

November 2, 2001

Ms. Clare Laune  
1661 Caulles Creek Ridge  
Chesterfield, MO 63005-6546

SUBJECT: NRC DISCUSSION OF COMMENTS RECEIVED ON OPERATIONAL ISSUES -  
UNIVERSITY OF MISSOURI-COLUMBIA CONSTRUCTION PERMIT  
RECAPTURE AMENDMENT (TAC NO. MB0850)

Dear Ms. Laune:

This letter regards comments that were submitted in response to a "Request for Public Comment, Environmental Assessment and Finding of No Significant Impact" which appeared in the FEDERAL REGISTER on August 1, 2001 (66 FR 39803), for the University of Missouri-Columbia Research Reactor (MURR). The University submitted a request for a license amendment to change the expiration date of Amended Facility License No. R-103 for the MURR from November 21, 2001, to October 11, 2006, to recapture the period of facility construction.

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Sincerely,

*/RA/*

Alexander Adams, Jr., Senior Project Manager  
Operational Experience  
and Non-Power Reactors Branch  
Division of Regulatory Improvement Programs  
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosure: As stated

cc w/o enclosures: Please see next page

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November 2, 2001

Ms. Kay Drey  
515 West Point Avenue  
University City, MO 63130

Dear Ms. Drey:

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Dr. Tom Sager  
8 Laird Avenue  
Rolla, MO 65401

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Ms. Angelina S. Howard  
Nuclear Energy Institute  
1776 I Street, NW  
Suite 400  
Washington, DC 20006-3708

Dear Ms. Howard:

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Ms. Becky Denney  
625 Angenette Avenue  
Kirkwood, MO 63122

Dear Ms. Denney:

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Ms. Bea Covington  
Executive Director  
Missouri Coalition for the Environment  
6267 Delmar Boulevard, 2-E  
Saint Louis, MO 63130

Dear Ms. Covington:

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Ms. Sandra A. Lowes  
7425 Teasdale  
St. Louis, MO 63130

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Mr. Ken Midkiff, Director  
Ozark Chapter/Sierra Club  
1007 North College Avenue  
Suite 1  
Columbia, MO 65201

Dear Mr. Midkiff:

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Mr. Leonard A. Sonnenschein, President  
St. Louis Children's Aquarium  
416 Hanley Industrial Court  
Brentwood, MO 63144

Dear Mr. Sonnenschein:

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St. Louis Children's Aquarium  
416 Hanley Industrial Court  
Brentwood, MO 63144

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Please find enclosed "Discussion of Operational Comments - University of Missouri-Columbia Construction Permit Recapture Amendment." This document contains a discussion of the disposition of comments related to the operation of the reactor and other issues not related to the Environmental Assessment or the license amendment request.

You will be sent under separate cover a copy of the staff's discussion of comments received that were relevant to the Environmental Assessment.

Sincerely,

*/RA/*

Alexander Adams, Jr., Senior Project Manager  
Operational Experience  
and Non-Power Reactors Branch  
Division of Regulatory Improvement Programs  
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosure: As stated

cc w/o enclosures: Please see next page

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DATE	10/18/2001	10/18/2001	10/18/2001

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November 2, 2001

Ms. Rebecca M. Wright  
2011 Rutger Street  
St. Louis, MO 63104

Dear Ms. Wright:

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November 2, 2001

Ms. Sandra Delcoure  
3029 Willow Creek  
Florissant, MO 63031

Dear Ms. Delcoure:

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Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosure: As stated

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Discussion of Operational Comments  
University of Missouri-Columbia  
Construction Permit Recapture Amendment  
Docket No. 50-186  
License No. R-103

By letter dated December 27, 2000, as supplemented on April 12 and June 6, 2001, the University of Missouri-Columbia (UMC or the licensee) submitted a request to change the expiration date of Amended Facility License No. R-103 for the University of Missouri-Columbia Research Reactor (MURR) from November 21, 2001, to October 11, 2006, to recapture the period of facility construction. This action is not unique and is consistent with prior precedents.

The State of Missouri Department of Natural Resources requested that the Environmental Assessment (EA) be circulated for public comment. In light of the request, the NRC determined to exercise its discretion to circulate the EA for a 30-day public comment period and on August 1, 2001 the Notice of "Request for Public Comment, Environmental Assessment and Finding of No Significant Impact" appeared in the *Federal Register* (66 FR 39803).

