These assumptions are nonmechanistic because the outside air temperature conditions to result in an operating temperature of 50°F are inconsistent with an initial containment atmosphere temperature of 120°F. The calculation of the differential pressure using this nonmechanistic approach results in a value of external pressure less than the 2.9 psid design external pressure. The design external pressure provides a bounding value for the design conditions. The load combination for the external pressure design condition includes deadweight, design external pressure, and reaction loads. Thermal loads are not included.

Several events are evaluated for the potential to result in an external pressure load. The credible limiting event for external pressure is the loss of all AC power. ~~A more credible value for external pressure is evaluated by assuming an inadvertent actuation of the active containment cooling during cold weather conditions. The net external pressure for this event is less than 1.0 psid.~~ For this event the external pressure used to evaluate the ASME Service Limits shall be 0.9 psid, combined with an outside air temperature of -40°F. This event conservatively results in a metal temperature of -18.5°F for those portions of the vessel above E.L. 131'-9" and a metal temperature of 70°F below this elevation with a step change at the external stiffener.

Loss of AC power is evaluated using more realistic, mechanistic assumptions than for the design external pressure analysis. The more credible determination of the external pressure for the loss of AC power results in a value smaller than the inadvertent actuation of the active containment cooling and considerably smaller than the design external pressure (2.9 psid).

Inadvertent actuation of the containment fan coolers is the worst case~~limiting event~~ for external pressure at cold conditions; however, this event is not credible due to the fact that the containment fan coolers will be operational and cannot be inadvertently actuated. However, this event was evaluated at several initial outside air temperature conditions to determine the maximum differential pressure. The thermal load associated with this event is due to the thermal gradient in the containment shell from the portion insulated by the external stiffener to the portion exposed to the outside air.

For AP1000, the passive containment cooling system (PCS) provides heat removal from the containment shell to the environment via natural circulation air flow. Since the passive containment cooling system water is relatively warm (minimum of 40°F) compared to the outside air temperature; for extreme cold conditions inadvertent actuation of this system results in a less limiting external pressure and shell temperature.

Inadvertent actuation of the containment spray is not credible since the AP1000 containment spray requires significant local operator action to align the system.

External pressure and thermal loads are used in load combinations to evaluate Service Level A and D stress limits. These external pressure conditions are included in the loading combinations in Table 3.8.2-1. The load combinations that include external pressures and thermal loads are evaluated for several cases of initiating event and external temperature to determine the limiting case of external pressure and external temperature.

Major loads that induce compressive stresses in the containment vessel are internal and external pressure and crane and seismic loads. Each of these loads and the evaluation of the compressive stresses are discussed below.

- Internal pressure causes compressive stresses in the knuckle region of the top head and in the equipment hatch covers. The evaluation methods are similar to those discussed in subsection 3.8.2.4.2 for the ultimate capacity.
- Evaluation of external pressure loads is performed in accordance with ASME Code, Section III, Subsection NE, Paragraph NE-3133.
- Crane wheel loads due to crane dead load, live load, and seismic loads result in local compressive stresses in the vicinity of the crane girder. These are evaluated in accordance with ASME Code, Case N-284.
- Overall seismic loads result in axial compression and tangential shear stresses at the base of the cylindrical portion. These are evaluated in accordance with ASME Code, Case N-284.

The bottom head is embedded in the concrete base at elevation 100 feet. This leads to circumferential compressive stresses at the discontinuity under thermal loading associated with the design basis accident. The containment vessel design includes a Service Level A combination in which the vessel above elevation 107′-2″ is specified at the design temperature of 300°F and the portion of the embedded vessel (and concrete) below elevation 100 feet is specified at a temperature of 70°F. The temperature profile for the vessel is linear between these elevations. Containment shell buckling close to the base is evaluated against the criteria of ASME Code, Case N-284.

Revision 1 of Code Case N-284 is used for the evaluation of the containment shell and equipment hatches.

~~Negative pressure is evaluated by assuming an inadvertent actuation of the active containment cooling. For AP1000, the passive containment cooling system provides heat removal from the containment shell to the environment via natural circulation air flow during normal operation. Since the passive containment cooling system water is relatively warm (minimum of 40°F) compared to the outside air temperature, actuation of this system results in a less limiting external pressure and shell temperature. The net external pressure for this event is approximately 0.9 psid. Inadvertent actuation of the containment fan coolers is the limiting event for external pressure at cold conditions. Inadvertent actuation of the containment spray is not credible since the AP1000 containment spray requires significant local operator action to align the system.~~

~~The bounding external pressure can be calculated by assuming that the containment is operating at the maximum temperature, 120F, with 100% relative humidity, and experiences a step change to the minimum operating temperature, 50F. The calculated pressure change for this transient is -2.9 psid. This value is bounding and is based on a nonmechanistic condition.~~

~~These external pressure conditions are included in the loading combinations in Table 3.8.2-1~~

Revise Table 3.8.2-1 as follows:

Table 3.8.2-1

LOAD COMBINATIONS AND SERVICE LIMITS FOR CONTAINMENT VESSEL

Load Description		**Load Combination and Service Limit**											
		Con	**Test**	**Des.**	**Des.**	**A**	**A**	**A**	**C**	**D**	**C**	**D**	~~**D**~~
Dead	D	x	x	x	x	x	x	x	x	x	x	x	~~x~~
Live	L	x	x	x	x	x	x	x	x	x	x	x	~~x~~
Wind[(6)]	W	x				~~x~~		x					
Safe shutdown earthquake	E_s								x	x		x	~~x~~
Tornado	W_t										x		
Test pressure	P_t		x										
Test temperature	T_t		x										
Operating pressure	P_o							x			x		
Design pressure	P_d			x			x		x			x	
Design External pressure ~~(2.9 psid)~~	P_e				x			~~x~~		~~x~~			
External pressure ~~(0.9 psid)~~[(3)]	P_e					x				x			~~x~~
Normal reaction	R_o				x	x		x		x	x		
Normal thermal[(5)]	T_o				~~(4)~~	~~(5)~~x		(4)		~~(4)~~x	~~x~~(4)		~~(5)~~
Accident thermal reactions	R_a			x			x		x			x	
Accident thermal	T_a			x			x		x			x	
Accident pipe reactions	Y_r											x	
Jet impingement	Y_j											x	
Pipe impact	Y_m											x	

Notes:
1. Service limit levels are per ASME-NE.
2. Where any load reduces the effects of other loads, that load is to be taken as zero, unless it can be demonstrated that the load is always present or occurs simultaneously with the other loads.
3. Reduced External pressure of 0.9 psid at one hour in loss of all ac transient based on evaluation of credible initiating events in cold weather or inadvertent PCS actuation. .
4. Temperature of vessel is 70°F.
5. Temperature distribution for credible initiating event inadvertent actuation of active containment cooling in cold weather or inadvertent PCS actuation. Evaluation of load combination cases including external pressure and thermal combine the coincident external pressure with thermal load for same temperature.
6. The "lowest service metal temperature" corresponding to -40°F outside temperature is -18.5°F.
6. Wind load for the construction load combination is based on a 70 mph wind. Wind load for the Service Level A load combination is analyzed as a reduction in external pressure.

The following paragraphs are added to subsection 3.8.2.4.1.1 in Revision 3 of this response. This DCD revision is superseded by the DCD revision for Revision 4 of the response.

Negative pressure is evaluated by assuming an inadvertent actuation of the active containment cooling. For AP1000, the passive containment cooling system provides heat removal from the containment shell to the environment via natural circulation air flow during normal operation. Since the passive containment cooling system water is relatively warm (minimum of 40°F) compared to the outside air temperature, actuation of this system results in a less limiting external pressure and shell temperature. The net external pressure for this event is approximately -0.9 psid. Inadvertent actuation of the containment fan coolers is the limiting event for external pressure at cold conditions. Inadvertent actuation of the containment spray is not credible since the AP1000 containment spray requires significant local operator action to align the system.

