

Date: 15 June 2023

To: Xiaosong Yin  
US Nuclear Regulatory Commission  
Research and Test Reactors Licensing Branch  
Officer of Nuclear Regulatory Regulation  
Washington, D.C. 20555-0001

Subject: Amendment Request for Facility License R-110 Docket Number 50-284

Dear Mr. Xiaosong Yin,

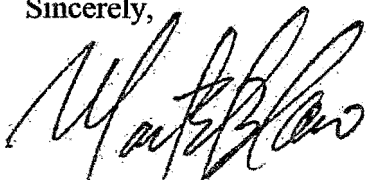
Idaho State University requests that four changes be made to facility license R-110 docket number 50-284.

- 1) Removal of Channel 2 low scram.
- 2) Removal of Channel 3 5% low scrams for all ranges below and including the range at which the detector output is above noise and indicates neutron detection, the "transition range"
- 3) Rewording of Technical Specifications Section 3.2 Specification d.
- 4) Removal of "Unit A" and "Unit B" from Technical Specifications Table 3.1.

Changes 1 through 3 will accommodate replacement of obsolete and commercially unavailable  $\text{BF}_3$  detectors with modern  $^{10}\text{B}$  detectors. The fourth change will remove an artifact reference to our former control console. There are no safety implications to this amendment, as discussed in the detailed request that accompanies this letter. As a point of reference, we compare the high and low power scram setpoints with NRC-approved reactor control and safety systems standards for other AGN reactor facilities.

Any questions or requests for additional information should be directed to the Reactor Administrator, Dr. Mary Lou Dunzik-Gougar ([mldg@isu.edu](mailto:mldg@isu.edu)), the Reactor Supervisor, Jonathan Scott ([jonathanscott@isu.edu](mailto:jonathanscott@isu.edu)) and the Reactor Supervisor in Training, Larry Foulkrod ([larryfoulkrod@isu.edu](mailto:larryfoulkrod@isu.edu)).

Sincerely,



Martin E. Blair, Ph.D.  
Vice President for Research  
Idaho State University

[martinblair@isu.edu](mailto:martinblair@isu.edu)

208-282-5907

ADD1  
ADD2  
NR R



Date: 13 February 2023

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US Nuclear Regulatory Commission  
Research and Test Reactors Licensing Branch  
Officer of Nuclear Regulatory Regulation  
Washington, D.C. 20555-0001

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Sincerely,

A handwritten signature in black ink, appearing to read 'Martin Blair'.

Martin E. Blair, Ph.D.  
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## Executive Summary

**Idaho State University requests that facility license R-110 docket number 50-284 be amended to remove low power scrams for nuclear safety Channels 2 and 3.** Table 1 of this amendment (Table 3.1 of the Technical Specifications) shows that currently there are low scrams for each of the 3 channels. In this amendment request, we are proposing that the number and type of low scrams should be different in the transition range vs. normal operating power range of the reactor. We define the transition range as the range at which the detector output is above noise level and indicates neutron detection. We request no changes for Channel 1, which will still scram if power is too low during startup. Channel 2 low scram will be eliminated completely. The Channel 3 5% low scram will be eliminated for the transition range and the ranges below it. The specific ranges to be modified by removing the 5% low scram are dependent on detector performance at low power. As an example, with the current BF<sub>3</sub> detector in Channel 3, the startup source registers in the 1-milliwatt range. The changes requested in this amendment would remove the 5% low scram for the 1-milliwatt range and the 6 ranges below 1 milliwatt. The ranges above 1 milliwatt would retain the 5% low scrams.

As a point of comparison (see Table 2 of this request), the Texas A&M AGN Technical Specifications (docket number 50-59 and facility license R-23) has low power scram set points for all three channels. Unlike ISU and Texas A&M, the University of New Mexico AGN Technical Specifications (docket number 50-252 and facility license R-102) has no low power scrams. As such, the requested amendment for ISU Technical Specifications will result in low and high power scrams, functions, and levels that are more conservative than the only other operational AGN in the United States.

**The reason for this request is the need to replace the BF<sub>3</sub> ionization chambers used in control Channels 2 and 3.** These detectors have surpassed their expected lifetimes and regularly malfunction, resulting in an inoperable reactor. BF<sub>3</sub> detectors are no longer commercially available and the <sup>10</sup>B detector replacements do not have the same low power functionality. Based on the preliminary <sup>10</sup>B specifications, the replacement detectors will not output electric current above noise levels at low reactor power. Lack of detector current output at low reactor power will cause scrams in Channels 2 and 3.

