FAQ 23-01 (Rev. 1)
DC Cook Unit 1 Unplanned Scram Exemption Request

Plant:	DC Cook	
Date of Event:	May 24, 2022	
Submittal Date:	February 22, 2023 (rev. 1)	
Licensee Contact:	M. Scarpello	Tel/email: mkscarpello@aep.com
NRC Contact:	Paul Zurawski	Tel/email: paul.zurawski@nrc.gov

Performance Indicator:

IE01 – Unplanned Scrams Per 7,000 Critical Hours

Site-Specific FAQ (see Appendix D)? Yes. This FAQ is submitted to request an exemption from the current guidance due to unique conditions.

FAQ to become effective when approved.

<u>Question Section</u>

NEI 99-02, Rev. 7 Guidance to be referenced for the one-time exemption request (including page and line citation):
Page number and line citations are from the copy of NEI 99-02, Revision 7 posted on the ROP Program Document Page of the NRC website.

- Section 2.1 Initiating Events Cornerstone, page 11, lines 6 – 19; "Definition of Terms"
- Section 2.1 Initiating Events Cornerstone, page 12, line 1 - 2; "Clarifying Notes"
- Appendix C, Background Information and Cornerstone Development, page C-1, lines 10 – 33; "Initiating Events Cornerstone"

Event or circumstances requiring guidance interpretation:

This FAQ is submitted to request a one-time exemption from the guidance related to "Unplanned Scrams Per 7,000 Critical Hours" for DC Cook. The request made is due to the unique circumstances of the event, which led operators to shut down the reactor by performing a manual reactor trip following a manual trip of the main turbine due to high vibrations. The high vibrations were encountered while attempting to return the unit to service following substantial maintenance on the high-pressure turbine. The maintenance activities are not optional and are critical to maintain the turbine. The scope of maintenance involved the complete replacement of all interstage and shaft gland labyrinth seals. Significant "rubs" within the turbine are expected to occur during startup following this maintenance that may result in vibration issues. The reactor shut down was performed at approximately 12 percent power, prior to synchronizing the generator to the electrical grid to conclude the refueling outage.

Sequence of Events

Following conclusion of refueling outage maintenance activities, operators manually tripped the main turbine on three occasions during activities to return the unit to service while following procedures for normal turbine generator startup:

- On 5/23/22 at 0620 hours: During the first turbine roll, the main turbine experienced elevated vibrations at approximately 500 rpm and operators manually tripped the turbine. The turbine rotor experienced a rub, which caused the shaft to bow.

- On 5/23/22 at 1420 hours: During the second turbine run, thrust bearing metal temperatures increased above operating limits at 1800 rpm and operators manually tripped the turbine. The cause of the increased temperatures was due to inadequate thrust bearing clearance.

- On 5/24/22 at 0403 hours: During the third turbine run, the main turbine experienced elevated vibrations and operators manually tripped the turbine in accordance with annunciator response procedure. The turbine was tripped during speed escalation through the first critical speed band at approximately 1221 rpm. The turbine rotor experienced a rub, which caused the shaft to bow.

- On 5/24/22 at 0414 hours: Following the manual turbine trip, the turbine speed lowered down through the first critical speed band, which exacerbated the rub. Due to reaching procedure pre-established vibration limits to preclude damage to the turbine, operators shut down the reactor by performing a manual reactor trip from approximately 12% power in accordance with DC Cook normal practice to permit breaking condenser vacuum in the main condenser in order to achieve a turbine speed below the first critical band as quickly as possible. Manually tripping the reactor was an understood planned response when vibrations reached pre-established limits, to aid in slowing the turbine much faster than with the turbine condenser under vacuum conditions. The planned manual reactor trip went as expected with no abnormal equipment response. Initially, decay heat was removed by the condenser steam dump system. As part of the planned sequence of activities, decay heat removal from the condenser steam dump system was transferred to the atmospheric steam dumps (SG PORV) as expected. This is done by the operators taking the controllers that were in automatic operation mode and at the normal setpoint of approximately 1025 psig and lowering the SG PORV controller pressure setpoints to closely match steam generator pressure to accept load. The steam generator stop valves were closed in preparation to break condenser vacuum. Following closure of the stop valves, the decay heat flow path was to the steam generator SG PORVs. RCS temperature stabilized, as expected. There were no equipment challenges or other issues present until condenser vacuum was re-established, as the unit could be cooled down and depressurized to Mode 5 with Residual Hear Removal (RHR), if desired. Condensate Storage Tank levels were normal and make-up sources remained available with ample capacity to replenish the condensate consumed by remaining on the Steam Generator PORVs to remove decay heat.

- On 5/24/22 at 0425 hours: Operators broke main condenser vacuum in accordance with the normal operating procedure. The procedure provides direction for breaking main condenser vacuum under specific conditions, which include turbine vibration limits (high-high vibrations (14 mils)), to prevent damage. The steam dump system was functional and available for use at a time when condenser vacuum was re-established.

- On 5/30/22 at 0539 hours: Following inspections and repairs to the main turbine, Unit 1 synchronized to the electrical grid.

