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25 October 2018

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn.: Document Control Desk

Subject: Response to Request for Additional Information for Nuclear Safety System Upgrade License Amendment Request (CAC #MF5003, EPID #L-2016-LLA-0003)

The Massachusetts Institute of Technology (MIT) hereby submits a response to the August 30, 2018, Request for Additional Information (RAI) on the License Amendment Request (LAR) to upgrade the Nuclear Safety System at the MIT Reactor (MITR).

Accordingly, MIT provides responses in the following format: the NRC RAI question in italics, followed by the MIT answer in normal font. Wherever necessary, MIT's responses will reference updated supporting documents in various Enclosures.

1. *TS replacement page 3-18 was submitted as part of the original application in a letter dated September 30, 2014, a revised replacement page was submitted as part of the supplement in a letter dated December 14, 2017. The NRC staff compared both of these replacement pages to the page in the license and could not identify any changes aside from the date on the bottom of the page.*

   Identify what changes are desired for page 3-18 and provide a safety basis for that change or withdraw the request to replace page 3-18 from the amendment application.

Response to **RAI #1**:

TS 3.2.3 Reactor Protection System required modification in its Table 3.2.3-1 and in its Basis. This TS contains four pages, ranging from page 3-18 through 3-21. Pages 3-19, 3-20, and 3-21 all required substantive modifications. Since page 3-18 refers to the table on pages 3-19 and 3-20, for completeness of documentation, all four pages were included in the two submittals above, as well as our 3 May 2018 submittal of a follow-up response regarding TS 3.2.3. Page 3-18 required no modification at all, and so is hereby withdrawn.

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2. *TS replacement page 3-19 was submitted as part of the original application in a letter dated September 30, 2014, revised replacements were submitted as part of the supplements with the most recent version submitted in a letter dated May 3, 2018.*

   The NRC staff compared the version submitted as part of the May 3, 2018, supplement to the page in the license to identify the proposed changes to the TS on page 3-19. Specifically the NRC staff compared the revised information in TS 3.2.3, Table 3.2.3-1, "Required Safety Channels," to the license and identified changes that appear to be administrative in nature (renumbering or reordering of items) and changes that were technical in nature and required to support the modification of the NSS and associated RPS input.

   Discuss administrative changes and explain why the changes are administrative in nature.

Response to **RAI #2**:

Comparing the version of Table 3.2.3-1 submitted on 3 May 2018 with the existing Table 3.2.3-1, item #13 ("Period channel level signal off-scale") becomes "Low count rate" for the new system, and in our opinion, is best positioned next to the first two items. Administratively, this groups together in the table the three items which are nuclear safety channel related.

Similarly, item #9 ("Experiment scrams") in the existing table becomes item #17 in the new table, and thus moves to page 3-20. Moving this item allows items #4 through #12 to stay together on the same page, as they are all process system related. This grouping gives the best layout for the table, such that its format-shift coincides with the page break between pages 3-19 and 3-20. Furthermore, the "Experiment scrams" line has its own unique formatting, and is therefore best moved to the end of the table. In summary, all these changes are administrative in nature, and therefore have no impact to safety.

3. *Table 3.2.3-1, item 1, "Period," the "Limiting Setpoint," values appear to be unchanged. The "Min. [minimum] No. Required," value was changed from two to three and superscript (5) was added. The desire to change the minimum number of channels from two to three was stated in the letter dated May 3, 2018, and the rationale for the change was provided in the TS Basis replacement page 3-21. The provided Basis information did not specifically state the impact to safety for this change.*

   Provide a discussion of the impact to safety of changing the minimum number of required channels from two to three.

Response to **RAI #3**:

Changing "Min. [minimum] No. Required" value for "Period" from 2 to 3 more closely and precisely describes the design of the new nuclear safety system, as stated in the letter dated 3 May 2018. The new nuclear safety system consists of four wide-range nuclear safety channels, each of which will produce a trip signal on high power level, short reactor period, low detector count rate, channel in test, or channel fault / equipment malfunction. The system is designed to allow the reactor to be critical with one channel in a tripped (inoperable / out of service) state.

Should any one of the remaining three channels produce a trip, the scram logic system downstream will scram the reactor. This design feature thus ensures there are always three operable channels whenever the reactor is not shut down. Therefore, changing the minimum number of required channels from two to three maintains the designed level of safety, and has a positive impact on safety by requiring more nuclear safety channels to be operable whenever the reactor is operating. Furthermore, requiring a third channel provides additional monitoring of the reactor core flux distribution to ensure safety limits are not exceeded.

The above description is supported by materials docketed in SAR Section 7.2.6(b), which was submitted to NRC as part of the LAR package on 30 September 2014.

4. *TS 3.2.3, Table 3.2.3-1, "Requires Safety Channels," item 2, "Neutron flux level," the "Limiting Setpoint," values appear to be unchanged. The "Min. [minimum] No. Required," value was changed from two to three, the superscript (1) was moved from column two and added to columns five, seven, and nine, a superscript (5) was also added. The desire to change the minimum number of channels from two to three was stated in the letter dated May 3, 2018, and the rationale for the change was provided in the TS Basis replacement page 3-21. The provided Basis information did not specifically state the impact to safety for this change.*

   Provide a discussion of the impact to safety of changing the minimum number of required channels from two to three.

