66 FR 39803
8/1/01
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515 West Point Ave.
University City, MO 63130
August 15, 2001

Mr. Michael T. Lesar, Chief
Rules and Directives Branch (MS T6 – D59)
Division of Administrative Services
US Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Lesar:

Below are comments and questions regarding the University of Missouri-Columbia's Research Reactor, NRC Docket No. 50-186, Amended Facility License No. R-103, and regarding the NRC's Environmental Assessment and Finding of No Significant Impact (66 FR 39803, August 1, 2001). The University submitted an application to the NRC on December 27, 2000, that seeks to extend the license expiration date for five years --- from November 21, 2001, to October 11, 2006. Application supplements were dated April 12 and June 6, 2001. It is expected that the University will submit an application for the Missouri University Research Reactor (MURR), during the five-year extension period, for an additional 20 years. The reactor began operating in 1966, 35 years ago, and is located less than a mile from the university.

Clearly the extension itself would significantly affect the quality of the environment, and therefore would have to be accompanied by an environmental impact statement. Further, the anticipated secondary and cumulative impacts, such as those resulting from an additional 20-year extension, emphasize that effect, and the resulting need for an environmental impact statement.

1. Bomb-Grade Uranium:

Unlike other US research and commercial power reactors, MURR fuel contains highly-enriched uranium --- that is, uranium enriched to a high percentage of the fissionable isotope, uranium-235 (20% or greater, as defined in the Code of Federal Regulations, Title 10, Part 50.2). It is my understanding that the MURR fuel contains over 93%. By comparison, the highest enrichment level of the Callaway nuclear power plant fuel is 4.5%. Because highly-enriched uranium (HEU) can be used for the manufacture of nuclear weapons, it is of great appeal to terrorists. Strict adherence to the NRC's safeguards regulations is therefore essential in order to try to protect against acts of radiological sabotage, theft or diversion during the storage and transport of MURR fuel. (10 CFR 73)

a. 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 continuing "unique purpose" exemption from the NRC's requirement that all domestic non-power reactors were to convert from the use of HEU (as per 10 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?

b. 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?

c. 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?

d. How much weapons-grade uranium is currently in use and stored at MURR?

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When the NRC was deciding whether to allow the continued use of HEU at university reactors, noted nuclear physicist and former nuclear weapons designer Theodore Taylor testified as follows (quoting from Science, 2 March 1984, "NRC Targets University Reactors"):

"Taylor said there is 'no excuse whatsoever" for HEU to be used on [the UCLA] campus. 'HEU should be prohibited except under conditions that I would say are extraordinary [national defense work]. The prohibition should come first and the exception should come later. No research facility should have a quantity of HEU sufficient for building a weapon under any circumstances for any purpose.' It is possible to make a bomb with less than a kilogram of HEU, depending on the 'talents and experience' of the designer, he added.

"According to Taylor, 12 research reactors are authorized to store more than 4 or 5 kilograms of HEU, ranging in the highest instance to a limit of 45 kilograms. He doubted that campus burglar alarms give enough protection, since a black marketer or terrorist might be willing to pay $100,000 to obtain a credible bomb threat. A blackmailer need only send authorities a small amount of HEU to make his threat credible. In view of this risk, Taylor said, 'there is no crucial research at university reactors of which I am aware that would require weapons-grade uranium.'" (emphasis added)

2. Graphite:

a. Does the licensee intend to continue to use graphite in MURR, both as a neutron reflector and in the thermal column? According to a November 12, 1986, article in the Columbia Daily Tribune, 400 pounds of graphite surround the beryllium shield that encompasses the reactor's fuel core.

b. 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?

c. 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?

d. "Wigner energy" is energy stored in nuclear reactor graphite during a reactor's operation as a result of neutron bombardment at relatively low temperatures. Wigner energy can be released suddenly as heat if the reactor temperature is raised above normal operating temperature. It was uncontrolled release of Wigner energy that led to the Windscale fire. (This information is from the Committee to Bridge the Gap's petition for an NRC rulemaking to reduce fire hazard from nuclear reactor graphite, submitted in July 1986.)

(1) Has the University or the NRC tested the graphite in MURR to measure any potential Wigner energy, in calories per gram?

