March 30, 1988

Docket No. 50-150

Dr. Robert F. Redmond
Executive Director
Engineering Experiment Station
Ohio State University
142 Hitchcok Hall
Columbus, Ohio 43210

Dear Dr. Redmond:

SUBJECT: QUESTIONS REGARDING CHANGE IN OPERATING POWER

We have reviewed the Safety Analysis Report for the Ohio State University Research Reactor, submitted by your letter of October 7, 1987, with regard to your request to increase the power level to 500 Kw. Enclosed are the questions resulting from this review. If you have any questions, please call me at (301) 492-1102.

Sincerely,

original signed by
Theodore S. Michaels, Project Manager
Standardization and Non-Power
Reactor Project Directorate
Division of Reactor Projects - III, IV, V and Special Projects
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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cc: See next page

cc: Ohio Department of Health
ATTN: Radiological Health
Program Director
P. O. Box 118
Columbus, Ohio 43216

Ohio Environmental Protection Agency
Division of Planning
Environmental Assessment Section
P. O. Box 1049
Columbus, Ohio 43216

Mr. Richard D. Myser
Reactor Operations Manager
Engineering Experiment Station
Ohio State University
142 Hitchcock Hall
Columbus, Ohio 43210

QUESTIONS ON OHIO STATE POWER INCREASE REQUEST

1.0 Restricted and Unrestricted Areas

Personnel radiation dose limits for 10 CFR 20 depend on whether the person is in a restricted area or a nonrestricted area.

1.1 Where is the perimeter surrounding the OSURR through which access is controlled? What is the function of the exclusion fence? What is the closest distance from the OSURR to this exclusion fence?

1.2 During normal operation of the reactor, where are people allowed to be within the restricted area? Where are people expected to be? Please provide drawings of your reactor building and restricted area showing the relative location (with distances) of the control room, catwalks, classrooms, and any other occupied area with respect to the reactor.

1.3 What is the distance between the reactor facility and the closest permanent residence? In the direction of the prevailing winds, what is the distance between the reactor facility and the closest permanent residence?

2.0 Heating and Ventilation Systems

Describe the normal operation of your heating and ventilation system during reactor operations. Furnish a schematic drawing showing relative flows, controls, control locations, intake, and exhaust locations, etc.

2.1 What are the relative pressures of the various areas within the reactor building, i.e., what direction is the air flow relative to the reactor bay during normal reactor operations?

2.2 To what extent is the normal air flow pattern dependent on the operation of certain fans, i.e., what is the air flow without the fans?

2.3 What types of ventilation system abnormalities could cause or allow the air in the reactor bay to enter into normally occupied areas such as the control room or classrooms? Could a failure of the building ventilation fan located 30 ft up the North wall cause this type of situation?

2.4 It is not clear how exhaust of reactor room air is controlled at all times during reactor operation, including the event of an accidental release of radioactivity into the room air. Please include in the schematic drawing that is requested above, the release paths, closures, radiation sensors, and emergency devices. Provide a discussion of the planned effectiveness of the systems and procedures in protecting the health and safety of the public for your 500 kW operations and provide cross-references to your Emergency Plan.

2.5 Describe the operation of your air filtration system under normal operations and accident conditions and provide cross references to your Emergency Plan.

3.0 General Questions

3.1 What provisions are made to prevent uncontrolled release of potentially contaminated liquid spills on the floor? What provisions or instrumentation exist to alert OSURR personnel that a contaminated spill has occurred? What procedures are in place to limit the consequences of such a spill?

3.2 In view of 500 kW:

3.2.1 What effect does radiation heating have on the lead walls located between the graphite reflectors and the thermal columns, Figure 3.12?

3.2.2 What is the effect and consequences of the buildup of radiation damage (Wigner energy) in your graphite i.e. graphite expansion? Please discuss graphite expansion and how you plan to cope with it.

3.2.3 What effect does radiation damage have on the rubber gaskets (page 78)? Are there any other materials located in the high flux regions of the facility which may degrade because of radiation damage?

3.3 In the water makeup system, check valves are apparently relied upon to assure primary water does not enter the campus water supply system. How leak tight are these check valves, i.e., are there any credible pressure conditions which could exist, such as a sudden drop in pressure of campus water supply, that would allow primary water into the public water supply?

