NEI 99-02 FAQ 20-05
RBS Unplanned Scram May 2019 – Proposed NRC Response

Plant:	River Bend Station, Unit 1	
Date of Event:	5/31/2019	
Submittal Date:	October 09, 2020	
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Performance Indicator: IE04 - Unplanned Scrams with Complications (USwC)

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

FAQ to become effective when approved or _____.

Question Section

NEI 99-02, Revision 7 Guidance needing interpretation (include page and line citation):

NEI 99-02, Revision 7, Page 11, Lines 11-14 *Unplanned Scram Definition*
NEI 99-02, Revision 7, Page 21, Lines 10-14 *USwC Indicator Definition*
NEI 99-02, Revision 7, Page 22, Lines 11-14 *Scram Response for a BWR*

Events or circumstances requiring guidance interpretation.

On May 31st RBS was being shutdown to repair an 'A' 5th Point Heater tube leak. The heater string had been isolated two days prior. Following the downshift of Recirculation Pumps 'A' and 'B', the feedwater (FW) system was aligned for low flow conditions utilizing the 'A' FW pump minimum flow valve. This alignment caused FW flow to raise by approximately 3,000 gpm which led to increased condensing action in the FW heaters, a high FW heater water level isolation, a loss of sufficient suction to the FW pumps and ultimately 'A' & 'C' FW pumps tripping on low suction pressure. A manual scram was inserted following the loss of suction to the 'A' & 'C' FW pumps. RBS classified this event as an Unplanned Scram per 7,000 Critical Hours.

Timeline Documented in CR-2019-3891 Causal Analysis:
(*** Notes provided to add clarity)

5/31/2019	Plant Shutdown is in progress. 'A' FW Heater String is isolated, and Heater Drain Pumps are secured. Reactor power was at 30%, Condensate Pumps 'B' and 'C' in service, Reactor FW Pumps 'A' and "C' in service, one FW Regulating Valve in service and Recirc Pumps in slow speed. Operations proceeded with shutdown of Reactor FW Pump 'A'.
23:38	Total Feedwater/Condensate flow is ~7,000 gpm and is all going through the 'B' FW Heater String.
23:39	FW Pump 'A' Min Flow Valve begins to Open, this increases total condensate flow through the 'B' FW heater string.

23:42 FW Pump Min Flow ‘A’ Valve is 100% Open, this increases total condensate flow through the ‘B’ FW heater string by 3,050 gpm. Total Feedwater/Condensate flow is now ~10,500 gpm.

*** The added condensate flow is condensing more Extraction steam in the 5th Point Heater. There is little DP (~8 psi) across the heater to force water out of the 5th Point Heater. This transient causes roughly 255 gal of water to be added to the 5th Point Heater in only 2.5 minutes. This equates to ~5.5 inches of level in the heater.

23:43 5th Point Heater Level reaches the High Level (8.125”) and ‘B’ FW heater isolation sequence begins.

*** This is the event that caused the conditions that ultimately led to the insertion of a Manual Scram. The system isolated as expected due to the high-water level in the 5th Point Heater.

23:44 5th Point Heater is isolated. ~10,000 gpm is now being pushed through the 5th Point Heater Bypass Line.

*** The Bypass line has an orifice (CNM-RO120). The rated maximum flow through the orifice is 3412 gpm. We were attempting to send ~10,000 gpm. Using 7247.431-145-052B (CNM-RO120 orifice calculation) it can be shown that it only takes 4170 gpm to yield a discharge pressure of 260 psi. This is the Feed Pump Suction Pressure trip setpoint.

23:45 FW pumps ‘A’ and ‘C’ trip on Low Suction.

23:45:10 Manual Scram inserted after Loss of FW pumps. Emergency Operating Procedure (EOP-0001) was entered.

23:45:30 RCIC was manually initiated for level control.

23:49:00 FW Pump ‘C’ was restarted for level control.

23:53:00 RCIC was manually tripped per CRS direction, level control transitioned to FW.

23:54:00 Reactor Scram reset.

23:55:00 Start-Up FW Regulating Valve placed in service.