(2) 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?

3. Transportation risks: Assuming that a federal geologic repository were to be sited and an interim storage facility then were to be built for high-level radioactive wastes during MURR's requested five-year license extension period (and that space would be available for the MURR fuel), would Missouri tax-payers be liable if an accident were to occur during the transport of MURR wastes?

The risk of a transport accident is of particular concern to those Missourians who live in a corridor community, located along a rail or highway route.

4. **Fuel Plates:** 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?

5. **Monitors:** According to the NRC's draft environmental assessment, dated June 25, neutrons that escape from the open reactor pool into the atmosphere of the reactor building convert the natural argon present in the building into detectable amounts of radioactive argon-41 (with a half-life of 1.82 hours).

a. Is the licensee claiming that argon-41 is the only radioactive gas present in significant quantities in the building's atmosphere --- that is, that virtually no tritium or noble gases escape from the reactor vessel and the open pool into the building? Does the NRC find it surprising that only a tiny percent of the tritium (radioactive hydrogen) created as a tertiary fission product in the reactor fuel or generated in the coolant would have escaped from the reactor into the building, and on into the environment? For example, the licensee reported that only 11 curies or less of tritium, plus other non-argon gases, were released in airborne effluents annually during the years 1995 through 2000. The reported argon-41 annual releases in those years ranged from 728 to 1130 curies.

I am also surprised that the University has reported that only fractions of one curie of radioactive isotopes were released annually in the liquid effluent to the sanitary sewer --- including, primarily, tritium. Since it is known that no financially feasible technology exists to filter tritium from a reactor's liquid or gaseous effluents, or to filter the dissolved and entrained noble gases, I find the reported annual liquid release of only about one-half curie, or much less, to be incredibly small.

I often tell people about my personal introduction to tritium. When I first learned in 1977 that tritium would be released to the air and to the Missouri River as a part of the routine operation of the Callaway nuclear plant, I phoned Oak Ridge National Laboratory to find out more about tritium. The health physicist there replied, "Oh, tritium is no big deal. All it can do is destroy a DNA molecule."

b. Is tritium created as a byproduct of MURR research on boron neutron capture therapy?

c. 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?

d. On the average, how frequently are gases vented to the environment and for what duration?

6. Personnel and Operating Problems:

a. 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)? (As you know, Dr. Deutsch then resigned on July 19.)

b. 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?

While the University is understandably striving to become designated a Comprehensive Cancer Center by the National Cancer Institute (with potential increases in federal and private funding), is it not apparent that personnel problems persist at MURR?

The incident on June 12, 2000, cited above, seems to be a good example of personnel weaknesses. While the reactor was shut down for maintenance, the MURR staff removed one of the four control blades (in order to perform the blade's semi-annual inspection) without first removing two of the eight fuel elements as required. This could have resulted in an unplanned startup of the reactor (a criticality accident). The MURR staff had apparently been distracted by the need to repair a leak in the shaft seal of the primary pump. Since no shift supervisor was on duty, a Senior Reactor Operator served as the "Lead Senior Reactor Operator" for one shift with different SROs rotating as the LSRO for subsequent shifts. Quoting from the NRC Special Inspection Report # 2000-203: "The event brought into question the effectiveness of MURR's shift turnovers, management and staff communications, attention to detail, and general awareness of facility conditions." (Report Details, p.7)

An incident on April 12, 2000, also points to inadequate staffing. An unscheduled shutdown occurred that resulted in the need to find space to store a fuel element. Both the Operations Engineer and Reactor Manager positions were vacant. The Reactor Physicist (who was also acting as the interim Operations Engineer) made the decision that the reactor operators should use a Z-basket inside the spent fuel storage pool to store a fuel element instead of installing the fuel inspection rig. This occurred while welds in the reactor pool's aluminum radiation or liner were being inspected. In order to examine the welds, magnetite concrete blocks in the adjacent storage pool's surrounding shielding wall had been removed, thereby leaving no protection against the fuel element's intensely penetrating radiation. As described by the NRC Region III Public Affairs Officer, Jan Strasma: "One group of workers had removed part of the wall, the other moved the rods, and neither knew what the other one was doing." (Columbia Tribune, 8/23/00)