**Idaho State University requests that facility license R-110 docket number 50-284 be amended to reword section 3.2 of the Technical Specifications. The reason for this request is to permit bypassing of Safety Channel 1 only when the reactor is subcritical.**

**Idaho State University requests that facility license R-110 docket number 50-284 be amended to modify Table 3.1 of the Technical Specifications by removing reference to "Unit A" and "Unit B". The reason for this request is to remove these artifact references that are not relevant to the current control console.**

The requested amendment has no safety implications for the maximum hypothetical accident that was evaluated in the 2006 Safety Evaluation Report (SER). The Maximum Hypothetical Accident (MHA) analyzed in the SER is a step insertion of reactivity that leads to the thermal fuse melting and the reactor shutting down after the core splits. Removal of low level scrams in Channels 2 and 3 has no impact on this accident scenario.

**Table 1.** Table 3.1 from Facility License R-110 Docket Number 50-284 Amendment 7 Technical Specifications. The third row of the table would be removed and the first and sixth rows modified per the proposed amendment.

<u>SAFETY CHANNEL</u>	<u>SET POINT</u>	<u>FUNCTION</u>
Nuclear Safety Channel No. 1 (Startup Count Rate Channel) Low Power	Unit A) 5% Full Scale OR Unit B) 0.5 counts/second	Scram at levels Below the set points
Nuclear Safety Channel No. 2 (Log Power Channel) High Power	6 watts (120% of licensed power)	Scram at power > 6 watts
Nuclear Safety Channel No. 2 (Log Power Channel) Low Power	<del>3.0 × 10<sup>-13</sup> amperes</del>	<del>Scram at source levels &lt; 3.0 × 10<sup>-13</sup> amps</del>
Reactor Period	5 sec	Scram at periods < 5 sec
Nuclear Safety Channel No. 3 (Linear Power Channel) High Power	6 watts (120% of licensed power)	Scram at power > 6 watts
Nuclear Safety Channel No. 3 (Linear Power Channel) Low Power	5% Full Scale (for ranges above transition* range)	Scram at levels < 5% of Full Scale
Manual Scram	---	Scram at operator option
Area Radiation Monitor	= 10 mR/hr	Alarm at or below level set to meet requirements of 10 CFR 20

\* The transition range is defined as the range at which the detector output is above noise level and is indicating neutron detection.

### Safety Implications of Requested Amendment

The requested amendment has no negative safety implications on the 2006 Safety Evaluation Report MHA. The period of the MHA 2%  $\Delta k/k$  power excursion is approximately 10 milliseconds. The MHA assumes that the period scam does not function and the power excursion terminates due to thermal expansion of the core at 210 milliseconds after reactivity insertion. The consequence of the MHA is limited to the dose to reactor operators from an uncontrolled reactor power excursion. Removal of low power scrams does not affect the magnitude of the power excursion, so there is no effect on the dose to reactor operators.

### Reason for Detector Change

When the AGN reactor control systems were designed in the 1950s, boron trifluoride (BF<sub>3</sub>) detectors were commercially produced and used in many nuclear applications because of their low cost and excellent low power resolution. Low power scram limits for the ISU AGN were set based on the output of the BF<sub>3</sub> detectors that were available. At that time, it was determined that a reasonably sized startup source of neutrons would cause a current response of  $3.0 \times 10^{-13}$  amps, which is the Channel 2 low scram set point. Due to the toxicity of BF<sub>3</sub> gas, BF<sub>3</sub> detectors are no longer produced.

The ISU BF<sub>3</sub> detectors have been in service since the 1960s and have exceeded their anticipated lifetime. In addition, detector malfunctions have occurred. In 2021, the Channel 2 BF<sub>3</sub> detector failed due to a worn high voltage input socket on the detector body. That problem was remedied by custom fabrication of a high voltage input socket that allows better electrical contact with the detector body. The Channel 3 BF<sub>3</sub> detector failed in 2016 when a solder connection ruptured during routine maintenance and BF<sub>3</sub> gas leaked from the detector. ISU employed its last remaining BF<sub>3</sub> replacement detector after the 2016 Channel 3 detector failure. Discussions about replacing the BF<sub>3</sub> detectors have been ongoing over the past decade, including consultation with Ph.D. and P.E. faculty and staff of ISU, retired engineers with decades of reactor operations experience, and experts from other reactor facilities.