The NRC's Public Electronic Reading Room (PERR) is found on the Internet at the following web address: <http://www.nrc.gov/NRC/ADAMS/index.html>. From this site, the public can gain access to the NRC's Agencywide Document Access and Management System (ADAMS), which provides text and image files of NRC's public documents. Documents concerning the MURR, including comments received on the EA, can be found under docket number 05000186. Persons who do not have access to ADAMS or who have problems in accessing the documents located in ADAMS may contact the PDR reference staff at 1-800-397-4209, 301-415-4737 or by email at [pdr@nrc.gov](mailto:pdr@nrc.gov). Documents can also be examined, or copied for a fee, at the NRC's Public Document Room found at One White Flint North, 11555 Rockville Pike (first floor), Rockville, MD.

During the comment period, the staff received 12 comment letters. The incoming comment letters are in Attachment 1. The majority of the comments received related to the operation of the reactor and other issues not related to the EA or the license amendment request. The staff has reviewed these comments and the response to specific comments is provided in Attachment 2. Comments related to the EA are dispositioned in a separate document prepared by the staff which is referenced in the EA. The responses are organized by topic and like-kind comments were organized together with a common response. Each comment was assigned a specific alpha-numeric identifier (e.g., A1) for ease of tracking the staff's considerations of the comment and the public's understanding of how the comment was dispositioned. The identifier is typed in the margin of the correspondence at the beginning of the discussion of the comment. Because Attachment 2 is limited to comments related to the operation of the reactor and other issues not related to the EA or the license amendment request, not all alpha-numeric identifiers shown on the comment letters are discussed in Attachment 2.

**NRC Staff's Discussion of Operational Comments  
University of Missouri - Columbia  
Construction Permit Recapture Amendment**

**1. Use of High-Enriched Uranium**

**Comments:** Eight commenters raised general concerns about the use of high-enriched uranium (HEU) in the MURR reactor. Some opposed the proposed amendment or continued operation of the reactor because the reactor used HEU (A2, B5, D7, E3, F5, I1, J3, L3).

**Response:** The comments are general in nature and do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** Seven letters raised concerns that the use of HEU in the MURR was a terrorism or sabotage security risk (A2, B6, D8 E4, F6, I2, J4). Three commenters raised a concern about the security of the transportation of HEU (A2, I3, J4). A commenter asked "are adequate protections in place at UMC to safeguard against the threats posed by terrorists (E7)?" Another asked "if the NRC were to decide to extend the MURR license for an additional five years, would the Commission require that the licensee provide enhanced safeguards protection and surveillance at the reactor site during that period (A4)?"

**Response:** The licensee has an NRC-approved physical security plan that meets the requirements of the regulations for the types and amounts of special nuclear material that MURR is authorized to possess and ship. The licensee did not request any changes in the physical security plan or in its use or possession of special nuclear material as part of its construction permit recapture amendment. No changes to the physical security plan or use and possession of special nuclear material were made by the licensee as part of this amendment.

The physical security plan for MURR has the measures deemed necessary to protect against radiological sabotage. Because the physical security plan meets the requirements of the regulations, the NRC has no basis to impose additional safeguards and surveillance requirements on the licensee.

The comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required. However, in light of the recent terrorists attacks against the World Trade Center and the Pentagon, the NRC is reviewing its security regulations and procedures and if any further actions are deemed appropriate, they will be implemented.

**Comment:** One commenter stated that it is inexcusable for an alleged "research reactor" to produce bomb-grade uranium and that the NRC should immediately prohibit MURR from enriching uranium (G20).

**Response:** While the MURR reactor uses HEU fuel for operation, operation of the reactor does not produce or enrich uranium. The comment does not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked “how frequently does the campus security department and/or the reactor staff conduct drills at MURR designed to prevent the theft or diversion of the HEU fuel? How recently has the NRC evaluated such a drill? Has there ever been a surprise force-on-force test at the site, and if so, were deficiencies identified (A5)?”