3.4 Discuss the relative pressures in the primary and secondary coolant systems within the heat exchanger. Could primary coolant enter the secondary system in the event of a leakage path, and if so, what would the consequences be? Is there any leak detection instrumentation?

3.5 It is stated that "expected alarms can be pre-acknowledged---". Please explain which alarms, the safety significance of pre-acknowledgement, who is authorized to pre-acknowledge, what written procedures exist, what restrictions exist, and implications with respect to your Technical Specifications.

3.6 What radiation monitors do you have on hand to be used in the event of an accident? Please consider this issue in the context of operating at 500 kW, i.e., does the range of the monitors cover all postulated normal operations and accident conditions?

3.7 On page 123, Section 5.4, it is stated that city water is provided for experiments. How, exactly is this water used? Is there any credible means by which water in the city water supply could become contaminated? Is this water used for cooling of experiments during power operations? If so, what provisions has the OSURR for radiological control?

3.8 On page 125 a demineralizer cartridge is discussed, however, Section 3.2.3 discusses in-house regeneration of the demineralizer. On page 156, Section 6.4, you mention both regeneration and disposal. Please clarify. Also, you mention decay of ^{24}Na to negligible levels. What quantitative level do you define as negligible?

3.9 On Page 158, Section 6.6, you mention encapsulation "where possible." The implication is that safety mandated encapsulation may not be required if it is not possible. This is not acceptable. Encapsulation "where necessary" might be acceptable provided the criteria were acceptable. Please discuss your Technical Specification criteria requiring encapsulation.

3.10 At least the first two of the references on page 159, Section 6.7 are probably superseded by later publications. Please provide a list of the most up-to-date references used by your staff.

4.0 Airborne Radiation

Before an amendment to the OSURR license authorizing power levels up to 500 kW can be granted, a yearly estimate power history must be made which conservatively bounds that annually expected at the OSURR. Then, it must be shown that these estimated power operations do not result in annual radiation exposure to any personnel greater than that allowed by 10 CFR 20. Specifically, annual exposures to personnel inside your restricted areas (i.e., those areas where entrance is controlled by the reactor operations staff), and outside your restricted areas (i.e., those areas accessible to the general public) must be estimated and compared to allowables under 10 CFR 20. Further, the manner in which the reactor will be operated to ensure that no personnel will receive radiation doses in excess of the established guidelines, and how the entire management and staff of the OSURR is dedicated to the goal that any and all logistics and aspects of reactor operations are conducted in such a fashion as to ensure radiation exposure to any individual is kept ALARA, must be addressed.

The following questions are posed in order to make the necessary judgements regarding personnel radiation safety resulting from operations of the OSURR. The OSURR SAR Chapter 6 (airborne Radiation) and Chapter 7 (direct radiation) were adequate presentations as far as they went. However, the maximum potential annual radiation dose to personnel due to reactor operations was not quantified. For example, Chapter 6 presented an exhaustive discussion of the potential sources of Argon-41 due to operation of the reactor and the experimental facilities, but did not translate these sources into expected annual doses. It was successfully shown that at 500 kW the OSURR is capable of producing significant amounts of Argon-41, however, it was not shown what steps or procedures may be necessary or will be taken to limit personnel exposure from this Argon-41. For example, it is not possible to assess probable annual doses to people from your Tables 6.7 and 6.9.

In answering the following questions, please be aware that we are looking for the justification that will support granting your requested power increase. The expected dose rate and total annual dose values must be quantified to allow comparison to existing standards. You then should show exactly how you plan to ensure doses to personnel in restricted and nonrestricted areas are kept within the provisions allowed in 10 CFR 20. Additionally, it is recommended that when specific radiation exposure is requested, calculated doses or Curie (concentration) be presented rather than (or in addition to) equivalent instantaneous MPCs. MPCs are for annual releases and do not present a realistic safety assessment of puff type releases that are generally infrequent and more characteristic of intermittent type reactor operations. The cumulative dose from such releases expected over the period of a year should, however, be provided.

4.1 What is a realistic and conservative estimate of the number of effective full power hours (EFPH) the OSURR will be operated per year?

4.2 What percent of the yearly EFPH will the experimental facilities listed in Table 6.3 be operated?

4.3 Which of the experimental facilities listed in Table 6.3 are capable of being operated simultaneously? Which would reasonably be expected to operate simultaneously and for how long at a time?

