Reactor Oversight Process Whitepaper –
Modification of the Description of Unplanned Scrams with Complications
Performance Indicator to Reflect AP1000 Design

Introduction

For several years, the NRC staff and industry have been discussing potential changes to the Reactor Oversight Process (ROP) to address the AP1000 design, two units of which are under construction by Southern Nuclear at Vogtle 3&4.[1] The AP1000 incorporates passive safety features and other design and terminology differences [2] from plants in use when the ROP was initiated. Through policy papers exchanged with the Commission,[3] the NRC aligned on the extent of changes needed in the ROP performance indicators described in NEI 99-02.[4] In SECY-18-0091, the staff stated its intent to engage with industry to discuss changes to the guidance for the Unplanned Scrams with Complications (USwC) performance indicator (also designated "IE04" in NEI 99-02).

This whitepaper describes changes to NEI 99-02 needed to add AP1000-specific features and terminology to the USwC performance indicator guidance. These changes provide clarity for use with the AP1000 plant terminology, design, and procedures and are in addition to those in FAQ 21-01 [ML21075A282], which approved AP1000 specific footnotes to clarify USwC Flowchart Blocks, "Was power lost to any ESF bus?" and "Was a Safety Injection signal received?" With the submittal of this whitepaper, the ROP Task Force seeks to begin engagement with the NRC as mentioned in SECY-18-0091.

Discussion

Under the ROP, the USwC performance indicator monitors the subset of unplanned automatic and manual scrams that either require additional operator actions beyond that of a normal scram or involve the unavailability of or inability to recover main feedwater during the scram response. Such events or conditions have the potential to present additional challenges to plant operators and therefore, may be more risk-significant than a normal, uncomplicated scram.

The criteria for determining whether a scram is complicated are presented in NEI 99-02, Figure 2, as six questions. (A copy of Figure 2 is included with this whitepaper for the reader's convenience.) A "yes" response to any of the six questions results in classifying the scram as complicated. One set of six questions applies to pressurized water reactors (PWRs); a different set of six questions applies to boiling water reactors (BWRs). With the entry of the AP1000 technology into the operating fleet, the following PWR questions in Figure 2 need adjustment to reflect fundamental differences in design and terminology of the AP1000:

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[1] Overview available at https://www.southerncompany.com/innovation/vogtle-3-and-4.html [retrieved December 27, 2022]

[2] An overview of the AP1000 pressurized water reactor is provided at the following URL: https://www.smartgrid.gov/files/documents/AP_1000_Nuclear_Power_Plant_200808.pdf

[3] For example: SECY-13-0137, *Recommendations for Risk-Informing the Reactor Oversight Process for New Reactors*, December 17, 2013 [ADAMS ML13263A339], its associated Staff Requirements Memoranda SECY-13-0137, dated June 30, 2014; and SECY-18-0091, *Recommendations for Modifying the Reactor Oversight Process for New Large Light Water Reactors with Passive Safety Systems such as the AP1000 (Generation Ill+ Reactor Designs)*, September 12, 2018 [ADAMS ML17166A238]

[4] NEI 99-02, *Regulatory Assessment Performance Indicator Guideline*, Revision 7 (line-in/line-out version), August 31, 2013 [ADAMS ML13261A116]

1. *Did two or more control rods fail to fully insert?*
2. *Was Main Feedwater unavailable or not recoverable using approved plant procedures during the scram response?*
3. *Was the scram response procedure unable to be completed without entering another EOP?*

Application to Scram Screening Questions in NEI 99-02

1. The current screening question for control rods failing to fully insert (NEI 99-02, Rev. 7, page 22, line 34) should be modified to add a remark qualifying AP1000 applicable control rods:

   - Did two or more control rods fail to fully insert? ***(For AP1000 plants: Consider Rod Cluster Control Assembly (RCCAs) Only)***

   The discussion of the NEI 99-02 Rev. 7 screening question for control rods failing to fully insert (page 22, line 36 through page 23 line 2) should be amended with the following text inserted below line 2 on page 23:

   For AP1000 plants, EOP steps justify multiple stuck gray rods would not constitute a complicated scram: ES-0.1 Step 10 Action/Expected Response (AER) checks all RCCAs fully inserted and uses this to determine whether or not to borate per AOP-102, "Rapid Boration". However, the Gray Rod Control Assemblies (GRCAs) are not considered when determining the need to borate, because GRCAs are not considered in the Shutdown Margin (SDM) calculation while in MODE 1 as displayed on On-Line Power Distribution Monitoring System (OPDMS) (OPDMS displays Xe-free conditions with one stuck rod). Per Tech Specs, SDM in Mode 2 with Keff < 1.0, and in Modes 3,4, and 5, the worth of fully inserted gray rods may be included in the SDM calculation if verified fully inserted by two independent means. Because NEI 99-02 Rev 7 Section 2.1 pages 22-23 beginning at line 34 (PWR Flowchart Question for "Did two or more control rods fail to fully insert?") defers to the plant's EOP evaluation criteria, based on whether additional actions are required by operators, no counting of stuck GRCAs is required for this indicator. That is, for AP1000, the question would be "Did two or more Black Control Rods (RCCAs) (excluding GRCAs) fail to fully insert?"

2. The current screening question about "Was Main Feedwater unavailable or not recoverable using approved plant procedures during the scram response?" (NEI 99-02, Rev. 7, page 24, line 4) should be modified to add a remark defining the AP1000 equivalent of Main Feedwater as Main, Cross-Tied, and Startup Feedwater Sources:

   - Was Main Feedwater unavailable or not recoverable using approved plant procedures during the scram response? **(*For AP1000 plants: Were all three of the following unavailable or not recoverable using approved plant procedures during the scram response:***
     (1) Main Feedwater,
     (2) Cross-Tied Feedwater, that is, Main Feed flow through the Startup Feed Control Valves, and
     (3) Startup Feedwater)

The discussion of the NEI 99-02 Rev. 7 screening question about Main Feedwater unavailable or not recoverable using approved plant procedures (page 24, lines 7 through 29) should be amended with the following text inserted below line 29 on page 24:

For AP1000 plants, the safety-related, non-electric, Passive Residual Heat Removal (PRHR) Heat Exchanger functions as Emergency Feedwater. Any AP1000 available or recoverable motor-driven feedwater source protects from complicated scrams requiring safety-related passive cooling.

3. The current screening question about "Was the scram response procedure unable to be completed without entering another EOP?" (NEI 99-02, Rev. 7, page 24, line 31) should be modified to add a remark permitting common and typical AP1000 EOPs used upon a normal uncomplicated scram:

   - Was the scram response procedure unable to be completed without entering another EOP? **(*For AP1000 plants: Use of ES-0.1 and/or ES-0.3 through ES-0.6, and/or Yellow Path procedures, do not constitute a complicated scram.)***

   The discussion of the NEI 99-02 Rev. 7 screening question about scram response procedure unable to be completed without entering another EOP (page 24, lines 33 through 40) should be amended with the following text inserted below line 40 on page 24:

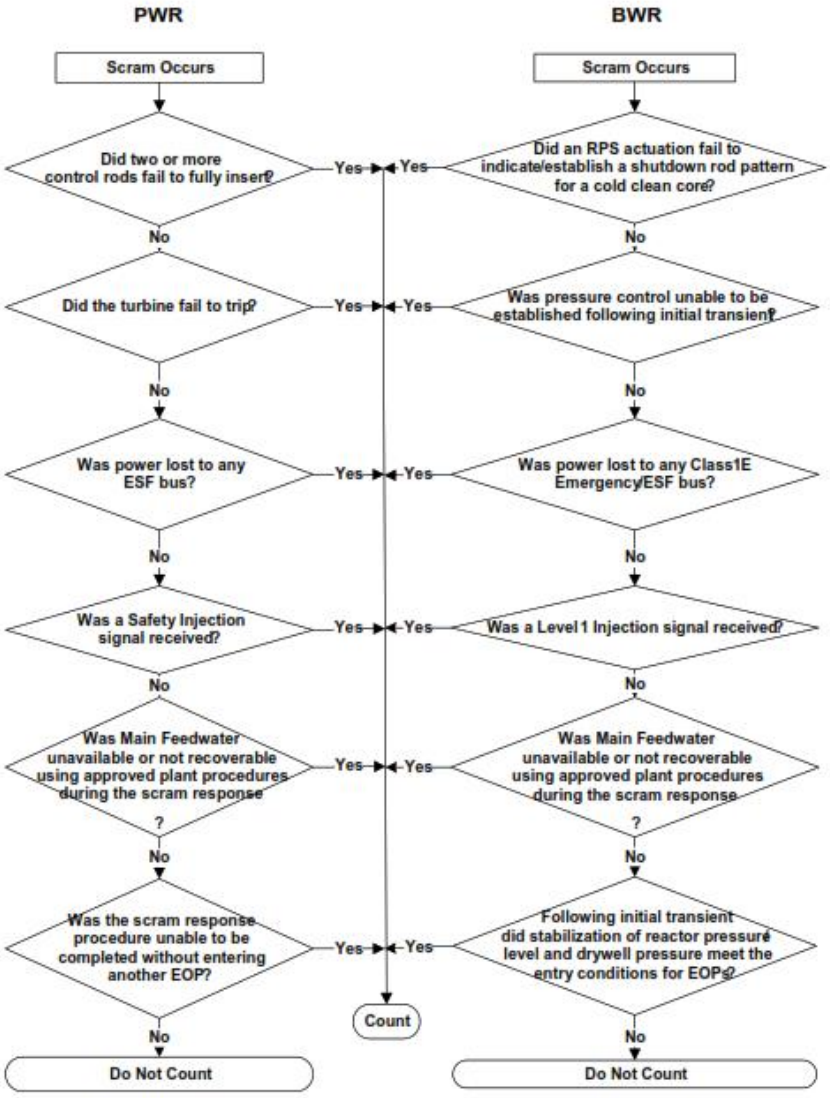
   For AP1000 plants, EOPs ES-0.1, ES-0.3, ES-0.4, ES-0.5, and ES-0.6 are commonly used upon a normal scram, and do not constitute a scram with complications:
   - ***F-0 "Critical Safety Function Status Trees"***
   - ***ES-0.1 "Reactor Trip Response"***
   - ***ES-0.3 "Steam Dump to Condenser"***
   - ***ES-0.4 "Steam Dump to Atmosphere"***
   - ***ES-0.5 "RCS Pressure Control"***
   - ***ES-0.6 "RCS Cooling with RNS"***

   AP1000 normal scrams begin in E-0, and quickly go to ES-0.1. Re-entry to E-0 for a Safeguards is already covered by a previous flowchart block to call a scram with Safeguards complicated. NEI 99-02 Rev. 7, page 24, line 34 is already clear that the use of ES-0.1 is acceptable: "The response to the scram must be completed without transitioning to an additional EOP after entering the scram response procedure (e.g., ES01 for Westinghouse)."

   However, use of F-0, ES-0.3, ES-0.4, ES-0.5, and ES-0.6 should be permitted without deeming the scram as complicated. NEI 99-02 Rev. 7, page 24, line 37 provides "The discretionary use of the lowest level Function Restoration Guideline (Yellow Path) by the operations staff is an approved exception to this requirement." While these EOPs are not yellow-path EOPs themselves, they do practically and functionally replicate yellow-path EOPs.

   Furthermore, ES-0.1 Step 6 AER (and Step 38 Response Not Obtained (RNO)) and Step 40 AER and RNO direct the operator to use ES-0.3 and/or ES-0.4, and Step 7 RNO (and 8 RNO) directs the operator to maintain Reactor Coolant System (RCS) pressure per ES-0.5. ES-0.6 would be used later after a scram

followed by a (controlled) cooldown and depressurization. Previous flowchart blocks for Safeguards/Safety Injection cover uncontrolled cooldowns or depressurizations well before Residual Heat Removal (RNS) cut-in conditions are reached. F-0 is a primarily flowchart-based procedure used by operators to identify potentially appropriate Functional Restoration Guideline procedures, such as yellow-path procedures. Entry into F-0 does not indicate complication.

Finally, procedure NMP-AP-005-004, "Transient Response Procedure User's Guide", Step 4.3.7.4 directs operators to use F-0 and ES-0.3 through ES-0.6 as attachments: "For communication purposes the following procedures may be treated as attachments while in the EOP network: F-0, ES-0.3, ES-0.4, ES-0.5, ES-0.6, and AOPs performed concurrent with EOPs. This includes the use of CPS (Computer Procedure System) or hardcopy procedures." Therefore, use of ES-0.1, F-0, and/or ES-0.3/ES-0.4/ES-0.5/ES-0.6 does not constitute "another EOP" for this flowchart block or constitute a complicated scram.

IE04 Unplanned Scrams with Complications – Flowchart
Figure 2