The bounding external pressure can be calculated by assuming that the containment is operating at the maximum temperature, 120F, with 100% relative humidity, and experiences a step change to the minimum operating temperature, 50F. The calculated pressure change for this transient is -2.9 psid. This value is bounding and is based on a nonmechanistic condition.

These external pressure conditions are included in the loading combinations in Table 3.8.2-1

Revise the first paragraph of Subsection 3.8.2.6 as follows: (Response Revision 3)

Materials for the containment vessel, including the equipment hatches, personnel locks, penetrations, attachments, and appurtenances meet the requirements of NE-2000 of the ASME Code. The basic containment material is SA738, Grade B, plate. The procurement specification for the SA738, grade B, plate includes supplemental requirements S1, Vacuum Treatment and S20, Maximum Carbon Equivalent for Weldability. This material has been selected to satisfy the lowest service metal temperature requirement of -15 -18.5°F. This temperature is established by analysis for the portion of the vessel exposed to the environment when the minimum ambient air temperature is -40°F. Impact test requirements are as specified in NE-2000.

Revise Note 3 to Table 3.8.2-1 as follows: (Response Revision 3) This revision is superseded by the revision for Response Revision 4 shown above.

3. Reduced pressure of 0.9 psid at one hour in event of inadvertent actuation of the containment fan coolers ~~loss of all ac transient~~ in cold weather.

The following revisions to Subsection 6.2.1.1.4 and Figure 6.2.1.1-11 were provided in Revision 2 of this response. Please see the response to RAI-SRP6.2.1.1-SPCV-07 Revision 1 and 2 for more recent revisions to this subsection. RAI-SRP6.2.1.1-SPCV-07 Revision 2 modifies Subsection 6.2.1.1.4 to be similar to the description in DCD Revision 15.

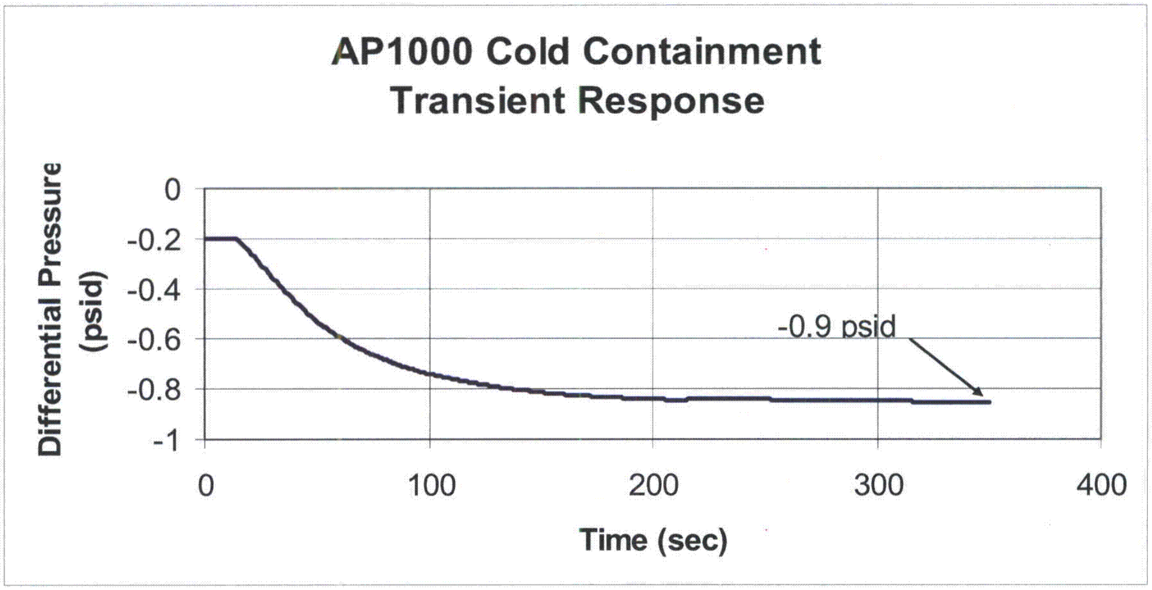
6.2.1.1.4 External Pressure Analysis

Certain design basis events and credible inadvertent systems actuation have the potential to result in containment external pressure loads. Evaluations of these events show that an inadvertent actuation of active containment cooling ~~a loss of all ac power sources~~ during extreme cold ambient conditions has the potential for creating the worst-case external pressure load on the containment vessel. This event leads to a ~~reduction in the internal containment heat loads from the reactor coolant system and other active components, thus resulting in a~~ temperature reduction within the containment and an accompanying pressure reduction. Evaluations are performed to determine the maximum external pressure to which the containment may be subjected during a postulated actuation of the active containment cooling~~loss of all ac power sources~~.

The evaluations are performed with the assumption of a -40°F ambient temperature with a steady 48 mph wind blowing to maximize cooling of the containment vessel. With no active cooling in use ~~T~~the initial internal containment temperature is conservatively calculated ~~assumed~~ to be 69~~120~~°F, creating the largest possible temperature differential to maximize the heat removal rate through the containment vessel wall. A negative 0.2 psig initial containment pressure is used for this evaluation. A conservative maximum initial containment relative humidity of 100 percent is used to produce the greatest reduction in containment pressure due to the loss of steam partial pressure by condensation. It is also conservatively assumed that no air leakage occurs into the containment during the transient.

Negative pressure is evaluated by assuming an inadvertent actuation of the active containment cooling. For AP1000, the passive containment cooling system provides heat removal from the containment shell to the environment via natural circulation air flow during normal operation. Since the passive containment cooling system water is relatively warm (minimum of 40°F) compared to the outside air temperature, actuation of this system results in a less limiting external pressure and shell temperature. Inadvertent actuation of the containment spray is not credible since the AP1000 containment spray requires significant local operator action to alig~~h~~n the system. Inadvertent actuation of the containment fan coolers is the limiting event for external pressure at cold conditions.

Evaluations are performed using WGOTHIC with conservatively low estimates of the containment heat loads and conservatively high heat removal through the containment vessel consistent with the limiting assumptions stated above. Results of these evaluations demonstrate that at one hour after the event the net external pressure is approximately -0.9 psid which is within the capability of the containment vessel. The pressure changes very slowly after the initial decrease and there is within the 2.9 psid design external pressure. This is sufficient time for operator action to prevent the containment pressure from dropping below the -0.9 psid external pressure, based on the PAM's containment pressure indications (four containment pressure instruments) and the ability to mitigate the pressure reduction by opening either set of containment ventilation purge isolation valves, which are powered by the 1E batteries.



