FAQ 23-02 Peach Bottom
PI Interpretation Issue Request

Plant:	Peach Bottom		
Date of Event:	5/16/22		
Submittal Date:	5/12/23		
Licensee Contact:	Wade Scott	Tel/Email:	717-456-3047 wade.scott@constellation.com
NRC Contact:	Scott Rutenkroger	Tel/Email:	717-456-3313 Scott.Rutenkroger@nrc.gov
	Ron Cureton		Ronald.Cureton@nrc.gov

Performance Indicator: Unplanned Scrams with Complications

Site-Specific FAQ (Appendix D)? ☒ Yes or ☐ No

FAQ requested to become effective when approved

Question Section

NEI 99-02 Guidance needing interpretation (include page and line citation):

Page 23, line 20-29

Within the BWR Flowchart Question 2, NEI 99-02 states, "Was pressure control unable to be established following the initial transient?

To be successful, reactor pressure must be controlled following the initial transient without the use of Safety Relief Valves (SRVs). Automatic cycling of the SRV(s) that may have occurred as a result of the initial transient would result in a "No" response, but automatic cycling of the SRV(s) subsequent to the initial transient would result in a "Yes" response. Additionally, the SRV(s) cannot fail open. The failure of the pressure control system (i.e., turbine valves / turbine bypass valves / HPCI / RCIC / isolation condenser) to maintain the reactor pressure or a failed open SRV(s) counts in this indicator as a complication beyond the normal reactor trip response and would result in a "Yes" response."

Page 24, line 16-37

Within the BWR Flowchart Question 5, NEI 99-02 states, "Was Main Feedwater not available or not recoverable using approved plant procedures during the scram response?

If operating prior to the scram, did Main Feedwater cease to operate and was it unable to be restarted during the reactor scram response? The consideration for this question is whether Main Feedwater could be used to feed the reactor vessel if necessary. The qualifier of "not recoverable using approved plant procedures" will allow a licensee to answer "NO" to this question if there is no physical equipment restraint to prevent the operations staff from starting the necessary equipment, aligning the required systems, or satisfying required logic circuitry using plant procedures approved for use that were in place prior to the scram occurring.

The operations staff must be able to start and operate the required equipment using normal alignments and approved emergency, normal and off-normal operating procedures. Manual operation of controllers/equipment, even if normally automatic, is allowed if addressed by procedure. Situations that require maintenance or repair activities or non-proceduralized operating alignments will not satisfy this question. Additionally, the restoration of Main Feedwater must be capable of being restored to provide feedwater to the reactor vessel in a reasonable period of time. Operations should be able to start a Main Feedwater pump and start feeding the reactor vessel with the Main Feedwater System within about 30 minutes from the time it was recognized that Main Feedwater was needed."

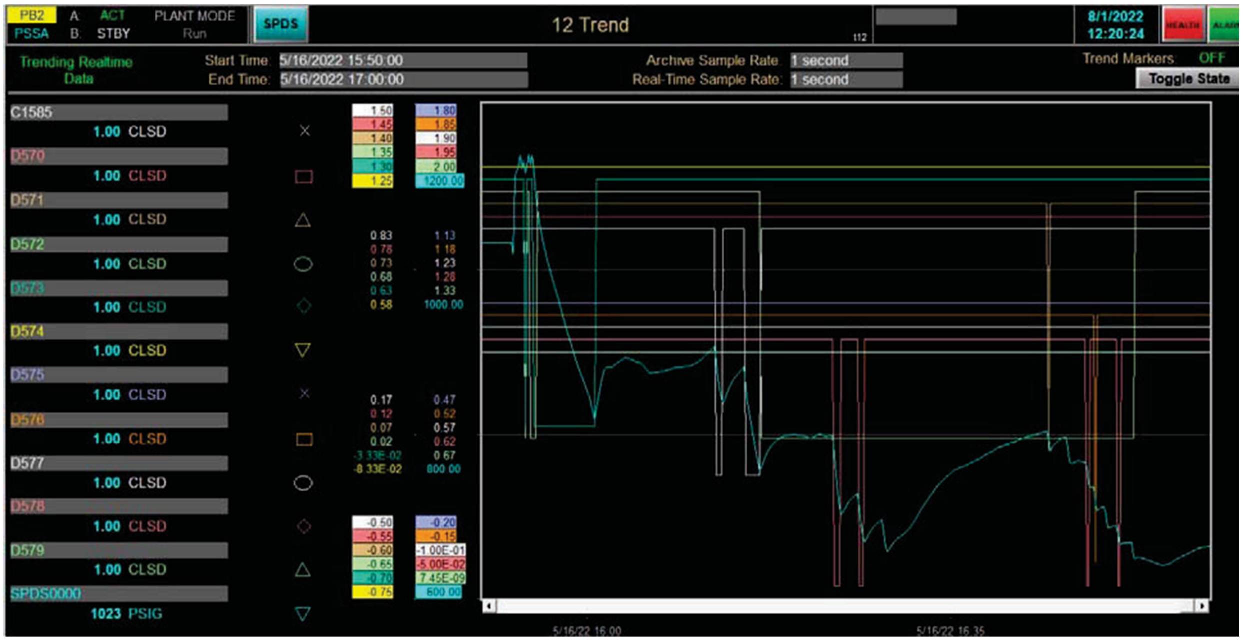
Event or circumstances requiring guidance interpretation:

To answer NEI 99-02 BWR Flowchart Questions 2 and 5, the following discusses the conditions of the scram, the operator response and the existing procedures and addresses each portion of the NEI question:

The initiating event for the scram was de-energization of both buses of the reactor protection system (RPS). This resulted in a reactor scram and Group I isolation, closing all main steam isolation valves (MSIVs). All control rods inserted as expected during the scram. Four safety relief valves (SRVs) (of 11 SRVs) opened to mitigate the reactor pressure rise, as expected. Following the initial transient, operators established pressure control in accordance with T-101, "RPV Control", which is entered as part of a normal scram response. Additionally, the response was aligned with procedure OP-PB-101-111-1001, "Strategies for Successful Transient Mitigation". Reactor Core Isolation Cooling (RCIC) was the primary method of level control with initial supplementation from High Pressure Coolant Injection (HPCI). Operators utilized SRVs manually in addition to HPCI in pressure control mode to maintain reactor pressure, as outlined in station procedures. No SRVs cycled automatically subsequent to the initial transient, and no SRVs failed open.

With HPCI in pressure control mode and by manual use of SRVs, operators executed a controlled depressurization to condensate injection. Condensate is able to inject with RPV pressure less than 600 psig, which allows for securing of HPCI and RCIC pumps for injection purposes. The effort to reduce pressure to condensate injection began approximately 40 minutes into the event, which accounts for some of the manual use of SRVs within the first hour.

Use of bypass valves to control pressure and feedwater to control level was not immediately available because the initiating event closed the MSIVs. There was no damage or failed equipment that would have prevented the use of bypass valves or main feedwater. Although several actions would be required to realign the systems, such as reopening of MSIVs and re-establishing condenser vacuum, the systems were available using normal alignments and existing procedures. Restoration of feedwater was not immediately pursued during this event, as level was adequately maintained with RCIC and later condensate, and containment cooling was in service and sufficient. As such, MSIVs were reopened approximately 9 hours after the scram. It is estimated that opening of the MSIVs and feedwater restoration could be completed within 90 minutes if needed.



NRC resident inspector position for Question 2:
This guidance first describes the usage of SRVs and states that reactor pressure must be controlled following the initial transient without their use. The guidance then expounds by providing a distinction between initial transient automatic cycling versus automatic cycling, subsequent to the initial transient. This guidance appears based on typical BWR post-scram pressure response given a scram at higher power levels with closure of the main steam isolation valves (MSIVs), which necessarily includes a brief period of automatic cycling of SRVs. It directly compares initial automatic to subsequent automatic operation. In particular, the guidance does not then make a distinction between subsequent automatic cycling versus subsequent manual cycling. As such, the inspectors determined that this guidance is intended to make a distinction between the use, or not, of SRVs following an initial transient, regardless of whether such use was automatic or manual and regardless of whether such usage was required to maintain pressure or reduce pressure further. To restate, the distinction is solely whether or not SRVS were cycled after the brief, initial pressure transient.

The inspectors reviewed the plant computer data and determined the SRV cycling which took place within the first few minutes of the scram (15:53:04 to 15:55:13) qualified as "occurred as a result of the initial transient." After this period, pressure control was maintained by manual cycling of SRVs and by using HPCI in CST-to-CST mode. Following the first few minutes, the operators initially dropped pressure to about 830 psig in 10 minutes. The operators then maintained reactor pressure up to 900 psig for 10 minutes (i.e. 20 minutes post-event). Operators then lowered pressure down to 660 psig between 20 minutes and 40 minutes post-event. Operators then allowed the pressure to rise to 800 psig. Operators then reduced the pressure from 800 psig back to 650 psig from about 50 minutes to 60 minutes post-event. Operators then, at approximately 90 minutes post-event, began reducing pressure further, lowering pressure to below 600 psig approximately two hours post-event. The inspectors counted ten SRV cycles between 20 minutes and 60 minutes post-event when the reactor pressure was maintained between 900 psig and 650 psig.