Response to **RAI #4**:

Changing "Min. [minimum] No. Required" value for "Neutron flux level" from 2 to 3 more closely and precisely describes the design of the new nuclear safety system, as stated in the letter dated 3 May 2018. The new nuclear safety system consists of four wide-range nuclear safety channels, each of which will produce a trip signal on high power level, short reactor period, low detector count rate, channel in test, or channel fault / equipment malfunction. The system is designed to allow the reactor to be critical with one channel in a tripped (inoperable / out of service) state. Should any one of the remaining three channels produce a trip, the scram logic system downstream will scram the reactor. This design feature therefore ensures there are always three operable channels whenever the reactor is not shut down. Therefore, changing the minimum number of required channels from two to three maintains the designed level of safety, and has a positive impact on safety by requiring more nuclear safety channels to be operable whenever the reactor is operating. Furthermore, requiring a third channel provides additional monitoring of the reactor core flux distribution to ensure safety limits are not exceeded.

The above description is supported by materials docketed in SAR Section 7.2.6(b), which was submitted to NRC as part of the LAR package on 30 September 2014.

5. *TS 3.2.3, Table 3.2.3-1 has a new item 3 "Low count rate." MIT proposed a limiting setpoint of 5 counts per second (CPS) value for 0, 1, or 2 primary pump operation. MIT failed to provide a safety related explanation or justification for the 5 CPS setpoint.*

   Provide a safety basis supporting the "low count rate" limiting setpoint value.

Response to **RAI #5**:

The "Low count rate" limiting setpoint value of 5 cps is selected by MIT as a minimum count rate that the fission chamber detectors and the DWK 250 neutron flux monitors can be expected to read. MIT uses the Mirion NY-10887 fission chamber detector, which has a thermal neutron response of ~0.1 cps/nv. The detector itself is rated for a target neutron flux ranging from 20 nv to 7×10^{10} nv. Therefore, the minimum count rate that can be measured by a DWK 250 neutron flux monitor connected to a NY-10887 fission chamber is 0.1 cps/nv * 20 nv, i.e., 2 cps. The Technical Specification of 5 cps was selected to give a margin to ensure a visible neutron count rate for each nuclear safety channel. This provides the safety basis supporting the "Low count rate" limiting setpoint value.

The specification for the Mirion NY-10887 fission chamber, describing its designed target neutron flux range, was submitted to NRC as part of the License Amendment Request package dated 30 September 2014, in Section 3.1.1 of the SAR Chapter 7 Appendix.

6. *MIT did not provide any discussion about the desire to change TS 3.2.3, Table 3.2.3-1, "Required Safety Channels," items 3 through 8. The NRC staff identified that items 3 through 8 have been renumbered as 4 through 9, respectively, and relocated to accommodate a new item 3 "Low count rate." The Channel/Parameter, Action, Limiting Setpoint, and Min. No, Required values all appear to be unchanged.*

   Provide a discussion of the impact to safety resulting from the proposed changes.

Response to **RAI #6**:

As pointed out in the response to RAI #2 above, the re-numbering of items 3 through 8 as 4 through 9 is to better categorize the scrams as process-system related. The new nuclear safety system has no impact on the process system scrams and the manual scrams. Therefore the relevant Channel / Parameter, Action, Limiting Setpoint, and Min. No. Required values all remain unchanged for the items which become lines 4 through 9 in the table. This re-numbering is purely administrative in nature, and therefore has no impact to safety.

7. *MIT did not provide any description of the change to TS 3.2.3, Table 3.2.3-1, "Required Safety Channels," item 9, "Experiment scrams." The proposed TS appears to move item 9 to item 17 in TS Table 3.2.3-1 (Continued) "Required Safety Channels," on TS replacement page 3-20. Table 3.2.3-1 (Continued) varies from Table 3.2.3-1 (on page 3-19) in the number of columns present. Table 3.2.3-1 has a limiting setpoint column and minimum number of required channels for conditions based on zero, one, or two pumps operating. Table 3.2.3-1 (Continued) only has one column for setpoint and the minimum number of required channels. Considering the fact that item 9 as it appears in the license merges all of the columns for the limiting setpoint and minimum number of required channels, moving item 9 from Table 3.2.3-1 to Table 3.2.1-1 (Continued), does not change the requirements for item 9.*

   Provide a detailed discussion of the impact to safety resulting from the proposed changes.

Response to **RAI #7**:

As pointed out in the response to RAI #2 above, the re-positioning of item 9 to become item 17 is to better categorize the item as reactor experiment related. The new nuclear safety system has no impact on the Experiment scrams. Therefore, no Channel / Parameter, Action, Limiting Setpoint, or Min. No. Required values are created for this item, and the format for the Experiment scrams remains unchanged. This re-positioning and re-numbering are purely administrative in nature, and therefore have no impact to safety.

8. *TS 3.2.3, Table 3.2.3-1, "Required Safety Channels," items 10, 11, and 12 do not appear to have any revisions, confirm the NRC staff understanding that no changes were intended for TS 3.2.3, Table 3.2.3-1, items 10, 11, and 12 or describe the desired changes and provide a discussion of the impact to safety resulting from the requested changes.*

Response to **RAI #8**:

MIT-NRL confirms that no changes were intended for TS 3.2.3, Table 3.2.3-1, items 10, 11, and 12. These three items are all for process system flow related scrams. The new nuclear safety system has no impact on the process system scrams. Therefore, there is no impact to safety.