Additional Information

The circumstances of attempting to return the unit to service following a refueling and maintenance outage that involved a manual reactor trip were not severe enough and unlikely to cause an initiating event, based on plant conditions at the time.

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

The NRC resident/region are in agreement with the licensee on the facts and circumstances surrounding or submitting this FAQ.

Additionally, the corresponding Licensee Event Report (LER) 315/2022-001-00 "Manual Reactor Trip Following Manual Turbine Trip Due to High Vibrations on Main Turbine" was reviewed in accordance with IP 71153. This review recommended the LER to be closed during the 4Q2022 Integrated Baseline Inspection exit meeting in January 2023, with no Findings or Violations.

Potentially relevant existing FAQ numbers:

There were no relevant FAQs that reflect similar requests or resolution for IE01 "Unplanned Scrams Per 7,000 hours."

<u>Response Section</u>

Proposed resolution of FAQ:

This FAQ is proposed as a one-time exemption for not counting the subject event as an unplanned scram for DC Cook, due to the unique circumstances of the event that led operators to perform a manual reactor trip.

Unit 1 had recently completed a refueling and maintenance outage. There was substantial critical maintenance completed on the high-pressure turbine that could not have been eliminated. The scope of maintenance involved the replacement of all interstage and shaft gland labyrinth seals. This maintenance is certain to produce "rubs" which result in vibration issues during startup. Following completion of critical maintenance activities on the turbine, the first opportunity and only method to verify effectiveness is during low power levels necessary to operate the machine at prescribed or rated speed. The manual reactor trip occurred prior to synchronizing to the electrical grid at a low power level of approximately 12 percent. Manually tripping the reactor was an expected response in the event that vibration levels reached pre-established limits in order to prevent damage to the turbine and is similar to the method that DC Cook normally uses to shut down the reactor from a low power level. The DC Cook normal shutdown procedure provides instruction to scram at approximately 17 percent power during normal shut down.

The manual turbine trip due to excessive vibrations and the shut down by manual reactor trip that followed was a known contingency to prepare to break condenser vacuum, as necessary, to protect large capital equipment. DC Cook plant relies on the Auxiliary Feedwater System (AFW) to provide dedicated feedwater flow that is not dependent upon main condenser vacuum to operate, unlike the turbine driven main feedwater pumps. The AFW system has a feedwater flow capacity limited to approximately 4 percent power. The SG PORVs have the capacity to remove decay heat up to approximately 10 percent power. Based on the design of the plant and reactor power level as described above, it is an expected response to pre-emptively, manually shut down the reactor to a power level that is within the capability of the AFW system to maintain steam generator levels, prior to breaking main condenser vacuum.

The SG PORVs are used as a normal mode of pressure and temperature control during conditions when condenser vacuum is unavailable. The SG PORV controllers are normally set in automatic operation at a pressure setpoint of 1025 psig. The condenser steam dump controllers are normally operated at a pressure setpoint of 1005 psig. The procedure steps taken prior to breaking condenser vacuum require closing the steam generator stop valves which transfers the decay heat flow path from the condenser steam dumps, allowing steam pressure to slightly rise, and open the SG PORVs at steam pressure setpoint. The SG PORV controllers produce a modulating output demand signal to gradually open and close the valves, as opposed to cycling full open or closed.

Under normal circumstances, main condenser vacuum is maintained until the main turbine generator decelerates to 10 percent of rated speed (180 rpm) to prevent damage to the low-pressure turbine last stage blades. When reaching procedure pre-established vibration limits, the main condenser vacuum breakers can be opened at any speed. High vibrations levels occurred as the turbine speed lowered down through the first critical speed band which is above 180 rpm.

Operator actions and power levels during normal power reduction to take the unit offline and during the event when the high turbine vibrations occurred are similar. During normal power reduction activities, operators plan to manually trip the reactor at approximately 17 percent power to bring the unit to hot standby conditions in a controlled manner. Similarly, the unit was at approximately 12 percent power during the manual reactor trip following a manual turbine trip due to high vibrations which did not upset plant stability.

The manual reactor trip was discussed by plant control room operators as a planned action if vibrations reached pre-established procedural vibration limits. The plant shut down was expected given the plant power level to support alignment of the plant to break condenser vacuum and quickly slow the main turbine.

There were no equipment failures or human performance events that led to the manual reactor trip.

Counting the scram where it was expected and pre-established contingency limits are met against the performance indicator as unplanned, is a disincentive to performing critical maintenance. Post maintenance testing of the main turbine can only be achieved at power levels necessary to operate the machine at prescribed or rated speed. This one-time exemption is appropriate due to these unique circumstances.

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

No. This FAQ is requesting a one-time, site-specific exemption from the current guidance due to unique conditions.

PRA update required to implement this FAQ? No.

MSPI Basis Document update required to implement this FAQ? No.

Proposed NRC Response:

The NRC staff completed 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 and other headquarters staff.

The purpose of IE01, "Unplanned Scrams per 7,000 Critical Hours," performance indicator, as stated in NEI 99-02, Revision 7 and IMC 208 Attachment 1 is as an indicator that monitors the number of unplanned scrams.