ISU has consulted several detector manufacturers about replacing the existing BF<sub>3</sub> ionization chambers in Channels 2 and 3 with detectors that have similar performance at low flux levels. Unfortunately, modern boron lined (<sup>10</sup>B) detectors are not guaranteed to offer low power performance comparable to the BF<sub>3</sub> detectors. **The lack of replacement BF<sub>3</sub> detectors and the inability to acquire new detectors with similar low power performance characteristics has resulted in the necessity of purchasing replacement detectors with different current responses than the original BF<sub>3</sub> detectors.**

## Detector Properties and Impact of Detector Change

In this section is presented an analysis of the operational impact of replacing the current  $\text{BF}_3$  detectors with new  $^{10}\text{B}$  lined ion chambers in Channels 2 and 3. For the purpose of clarity, the term detector "sensitivity" as used in this section refers to the current output per unit neutron flux at the detector. Unit neutron flux equals one neutron per  $\text{cm}^2$  per second, often notated as "nv." The term "operational threshold thermal neutron flux" is the flux below which the detector does not function.

The current detector for Channels 2 and 3 is the WL-6937 uncompensated ionization chamber, a  $\text{BF}_3$  filled chamber of guard ring construction for the detection of thermal neutrons. It is filled to 250 mm-Hg with  $\text{BF}_3$  enriched to 96% with  $^{10}\text{B}$ . The sensitivity of the chamber is approximately  $4\text{E}-14$  amps per unit flux. The neutron flux at the detectors with the current startup source is approximately 25 nv.

The majority of the nuclear industry, and thus detector manufacturers, have shifted from  $\text{BF}_3$  detectors to  $^{10}\text{B}$  lined ion chambers filled with a gas like nitrogen or helium. The detectors currently available as a replacement for the WL-6937 detector also are  $^{10}\text{B}$  lined. The quoted sensitivities of these detectors vary from  $4.4\text{E}-14$  amps/nv (WL6937A) to  $1.2\text{E}-13$  amps/nv (RS-C2B-2510-135). The operational threshold thermal neutron flux varies with the lowest being 150 nv (WL6937A). This threshold value is 6x higher than the flux level at the location of our current detectors with startup source.

At the University of New Mexico's AGN-201 reactor, two ion chambers (RS-C2-2511-137) are in use as replacements for the  $\text{BF}_3$  detectors. These ion chambers have a thermal neutron sensitivity of  $\sim 3\text{E}-13$  amps/nv and an operational threshold thermal neutron flux range on the order of 1000 nv. The UNM detectors are less sensitive (give less current per unit flux) than the replacement detectors ordered by ISU and are more sensitive than ISU's current  $\text{BF}_3$  detectors. At startup source level, the UNM control system reads approximately  $2.2\text{E}-11$  amps on Channel 2. This value is consistent with that estimated for the ISU's planned replacement detectors. This sensitivity value for the proposed  $^{10}\text{B}$  replacement detectors is 3 orders of magnitude higher than the current  $\text{BF}_3$  detectors.

It is clear that detectors currently on the market have the same or better sensitivities than the current WL-6937. However, because of the much higher operational threshold thermal neutron flux values, none of the available detectors will be able to produce a signal below approximately  $1\text{E}-11$  amps. This value is two orders of magnitude higher than our current low scram set point for Channel 2 ( $3\text{E}-13$  amps.). As a point of reference,  $1\text{E}-11$  amps is equivalent to the current reading with our fueled Safety Rods 1 and 2 (SR-1 and SR-2) inserted into the core.