9. *On TS replacement page 3-19, footnote 1) discussing the "On-scale neutron flux level" has been replaced with a new footnote 1) discussing the "two out of four" scram logic. MIT provided a safety impact discussion of the change to the scram logic in Chapter 7 of the updated safety analysis report (SAR) submitted as part of the LAR dated September 30, 2014. A description of the change to footnote 1) and the safety impact of the change was not included in the SAR section, the cover letter, or any of the supplemental material. The change in the system response to a low flux level has been significantly impacted by the NSS upgrade. The upgraded NSS will create a scram condition if any two channels have a count rate of less than 5 counts per second (CPS), which prevents power from reaching the shim blade magnets. MIT did not provide an explanation regarding deletion of this footnote.*

   Provide a description about the desire to change footnote 1) including the safety impact of the change.

Response to **RAI #9**:

Shim blade magnet current is enabled when the nuclear safety channel is on scale. This is an important feature of the existing nuclear safety system, as well as the new nuclear safety system (NSS). The phrase "on-scale neutron flux level" in the existing footnote requires two of the three period channels' neutron detectors to be in the readable range (as used in Table 3.2.3-1 line 1). It also requires two of the three neutron flux level channels to be in the readable range (as used in Table 3.2.3-2 line 2). For the new nuclear safety system, both of these actions are accomplished by the "Low count rate" trip.

For the new NSS, if the neutron count rate is less than 5 counts per second, the nuclear safety channel will produce a low count rate trip. This feature has been described throughout the SAR for the new NSS. If two or more nuclear safety channels in the new system present trips at the scram logic card, a reactor scram will be effected, with magnet current to the shim blade magnets cut off. Thus, footnote 1 is replaced with a message about the two-out-of-four scram logic which applies to all trip functions of the new nuclear safety channels, including the low count rate trip. Therefore, this change maintains safety, because the new message not only encompasses the message of the original footnote 1, but also properly matches the operating requirements to the design of the new system.

10. *TS replacement page 3-19 footnote 2), footnote 3), and footnote 4) appear to be unchanged from the license document.*

    Confirm the NRC staff understanding that no changes are intended for footnote 2), footnote 3) and footnote 4) on TS page 3-19 or provide a description about the desire to change to the footnote(s) including the safety impact of the change.

Response to **RAI #10**:

MIT-NRL confirms that no changes were intended for footnotes 2, 3, and 4 on page 3-19. These footnotes refer to independent scrams upon which the new nuclear safety system has no effect. Therefore, there is no impact to safety.

11. *The most recent replacement TS page 3-19 footnote 5) was provided in the supplement letter dated May 3, 2018. The supplement makes the statement that a brief but non-zero time limit prevents an instantaneous TS violation, however, contrary to the regulatory requirements in 50.36(c)(2)(i) MIT failed to provide a statement regarding the safety impact of the 15 minute delay time.*

    Provide a safety statement regarding the impact of the 15 minute allowed action time. Include equipment reliability, additional indicators available for operator action, and other automatic safety features that could mitigate the consequences of a second component failure during the 15 minute action time or delete footnote 5) from the proposed TS changes.

Response to **RAI #11**:

Each of the four nuclear safety channels is capable of automatically generating a trip when any of the six conditions is met: high power, short period, high power 100 kW operation (if the <100 kW Operation is selected on the Key-Switch Module), low count rate, channel in test, and channel fault / equipment malfunction. If any nuclear safety channel is already in a tripped state, and a second one is declared inoperable, then the "15 minutes" limitations defined in footnote 5 apply. It is the time prescribed when human action is warranted to put the second channel in a tripped state upon observation of abnormal behavior, should automatic trip generation not occur.

The 15-minute time is selected to allow time for the console operator to notify the shift supervisor, for the shift supervisor to respond to the control room to review recorded data and other console parameters, and for confirmation of the necessary response or corrective actions. During this time, other automatic reactor safety features continue to provide instantaneous protective scrams based on parameters such as high temperature, low flow, and low core tank level, as well as the two remaining independent nuclear safety channels. Once a second channel is manually placed in a tripped state, the reactor scrams immediately, because the two-out-of-four scram logic is met. For these reasons, footnote 5 and the time allowance that it defines do not reduce the safety protection provided by the Tech Spec compared to that of the existing nuclear safety system, which required only two operable nuclear safety channels to trip on each of high neutron flux level, short period, etc.

12. *Proposed TS page 3-20, TS 3.2.3, Table 3.2.3-1 (Continued) "Required Safety Channels," item 13, "Period channel level signal off-scale," no longer appears in Table 3.2.3-1 (Continued). New item 3 "Low count rate," in TS 3.2.3, Table 3.2.3-1, "Required Safety Channels," on page 3-19 was a proposed change to the TS in the supplement dated December 14, 2017. In the letter dated December 14, 2017, MIT stated that item 13 was no longer required because the minimum number of operable channels has been increased from two to three and the footnote explains the scram logic.*

    Provide an explanation and a safety basis for the proposed change.

Response to **RAI #12**:

The revision reflects a safety feature of the new nuclear safety system, in which the "Period channel level signal off-scale" scram is replaced by the "Low count rate" scram function. The existing nuclear safety system is composed of three period channels and three level channels. The new nuclear safety system combines the period and level scram functions in each of the four independent nuclear safety channels, so there are no longer any stand-alone period channels. "Signal off-scale" is when the channel receives no signal, or very little signal, from its associated neutron detector. For this condition, when the incoming detector signal is below 5 cps, each new nuclear safety channel will generate a "Low Count Rate" trip indication. Therefore, Item 13 "Period channel level signal off-scale" becomes no longer required for the new nuclear safety channel. This safety feature for the new nuclear safety system is "Low count rate", which was inserted as Item 3 in Table 3.2.3-1, and is necessary to maintain the designed level of safety. (See also the Response to RAI #2 above for discussion of the repositioning of the "Low count rate" item. The repositioning is administrative in nature, and has no impact to safety.)