Quoting from the NRC Special Inspection Report # 2000-202: "Upon [hearing] the area radiation monitor alarm, the Health Physicist went down the stairs [from the reactor bridge], picked up an ion chamber, and measured 10-millirem per hour toward the bottom of the stairs." Then when she "went down the stairs [again] onto the beam port floor to more closely monitor the radiation field," she got a 200-rem / hr reading --- 200,000 millirem per hour! (p. 14, emphases added) "The Health Physics Manager calculated the maximum dose rate during the event at about 400-rem / hour. ... Although the Health Physicist was present, she was not monitoring radiation levels at the time of the liner examination in the Spent Fuel Element Irradiation Facility, because the licensee believed there was no radiation source or potential. In fact, no one was in the radiation field at the time of the event. However, if personnel were assumed in a radiation field of about 400 rem/hour, exposure for 45 seconds would exceed 10 CFR Part 20 occupational limits." (p. 9, emphases added)

Not only were significant senior positions unfilled at the time of the April 12 event, but apparently not enough of the personnel were sufficiently trained to qualify to serve on the Incident Response Team of senior licensee managers. "The [NRC] inspectors found that although the team included experienced operations and radiation safety personnel (i.e., the Associate Director responsible

for Operations, the Associate Director responsible for Reactor Income Generating Operations, and the Health Physics Manager), some members of this group had little nuclear safety experience." (p. 2, emphasis added)

7. **Worker exposure:**

a. How many reactor or contractual employees participate in a typical refueling?

b. What was the highest radiation dose to which an employee was exposed during the past year as the result of the refuelings?

c. To what extent does the NRC oversee the amount of radiation to which MURR employees are exposed during the weekly refueling operations?

d. 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?

e. 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?

8. Accidents: 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?

9. **Radioactive waste:**

a. High-level radioactive waste: What assurances can the NRC provide to the State of Missouri that the University will be permitted to continue sending its irradiated fuel plates to a federally licensed storage facility? Or is it conceivable that these wastes would have to remain in Missouri for an indefinite period? (A July 31, 2001, New York Times article makes it quite apparent that Yucca Mountain, Nevada, as the promised deep geologic disposal site, has many flaws. "Yucca Mountain has turned out to be wetter and its geology more complex than proponents had first thought.")

A recent dispute between Missouri and the Federal Government gives cause for concern. Because of evidence submitted to the Department of Energy (DOE) by the State about the deteriorated, hazardous condition of Interstate 70 in the summer of 2000, the State was able to dissuade the DOE from using that route for the transport of research reactor fuel imported from England and destined for the DOE's Idaho National Engineering and Environmental Laboratory. In retaliation, the DOE closed its Savannah River storage facility in South Carolina to shipments of MURR irradiated fuel.

Because by June 30, 2001, the University would have reached its maximum licensed amount of uranium-235 in storage, the NRC would have forced the reactor to shut down. Physicians statewide protested to state officials about their need for a continuing source of MURR-generated radiopharmaceuticals. Faced with the choice of seeing MURR shut down or of permitting the I-70 passage of German reactor fuel earlier this summer --- through our two major metropolitan areas!), the State withdrew its objections to the foreign shipments. The DOE then announced it would allow MURR to resume shipments of its spent fuel to Savannah River. During the next ten years, the DOE will be importing irradiated research reactor fuel into the US from 41 nations, for storage in South Carolina or Idaho. And for ultimate disposal, but no one knows where.

The amount of high-level radioactive waste (irradiated fuel) generated at MURR is significant. According to data provided by the DOE, an average shipment of MURR irradiated fuel, typically sent to DOE facilities at Savannah River or Idaho Falls, contains approximately 250,000 curies. To put that amount of radioactivity in perspective, more than 1,000 research laboratories at Washington University and the Barnes-Jewish Hospital complex share a total of two curies at any one time.

b. Low-level radioactive waste:

(1) Since no low-level waste burial facility has yet to be built or even sited for the disposal of "low-level" radioactive wastes generated in the Midwest Compact states, what fall-back position does the University have for the disposal of its low-level wastes when the Barnwell, South Carolina, facility no longer accepts wastes from states outside the Southeastern Compact?