23:56:00 85-degree F per hour cooldown rate established.

23:57:00 Reactor Core Isolation Cooling placed in a standby lineup.

6/1/2019

00:00:00 Emergency Operating Procedures (EOP-0001) was exited. Reactor Pressure Vessel water level and pressure are being controlled via normal operating procedures.

00:14:00 Secured CNM-P1B CONDENSATE PUMP B, per normal operating procedure.

*** Suction to the RFPs was still through the Low-pressure Heater String Bypass only. During the cooldown of the Reactor Vessel, Reactor Vessel level was cycling between 19 inches to 30 inches as Main Steam Bypass Valves cycled to maintain Reactor Pressure. The Startup FRV was cycling from full closed to 26 inches open to control Reactor Water Level. Whenever the Startup FRV was closed, the 'C' RFP minimum flow valve would open and start to close as the Startup FRV opened. When Condensate Pump 'B' was secured, the reduced pressure to the suction of the RFP resulting in the cycle times becoming larger—i.e. the Startup FRV would be open longer to raise level, etc. This combination of events eventually resulted in a low suction pressure to FW Pump 'C' which then tripped at 0028. The dynamics of the 0028 trip was different than that from the original trips at 2345 that led to the SCRAM. In the original trip, the low suction was caused solely by the heater string isolation. The 0028 trip was caused by combination of heater strings being isolated AND securing of the 'B' Condensate Pump.

00:28:00 Unexpected occurrence: Main Control Room alarm for FW Low Suction pressure was received for FW Pump 'C'.

*** On the restart of FW Pump 'C', the discharge MOV breaker tripped on thermal overload preventing the discharge valve from opening. With the 'C' RFP minimum FCV open, the 'C' RFP tripped on low suction pressure again. (Highlighted for emphasis)

00:32:00 Level 3/ Entered Emergency Operating Procedure EOP-0001.

*** At this point, Operations un-isolated the 'B' FW Heater String, in accordance with normal operating procedure SOP-0007 Condensate System, introducing another flow path to the RFP suctions and started the 'A' RFP with no issues. EOP's were entered and exited because Reactor Water Level and Pressure were under control and being managed by normal means. This was a separate event from the original scram due to low suction pressure caused by the FW heater isolation. In this event, the low suction was caused by the securing of the Condensate pump at 0014, which combined with the still isolated 'B' Low Pressure Heater String, caused larger oscillations in Reactor FW Level controls that ultimately led to a low suction trip. If the B Condensate pump had continued to run, the low suction pressure would have never occurred.

00:33:00 FW Pump ‘A’ was started.

00:36:00 Exited Emergency Operating Procedure EOP-0001. RPV water level and pressure are being controlled via normal operating procedures.

02:15:05 Completed NRC Form 361 Immediate (4-hour) Report (EN #54096) per 10 CFR 50.72 for manual reactor scram due to loss of FW.

Following the initial scram on 5/31/19 at 23:45, the plant was stabilized. EOP-001 RPV Control was exited and a normal shutdown was in process in accordance with GOP-0002 Plant Shutdown. A controlled, procedurally directed 85˚/hr cooldown was commenced and reactor water level was being controlled in accordance with procedural guidance with feedwater.

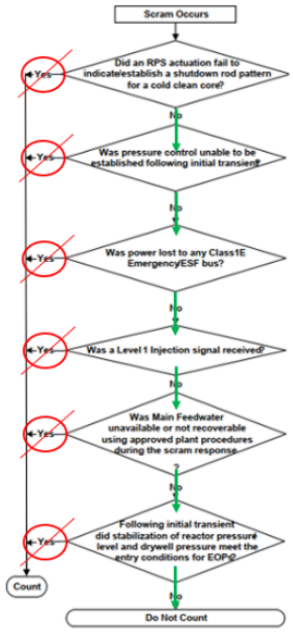
An USwC as defined by NEI 99-02 Rev. 7, in part states, *“…scrams…that require additional operator actions or involve the unavailability of or inability to recover main feedwater...during the scram response.”* NEI 99-02 Rev. 7 defines the time period of scram response as, *“…the period of time that starts with the scram and concludes when operators have completed the scram response procedures and the plant has achieved a stabilized condition in accordance with approved plant procedures and as demonstrated by meeting the following criteria:*

