



Nuclear Reactor Facility

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POLICY MEMORANDUM

TO: EXPERIMENTERS, NERS FACULTY, MSTR STAFF
FROM: ETHAN TABER, REACTOR MANAGER
DATE: FEBRUARY 18, 2021
RE: REACTOR USAGE POLICY (REV. 3)

The Missouri S&T Reactor (MSTR) is available for all S&T faculty and students to use for research, labs, and training activities. External organizations may also contract or conduct research and production efforts. The facility supports outreach activities, such as group tours, for both internal (e.g., student organizations) and external (e.g., high school or community college classes, civic/service organizations, commercial ventures) parties.

This unique facility can only remain available through strong adherence with relevant rules and regulations, such as those in Title 10 of the Code of Federal Regulations (10 CFR), Nuclear Regulatory Commission (NRC) Regulatory Guides, American National Institute of Standards (ANSI)/American Nuclear Society (ANS) standards, the MSTR license and Technical Specifications (TS), Standard Operating Procedures (SOPs), and the Missouri S&T Radiological Handbook along with Environmental Health and Safety (EHS) directives. License and regulatory commitments are required to be followed at all times. Additionally, Missouri S&T has committed to ALARA (As Low As Reasonably Achievable) practices for radiation doses to personnel, students, and the public.

The policies described herein apply to research, lab experiments, isotope production, group tours, and training activities conducted outside of the following:

- MSTR Operator Training
- NE 1105, Nuclear Technology Applications
- NE 2406, Reactor Operations I

- NE 4312/5312, Radiation Detection and Measurement
- NE 4428/5428, Reactor Lab I
- NE 4456/5456, Reactor Operations II
- NERS Camp
- Jackling Camp

These classes/activities have pre-arranged labs, tours, experiments, or training in-line with Nuclear Engineering and Radiation Science (NERS) department objectives and are therefore exempt. Other activities covered by contract may also be exempt.

Personnel participating in reactor usage activities shall be trained on any relevant facility policies and procedures (such as those described by SOPs 211-213) on an as-needed basis, including the following:

- Use of measurement equipment
- Experimental facility usage
- Sample handling
- Transport and shipping
- Waste disposal

Experimenters shall be responsible for any materials or equipment damaged through their use. No tools or equipment shall be used without reactor staff approval and supervision.

Facility utilization will be scheduled with the following priorities (highest-to-lowest, by order of usage request approval for otherwise equal priorities):

1. Essential facility operations and maintenance
2. NERS course delivery
3. Operator Training
4. Funded research (internal and external)/Isotope Production
5. Funded tours, training, and lab experiments
6. Recruitment activities (NERS Camp, Jackling Camp, Discovery Days, etc.)
7. Unfunded (e.g., by research credit) research – Faculty, Graduate, Undergraduate
8. Outreach tours, training, and lab experiments

Reactor Usage Requests

To request usage of the MSTR, a Missouri S&T Reactor Usage Request (RUR) will need to be filled out and submitted. RURs will then be reviewed by MSTR management and approved prior to proceeding. Incomplete forms or usage requests that require additional supporting documentation will not be processed or reviewed. RURs may go through an iterative feedback process to address any safety or regulatory/licensing concerns. In general, projects should be discussed with the reactor staff prior to RUR submittal to identify any potential pitfalls and the need for additional review or supporting efforts, such as for untried/fueled experiments (Missouri S&T Radiation Safety Committee, RSC) or for experiments requiring a 10 CFR 50.59 Screening and Evaluation/license amendment.

Following the approval of the RUR, MSTR staff will schedule any supporting operations and mobilize personnel and equipment as necessary. For experiments involving neutron activation, a relevant Irradiation Request Form (IRF, per SOP 702) must be selected from existing examples (updated if necessary) or a new IRF shall be generated. MSTR management may elect to perform pilot or demonstration runs even for “tried” experiments, to ensure that irradiation characteristics (e.g., doses and decay profiles) line up with facility records. This may be especially necessary when materials are sourced from different vendors and may have differing contaminants or trace elements present. Except as to support “new/untried” or hazardous experiments, facility resources and usage time for pilot runs are generally not charged to a project.

Appropriate lead times should be incorporated when submitting RURs to permit scheduling, with simple experiments (e.g., activation of a non-hazardous material for which irradiation characteristics are well-documented at MSTR) generally needing at least three days (one week is strongly encouraged). RURs to support complex activities, such as those requiring RSC review and approval, should be submitted at least a month in advance (RSC normally meets quarterly), in addition to any fabrication or materials sourcing time.

The following sections break down and provide guidance on completing Usage Requests, with each usage type categorized (Research, Lab Experiments, Tours, and Training). Note that Isotope Production will be addressed in a future revision of this policy.

