

Technical Specification Change Evaluation: TS 4.2.a.2 and 4.2.g

Summary Description

On November 5, 2020, the Nuclear Regulatory Commission (NRC) staff notified Purdue University that the Purdue University Reactor Number One (PUR-1) had an issue in the Technical Specifications (TS) that precludes operation of the reactor. In short, TS 4.2.a.2 as supplemented (ML187282A192) and approved (ML18262A434) reads:

A power calibration by foil activation shall be performed annually, with no interval to exceed 15 months. The power calibration may be deferred with CORO approval during periods of reactor shutdown, but shall be performed prior to startup.

Additionally, TS 4.2.g reads (which is verbatim from ANSI/ANS 15.1):

Appropriate surveillance testing on any technical specification required system shall be conducted after replacement, repair, or modification before the system is considered operable and returned to service.

However, there is no way to perform the required power calibration without operating the reactor. TS 3.2, Limiting Conditions for Operation of the Reactor Safety System, requires that “the reactor safety channels and safety-related instrumentation shall be operable in accordance with Tables I and II including the minimum number of channels and the indicated maximum or minimum set points.”

Therefore, the NRC staff believes that any operation of the PUR-1 before the foil calibration is complete will result in a Technical Specification Violation, and that the calibration is itself prevented because the uncalibrated instruments prevent operation of the reactor. They believe, therefore, that a License Amendment Request is required by the licensee or a violation will occur.

Detailed Description

This evaluation and associated letter requests amendment No. 16 to the Technical Specifications for the PUR-1 as mandated by NRC staff in order to operate the PUR-1 without violation.

Specifically, amendments to Technical Specification 4.2.a.2 and 4.2.g, are requested to add an additional descriptor addressing the situation whereby one or all the safety-related instruments has not been calibrated, but requires reactor operation for the calibration.

The proposed new TS 4.2.a.2 would read:

A power calibration by foil activation shall be performed annually, with no interval to exceed 15 months. The power calibration may be deferred with CORO approval during periods of reactor shutdown, but shall be performed **as soon as practicable after reactor startup**.

And TS 4.2.g is proposed to read:

Appropriate surveillance testing on any technical specification required system shall be conducted after replacement, repair, or modification before the system is considered operable and returned to service **unless reactor operation is required for the performance of the surveillance, whereby it shall be done as soon as practicable after reactor startup.**

In some scenarios, such as those described above, the operation of the PUR-1 may be required to perform the initial calibration of channels following maintenance, detector replacement, movement of a detector, or extended shutdown.

While there is no definition of the word startup, it is taken to mean that period of operations which is performed first, at the start. A reactor operation is when the reactor is operating. Reactor operation, as defined by TS 1.29 is when the reactor is not shutdown or secured. Due to the nature of a foil irradiation for power calibration, that is requiring the reactor to be at a sufficient power level for the calibration, the reactor must be operating to perform the surveillance.

The Technical Specification 4.2.a.2 change clarifies that operations are permitted without a current power calibration for the purpose of performing that calibration. There is simply no other way to perform the calibration without taking the reactor to power. Due to the low operating power of the PUR-1, other methods such as thermal calibration are not physically realizable. It is noted though, that reactor operations would be necessary for that scenario as well. It is the responsibility of the licensee to create a procedure to perform that calibration in a way that is in accordance with the other Technical Specifications and meets safe operating practices. In practice, this implies a gradual approach to power starting from some nominal value and incrementally approaching full power operations.

There is strong precedent for this change. The Technical Specifications and bases for the Dow Triga Research Reactor, R-108, Docket No. 50-264 (ML12137A171) has nearly identical language: "Surveillance requirements may be deferred during reactor shutdown...however, they shall be completed prior to reactor startup unless reactor operation is required for performance of the surveillance. Such surveillance shall be performed as soon as practicable after reactor startup." Similar language exists in the Reed College Technical Specifications (ML120530021), Missouri S&T Technical Specifications (ML090140520), University of Utah (ML112500333), and others. While precedent does not itself demonstrate the acceptability of a proposed amendment, it should provide NRC staff with information about how the agency has treated similar changes in the past. For example, licensee R-79 (Missouri S&T) appears to have added the "as soon as practicable" language as part of the 20-year renewal in the mid-2000s. There were no RAIs issued as part of that renewal which addressed this change likely due to its obvious nature. Their former language read, "Surveillance tests...may be deferred during reactor shutdown; however, they must be completed prior to or at the time of the next reactor startup." That change was found acceptable by the NRC staff to satisfy the requirements in 10 CFR 50.36(d)(3).