13. *For TS 3.2.3, Table 3.2.3-1 (Continued), items 14 through 16, MIT did not provide any discussion about the desire to modify these items. The NRC staff identified that items 14 through 16 have been renumbered as items 13 through 16 respectively and relocated to accommodate deletion of item 13, discussed above. The values in the Parameter, Action, Setpoint, and Min. No, Required columns all appear to be unchanged.*

    Provide a discussion of the impact to safety resulting from the proposed changes

Response to **RAI #13**:

Existing Table 3.2.3-1 (Continued) Items 14 through 17 have been renumbered as Items 13 through 16 for the updated Technical Specification, while the values in their Parameter, Action, Limiting Setpoint, and Minimum No. Required columns all remain unchanged. This re-numbering is purely administrative in nature, and therefore has no impact to safety.

14. *TS replacement page 3-21 contains the Basis for TS 3.2.3. While bases are not considered to be part of the license per 10 CFR 50.36, bases shall be included with each specification. MIT provided a replacement page for the basis associated with TS 3.2.3, its associated tables, and changes supporting the modification to the facility.*

    Confirm that MIT desires to replace TS page 3-21 with the version provided as an enclosure to the letter dated May 3, 2018, or withdraw the request to replace TS page 3-21.

Response to **RAI #14**:

MIT confirms the intent to replace TS page 3-21 with the version provided as an enclosure to the letter dated May 3, 2018. As per item (d) of the letter, the first paragraph of the Basis is expanded to support and describe the reasoning behind "three" as the required minimum number of operable channels, together with the footnote (5) action statement. It also explicitly states that the new system is designed to allow reactor operation with one nuclear safety channel out of service; that channel is placed into a tripped state.

15. *TS replacement page 3-26 was submitted as part of the original application in a letter dated September 30, 2014. The replacement page 3-26 for TS 3.2.7 "Control Systems and Instrumentation Requirements for Operation," does not appear to have any changes to the Applicability, Objective, or Specification. The Basis for TS 3.2.7 is not on the replacement page 3-26 and TS 3.2.7, Table 3.2.7-1 "Required Instrumentation for Display" (from the existing TS page 3-27) is on the replacement TS page 3-26.*

    Confirm the NRC staff understanding that no changes to the Applicability, Objective, or Specification for TS 3.2.7 are desired or describe the desired change and provide a detailed discussion of the impact to safety resulting from the proposed change.

Response to **RAI #15**:

MIT confirms that there are no changes intended to the Applicability, Objective, or Specification sections for TS 3.2.7.

16. *On TS replacement page 3-26, TS 3.2.7, Table 3.2.7-1, "Required Instrumentation for Display," items 1, 3, 4, 5, 6, and 7 as well as footnotes (1) and (2) appear to be unchanged.*

    Confirm that no changes are desired for TS 3.2.7, Table 3.2.7-1, "Required Instrumentation for Display," items 1, 3, 4, 5, 6, and 7 as well as footnotes (1) and (2) or identify the desired change and provide a discussion of the impact to safety resulting from the proposed change.

Response to **RAI #16**:

MIT confirms that there are no changes intended to TS 3.2.7, Table 3.2.7-1 "Required Instrumentation for Display" items 1, 3, 4, 5, 6, and 7, as well as its footnotes (1) and (2).

17. *On the TS replacement page 3-26, TS 3.2.7, Table 3.2.7-1, "Required Instruments for Display," item 2, "Neutron Flux Level," contains a proposed revision that eliminates a) startup and b) linear power and replaces it with a new description of "(wide range)." Consistent with the regulatory requirements in 10 CFR 50.36(c)(3) "Surveillance requirements," TS 4.2.8 "Heat Balance," requires that the "linear power channel" is checked against a heat balance at least monthly ensuring that facility operation will meet the limiting condition for operations (LCO). Changing the term for "Neutron Flux Level" from "linear power" to "wide range" for the console display no longer ensures the surveillance requirements in 10 CFR 50.36(c)(3) will be met. The information provided in the updated SAR submitted as part of the LAR in the letter dated September 30, 2014, described in Section 7.4.1.2 (page 7-32) the intention to calibrate the NSS setpoint to the heat balance. The NRC staff noted that the analog DWK displays identified in figure 8 in letter dated December 14, 2017, for the wide range power indication are displayed on a logarithmic, not a linear, scale and the displays are not in front of the reactor operator (as part of the operator console display).*

    Explain the relationship between the operator display for "linear" reactor power and describe how the proposed TSs ensure the LCO is assured with an appropriate surveillance. Provide revised TSs if needed to meet this requirement or explain how the proposed TSs satisfy the regulatory requirements described above.

Response to **RAI #17**:

MIT does not intend to remove the requirement for a heat-balanced linear power display channel. Accordingly, a newly-revised TS 3.2.7 (dated 25 October 2018) is included in this response as Enclosure 1, to preserve the heat balance surveillance requirement for a "linear power channel" as stated in TS 4.2.8 "Heat Balance". Table 3.2.7-1, line 2b, requiring one "Linear Power" instrument for display on console, is hereby restored in the new version. It supersedes the proposed version that was docketed dated 30 September 2014. This helps to clarify the intention to maintain a linear flux power channel to be displayed on console at all times during reactor operation and prior to reactor startup.

