WASHINGTON STATE UNIVERSITY
PULLMAN, WASHINGTON 99164

NUCLEAR RADIATION CENTER



October 24, 1983

Mr. Ross A. Scarano, Director
Division of Radiological Safety
and Safeguards Programs
U.S. Nuclear Regulatory Commission
Region V
1450 Maria Lane, Suite 210
Walnut Creek, California 94596

Dear Mr. Scarano:

In accordance with the requirements of 10 CFR 2.201 and your letter of October 14, 1983, the following response to the alleged violation is hereby submitted:

I) Washington State University denies that the W.S.U. TRIGA Reactor Facility has violated the requirements of the facility technical specifications relating to the calibration of the continuous air monitor (CAM). The University contends that the U.S. Nuclear Regulatory Commission Division of Inspection and Enforcement is attempting to impose a new requirement above and beyond those previously set by the Division of Reactor Licensing. This contention is based on the following considerations:

a) In 1982 the W.S.U. TRIGA Reactor Facility went through the relicensing process and the entire facility, instrumentation, and associated procedures were extensively reviewed. A team of 5 people from the Licensing Division spent a week at the facility during which time a SER and the new technical specifications were drafted. No question was raised during the review about the CAM instrumentation or the method used to calibrate this system.

b) In May of 1982 the U.S. NRC published NUREG-0911 entitled, "Safety Evaluation Report Related to the Renewal of Operating License for the Washington State University TRIGA Reactor," as part of the relicensing process. Pages 7-1 to 7-4 of this report cover the control and instrumentation of the facility (a copy of these pages is attached as appendix a of this reply). Figure 7.1 on page 7-3 shows a block diagram of the CAM and table 7.1 on page 7-4 lists the alarm set point for the CAM as being 2000 CPM.

c) The NRC review team obviously was aware of the way the CAM at the W.S.U. facility operated and how it was calibrated. They were aware of the fact that the CAM was not calibrated in terms of $\mu Ci/cm^3$ but was used to indicate a potential airborne contamination problem in the pool room. They knew that operating procedures specified that the reactor is to be shut down in the event of a CAM alarm.

II. The CAM calibration procedure that has been used at the facility for a number of years is given in appendix B.

a) This procedure insures that the CAM unit detector is operating correctly and that the ratemeter calibration is correct. In other words, the procedure insures that the CAM instrumentation is capable of performing its intended function.

b) The present CAM system has been installed for many years and has functioned reliably. In 1971 a sample being irradiated in the reactor that contained a very small amount of uranium developed a leak and produced a classical very small fission product release into the pool room. When the CAM reached 2000 CPM the reactor was shut down, and the pool room was isolated and evacuated. The CAM reading continued to climb after the reactor was shut down and peaked at 30,000 CPM about 10 minutes after shutdown. Subsequent analyses including data collection and analysis using a large high volume air sampler yielded a value of $4 \times 10^{-8}$ $\mu Ci/cm^3$ for peak concentration of fission products in the pool room. No limits were exceeded and a written report of the incident was forwarded to the NRC.

This incident showed that the existing CAM system functions as designed to provide a warning of airborne contamination at a level which will allow action to be taken to avert a serious incident.

III. Technically it is not possible to directly calibrate a ratemeter connected to a fixed filter paper-type CAM in terms of the concentration of the radionuclide content of the air passing through the CAM. In reality, the counting rate from a fixed filter paper-type CAM is proportional to the integral of the particulate radionuclide concentration of the air passing through the CAM. Additional complexities include the decay of the collected radionuclides and the build up of natural background radionuclides.

The actual specific radionuclide content per unit volume of air in the case of a fixed filter paper CAM is approximately proportional to the time derivative of the CAM ratemeter reading. In other words, at a constant flow rate, the rate of change or slope of the CAM ratemeter reading is proportional to air radionuclide concentration.

a) The statement made in section 6 of the inspection report would lead one to conclude that the NRC H.P. inspector who wrote the report is not aware of the complex nature of the relationship of the CPM reading from a fixed filter paper CAM and the air radionuclide concentration. The implication is that all that is required for a specific air radionuclide calibration for the existing CAM is a new procedure and some simple measurements involving flow rate and the counting of absolutely calibrated sources. In actual fact additional instrumentation is required that would determine the rate of change of the CAM reading in order to provide a direct reading of concentration of air particulate radionuclide concentration.

b) If non-power reactors are required to have an air monitoring system that is directly calibrated in terms of $\mu Ci/cm^3$, a general upgrade requirement to this effect should be issued by the Office of Nuclear Reactor Regulation. The imposition of such a requirement on any facility by the Division of Inspection and Enforcement is beyond the scope of the authority of I and E as specified in 10 CFR 1.64.