Based on the facts thus presented, it is likely that the replacement Channel 2 and Channel 3 detectors will not produce current above noise levels with only a startup source in the reactor. **This anticipated lack of Channels' 2 and 3 performance at very low powers is the primary reason for requesting modifications to the Technical Specifications.**

While ISU is requesting modifications to the Technical Specifications to remove low power scrams for Channels 2 and 3, it should be noted that the functionality of the Channel 2 and 3 detectors will otherwise be confirmed before startup. ISU's start up procedure requires a "Rod Drop Test", in which Safety Rods 1 and 2 are inserted and the readings of all 3 detection channels are recorded. The change in channel readings before and after insertion of the safety rods indicates that the detection channels are functioning properly. The procedure states that a statistically insignificant difference in channel readings before and after the safety rods have been inserted indicates a problem with the detection channels. For years, this rod drop test has been used to check the operability of the detection channels prior to inserting a critical amount of fuel. The rod drop test will continue to be used with new detectors so that operators proceed with reactor startup only if the detection channels are operable.

#### The Reason for Low Power Scrams and the Case for Removing Them

In this section, the set points for Channels 1, 2, and 3 are discussed, as well as the intended purpose of the Channel set points.

The Technical Specifications for the three U.S.-based AGN reactors differ on the subject of low power scrams. These differences are summarized in Table 2 as well as the original 1968 Technical Specifications for Oregon State University's AGN-201. ISU and Texas A&M have scrams that are similar in function and purpose, but with different setpoints and power limits. UNM has two high scrams but no low scrams. These differences raise the question about the purpose of the low level scrams. Clearly, they are not a necessity, or UNM wouldn't be able to operate. But the scrams do appear in the tech specs for the other three US reactors.

Channel 1 produces usable signal only during startup for each AGN reactor. When the reactors transition from low power startup to normal operation power levels, the Channel 1 detector reaches saturation current and does not produce a signal that can be used for any operational purpose. By the time Channel 1 is saturated, Channels 2 and 3 detectors have enough neutron interaction to produce signal currents that are higher than noise level. The use of Channel 1 for startup, but not higher power operation, is similar among the AGN reactors. ISU and Texas A&M use the Channel 1 signal to induce a low scram at powers less than startup source level. University of New Mexico uses Channel 1 as an indicator during startup, similar to ISU and Texas A&M, but there is no low scram function.

Channel 2 displays the logarithmic detector current throughout the operable range of the reactor from startup to maximum power. With  $\text{BF}_3$  detectors, the three AGNs have used Channel 2 in operationally similar ways, but with different scram functions and setpoints. ISU and Texas A&M have the same low scram function, but with different setpoint levels that correspond to differences in startup source strength. Texas A&M has a significantly higher startup source strength which causes a higher detector current and therefore a higher scram setpoint for its low scram. The University of New Mexico Channel 2 operates similarly to ISU and Texas A&M but without a low scram function. The Oregon State University 1968 Technical Specifications have a low trip set point if the Sensitrol is off-scale low. **The implication is that the original reason for the low trip, that still exists in ISU's and Texas A&M's Technical Specifications, was to ensure that the Channels were on and operating prior to reaching criticality.**

$\text{BF}_3$  detectors in Channel 2 are able to produce current signals above noise level for the full range of operation and during startup because of detector response characteristics at low power. When the change is made from a  $\text{BF}_3$  to a  $^{10}\text{B}$  detector in ISU's Channel 2, the current output of the  $^{10}\text{B}$  detector at startup and low power likely will not produce a signal that is statistically above noise level. The difference in detector response from  $\text{BF}_3$  to  $^{10}\text{B}$  will affect Channel 2 such that it will not provide useful signal until SR1 and SR2 are inserted into the core during startup.

Currently, Channel 3 detectors are identical to Channel 2 detectors for the three AGN reactors, but the detector signal is not modified like in Channel 2. Each AGN Channel 3 is a linear power channel. Unlike Channel 2, which uses a logarithmic amplifier to display detector current over several orders of magnitude, Channel 3 relies on manual range selection by the reactor operator to process and display the same information.

Although each AGN uses a  $\text{BF}_3$  detector in Channel 3 to indicate linear reactor power, there are significant operational differences for each AGN reactor. ISU has the most extensive Channel 3 low and high scrams when compared to the other AGNs. By ISU Technical Specification, each range of Channel 3 must low scram at or below 5% of the range. The ISU SAR requires that each range of Channel 3 high scram at or above 95% of the range and the Technical Specifications requires a 6-Watt high scram in the top range of Channel 3 (which will occur before 95% of that range). Texas A&M does not have the 5% or 95% scram requirements for each of its ranges and instead has a single low-level scram for Channel 3 that is identical to its Channel 2 low scram. University of New Mexico has no Channel 3 low level scram. Like the Channel 2 low scram requirement, the 1968 Oregon State University Technical Specifications state that the low scram set point is off-scale low. **The implication is that the original reason for the low trip was to ensure that the Channels were on and operating prior to reaching criticality.**