4.4 What is the equilibrium Argon-41 level (Curies) and airborne concentration in all areas of the reactor building following a power run where the reactor is operated long enough at 500 kW to establish equilibrium Argon-41 conditions and all experimental facilities which can be operated simultaneously are running. Assume the ventilation system is operating normally. Please compute peak Argon-41 concentration in addition to the average in determining the potential personnel exposures.

4.5 Assuming the conditions of Question 4.4 above, what would be the Argon-41 concentration in the reactor building if the building ventilation system suddenly quit during a continuing release?

4.6 What is the maximum dose rate in the unrestricted area from Argon-41 assuming the conditions of Question 4.4 above, and, assuming the resultant Argon-41 is being exhausted from the reactor building at its maximum concentration? In answering this, please consider the following concerns regarding your original SAR analysis:

4.6.1 In the estimate of the Argon-41 concentration being released from the exhaust you assume uniform mixing in the reactor building prior to release. This may not be a conservative assumption especially for the rabbit blower contribution which exhausts directly to the outside near the building exhaust header.

4.6.2 The reference for the offsite dose equation (page 150) should be cited. Please justify why you believe this equation results in the minimum dilution for outside releases.

4.6.3 The calculated dilution factor (page 151) may not be the most limiting value that will occur during a release at distances further downwind than the building wall. For short term (puff) releases, dilution factors on the order of 10^{-1} may exist. This is an order of magnitude less dilution than used in your SAR calculations. To adequately address this concern, OSURR must clearly define where the receptor is located and why this location results in the maximum potential dose in the unrestricted area.

4.7 In view of the results of Questions 4.4, 4.5, and 4.6, what restrictions, if any, do you intend to impose in your Technical Specifications, on operations to limit the doses to 10 CFR 20 guidelines?

4.8 What controls are placed on access to the reactor building, both during shutdown and reactor operation? What controls are placed on opening doors and the status of windows leading from the reactor building to nearby classrooms? Are the classrooms occupied during reactor operation? What is the worst accident scenario associated with the people in the classroom area? Are students in classes considered to be members of the public or "radiation workers"?

4.9 What dose would result if the operator breathes the gas contained in the carrier tube before it is mixed in the reactor building air? What are the precautions taken to prevent this?

4.10 When does the Argon-41 activity released to the effluent system have to be measured and recorded? When would you compare it to some limit (what limit)? Would you compare it to this limit every time a release occurs? Is the Argon-41 production recorded on an annual basis? Is it recorded on a cumulative or on a case by case comparison basis?

4.11 In your identification of possible sources of Argon-41 you neglect any air which may be trapped in the unclad graphite reflectors in the high flux regions. Do you have experience or have you had communication with another facility with a graphite thermal column that justifies your neglect of this possible source of Argon-41?

5.0 Radiation Control

5.1 In Chapter 7 you describe several sources of direct radiation resulting from reactor operations which clearly show radioactive dose control to personnel in the restricted area will depend very heavily on administrative controls. Please describe what specific procedures and controls are in place to control personnel dose to well within 10 CFR 20 limits.

5.2 Please state the Ohio State University ALARA policy. To what level is the upper management of the University committed to ALARA? Who are the signators of the ALARA policy? Discuss how your facility implements the ALARA principle for airborne effluents to the restricted area and the unrestricted area. ALARA also relates to releases of radioactivity in any form and potential exposures to the public. Please provide a quantitative discussion.

5.3 In the first sentence of paragraph 2, page 179, Section 7.2, is there a typographical error in that administrative controls are generally required to implement the ALARA principle, not simply to compliment it?

5.4 Given the radiation sources defined in Chapter 7 resulting from 500 kW power operations, how much cumulated dose from these direct (and to a large degree avoidable) sources would you expect a worker at the OSURR to acquire over the course of a year consistent with your ALARA policy.

5.5 Table 7.5, page 171, presents potential exposure rates from neutrons that appear to be unacceptable at 500 kW operation. Please explain how you intend to deal with these results. Convert the results to Rem, so that it is clear that the biological effectiveness of neutrons is accounted for.