As reported in the August 11, 2001, New York Times, South Carolina Governor Jim Hodges is threatening to bar shipments of plutonium from dismantled weapons into his state. "I'll stand squarely in front of the trucks, if that's what it takes to protect the health and safety of our people," he said. "In the meantime, we've got a range of options, including roadblocks." A similar rebellion occurred after the start of the Three Mile Island accident, in 1979, when governing officials of South Carolina, Nevada and Washington decided they no longer wanted to serve as the nation's dumping grounds for low-level waste. Although no new low-level waste facility has been created since then, the financial profits from Barnwell have apparently been sufficient to compensate the State for hosting wastes from facilities nationwide. Barnwell continues operating --- at least for now.

It should be noted that exposure to some of a reactor's "low-level" wastes can cause a lethal dose, and that some isotopes present in low-level wastes have extremely long half-lives --- technetium-99, for example, has a half-life of 213,000 years, and cesium-135 (a daughter-product of xenon-135) has a half-life of 2.3 million years. Their hazardous lives last for roughly ten times their half-lives.

(2) If the Barnwell facility were to be closed to MURR's irradiated and surface-contaminated low-level wastes, is it possible the NRC or other Federal agency would mandate that a storage or disposal site would have to be established in Missouri? These wastes typically include:

(a) a shielded cask that was shipped in 1993 from MURR, probably to Barnwell, that contained 59.5 curies of "low-specific" radioactive waste --- according to an April 12, 2001, MURR response to the NRC's request for additional information regarding the license extension application (submitted by the immediate past Director Edward A. Deutsch);

(b) beryllium [perhaps from the reactor's reflector] and a heat exchanger for the spent fuel holding pool which were removed and replaced at MURR in April 2000 at the time an unplanned radiation field event occurred (NRC Special Inspection Report No. 2000-202, page 5);

(c) depending on whether or not the April 2000 inspection of the welds of the spent fuel holding pool's aluminum liner indicated the liner required repair or replacement, the defective liner would have been a candidate for disposal at a low-level waste site; and –

(d) if it is correct that one of the four control blades is replaced every six months, the highly radioactive, discarded control blades would require disposal at a LLW site.

(3) Is it correct that MURR's liquid wastes are discharged only to the sanitary sewers --- that none drains or is released into nearby Hinkson Creek?

10. Financial challenges: Because of concerns about the safety and operating costs of a research reactor, and the declining number of nuclear engineering students and qualified reactor operators, some

universities have quit operating their research reactors. An NRC fact sheet on non-power reactors includes the following such institutions: Georgia Institute of Technology, University of California-Los Angeles, Iowa State University-Ames, University of Illinois-Urbana, University of Washington-Seattle, University of Virginia-Charlottesville (two reactors), Cornell University, and State University of New York-Buffalo. In addition, media reports indicate that the University of Michigan-Ann Arbor (2 megawatts) and the Massachusetts Institute of Technology (5 MW) may also decommission their reactors.

The increasing number of US college campuses that are closing their reactors is described as follows in the University of Missouri's April 12, 2001, response to the NRC's request for information on the license renewal: "Currently there are only 28 operating research and training reactors, over a 50% decline since 1980." (p.5) [According to Nucleonics Week, 5/17/01, forty university research reactors were operating in 1988.] According to the Wall St. Journal: "A 1997 Department of Energy survey found only 570 students nationwide majoring in nuclear engineering, down nearly a thousand from five years earlier." ("Closing Campus Reactors May Nuke Energy Plans," 7/26/01)

a. As a 10-megawatt-thermal reactor, MURR is reported to be the largest research reactor at any university in the world, and is the second largest non-power reactor in the US (next to the 20-megawatt-thermal reactor at the National Institute of Standards and Technology in Gaithersburg, Maryland). While universities elsewhere in the nation have been reducing or eliminating their commitment to nuclear engineering training, is it correct that the University of Missouri-Columbia is communicating with the NRC about the possibility of tripling the size of MURR?

b. 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?

c. 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?

d. 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?

Sincerely,

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