Research

Research consists of investigatory efforts involving the use of the reactor, facility equipment and space, and/or personnel. It should be noted that any lab experiments performed as part of NE 4438/5438 (Reactor Lab II) are treated as research. Student research must be conducted under the guidance and authority of a faculty or staff member, who will be responsible for ensuring the accuracy of all documentation submitted for review (especially for dose/shielding calculations) and appropriate use of the facility.

Except as covered by specific exemption by MSTR staff (such as NE 4438/5438), all research must be funded. For small exploratory efforts, reactor usage credits may be used in accordance with the Reactor Research Investigator and Reactor Student Researcher policies.

Especially for new/untried or hazardous experiments, reactor management or the RSC may determine that pilot runs are necessary. Pilot runs consist of limited sample size and/or fluences/doses and may be accommodated through either providing sacrificial material (e.g., outside of the intended main experiment profile) or by accounting for pilot run in the experiment profile.

Directions for Completing RUR for Research

The RUR should include contact information for the interested research party. This includes the following:

- Organization – if applicable, the organization under which the research party operates or will operate. This may be an S&T department (e.g., NERS), student organization (e.g., S&T ANS chapter), or external organizations (e.g., local company).
- Project Contact Information:
 - Name – member of research party who will be responsible for interacting with MSTR and related organizations in communicating project details.
 - Role – organizational title and/or role (e.g., student, instructor, faculty, research engineer)
 - Phone/Email

For student research, mark the box. Additionally, provide the following details regarding the sponsor or advisor:

- Name
- Organization (if different from Project Contact)
- Phone/Email

The Project Type refers to the generally category of the work to be conducted. The following categories are listed, and multiple categories may apply (Select all that apply):

- General Sample Irradiation – neutron activation of a sample or target.
- Gamma Irradiation – exposure of a sample or target to gamma radiation, either through use of a standalone source (e.g., Co-60, Cs-137) or the reactor in a shutdown configuration.
- Neutron Activation Analysis (NAA) – activating a sample or target to determine trace element concentrations using a gamma spectroscopy system.
- Imaging – discrete or composite x-ray, gamma, and/or neutron imaging of a target.
- Fueled Experiment – ANY experiment using fissile materials in greater than trace quantities. Strict limits on material quantities, encapsulation, handling, thermal powers produced by samples/targets, and follow-up processes apply. Note: requires RSC review and approval.
- Explosive Materials – ANY experiment using highly reactive materials, as defined by the MSTR TS. Strict limits on material quantities, encapsulation, handling, irradiation locations, and follow-up processes apply. Note: requires RSC review and approval.
- Other – an experiment that is not well- or fully-described by other categories.

Reactor management will determine if the experiment is considered “new/untried,” but if known a priori, this may be indicated on the usage form. Note that “new/untried” experiments require review by the RSC, which may delay approval and scheduling. Pilot runs may be required.

The Reason for Usage should explain the need to use the MSTR or facility resources, including driving factors. For the Project Description, a project narrative describing the following shall be included, with any assumptions clearly identified:

- Sample or target identification, including:
 - General description
 - Form (e.g., powder, solid, liquid, gas, assembled structure)
 - Mass
 - Initial dose and decay rate (if radioactive material)
 - Material Safety Data Sheet (MSDS), if requested
 - Method of identification (ID or serial numbers, indexing, etc.)
 - Composition, if known
 - Sourcing information
- Encapsulation
- End-use, including any of the following if applicable:
 - Chemical separation or processing of byproduct material
 - If on-campus, must be in-line with both reactor and campus material's licenses.
 - Transfer outside of facility must be performed under SOP 603.
 - Measurement
 - Mechanical specimen testing
 - Disposal
 - Organization responsible for long-term disposal of byproduct material
 - Transfer off-campus:
 - NRC license details to support transferal.
 - Shipping requirements
- Equipment needed, including:
 - Experimental facility(s) – e.g., beam port, rotary assembly, rabbit system(s), core access element, etc.
 - Measurement – e.g., spectroscopy detectors, thermoluminescent dosimeter (TLD) reader, mass balance, thermocouples, calipers, neutron imager, Charpy specimen tester, etc.
 - Non-standard handling – e.g., heavy tongs, shield assemblies, building/gantry crane, furnace/autoclave, etc.

- Target fluences or reactor powers/exposure times on a per sample basis
- Procedure for conducting the experiment
- Identification of hazards, both potential and anticipated, including supporting dose and reactivity calculations for neutron activation experiments (may be satisfied by reference existing MSTR documentation).
 - A formal safety analysis may be required.
 - Pilot runs may be required.
- Mitigating methods of above hazards if determined to present an unacceptable risk

Additional pages or attachments should be attached to ensure that all supporting details of the Project Description are fully addressed.