**Response:** Details of the MURR physical security plan including testing and surveillance requirements are safeguards information and are generally protected from public disclosure. The NRC inspects the licensee’s performance in this area annually. The results of recent NRC inspections found that the licensee is meeting the requirements of the physical security plan and the applicable regulations. The regulations do not require security drills or force-on-force tests for this class of licensee. The comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked “does the licensee plan to redesign and convert its reactor to use fuel with lower enriched uranium during the requested five-year extension? Or has the University been able to justify that it is entitled to a continued “unique purpose” exemption from the NRC’s requirement that all domestic non-power reactors were to convert from the use of HEU (as per CFR 50.64, published in the Federal Register, 2/25/86)? Are there not advanced low-enriched fuels to which this reactor could be converted (A3)? How much weapons-grade uranium is currently in use and stored at MURR (A6)?” Another asked “has the UMC reactor met the criteria for the continued use of this dangerous material (E5)? What are the alternatives to continued use of highly-enriched uranium at the reactor (E6)?”

**Response:** The licensee has not made the NRC aware of any plans to convert its reactor to low-enriched uranium (LEU) during the next five years. The licensee has informed the NRC in accordance with the regulations that the Department of Energy (DOE) has indicated that no funds are available to convert the reactor to LEU fuel. The licensee meets the requirements of 10 CFR 50.64 on limitations on the use of HEU. The licensee has not been granted a unique purpose exemption. No LEU fuel acceptable to the Commission is available. None of the currently available LEU fuels would allow conversion of the MURR. The NRC closely follows the LEU fuel development efforts of the Reduced Enrichment for Research and Test Reactor (RERTR) program, the world-wide effort to develop LEU fuels which in the United States is based at Argonne National Laboratory. The amount of special nuclear material possessed by the licensee is within the limits of the reactor license. This is confirmed by the NRC inspection program. The comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

## **2. Operational Safety Issues**

**Comment:** Eleven letters contained comments related to operational safety issues with regard to the MURR, administrative issues, and specific past events. Comments with regard to MURR include:

- the age of the facility (D9, F2, L7)
- reliability of computer technology (L11)

Comments with regard to administrative issues include:

- the Director has been involved in considerable controversy of a highly-visible public nature (G1)
- the operations, from a public perspective seem to be poorly supervised (G2)
- the Director has resigned, while filing defamation lawsuits against former employees (E15, G3, J14)
- there have been allegations of discrimination and retaliation or stifling of concerns of employees (“anti-whistleblower”) which have warranted investigation by the NRC (E13, G5, J12)
- there is a “chilling effect” at the facility where administrative actions are taken against those who have reported problems (G7)
- the personnel record of this facility is dismal (G6) and the MURR continues to be plagued with significant personnel problems (B7, I5)
- the departure of the key players and trouble the licensee has finding qualified employees is a safety issue; facility has high turnover rate (B7, D10, G23, L6)
- NRC must determine if MURR has capable staff on hand to operate this facility, and if not, ascertain what the plans are to acquire such personnel (G24)
- there should be an annual assessment for the need of research nuclear reactor facilities (H1)
- there should be an annual review of operation procedures and staffing (H1)
- a stakeholder advisory panel should be formed (H3)
- management problems certainly increase the chance of a serious accident at the reactor and increase the danger to the surrounding community (J15)
- there is a dire need for strict standards concerning the operation of MURR (K1)

Comments with regard to specific past events include:

- two violations in the refueling area (E12, J11)
- two preventable accidents that could have caused great harm to persons and the environment (B4)
- serious violations, in conjunction with the multiple personnel issues at the reactor, require careful attention from the NRC (E16)
- employees have reported issues directly related to releases-potential or real-of radioactive emissions to the environment (G8)
- the incident of June 12, 2000, where a control blade was removed from the reactor without first removing two fuel elements from the core seems to be a good example of personnel weakness (A19)
- the incident of April 12, 2000, where a fuel element was placed in the wrong storage location creating a 400 rem/hour radiation field at a location where primary shielding was removed to inspect the pool liner also points to inadequate staffing (A20)

One commenter stated that the NRC must take into account the past record of operations of this facility (G9). Another asked “to what extent will the NRC evaluate recent operating problems at the plant in determining whether to issue a 5-year extension of the operating license? For example, is it of concern to the NRC that two separate violations occurred in the critically important refueling area within just two months --- one on April 12, and one on June 12, 2000? Is it of concern that allegations of discrimination and retaliation were filed by a reactor employee who had raised safety concerns; that other former employees have raised concerns about the level of commercial activity and about related conflicts of interest at MURR;

and that a defamation lawsuit, filed on June 25 by the immediate past director, is pending against two retired MURR scientists (Missouri Lawyers Weekly, 7/9/01) (A17)?”