6.0 Chapter 8 General

6.1 On page 189 you state that because the LITR could safely sustain an instantaneous LOCA following infinite operation at 3 MW, the OSURR could safely sustain an instantaneous LOCA at 500 kW. Please describe the physical similarity between those two facilities that lead to this conclusion. Specifically, power density, maximum heat generation rate, heat capacity, heat conduction, heat sinks, fuel plate temperature, etc. should be discussed. Please provide explicit references.

6.2 In the event of a total loss of coolant, what radiation levels would be expected in the various areas of the reactor building and surrounding areas? What procedures or precautions are in place to control personnel dose?

6.3 On page 211 you state fuel element inspections are performed once a year. Will this still be possible at 500 kW operation? If so, what special handling procedures are required? Are there any Technical Specification restrictions?

6.4 On Page 184, it is mentioned that PARET is used. Is this the original PARET of the 1960s or is it related to the PARET/ANL, as revised by ANL for nonpower reactors?

6.5 Please reference your sources of information for the Thyroid Dose Conversion on page 218. Please reference your source of information for the absorption coefficient in Table 8.11, page 223.

7.0 Chapter 8 - MCA

The accident that has been defined which has the highest potential for the release of radioactive fission products is the Damaged Fuel Plate Accident, Section 8.4.4. Before a power increase to 500 kW can be granted, we must be assured the radioactive dose consequences resulting from this maximum credible accident (MCA) to persons in the restricted area and to persons in the unrestricted area are within acceptable guidelines such as the guidelines of 10 CFR 20. Additionally, we must be convinced that the OSURR operations personnel understand their facility sufficiently well to exercise proper accident management procedures in order to minimize those radiological consequences. Accordingly, the following questions regarding Chapter 8 are submitted.

7.1 What are the accident scenarios, i.e. at what locations (control room, reactor building, nearby classrooms) would people be exposed, how many people; what is worst credible case (heating and ventilating systems working or not) for both in-building doses and external doses considering the inplace evacuation plans and mitigative features (isolation, venting, etc.)?

.2 What are your proposed dose guidelines for both the personnel in the reactor building and the people external to the facility (nearest personnel occupancy in the unrestricted environment)?

7.3 What is the reasonable (conservative) upper limit for personnel occupancy time in the reactor building in the event of your proposed accident?

7.4 What are the resulting doses (both inhalation and immersion doses) for a person remaining in the building for the time period established in (3) above? Specifically, what is the whole-body immersion dose (in Rem); and what is the thyroid committed dose (in Rem)? Nonpertinent information should be eliminated such as doses for exposure times beyond the time established in Item (3).

7.5 What atmospheric dispersion factors, absorption coefficients, etc., are used in your analysis to get to the location of the nearest unrestricted area. Are they conservative. Please reference.

7.6 What is the calculated maximum offsite (unrestricted area) dose, for the duration of the release, considering both inhalation and immersion direct radiation. Specifically, what is the whole-body immersion dose (in Rem) and the thyroid committed dose (in Rem)?

7.7 What is the comparison of the calculated doses to acceptable guidelines? If any mitigative features are required to meet these guidelines, then are these features incorporated into the technical specification requirements, e.g. building vents, evacuation of personnel, instrumentation setpoints, etc.? The position of the safety analysis as to whether the results meet the guidelines (and why) should also be presented.

7.8 In Section 8.4.4.2, page 214, shouldn't the equation be written:

$$X_w = (N_I/N_A)/\left(\frac{VK\rho}{M}\right)$$

8.0 <u>OSURR Technical Specifications Related to Power Increase</u>

8.1 Section 2.2, page 243:

8.1.1 Please make changes in these specifications necessary for an authorized steady state operation not to exceed 0.5 MW (500kW) thermal.

8.1.2 Please review your bases, including specific references to your revised SAR, to ensure that they are complete and appropriate.

8.2 Section 3.1.1, Specification No. 1, page 244:

Please be sure that the bases for this specification, if changed from your current value, addresses both operational requirements and safety considerations, including specific references to your revised SAR.

8.3 Section 3.2.3, Table on pages 248, 249:

8.3.1 Item 2: Please be sure that the appropriate scram level is inserted for the 0.5 MW power level.

8.3.2 Items 4 and 5: Provide a more quantitative justification in the SAR and your bases for the 120 kW level. This question also applies to Section 3.3.1.