**Table 2. Low and High Power Scrams for AGN Reactor Licenses at Idaho State University, Texas A & M, University of New Mexico, and Oregon State University**

Channel Scram	Idaho State University (ISU)	Texas A&M University (A&M)	University New Mexico (UNM)	Oregon State University (1968)
Channel 1 - Low	5% of full scale or 0.5 counts per second	10 counts per second	NA	Off Scale
Channel 2 - Low	$3.0 \times 10^{-13}$ amps	$1.0 \times 10^{-12}$ amps	NA	Off Scale
Channel 2 - High	6 watts	10 watts	6 watts	200% maximum licensed power
Channel 3 - Low	5% of scale	$1.0 \times 10^{-12}$ amps	NA	Off Scale
Channel 3 - High	6 watts	10 watts	6 watts	200 % maximum licensed power

During reactor operations, there must be some method of determining reactor power from startup through maximum licensed power levels. Measurement of reactor power usually requires separate detectors that operate in different power ranges with some overlap. For operational and safety reasons, it is preferable to verify that the detection channels that measure reactor power are functioning properly prior to reactor startup. Low power scrams indicate a detector is functional, which is likely the reason they were included in the original licensing documentation of AGN reactors. However, there is no known documentation that explains the basis for AGN low level scrams or the scram setpoints.

**In this license amendment request, ISU assumes that the original purposes for the Channel 2 and Channel 3 low scrams were to ensure channel functionality prior to startup. The Rod Drop Test in the start up procedure assures that the original purpose served low scrams, indication of channel functionality, will be maintained.** The complete range of reactor power measurement will be maintained through procedural checks of detector function prior to each startup instead of specific amperage limit scram settings being called out in the Technical Specifications. The reactor startup operational procedure requires that Safety Rods 1 and 2 be inserted and then dropped prior to insertion of a critical amount of fuel. The responses of Channels 2 and 3 before and after the addition of safety rods 1 and 2 are compared to ensure detector operability. With this administrative control in place, reactor power will be monitored continuously throughout the operational range.

## What Happens If We Don't Remove the Low Power Scrams in Channels 2 And 3?

As already discussed, the  $^{10}\text{B}$ -lined detector replacements for Channels 2 and 3 are not expected to produce current at powers less than approximately  $1\text{E-}11$  amps. This value is two orders of magnitude higher than our current low scram set point for Channels 2 and 3 ( $3\text{E-}13$  amps). Therefore, the current low power scram set points would prevent operation with the new detectors.

Another anticipated consequence of not removing the low scram in the startup power range of Channel 3 using a  $^{10}\text{B}$  detector would be the following scenario:

The startup source is inserted into the core. The reactor operator has set Channel 3 to the proper startup range at which the detector will begin to register reactor power. Channel 3  $^{10}\text{B}$  detector does not have the low power sensitivity to measure the source. The detector outputs a noise current that is 3% in the startup range. Rods cannot be inserted into the core to begin startup because detector current is below the 5% scram.

At first, the solution to this problem may appear to be a stronger startup source or a lower power range for Channel 3. Neither of these solutions address the problem adequately. A startup source large enough to generate a current response in the  $^{10}\text{B}$  detector would result in unnecessary, non-ALARA exposure to students and staff. Using a lower Channel 3 range that reads between 5% and 95% for  $^{10}\text{B}$  noise level current does not adhere to the original intent of the low scram. The original  $\text{BF}_3$  Channel 3 detector can output a statistically significant signal at source level (when the detector is functioning properly), so the startup source power was in the operational range of the detector. Because the  $^{10}\text{B}$  detector likely will not respond at source level, it is improper to use low power ranges and set scrams in ranges the detector does not measure power. For this reason, ISU requests that the Channel 3 5% low scrams be eliminated for the transition range and each range below the startup range.