**Response:** These comments refer to past or current operational issues at MURR. The events of April 12 and June 12, 2000, were closely followed by NRC. Two special inspections were performed (50-186/2000-202 and 50-186/2000-203), an enforcement conference which was open to public observation, was held with the licensee in Columbia, Missouri, and the licensee was issued two violations. The NRC continues to have open items from these events and continues to carefully monitor the effectiveness of the licensee’s corrective actions. The NRC has concerns about the potential for a work environment at MURR where employees may be reluctant to identify safety concerns and is pursuing an apparent violation of 10 CFR 50.7, which prohibits discrimination against employees who engage in protected activities. These issues are being pursued in accordance with the applicable NRC policies and practices. There is no direct connection between these issues and the pending construction permit recapture license amendment request. Some comments referred to aging and equipment issues. The NRC’s safety evaluation prepared for this amendment will consider and evaluate these types of issues.

These comments refer to past or current and operational issues at MURR and they do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

### 3. Financial Issues

**Comment:** Six commenters brought up financial issues related to MURR:

- the facility itself is engaged in commercial operations of uncertain ethical standards and practices (G4)
- employees have raised concerns about the level of commercial activity and related conflicts of interest (E14)
- the facility stays open due to its commercial ventures, the University of Missouri-Columbia could not afford to provide the necessary financial support to maintain this operation (G11)
- commercial operations are the basis of problems at the facility (G12)
- commercial ventures need to have distinct timetables when projects are expected to be completed (G13)
- the NRC must determine whether MURR is a “private” or “public” reactor, and whether its mission as a “research reactor” is compromised by commercial contracts (G14)
- the NRC must determine if the commercial ventures of MURR are appropriate for a research facility, in light of the difficulties caused by the commercial ventures (G15)
- the citizens of Missouri must pay the bill for this reactor now and in case of accidents and widespread contamination (D11)
- there are safety and cost concerns (which are prompting closures of research reactors at other Universities) (L5)
- currently MURR has become a commercial facility raising questions of conflict of interest (J13)

One commenter asked whether it is of concern that other former employees have raised concerns about the level of commercial activity and about related conflicts of interest at MURR (A17)?

**Response:** Commercial and industrial facilities are defined in 10 CFR 50.22. A non-power reactor is considered a commercial facility if the facility is used so that more than 50 percent of the annual cost of owning and operating the facility is devoted to the production of materials, products, or energy for sale or commercial distribution, or to the sale of services, other than research and development or education or training. The NRC has determined that the MURR does not meet the definition of a facility used for industrial or commercial purposes. The NRC reviewed the financial status of the MURR in Inspection Report 50-186/2000-202 dated July 26, 2000. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked “has the University of Missouri-Columbia been required to submit to the NRC a financial analysis of its ability to operate and maintain the reactor safely during the proposed five-year license extension? If so, to what extent does it rely upon the State Legislature to appropriate funds (A32)?”

**Response:** UMC is not required by the regulations to submit this type of financial analysis for the requested amendment. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked “is the University, as a nonprofit educational institution, required to post a bond to cover the costs of decommissioning the reactor (as per 10 CFR 140)? If not, what federal or state agency would be held responsible for those costs? Has the University provided the NRC with a decommissioning plan (A33)?”

**Response:** The requirements for decommissioning funding assurance are provided in 10 CFR 50.75. UMC has submitted a statement of intent in accordance with 10 CFR 50.75(e)(1)(iv). The University is not required by the regulations to post a bond. The licensee is responsible for the cost of decommissioning. In accordance with the regulations, the licensee has provided the NRC with a decommissioning report which establishes how it will fund decommissioning activities. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** One commenter asked “if Congress fails to renew the Price-Anderson Act this year or reduces the amount of the federal insurance subsidy, will that affect the University? Does the University pay annually for insurance to cover the liability of an accident at MURR? What are the estimated costs of a major accident (A34)?” A commenter asked would Missouri tax-payers be liable if an accident were to occur during the transport of MURR wastes (A11)?

**Response:** The licensee acquires insurance from the commercial insurance pool for the first \$250,000. If Congress does not renew the Price-Anderson Act, the University will still be indemnified above their \$250,000 limit (i.e., up to \$500 million in Government indemnification). The licensee’s indemnity is in effect as long as it maintains an operating license. Licensees are not required to estimate the potential cost of accidents. Shipments made by the licensee under the reactor license are covered. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

#### 4. Facility Location Issues

**Comment:** Five letters commented that MURR is located in a large growing urban area (B8, G16, I4, J1, L12). One letter stated that three hospitals and the campus and dormitories are in close proximity (J1). In addition, a commenter points out that on football weekends there are as many as 60,000 additional persons within ½ mile of MURR (G17).