IV. During the exit interview as recorded in section 10 of the inspection report, the inspector was informed that the new Emergency Plan for the facility necessitates upgrading of the CAM system to allow the absolute concentration of radionuclides in the pool room air to be determined. The method that would be employed or the instrumentation that would be required was not, however, discussed.

a) The facility on its own initiative was in the process of evaluating methods of upgrading the CAM system. The upgrade is, however, not a simple matter of procedures but involves purchasing additional instrumentation.

b) The actual instrumentation that is currently planned involves adding a small digital computer to the CAM system in order to perform the complex time-dependent calculations that are required. The development and installation of this system will take of the order of one year.

V. It is impossible for W.S.U. to fulfill the requirements of 2.201 with respect to the alleged violation since it is not a violation but actually a new requirement. An upgraded CAM system and an absolute calibration procedure is in the planning stage based on the facility's own initiative, not on a license requirement. The upgraded CAM system should be in operation in about one year.

VI. Based on the information provided above, Washington State University requests that the alleged violation be retracted.

Sincerely,

W. E. Wilson

W. E. Wilson
Associate Director

WEW:efm
enclosures

cc: Bob Carter
Cecil Thomas
Victor Stello
Dr. Forrest J. Remmick

APPENDIX A

NUREG-0911

# Safety Evaluation Report

## related to the renewal of the operating license for the Washington State University TRIGA Reactor

Docket No. 50-27


**U.S. Nuclear Regulatory Commission**

**Office of Nuclear Reactor Regulation**



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## 7 CONTROL AND INSTRUMENTATION

Basically, the control and instrumentation system at the WSU reactor consists of a primary system with controls and instrumentation that are concerned with the reactor itself and with the safe control and monitoring of radioactivity; there is a supplementary system that is concerned with various processes such as water demineralization. Both systems are interlocked through the scram-logic circuitry to form the overall facility control and instrumentation system. From an engineering viewpoint, the control and instrumentation system at the WSU reactor is well designed and maintained. All wiring that is necessary for the safe operation of the facility is located in conduit or cable trays to protect it from physical damage. All power supplies for the instruments are common phase, and all circuits contain solid-state devices for reliability and ease of maintenance. Indicators are placed on the control console facilitating operator readability and accessibility.

Each scram function is represented with a dual-colored indicator lamp mounted on the control panel that displays the status of the scram circuit. This enables the reactor operator to immediately and positively determine the cause(s) of a scram.

All essential relays and terminal boards are mounted on slideout trays for easy maintenance. Instruments and control circuits are essentially free from ground-loop disturbances and extraneous electrical noise, and the control console layout reflects considerations of human engineering. The relays, amplifiers, and power supplies used in the system exceed minimum system performance requirements. The individual components of the control and instrumentation system are discussed in the following sections.

### 7.1 Control Systems

#### 7.1.1 Primary Reactor Control

Control over the reactor is achieved by inserting and withdrawing neutron-absorbing control elements by use of control drives mounted on the reactor support structures. The control elements are the blade type and are suspended by electromagnets so that any power failure or other malfunction will result in the control elements falling into the core by gravity, resulting in a reactor scram. The control rods and the transient rod are controlled from the control room by use of electromechanical drive systems discussed in Section 4.8.

#### 7.1.2 Primary System Prevents

A total of four primary system "prevents" is provided by the interlock and scram circuitry. The prevents are designed to preclude the possibility of uncontrolled reactor operation. The four primary system prevents are

(1) The control rod withdrawal prevent is provided through the pulse-mode switch and prevents the withdrawal of the control rods while the reactor is in the pulse mode.

(2) The 2-kW pulse prevent interlock prevents the initiation of a pulse above 2 kW steady state and is achieved through the wide-range power channel.

(3) The low-count withdrawal prevent is achieved through the wide-range power channel and prevents withdrawal of the control elements when the neutron count is less than 2 counts per second.

