February 13, 2004
WOG-04-077

WCAP-15791-P/NP
Project Number 694

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Attention: Chief, Information Management Branch
Division of Program Management

Subject: **Response to Request for Additional Information – WCAP-15791-P (Proprietary), "Risk-Informed Evaluation of Extensions to Containment Isolation Valve Completion Times," Tac No. MB5751 (MUHP-3010)**

In June 2002, the Westinghouse Owners Group (WOG) submitted WCAP-15791-P (Proprietary), "Risk-Informed Evaluation of Extensions to Containment Isolation Valve Completion Times," for approval (Ref. 1). In July 2003, the NRC issued a Request for Additional Information (RAI) concerning WCAP-15971-P (Ref. 2).

Enclosure 1 to this letter contains the responses to the RAIs. The attached RAI responses are non-proprietary. As noted in the responses to RAI questions, WCAP-15791 will be revised to incorporate the RAI responses. Revision 1 to WCAP-15791-P will be submitted to the NRC by March 31, 2004.

If you require further information, feel free to contact Mr. Ken Vavrek, Westinghouse Owners Group Project Office at 412-374-4302.

Sincerely,

Frederick P. "Ted" Schiffley, II
Chairman
Westinghouse Owners Group

Enclosure

WOG-04-077
February 13, 2004

cc: S. Dembek, NRC, Westinghouse
D. G. Holland, NRC (via Federal Express)
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References:

1) WOG Letter OG-02-022, R. H. Bryan to US NRC Document Control Desk, "Transmittal of Reports: WCAP-15791-P, Rev. 0, (Proprietary) and WCAP-15791-NP, Rev. 0, (Non-Proprietary), Entitled Risk-Informed Evaluation of Extensions to Containment Isolation Valve Completion Times," June 6, 2002.

2) NRC Letter, NRC Letter, D. Holland (NRC) to G. Bischoff (Westinghouse), "Request for Additional Information – WCAP-15791-P, Risk-Informed Evaluation of Extensions to Containment Isolation Valve Completion Times," (TAC No. MB5751), July 3, 2003.

ENCLOSURE

Response to NRC's RAIs on WCAP-15791-P
"Risk-Informed Evaluation of Extensions to Containment Isolation Valve Completion Times"

RAI 1: Page 5-1 of WCAP-15791-P indicates that the containment isolation signals will not isolate systems required for accident mitigation. Please confirm that the emergency core cooling system, decay heat removal system, and their supporting systems do not contain any isolation valves which are either classified as containment isolation valves (CIVs) or are designed to be closed on containment isolation signals.

Response: In the Wolf Creek Updated Safety Analysis Report, Section 6.3, "Emergency Core Cooling System," Subsection 6.3.1.1, Safety Design Basis Six, states: "The capability to isolate components or piping was provided so that the ECCS safety function is not compromised. This includes isolation of components to deal with leakage or malfunctions and to isolate safety-related portions of the system (GDC-35)."

In addition, the penetrations associated with the emergency core cooling system (ECCS), decay heat removal system, and their supporting systems were reviewed to confirm that these systems do not contain any containment isolation valves which would close on a containment isolation signal and compromise the function of the mitigation system. Appendix C in WCAP-15791-P provides a listing of the WCGS containment penetrations. The CIVs and signals that each CIV receives are provided for each penetration. This information was reviewed to address this RAI.

Table RAI 1-1 provides a summary of this review and lists the penetrations associated with the emergency core cooling system (ECCS) and decay removal system. Within these systems are valves identified as CIVs. Many of these valves are on smaller lines that are used as drain lines, sample lines, and test lines. CIVs associated with these lines are either normally closed during plant operation or, if they may be open during plant operation, receive a containment isolation signal to ensure the containment is isolated when necessary. It was concluded from this review that there are no CIVs in the ECCS or decay heat removal system that receive a containment isolation signal that would compromise the accident mitigation function of the system. The CIVs that do receive containment isolation signals associated with these systems are in test lines.

The CIVs for penetrations in support systems for the ECCS and decay heat removal system were also reviewed. Penetration P-30 is associated with the compressed air system and CIV KAFV-29 receives a containment isolation signal. Isolating the air system has no impact on the CIVs in the penetrations associated with the ECCS and decay heat removal system since, as noted on Table RAI 1-1, the isolation valves in question fail to the closed (isolated) position.

Table RAI 1-1 Summary of ECCS and Decay Heat Removal System Penetrations with Containment Isolation Valves			
Penetration Number	**Penetration Description**	**CIVs That Receive a CI Signal**	**Purpose of CI Signal**
P-14	Residual heat removal system, recirculation line	None	
P-15	Residual heat removal system, recirculation line	None	
P-21	Residual heat removal system, hot leg injection	EJHCV-8825 (AOV)	To isolate a ¾ inch test line – CIV fails closed
P-27	Residual heat removal system, cold leg injection	EJHCV-8890B (AOV)	To isolate a ¾ inch test line – CIV fails closed
P-48	High pressure SI system, hot leg injection	EMHV-8824 (AOV)	To isolate a ¾ inch test line – CIV fails closed
P-49	High pressure coolant injection system, cold leg injection	EMHV-8823 (AOV)	To isolate a ¾ inch test line – CIV fails closed
P-52	Residual heat removal system, RHR shutdown lines	None	
P-79	Residual heat removal system, RHR shutdown lines	None	
P-82	Residual heat removal system, cold leg injection	EJHCV-8890A (AOV)	To isolate a ¾ inch test line – CIV fails closed
P-87	High pressure coolant injection system, hot leg injection	EMHV-8881 (AOV)	To isolate a ¾ inch line – CIV fails closed
P-88	High pressure coolant injection system, boron injection to cold legs	EMHV-8843 (AOV)	To isolate a ¾ inch test line – CIV fails closed