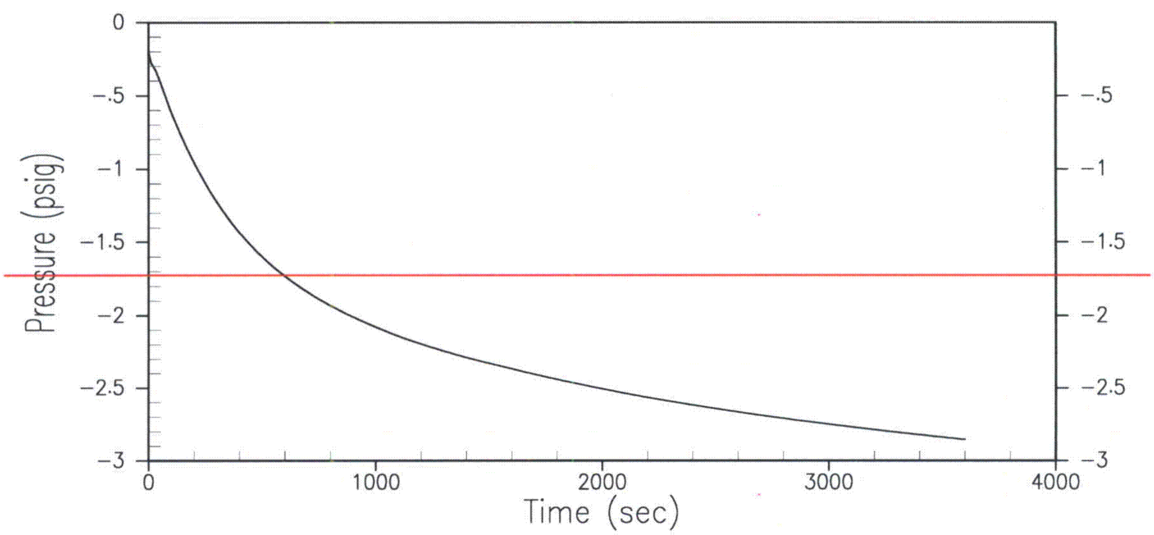


Figure 6.2.1.1-11 AP1000 External Pressure Analysis Containment Pressure vs. Time

The following revision is included as part of the Revision 3 response. Revision 5 of this response negates the following change to the Technical Specification Bases for B 3.6.4.

Revise the third paragraph of APPLICABLE SAFETY ANALYSES in the Technical Specification Bases for B 3.6.4 Containment Pressure as follows:

> The containment was also designed for an external pressure load equivalent to 2.9 psig. The limiting negative pressure transient is ~~a loss of all AC power sources coincident with extreme cold weather conditions which cool the external surface of the containment vessel~~ based on a nonmechanistic step change in containment atmosphere at 120 degrees F, with 100% relative humidity, to the minimum operating temperature of 50 degrees F. The initial pressure condition used in this analysis was -0.2 psig. This resulted in a minimum pressure inside containment, as illustrated in Reference 1, which is less than the design load. Other external pressure load events evaluated include:
>
> Failed fan cooler control
>
> Malfunction of containment purge system

The following revision is included as part of the Revision 5 response.

Revise the Technical Specification for 3.6.5 as follows:

3.6 CONTAINMENT SYSTEMS

3.6.5 Containment Air Temperature

LCO 3.6.5 Containment average air temperature shall be ≥ 70°F and ≤ 120°F.

Containment Fan Coolers (VFS) shall be in operation with 2 of the 4 fan coil (chiller) units in operation.

[- Reviewer's Note -

The low temperature limit is not needed for plant locations for which the lowest possible environmental outside air temperature is approximately 20°F.]

APPLICABILITY: MODES 1, 2, 3, and 4 for the average temperature limits.

MODES 1, 2, 3, and 4 with containment average temperature > 100°F higher than the environmental outside air temperature for the VFS.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Containment average air temperature not within limits.	A.1 Restore containment average air temperature to within limits.	8 hours
B. VFS with ≥ 2 fan coil units not in operation.	B.1 Place VFS in operation with ≥ 2 fan coil units in operation.	8 hours
	OR	
	B.2 Reduce containment average air temperature to ≤ 100°F higher than the environmental outside air temperature.	8 hours
B C. Required Action and associated Completion Time not	BC.1 Be in MODE 3.	6 hours

met.	AND	
	~~B~~C.2 Be in MODE 5.	36 hours

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.6.5.1	Verify containment average air temperature is within limits.	24 hours
SR 3.6.5.2	--- **- NOTE -** Not required to be performed when the containment average air temperature is ≤ 100°F higher than the environmental outside air temperature ---	
	Verify VFS operation with 2 of the 4 fan coil units in operation.	24 hours

B 3.6 CONTAINMENT SYSTEMS
B 3.6.4 Containment Pressure

BASES

BACKGROUND

The containment pressure is limited during normal operation to preserve the initial conditions assumed in the accident analyses for a loss of coolant accident (LOCA) or steam line break (SLB). These limits also prevent the containment pressure from exceeding the containment design negative pressure differential with respect to the outside atmosphere in the event of transients which result in a negative pressure.

Containment pressure is a process variable that is monitored and controlled. The containment pressure limits are derived from the operating band of conditions used in the containment pressure analyses for the Design Basis Events which result in internal or external pressure loads on the containment vessel. Should operation occur outside these limits, the initial containment pressure would be outside the range used for containment pressure analyses.

APPLICABLE SAFETY ANALYSES

Containment internal pressure is an initial condition used in the DBA analyses to establish the maximum peak containment internal pressure. The limiting DBAs considered, relative to containment pressure, are the LOCA and SLB, which are analyzed using computer pressure transients (Ref. 1).

The initial pressure condition used in the containment analysis was 15.7 psia (1.0 psig). This resulted in a maximum peak pressure from a LOCA, P_a, of 57.8 psig. The containment analysis (Ref. 1) shows that the maximum peak calculated containment pressure results from the SLB. The maximum containment pressure resulting from the SLB, 57.3 psig, does not exceed the containment design pressure, 59 psig.

The containment was also designed for an external pressure load equivalent to 2.9 psig. The limiting negative pressure transient is a loss of all AC power sources coincident with extreme cold weather conditions which cool the external surface of the containment vessel. The initial pressure condition used in this analysis was -0.2 psig. This resulted in a minimum pressure inside containment, as illustrated in Reference 1, which is less than the design load. Other external pressure load events evaluated include:

Failed Containment Fan Cooler (VFS) ~~fan cooler~~ control

Malfunction of containment purge system

BASES

APPLICABLE SAFETY ANALYSES (continued)

Inadvertent Incontainment Refueling Water Storage Tank (IRWST) drain
Inadvertent Passive Containment Cooling System (PCS) actuation

Since the containment external pressure design limits can be met by ensuring compliance with the initial pressure condition, NUREG-1431 LCO 3.6.12, Vacuum Relief System is not applicable to the AP1000 containment.

Containment pressure satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

BASES

LCO	Maintaining containment pressure at less than or equal to the LCO upper pressure limit ensures that, in the event of a DBA, the resultant peak containment accident pressure will remain below the containment design pressure. Maintaining containment pressure at greater than or equal to the LCO lower pressure limit ensures that the containment will not exceed the design negative differential pressure following negative pressure transients.
APPLICABILITY	In MODES 1, 2, 3, and 4, a DBA could cause a release of radioactive material to containment. Since maintaining containment pressure within limits is essential to ensure initial conditions assumed in the accident analyses are maintained, the LCO is applicable in MODES 1, 2, 3, and 4. In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Therefore, maintaining containment pressure within the limits of the LCO is not required in MODE 5 or 6.
ACTIONS	<u>A.1</u> When containment pressure is not within the limits of the LCO, it must be restored within 1 hour. The Required Action is necessary to return operation to within the bounds of the containment analysis. The 1 hour Completion Time is consistent with the ACTIONS of LCO 3.6.1, "Containment," which requires that containment be restored to OPERABLE status within 1 hour.

BASES

ACTIONS (continued)	B.1 and B.2 If containment pressure cannot be restored to within limits within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.
SURVEILLANCE REQUIREMENTS	SR 3.6.4.1 Verifying that containment pressure is within limits ensures that unit operation remains within the limits assumed in the containment analysis. The 12 hour Frequency of this SR was developed based on operating experience related to trending of both containment pressure variations during the applicable MODES. Furthermore, the 12 hour Frequency is considered adequate in view of other indications available in the main control room, including alarms, to alert the operator to an abnormal containment pressure condition.
REFERENCES	1. Section 6.2, "Containment Analysis."

B 3.6 CONTAINMENT SYSTEMS
B 3.6.5 Containment Air Temperature

BASES

BACKGROUND

The containment structure serves to contain radioactive material that may be released from the reactor core following a Design Basis Accident (DBA). The containment average air temperature is limited during normal operation to preserve the initial conditions assumed in the accident analyses for a loss of coolant accident (LOCA) or steam line break (SLB).