(4) The transient rod air-supply prevent interlock acts through the transient rod control circuitry and prevents pressurization of the transient rod pneumatic drive unless the transient rod is fully inserted in its down position.

### 7.1.3 Supplementary Control Systems

These control systems are designed to control the various processes involved in reactor operation but do not directly relate to safety. Included in this category are the pool water makeup system and the primary and secondary cooling pump controls.

### 7.1.4 Control Interlock System

As stated earlier, both the primary and supplementary control and instrumentation systems are interlocked to form the overall system. The control interlock system consists of circuitry designed for use in steady-state reactor operation and additional circuitry designed for use in pulse-mode operations.

## 7.2 Instrumentation Systems

The instrumentation system of the WSU reactor consists of both nuclear and nonnuclear detecting devices and recorders. The instrumentation is interlocked with the control circuitry by way of the scram-logic circuitry.

### 7.2.1 Nuclear Instrumentation

The nuclear instrumentation at WSU includes one compensated ion chamber and one fission chamber located in the core support structure near the core. Also included is a gamma radiator monitor located in the pool above the core. These instruments are coupled, respectively, to the linear-indication channel, the wide-range channel, and the pulse-power channel.

Instrumented fuel elements contain thermocouples that are connected to the scram system.

Additional nuclear instrumentation includes the continuous air-monitoring system (Figure 7.1) and the gaseous-effluent-monitoring system (Figure 7.2). All the nuclear instrumentation outputs are indicated and recorded in the control room and are connected to the alarm system. In addition to the instrumentation mentioned above, the facility is provided with five area monitors with indications and annunciators in the control room.