RAI 2: The topical report (TR) references a deterministic evaluation approach to determine the minimum penetration size that will result in a large release from containment atmosphere. The TR concludes that penetration pipe size diameters of 5?, 6?, and 3? can be screened out for sub-atmospheric, ice condenser, and dry ambient containment types. This result seems counter-intuitive since for the same volumetric leak rate (%/day) a smaller containment should have a similar hole size. Also, these sizes are significantly larger that the 1? and 2? diameter line size criteria typically used in the methodologies to identify penetrations whose failures could result in a large early release.

Please provide the following:

2.a An assessment of the impact of a line size screening criteria similar to the containment penetration screening criteria used in a typical probabilistic risk assessment (PRA) (e.g., a 2? line diameter). This should include an estimate of the number and types of lines in the size range between 2? and 6?.

Response: The impact of reducing the large release diameter from 6 inches to 2 inches based on the Wolf Creek plant specific application of WCAP-15791-P is as follows. This applies only to CIVs that are contained in a leakage path from the containment atmosphere. The CIVs that are contained in leakage paths from the reactor coolant system or steam generators are not affected, since they do not provide a leakage path from the containment atmosphere.

- The number of CIVs associated with connections to the containment atmosphere (only for maintenance activities with the pressure barrier function of the CIV intact) is 233.
- The number of CIVs in lines with a diameter of 2 inches or less is 174.
- The number of CIVs in lines with a diameter of 6 inches or less is 202.

The number of additional CIVs that would be impacted by reducing the large release diameter from 6 inches to 2 inches is 202 – 174 = 28. If the large release diameter were reduced from 6 inches to 2 inches, these 28 CIVs would not default to a 7 day (168 hour) Completion Time (CT) and PRA (ICLERP and ΔLERF) calculations would need to be performed to determine the appropriate CT. The CT could range from 4 hours to 7 days (168 hours), depending on the results of the PRA calculations.

To determine the CTs for these additional CIVs based on the PRA approach requires categorization of the CIV into the appropriate group and a PRA calculation. If the CIV(s) does not fall into any existing group, then a new group would need to be developed for that CIV(s) . After the new group(s) are developed and analyzed, CTs for the additional CIV(s) can be determined.

2.b Provide the details of the calculations performed to determine the pipe size screening criteria for one of the containment types. Explain how choked flow considerations are accounted for in the calculation.

Response: Following several detailed discussions with the Staff's reviewers of this WCAP on the offsite consequences associated with containment hole sizes, the WOG decided to default to a 2 inch hole size limitation to define the threshold for a large release, instead of further pursuing a hole size based on an alternate large release criteria. The 2 inch hole size has been used for screening in the development of containment isolation PRA models and is acceptable to the NRC. Due to this change in the approach to set the minimum penetration size that will result in a large release, a detailed response will not be provided to this RAI. However, as a result of the large release criteria change, the impacted CIVs will be re-analyzed via the probabilistic approach with the results provided in a revision to WCAP-15791.

2.c If a PRA-type screening criteria is not adopted, please provide the results of offsite consequence calculations demonstrating that early health effects would not occur given a severe accident with containment breach sizes equivalent to the screening criteria proposed in the TR.

Response: Following several detailed discussions with the Staff's reviewers of this WCAP on the offsite consequences associated with containment hole sizes, the WOG decided to default to a 2 inch hole size limitation to define the threshold for a large release, instead of further pursuing a hole size based on an alternate large release criteria. The 2 inch hole size has been used for screening in the development of containment isolation PRA models and is acceptable to the NRC. Due to this change in the approach to set the minimum penetration size that will result in a large release, a detailed response will not be provided to this RAI. However, as a result of the large release criteria change, the impacted CIVs will be re-analyzed via the probabilistic approach with the results provided in a revision to WCAP-15791.

RAI 3: The TR states that the impact on core damage frequency (CDF) and incremental conditional core damage probability (ICCDP) were not evaluated. The TR states that containment isolation is a function of containment response to an event and not the ability of the plant design to prevent or mitigate core damage. Provide an evaluation of the impact on CDF for the containment isolation configurations and systems associated with an accident mitigation function (engineered safety feature actuation system, sample lines, letdown, containment cooling, reactor coolant system (RCS) inventory control, or containment sprays, for example. See pages 1-1, 8-2 of the TR). In addition, discuss the impact of an open system during maintenance activities (preventive maintenance or corrective maintenance (CM) (valve hardware removed, for example)). Discuss the ICCDP associated with the valves that also have a safety function (in addition to primary containment isolation) that are in a closed position during maintenance.