The containment average air high temperature limit is derived from the input conditions used in the containment functional analyses and the containment structure external pressure analyses. This LCO ensures that initial conditions assumed in the analysis of containment response to a DBA are not violated during plant operations. The total amount of energy to be removed from containment by the passive containment cooling system during post accident conditions is dependent upon the energy released to the containment due to the event, as well as the initial containment temperature and pressure. The higher the initial temperature, the more energy that must be removed, resulting in higher peak containment pressure and temperature. Exceeding containment design pressure may result in leakage greater than that assumed in the accident analysis.

Operation with containment temperature in excess of the LCO upper limit violates an initial condition assumed in the accident analysis.

Operation of the Containment Fan Coolers (VFS) when the containment average air temperature is > 100°F higher than the environmental outside air temperature precludes the possibility of inadvertent VFS actuation and containment depressurization to below the minimum pressure limit.

Operation of the VFS with the containment average air temperature < 70°F is not consistent with the normal operating containment average air temperature objective.

When the containment average air temperature is > 100°F higher than the environmental outside air temperature (e.g.,< -30°F), the containment average air temperature must be controlled to ≥ 70°F to permit operation of the VFS and thus preclude containment depressurization to below the minimum pressure limit due to inadvertent VFS actuation.

APPLICABLE SAFETY ANALYSES

Containment average air temperature is an initial condition used in the DBA analyses that establishes the containment environmental qualification operating envelope for both pressure and temperature. The upper limit for containment average air temperature ensures that operation is maintained within the assumptions used in the DBA analyses for containment (Ref. 1).

The limiting DBAs considered relative to containment OPERABILITY are the LOCA and SLB. The DBA LOCA and SLB are analyzed using computer codes designed to predict the resultant containment pressure transients. No two DBAs are assumed to occur simultaneously or consecutively. The postulated DBAs are analyzed with regard to containment Engineered Safety Feature (ESF) systems, assuming the loss of one Class 1E Engineered Safety Features Actuation Cabinet (ESFAC) Division, which is the worst case single active failure, resulting in one Passive Containment Cooling System flow path being rendered inoperable.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The limiting DBA for the maximum peak containment air temperature is a LOCA or SLB. The initial containment average air temperature assumed in the design basis analyses (Ref. 1) is 120°F.

The DBA temperature transients are used to establish the environmental qualification operating envelope for containment. The basis of the containment environmental qualification temperature envelope is to ensure the performance of safety related equipment inside containment (Ref. 2). The containment vessel design temperature is 300°F. The containment vessel temperature remains below 300°F for DBAs. Therefore, it is concluded that the calculated transient containment air temperature is acceptable for the DBAs.

The high temperature limit is also used in the depressurization analyses to ensure that the minimum pressure limit is maintained following an inadvertent actuation of the Passive Containment Cooling System (Ref. 1).

The containment pressure transient is sensitive to the initial air mass in containment and, therefore, to the initial containment air temperature. The limiting DBA for establishing the maximum peak containment internal pressure is an SLB or LOCA. The high temperature limit is used in the DBA analyses to ensure that in the event of an accident the maximum containment internal pressure will not be exceeded.

Operation of the VFS when the containment average air temperature is ≥ 100°F higher than the environmental outside air temperature precludes the possibility of inadvertent VFS actuation and containment depressurization to below the minimum pressure limit. With containment average air temperature below 100°F higher than the environmental outside air temperature, inadvertent actuation of the VFS will not depressurize containment to below the minimum pressure limit.

Maintaining the containment average air temperature ≥ 70°F permits operation of the VFS with 2 of the 4 fan coil units in operation. With the VFS in operation, inadvertent VFS actuation is not possible, precluding depressurization of containment to below the minimum pressure limit.

Containment average air temperature satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

During a DBA, with an initial containment average air temperature less than or equal to the LCO high temperature limit, the resultant peak accident temperature is computed to remain within acceptable limits. As a result, the ability of containment to perform its design function is ensured.

APPLICABILITY

In MODES 1, 2, 3, and 4, a DBA could cause a release of radioactive material to containment. In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Therefore, maintaining containment average air temperature within the limits is not required in MODE 5 or 6.

In MODES 1, 2, 3, and 4, when the containment average air temperature is ≥ 100°F higher than the environmental outside air temperature, inadvertent actuation of the VFS could reduce containment pressure below the design limit. Maintaining the VFS in operation precludes containment depressurization. Since maintaining containment pressure within limits is essential to ensure initial conditions assumed in the accident analyses are maintained, the LCO is applicable in MODES 1, 2, 3, and 4 when the

containment average air temperature is > 100°F higher than the environmental outside air temperature.
In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Therefore, maintaining the VFS in operation is not required in MODE 5 or 6.

BASES

ACTIONS

A.1
When containment average air temperature is not within the limits of the LCO, it must be restored to within its limits within 8 hours. This Required Action is necessary to return operation to within the bounds of the containment analysis. The 8 hour Completion Time is acceptable considering the sensitivity of the conservative analysis to variations in this parameter, and provides sufficient time to correct minor problems.

B.1 and B.2
With VFS not in operation and containment average air temperature > 100°F higher than the environmental outside air temperature, action is required to place the VFS in operation with 2 of the 4 fan coil units in operation or to reduce containment average air temperature to ≤ 100°F higher than the environmental outside air temperature within 8 hours.
Operation of the VFS and/ or reduction of the containment average air temperature must be performed in a controlled manner to maintain containment pressure within the limits of LCO 3.6.4. This Required Action is necessary to return operation to within the bounds of the containment analysis. The 8 hour Completion Time is acceptable considering the sensitivity of the conservative analysis to variations in this parameter, and provides sufficient time to correct minor problems.

~~B~~C.1 and ~~B~~C.2
If the containment average air temperature cannot be restored to within its limits or the VFS placed in operation with 2 of the 4 fan coil units in operation within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.6.5.1
Verifying that the containment average air temperature is within the LCO limits ensures that containment operation remains within the limits assumed for the containment analyses. In order to determine the containment average air temperature, a weighted average is calculated using measurements taken at locations within the containment selected to provide a representative sample of the associated containment atmosphere. The 24 hour Frequency of this Surveillance Requirement is considered acceptable based on observed slow rates of temperature increase within containment as a result of environmental heat sources (due to the large volume of containment). Furthermore, the 24 hour Frequency is considered adequate in view of other indications available in the main control room, including alarms, to alert the operator to an abnormal containment temperature condition.

SR 3.6.5.2
Verifying that the VFS is in operation with 2 of the 4 fan coil units in operation ensures that unit operation remains within the limits assumed in the containment analysis.

BASES	
	Consistent with the VFS Applicability, the Note specifies that this surveillance is not required to be performed when the containment average air temperature is ≤ 100°F higher than the environmental outside air temperature. The 24 hour Frequency is based on the availability of alarms and indications in the main control room providing containment average air temperature, environmental outside air temperature and the status of the VFS.
REFERENCES	1. Section 6.2, "Containment Systems." 2. 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."

NOTE: See the 'accept changes' version of the DCD and TR after the TR Revision changes below.

PRA Revision:
None

Technical Report (TR) Revision:

The technical report revisions shown below were included in Revision 2 of the response. Revision 3 ~~and 4~~ of the response does not include additional technical report revisions. Revision 4 and 5 do include additional technical report revisions.

Revise section 2.4 as shown below.

