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) that would be needed to address new reactor designs. The new reactor design that is expected to enter into operation in the near future and then be subject to the ROP is the AP1000, two units of which are under construction at Southern Nuclear's Vogtle site.[1] The AP1000 incorporates passive safety features and other design and terminology differences from the plants in use when the ROP was conceived.[2] Through several policy papers the staff exchanged with the Commission in the past seven years,[3] the NRC aligned on the extent of changes needed in the ROP performance indicators described in NEI 99-02.[4] In the most recent of those policy papers[5], the staff stated its intent to engage with industry to discuss changes to the guidance for one performance indicator in particular, the Unplanned Scrams with Complications (USwC) performance indicator (also designated "IE04" in NEI 99-02). This whitepaper describes the changes in NEI 99-02 needed to add AP1000-specific features and terminology to the guidance for the USwC performance indicator. With the submittal of this whitepaper, the ROP Task Force thus seeks to begin the engagement with NRC the staff 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 attached to 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 coming entry of the AP1000 technology into the operating fleet, the PWR questions in Figure 2 need adjustment to reflect fundamental differences in design and terminology of the AP1000:

1. *Was power lost to any Emergency Safeguards Features (ESF)*[6] *bus*?
2. *Was a safety injection signal received**?***

[1] Overview available at https://www.southerncompany.com/innovation/nuclear-energy/plant-vogtle-3-and-4.html and https://www.georgiapower.com/company/plant-vogtle.html [retrieved August 18, 2020]

[2] An overview of the AP1000 pressurized water reactor is provided at the following URL: https://www.westinghousenuclear.com/new-plants/ap1000-pwr

[3] See, for example: SECY-13-0137, Recommendations for Risk-Informing the Reactor Oversight Process for New Reactors, December 17, 2013, ADAMS ML13263A339, and its associated SRM-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.

[5] SECY-18-0091, page 5.

[6] The acronym "ESF" is used in the current version of NEI 99-02 as an abbreviation of the term "Emergency Safeguards Features" and the term "Engineered Safety Features". The next revision of NEI 99-02 will use the acronym ESF to mean "Engineered Safety Features" throughout.

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Engineered Safety Features and the AP1000

Engineered Safety Features mitigate the consequences of accidents by maintaining the integrity of the fuel cladding, reactor coolant pressure boundary, and primary reactor containment. The AP1000 is designed so that only the Class 1E DC and Uninterruptible Power System (IDS) is required in order to initiate and actuate the systems necessary for maintaining core cooling and containment integrity. The AP1000 ESF systems (Containment, Passive Containment Cooling System, Containment Isolation System, Passive Core Cooling System) use the Class 1E DC and UPS System to provide power for mitigation and control of accident conditions, including a total loss of offsite or onsite AC power. The IDS provides reliable power for the safety-related equipment required for the plant instrumentation, control, monitoring, and other vital functions needed for shutdown of the plant. Loss of power to an IDS bus would result in a safeguards actuation signal and require additional operator actions beyond that of the normal scram.

Application to Scram Screening Questions in NEI 99-02

1. Given the above, the current screening question about losing any ESF bus (NEI 99-02, Rev. 7, page 21, line 15) should be modified to add a remark indicating this question does not apply to the AP1000:
   - **Was power lost to any ESF bus (For PWRs other than AP1000)?**

2. The accompanying discussion of the question in NEI 99-02 (page 21, lines 17-33) should be copied, modified as shown below, and inserted below line 34 with a note indicating it applies only to AP1000 units:
   - **Was power lost to any battery backed Class 1E DC and UPS System (IDS) bus (For AP1000 only)**?

     During a reactor trip or during the period operators are responding to a reactor trip using reactor trip response procedures, was power lost to any battery backed IDS (Class 1E DC and UPS System) bus (e.g., IDSA-DD-1, IDSC-EA-3)? Operator action to re-energize the ESF bus from the main control board is allowed as an acceptable action to satisfy this metric.

     The question is looking for a loss of power at any time for any duration where the bus was not energized/reenergized within 10 minutes. The bus must have:

     - Remained energized until the Reactor Trip response procedure was exited, or
     - Been re-energized automatically (e.g., a standby diesel generator automatically restores IDSA-EA-1 when its inverter is manually bypassed to the Voltage Regulating Transformer), or
     - Been re-energized from normal or emergency sources by an operator closing a breaker from the Main Control Room.

     The question applies to all battery-backed IDS DC and 24- and 72-hour emergency AC busses. This does NOT apply to non-battery-backed IDS busses (e.g., IDSA-EA-2). It is expected that operator action to re-energize a battery backed IDS bus would not take longer than 10 minutes.