Response:

Part 1: Provide an evaluation of the impact on CDF for the containment isolation configurations and systems associated with an accident mitigation function

Systems that are used for accident mitigation and which contain valves that perform a containment isolation function may impact core damage frequency (CDF) due to the possible longer CIV inoperability times that may now occur with the extended CIV CT. The availability of the mitigation function may be decreased with the increased CIV CT.

Some of the CIVs perform functions important to other safety systems and their inoperability can affect proper operation of these other safety systems. In the cases where a CIV is inoperable, and this inoperability impacts the operability of another function, the CT of the impacted system also needs to be considered. The shorter of the CTs, either the CIV CT or the CT of the impacted system, will be applicable. Two examples follow:

Example 1: Motor-operated valve (MOV) HV8811A is a CIV for penetration P-15 at WCGS (see WCAP-15791-P, Appendix C). It is also part of the emergency core cooling system (ECCS). As part of the ECCS, this MOV is in the flow path from the containment sump to a residual heat removal (RHR) pump. This valve is normally closed and is required to be closed during the ECCS injection phase when the RHR pump is taking suction from the refueling water storage tank (RWST). This valve then opens for cold leg recirculation when the RHR pump suction switches to the containment sump. If this valve is inoperable in the open position, then the applicable Technical Specification CIV and ECCS Actions would be entered. The CIV CT is 8 hours, from the WCGS plant specific analysis (see WCAP-15791-P, Table 10-1), and the ECCS CT is 72 hours. In this case, the limiting CT is the CIV CT of 8 hours.

Example 2: Air-operated valve EMHV-8824 is a CIV in penetration P-48 at WCGS (see WCAP-15791-P, Appendix C). This valve is also part of the ECCS, and is normally closed and used to isolate the RHR test line. If this valve is inoperable in the open position, then the CIV and the ECCS Actions would be entered. (This assumes that if this valve is open and inoperable, the ECCS is adversely impacted.) If it is open and inoperable, the CIV CT is 168 hours, from the WCGS plant specific analysis (WCAP-15791-A, Table 10-1), and the ECCS CT is 72 hours. In this case, the limiting CT is the ECCS CT of 72 hours.

The same rationale follows for other CIVs that can impact the operability of core damage mitigation systems or containment release mitigation systems. The more limiting, or shorter, CT determines the length of time the CIV can be inoperable. In all cases, the more limiting time will be equal to or less than the CT for the Technical Specification associated with the core damage or containment release mitigation function.

If the CIV CT is increased beyond the current 4 hour CT, there could be a small impact on CDF since the CIV(s) may be inoperable and in a position that impacts the function of the mitigation system for a longer period of time. Currently, CIV inoperability is limited by the CIV CT to 4 hours. For some CIVs this CT can be increased up to the CT of the other affected Technical Specification's CT. As noted above, this could be 72 hours for an inoperable ECCS train. This 72 hour limit would also apply for many other systems. Therefore, a mitigation system containing a valve that performs a CIV function and which can cause the mitigation system to be inoperable, may experience a small increase in unavailability. This is expected to be a very small impact since the majority of system unavailability is typically related to pumps.

The extended CIV CTs will only impact a limited number of systems since a CIV that is inoperable and cannot be closed for the CT, in many cases is in the correct position for its other safety function. For example, if a CIV in the service water flow path providing cooling to the containment coolers is inoperable in the open position, the containment cooling function is not impacted. The limited cases in which this is not true apply primarily to the ECCS, where several CIVs may be required to change position during the course of a LOCA event.

The impact of an inoperable CIV on CDF should consider both preventive and corrective maintenance activities. Preventive maintenance on a CIV would be expected to be done with other preventive maintenance activities associated with the train, such as, pump preventive maintenance activities. Therefore, preventive activities related to the CIVs are not expected to increase the unavailability of the associated train. Corrective maintenance activities on CIVs could impact the availability of a train of a mitigation system, therefore, corrective maintenance activities could have an impact on CDF. With the current 4 hour CT, the maintenance activity would need to be completed within 4 hours, but with the extended CT, the maintenance activity could go on up to the CT of the impacted system (72 hours for example).

The following is a bounding assessment of the potential impact on CDF due to the extended CIV CT. A simple and conservative approach to assess the potential impact on CDF is to determine the increase in system unavailability followed by a calculation for CDF. The ECCS will be used as an example.

It was conservatively estimated in the WCAP that the corrective maintenance frequency is 0.1/yr (see WCAP-15791-A, Table 8-1). Based on this, the CIV unavailability contribution from corrective maintenance activities to the unavailability of a single train of a safety system is:

- Current CT: 0.1/year x 4 hours/8760 hours/year = 4.6E-05
- Extended CT: 0.1/year x 72 hours/8760 hours/year = 8.2E-04.
  This assumes the full CT will be used for each corrective maintenance activity. This is conservative since many, if not all, maintenance activities are completed well within the CT.