### Qualification of the New Detectors

Through a Reactor Safety Committee-approved experimental procedure, the low power response of the  $^{10}\text{B}$  detector will be determined as soon as the detector is available. The experiment will determine the detector response at low power, specifically the power at which the detector begins to produce a statistically significant current signal above noise level. When this low power measurement limit of the  $^{10}\text{B}$  detector is known, Channel 3 will be modified so that a range will include the transition from noise to power measurement for the  $^{10}\text{B}$  detector. This experimentally determined transition range for Channel 3 will not have a 5% low scram.

It should be noted that this amendment request is worded in such a way as to make the scram settings detector neutral. The original Technical Specifications defined scrams that were specific to the capabilities of the BF<sub>3</sub> detectors. This amendment request will establish the flexibility to determine the startup range according the detector capability, whatever that detector may be, without requiring another amendment.

#### Summary of New Detector Test Procedure:

The New Detector Test Procedure will guide the testing and evaluation of new detectors for Channels 2 and 3. Stage I of testing will keep existing BF<sub>3</sub> detectors connected to the console. In Stage I, the new detectors will be inserted into the thermal column or water shield of the reactor and connected to measurement equipment that is independent of the console. This testing will answer questions about detector response throughout the operating range without making any changes to the existing licensed detection and operational equipment. Observations from Stage I will determine the changes that may be necessary before removing the existing BF<sub>3</sub> detectors and replacing them with new detectors. Potential changes are discussed in more detail in the Stage summaries.

In Stage II of testing, the existing BF<sub>3</sub> Channel 3 detector will be replaced with the new <sup>10</sup>B detector(s) (individually). Testing throughout the complete operational power range will characterize the new detector response relative to known Channel 2 BF<sub>3</sub> response. Completion of Stage II will result in the acceptance of a new <sup>10</sup>B detector in place of the old BF<sub>3</sub> detector in Channel 3.

Stage III will result in the Channel 2 BF<sub>3</sub> detector being replaced with a new <sup>10</sup>B detector. In this final stage of testing, the response of the Channel 2 <sup>10</sup>B detector will be compared to the previously tested and accepted <sup>10</sup>B replacement detector in Channel 3.

The three stages of the New Detector Test Procedure are summarized below:

#### Stage I: Adding New Detectors Without Changing Existing Operational Configuration

- Before anything is added to the reactor or modified, the reactor will run with the old BF<sub>3</sub> detectors connected to the console. Channel 2 and 3 detector response data throughout the operational power range will be recorded for future comparisons.
- New detectors will be inserted in the thermal column, beam port, or shielding tank without modifying the existing BF<sub>3</sub> detectors.
- The reactor will be run to obtain an initial response of the new detectors. Amperage data from the new detectors will be recorded.
- Stage I testing should show how the Reuter Stokes and Mirion detector designs compare to each other regarding low power sensitivity and high power current output.

- Observations during Stage I will determine which detector design is chosen to replace the Channel 3 BF<sub>3</sub> detector in Stage II of testing.

#### Stage II: Replacing Existing BF<sub>3</sub> Channel 3 Detector With New Detector

- Channel 3 BF<sub>3</sub> detector will be replaced by either the Reuter Stokes or Mirion design as determined by the initial response observations in Stage I.
- Based on the observations in Stage I, it may be necessary to modify the Channel 3 console electronics to accept the anticipated signal from the new detector. Documentation of changes will be recorded.
- With the new detector in place, the reactor will be started and operated through a partial power range (or full power range depending on new detector output and console's ability to handle the output current) and the responses of Channels 2 and 3 will be recorded.
- After shutdown, adjustments will be made to the Channel 3 console module so that Channel 3 displays the correct reactor power as determined by known Channel 2 values.
- Adjustments and modifications to Channel 3 will be documented and repeated until the console output for Channel 3 satisfactorily matches the known power from Channel 2.
- To ensure correct function of the detection channels, a gold foil power calibration will be completed and final adjustments made to Channel 3.
- After successful completion of the gold foil power calibration, the new detector will be accepted as the permanent replacement for the old BF<sub>3</sub> detector.