Therefore, during this event, SRVs lifted as expected during the initial transient (a few minutes or less) to mitigate the rise in reactor pressure. Then, there were additional SRV actuations beyond the initial transient (in this case beyond 20 minutes) and the question should be answered "Yes" absent an approved FAQ stating otherwise.

NRC resident inspector position for Question 5:
This section describes considering whether main feedwater could be used to feed the reactor vessel if necessary. This section also provides guidance that the operators should be able to start and feed the reactor vessel with the main feedwater system about 30 minutes from the time "it was recognized that main feedwater was needed." The inspectors considered 30 minutes to provide an approximate amount of time that is considered reasonable for placing main feedwater back in service in order to screen the event as not risk-significant. In addition, the inspectors viewed the question as not intending to exclude events in which main feedwater was determined, during the event, to not be needed as a result of operators relying upon continued success of RCIC and HPCI. In this event with a Group I isolation, i.e. MSIVs closed, the main feedwater pumps were not available until the MSIVs were re-opened.

In this event, the MSIV's were physically reopened approximately 9 hours after the scram. The reason for the delayed reopening of the MSIVs was the time required to lower the differential pressure across the MSIVs to reach below the procedural limit of 50 psid. The differential pressure was significantly greater than 50 psid for hours post-event. Main feedwater remained unavailable for the entire 9 hours until such time as the MSIVs were reopened. The inspectors recognize that the operators could have prioritized reopening the MSIVs sooner. However, the electrical transient caused various plant impacts on both units, along with the Unit 2 Scram and Group I isolation, and the operators prioritized restoring other systems. Although 9 hours is not necessarily a measure of the total minimum time that was required to restore main feedwater, if it had been required, it does provide a sense of the time required to reduce the differential pressure across the MSIVs in order to reopen them given the circumstances of this event. The licensee determined later by running a simulator scenario that under ideal circumstances with no distractions or other priorities it took a minimum of 90 minutes to recover main feedwater after a Group I isolation. Notably, this best-case time of 90 minutes already exceeds the 30 minutes benchmark for restoring main feedwater by a significant degree.

The inspectors considered Question 5 from two different perspectives. First, the NEI 99-02 Revision 7 guidance provides criteria for consideration of events given benchmark values, such as the 30 minutes. By this measure, a Scram with a Group I isolation at Peach Bottom will always result in non-recoverable main feedwater for well beyond the benchmark. If this question's consideration of complications is intended to measure the risk of an event as evaluated by the approximate time that main feedwater is not recoverable, then clearly a Scram with a Group I isolation will always be a complicated event at Peach Bottom. This may be appropriate for Question 5, being focused on the recoverability of main feedwater, since plant design differences result in some BWRs being able to restore main feedwater well within 30 minutes, representing significantly less risk in this aspect for Scrams with closure of the MSIVs.

Second, the inspectors considered the totality of the circumstances which led to the decision-making that prioritized other activities in lieu of more aggressively taking actions to reduce the differential pressure across the MSIVS in order to reopen them and recover main feedwater sooner. Although the plant circumstances did not add additional overt barriers to restoring main feedwater, the inspectors concluded that the operators' prioritization and decision-making, which resulted in taking 9 hours to reopen the MSIVs, provides a holistic perspective on the overall degree of cumulative complications that existed due to the electrical transient and the Scram with Group I isolation. In particular, the operators would otherwise have prioritized reopening MSIVs earlier absent other competing priorities. However, the inspectors note that the operators transferred reactor water level control from reactor core isolation cooling (RCIC) to the condensate system about 3.5 hours after the scram, and the condensate pumps can inject into the reactor pressure vessel at high pressures (up to 600 psig).

Since operations staff was not able to start and operate the normal alignment, i.e. main feedwater, within about 30 minutes following the event, and could not start and operate main feedwater until 9 hours following the event when the MSIVs were reopened, the question should be answered "Yes" absent an approved FAQ stating otherwise.