Given the following:

- ECCS train unavailability: 5E-03
- Common cause failure probability across trains: $\beta = 0.1$
- ECCS train unavailability due to CIV inoperability with a 4 hour CT: 4.6E-05
- ECCS train unavailability due to CIV inoperability with a 72 hour CT: 8.2E-04
- Initiating event frequency for events requiring ECCS: 2E-03/yr
  (This includes the small, medium, and large LOCA events with mean frequencies of 1.5E-03/yr, 6.1E-05/yr, and 7.2E-06, respectively, from the NRC's Interim LOCA Frequencies. The sum of these frequencies is 1.57E-03/yr which has been rounded up to 2E-03/yr for this calculation.)

The CDF impact is calculated as follows:

- ECCS System Unavailability = Train 1 Unavailability x Train 2 Unavailability + Train Unavailability x ß
- Case 1: 4 hour CT
  System unavailability = (5E-03 + 4.6E-05) x (5E-03 + 4.6E-05) + 5E-03 x 0.1 = 5.25E-04
- Case 2: 72 hour CT
  System unavailability = (5E-03 + 8.2E-04) x (5E-03 + 8.2E-04) + 5E-03 x 0.1 = 5.34E-04
- System unavailability increase = 5.34E-04 – 5.25E-04 = 9.0E-06
- CDF impact = Initiating event frequency x system unavailability increase =
  2E-03/yr x 9.0E-06 = 1.8E-08/yr

The same calculation done with a typical ECCS train unavailability of 1E-02, instead of 5E-03, provides the following results:

- System unavailability increase = 1.12E-03 – 1.10E-03 = 2.0E-05
- CDF impact = 2E-03/yr x 2.0E-05 = 4.0E-08/yr

The same calculation done with a typical ECCS train unavailability of 5E-02, instead of 5E-03, provides the following results:

- System unavailability increase = 7.58E-03 – 7.50E-03 = 8.0E-05
- CDF impact = 2E-03/yr x 8.0E-05 = 1.6E-07/yr

These three values are well within the ?CDF acceptance guideline of 1E-06/yr in Regulatory Guide 1.174. Therefore, the potential additional unavailability of the ECCS related to corrective maintenance activities during the extended CTs will have only a very small impact on plant risk.

<u>Part 2: Discuss the impact of an open system during maintenance activities (preventive maintenance or corrective maintenance (CM) (valve hardware removed, for example))</u>

Maintenance can be completed on a CIV with the valve remaining in the containment penetration line or with the valve removed from the containment penetration line. With the valve remaining in the penetration line, the pressure boundary function for the system impacted by the CIV is maintained. With the valve removed, the pressure boundary function is compromised. In the first case, the impacted system may be able to continue to operate (remain operable). In the second case, the impacted system is also inoperable and the shorter of the CTs of the applicable Technical Specifications is applied. This second case is discussed in Part 1 of this RAI response.

The situation in which the CIV is removed from the penetration line for maintenance was specifically considered and analyzed with regard to LERF and ICLERP as discussed in Section 8 of the WCAP. The CTs associated with this maintenance configuration are provided in the WCAP. The impact of this maintenance configuration on CDF was not evaluated in the WCAP, but is discussed in the following paragraphs for penetration flow paths connected to containment atmosphere and the RCS.

Penetration Fbw Paths Connected to the Containment Atmosphere

These penetrations include all those that are not connected to the RCS or SGs, and include flow paths through containment that may be open or closed, inside or outside containment. A CIV in this type of penetration that remains in the penetration line, but is open and inoperable, is the same as a CIV that has been removed. In both cases, the CIV cannot isolate the penetration if it is required to do so. But with regard to the functioning or operability of the system associated with the CIV, the impact is different. With a CIV remaining in the penetration line, but open and inoperable, as discussed above in many cases the associated system is still operable. The system would be inoperable if the CIV is required to close or be closed for the system to function properly. An inoperable system, if it is a core damage mitigation system, can impact CDF. As discussed above, if the system is inoperable, then additional Technical Specifications need to be considered and the shorter of the CTs will be applicable. An assessment of the impact on CDF is provided above in Part 1 of this RAI response. This is also applicable to mitigation systems that are impacted by a CIV that is removed for maintenance. That is, with a CIV removed, the associated mitigation system is inoperable as well as the containment isolation function of the CIV, therefore, the shorter of the two CTs applies.

Penetration Flow Paths Connected to the RCS

CIVs in penetrations associated with systems connected to the RCS have the potential to impact CDF. If the CIV is open and inoperable, it will not be able to perform its isolation function as required. This impacts the frequency of an interfacing systems LOCA that bypasses containment. In this case, a core damage event becomes a large containment release. The CTs for these CIVs were set based on the LERF related acceptance criteria in Regulatory Guides 1.174 and 1.177. The LERF acceptance criteria are more limiting than the CDF acceptance criteria, therefore, if the LERF criteria are met, then the CDF criteria are also met. It's concluded from this that the CDF impact has already been considered for penetrations with flow paths connected to the RCS in which the CIV is intact, but in the open position and inoperable.

The situation when the CIV inside containment in the line connecting the system to the RCS has been removed can also impact CDF. In this case, an interfacing systems LOCA bypassing containment is no longer the concern. The interfacing system LOCA will exhaust into containment and can be mitigated. Therefore, there is an impact on CDF since there will be one less valve maintaining the RCS pressure boundary. The following provides a conservative ICCDP and CDF impact assessment.

