

** MISSOURI S&T REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 702 TITLE: **IRRADIATION REQUEST FORMS**

Revised: August 9, 2016

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A. PURPOSE

To provide for the thorough Reactor Staff review of all experiments to be irradiated by neutrons from the MSTR. The review evaluates potential 1) reactivity effects, 2) dose hazards to the experimenter, and 3) hazards to the reactor.

B. PRECAUTIONS, PREREQUISITES OR LIMITATIONS

1. All sample irradiations must be performed under an approved Irradiation Request Form (IRF) with two approval signatures.
2. All materials to be irradiated are to either be corrosion resistant or encapsulated in corrosion resistant containers.
3. Approved IRFs remain valid for future irradiations.
4. IRFs will be numbered sequentially following the last two digits of the current year (e.g. 95-1, 95-2, etc.).
5. Radiation Safety Committee approval is required for
 - a. experiments worth more than 0.4% $\Delta k/k$,
 - b. explosive materials,
 - c. fueled experiments, or
 - d. untried experiments.
6. The total of the absolute values of all experiments is limited to 1.2% $\Delta k/k$. | Rev
7. Experiments having moving parts shall not have an insertion rate greater than 0.05% $\Delta k/k$ per second.
8. Cooling is to be provided as needed to prevent the surface temperature of an experiment being irradiated from exceeding the boiling point of the pool.

Revised By: Craig T Reisner

Approved By: William Bonzer

C. **PROCEDURE - IRRADIATION REQUEST FORM**

The IRF should be completed according to the following steps:

1. **IRRADIATION REQUEST** - This section of the IRF should be completed by the experimenter.
 - a. **Sample Description** - Describe the sample material to be irradiated (e.g. dried tobacco leaves, powdered milk, gold foil, etc.)
 - b. **Physical Form** - Specify the physical form of the sample material (e.g., powder, ash, liquid, etc.).
 - c. **Encapsulation** - Check the box marked "Poly-vial" or check "other" and describe.
 - d. **Irradiation Location** - Specify the irradiation facility to be used. More than one facility may be authorized on a single IRF. If "Other" is specified, describe the irradiation location (for example: "wire stringer in Grid Position C-3").
 - e. **Irradiation Limits** - Specify the irradiation limits as follows:
 - 1) **Power** - Specify the maximum reactor power for irradiation. Samples may **NOT** be irradiated at powers higher than specified.
 - 2) **Time** - Specify the irradiation time for the sample(s) at the maximum power. Samples may be irradiated at lower powers for times longer than the specified irradiation time as long as the total fluence (i.e. kW-hrs) does not exceed the product of the specified maximum power and irradiation time.
 - 3) **Mass** - Specify the maximum sample mass (grams) to be irradiated in any single irradiation.

Handwritten revisions to the limits are allowed based on the measured dose rate from the initial irradiation. Assume dose rate is a linear function of power, irradiation time, and sample mass. Revised irradiation limits require the review and approval of either the SRO on Duty, Reactor Manager, or Reactor Director as signified by their initials with dates.

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- f. **Expected Dose Rate** - Specify the expected 1 foot dose rate when the sample comes out of the reactor based on one of the categories below:

Experience - The expected dose rate may be based on measurements made during previous similar irradiations. In such instances, record the IRF number of the previous similar irradiation.

Calculations - The expected dose rate may be calculated using the DR=6CE rule (or other appropriate method) where DR is the 1 foot dose rate in mrem/hr, C is the expected activity in mCi, and E is the gamma energy in MeV. The expected activity can be calculated using $A = N\sigma\varphi(1 - e^{-\lambda t_{irr}})$ where N is the number of target atoms, σ is the cross section, φ is the neutron flux, λ is the decay constant and t_{irr} is the irradiation time.

Completely Unknown - A trial irradiation is required if the expected dose rate is completely unknown. The irradiation limits for a trial irradiation are normally reactor power \leq 2 kW, irradiation time \leq 1 minute, and sample mass \leq 1 gram. The reviewers may approve different trial irradiation limits at their discretion. Dose rates for higher powers, masses and times can then be linearly extrapolated based on the measured dose rate resulting from the trial irradiation.

- g. **Reactivity Worth** - Estimate the reactivity worth of the sample based on one of the categories below:

Default - A default reactivity worth of <0.05% $\Delta k/k$ may be used for the rabbit facilities if the sample mass is less than 7 grams. A default reactivity worth for core periphery stringers of <0.1% $\Delta k/k$ may be used for holders with a volume of 35 cm³ or less and a sample mass of 7 grams or less. (Note: The default mass and location values are based on a report by Wagner, 1992.) Beamport and thermal column irradiations have a default reactivity of 0.0%.