2.4.1 External pressure and thermal loads

Design conditions for the containment vessel are specified as:

- Design Pressure — 59 PSIG at design temperature of 280°F
- Design External Pressure — 2.9 PSIG at design temperature of 70°F
- External Pressure — 0.9 PSID at cold weather conditions

Both the maximum external pressure and the temperature conditions are affected by the ambient temperature. Combinations of normal temperature and external pressure are evaluated as service conditions as follows:

Service Level A

- ~~Dead load, uniform temperature of 70F, design external pressure of 2.9 psid~~

- Dead load, cold weather temperature distribution one hour after inadvertent actuation of active containment coolingfor credible initiating event in cold weather, reduced pressure of 0.9 psid one hour after inadvertent actuation of active containment cooling in cold weatherbased on evaluation of credible initiating events in cold weather. This conservatively includes the low probability inadvertent actuation of active containment cooling in cold weather event as a normal operating condition.

Service Level D

- Dead load, uniform temperature of 70F, SSE, design external pressure of 2.9 psid
- Dead load, cold weather temperature distribution one hour after inadvertent actuation of active containment coolingfor credible initiating event in cold weather, SSE, reduced pressure of 0.9 psid one hour after inadvertent actuation of active containment cooling in cold weatherbased on evaluation of credible initiating events in cold weather.

Two temperature conditions are considered corresponding to plant operation during cold weather with the outside air temperature at the minimum value of -40F and during hot weather with the outside air temperature at 115F. The cold weather operation results in a significant temperature differential in the vicinity of the horizontal stiffener at elevation 131' 9". The vessel above the stiffener is exposed to the outside air in the upper annulus. This cold weather condition is assumed concurrent with the pressure reduction resulting from inadvertent actuation of active containment cooling a credible initiating event and is conservatively assumed as a normal operating condition. It is evaluated during normal operation as a Service level A event. It is also evaluated under Service level D in combination with the Safe Shutdown Earthquake.

differential to maximize the heat removal rate through the containment vessel wall. A negative 0.2 psig initial containment pressure is used for this evaluation. A conservative maximum initial containment relative humidity of 100 percent is used to produce the greatest reduction in containment pressure due to the loss of steam partial pressure by condensation. It is also conservatively assumed that no air leakage occurs The design external pressure of 02.9 psid is based on credible conservative analyses as described in DCD subsection 6.2.1.1.43.8.2.4.1.1. (see Section 5.2 of this Technical Report). The evaluations are performed with the assumption of a -40°F ambient temperature with a steady 48 mph wind blowing to maximize cooling of the containment vessel. The initial internal containment temperature is conservatively assumed to be 120°F, creating the largest possible temperature into the containment during the transient. Results of these evaluations demonstrate that at one hour after the event the net external pressure is within the 2.9 psid design external pressure.

The extreme conservatism in the above analyses was reduced and an estimate of the external pressure was provided in the response to DSER Open Item 3.8.2.1-1.

With the postulated low outside temperatures, it is physically very unlikely, if not impossible (due to air cooling on the surface of the containment vessel) that the initial containment temperature will ever be 120 degrees F. A WGOTHIC calculation was performed to determine the containment pressure response with the containment initial temperature at as high a value as possible, and with the environment temperature as low as possible. An analysis was performed that determined that the highest containment atmosphere temperature that could occur would be 75F while the reactor is operating and the environment temperature is -40F.

To determine the reduced pressure, the following assumptions were made:

1.Initial containment conditions from steady-state analysis; 75F, 100% relative humidity
2. Internal heat sinks inside containment are assumed to be 75F.
3Fan coolers remove operating reactor heat so that no net heat load to containment is assumed.
4. Environment temperature assumed to be -40F.
5. Heat transfer coefficients to heat sinks and containment shell are nominal.

Without an internal heat load, the containment atmosphere will cool and the pressure will decrease. The pressure falls from 14.5 psia to 13.6 psia (0.9 psid) at 3600 seconds after the heat input to the containment atmosphere is terminated. This is sufficient time for operator action to prevent further pressure reduction, as discussed in AP1000 DCD Section 6.2.1.1.4. Thus the design value of 2.9 psid external pressure is very conservative.

Note that the 0.9 psid considered in this second case is also conservative since it assumes no net heat load into the containment. Immediately after reactor trip the reactor coolant loop stays hot and heat loads to the containment remain close to those during normal operation. The fan coolers cannot operate with the assumption of loss of all AC; nor would they be expected to be providing cooling when the exterior temperatures are so low.

Table 2-4 – Load Combinations for the Large Penetrations

Load			Design		Level A Service Limit			Level C Service Limit		Level D Service Limit		
	Con	Test	Des1	Des2	A1	A2	A3	C1	C2	D1	~~D2~~	~~D3~~D2
D	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	~~1.0~~	1.0
E_s								1.0		1.0	~~1.0~~	1.0
P_t		1.0										
T_t		1.0										
P_o							1.0		1.0			
P_i			1.0			1.0		1.0				1.0
P_e (2.9psid)				1.0			~~1.0~~			~~1.0~~		
P_e (0.9psid)					1.0					1.0	~~1.0~~	
T_o (5)				~~(4)~~	~~(5)~~1.0		(4)		(4)	~~(4)~~1.0	~~(5)~~	
T_a			1.0			1.0		1.0				1.0

Notes:

1. Service limit levels are per ASME-NE.
2. Where any load reduces the effects of other loads, that load is to be taken as zero, unless it can be demonstrated that the load is always present or occurs simultaneously with the other loads.
3. ~~Reduced~~ External pressure based on credible initiating events~~of 0.9 psid at one hour in inadvertent actuation of active containment cooling loss of all AC transient~~ in cold weather.
4. Temperature of vessel is 70F.
5. Temperature distribution for ~~inadvertent actuation of active containment coolingloss of all AC~~credible initiating event in cold weather. Evaluation of load combination cases including external pressure and thermal combine the coincident external pressure with thermal load for the same temperature.
~~The 'Lowest Service Metal Temperature' corresponding to -40 degree F outside temperature is 18.5 °F.~~

Revise section 5.1 as shown below.

5.1 DCD Changes from Rev 15 to Rev 16

The DCD changes from Rev 15 to Rev 16 were shown in Rev 0 and Rev 1 of this report. DCD Rev 16 has been issued so these changes have been deleted from this section of the Technical Report.

Revise section 5.2 as shown below.

5.2 DCD Changes to Rev 16

The following revisions are to DCD Rev 16.

Revise classification in Table 3.2-3 as shown below from MC to Class 2 for penetrations where the process pipe penetrates directly the containment vessel without the use of a flued head (see typical detail on lower half of Figure 3.8.2-4, sheet 4 of 6). In this case the sleeve is a boundary of the process fluid and is required by the ASME Code to be Class 2.

Revise sheets 2, 3, 4 and 6 of Figure 3.8.2-4 as shown on the following pages to reflect detail design of the penetration reinforcement.

Add text and figure showing changes to subsection 6.2.1.1.4, "External Pressure Analysis" as shown in the DCD Revisions in this RAI response (pages 2 and 3 in this RAI response).The DCD changes from Rev 16 to Rev 17 were shown in Rev 1 of this report. DCD Rev 17 has been issued so these changes have been deleted from this section of the Technical Report.

5.2 DCD Changes to Rev 17

The following revisions are to DCD Rev 17

None.

The 'accept changes' version of the DCD and TR markups is shown below:

The following are DCD changes as a result of the response to RAI-TR09-008, R5. The DCD changes include sections 3.8.2.4.1.1 and Tech Spec 3.6.5.

3.8.2.4.1.1 Axisymmetric Shell Analyses

The containment vessel is modeled as an axisymmetric shell and analyzed using the ANSYS computer program. A model used for static analyses is shown in Figure 3.8.2-6.

Dynamic analyses of the axisymmetric model, which is similar to that shown in Figure 3.8.2-6, are performed to obtain frequencies and mode shapes. These are used to confirm the adequacy of the containment vessel stick model as described in subsection 3.7.2.3.2. Stress analyses are performed for each of the following loads:

Dead load
Internal pressure
Seismic
Polar crane wheel loads
Wind loads
Thermal loads

The seismic analysis performed envelope all soil conditions. The seismic analysis is discussed in Section 3.7. The torsional moments, which include the effects of the eccentric masses, are increased to account for accidental torsion and are evaluated in a separate calculation.