Site Position for Question 2:
To be successful, reactor pressure must be controlled following the initial transient without the use of Safety Relief Valves (SRVs).

Four SRVs lifted during the initial transient to mitigate the pressure rise in the reactor. After the initial transient, no SRVs cycled automatically, and reactor pressure did not rise to a point where SRVs would be expected to lift automatically. SRVs were cycled manually in addition to maximizing use of HPCI in pressure control mode. Due to the high power level achieved in this reactor, the response to a PCIS group I isolation from full power will always require the manual use of SRVs for pressure control beyond the initial automatic cycling on setpoints. This is acknowledged in existing site procedure OP-PB-101-111-1001, "Strategies for Successful Transient Mitigation" and was demonstrated in simulator runs of this initiating event. While this procedure lists SRV use as a portion of the response strategy, it also directs that their use be limited. The method of limiting their use, by maximizing HPCI in pressure control, was followed during this event. This procedure also prescribes a 300 psig pressure control band while SRVs are being used for pressure control, which was followed. For the initiating event of a scram with MSIV closure, the response of the operators and plant equipment was as expected and is considered a normal response for this unit.

Sites with lower power density or additional SRVs may be able to withstand an MSIV closure without manually cycling SRVs, but Peach Bottom's design does not afford this opportunity. The response to this initiating event was executed without error or complication, in accordance with site procedures.

Automatic cycling of the SRV(s) that may have occurred as a result of the initial transient would result in a “No” response, but automatic cycling of the SRV(s) subsequent to the initial transient would result in a “Yes” response.

As stated above, SRVs automatically cycled during the initial transient, but did not automatically cycle subsequent to the initial transient. Therefore, the answer to this statement is "no".

Additionally, the SRV(s) cannot fail open.

No SRVs failed open during this event. Therefore, the answer to this statement is "no".

The failure of the pressure control system (i.e. turbine valves / turbine bypass valves / HPCI / RCIC / isolation condenser) to maintain the reactor pressure or a failed open SRV(s) counts in this indicator as a complication beyond the normal reactor trip response and would result in a "yes" response.

The pressure control system was not failed. Available systems were maximized to control pressure and minimize the necessary manual use of SRVs. Pressure control was established by the operators in accordance with the standard scram response procedure, T-101, "RPV Control". Manual use of SRVs is the directed strategy in station operating procedures for responding to a scram with MSIV closure. Alternate pressure control strategy is regularly exercised in requalification training by the operators, as demonstrated by successful execution of the strategy for a Group I isolation outlined in existing site procedure OP-PB-101-111-1001, "Strategies for Successful Transient Mitigation".

Site position for Question 5:
If operating prior to the scram, did Main Feedwater cease to operate and was it unable to be restarted during the reactor scram response? The consideration for this question is whether Main Feedwater could be used to feed the reactor vessel if necessary. The qualifier of "not recoverable using approved plant procedures" will allow a licensee to answer "NO" to this question if there is no physical equipment restraint to prevent the operations staff from starting the necessary equipment, aligning the required systems, or satisfying required logic circuitry using plant procedures approved for use that were in place prior to the scram occurring.

The Main Feedwater system was isolated by closure of the MSIVs, however the system did not sustain damage during this event and there were no physical limitations to recovering the system using approved plant procedures. Although several actions would be required to realign the system, such as reopening of MSIVs and re-establishing condenser vacuum, these actions are contained in existing procedures.

Several aspects of the Peach Bottom design slow the process to reopen the MSIVs. The Peach Bottom design dictates that in order to restore Feedwater after the MSIVs have closed, differential pressure between the MSIVs must be reduced so the MSIVs can be reopened and condenser vacuum must be re-established. As stated in station procedure SO 1A.7.A-2, the MSIVs cannot be opened with a differential pressure greater than 50 psid across them. This is a limitation based on the design of the steam lines. The procedure directs the opening of 2-inch main steam line drains to allow for the differential pressure across the inboard MSIVs to reduce to less than 50 psid, then an inboard MSIV is opened.

Additionally, Peach Bottom's Feedwater pumps are turbine-driven, so the electrically driven option for feeding water into the RPV is from Condensate. Peach Bottom does not have a large enough bypass around the MSIVs to allow for operating a Feedwater pump turbine.

The operations staff must be able to start and operate the required equipment using normal alignments and approved emergency, normal and off-normal operating procedures. Manual operation of controllers/equipment, even if normally automatic, is allowed if addressed by procedure. Situations that require maintenance or repair activities or non-proceduralized operating alignments will not satisfy this question.