The RUR submitter should indicate their authoring of the RUR, as well as sign and date the form. Following completion of the form, submit the RUR and any supporting documentation for MSTR management review and approval. Funded research should include S&T Office of Sponsored Programs (OSP) forms as needed.

Lab Experiments

Lab experiments (“labs”) are pre-planned activities and demonstrations for educational purposes. Labs typically follow a standard script/experiment procedure and generally do not involve the investigation of new or unexplained phenomena. Labs are typified by reactor physics and measurement experiments, such as measuring neutron fluxes in experimental facilities or determining control rod reactivity worths. Measuring half-lives of known materials through neutron activation are also included.

Labs are conducted as part of regular NERS classwork and may be conducted for other campus and external organizations. Unless being conducted for outreach purposes or are otherwise exempted (e.g., above-mentioned NERS classes), labs must be funded to account for personnel, materials, and equipment usage costs.

Directions for Completing RUR for Lab Experiments

The RUR should include contact information for the interested party. This includes the following:

- Organization – if applicable, the organization under which the party operates or will operate. This may be an S&T department (e.g., NERS), student organization (e.g., S&T ANS chapter), or external organizations (e.g., local company).
- Primary Contact Information:
 - Name – member of party who will be responsible for interacting with MSTR and related organizations in coordinating the experiment(s).
 - Role – organizational title and/or role (e.g., student, instructor, faculty, research engineer)
 - Phone/Email

For class- or S&T organization-based lab experiments, mark the box. Additionally, provide the following details (when applicable) regarding the sponsor or advisor:

- Name
- Organization (if different from Primary Contact)/Class and Role
- Phone/Email

The Lab Experiment(s) refers to the experiment(s) to be conducted. The following experiments are listed (Select all that apply):

- Reactor Physics:
 - Approach to criticality (1/M)
 - Excess reactivity and shutdown margin
 - Rod worth by positive period
 - Rod worth by drop method
 - Void coefficient
 - Moderator temperature coefficient
 - Xenon reactivity coefficient
- Subcritical Assembly (SCA):
 - Approach to criticality (1/M)
 - Neutron poison demonstration
 - Moderator temperature coefficient
- Neutron Activation and Analysis:
 - “Unknown” foil activation
 - Multi-vitamin/mineral activation
 - Half-life determination
 - Reactor axial flux profile (segmented copper wire)
- Other – any other teaching experiment or demonstration (may require additional review and preparation)

The Reason for Usage should explain the need to use the MSTR or facility resources, including driving factors. For the Project Description, a project narrative describing any optional or non-standard experiment details (e.g., which foils to be used in half-life measurements) shall be provided.

The RUR submitter should indicate their authoring of the RUR, as well as sign and date the form. Following completion of the form, submit the RUR and any supporting documentation for MSTR management review and approval. Funded lab activities should include S&T Office of Sponsored Programs (OSP) forms as needed.

Tours

Tours are scheduled, in-person group walkthroughs of the MSTR, especially for outreach or recruiting purposes. Tours may be coupled with other facility usage, such as lab experiments, or conducted as standalone events. Demonstration of Cherenkov radiation effects (“Blue Glow”) while the MSTR is operating at high power can be specifically requested. Unless conducted for outreach or recruiting, tours for external non-educational or non-public service organizations should be funded to account for operating staff costs.

Directions for Completing RUR for Tours

The RUR should include contact information for the interested party. This includes the following:

- Organization – if applicable, the organization for which the tour is being held. This may be an S&T department (e.g., NERS), student organization (e.g., S&T ANS chapter), or external organization (e.g., local company).
- Primary Contact Information:
 - Name – person responsible for interacting with MSTR in scheduling and coordinating the tour.
 - Role – organizational title and/or role (if applicable, e.g., student, instructor, faculty, youth leader)
 - Phone/Email

If the tour is to be conducted at power and include a Cherenkov radiation demonstration, mark “Blue Glow”. The Reason for Usage should explain the need to use the MSTR or facility resources, including driving factors.

The RUR submitter should indicate their authoring of the RUR, as well as sign and date the form. Following completion of the form, submit the RUR and any supporting documentation for MSTR management review and approval. Funded tours should include S&T Office of Sponsored Programs (OSP) forms as needed.

Training

Training consists of lectures and demonstrations outside of those described by lab experiments for educational purposes. Training is dependent upon the needs and background of the intended group, with examples include:

- Reactor operations – a reduced scope program similar to MSTR operator training
- Radiation surveying – demonstration of survey meter types and usage, including a “scavenger hunt” of check sources.
- Contamination control – demonstration of handling and cleaning techniques intended to reduce or prevent radioactive contamination of equipment and personnel.

Training activities for non-public or commercial organizations should be funded.

Given the highly-specific nature of training programs available at MSTR, please contact staff directly to discuss curricula needs and options.