18. *The proposed replacement TS page 3-27 contains the Basis that was on the existing license page 3-26. While bases are not considered to be part of the license per 10 CFR 50.36, bases shall be included with each specification. MIT provided a replacement page for the basis associated with TS 3.2.7, its associated tables, and changes supporting the modification to the facility.*

    a. *Are the new DWK displays intended to satisfy the reactor operator display requirements? If not, describe the display intended to be used by the console operator.*

    b. *Describe the intended final location of the DWK reactor power and period displays relative to the normal console operator position.*

    c. *Explain how the location of the reactor power level display is readily available to the console reactor operator.*

Response to **RAI #18**:

The new DWK 250 displays described below are intended to satisfy the display requirement of the newly-revised (25 October 2018) Table 3.2.7-1, line 2a, for wide-range neutron flux levels. This revised table can be found as part of Enclosure 1.

In the RAI Follow-Up Response material docketed with date 20 April 2018, there is a revised memorandum marked Enclosure V and dated 11 April 2018. Item 6 of that memorandum describes the displays for wide-range reactor power and reactor period on console in front of the operator, in the same location as those for the existing system. The new system will have a total of eight remote display meters originating from the four DWK 250 units. Figures 7 & 8 for the proposed console meter layout can be found in the initial RAI response (cover letter dated 14 December 2017) Enclosure V figures. They show the view at eye level directly in front of the console operator's seat, so the locations of the reactor power level and period displays are readily available to the console operator. Additionally, each DWK 250 has an edgewise logarithmic meter for reactor power, and another for reactor period, directly on its chassis. The four DWK 250 chassis will be mounted in the control room instrument cabinets to the right of the console operator's seat, in locations shown in Figure 6 of the 14 December 2017 Enclosure V figures.

19. TS replacement page 4-4 containing TS 4.2.4, "Scram and Power Measuring Channels," was submitted as part of the original application in a letter dated September 30, 2014. The NRC staff compared the replacement page to the page in the license and could not identify any changes aside from a small grammatical change deleting the word "the" from the last line on the page. A second replacement page 4-4 was submitted as part of the RAI response in a letter dated December 14, 2017. The NRC staff compared the second replacement page to the page in the license and identified that the word "drive" was added to TS 4.2.2 in two places, 1) after the phrase "shim blade" and 2) after "regulating rod." The addition of the word "drive" changes the meaning of the phrase and appears to exclude the reactivity insertion device (shim blade or regulating rod) itself. MIT failed to identify this apparent change and did not provide a safety basis for the change. Additionally, the addition of the word "drive" changes the surveillance requirement so that it no longer appears to meet the regulatory requirements of ensuring that the LCO (TS 3.2.2.1) will be met.

Identify the desired changes for TS 4.2.2 on page 4-4 providing a safety basis for the changes and explaining how the proposed surveillance ensures TS 3.2.2.1 will be met or withdraw the request to replace page 4-4 in the TSs.

Response to **RAI #19**:

MIT proposed adding the word "drive" in two places in Technical Specification 4.2.2 – after the phrase "shim blade" and after the phrase "regulating rod" – in Enclosure T of the RAI response docketed 14 December 2017. MIT believes the addition not only does not change the effective meaning of the phrase, but also enhances the clarity of the intention of the requirement. TS 4.2.2 specifically concerns measuring annually to verify rod withdrawal and insertion speed. This speed is generated by the drive mechanisms for the shim blades and the regulating rod. The shim blades and the regulating rod themselves cannot move at steady (controlled) speeds without their drives.

While the shim blades can insert themselves by gravity when decoupled from their drives, measuring this uncontrolled insertion/drop speed was not the intent or effect of the Tech Spec. The measurement is done by running the drive (with the shim blade attached) and measuring the time between positions, in the withdrawal and insertion directions. Likewise for the regulating rod, the measurement is done by running its drive, to which it is mechanically affixed.

Therefore, the addition of the word "drive" clarifies the intent of the surveillance requirement, such that it continues to ensure that the LCO of "maximum controlled reactivity addition rate" in TS 3.2.2.1 will be met.

20. *Replacement TS page 4-5 contains the continuation of TS 4.2.4, "Scram and Power Measuring Channels," TS 4.2.5 "Channel Tests," TS 4.2.6 a) through 4.2.6.i), and TS 4.2.7, "Thermal Power." The only change made to the TSs on this page was a wording change to 4.2.6.i) changing "Period Channel Level Signal Off-Scale," to "Nuclear Safety Channel Low Count Rate." During its review the NRC staff confirmed that the proposed TS 4.2.6.i) was an appropriate surveillance requirement supporting the upgraded NSS. In a letter dated December 14, 2017, 4.2.6.i) was deleted in its entirety with no justification for the change.*

    Provide the safety basis to support deletion of TS 4.2.6.i) from the group of instruments requiring calibration and trip point verification or propose an equivalent TS 4.2.6.i) that ensures the low count rate scram occurs at or before its required value of 5 CPS.