**Response:** Due to the limited inventory of radioactive material in the reactor, the emergency planning zone (EPZ) for the MURR is 150 meters (500 feet) surrounding the facility. The licensee has the ability to control access within this zone. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

#### 5. Health Physics Issues

**Comment:** A commenter asked “is tritium created as a byproduct of MURR research on boron neutron capture therapy (A14)?” The commenter also asked “what, briefly, is the design of the equipment installed in 1995 that is used to detect and sample the continuous flow of gases in the gas channel of the exhaust stack, during the venting of the gases to the environment? Is the continuous flow of tritium and noble gases detected by this new equipment (A15)?”

**Response:** With respect to Boron Neutron Capture Therapy (BNCT), NRC is not aware of any active research in this area. Thus, while permitted, no tritium is being produced as a result of BNCT at the facility.

The exhaust monitoring system at MURR consists of a three-channel radiation detection system designed to measure the airborne concentrations of radioactive particulate, iodine, and noble gas in the exhaust air. The air is sampled by an isokinetic probe located in the ventilation exhaust plenum. Detectors monitor the concentration of particulates, iodine, and noble gases in the exhaust and that information is constantly supplied to an instrument panel located in the control room. Tritium is not detected or measured by the system but is measured separately. Exhaust air is drawn through a desiccant in a known volume and moisture accumulates. After a specified time has elapsed, the sample is removed from the exhaust system and the moisture that has accumulated in the sample is driven off and retained. The liquid is analyzed and the concentration of tritium present is determined. The licensee can then determine the amount of tritium released in the exhaust air as a relationship with the volume of air that flowed in the exhaust during the specified time.

These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked “are the University’s personnel training and radiation protection programs adequate, including personnel oversight, the use of equipment and instrumentation, and the control of licensed materials (A18)?”

**Response:** The NRC inspection program has found that the licensee’s personnel training and radiation protection programs, including personnel oversight, the use of equipment and instrumentation, and the control of licensed materials, are acceptable. The comment does not

provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** One commenter asked various questions pertaining to the exposures workers at MURR receive as a result of their employment at the facility. “How many reactor or contractual employees participate in a typical refueling (A21)? What was the highest radiation dose to which an employee was exposed during the past year as the result of the refuelings (A22)? To what extent does the NRC oversee the amount of radiation to which MURR employees are exposed during the weekly refueling operations (A23)? What is the average duration during which MURR irradiated fuel is stored on site before it is shipped to a DOE storage facility, in South Carolina or Idaho? Are reactor personnel exposed to the stored fuel (A24)? Because the reactor has been operating for 36 years, have radioactive corrosion products (which emit highly penetrating gamma radiation) accumulated in and on the piping and other components? If so, has this increased the radiation dose of the maintenance personnel? Are chelating agents used at MURR to dissolve the corrosion products (A25)?”

**Response:** 10 CFR Part 20 provides the annual dose limits for workers exposed to radiation as a result of their employment at an NRC licensed facility. The exposures of all radiation workers at the facility are reviewed by NRC annually to ensure that they are within the regulatory limits. Within the past several years, there have been no exposures above the established limits.

In response to the first comment (A21), three to four individuals typically participate in a refueling operation. With respect to the second comment (A22), as noted above, no one working at the facility, whether participating in refueling operations or not, received a dose approaching or in excess of any regulatory limit.

As noted above, in response to the third comment (A23), the NRC reviews exposure records at least annually.

Regarding the remaining comments (A24 and A25), irradiated fuel is typically stored on site for about ten to twelve months before it is shipped off site. It is stored in the pool area near the reactor and is afforded about the same amount of shielding as the reactor itself. Because the reactor has operated for many years, some small accumulation of radioactive products is expected in the piping system of the reactor. However, routine, periodic surveys are conducted in all areas of the facility by the health physics staff and any areas with radiation levels higher than those typically detected in the area are identified and actions are taken to reduce the levels and/or restrict access to those areas. Chelating agents were used to clean up a waste tank in the past, but have not been used at the facility for over fifteen years.

The comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

## 6. Issues With the Use of Graphite

**Comment:** Five letters contained comments about the use of graphite in the MURR (B12, E11, F7, G21, L8).

**Response:** In September of 1987, the Brookhaven National Laboratory (BNL), under contract to the U.S. Nuclear Regulatory Commission, performed a comprehensive study to “review existing literature and knowledge on graphite burning and on stored energy accumulation and releases in order to assess what role, if any, a stored energy release can have in initiating or contributing to hypothetical graphite burning scenarios in research reactors. It [the study] also addresses the question of graphite ignition and self-sustained combustion in the event of a loss of coolant accident (LOCA).” This study is available as NUREG/CR-4981, “A Safety Assessment of the Use of Graphite in Nuclear Reactors Licensed by the U.S. NRC.”

The responses to many of the comments below are derived from the BNL study. The study investigated the conditions necessary to initiate and maintain graphite burning. The study also reviewed and summarized the Chernobyl and Windscale accidents, and investigated the role of stored energy releases in these events. The study reviewed the considerable amount of experimental data with regard to graphite burning and stored energy release. The study concluded that any reactor containing graphite in which the lowest irradiation temperature is 70°C or higher can be excluded from stored energy safety concerns and that any reactor in which the graphite is irradiated at temperatures below 70°C but has received a total fast neutron exposure that is less than  $3.5 \times 10^{19}$  nvt can be excluded from stored energy concerns. The graphite used at MURR meets these conditions. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A concern expressed was that graphite is combustible (B12, F7, G21). It was stated that graphite fires are difficult to extinguish (B12). One commenter asked if the graphite could burn and once burning if it would be hard to extinguish (D2)?

**Response:** Nuclear grade graphite is very difficult to burn because it is free of impurities that aid in the oxidation process. In order to initiate burning, the graphite must be heated to at least 650°C. Furthermore, there must be an adequate supply of air or oxygen, and the air or oxygen must flow at a rate capable of removing gaseous reaction products without excessive cooling of the graphite surface. In the absence of adequate air flow, graphite will not burn at any temperature. Since graphite cannot burn under water, all accidents in which the core and graphite reflector remain submerged (or can be exposed to water) will not be accompanied by graphite burning. Conditions that could lead to graphite burning are not credible at MURR based on these required conditions and the further discussion below. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked “has the University or the NRC tested the graphite in MURR to measure any potential Wigner energy, in calories per gram? What analyses have been performed of potential rise in graphite temperature due to Wigner energy release, and the potential for graphite ignition and contribution to fuel melting, particularly in a loss-of-coolant accident (A10)?”

**Response:** Fast neutron irradiation of graphite results in the development of stored (Wigner) energy. The amount of stored energy, measured in calories per gram, depends on the temperature at which the neutron irradiation occurs. Measurements of stored energy show that if the graphite was irradiated at a temperature of 70°C, the maximum stored energy releasable below 700°C is about 150 calories per gram. (One pound of graphite releasing a stored energy of 150 calories per gram is equivalent to operating a 75 watt light bulb for one hour.) If the irradiation temperature is 70°C or above, the maximum energy released below 650°C is not sufficient to raise the temperature of the graphite to its ignition temperature even under the most unfavorable of assumptions of heat transfer. At MURR, fast neutron irradiation of the graphite reflector occurs at a temperature of approximately 100°C.

The stored energy also depends on the amount of fast neutron flux, since it is this flux that produces the lattice distortions resulting in stored energy. If the irradiation temperature is less than 70°C and the fast neutron flux is less than  $3.5 \times 10^{19}$  nvt, stored energy considerations can be excluded from energy safety concerns. At MURR, the maximum fast neutron flux to which the thermal column graphite has been exposed is about half of the threshold value. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** One commenter stated that the problems associated with the use of graphite in the MURR reactor have not been sufficiently investigated by NRC (E11).

**Response:** The potential problems associated with the use of graphite at research reactors, including MURR, was analyzed in NUREG/CR-4981. Based on the findings in NUREG/CR-4981, the NRC determined that the use of graphite at MURR was acceptable and no additional actions were needed. This comment does not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked “what lessons were learned regarding the potential of a graphite fire as the result of the April 26, 1986, Chernobyl explosion in the Soviet Union and the 1957 Windscale reactor fire in England? To what extent are these lessons relevant to MURR (A8)?”