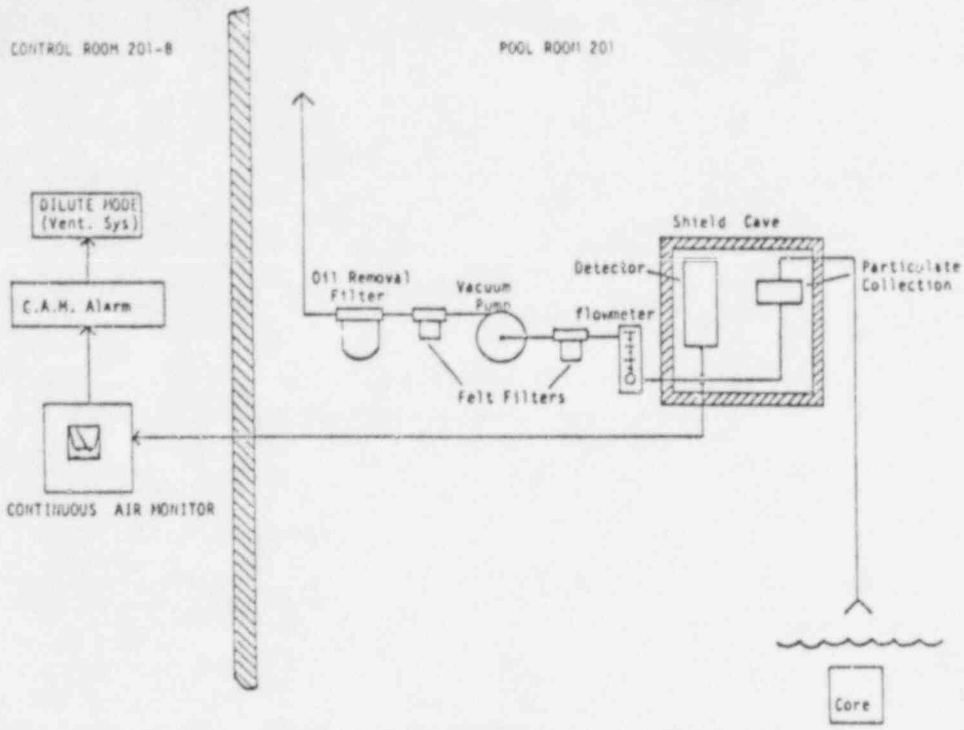


Figure 7.1 Continuous air-monitoring system

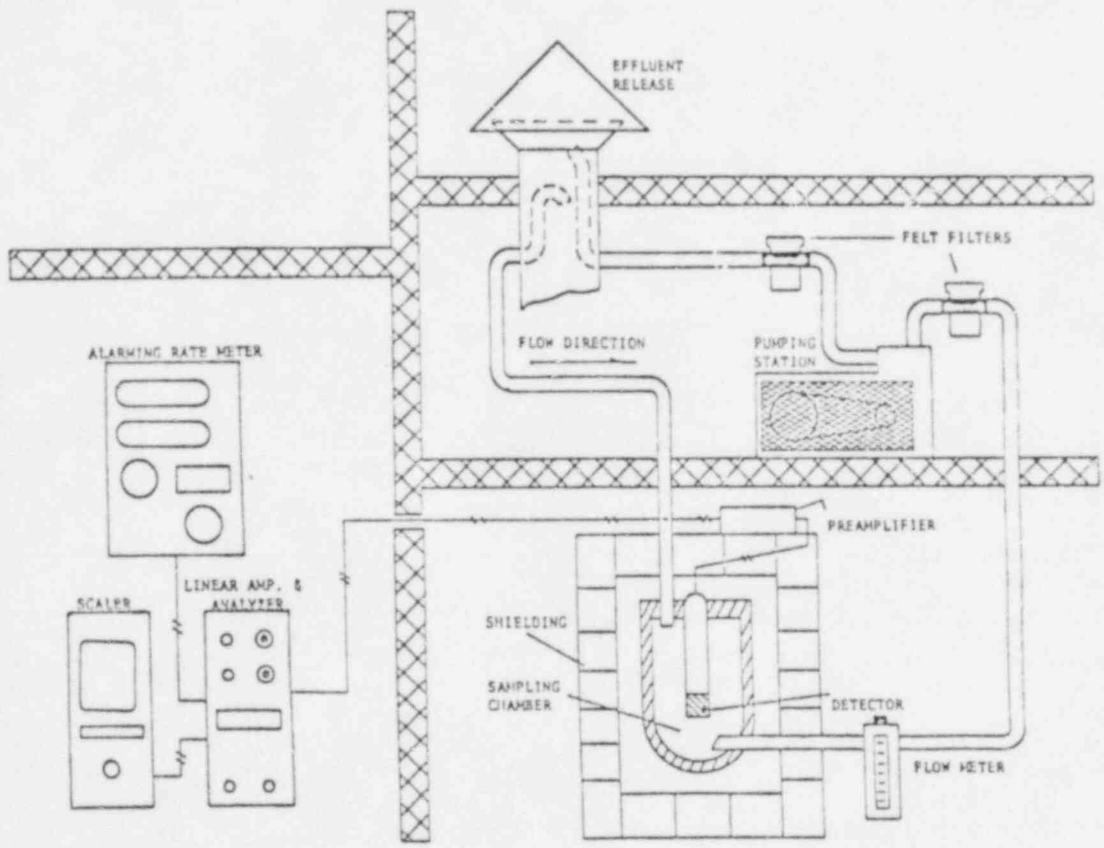


Figure 7.2 Gaseous-effluent-monitoring system

7.2.2 Supplementary Instrumentation

In addition to the primary instrumentation mentioned in Section 7.2.1, there is a wide variety of other instrumentation in use at the WSU reactor. Pool water temperatures, water flow rate, water conductivity, air flow, and waste water radiation levels are all parameters that are measured at the facility. In addition, a closed circuit television system is used to monitor the beam room and the radiochemistry laboratory.

7.3 Alarm and Indicator Systems

Alarms and/or indicators are provided in the control room as indicated in Table 7.1.

Table 7.1 Alarms and indicators

| Unit | Set point | Visible | Audible | Location |
|---|---|---|---|---|
| Seismograph | 0.05 g | X | X | Control room |
| Short period | 5 sec | X | X | Control console |
| HV failure | 590 V | X | X | Control console |
| High power | 122% | X | X | Control console |
| Fuel temperature | 500°C | X | X | Control console |
| High radiation | 100 mR/hr | X | X | Control console |
| CAM | 2000 cpm | X | X | Control console |
| A41 level | 6700 cpm | X | X | Control console |
| Stack | 2000 cpm | X | X | Control console |
| Neutron flux | 110% | X | X | Control console |
| Pool level | 6-in. drop | X | X | Control console |
| Pool conductivity | 1 μmho | X | X | Control console |
| Low air pressure | 70 psi | X | X | Control console |
| Blade disengage | | X | X | Control console |
| Sample monitor | 100 mR/hr | X | X | Control console |
| Beam port plugs | | X | X | Control console |
| Bldg. evacuation | 100 mR/hr | X | X | Control console |
| Vent. air flow | Flow/no flow | X | | Auxiliary panel |