ICCDP Assessment

- Assuming that a single closed valve is maintaining the RCS pressure boundary for the system of interest – there may be additional valves, but to provide a conservative and bounding assessment only one will be credited.
- This configuration will exist for 168 hours. This is the maximum CT that can be applied.
- Probability of the valve spuriously opening = 2E-07/hr (from WCAP-15791-P, Table 8-1, Note 1) Note that the larger of the two valve spurious opening values is used. A third value for check valve reverse leakage of 1E-06/hr was rejected for this calculation. This calculation is addressing a core damage event due to a LOCA, and check valve reverse leakage does not meet this requirement.
- Conditional core damage probability (conditional CDP) for a LOCA = 1E-02. This value represents the CDP given a LOCA event has occurred, and was obtained from a review of several WOG plant LOCA initiating event frequencies and CDF contributions for small, medium, and large LOCAs. The conditional CDPs ranged from 1.0E-02 to 1.4E-04. As an example, given a medium LOCA IE frequency of 1E-03/r and a medium LOCA CDF contribution of 4.3E-06/yr, the CDP is 4.3E-03 (4.3E-06/1E-03).
- LOCA IE frequency given the specific configuration = 2E-07/hr x 8760 hr/yr = 1.75E-03/yr

- LOCA CDF for this specific configuration = 1.75E-03/yr x 1E-02 = 1.75E-05/yr (this is the increase in CDF due to the specific configuration)
- ICCDP = Increase in CDF x CT = 1.75E-05 x 168/8760 = 3.36E-07

This meets the ICCDP acceptance guideline of 5E-07 in Regulatory Guide 1.177.

CDF Impact Assessment

The plant CDF will be impacted due to the longer period of time the plant can now spend in the configuration with a single valve providing the RCS pressure boundary in the system of interest (with the CIV removed from the penetration line).

- Assuming that a single closed valve is maintaining the RCS pressure boundary for the system of interest – there may be additional valves, but to provide a conservative and bounding assessment only one will be credited.
- This configuration will exist for 168 hours. This is the maximum CT that can be applied.
- Probability of valve spuriously opening = 2E-07/hr (from WCAP-15791-P, Table 8-1, Note 1) Note that the larger of the two valve spurious opening values is used. A third value for check valve reverse leakage of 1E-06/hr was rejected for this calculation. This calculation is addressing a core damage event due to a LOCA, and check valve reverse leakage does not meet this requirement.
- Initiating event frequency given this configuration = 2E-07/hr x 8760 hr/yr = 1.75E-03/yr
- Conditional core damage probability (conditional CDP) for a LOCA = 1E-02. This value represents the CDP given a LOCA event has occurred.
- CDF for operating in this configuration for a full year = IE freq. x CCDP = 1.75E-03/yr x 0.01 = 1.75E-05/yr
- Probability of operating in this configuration = 0.1 (from WCAP-15791-P, Table 8.1, Note 4)
- ?CDF = 1.75E-05/yr x 0.1 activities/yr x (168 hrs/activity/8760 hrs/yr – 4 hrs/activity/8760 hrs/yr) = 3.3E-08/yr

This meets the ?CDF acceptance guideline of 1E-06/yr in Regulatory Guide 1.174.

<u>Part 3: Discuss the ICCDP associated with the valves that also have a safety function (in addition to primary containment isolation) that are in a closed position during maintenance</u>

As discussed above, some of the CIVs perform functions important to other safety systems and their inoperability can affect the proper operation of these other safety systems. In the cases where a CIV is inoperable and the CIV inoperability impacts the operability of another function, the CT of the impacted system also needs to be considered. The shorter of the CTs, either the CIV CT or the CT of the impacted system, will be applicable.

Since the length of time a CIV can be inoperable will be limited by the shorter of the CIV CT or impacted safety system CT, the ICCDP for the safety system will not be impacted by the CIV CT extension. The ICCDP value will continue to be what already exists for the safety system CT.

RAI 4: Discuss the applicability and basis for eliminating the distinction between penetration flow paths that contain two or more CIVs and penetration flow paths that contain one CIV and a closed system. This is discussed on page 1-2 of the TR.

Response: Technical Specification 3.6.3, "Containment Isolation Valves", in NUREG-1431, Rev. 2 (Standard Technical Specifications, Westinghouse Plants) distinguishes between penetration flow paths with two (or more) containment isolation valves (Condition A) with a Completion Time (CT) of 4 hours and penetration flow paths with only one containment isolation valve and a closed system (Condition C) with a CT of 72 hours. This distinction allows crediting the passive isolation barrier (a closed system) for providing a longer CT.

WCAP-15791-P analyzes each penetration type separately with each CIV in each penetration evaluated individually. A penetration for a closed system with a single CIV is analyzed differently than a penetration with two (or more) CIVs. For example, Section 8.2.2.1 of the WCAP provides a sample calculation for determining the CT for a penetration for a system open inside and outside containment with two CIVs. Section 8.2.2.2 of the WCAP provides a sample calculation for determining the CT for a penetration for a system closed inside containment and open outside containment. Section 8.2.2.3 of the WCAP provides a sample calculation for determining the CT for a penetration for a system open inside containment and closed outside containment. Section 8.2.2.4 of the WCAP provides a sample calculation for determining the CT for a penetration for a system closed inside containment and closed outside containment.