Response to **RAI #20**:

Deletion of TS 4.2.6i) "Nuclear Safety Channel Low Count Rate" in the docketing dated 14 December 2017 was determined to be necessary. TS 4.2.6 concerns frequency of instrument calibration and trip point verification. MIT sets the low count rate trip point for each DWK 250 unit at or above 5 cps. (See response to RAI #5 above for MIT's reasoning in choosing a value of 5 cps for the Technical Specification.) This set point value is a numerical input for which no calibration is possible. It is not subject to drift, and is secured via key control after being input, as described in SAR Chapter 7 Appendix, Section 5 "Security and Cyber Vulnerability Evaluation". The trip set point is verified on the reactor startup checklist by the testing already required by TS 4.2.4 Scram and Power Measuring Channels via Table 4.2-1, item #15 Nuclear Safety Channel Low Count Rate, at least quarterly and each time before startup of the reactor if the reactor has been in a secured condition or if the instrument or channel has been repaired or de-energized. Therefore, removal of TS 4.2.6i) is justified, and has no effect on safety.

21. *The proposed replacement TS page 4-6 contains Table 4.2-1 "Surveillance of Scram and Power Measuring Channels," this table appears on the existing license TS page 4-8. MIT failed to provide a request to relocate the table and did not describe any of the changes to Table 4.2-1. The NRC staff compared the information from the proposed TS 4.2, Table 4.2-1 to the information in the license and identified the following information:*

    - *Item 1 "Period[(1)]" the only change appears to be the addition of a superscript (1) which references a footnote identifying the scram logic.*
    - *Item 2 "Neutron Flux Level[(1)]" the only change appears to be the addition of a superscript (1) which references a footnote identifying the scram logic.*
    - *Items 3 through 10 do not appear to have any proposed changes.*
    - *Items 11 through 13 appear to have the "*" replaced by a superscript (2). The footnote (2) reads the same as the footnote for the "*" which appears to be a direct replacement for clarification between the existing footnote and the added footnote referring to the scram logic.*
    - *Item 14 appears to be unchanged.*
    - *Item 15 "Period Channel Level Signal Off Scale" now reads "Nuclear Safety Channel Low Count Rate[(1)]." This appears to be a direct replacement with the superscript (1) referring to the footnote for the scram logic.*
    - *Items 16 and 17 appear to be relabeled as items 18 and 19 respectively with no changes to the content of these items.*
    - *New item 16 "Nuclear Safety Channel in Test[(1)]" appears to be a new scram associated with the upgraded NSS reflecting a scram output from the Mirion system with the superscript (1) referring to the footnote for the scram logic.*
    - *New item 17 "Nuclear Safety Channel Fault[(1)]" appears to be a new scram associated with the upgraded NSS reflecting a scram output from the Mirion system with the superscript (1) referring to the footnote for the scram logic.*

    For each item in TS 4.2.4, Table 4.2-1, "Surveillance of Scram and Power Measuring Channels," identify if no change from the license version is desired, if an administrative type change is desired (reordering or renumbering), or the item is new. For each modified or new item in the table provide a rationale for the change, identify the impact to safety for the item, and explain the relationship between the item and the upgraded NSS.

Response to **RAI #21**:

TS 4.2, Table 4.2-1 "Surveillance of Scram and Power Measuring Channels" is relocated to become the third page of the Specification. The existing TS 4.2 has the table positioned partway through the Basis section. The relocation puts the table within the Specification section, immediately following the Specification pages containing references to it. This relocation is an administrative change, intending to emphasize the mandatory nature of the table. It has no impact on safety. The following is a narrative for each item on Table 4.2-1:

Items 1 & 2: The only change is the addition to each item of a superscript "(1)" which references a footnote identifying the scram logic. Footnote (1) itself is new: "Reactor scrams when two trips in any combination are present simultaneously from any two of the four nuclear safety channels." The footnote is necessary in order to clarify that the Channel Test is to verify a reactor scram when two trip signals are present simultaneously at the scram logic circuit, with at least one of the two trip signals being a short period trip (for Item 1, with the short period trip coming from the channel being tested) or a high neutron flux level trip (for Item 2, with the high neutron flux level trip coming from the channel being tested). This change maintains safety by correctly matching the testing requirements to the design of the new nuclear safety system.

Items 3 through 10 do not have any proposed changes.

Items 11 through 13 each have an administrative change, in which the asterisk in the existing table becomes a superscript "(2)". The corresponding footnote also has its asterisk marker changed to a "(2)". These changes have no impact on safety. No change is made to the text of the footnote.

Item 14 does not have any proposed changes.

Item 15: In the proposed text, "Nuclear Safety Channel Low Count Rate$^{(1)}$" replaces "Period Channel Level Signal Off Scale". This wording change is the same as was used for TS 3.2.3, Table 3.2.3-1 (Continued), and is explained in the Response to RAI #12 above. Retaining reference to the low count rate feature for the new nuclear safety system is necessary in order to maintain the designed level of safety. This item makes reference to footnote (1) in order to provide Channel Test clarification similar to those described in Items 1 & 2 above. Accordingly, the reactor will scram when two trip signals are present simultaneously at the scram logic circuit, with at least one of the two trip signals being a low count rate trip, and with the low count rate trip initiated from the channel being tested. This part of the change maintains safety by correctly matching the testing requirements to the design of the new nuclear safety system.

Existing Items 16 & 17 are re-numbered to 18 & 19 in the proposed TS. There is no change to their content. The renumbering allows space for two new items to be grouped with Item 15, to which they are similar. This change is administrative and has no impact to safety.