## 7.4 Conclusion

The control and instrumentation system at the WSU reactor employs redundancy and is suited for measuring and monitoring all parameters required by current regulations. It is the staff's opinion that the control and instrumentation system is adequate to ensure the safe operation of the reactor within the context of current Technical Specifications and license conditions for the duration of the licensing period. The safety-related instrumentation fails into a safe mode, causing the reactor to shut down safely, and reactor restart is precluded by interlocks until the malfunction is repaired.

(16) Lower the power supply to below the alarm set-point and reset the High Alarm.

(17) Switch Function switch to the Alarm position and hold there since it is spring loaded.

(18) Adjust R53 (alarm meter adjust) and observe that the meter indicates exactly full scale.

(19) Decade all ranges to ensure proper spanning. Repeat the above steps if necessary.

(20) To make alarm set-point adjustments, simply turn Function switch to Alarm position and adjust the alarm set-point potentiometer (R37) to the desired mR/hr reading on the meter scale.

(21) Turn the Function switch to OFF position. Disconnect the external power supply and remove the jumper.

(22) Reconnect the Sig. Input lead from the detector back to its terminal.

(23) Turn the Function switch to the Oper. position. The Model 855 G-M Area Monitor is now operational.

(24) Calibration complete.

B. Continuous Air Monitor

1. Operability Check

a. Ensure that the AC pilot light is on.

b. Place the Range Selector switch in the "X10" position.

c. Place the Test toggle switch located on back side of monitor in the "TEST" position.

d. Ensure that 3600 CPM is indicated on the meter.

e. Return the Test switch to "OPERATE" and place the Range switch in the "X1" position.

(1) Attach Rm-14 calibration box to the output of Systron-Donner 100A pulse generator. Attach calibration box output to oscilloscope and set pulse generator to obtain a -100 mV pulse. Set pulse width on pulse generator to obtain a "clean" negative pulse.

(2) Place the Range Selector switch in the "OFF" position.

(3) Disconnect the detector cable and replace it with output of calibration box.

(4) Place the Range Selector switch in one of the three ranges (X1, X10, X100).

(5) Connect Reference output of pulse generator into Ortec 775 counter or equivalent. Connect Tennelec 541 timer to gate of counter. By using timer and counter, adjust output frequency to obtain approximately 3/4 meter scale (360-400) reading on Rm-14 for each range (X1, X10, X100).

(6) Adjust the pulse generator frequency to correspond with approximately 3/4 meter scale and adjust the calibration control for the range selected until the meter reading agrees with the input frequency. Repeat for each range.

(7) Place the 3 mg natural Uranium check source in the CAM filter holder and record the observed count rate in the Maintenance Record section of the Continuous Air Monitor book. Repeat using the 30 mg and 300 mg natural Uranium standards.

b. Alarm Set Calibrate

(1) The alarm set calibrate control (R35) should be set so the meter reading at the alarm point agrees with the setting of the Alarm Set control.

2. Alarm Operability Check

   a. Ensure that background counts are being measured. If none, or quite low, place a check source near the detector.

   b. Rotate the ALARM SET switch counterclockwise until an alarm occurs.

   c. Check that the alarm set point and meter reading correlate at the alarm point.

   d. Reset the alarm set point to the required location and push the RESET button.

   Note: Select the lowest range which will allow the alarm set point to be set at 10 times the background counts (not to exceed 2000 CPM) and adjust the alarm set point to this value.

3. Calibration Check

   a. Place the 3 mg natural Uranium check source in the CAM filter holder and compare the observed count rate with the count rate obtained during the calibration most recently performed.

   b. Repeat a. for the 30 mg and 300 mg natural Uranium standards.

   c. If a variation <10% of last calibrated count rate, compensated for source decay, is observed, complete the calibration procedure.

4. Calibration 11-15-78

   a. Count Rate

      Note: Calibration is made to true frequency. Capacitively couple a pulse generator to the DETECTOR connector using a special calibration box. The pulse generator must have a negative pulse approximately 100 mV amplitude and a frequency covering that of the instrument range.