**Response:** The Chernobyl explosion was a steam explosion (not a fuel explosion) as a result of an experiment during which multiple violations of safety procedures and requirements occurred. Such a steam explosion cannot occur at MURR because of the significant differences between the design of the Chernobyl and MURR reactors. As a result of the explosion, asphalt roofing materials were ignited and fragmented graphite burned, supported by asphalt fires and decay heat from the buried fuel. There is no evidence that stored energy in graphite played any role in this event.

The Windscale fire occurred as a result of pulsing the reactor (the MURR reactor cannot be pulsed.) The reactor, in fact, was “over pulsed,” causing the fuel cladding to break down and exposing the uranium fuel to air. Uranium reacts readily with air with the release of a large amount of heat. There is no evidence that stored energy releases initiated or played a significant role in the evolution of the Windscale accident. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked if the graphite shield at MURR is similar to the one at the Chernobyl plant (D3)?

**Response:** There is no similarity between the design of the Chernobyl power plant and the MURR research reactor. This comment does not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** A commenter asked “does the licensee intend to continue to use graphite in MURR, both as a neutron reflector and in the thermal column (A7)?”

**Response:** The proposed license amendment makes no changes to the design of the facility. This comment does not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

## 7. Emergency Planning Issues

**Comment:** Two commenters raised general concerns about the ability of MURR to handle emergency situations (F9, L10). One commenter asked “in the event of a radiological accident at MURR, does the University medical complex have isolated rooms dedicated to radioactively contaminated patients? If so, for how many patients (A26)?” Other commenters indicated that the local hospitals and medical facilities are not equipped to handle a large number of irradiated patients (B9, L10). One commenter was concerned that a proper evacuation of the facility could not be conducted in a timely manner. Another commenter was not aware that MURR has any fire response and evaluation plan on file with NRC specifically regarding the hazards associated with the use of graphite (G22). One commenter asked “does MURR have a current, NRC - approved fire response plan and evacuation plan for a graphite fire that adequately reflects the facts that if water or carbon dioxide were to be used to fight a graphite fire, combustible gases (such as carbon monoxide or hydrogen) could cause an explosion, and that graphite fires are notoriously difficult to extinguish? Does the response plan identify which materials are to be used to suppress the fire without increasing the risk of an explosion (A9)?”

**Response:** MURR has an Emergency Plan that has been approved by the NRC and meets the requirements of the regulations. The Emergency Plan addresses all credible events (note that a graphite fire is not considered a credible event and is not specifically addressed). None of the accidents identified for MURR would lead to a large number of irradiated patients and would not have significant effect on members of the public. The Emergency Plan and Implementing Procedures outline the actions MURR would take in various situations, including a problem involving radiological contamination and the possible evacuation of the facility. The Plan states that MURR will take preliminary action to control the situation and then send personnel to a medical facility for treatment if necessary. MURR has a Letter of Agreement with the City of Columbia indicating that the Fire Department will respond to fires or other emergencies should they occur at the research reactor. The fire department has the training, facilities and procedures to ensure that potential fires are safely controlled and extinguished. The University of Missouri Hospital and Clinics is the medical center that would provide medical assistance in case of an emergency. The University of Missouri Hospital and Clinics also has an emergency plan for use in such instances. The hospital and clinic procedures and facilities can accommodate radioactively contaminated patients. Further assistance is available from the Radiation Emergency Assistance Center/Oak Ridge National Laboratory, if needed. These

comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

## 8. Other Comments

**Comment:** A commenter asked if UMC is communicating with the NRC about the possibility of tripling the size of MURR (A31)? Another asked what this increase in size will mean for the city of Columbia which surrounds this facility (J16)?

**Response:** There has been no correspondence from UMC about increasing the size of MURR. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.

**Comment:** One commenter asked “have MURR irradiated fuel plates ever been tested in a hot-cell laboratory to assess the integrity of the aluminum cladding --- for example, to determine to what extent pin-hole leaks may exist through which particulate and gaseous fission products may escape? If such tests have been performed, when did the most recent one occur, at which laboratory, and with what results (A12)?”

**Response:** No such tests have been conducted. It is worth noting that the fuel is checked extensively at various stages during the manufacturing process and prior to being shipped to the licensee. Also, the licensee does visually inspect approximately one out of every eight fuel elements after the fuel has been used to check for defects. The coolant channels are also gauged to ensure that they are not blocked. In addition, there is a monitor installed in the exhaust system to continually check for fission products that would be released if there were pin-hole leaks in the fuel. These comments do not provide any new information related to the safety or regulation of the facility. Therefore, no further evaluation was required.