On November 5, 2018, the NRC transmitted by letter a Request for Additional Information Regarding the Renewal of Operating License No. R-125 (ML18253A088) which contained on Page 26 of 52 a reference to ANSI/ANS-15.1 Section 4. The request calls for the licensee to "Provide a TS requiring that appropriate surveillance testing on any TS-required system shall be

conducted after replacement, repair, or modification before the system is considered operable and returned to service, regardless of when the TS-required surveillance for that system was last performed or when it is next due. Alternatively discuss why no such TS is required” in RAI-14.4.1. Additionally, the letter asks in RAI 14.4.2, “it should also be specified which activities shall be performed prior to reactor operation.” Similar to Purdue, that licensee simply added the requested language by response on March 5, 2019 (ML19064B375 and ML19064B376). The new proposed specification reads “Surveillance requirements may be deferred during reactor shutdown... however, they shall be completed prior to reactor startup unless reactor operation is required for performance of the surveillance. Such surveillance shall be performed as soon as practical after reactor startup.” Notably, TS 4.0.B does not include an action statement, “The appropriate surveillance testing on any Limiting Condition of Operation required equipment shall be conducted after replacement, repair or modification before the equipment is considered operable and returned to service.” These examples of other research reactors set a licensing precedent that the NRC staff have found acceptable. The proposed Purdue change is consistent with these prior licensing actions.

Operation of the reactor at power is required in order to perform a power calibration. Operation of the reactor to perform the channel calibration is not inimical to public health and safety for several reasons. Fuel integrity is maintained by ensuring its temperature remains below 530C. The Safety Analysis Report shows that operations up to 12 kW (120% operating power level) will not cause excess fuel temperature. The principal concern is that a high-power scram may not occur at 120% true power if the channels are not calibrated correctly. Table I of the Technical Specifications requires two channels to be on scale at start-up. That requirement is not altered in this License Amendment Request. By requiring that at least two channels are on scale, the Reactor Operator will know the relative power at which the reactor is operating and that the instrumentation is responding correctly to a changing neutron flux. Additionally, the prestart checklist confirms response of the low power channel to changing reactor conditions. Historical knowledge of the facility has shown that with an initial count rate of at least two counts per second on Channel 1, the reactor reaches criticality with several thousand counts per second or a power level of not more than 0.1% (10 W), but typically as low as 0.001% (0.1 W). Based on this historical knowledge, the operator is then able to compare the power level at which the reactor becomes supercritical and understand the change of the relative from this nominal starting point. At this low power level, simply by comparing the initial indications of the two “on-scale” channels with the operating power level of those two channels, the operator is able to monitor the status of the facility. The operator may then maintain the power level to obtain the first calibration point as set forth in the procedure. In the event of an unexpected transient, the reactor operator would have ample time to initiate a manual scram and stop the increase in reactor power without violating any limiting factor and radiation levels remain low. These lower power operations are therefore safe because of the operator is able to monitor reactor status and intervene if necessary.

There are other protection mechanisms available which do not depend on the absolute reactor power measurement. The electronic calibration ensures, in part, that the protection system is capable of initiating a scram on high change rate. If the maximum change rate (15%/s) were initiated from a power level of 100 W (10 times higher than that discussed above) the operator

would have over 30 seconds before the reactor exceeded the licensed power level of 12 kW. 30 seconds is sufficient time for an operator to recognize the transient and initiate a manual scram (which is fully executed not more than 1 second after initiation and is an independent circuit from the instrumentation scram signals). Additionally, other protection systems such as the Radiation Area Monitor (located at the pool top) measure the exposure rate to facility personnel and are capable of intervening if an unsafe condition develops. The Radiation Area Monitors are independently calibrated with an external source.

The Technical Specification requirement “as soon as practicable” prohibits any other reactor operations other than those to perform the power calibration. This conditional ensures the only operation following replacement, repair, or modification is to perform the power calibration and before continuing normal work.

The Technical Specifications in Section 6.4 require certain special procedures, including those for surveillance calibrations. A specific procedure is required to fulfill the requirements of a startup following a system change that makes a safety related channel inoperable and perform its calibration. CORO is required to approve all procedures listed in TS 6.4. The approved PUR-1 power calibration procedure dictates the reactor is operated to obtain at least five power calibration points, each at incrementally increasing levels. This provides a slow and controlled approach to full power.

Regulatory Evaluation

The complete replacement of the PUR-1 instrumentation and control system appears to be a unique occurrence among the non-power utilization facilities. There are no precedent setting licensing action, topical reports or similarly relevant LARs that would pertain to the non-calibrated status of the entire system. However, the process for returning to operations following fuel conversion was safely completed. At that time, NRC staff were aware of operations with uncalibrated reactor channels as the issuance of the order modifying the facility operating license (ML071920168) safety evaluation specifically references reactor start-up testing and permits operations with a licensee-controlled start-up procedure.

Environmental Consideration

This Technical Specification does not include any change to facility design or layout. The change will allow operations of the facility such that the initial instrument calibration can be performed. This does not require an environmental impact statement or environmental assessment. The changes involve use of facility equipment located within the restricted area as defined in 10 CFR 20 and changes to surveillance requirements. There is no significant increase in the amounts or types of any effluents that may be released off site and no significant increase in individual or cumulative occupational radiation exposure.