As stated above, there were no physical limitations to recovering the system using approved plant procedures.

*Additionally, the restoration of Main Feedwater must be capable of being restored to provide feedwater to the reactor vessel in a **reasonable period of time**. Operations should be able to start a Main Feedwater pump and start feeding the reactor vessel with the Main Feedwater System within about 30 minutes **from the time it was recognized that Main Feedwater was needed.***

Once a Group I isolation has occurred, it is estimated that recovering the Main Feedwater system under ideal circumstances would take approximately 90 minutes. In this case, which was the expected response for Peach Bottom, plant procedures and design require more than 30 minutes even though all systems were hot and the material condition of the systems following the reactor trip was normal. Because feedwater injection was not needed in response to this event, the MSIVs were physically reopened approximately 9 hours after the scram. The priorities for operators were restarting recirculation pumps and injection via condensate. The scram occurred near the end of day shift, and so the response also included shift turnover. The action to open the MSIVs was thoroughly discussed by the oncoming crew, in support of precise operation. Unit parameters were compared to the procedural options for opening MSIVs to determine which approach was most appropriate given the conditions, and the anticipated actions required to obtain the appropriate differential pressure between the valves prior to opening. This was a careful assessment of the situation by the crew, and not an unnecessary delay or hesitation. Time was afforded for this assessment since plant parameters were stable at the time with the MSIVs closed, and equipment responded as expected.

Although the overall duration for recovering Main Feedwater is longer than the recommended time frame given in NEI 99-02 and the routine time estimated for Peach Bottom, there was no need for full restart of feedwater and no equipment damage that prevented the restart from being accomplished. If feedwater was needed, there were no plant circumstances that would have required additional time beyond the 90 minute routine time stated above. Reactor level was maintained such that no automatic low level initiation setpoints for HPCI or RCIC were reached. Since containment cooling systems were available, and all supporting electrical systems were available, the use of ECCS systems did not create a challenge to containment parameters. The maximum suppression pool temperature during this event was 97.3F.

Because the Peach Bottom design does not feature an electrically driven Feedwater pump nor a Main Steam bypass capable of driving the Feedwater pump turbines, restoration of feedwater includes several proceduralized steps that cannot be reasonably accomplished within 30 minutes, as described above. The Condensate pumps are electrically driven and were available after a controlled partial depressurization to injection pressure. Condensate pumps were used to transfer from safety related injection sources in response to this event.

Site Conclusion:
Pressure control was established by operators following the initial transient in accordance with the normal scram response procedure, T-101, "RPV Control". The response by plant equipment and operations staff was as expected for this initiating event and had no factors which complicated the response. Procedures and training are written to align with the expected response of this high powered unit, which requires the manual use of SRVs to control pressure. Additionally, due to the available design features, Peach Bottom would not be able to re-establish Feedwater injection within 30 minutes. There were no abnormal barriers or malfunctions that prevented the restoration of feedwater, if needed.

If licensee and NRC resident/region do not agree on the facts and circumstances explain:
The licensee and the NRC concur on the facts and circumstances surrounding the event.

Potentially relevant existing FAQ numbers:

FAQ 18-01 - "Definition of Initial Transient"
FAQ 22-03 - "Susquehanna Scram"

Response Section

Proposed Resolution of FAQ

The NRC staff completed the evaluation of this FAQ by reviewing the details of the event provided in this FAQ and the guidance provided in NEI 99-02, Revision 7. The evaluation took into consideration the review by resident inspectors as well as regional and headquarters staff.

The purpose of the IE04, “Unplanned Scrams with Complications,” performance indicator, as stated in NEI 99-02, Revision 7 and IMC 308 Attachment 1, is to monitor “that subset of unplanned automatic and manual scrams that either require additional operator actions beyond that of the “normal” scram or involve the unavailability of or inability to recover main feedwater. Such events or conditions have the potential to present additional challenges to the plant operations staff and therefore, may be more risk-significant than uncomplicated scrams.” Further clarifying guidance on what is considered an unplanned scram with complications is included in NEI 99-02, Revision 7. Specifically, NEI 99-02 includes six questions applicable to Boiling Water Reactor (BWR) scrams – if any of the questions are answered ‘yes’ then the scram counts as a complicated scram.