Since specific analyses are done for each type of penetration and the results (extended CTs) are penetration and CIV specific, Technical Specification 3.6.3 was revised to reflect the actual penetration/system configuration. Therefore, the distinction between penetration flow paths that contain two or more CIVs, and penetration flow paths that contain one CIV and a closed system is no longer necessary.

RAI 5: The TR lists the types of containment penetrations as;

- Penetration flow paths connected to the containment atmosphere,
- Penetration flow paths connected to the RCS, and
- Penetration flow paths connected to the steam generators (SGs).

Do these penetration classifications include non-primary connections, cooling lines, heat exchangers, etc? Does RCS only include lines connected to the RCS pressure boundary? The list does not seem complete. See page 8-1 on the TR.

Response: All the lines that penetrate the containment can be classified into one of these three groups. This categorization is used to help decide the potential path to a release and the appropriate type of analysis to apply to the CIVs. The classification or category used is dependent on the specific penetration configuration.

Penetration flow paths connected to the RCS are those flow paths that can potentially be exposed to the RCS coolant pressure and temperature. These are lines connected to the RCS pressure boundary. Penetration flow paths connected to the SGs are those flow paths that can potentially be exposed to the SG secondary side coolant pressure and temperature. These lines are connected to the SG secondary side pressure boundary. The remaining containment penetrations are grouped into the category of penetration flow paths connected to the containment atmosphere. These penetrations flow paths may be open to the containment atmosphere or closed to it, but will not be exposed to RCS or SG secondary side conditions.

All the penetrations for a plant can be placed into one of these three categories. A system that is not connected to the RCS or SG secondary side, and closed to the containment atmosphere, such as a service water line providing coolant to the containment fan coolers, can potentially be exposed to the containment atmosphere via a pipe rupture of the service water line inside containment. However, this system cannot be exposed to RCS or SG secondary side conditions.

RAI 6: The TR states that only one valve can be in maintenance in a single penetration. Are additional valves in maintenance (additional penetrations) additive with respect to large early release frequency (LERF) and ?LERF? See page 8-2 of the TR. The technical specifications appear to allow separate entry for each penetration. In addition, Tier 2 requirements are stated to not be applicable for the proposed allowed outage time (AOT) extension. Does this consider multiple valves out for maintenance at an increased AOT? Discuss the impacts of multiple simultaneous and sequential entries into the TS. This is related to Question 2.

Response: The analysis evaluates each CIV in each penetration individually and determines an acceptable Completion Time based on the ICLERP and ?LERF for each CIV. It is assumed that only a single CIV is inoperable in one penetration flow path. If additional CIVs are also inoperable in other penetrations, then the total ?LERF impact can be determined by summing the individual CIV ?LERF increases. Therefore, the impact is additive with respect to LERF and ?LERF.

TSTF-446, Revision 0, "Risk Informed Evaluation of Extensions to Containment Isolation Valve Completion Times (WCAP-15971)," proposed revisions to Technical Specification 3.6.3, "Containment Isolation Valves," in NUREG-1431, Rev. 2, and was transmitted to the NRC by an NEI letter dated October 21, 2002. The Technical Specification and Bases markups contained in TSTF-446 supercede the Technical Specification and Bases markups contained in Appendix A of WCAP-15791-P. TSTF-446 will be revised to be consistent the analysis in WCAP-15791-P that only evaluated a single inoperable CIV in one penetration flow path.

The Tier 2 discussion in Section 8.4 of WCAP-15791-P did not consider multiple CIVs out of service for maintenance at increased CTs. CIV inoperability is not expected to occur frequently and single CIV inoperabilities in multiple penetration flow paths are expected to occur less frequently. The Tier 2 discussion considers potential interactions between containment mitigation systems. Additionally, proposed Technical Specification 3.6.3 Condition C in TSTF-446 addresses multiple inoperable CIVs in the same penetration flow path.

Sequential CIV inoperabilities will be addressed consistent with the current practice that is used to address sequential SSC inoperabilities for any other SSCs contained in the Technical Specifications. This CIV CT extension evaluation does not change the current practice of sequential SSC inoperabilities.

RAI 7: Discuss common cause for only identical type values. Discuss control circuits and associated hardware that may be the same for different valve types. What are the major contributors to spurious valve actuations? See page 8-3 of the TR.

Response:

Common Cause Failure Modeling

Consistent with plant PRA models, the CIVs as modeled in this assessment include the valve, actuator, and local control circuitry. Also consistent with plant PRA models, common cause failure is included for similar types of valves performing the same function with the same failure mode. In this case, for example, common cause failure is included for two motor-operated valves of which either is required to close to isolate the penetration. Both would need to fail to close in order to fail penetration isolation, therefore, common cause is included across these valves. The same would be true for two air-operated valves or two check valves. Common cause is not typically included across different types of valves performing the same function even if they contain some similar elements, such as the control circuitry. This is primarily for two reasons:

- Data for failure of components is typically collected at the component level, not the subcomponent level. As noted above, the component level for a MOV includes the valve, actuator, and local control circuitry.
- Common cause failure of a component such as an MOV can be related to a number of issues, one is the mechanical/electrical failure of the component. Others include errors during valve re-assembly following maintenance activities and the inappropriate application of a valve. These common cause failure modes become very small contributors to common cause failure when different valves are considered in different applications.