New Item 16: "Nuclear Safety Channel in Test$^{(1)}$" is a new scram associated with the upgraded NSS reflecting a trip output from the DWK 250 units. This item makes reference to footnote (1) in order to provide Channel Test clarification similar to those described in Items 1 & 2 above. Accordingly, the reactor will scram when two trip signals are present simultaneously at the scram logic circuit, with at least one of the two trip signals being a channel-in-test trip, and with the channel-in-test trip initiated from the channel being tested. This change maintains safety by matching the testing requirements to the design of the new nuclear safety system.

New Item 17: "Nuclear Safety Channel Fault$^{(1)}$" is a new scram associated with the upgraded NSS reflecting a trip output from the DWK 250 units. This item makes reference to footnote (1) in order to provide Channel Test clarification similar to those described in Items 1 & 2 above. Accordingly, the reactor will scram when two trip signals are present simultaneously at the scram logic circuit, with at least one of the two trip signals being a channel fault trip, and with the channel fault trip initiated from the channel being tested. This change maintains safety by matching the testing requirements to the design of the new nuclear safety system.

22. *TS replacement page 4-7 contains the LCOs from license TS page 4-6 for TS 4.2.8, "Heat Balance," TS 4.2.9, "Control Device Inspection," TS 4.2.10 "Control System Interlocks," and the beginning of the Basis for TS 4.2. The NRC staff compared the TSs on TS replacement page 4-7 to the TSs on the license page 4-6 and did not identify any proposed changes to TSs 4.2.8, 4.2.9, and 4.2.10.*

    Confirm the NRC staff understanding that the LCOs for the TSs from page 4-6 remain unchanged and provide an administrative change request, supporting the relocation of the TS LCOs from page 4-6 to the proposed TS page 4-7 or withdraw the request to change TS page 4-7.

Response to **RAI #22**:

The existing license TS page 4-6 is not intended to have any content change, but to be re-numbered as page 4-7 in the proposed TS, in order to allow space for Table 4.2-1 to be placed before it as page 4-6. The reason for relocating Table 4.2-1 is discussed in the first paragraph of the Response to RAI #21 above. This page re-numbering is an administrative change, and has no impact on safety.

During review, MIT staff discovered a typographical error in the numbering of the three Specifications on the proposed page 4-7. Accordingly, the Specification "Heat Balance" should be numbered "8" instead of "9", "Control Device Inspection" should be numbered "9" instead of "10", and "Control System Interlocks" should be numbered "10" instead of "11". With this correction, the content of the page remains unchanged from the existing license TS page 4-6. A revision of the proposed page is included as Enclosure 2, with a current date at the lower right.

23. *Replacement page 4-8 contains part of the Basis for TS 4.2, "Reactor Control and Safety System." The Basis for TS 4.2 appears on the license TS pages 4-6, 4-7, and 4-9. Bases are not considered to be part of the license per 10 CFR 50.36, however, MIT provided replacement pages for the Basis associated with TS 4.2, its associated tables, and changes supporting the modification to the facility. The NRC staff reviewed the Basis information on the proposed TS pages 4-7 and 4-8 and determined that all of the Basis information for TS 4.2 appears on the two replacement pages. License page 4-9 contains part of the bases information for TS 4.2. No replacement for this page was provided by MIT. The information on page 4-9 appears on page 4-8 creating duplication of the information on page 4-9.*

    Provide an administrative change request, supporting the relocation of the TS 4.2 Basis information from page 4-9 or provide alternative replacement pages that do not require TS pages 4-8 or 4-9 to be replaced in order to eliminate the duplication of information that would result from the proposed changes.

Response to **RAI #23**:

The Basis for TS 4.2 is intended to have one minor change from the existing license text. – In the third paragraph, the reference to Specification "3.2.1.2" is corrected to "3.2.1", as there is no Specification 3.2.1.2 in the existing or proposed TS. MIT understands the proposed

consolidation of the Basis into two pages (pages 4-7 and 4-8) produces a pagination shortcoming. Therefore, MIT proposes to move the last paragraph of the proposed page 4-8 onto a new proposed page 4-9, leaving a blank at the bottom of proposed page 4-8. A revision of the proposed pages is included as Enclosure 3, with a current date at the lower right. This proposed re-pagination is an administrative change and has no impact on safety.

In summary, these RAI responses and enclosures represent additional information identified in NRC Request for Additional Information dated August 30, 2018. The RAI responses and enclosures submitted herewith do not contain any proprietary information.

This RAI response submittal contains the following three Enclosures:

Enclosure 1 Technical Specification 3.2.7 Control Systems and Instrumentation Requirements for Operation, final version and version showing tracked changes when compared against the existing license Technical Specification.

Enclosure 2 Technical Specification 4.2 Reactor Control and Safety Systems page 4-7.

Enclosure 3 Technical Specification 4.2 Reactor Control and Safety Systems pages 4-8 & 4-9.

Sincerely,

Edward S. Lau, NE
Assistant Director of Reactor Operations
MIT Research Reactor

Alberto Queirolo
Director of Reactor Operations
MIT Research Reactor

I declare under penalty of perjury that the foregoing is true and correct.

Executed on November 7, 2018
Date

Signature

Enclosures: As stated.

cc: USNRC – Senior Project Manager
Research and Test Reactors Licensing Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

USNRC – Senior Reactor Inspector
Research and Test Reactors Oversight Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Enclosure 1

3.2.7 Control Systems and Instrumentation Requirements for Operation

Applicability

This specification applies to the reactor control system and to the control console display instrumentation.

Objective

To ensure that the console operator has sufficient indication of power level, reactor period, primary coolant flow, primary coolant outlet temperature, core tank level, and control device position.