#### Stage III: Replacing Existing BF<sub>3</sub> Channel 2 Detector With New Detector

- Channel 2 BF<sub>3</sub> detector will be replaced by either the Reuter Stokes or Mirion design as determined by the data collected during Stage I and Stage II.
- Depending on the low level response of the new detector designs, it may be necessary to disable the low level scram of Channel 2 to continue testing. Before taking this action, ISU would consult with NRC.
- The reactor will run through the operational range and detector response data for Channels 2 and 3 will be recorded and evaluated.
- Channel 2 is a continuous measurement channel without ranges like Channel 3, so there will be no adjustment necessary. Depending on the detector output, there is a possibility that the signal range of Channel 2 measurement electronics may need to be modified to align with the output characteristics of the new Channel 2 detector.
- Any modifications to the Channel 2 electronics will be recorded and tested until satisfactory measurement throughout the licensed reactor power range can be achieved.
- When the new Channel 2 detector and console electronics function properly, the new detector will be accepted as the permanent replacement for the old BF<sub>3</sub> detector.

#### Modification to Technical Specifications Section 3.2 Specification d.

One of the benefits of the AGN design is the ability to safely run at extremely low power for experimental purposes. ISU wants to maintain this capability after the Channels 2 and 3 detectors have been replaced. The Revision 7 wording of Section 3.2 Specification d allows for Channel 1

to be disabled at any time when any of the fuel rods are partially or completely in the core. As written, the Specification allows for Channel 1 to be disabled when the reactor is in a critical configuration:

*All reactor safety system instrumentation shall be operable in accordance with Table 3.1 with the exception that, with the approval of the Reactor Supervisor, Safety Channel No. 1 may be bypassed whenever the reactor control or safety rods are not in their fully withdrawn position.*

This specification was probably written so that experimenters could bypass Channel 1 if it were more limiting than the low scram of Channel 2. As long as the low scram on Channel 2 functioned as designed, there could not be a situation where the reactor was critical or supercritical without a source of neutrons.

**Removing the low scram on Channel 2 impacts the operational conditions that originally made Specification d acceptable. To address this problem, ISU proposes that Specification d be rewritten as follows:**

*All reactor safety system instrumentation shall be operable in accordance with Table 3.1 with the exception that with the approval of the Reactor Supervisor, Safety Channel 1 may be bypassed when the reactor is in a subcritical configuration.*

The proposed modification to Specification d allows for low power (below source level) subcritical experimentation **and** ensures safer operation when the reactor is critical. According to the revised Specification d, the reactor can be placed into a critical configuration **only** when all three detection channels are operable. Disabling Channel 1 will only occur when the reactor is in a subcritical configuration. The administratively enforced subcritical condition combined with the automatic Channel 2 and 3 high scrams and period scram ensure that unplanned power excursions will not occur. The proposed Section 3.2 Specification d maintains experimental capabilities **and** is more conservative than Technical Specifications Revision 7.

$$\frac{dn}{dt} = \frac{\rho - \alpha T - \beta}{\ell} n + \sum_{i=1}^6 \lambda_i C_i - \frac{dC_i}{dt} = \frac{\beta_i}{\ell} n - \lambda_i C_i, \quad i = 1, 2, \dots, 6$$

$$\sum_f n v \Sigma_f \frac{dT}{dt} = \frac{P}{\delta V C_p} = \frac{1}{\delta V C_p} (P - UA[T_f - T_0]) UA = \frac{P}{\Delta T} = 2 \text{ W/}^\circ\text{C P}_f =$$

$$UA \left( \frac{P}{\alpha} - T_0 \right) T_f = \rho / \alpha - 4$$

### **Summary of Amendment Request**

Idaho State University requests an amendment to License R-110 Docket Number 50-284 for its AGN-201 reactor. The amendment would

- 1) Remove the low power scram for Channel 2.
- 2) Remove the 5% low power scrams for the transition range of Channel 3 and each range below.
- 3) Reword Section 3.2 Specification d to permit bypassing of Safety Channel 1 only when the reactor is subcritical.
- 4) Remove the reference to Unit A for Channel 1 scram. Unit A is no longer in use and has been replaced by the new console (Unit B).

The reason for this request is to enable replacement of the aging BF<sub>3</sub> neutron detectors with modern <sup>10</sup>B neutron detectors that likely will not have the same performance at low power levels. With the requested scram removals implemented, ISU will retain low scram settings in Channel 1 and every power range of Channel 3 above the transition range. Neither modification will impact the assessment of the 2006 Safety Evaluation Report MHA. These Technical Specification amendments for the ISU reactor will result in safety channel scrams that are consistent with other licensed AGN-201 reactors in the U.S.