Therefore, the common cause failure analysis applied in this assessment is consistent with methods typically used in current plant PRA models and risk-informed applications.

Spurious Valve Actuations

The causes of spurious valve actuations (i.e., position change) depend on the valve type to some extent. For example, a spurious signal may cause a MOV to change position, but this would not be applicable to a manually operated valve. The following lists typical causes for spurious valve actuations.

1. Failures of valve control circuits
2. Failures of power supplies
3. Mispositioned valves following maintenance or test activities
4. Spurious signals from actuating systems
5. Inadvertent operator actuations
6. Failures of air supplies (applicable to air-operated valves that fail open on loss of air, which is not a fail safe position for a CIV)

Note that checking valve positions of the operable CIVs in a penetration prior to starting CIV maintenance activities will identify any initially mispositioned valves. The concern with mispositioned valves is during the time period when performing the CIV maintenance activity. This is addressed in the analysis as shown in the example calculations in Section 8.2 of the WCAP.

RAI 8: The proposed AOT times appear to be calculated based on using the guidance in Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" and RG 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications," as a target and varying the AOT to fit the guidance of the RG. Discuss how the uncertainty of the calculated LERF and the incremental conditional large early release probability is accounted for in the proposed AOT results such that the guidance presented in RGs 1.174 and 1.177 is met.

Response: Uncertainty can be characterized as aleatory and epistemic. Uncertainties related to data are termed aleatory. This uncertainty is often associated with component failure rates and initiating event frequencies, for example. Epistemic uncertainty is related to model uncertainties and associated with, for example, assumptions and simplifications. Both are discussed in the following.

This analysis did not directly address data uncertainty by assigning distributions to the component failure rates, initiating event frequencies, etc. and then propagating them through to the results. However, the generic analysis indirectly addresses this component of uncertainty by using conservative values for the key parameters. The key parameters that form the basis of the analysis include:

- isolation valve failure rates
- core damage frequency from internal events
- core damage frequency from seismic events
- common cause failure factors

The values used for these parameters were obtained from WOG plant PRA models. The values for each parameter were compared across the plants and the most conservative values chosen. For example, the most conservative value for CDF from internal events is 7.8E-05/yr (see WCAP-15791-P, Table 8-1), which came from one plant, while the most conservative value for a motor-operated valve to fail to close is 1.09E-02/demand (see WCAP-15791-P, Table 8-1), which came from another plant. Using this approach provides an extremely conservative analysis, since the most conservative values for most parameters are used based on all the possible values in WOG member PRA models. This provides a bounding analysis that is applicable to all WOG plants, therefore, no data uncertainty analysis was necessary in the analysis.

This analysis did not directly address epistemic uncertainty. A review of all the PRA models considered when collecting the appropriate values for the parameters was not done to determine if the PRA models appropriately address this uncertainty source. But epistemic uncertainty is indirectly addressed by the approach used in the analysis to determine appropriate parameter values. Individual PRA models may contain sources of epistemic uncertainty, but the same source would most likely not carry across all WOG plants, and since the more conservative values for the parameters are used in the analysis, epistemic uncertainty should not be a concern.

Epistemic uncertainty of particular interest in this analysis is the CDF contribution from external events other than seismic. This primarily includes fire, external flooding, and high winds. Depending on the plant, these may or may not be a significant contributor to CDF. But the internal CDF value used in the analysis is relatively high, therefore, for most plants, if not all, this CDF value encompasses the CDF value including external events for the generic analysis.

The plant specific analysis was based on point estimates and did not consider a data uncertainty analysis that included propagating uncertainty distributions though the model and did not explicitly consider epistemic uncertainty sources. This was not done the following reasons:

- Wolf Creek is not considered an outlier with regard to plant/system/component performance. A comparison of Wolf Creek plant specific values for the parameters of interest in this analysis, indicates that the Wolf Creek values are typical in most cases and, for the most part, near the center of the data group or leaning in the conservative direction.

- Wolf Creek is a typical Westinghouse 4-loop, single unit site, that does not have unique features that would cause the plant risk to be abnormally different from other Westinghouse plants. No specific features exist that would result in unique plant specific initiators and no unique event mitigating features exist. In a cross comparison between Wolf Creek and similar plants, the important parameters, such as CDF, are typical.

- Of interest in the analysis are changes or delta values, that is, impact on LERF (or ?LERF) and ICLERP, which looks at the difference between the base LERF with all CIVs available and the LERF with a CIV not available. In this situation, the uncertainties tend to drop out and have no impact on the decisionmaking process.

Based on this, an explicit uncertainty analysis was not done.