The results of these load cases are factored and combined in accordance with the load combinations identified in Table 3.8.2-1. These results are used to evaluate the general shell away from local penetrations and attachments, that is, for areas of the shell represented by the axisymmetric geometry. The results for the polar crane wheel loads are also used to establish local shell stiffnesses for inclusion in the containment vessel stick model described in subsection 3.7.2.3. The results of the analyses and evaluations are included in the containment vessel design report.

Design of the containment shell is primarily controlled by the internal pressure of 59 psig. The meridional and circumferential stresses for the internal pressure case are shown in Figure 3.8.2-5. The most highly stressed regions for this load case are the portions of the shell away from the hoop stiffeners and the knuckle region of the top head. In these regions the stress intensity is close to the allowable for the design condition.

Table 3.8.2-1 includes a second design load combination to address external pressure. For the design external pressure load combination a conservatively large magnitude of 2.9 psi differential pressure is used. This design external pressure is validated by assuming that the containment is operating at the maximum temperature, 120°F, with 100% relative humidity, and experiences a step change to the minimum operating temperature, 50°F. The assumptions used to validate the 2.9 psi differential pressure are discussed in Subsection 6.2.1.1.4. These assumptions are nonmechanistic because the outside air temperature conditions to result in an operating temperature of 50°F are inconsistent with an initial containment atmosphere temperature of 120°F. The calculation of the differential pressure using this nonmechanistic approach results in a value of external pressure less than the 2.9 psid design external pressure. The design external pressure provides a bounding value for the design conditions. The load combination for the external pressure design condition includes deadweight, design external pressure, and reaction loads. Thermal loads are not included.

Several events are evaluated for the potential to result in an external pressure load. The credible limiting event for external pressure is the loss of all AC power. For this event the external pressure used to evaluate the ASME Service Limits shall be 0.9 psid, combined with an outside air temperature of -40°F. This event conservatively results in a metal temperature of -18.5°F for those portions of the vessel above E.L. 131'-9" and a metal temperature of 70°F below this elevation with a step change at the external stiffener.

Loss of AC power is evaluated using more realistic, mechanistic assumptions than for the design external pressure analysis. The more credible determination of the external pressure for the loss of AC power results in a value smaller than the inadvertent actuation of the active containment cooling and considerably smaller than the design external pressure (2.9 psid).

Inadvertent actuation of the containment fan coolers is the worst case for external pressure at cold conditions; however, this event is not credible due to the fact that the containment fan coolers will be operational and cannot be inadvertently actuated. However, this event was evaluated at several initial outside air temperature conditions to determine the maximum differential pressure. The thermal load associated with this event is due to the thermal gradient in the containment shell from the portion insulated by the external stiffener to the portion exposed to the outside air.

For AP1000, the passive containment cooling system (PCS) provides heat removal from the containment shell to the environment via natural circulation air flow. Since the passive containment cooling system water is relatively warm (minimum of 40°F) compared to the outside air temperature; for extreme cold conditions inadvertent actuation of this system results in a less limiting external pressure and shell temperature.

Inadvertent actuation of the containment spray is not credible since the AP1000 containment spray requires significant local operator action to align the system.

External pressure and thermal loads are used in load combinations to evaluate Service Level A and D stress limits. These external pressure conditions are included in the loading combinations in Table 3.8.2-1. The load combinations that include external pressures and thermal loads are evaluated for several cases of initiating event and external temperature to determine the limiting case of external pressure and external temperature.

Major loads that induce compressive stresses in the containment vessel are internal and external pressure and crane and seismic loads. Each of these loads and the evaluation of the compressive stresses are discussed below.

- Internal pressure causes compressive stresses in the knuckle region of the top head and in the equipment hatch covers. The evaluation methods are similar to those discussed in subsection 3.8.2.4.2 for the ultimate capacity.

- Evaluation of external pressure loads is performed in accordance with ASME Code, Section III, Subsection NE, Paragraph NE-3133.

- Crane wheel loads due to crane dead load, live load, and seismic loads result in local compressive stresses in the vicinity of the crane girder. These are evaluated in accordance with ASME Code, Case N-284.

- Overall seismic loads result in axial compression and tangential shear stresses at the base of the cylindrical portion. These are evaluated in accordance with ASME Code, Case N-284.

The bottom head is embedded in the concrete base at elevation 100 feet. This leads to circumferential compressive stresses at the discontinuity under thermal loading associated with the design basis accident. The containment vessel design includes a Service Level A combination in which the vessel above elevation 107′-2″ is specified at the design temperature of 300°F and the portion of the embedded vessel (and concrete) below elevation 100 feet is specified at a temperature of 70°F. The temperature profile for the vessel is linear between these elevations. Containment shell buckling close to the base is evaluated against the criteria of ASME Code, Case N-284.

Revision 1 of Code Case N-284 is used for the evaluation of the containment shell and equipment hatches.

Revise Table 3.8.2-1 as follows:

Table 3.8.2-1

LOAD COMBINATIONS AND SERVICE LIMITS FOR CONTAINMENT VESSEL

Load Description		**Load Combination and Service Limit**											
		Con	**Test**	**Des.**	**Des.**	**A**	**A**	**A**	**C**	**D**	**C**	**D**	
Dead	D	x	x	x	x	x	x	x	x	x	x	x	
Live	L	x	x	x	x	x	x	x	x	x	x	x	
Wind[6]	W	x						x					
Safe shutdown earthquake	E_S								x	x		x	
Tornado	W_t										x		
Test pressure	P_t		x										
Test temperature	T_t		x										
Operating pressure	P_o							x			x		
Design pressure	P_d			x			x		x			x	
Design External pressure	P_e				x								
External pressure [3]	P_e					x				x			
Normal reaction	R_o				x	x		x		x	x		
Normal thermal[5]	T_o					x		(4)		x	(4)		
Accident thermal reactions	R_a			x			x		x			x	
Accident thermal	T_a			x			x		x			x	
Accident pipe reactions	Y_r											x	
Jet impingement	Y_j											x	
Pipe impact	Y_m											x	

Notes:

1. Service limit levels are per ASME-NE.
2. Where any load reduces the effects of other loads, that load is to be taken as zero, unless it can be demonstrated that the load is always present or occurs simultaneously with the other loads.
3. External pressure based on evaluation of credible initiating events in cold weather.
4. Temperature of vessel is 70°F.
5. Temperature distribution for credible initiating event in cold weather. Evaluation of load combination cases including external pressure and thermal combine the coincident external pressure with thermal load for same temperature.
6. Wind load for the construction load combination is based on a 70 mph wind. Wind load for the Service Level A load combination is analyzed as a reduction in external pressure.

Technical Specification Revisions:

The following are changes to Technical Specification 3.6.5

3.6 CONTAINMENT SYSTEMS

3.6.5 Containment Air Temperature

LCO 3.6.5 Containment average air temperature shall be ≥ 70°F and ≤ 120°F.

Containment Fan Coolers (VFS) shall be in operation with 2 of the 4 fan coil (chiller) units in operation.

[- Reviewer's Note -

The low temperature limit is not needed for plant locations for which the lowest possible environmental outside air temperature is approximately 20°F.]

APPLICABILITY: MODES 1, 2, 3, and 4 for the average temperature limits.

MODES 1, 2, 3, and 4 with containment average temperature > 100°F higher than the environmental outside air temperature for the VFS.