- *No Emergency Operating Procedure (EOP) entry conditions exist related to either the primary containment or the reactor.*
- *Reactor cool-down rates are less than 100 degrees F/hr.*
- *Reactor water level is being maintained within the range specified by plant procedures.”*

Based upon the above timeline and NEI 99-02 Rev. 7 definitions, RBS was outside the “Scram Response Time” by 30 minutes before the subsequent level three scram signal and therefore did not have an Unplanned Scram with Complications. Additionally, the below flowchart demonstrates this conclusion as seen in NEI 99-02 Rev.7, Figure 2.

IE04 Unplanned Scrams with Complications – Flowchart
Figure 2

BWR



If licensee and NRC resident/region do not agree on the facts and circumstance, explain:

NOTE: The following verbiage (*in Times New Roman font and italics*) was provided by the NRC residents and is their perspective on the events.

The resident inspectors believe the May 31, 2019 scram is an unplanned scram with complications based on answering "Yes" to NEI 99-01 Revision 7, "IE04 Unplanned Scrams with Complications – Flowchart" questions #5 and #6.

Question #5

On Question #5, "Was main feedwater unavailable or not recoverable using approved plant procedures during the scram response", the resident believes the answer is "Yes." The resident takes the word "recoverable" in the sentence to mean recoverable in a sustainable manner. Main feedwater was not recoverable in a sustainable manner using approved plant procedures because approved plant procedures did not instruct operators to un-isolate the heater string when bringing the feed pump back online. In using approved plant procedures, operators failed to un-isolate the heater string during their initial start of the feed pump. Consequently, when they secured the condensate pump per procedure, they caused the feed pump to trip, resulting in a low-level scram signal and an EOP re-entry.

NEI 99-02 provides clarifying guidance that "situations that require maintenance or repair activities or non-proceduralized operating alignments will not satisfy this question." The situation in question required a "non-proceduralized" operating alignment in the sense that it required operators to take actions and observe restrictions that were not specified in any procedures. Specifically, to allow for sustained recovery of feed flow, operators needed to either un-isolate a heater string, or refrain from securing condensate pumps per the condensate system operating procedure. Neither of these actions or restrictions were specified in any of the procedures in use at the time, and therefore operators did not know that they applied. After the feed pump tripped, operators continued to attempt to restart it in the non-proceduralized lineup. Only after the additional restart attempts failed did operators recognize that the system needed to be realigned.

Question #6

On Question #6, "Following initial transient, did stabilization of reactor pressure/level and drywell pressure meet the entry conditions for EOPs?", NEI 99-02 offers the following clarifying guidance:

> ***"****When a scram occurs plant operators will enter the EOPs to respond to the condition. In the case of a routine scram the procedure entered will be exited fairly rapidly after verifying that the reactor is shutdown, excessive cooling is not in progress, electric power is available, and reactor coolant pressures and temperatures are at expected values and controlled. Once these verifications are done and the plant conditions considered "stable" (see guidance in the Definition of Terms section under scram response) operators will exit the initial procedure to another procedure that will stabilize and prepare the remainder of the plant for transition for the use of normal operating procedures. The plant would then be ready be maintained in Hot Standby, to perform a controlled normal cool down, or to begin the restart process. The criteria in this question is used to verify that there were no other conditions that developed during the stabilization of the plant in the scram response related vessel parameters that required continued operation in the EOPs or re-entry into the EOPs or transition to a follow-on EOP."*

The guidance clearly indicates that the scope of the question includes the period after the plant has been initially stabilized and EOP's have been exited, where operators are stabilizing the remainder of the plant to allow for the use of normal operating procedures. The station was in that period when the second EOP entry occurred. Due to the abnormal feed system lineup that the station implemented during the initial response and stabilization, an abnormal condition developed in a scram response related vessel parameter—specifically, reactor vessel level—that required re-entry into EOPs.