The review of this FAQ will focus on interpreting the following sections of NEI 99-02, Revision 7 to determine if the DC Cook event should be exempt from being counted as an unplanned scram due to extenuating circumstances:

- Section 2.1 Initiating Events Cornerstone, page 11, lines 6 – 19; "Definition of Terms"
- Section 2.1 Initiating Events Cornerstone, page 12, line 1 - 2; "Clarifying Notes"
- Appendix C, Background Information and Cornerstone Development, page C-1, lines 10 – 33; "Initiating Events Cornerstone"

<u>NEI 99-02, Revision 7, Section 2.1 Initiating Events Cornerstone, "Definition of Terms"</u>

> ***<u>Definition of Terms</u>***
>
> ***Scram*** *means the shutdown of the reactor by the rapid addition of negative reactivity by any means, e.g., insertion of control rods, boron, use of diverse scram switch, or opening reactor trip breakers.*
>
> ***Unplanned scram*** *means that the scram was not an intentional part of a planned evolution or test as directed by a normal operating or test procedure. This includes scrams that occurred during the execution of procedures or evolutions in which there was a high chance of a scram occurring but the scram was neither planned nor intended.*

__Criticality__, for the purposes of this indicator, typically exists when a licensed reactor operator declares the reactor critical. There may be instances where a transient initiates from a subcritical condition and is terminated by a scram after the reactor is critical—this condition would count as a scram.

It is the NRC staff's position that the DC Cook scram on May 24, 2022, was an unplanned scram by the definition stated in NEI 99-02, Revision 7. The FAQ states,

"Manually tripping the reactor was an expected response in the event that vibration levels reached pre-established limits in order to prevent damage to the turbine and is similar to the method that DC Cook normally uses to shut down the reactor from a low power level."

The expected response described in the FAQ would only happen in the event of high vibrations outside of pre-established limits which would indicate that a scram was a possibility and not a certainty. NEI 99-02 Revision 7, Section 2.2 Initiating Events Cornerstone, "Clarifying Notes," gives examples of the types of scrams that are/are not included. An example of a scram that is included is shown below:

A scram that occurs during the execution of a procedure or evolution in which there is a high likelihood of a scram occurring but the scram was neither planned nor intended.

It is the staff's position that this example applies to the DC Cook scram. While there may have been a high likelihood of a scram it was not the planned or intended outcome, but rather as a contingency. An example of a scram that would not be included, according to NEI 99-02, Revision. 7, is shown below:

Scrams that are planned to occur as part of a test (e.g., a reactor protection system actuation test), or scrams that are part of a normal planned operation or evolution.

This example would not apply to the DC Cook scram because, while in the example a scram is an intended or directed outcome of a test, in this case it was planned as a response to potential turbine conditions and not as a specified and intended action of the evolution.

Appendix C, Background Information and Cornerstone Development, page C-1, lines 10 – 33; "Initiating Events Cornerstone"

GENERAL DESCRIPTION

The objective of this cornerstone is to limit the frequency of those events that upset plant stability and challenge critical safety functions, during shutdown as well as power operations. When such an event occurs in conjunction with equipment and human failures, a reactor accident may occur. Licensees can therefore reduce the likelihood of a reactor accident by maintaining a low frequency of these initiating events. Such events include reactor trips due to turbine trip, loss of feedwater, loss of offsite power, and other reactor transients. There are a few key attributes of licensee performance that determine the frequency of initiating events at a plant.

PERFORMANCE INDICATORS

PRAs have shown that risk is often determined by initiating events of low frequency, rather than those that occur with a relatively higher frequency. Such low-frequency, high-risk events have been considered in

> selecting the PIs for this cornerstone. All of the PIs used in this cornerstone are counts of either initiating events, or transients that could lead to initiating events (see Table 2 in the main body of NEI 99-02). They have face validity for their intended use because they are quantifiable, have a logical relationship to safety performance expectations, are meaningful, and the data are readily available. The PIs by themselves are not necessarily related to risk. They are however, the first step in a sequence which could, in conjunction with equipment failures, human errors, and off-normal plant configurations, result in a nuclear reactor accident. They also provide indication of problems that, if uncorrected, increase the risk of an accident. In most cases, where PIs are suitable for identifying problems, they are sufficient as well, since problems that are not severe enough to cause an initiating event (and therefore result in a PI count) are of low risk significance. In those cases, no baseline inspection is required (the exception is shutdown configuration control, for which supplemental baseline inspections is necessary).

The May 24, 2022, DC Cook reactor scram was an initiating event, and the objective of the initiating events cornerstone is to limit the frequency of those events that upset plant stability and challenge critical safety functions, during shutdown as well as power operations. When such events occur in conjunction with equipment and human failures, a reactor accident may occur.

Considering the objective of the initiating events cornerstone and the circumstances of the scram being of high likelihood as opposed to an inevitable function of the evolution, the staff does not approve of a one-time exemption of IE01 – Unplanned Scrams per 7,000 hours.