1. Did an RPS actuation fail to indicate/establish a shutdown rod pattern for a cold clean core?
2. Was pressure control unable to be established following the initial transient?
3. Was power lost to any Class 1E Emergency/ESF bus?
4. Was a Level 1 injection signal received?
5. Was Main Feedwater unavailable or not recoverable using approved plant procedures during the scram response?
6. Following initial transient, did stabilization of reactor pressure/level and drywell pressure meet the entry conditions for EOPs?

The review of this FAQ will focus on clarifying questions 2 and 5 for this event since the circumstance in question does not impact the other questions.

- *Was pressure control unable to be established following the initial transient?*

- *Was Main Feedwater unavailable or not recoverable using approved plant procedures during scram response?*

Guidance on answering these questions is contained in NEI 99-02, Rev. 7 in the following areas:

- Page 23, line 20-29

- Page 24, line 16-37

Regarding Question 2, NEI 99-02, Revision 7, Page 23, lines 20-29 state:

To be successful, reactor pressure must be controlled following the initial transient without the use of Safety Relief Valves (SRVs). Automatic cycling of the SRV(s) that may have occurred as a result of the initial transient would result in a "No" response, but automatic cycling of the SRV(s) subsequent to the initial transient would result in a "Yes" response. Additionally, the SRV(s) cannot fail open. The failure of the pressure control system (i.e., turbine valves / turbine bypass valves / HPCI / RCIC/isolation condenser) to maintain the reactor pressure or a failed open SRV(s) counts in this indicator as a complication beyond the normal reactor trip response and would result in a "Yes" response.

For the Peach Bottom Unit 2 scram on May 16, 2022, reactor pressure was not successfully controlled following the initial transient without the use of Safety Relief Valves (SRVs). Approximately 40 minutes into the event, operators used High Pressure Coolant Injection (HPCI), in pressure control mode, and manually cycled SRVs to depressurize to condensate injection. NEI 99-02, Revision 7 does not distinguish between automatic and manual use of SRVs to control pressure. The staff acknowledges the relatively high-power density at Peach Bottom potentially requiring the use of SRVs to be able to withstand a scram with a MSIV closure. However, MSIV closure is not a default response to a reactor scram. Manual cycling of SRVs presents additional risk compared to the baseline scram response and those actions have the potential to present additional challenges to the plant operations staff.
The staff determined that the answer to Question 2 regarding pressure control is 'Yes' and that this event should be classified as an Unplanned Scram with Complication (IE04)

Regarding Question 5, NEI 99-02, Revision 7, Page 24, lines 16-37 state:

If operating prior to the scram, did Main Feedwater cease to operate and was it unable to be restarted during the reactor scram response? The consideration for this question is whether Main Feedwater could be used to feed the reactor vessel if necessary. The qualifier of "not recoverable using approved plant procedures" will allow a licensee to answer "NO" to this question if there is no physical equipment restraint to prevent the operations staff from starting the necessary equipment, aligning the required systems, or satisfying required logic circuitry using plant procedures approved for use that were in place prior to the scram occurring.

The operations staff must be able to start and operate the required equipment using normal alignments and approved emergency, normal and off-normal operating procedures. Manual operation of controllers/equipment, even if normally automatic, is allowed if addressed by procedure. Situations that require maintenance or repair activities or non-proceduralized operating alignments will not satisfy this question. Additionally, the restoration of Main Feedwater must be capable of being restored to provide feedwater to the reactor vessel in a reasonable period of time. Operations should be able to start a Main Feedwater pump and start feeding the reactor vessel with the Main Feedwater System within about 30 minutes from the time it was recognized that Main Feedwater was needed. During startup conditions where Main Feedwater was not placed in service prior to the scram, this question would not be considered, and should be skipped.

For the Peach Bottom Unit 2 scram, Main Feedwater was not capable of being restored to provide feedwater to the reactor vessel within roughly 30 minutes. During this event, the MSIVs were not reopened for approximately 9 hours after the scram due to the need to lower differential pressure across the MSIVs and prioritizing other actions during the event. The staff acknowledges that 9 hours would not be the minimum time needed to restore main feedwater however, the licensee determined via simulator scenarios that under ideal conditions with no distractions or other priorities it would take a minimum of 90 minutes to restore main feedwater.

This best case time significantly exceeds the 30-minute time offered in NEI 99-02, Revision 7 as a reasonable period of time to restore main feedwater. The staff determined that the answer to Question 5 (Main Feedwater Availability) is ‘Yes’ and this event should be classified as an Unplanned Scram with Complications.

No changes to NEI 99-02 are needed because of this FAQ.