3. The current question about receiving a safety injection signal (NEI 99-02, Rev. 7, page 21, line 35) should be modified to add a note indicating this question does not apply to the AP1000:
   - **Was a Safety Injection signal received (For PWRs other than AP1000)?**

4. The accompanying discussion of the question in NEI 99-02 (page 21, lines 35-43 and page 22, lines 1-2) should be copied, modified as shown below, and inserted below line 2 on page 22 with a note indicating it applies only to AP1000 units:
   - **Was a Safeguards Actuation signal received (For AP1000 only)?**[7]

     Was a Safeguards Actuation signal generated either manually or automatically during the reactor trip response? The question's purpose is to determine if the operator had to respond to an abnormal condition that required passive safety injection or respond to the actuation of additional equipment that would not normally actuate on an uncomplicated scram. This question would include any condition that challenged Reactor Coolant System (RCS) inventory, pressure, or temperature severely enough to require passive safety injection.

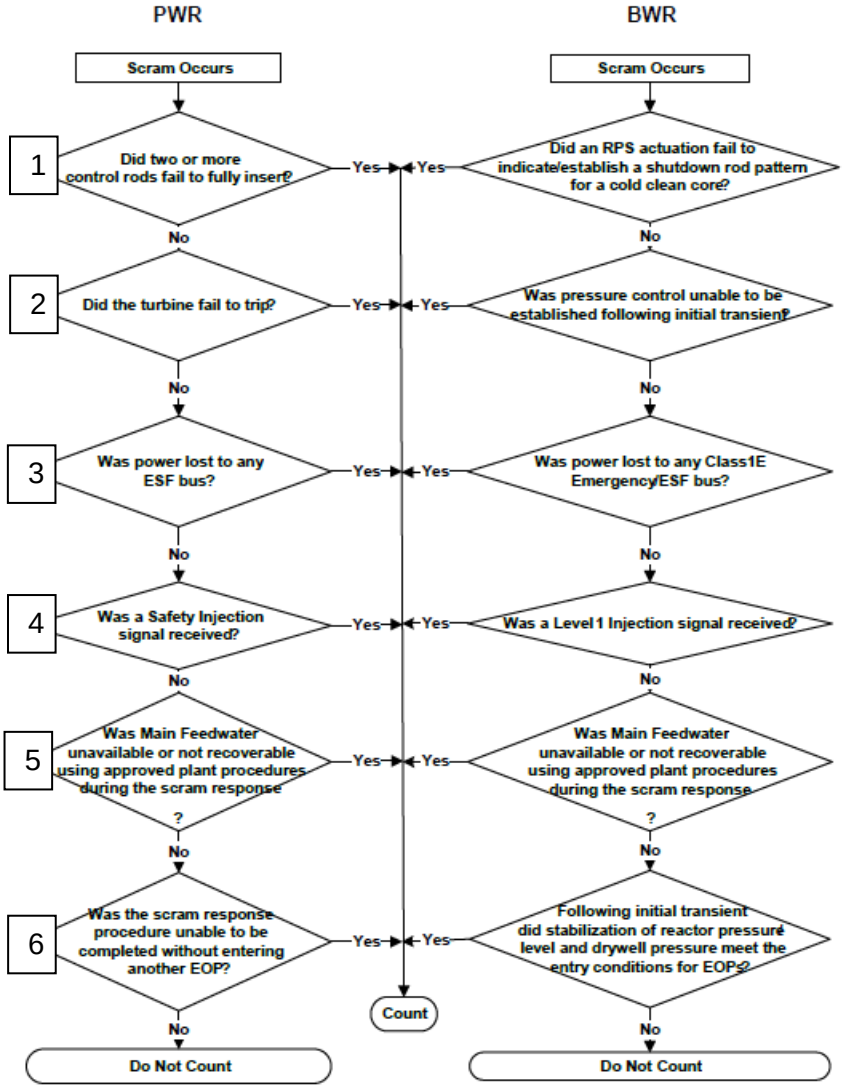
5. Conforming changes are needed in the depiction of PWR scram screening questions in Figure 2, as follows:

   a) For the third decision diamond, which reads, "Was power lost to any ESF bus?", add the following footnote: "For AP1000: Was power lost to any battery backed Class 1E DC and UPS System (IDS) bus?"

   b) For the fourth decision diamond, which reads "Was a Safety Injection signal received?", add the following footnote: "For AP1000: Was a Safeguards Actuation signal received?"

[7] An additional footnote would be added to this question in NEI 99-02 to explain that for the AP1000, a safeguards actuation signal is used in the initiation logic of engineered safety features.

1 **IE04 Unplanned Scrams with Complications – Flowchart**
2 **Figure 2**



3

See footnote[8]

[8] The boxed numbers to the left of each decision diamond do not appear in the original Figure 2. They were added here for ease of reference to the individual questions.