ACTIONS

CONDITION		REQUIRED ACTION		COMPLETION TIME
A.	Containment average air temperature not within limits.	A.1	Restore containment average air temperature to within limits.	8 hours
B.	VFS with ≥ 2 fan coil units not in operation.	B.1	Place VFS in operation with ≥ 2 fan coil units in operation.	8 hours
		<u>OR</u>		
		B.2	Reduce containment average air temperature to ≤ 100°F higher than the environmental outside air	8 hours

		temperature.	
C. Required Action and associated Completion Time not met.	C.1	Be in MODE 3.	6 hours
	AND		
	C.2	Be in MODE 5.	36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.5.1	Verify containment average air temperature is within limits.	24 hours
SR 3.6.5.2	-- **- NOTE -** Not required to be performed when the containment average air temperature is ≤ 100°F higher than the environmental outside air temperature --	
	Verify VFS operation with 2 of the 4 fan coil units in operation.	24 hours

B 3.6 CONTAINMENT SYSTEMS
B 3.6.4 Containment Pressure

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BACKGROUND	The containment pressure is limited during normal operation to preserve the initial conditions assumed in the accident analyses for a loss of coolant accident (LOCA) or steam line break (SLB). These limits also prevent the containment pressure from exceeding the containment design negative pressure differential with respect to the outside atmosphere in the event of transients which result in a negative pressure. Containment pressure is a process variable that is monitored and controlled. The containment pressure limits are derived from the operating band of conditions used in the containment pressure analyses for the Design Basis Events which result in internal or external pressure loads on the containment vessel. Should operation occur outside these limits, the initial containment pressure would be outside the range used for containment pressure analyses.
APPLICABLE SAFETY ANALYSES	Containment internal pressure is an initial condition used in the DBA analyses to establish the maximum peak containment internal pressure. The limiting DBAs considered, relative to containment pressure, are the LOCA and SLB, which are analyzed using computer pressure transients (Ref. 1). The initial pressure condition used in the containment analysis was 15.7 psia (1.0 psig). This resulted in a maximum peak pressure from a LOCA, P_a, of 57.8 psig. The containment analysis (Ref. 1) shows that the maximum peak calculated containment pressure results from the SLB. The maximum containment pressure resulting from the SLB, 57.3 psig, does not exceed the containment design pressure, 59 psig. The containment was also designed for an external pressure load equivalent to 2.9 psig. The limiting negative pressure transient is a loss of all AC power sources coincident with extreme cold weather conditions which cool the external surface of the containment vessel. The initial pressure condition used in this analysis was -0.2 psig. This resulted in a minimum pressure inside containment, as illustrated in Reference 1, which is less than the design load. Other external pressure load events evaluated include: Failed Containment Fan Cooler (VFS) control Malfunction of containment purge system

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APPLICABLE SAFETY ANALYSES (continued)

Inadvertent Incontainment Refueling Water Storage Tank (IRWST) drain

Inadvertent Passive Containment Cooling System (PCS) actuation

Since the containment external pressure design limits can be met by ensuring compliance with the initial pressure condition, NUREG-1431 LCO 3.6.12, Vacuum Relief System is not applicable to the AP1000 containment.

Containment pressure satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

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LCO	Maintaining containment pressure at less than or equal to the LCO upper pressure limit ensures that, in the event of a DBA, the resultant peak containment accident pressure will remain below the containment design pressure. Maintaining containment pressure at greater than or equal to the LCO lower pressure limit ensures that the containment will not exceed the design negative differential pressure following negative pressure transients.
APPLICABILITY	In MODES 1, 2, 3, and 4, a DBA could cause a release of radioactive material to containment. Since maintaining containment pressure within limits is essential to ensure initial conditions assumed in the accident analyses are maintained, the LCO is applicable in MODES 1, 2, 3, and 4. In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Therefore, maintaining containment pressure within the limits of the LCO is not required in MODE 5 or 6.
ACTIONS	A.1 When containment pressure is not within the limits of the LCO, it must be restored within 1 hour. The Required Action is necessary to return operation to within the bounds of the containment analysis. The 1 hour Completion Time is consistent with the ACTIONS of LCO 3.6.1, “Containment,” which requires that containment be restored to OPERABLE status within 1 hour.

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ACTIONS (continued)	B.1 and B.2 If containment pressure cannot be restored to within limits within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.
SURVEILLANCE REQUIREMENTS	SR 3.6.4.1 Verifying that containment pressure is within limits ensures that unit operation remains within the limits assumed in the containment analysis. The 12 hour Frequency of this SR was developed based on operating experience related to trending of both containment pressure variations during the applicable MODES. Furthermore, the 12 hour Frequency is considered adequate in view of other indications available in the main control room, including alarms, to alert the operator to an abnormal containment pressure condition.
REFERENCES	1. Section 6.2, "Containment Analysis."

B 3.6 CONTAINMENT SYSTEMS
B 3.6.5 Containment Air Temperature

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BACKGROUND	The containment structure serves to contain radioactive material that may be released from the reactor core following a Design Basis Accident (DBA). The containment average air temperature is limited during normal operation to preserve the initial conditions assumed in the accident analyses for a loss of coolant accident (LOCA) or steam line break (SLB). The containment average air high temperature limit is derived from the input conditions used in the containment functional analyses and the containment structure external pressure analyses. This LCO ensures that initial conditions assumed in the analysis of containment response to a DBA are not violated during plant operations. The total amount of energy to be removed from containment by the passive containment cooling system during post accident conditions is dependent upon the energy released to the containment due to the event, as well as the initial containment temperature and pressure. The higher the initial temperature, the more energy that must be removed, resulting in higher peak containment pressure and temperature. Exceeding containment design pressure may result in leakage greater than that assumed in the accident analysis. Operation with containment temperature in excess of the LCO upper limit violates an initial condition assumed in the accident analysis. Operation of the Containment Fan Coolers (VFS) when the containment average air temperature is > 100°F higher than the environmental outside air temperature precludes the possibility of inadvertent VFS actuation and containment depressurization to below the minimum pressure limit. Operation of the VFS with the containment average air temperature < 70°F is not consistent with the normal operating containment average air temperature objective. When the containment average air temperature is > 100°F higher than the environmental outside air temperature (e.g.,< -30°F), the containment average air temperature must be controlled to ≥ 70°F to permit operation of the VFS and thus preclude containment depressurization to below the minimum pressure limit due to inadvertent VFS actuation.
APPLICABLE SAFETY ANALYSES	Containment average air temperature is an initial condition used in the DBA analyses that establishes the containment environmental qualification operating envelope for both pressure and temperature. The upper limit for containment average air temperature ensures that operation is maintained within the assumptions used in the DBA analyses for containment (Ref. 1). The limiting DBAs considered relative to containment OPERABILITY are the LOCA and SLB. The DBA LOCA and SLB are analyzed using computer codes designed to predict the resultant containment pressure transients. No two DBAs are assumed to occur simultaneously or consecutively. The postulated DBAs are analyzed with regard to containment Engineered Safety Feature (ESF) systems, assuming the loss of one Class 1E Engineered Safety Features Actuation Cabinet (ESFAC) Division, which is the worst case single active failure, resulting in one Passive Containment Cooling System flow path being rendered inoperable.

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APPLICABLE SAFETY ANALYSES (continued)

The limiting DBA for the maximum peak containment air temperature is a LOCA or SLB. The initial containment average air temperature assumed in the design basis analyses (Ref. 1) is 120°F.

The DBA temperature transients are used to establish the environmental qualification operating envelope for containment. The basis of the containment environmental qualification temperature envelope is to ensure the performance of safety related equipment inside containment (Ref. 2). The containment vessel design temperature is 300°F. The containment vessel temperature remains below 300°F for DBAs. Therefore, it is concluded that the calculated transient containment air temperature is acceptable for the DBAs.

The high temperature limit is also used in the depressurization analyses to ensure that the minimum pressure limit is maintained following an inadvertent actuation of the Passive Containment Cooling System (Ref. 1).

