FAQ 22-03: Susquehanna Scram

Plant: Susquehanna Steam Electric Station Unit 2
Date of Event: 10/11/21
Submittal Date:
Licensee Contact: Melisa Krick Tel/email: melisa.krick@talenenergy.com
NRC Contact: Christopher Highley Tel/email: christopher.highley@nrc.gov

Performance Indicator: Unplanned Scrams with Complications

Site-Specific FAQ (see Appendix D)? No

FAQ to Become Effective: when approved

Question Section

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

Page 25, line 26-33

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."

Event or circumstances requiring guidance interpretation:

NRC Position:

While the NRC agrees on the timeline of events and that operators responded in accordance with site procedures, inspectors have concluded that the event should be assessed as an Unplanned Scram with Complications in accordance with NEI 99-02.

From NEI 99-02, "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 initiating event for the scram was a Turbine Generator trip from 94.7% power which caused a reactor scram. All turbine bypass valves (TBV) immediately opened. Three (3) Safety Relief Valves (SRVs) (of the 16 SRVs) opened to help mitigate the reactor pressure rise, as expected. Reactor pressure peaked and turned downward and the open SRVs closed. All control rods inserted. As reactor pressure lowered, the station determined the 'B' Electro-Hydraulic Control (EHC) pressure regulator was stuck which held all bypass valves open. This resulted in reactor pressure continuing to reduce rapidly and operators taking manual action to close the Main Steam Isolation Valves (MSIVs) to stop the rapid pressure reduction.

During an uncomplicated scram where there is no failure of the pressure control system (i.e., turbine bypass valves), the EHC pressure regulator would normally establish reactor pressure at approximately

800 psig which would end the initial transient. Since there was a failure of the pressure regulator in the EHC system, reactor pressure continued to decrease below 800 psig, which was beyond the pressure expected for the initial transient. Operators recognized that the pressure control system (i.e., turbine bypass valves) was not functioning and closed the MSIVs per station procedures.

It is correct that additional SRV cycling was not required post-scram. Due to the initial failure of the turbine bypass valves, which resulted in pressure lowering to approximately 550 psig, operators had sufficient time to mitigate the pressure rise using HPCI/RCIC and steam line drains.

It is also important to note that another question in the BWR flowchart asks, "Was Main Feedwater not available or not recoverable using approved plant procedures during the scram response?" While plant procedures would have allowed the use of main feedwater, the use of the system had it been needed would have further complicated the scram. Specifically, to use main feedwater the MSIVs would have needed to be reopened. Due to a failure of the B EHC pressure regulator, opening of MSIVs would have caused further excessive cooldown without securing of the EHC system. The specific failure mode of the pressure regulator was determined to be a stuck closed isolation valve, which locked in a high pressure to the sensor. This pressure in the line slowly lowered as the line cooled to ambient temperature, and ~1 hour into the event the pressure had dropped to below the setpoint of the A EHC pressure regulator. As such, the restoration of feedwater anytime in the first hour of the event would have required securing of the EHC system. While inspectors agree with answering "No" to this specific question, because narrowly focused feedwater was able to be recovered, it highlights the impact the failure of the pressure control system had on the nature of event response.

NRC Conclusion:

The failure of the pressure regulator in the EHC system results in a "Yes" response for a failure of the pressure control system to maintain reactor pressure since turbine bypass valves were unable to maintain reactor pressure and thus required operators to manually close the MSIVs to stop the rapid pressure reduction. The failure of the EHC system and manual closure of the MSIVs to maintain reactor pressure was a complication beyond the normal reactor trip response.

Site Position:

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

The initiating event for the scram was a Turbine Generator trip from 94.7% power which caused a reactor scram. All turbine bypass valves (TBV) immediately opened, completing their safety function. Three (3) Safety Relief Valves (SRVs) (of the 16 SRVs) opened to help mitigate the reactor pressure rise, as expected. Reactor pressure peaked and turned downward and the open SRVs closed. All control rods inserted as expected during the scram. As reactor pressure lowered, the 'B' Electro-Hydraulic Control (EHC) pressure regulator stuck which held all bypass valves open. This resulted in reactor pressure continuing to reduce rapidly and Operators taking manual action to close the Main Steam Isolation Valves (MSIVs). Following the initial transient, operators established pressure control in accordance with EO-000-102, RPV Control, which is entered as part of a normal scram response. Approximately eight (8) minutes following the reactor scram, pressure control was established using Main Steam Line Drains with reactor pressure at ~880 psig. This did not require using any procedures beyond the normal scram response. Approximately 30 minutes following the reactor scram, High Pressure Coolant Injection (HPCI) was placed into pressure control mode at ~950 psig to support pressure control while maintaining steady RPV level control. The scram response procedure, EO-000-102, RPV Control, was also used by Operators to place Reactor Core Isolation Cooling (RCIC) in service to control Reactor Pressure Vessel (RPV) level. Subsequent to the MSIV closure, the Turbine Bypass Valves automatically closed. Later in the scram response, the MSIVs were re-opened and pressure control was transferred to the Turbine Bypass Valves. Figure 1 below is provided for reference to key parameter response during the event.

As discussed above, the following is Question 2 and the associated response to each portion of the question.

"To be successful, reactor pressure must be controlled following the initial transient without the use of Safety Relief Valves (SRVs)."

SSES Response:

Three (3) Safety Relief Valves (SRVs) out of sixteen (16) lifted, as expected, during the initial transient to mitigate the pressure rise in the reactor. No additional SRV actuations occurred automatically or manually beyond the initial transient. Pressure control was established following the initial transient through the use of Main Steam Line Drains to the condenser and the use of High Pressure Coolant Injection (HPCI) in pressure control mode. Susquehanna FSAR Chapter 7.3 identifies pressure control mode as an option for HPCI when the Main Steam Isolation Valves (MSIV) are closed. Pressure control was established by the Operators in accordance with the standard scram response procedure, EO-000-102, RPV Control. Alternate Pressure Control strategy is regularly exercised in requalification training by the operators. The operating crew demonstrated proficiency in this task during the event by establishing Main Steam Line (MSL) drain operation in approximately 8 minutes following the reactor scram and approximately 5 minutes following the manual MSIV closure. At Susquehanna Steam Electric Station (SSES), Alternate Pressure Control Systems are readily implemented from the Control Room with the use of staged hard cards from their applicable operating procedures. Therefore, the answer to this statement is "No."

"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."

SSES Response:

Three (3) SRVs out of sixteen (16) lifted, as expected, during the initial transient to mitigate the pressure rise in the reactor. No additional SRV actuations occurred automatically or manually beyond the initial transient. Therefore, the answer to this statement is "No."

"Additionally, the SRV(s) cannot fail open."

SSES Response:

Three (3) SRVs out of sixteen (16) lifted, as expected, during the initial transient to mitigate the pressure rise in the reactor. No additional SRV actuations occurred automatically or manually beyond the initial transient. No SRV(s) failed open. 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."

SSES Response:

Pressure control was established following the initial transient through the use of Main Steam Line Drains to the condenser and the use of High Pressure Coolant Injection (HPCI) in pressure control mode. As designated in the NEI 99-02 statement above, HPCI is an acceptable pressure control method when MSIVs close. Pressure control was established by the Operators in accordance with the standard scram response procedure, EO-000-102, RPV Control. Alternate Pressure Control strategy is regularly exercised in requalification training by the operators. The operating crew demonstrated proficiency in this task during the event by establishing Main Steam Line (MSL) drain operation in approximately 8 minutes following the reactor scram and approximately 5 minutes following the manual MSIV closure. At SSES, Alternate Pressure Control Systems are readily implemented from the Control Room with the use of staged hard cards from their applicable operating procedures. Successful pressure control resulted in no additional SRV(s) lifting beyond the initial transient. Therefore, the answer to this statement is “No.”

Site Conclusion:

Pressure control was established by operators following the initial transient in accordance with the normal scram response procedure, EO-000-102, RPV Control. The use of Main Steam Line Drains and HPCI to control pressure beyond the initial transient were the methods utilized by the Operators. This strategy is aligned with the pressure control methods discussed in NEI 99-02 and resulted in no subsequent SRV lifts beyond the initial transient. Therefore, SSES maintains that question #2 is a “No” response.

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 FAQs:

FAQ 18-01 – “Definition of Initial Transient”
FAQ 20-01- “Nine Mile Point Scram”

Response Section

Proposed Resolution of FAQ:

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

PRA update required to implement this FAQ?
No

MSPI Basis Document update required to implement this FAQ?
No

Figure 1: Reactor Pressure Control