Experience - The estimated reactivity worth based on previous "experience" may be specified along with the applicable IRF number. If no previous experience exists, estimate the reactivity worth using SOP 306.

Completely Unknown - If reactivity worth is completely unknown and not easily calculated, it must be experimentally determined.

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- h. **Comments** - Provide additional comments, if any.
- i. **Request Completed By** - The person completing items **a** through **h** above should sign their name in the blank provided.
2. **REVIEW AND APPROVAL** - This portion of the IRF is to be completed by one of the reviewers and approved by both of the reviewers.
 - a. **Analysis of Potential Hazards** - Reviewers shall analyze potential hazards associated with the experiment with regard to following:
 - 1) **Reactivity** - Review the expected reactivity worth information. Assure that the Technical Specification Section 3.7 requirements are met. Check the box marked "None" or "Other" as appropriate. If "Other" is specified, explain.
 - 2) **Dose Rate** - Review the expected dose rate information and assess potential dose rate hazards. Check the box marked "None" or "Other" as appropriate. If "Other" is specified, explain.
 - 3) **Reactor Equipment** - Verify that no corrosion problems exist. Verify that no explosive materials or fueled experiments are to be irradiated without Radiation Safety Committee approval. Verify that proper provisions for cooling have been made. Evaluate the experiment with respect to potential hazards to the reactor or reactor operations (for example, detector "shadowing"). Check the box marked "None" or "Other" as appropriate. If "Other" is specified, explain.
 - 4) **Other** - Evaluate the experiment for any other types of conceivable hazards to personnel or equipment.
 - b. **Additional Restrictions/Requirements** - The reviewers are to specify any additional restrictions or requirements deemed appropriate.
 - c. **Approvals** - Reviewers shall signify approval of the experiment by signing and dating in the appropriate blank. Two signatures are required from either the Director, Manager, SROs, or the Health Physicist.

Revised By: Craig T Reisner

Approved By: William Bonzer

D. PROCEDURE - SAMPLE IRRADIATION LOG

A Sample Irradiation Log will accompany each IRF to document sample irradiation information. An entry shall be made on the Sample Irradiation Log for each sample irradiated.

1. **Date** - Specify the date of the sample irradiation.
2. **Sample ID** - Specify the sample identification number or name.
3. **Experimenter's Name** - Provide the name of the experimenter responsible for the sample.
4. **Location** - Specify the irradiation location.
5. **Power** - Specify the power level at which the irradiation is performed.
6. **Time In** - Specify the console time at which the irradiation began.
7. **Time Out** - Specify the console time at which the irradiation ended.
8. **Total Time** - Specify the total time of the irradiation.
9. **Dose Rate @ 1 foot** - Record the 1 foot dose rate from the sample at the time of initial sample handling.
10. **Decay Time** - Specify the approximate decay time between the end of the irradiation and the time of the dose rate measurement.
11. **Initials** - Either the console operator (licensed operator, student, or trainee) or the experimenter will provide their initials signifying that sample irradiation information is complete.

IRRADIATION REQUEST FORM

IRF # _____

1. IRRADIATION REQUEST

- a. Sample Description: _____
- b. Physical Form: _____ c. Encapsulation Poly-Vial Other _____
- d. Irradiation Location: Bare Rabbit Cad Rabbit Beam Port Thermal Column
 Other _____
- e. Irradiation Limits: 1) Power: _____ 2) Time: _____ 3) Mass: _____ gm
- f. Expected 1 Foot Dose Rate: _____ mrem/hr Based on: experience (IRF# _____)
 calculations (attached)
 completely unknown
- g. Expected Reactivity Worth: _____ % k/k Based on: default
 experience (IRF# _____)
 SOP 306 calculations (attached)
 completely unknown
- h. Comments: _____
- i. Request Completed By: _____

2. REVIEW AND APPROVAL

- a. Analysis of Potential Hazards:
- | | |
|----------------------|--|
| 1. Reactivity | <input type="checkbox"/> None <input type="checkbox"/> Other _____ |
| 2. Dose Rate | <input type="checkbox"/> None <input type="checkbox"/> Other _____ |
| 3. Reactor Equipment | <input type="checkbox"/> None <input type="checkbox"/> Other _____ |
| 4. Other | <input type="checkbox"/> None <input type="checkbox"/> Other _____ |
- b. Additional Restrictions/Requirements

- c. Irradiation Request Reviewed and Approved (two signatures required):
- Director _____ Date _____, Manager _____ Date _____
 SRO _____ Date _____, SRO _____ Date _____
 Health Physicist _____ Date _____

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TIRE #

SAMPLE IRRADIATION LOG

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