The containment pressure transient is sensitive to the initial air mass in containment and, therefore, to the initial containment air temperature. The limiting DBA for establishing the maximum peak containment internal pressure is an SLB or LOCA. The high temperature limit is used in the DBA analyses to ensure that in the event of an accident the maximum containment internal pressure will not be exceeded.

Operation of the VFS when the containment average air temperature is > 100°F higher than the environmental outside air temperature precludes the possibility of inadvertent VFS actuation and containment depressurization to below the minimum pressure limit. With containment average air temperature below 100°F higher than the environmental outside air temperature, inadvertent actuation of the VFS will not depressurize containment to below the minimum pressure limit.

Maintaining the containment average air temperature ≥ 70°F permits operation of the VFS with 2 of the 4 fan coil units in operation. With the VFS in operation, inadvertent VFS actuation is not possible, precluding depressurization of containment to below the minimum pressure limit.

Containment average air temperature satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

During a DBA, with an initial containment average air temperature less than or equal to the LCO high temperature limit, the resultant peak accident temperature is computed to remain within acceptable limits. As a result, the ability of containment to perform its design function is ensured.

APPLICABILITY

In MODES 1, 2, 3, and 4, a DBA could cause a release of radioactive material to containment. In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Therefore, maintaining containment average air temperature within the limits is not required in MODE 5 or 6.

In MODES 1, 2, 3, and 4, when the containment average air temperature is > 100°F higher than the environmental outside air temperature, inadvertent actuation of the VFS could reduce containment pressure below the design limit. Maintaining the VFS in operation precludes containment depressurization. Since maintaining containment pressure within limits is essential to ensure initial conditions assumed in the accident analyses are maintained, the LCO is applicable in MODES 1, 2, 3, and 4 when the containment average air temperature is > 100°F higher than the environmental outside air temperature.

In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Therefore, maintaining the VFS in operation is not required in MODE 5 or 6.

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ACTIONS

A.1

When containment average air temperature is not within the limits of the LCO, it must be restored to within its limits within 8 hours. This Required Action is necessary to return operation to within the bounds of the containment analysis. The 8 hour Completion Time is acceptable considering the sensitivity of the conservative analysis to variations in this parameter, and provides sufficient time to correct minor problems.

B.1 and B.2

With VFS not in operation and containment average air temperature > 100°F higher than the environmental outside air temperature, action is required to place the VFS in operation with 2 of the 4 fan coil units in operation or to reduce containment average air temperature to ≤ 100°F higher than the environmental outside air temperature within 8 hours.

Operation of the VFS and/ or reduction of the containment average air temperature must be performed in a controlled manner to maintain containment pressure within the limits of LCO 3.6.4. This Required Action is necessary to return operation to within the bounds of the containment analysis. The 8 hour Completion Time is acceptable considering the sensitivity of the conservative analysis to variations in this parameter, and provides sufficient time to correct minor problems.

C.1 and C.2

If the containment average air temperature cannot be restored to within its limits or the VFS placed in operation with 2 of the 4 fan coil units in operation within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.6.5.1

Verifying that the containment average air temperature is within the LCO limits ensures that containment operation remains within the limits assumed for the containment analyses. In order to determine the containment average air temperature, a weighted average is calculated using measurements taken at locations within the containment selected to provide a representative sample of the associated containment atmosphere. The 24 hour Frequency of this Surveillance Requirement is considered acceptable based on observed slow rates of temperature increase within containment as a result of environmental heat sources (due to the large volume of containment). Furthermore, the 24 hour Frequency is considered adequate in view of other indications available in the

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main control room, including alarms, to alert the operator to an abnormal containment temperature condition.

SR 3.6.5.2

Verifying that the VFS is in operation with 2 of the 4 fan coil units in operation ensures that unit operation remains within the limits assumed in the containment analysis. Consistent with the VFS Applicability, the Note specifies that this surveillance is not required to be performed when the containment average air temperature is ≤ 100°F higher than the environmental outside air temperature. The 24 hour Frequency is based on the availability of alarms and indications in the main control room providing containment average air temperature, environmental outside air temperature and the status of the VFS.

REFERENCES

1. Section 6.2, "Containment Systems."
2. 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."

Technical Report (TR) Revision:

The technical report revisions shown below were included in Revision 2 of the response. Revision 3 of the response does not include additional technical report revisions. Revision 4 and 5 do include additional technical report revisions.

Revise section 2.4 as shown below.

2.4.2 External pressure and thermal loads

Design conditions for the containment vessel are specified as:

- Design Pressure — 59 PSIG at design temperature of 280°F
- Design External Pressure — 2.9 PSIG at design temperature of 70°F
- External Pressure — 0.9 PSID at cold weather conditions

Both the maximum external pressure and the temperature conditions are affected by the ambient temperature. Combinations of normal temperature and external pressure are evaluated as service conditions as follows:

Service Level A

- Dead load, cold weather temperature distribution for credible initiating event in cold weather or inadvertent PCS actuation, reduced pressure of 0.9 psid based on evaluation of credible initiating events in cold weather. This conservatively includes the low probability inadvertent actuation of active containment cooling in cold weather event as a normal operating condition.

Service Level D

- Dead load, cold weather temperature distribution for credible initiating event in cold weather, SSE, reduced pressure of 0.9 psid based on evaluation of credible initiating events in cold weather.

Two temperature conditions are considered corresponding to plant operation during cold weather with the outside air temperature at the minimum value of -40F and during hot weather with the outside air temperature at 115F. The cold weather operation results in a significant temperature differential in the vicinity of the horizontal stiffener at elevation 131' 9". The vessel above the stiffener is exposed to the outside air in the upper annulus. This cold weather condition is assumed concurrent with the pressure reduction resulting from a credible initiating event and is conservatively assumed as a normal operating condition. It is evaluated during normal operation as a Service level A event. It is also evaluated under Service level D in combination with the Safe Shutdown Earthquake.

The external pressure of 0.9 psid is based on credible analyses as described in DCD subsection 3.8.2.4.1.1.

Table 2-4 – Load Combinations for the Large Penetrations

Load			Design		Level A Service Limit			Level C Service Limit		Level D Service Limit		
	Con	Test	Des1	Des2	A1	A2	A3	C1	C2	D1		D2
D	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0
E_s								1.0		1.0		1.0
P_t		1.0										
T_t		1.0										
P_o							1.0		1.0			
P_i			1.0			1.0		1.0				1.0
P_e (2.9psid)				1.0								
P_e (0.9psid)					1.0					1.0		
$T_o^{(5)}$					1.0		(4)		(4)	1.0		
T_a			1.0			1.0		1.0				1.0

<u>**Notes:**</u>

6. Service limit levels are per ASME-NE.
7. Where any load reduces the effects of other loads, that load is to be taken as zero, unless it can be demonstrated that the load is always present or occurs simultaneously with the other loads.
8. External pressure based on credible initiating events in cold weather.
9. Temperature of vessel is 70F.
10. Temperature distribution for credible initiating event in cold weather. Evaluation of load combination cases including external pressure and thermal combine the coincident external pressure with thermal load for the same temperature.

Revise section 5.1 as shown below.

5.1 DCD Changes from Rev 15 to Rev 16

The DCD changes from Rev 15 to Rev 16 were shown in Rev 0 and Rev 1 of this report. DCD Rev 16 has been issued so these changes have been deleted from this section of the Technical Report.

Revise section 5.2 as shown below.

5.2 DCD Changes to Rev 16

The following revisions are to DCD Rev 16.

Revise classification in Table 3.2-3 as shown below from MC to Class 2 for penetrations where the process pipe penetrates directly the containment vessel without the use of a flued head (see The DCD changes from Rev 16 to Rev 17 were shown in Rev 1 of this report. DCD Rev 17 has been issued so these changes have been deleted from this section of the Technical Report.

5.2 DCD Changes to Rev 17

The following revisions are to DCD Rev 17

None.