RAI 9. The Technical Specification markups add the AOT times for various valve Categories 1 thru 13. How are these categories related to the TR valve groups? See page A-3 of the TR.

Response: The Technical Specification markups containing the CIV Categories on page A-3 are not related to the WCAP valve groups. These Categories were used to "bin" the various valve groups with the same Completion Time into a common Category. This was done for presentation and usage purposes in the Technical Specifications. The CIVs are categorized according to the assigned (or justified) CT. All the CIVs with a 4 hour CT are Category 1 CIVs, all the CIVs with an 8 hour CT are Category 2 CIVs, and so forth. There may be various valve groups within the same Completion Time, making it impractical to develop a Technical Specification based on the valve groupings contained in WCAP-15791-P.

The valve groups, used in the WCAP, are used to combine similar type of penetrations for analysis purposes only. The analysis results are applied to plant specific penetrations and CIVs, with a CT assigned to each CIV. The CTs for the various groups can be 4 hours, 8 hours, 12 hours, 24 hours, 48 hours, 72 hours, or 7 days hours depending on the analysis results.

RAI 10: The TR proposes a completion time of 168 hours to perform online preventive maintenance. Does the TR also assume CM will be performed such that CM risk impacts are also included in the evaluation?

Response: The ICLERP analysis used in the WCAP is based on an analysis approach applicable to a corrective maintenance activity. That is, when a CIV is inoperable and there is a similar operable CIV in the penetration that is required to close to perform the isolation function, common cause failure of operable CIV is applied in the analysis. This will typically be the Beta value when using the Multiple Greek Letter approach to common cause failure analysis. That is, the probability of the operable CIV failing to close on demand is the Beta factor. This approach is the most conservative, that is, it results in the largest ICLERP value, and directly addresses corrective maintenance activities and encompasses preventive maintenance activities. With preventive maintenance activities, the ICLERP value will be based on the random failure probability for the operable CIV. Since the Beta factor (used assuming a common cause failure) is significantly greater that the random failure values, the CCF values will provide a more conservative result, that is, shorter Completion Times. Therefore, the results in the WCAP are based on the most conservative approach, and the Completion Time can be used for either corrective or preventive maintenance activities.

RAI 11: CDF_T is stated to include internal events only. Please discuss considerations for external events including CDF_T and LERF. See Table 8.1 of the TR.

Response: The analysis included the total CDF (CDF_T) from internal events. In addition, to analyze systems that are closed inside or outside containment, the analysis considered the CDF from seismic events as discussed in Section 8.2.2 of the WCAP. For the generic analysis, the CDF_T is 7.8E-05/yr. To ensure the CDF_T adequately covers both internal and external events, this value will be increased to 1E-04/yr. The generic probabilistic risk analysis will be re-done using a CDF_T value of 1E-04/yr. The new Completion Times will be provided in a revision to the WCAP.

To implement the generic analysis, licensees will need to demonstrate that their total plant CDF is equal to or less than 1E-04/yr. For the Wolf Creek Generating Station (WCGS) the CDF contributions are:

- $CDF_{\text{internal events less internal flooding}}$ = 5.5E-05/yr
- CDF_{fire} = 1.0E-05/yr
- $CDF_{\text{internal flooding}}$ = 2.5E-06/yr
- $CDF_{\text{other external events}}$ = screened out
- $CDF_{\text{total less seismic}}$ = 6.8E-05/yr

Seismic CDF was not calculated for WCGS, but a reduced scope seismic margins evaluation was completed. Based on the results of this evaluation, the seismic risk for WCGS is low and it is concluded that the total CDF for WCGS will be less than 1E-04/yr.

With regard to the plant specific analysis for WCGS, only the internal event CDF value was used for CDF_T. The plant specific probabilistic risk analysis for the CIVs in lines greater than 2 inches will be re-done using a CDF_T of 1E-04/yr. The new Completion Times will be provided in a revision to the WCAP.

RAI 12: The following statement is on page 9-3:

> Note 3: CDF due to SGTR is not provided since WCGS has no containment penetrations from the SGs due to their containment boundary definition.

The staff does not understand how there could be no containment penetrations from the SGs due to their containment boundary definition. Provide a detailed explanation for this design concept.

Response:

The following is taken from Chapter 6 of the WCGS USAR.

> SAFETY DESIGN BASIS SEVEN – Each line that penetrates the primary reactor containment and is neither part of the reactor coolant pressure boundary nor connected directly to the containment atmosphere has:
> a. At least one containment isolation valve which is either automatic, locked closed, or capable of remote manual operation; or
> b. Some other defined bases that meet the intent of containment isolation as an alternative to a above.

The steam generators are addressed via b above. As discussed in the USAR, the containment penetrations associated with the steam generators are not subject to GDC-57, since the containment barrier integrity is not breached. The boundary or barrier against fission product leakage to the environment is the inside of the steam generator tubes, the outside of the steam generator shell, and the outside of the lines emanating from the steam generator shell side.

As a note of clarification, WCGS has containment penetrations from the steam generator, but has no CIVs associated with these penetrations due to the justification provided above. Note 3 should read "CDF due to SGTR is not provided since WCGS has no CIVs in the containment penetrations from the SGs due to their containment boundary definition."