If the USwC performance indicator only applied during the brief window between the scram and the initial stabilization that allows for EOP exit, then the above guidance--in particular, the specification of EOP re-entry as a basis for triggering the USwC PI--would not make sense. As soon as the EOP was exited, the window of applicability for the PI would close, preventing EOP re-entry from triggering the PI. The clarifying language explicitly calls out EOP re-entry as a basis for triggering the PI, so an interpretation that closes out the window of applicability as soon as the EOP is exited cannot be consistent with the intent.

Potentially relevant FAQs:

FAQ 10-02 significantly revised Section 2.1 of NEI 99-02 on August 31, 2013.
FAQ 18-03 Unplanned Scrams with Complications (USwC) PI

Response Section

Licensee Proposed Resolution of FAQ:

Based on the definition of Scram Response Time, the response to the guidance questions below are:

1. Was main feedwater unavailable or not recoverable using approved plant procedures during the scram response?"

   Should be "NO" provided that the main FW system was available for use within an estimated 30 minutes of the event.

2. Following initial transient did stabilization of reactor pressure level and drywell pressure meet the entry conditions for EOPs?

   Should be "NO" since all Scram Response criteria were met within 11 minutes of the initial scram and was being maintained in a stable condition for the duration of the event. Therefore, the reactor was never considered to be in an unstable condition.

If appropriate, provide proposed rewording of guidance for inclusion in next revision:

Because it is believed this FAQ is answered with existing NEI 99-02 Rev. 7 guidance no wording changes are proposed.

NRC Proposed Response:

This FAQ is associated with a River Bend Station (RBS) shutdown repair of an "A" 5th Point Heater tube leak on May 31st, 2019. RBS classified this event as an Unplanned Scram per 7,000 Critical Hours, but the resident inspector believes that the scram should be classified as an Unplanned Scram with Complications. This FAQ is requesting guidance interpretation to resolve the disagreement with the classification of this event. For the review of this FAQ we took into consideration the information provided within the FAQ, guidance within NEI 99-02, Revision 7, the Event Notification report, and operating logs for this event.

The purpose of the IE04, "Unplanned Scrams with Complications," performance indicator, as stated in NEI 99-02, Revision 7, 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 not available or not recoverable using approved plant procedures during the scram response?*
6. *Following initial transient, did stabilization of the reactor pressure/level and drywell pressure meet the entre conditions for EOPs?*

The licensee answered questions one through four as 'No' for this event and there is no disagreement among the staff on these answers, thus the staff focused its review on questions five and six. To address both questions, we first determined if the site was still within the 'Scram Response" window for the second scram. The term 'Scram Response,' is defined within NEI 99-02, Revision 7 as *"the period of time that starts with the scram and concludes when operators have completed the scram response procedures and the plant has achieved a stabilized condition in accordance with approved plant procedures and as demonstrated by meeting the following criteria:*

For BWR:

- *No Emergency Operating Procedure (EOP) entry conditions exist related to either the primary containment or the reactor.*
- *Reactor cool-down rates are less than 100 degrees F/hr.*
- *Reactor water level is being maintained within the range specified by plant procedures."*

The licensee stated that they achieved stabilized conditions given the specific bulleted items described in the Scram Response definition within NEI 99-02 and that they were outside of the "Scram Response Time" before the second scram occurred. The staff and inspectors pulled the

operating logs and found that when the site re-entered EOP-1, RPV Control for the second scram, they still had not exited procedure AOP-0001, Reactor Scram Response, which was entered when the first manual scram occurred. Below you can find the procedure timeline gathered from the operating logs:

Time	Procedure
2344	AOP-0006: Condensate and Feedwater Failure (cause of the scram)
2346	EOP-1: RPV Control entered
2349	AOP-0001: Reactor Scram Response and AOP-0002: Turbine Trips entered
2350	AOP-0003: Automatic Isolations entered
0000	EOP-1 and AOP-0002 exited
0006	AOP-0003 exited
0032	EOP-1: RPV Control re-entered
0036	EOP-1, AOP-0001, and AOP-0006 exited

Based on our review, it was determined that the licensee was still in the "Scram Response" window when the second scram occurred and did not meet the 'and' condition within the "Scram Response" definition that states in part, "*and concludes when operators have completed the scram response procedures*", per NEI 99-02, Rev. 7.