8.3.3 Item 6: The water also functions as a radiation shield. Please discuss this basis too.

8.3.4 Item 13: As a minimum, please point out where you have addressed this in your SAR, and justify the value of 60 ma. Please add a provision for surveillance of this parameter in Section 4 of your Technical Specifications.

8.4 Section 3.3.2:

Section 7.1.1.4 of your SAR indicates high exposure rates at the top of the pool at 0.5 MW operation. Please address specific provisions you will make to prevent personnel access and/or overexposure, and add a specification to this section that will assure implementation and control.

8.5 Section 3.3.3:

Please address the fact that operation at 0.5 MW will activate impurities much more than at 10 kW. What provisions for this have you made? Provide the bases.

8.6 Section 3.3.4:

Please clarify whether this "detection system" is automatic, and also whether it is the same system that initiates the scram (Item No. 6, page 240).

8.7 Section 3.3.5:

This specification is not sufficiently explicit for a limiting condition of operation. Monitoring is appropriate, but specific limits on radioactive concentrations should be specified to trigger non-operation of the system and corrective action. Your objective seems reasonable, but your specification itself does not assure it. Please be specific.

8.8 Section 3.3.5 and 3.4:

Both of these relate to potential releases of radioactivity to the unrestricted environment. Please be more specific about sufficient control to assure compliance with regulations and ALARA.

8.9 Section 3.4:

Please be more specific about doors and windows being "operable." Justify why the doors and windows might not need to be closed during reactor operation at 0.5 MW, so that airborne releases will be through known and controlled pathways, in accordance with the requirements of 10 CFR 20.105 and 20.106. Please show how you will ensure compliance with regulations and your ALARA program.

8.10 Section 3.6.1:

8.10.1 For all of these radiation monitoring systems, your Technical Specifications should include explicit alarm settings and your responses. These settings should be based on your SAR analyses and permissible dose or exposure rate limits. Please provide these settings for the 0.5 MW operating power.

8.10.2 For this specification and others where you have used the word "on," please use the term "operating," which you have defined in Section 1.3.

8.11 Section 3.6.2:

You should rethink this entire specification. Compliance with 10 CFR 20, for both restricted and unrestricted areas is already required. This specification should specifically limit effluents such that the facility will stay well within 10 CFR 20 (ALARA) or the reactor should not be operated. Sections 6.2 and 6.3 of the SAR do not provide concentration limits or other measurable parameters. Furthermore, Section 6.3 of the SAR implies that not all experimental facilities could operate indefinitely without added restrictions. Please provide for this Technical Specification the limits that you deem necessary, and give the basis.

8.12 Section 3.7.1:

8.12.1 Please insert the word "absolute" before the word "value" in these specifications to account for any mode of failure.

8.12.2 The differences between items (4) and (5) are not clear. Are they both needed?

8.12.3 Your use of the term "movable" in item (5) seems consistent with ANSI 15.1. However, your definition of "movable" in Section 1.3 is not consistent with ANSI 15.1. Please address this comment, and consider your use of "movable" in Item (3). It seems that ANSI 15.1 would use "secured" here instead of "movable". Please consider.

8.12.4 The basis for Specifications 4 and 5 should include "...limits the rate of change of reactivity insertions to levels that have been analyzed." And please reference the sections of your SAR that apply to these specifications and analyses.

8.13 Section 4.3.1:

It is recommended that the word "conductivity" in this specification be replaced with "conductivity and pH." In addition, it is suggested that the bases should include the concept that "changes... are detected in a timely manner, and that the concentrations of impurities that might be made radioactive by neutron irradiation do not increase significantly."

8.14 Section 4.3.2:

It is recommended that the bases for the secondary and tertiary coolant checks should include the concept that "help assure that radioactivity in the primary system is not permitted to escape to the secondary system in an uncontrolled manner." Otherwise, there would be no assurance that 10 CFR 20, plus ALARA, were in fact being complied with.

8.15 Section 5.1.1:

Because you have used a specific building volume in some of your analyses for concentrations of airborne radioactivity, you should add something like the following: "The minimum free air volume of the room housing the reactor will be $\geq$ 70,000 ft^3. There is an exhaust fan and stack system with dampers, providing for control of release of airborne radioactivity."