Specification

Indication from the instrumentation listed in Table 3.2.7-1 shall be provided to the reactor console operator prior to reactor startup and during reactor operation.

Table 3.2.7-1

Required Instrumentation for Display

Parameter	Minimum Number	Location
1. Period	1	Console
2. Neutron Flux Level		
a) Wide Range	1	Console
b) Linear Power	1	Console
3. Core Tank Level	1	Control Room
4. Primary Coolant Flow	1	Control Room
5. Coolant Outlet Temperature	1	Control Room
6. Shim Blade Position(1)	5	Console
7. Regulating Rod Position(2)	1	Console

(1) Indication required for all operable shim blades. Indication may be either numeric or analog meter or both.

(2) Indication may be either numeric or analog meter or both.

Basis

The basis of this specification is given in Section 7.4 of the SAR. The limiting safety system settings are a function of the reactor power, coolant flow, coolant temperature, and core tank level. These parameters, together with reactor period, are important to safe operation. Indication of shim blade position is also important. There are four independent nuclear safety channels, each of which monitors wide-range reactor power level and period. The operator requires continuous indication of reactor power, reactor period, and control device position in order to perform power manipulations. Hence, these parameters are displayed on the reactor console. The operator requires knowledge of whether or not flow, temperature, and level are within their normal ranges. Hence, they are displayed in the control room but not necessarily on console.

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Table 3.2.7-1

Required Instrumentation for Display

Parameter	Minimum Number	Location
1. Period	1	Console
2. Neutron Flux Level		
a) ~~Startup~~Wide Range	1	Console
b) Linear Power	1	Console
3. Core Tank Level	1	Control Room
4. Primary Coolant Flow	1	Control Room
5. Coolant Outlet Temperature	1	Control Room
6. Shim Blade Position(1)	5	Console
7. Regulating Rod Position(2)	1	Console

(1) Indication required for all operable shim blades. Indication may be either numeric or analog meter or both.

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Basis

The basis of this specification is given in Section 7.4 of the SAR. The limiting safety system settings are a function of the reactor power, coolant flow, coolant temperature, and core tank level. These parameters, together with reactor period, are important to safe operation. Indication of shim blade position is also important. There are four independent nuclear safety channels, each of which monitors wide-range reactor power level and period. The operator requires continuous indication of reactor power, reactor period, and control device position in order to perform power manipulations. Hence, these parameters are displayed on the reactor console. The operator requires knowledge of whether or not flow, temperature, and level are within their normal ranges. Hence, they are displayed in the control room but not necessarily on console.

8. Heat Balance: The signal from the linear power channel shall be checked against a heat balance calculation at least monthly, for any month that the reactor is operated above 1 MW continuously for at least 48 hours.

9. Control Device Inspection: Control devices shall be inspected annually as follows:

   a) Shim blade absorbers shall be checked visually.

   b) Shim blade electromagnets shall be checked both visually and by measuring the resistance of the coils.

   c) Shim blade and regulating rod drives shall be monitored for proper operation.

10. Control System Interlocks: A channel test of the following interlocks and scram shall be performed at least annually:

   a) Withdraw Permit Interlock,

   b) Subcritical Limit – Shim Blades Interlock,

   c) No Overflow Reflector Startup Interlock, and

   d) Low Level D_2O Reflector Scram.

Basis

The MITR-II has observed the criteria given in Specification 4.2.1 for determination of control device reactivity worths and found it to be adequate. Measurements of the integral and differential worths are required annually. Measurements following changeouts of absorbers and change of core configuration are desirable. However, such measurements are very time consuming. Moreover, sufficient experience exists with such changes that their effect on integral and differential reactivity worths can be predicted with reasonable accuracy. Accordingly,

normal MITR-II practice is to do a complete set of measurements following replacement of all absorber sections rather than to do measurements as each is replaced. (Note: It requires several days to replace one absorber and the entire process is usually done over an interval of several months.) Estimates of the change of worth are used pending the measurement. Estimates, not measurements, are normally used for changes of core configuration.

The insertion and withdrawal speed of the control devices is fixed by the motor and drive design as discussed in Section 4.2.2 of the SAR. These speeds are verified annually.

Scram time is as defined by Specifications 1.3.37 and 3.2.1. It is verified at least annually and whenever maintenance has been performed that could affect it.

The instruments and channels listed in Table 4.2-1 correspond to those in Table 3.2.3-1, "Required Safety Channels" with the exception that surveillance of the building overpressure and gasket deflated scrams is addressed elsewhere (Specification 4.4).

The thermal power indication is calibrated at least annually and the signal from the linear power channel is compared against a heat balance at least monthly for any month that the reactor is operated above 1 MW. These actions are done under conditions of thermal equilibrium which, because of the MITR-II's heat capacity (especially that of the graphite reflector), occurs after 48 hours of steady-state operation.

Control devices are inspected at least annually. The inspection focuses on those components that are important to safety. Those include the absorber sections (Section 16.3.1.5 of the SAR) and electromagnets (Section 16.3.1.4(d) of the SAR). The status of the shim blade and regulating rod drives can be deduced from external observations such as the measurement of blade and regulating rod insertion/withdrawal speeds (Specification 4.2.2). Internal inspections require lowering of the core tank level and removal of the drive. These are usually done whenever an absorber is changed out. As described in Section 16.3.1.5 of the SAR, this is normally done every 125,000 MWH. A prespecified frequency for an internal inspection would involve serious ALARA issues.