For the review of Question #5: *Was Main Feedwater not available or not recoverable using approved plant procedures during the scram response?* The clarifying guidance within NEI 99-02, Rev. 7 states in part, … *"Situations that require maintenance or repair activities or non-proceduralized operating alignments will not satisfy this question."*

The event details gathered from discussions with the inspectors revealed that the reactor feedwater system alignment was not prescribed in approved plant procedures, as they were operating the 'C' feedwater pump on isolated heater strings. As a result of this event, the licensee subsequently identified the reactor feedwater system alignment as an invalid alignment and updated plant procedures to address it. Even if the staff were to have considered the reactor feedwater system lineup as proceduralized, the second 'C' feedwater pump trip revealed that the reactor feedwater system was not in a stable configuration. Because the reactor feedwater system was in a lineup not covered at the time by approved plant procedures and that lineup was not stable in that it resulted in the 'C' feedwater pump trip, the staff determined that the reactor feedwater system could not be considered recovered. Therefore, the answer to question #5 would be 'Yes' and would make the classification of this scram event an USwC.

Question #6 states: *Following initial transient, did stabilization of reactor pressure/level and drywell pressure meet the entry conditions for EOPs?* Clarifying guidance for this question states that:

> *This step is used to determine if the scram was uncomplicated and did not require using other procedures beyond the normal scram response. Following the initial transient, maintaining reactor and drywell pressures below the Emergency Procedure entry values while ensuring reactor water level is above the Emergency Procedure entry values allows answering 'No.' The requirement to remain in the EOPs because of reactor pressure/water level and drywell pressure following the initial transient indicates complications beyond the typical reactor scram. Additionally, reactor water level scram signal(s) during the scram response indicate level could not be stabilized and required this question be answered 'Yes'."*

Additional guidance on how to answer the USwC questions is found in NEI 99-02, Revision 7, App H. For question #6, Page H-21, lines 12-16 state: "*The criteria in this question is used to verify that there were no other conditions that developed during the stabilization of the plant in the scram response related vessel parameters that required continued operation in the EOPs or re-entry into the EOPs or transition to a follow-on EOP."*

In this event, after the licensee experienced the first '1A and 1C' feedwater pump trip on low suction and inserted a manual scram as a response, the operators restarted the 'C' feedwater pump, but failed to un-isolate the 'B' heater string, which caused the 'C' feedwater pump to trip on low suction pressure for a second time. This second 'C' feedwater pump trip caused a full RPS actuation on reactor vessel Level 3 and required a second entry to EOP–001, "RPV Control." The criteria in this question is used to verify that there were no other conditions that developed during stabilization of the plant in the scram response related vessel parameters that required continued operation in the EOPs, re-entry into the EOPs, or transition to a follow-on EOP. Because the operators were attempting to restart the 'C' feedwater pump without the correct alignment, which resulted in a second automatic scram and re-entry to EOP-1, the answer to question #6 would be 'Yes'.

The NRC staff reviewed both previously approved FAQs referenced within this FAQ. Details from FAQ 10-02 are already included in the latest revision of the NEI 99-02, Revision 7 guidance. We also reviewed the event details described in FAQ 18-03: Columbia Unplanned Scram with Complications (ML18144A977). In the Columbia event, the feedwater system remained available and the feedwater level control system automatically responded to the level decrease without any operator action needed. Also, the evolution that caused the brief and minor Level 3 excursion was deliberately conducted via appropriate plant procedure, and there were no other complications before, during, or after the Level 3 deviation that would result in answering one of the NEI 99-02 BWR scram questions as 'yes.' In conclusion, FAQ 18-03 was a plant-specific exemption approved for Columbia and it was determined that it does not apply for this River Bend Station event.

In conclusion, upon reviewing the event details, prior applicable FAQs, and discussing the circumstances surrounding the May 31st, 2019 reactor scram, the staff determined that this event should be classified as an Unplanned Scram with Complications (IE03). No changes to NEI 99-02 needed as a result of this FAQ.