Update on the University of Missouri-Columbia Research Reactor Upgrade

J. Charles McKibben, James J. Rhyne (University of Missouri-Columbia)

I. INTRODUCTION

The University of Missouri-Columbia (MU) is in the process of upgrading the research and operational capabilities of the MU Research Reactor (MURR) and associated facilities. The plans include an expanded research building that will double the laboratory space, the addition of new research programs, instrumentation and equipment, a cold neutron source, and improved reactor systems. These enhancements, which are in various stages of completion, will greatly expand the present active multidisciplinary research programs at MURR.

II. DISCUSSION

Current Facility

Built in 1966, MURR is a 10 MW, pressurized loop, open pool-type reactor that has operated at full power more than 90 percent of the available time over the past fifteen years. It is the highest power and most versatile research reactor located on a university campus in the world. It provides a breadth of research facilities and opportunities in the fields of nuclear-related science and engineering unequalled at any other educational institution. A sampling of programs includes nuclear medicine (radioisotope applications); archaeometry, epidemiology, and human and animal nutrition (neutron activation analysis); actinide chemistry; materials science (neutron and gamma-ray scattering and radiation effects); health physics; and nuclear engineering.[1]

Need for Upgrade

This unique facility presents to MU the opportunity and the obligation to become a leading university in nuclear related fields. The development and advancement of industries and laboratories in these areas of science and engineering as well as national projects such as the Advanced Neutron Source depend upon the availability of highly qualified and well trained personnel.

Over the past 24 years, MURR has progressed through a series of upgrades that have greatly increased its versatility for research. During 1985-89, a major, three-part plan[2,3] was developed to include:

- an increase in the reactor power level
- an addition to the research laboratory building
- a cold neutron source for enhanced beam research opportunities

With the evolution of reactor programs and MURR's recent administrative transfer to MU from the University of Missouri system, the need for an expanded research laboratory building clearly emerged as the highest priority. The reactor (as a neutron source) is not the limiting entity; it is fully capable of providing greatly expanded isotope production, sample irradiations and beam research opportunities whenever the necessary laboratory facilities become available.

Research Laboratories

As an interim solution nine new laboratories were established during 1990. An alpha laboratory was constructed for a new actinide chemistry program. With a facility ventilation exhaust system upgrade that doubled the flow rate,[4] several offices were relocated to a contiguous temporary building and four laboratories were recovered for:

- the archaeometry program
- isotope production sample preparation
- neutron activation analysis sample preparation
- cell culture work with radionuclides

Additionally four new laboratories were created in rented space to support collaborative research among MURR, MU Radiology and MU Chemistry that focuses on nuclear medicine and therapeutic application of radioisotopes.

During 1992, a third contiguous temporary building is being installed to relocate offices to free up another radioisotope applications laboratory and the space on the beamport floor for the new horizontal SANS. By early 1993, a preengineered building addition will be installed and attached to the back of the current building. This will provide 930 square meters of additional office, laboratory (dry), and shop space. This will free up more radioactive wet laboratory space that is currently used as offices and dry laboratories.

For the long term solution, MU and Sverdrup Corporation are completing a schematic design of a 8,000 square meter two-part building addition. One

part will contain a neutron guide hall and low background research laboratories. The second will house research laboratories centered around new hot cells and shielded glove boxes designed for work with higher levels of radioisotopes. Together they will add around 40 new laboratories and the necessary associated offices/support spaces.[5]

Neutron Scattering Facilities

Upgrades also are being made to the neutron beam facilities and instrumentation. A new high resolution powder diffractometer (PSD-II) and a second neutron interferometer have been installed. Three neutron beam facilities are being built and two additional instruments are in the design or development stages:

- TRIAX, a joint MU-Ames Laboratory triple axis spectrometer
- a new 15 meter horizontal small angle neutron scattering instrument (SANS)
- a neutron reflectometer
- conversion of a long wavelength, five-element diffractometer to a dedicated residual stress instrument
- a double perfect crystal sans diffractometer

Cold Neutron Source

To meet the rapidly increasing demand for long wavelength neutrons, the MURR upgrade includes plans for adding a cold neutron source (CNS) facility. The preliminary CNS designs from three suppliers of this equipment (Technicatome, Interatom, and AECL) were evaluated to determine feasibility and cost.[2] The schedule for the CNS is dependent on funding.

Reactor Systems

In August 1990, culminating a four year review process, the NRC approved the new Extended Life Aluminide Fuel (ELAF) element for the MURR.[6] The first elements are tentatively scheduled to be received in 1993. This new fuel design will cut the fuel cycle cost by 50 percent for the current 10 MW power level by at least doubling the allowable burnup per fuel element. The variation in uranium loading density between plates provides a much more uniform power density in the core. Feasibility studies based on the ELAF core show that power can be increased to between 20 to 30 MW.[7,8,9] The detailed safety analysis for the power increase will be submitted to the NRC in 1994.

The reactor instrumentation and control (I&C) and electrical systems are being upgraded with the following new systems installed or in process:

- 275 KW emergency generator–1989
- uninterruptable power supply–1989
- area radiation monitoring system–1990
- stack monitor–1991
- nuclear instrumentation systems–being installed in 1992
- control rod drive mechanisms–funding requested for 1993

III. CONCLUSION

MU is investing its resources for a significant expansion of the research capabilities and utilization of MURR to provide it the opportunity to deliver on its obligation to become the nation's premier educational institution in nuclear related fields which can provide scientific personnel and a state-of-the-art research test bed to support the Advanced Neutron Source.

IV. REFERENCES

1. "University of Missouri Research Reactor–MURR," Neutron News **2**(4), 3, Gordon and Breach Science Publishers, New York, 1991
2. "University of Missouri Research Reactor Upgrade," Stone and Webster Engineering Corporation, Boston, March 1987
3. J.C. McKibben, C.B. Edwards and A.K. Banerjee, "Upgrade of the University of Missouri Research Reactor," Trans. Am. Nucl. Soc. **55**, 760 (1987)
4. C.B. Edwards, J.C. McKibben, and C.B. McCracken, "University of Missouri Research Reactor Exhaust Ventilation/Laboratory Fume Hood Upgrade," Trans. Am. Nucl. Soc. **59**, 90 (1989)
5. "University of Missouri-Columbia–MURR Upgrade Addition," Sverdrup Corporation, St. Louis (to be published)
6. "Issuance of Amendment No. 20 to Facility License No. R-103 - University of Missouri Research Reactor," U.S. Nuclear Regulatory Commission, August 1990
7. S.S. Kim and J.C. McKibben, "MURR Upgrade Safety Limit Analysis," September 1986
8. S.S. Kim and J.C. McKibben, "MURR Upgrade Reactivity Transient Analysis," April 1987
9. J.L. Wang, "Analysis of Loss of Coolant Accident for MURR 30 MW Power Upgrade Project Using Relap5/MOD2," UMC PhD Dissertation, December 1987