OREGON STATE TRIGA REACTOR
OPERATING PROCEDURES

OSTROP 18

Procedures for the Approval and Use of Reactor Experiments

Appendix A

Procedures for Irradiating a Sample in the Oregon State TRIGA Reactor

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APPROVED BY: ____________________________

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Appendix A
Procedures for Irradiating Samples in the Oregon State TRIGA Reactor

I. OSTR PROCESS, LICENSE, AND ENCAPSULATION LIMITATIONS

A. Process Overview

This document explains the proper method for requesting an irradiation in the Oregon State University TRIGA Reactor (OSTR) located within the OSU Radiation Center. The following is a brief overview of what is required to perform an irradiation:

1. Contact the Radiation Center Director, Reactor Administrator or Reactor Supervisor to help you through this process.

2. If this is the first time you have performed an irradiation, please complete and submit the Project Application Form to either the Director or Reactor Administrator of the Radiation Center. The Project Application Form is a generic way Radiation Center Staff collects information on the experimenter and irradiations. This information goes into the Radiation Center's project database and is used to track a project, create billing information, and to provide information for our Annual Report.

3. Prepare the samples in accordance with the encapsulation requirements described in this document.

4. Complete the appropriate Irradiation Request (IR) forms. There are three IR forms. There is the IR Information Form, the IR Standard Sample Information Form, and the IR Pneumatic Transfer Sample Information Form. Procedures for filling out and examples of IR forms are given later in this document.

5. Mail or otherwise submit the samples and IR forms to the Radiation Center for irradiation. Samples and IR forms should be submitted 24 hrs in advance of any scheduled irradiation. Also include a copy of the license to possess radioactive material from the appropriate licensing agency if a current copy is not on file at the Radiation Center.

B. OSTR Reactor Experiments

1. An experiment is a specifically described and approved use of the OSTR. Determination of which experiment your irradiation should be performed

under shall be determined by the Director, Reactor Administrator, or the Reactor Supervisor. The currently approved reactor experiments are:

A-1 Normal TRIGA Operations

B-3 Irradiation of Materials in the Standard OSTR Irradiation Facilities

B-11 Irradiation of Materials Involving Specific Quantities of Uranium and Thorium in the Standard OSTR Irradiation Facilities

B-12 Exploratory Experiments

B-23 Studies Using the TRIGA Thermal Column

B-29 Reactivity Worth of Fuel

B-30 Irradiation of Jet, Diesel, and Furnace Fuels

B-31 TRIGA Flux Mapping

B-32 Argon Production Facility

2. The description of a specific experiment may include additional limitations and more severe restrictions than those given below. The experimenter is obligated to be familiar with and comply with all limitations on a given experiment in addition to these general limitations. Any variations from these limitations or experiments must be approved by the OSTR Reactor Operations Committee.

C. OSTR License Limitations

1. The radionuclides and quantities to be produced for ultimate release shall not exceed the types and amounts authorized to the experimenter on an applicable license.

2. The steady state power level of the reactor shall not exceed 1100 kW (thermal).

3. The reactivity inserted for pulse operation shall not exceed $2.25.

4. In-core experiments shall not occupy more than a single fuel element position.

5. The reactor shall not be operated at power levels exceeding 1 kW with a core lattice position vacant, except for positions on the periphery of the core assembly.

6. Non-secured experiments shall have reactivity worth less than $0.50.

7. The total reactivity worth of all experiments shall not exceed $2.30.

8. Explosive materials in quantities greater than 25 mg shall not be irradiated.

9. Explosive materials in quantities less than 25 mg may be irradiated provided the pressure produced upon detonation of the explosive has been calculated and/or experimentally demonstrated to be less than the design pressure of the container housing the explosives.

10. Where the possibility exists that the failure of an experiment (except fueled experiments) could release radioactive gases or aerosols to the reactor bay or the unrestricted area, the quantity and type of material to be irradiated shall be limited such that the airborne radioactivity in the reactor bay or the unrestricted area shall not result in exceeding the applicable dose limits in 10 CFR 20, assuming 100% of the gases or aerosols escape.

11. Irradiation of the following materials shall require specific prior review and approval by the Reactor Operations Committee, including the Reactor Supervisor, the Senior Health Physicist, and the Reactor Administrator, even when such an irradiation appears to fall generally within the scope of an approved reactor experiment.

    a. Highly flammable organic solids and solvents, or other highly flammable materials.
    b. Any substance known or likely to exhibit characteristics due to irradiation that would require special safety precautions.
    c. Anything containing mercury.

Such characteristics include, but are not limited to, excessive gas buildup in sample containers, unusually high radiation dose rates, and the release of airborne radioactivity.

D. OSTR Encapsulation Limitations

A. Specifically-Approved Minimum Encapsulation Methods

The methods of encapsulation detailed in Tables 18.1 through 18.6 below have been found by testing and experience to provide satisfactory containment for the specified sample forms. Designated containments are applicable only to the specific irradiation facilities, the physical forms of materials, and the corresponding irradiation times shown in the tables. Proposed use of encapsulations not specified in the tables shall be evaluated under, “Other Encapsulation Methods.” All polyethylene vials, except those designated as “vented,” and all Nalgene liquid scintillation bags shall be heat-sealed. Other containments shall be closed according to the specifications given in the tables. Except for the thermal column and beam ports, containments specified in the tables are in addition to the containment provided by the TRIGA tube or rabbit tube used to hold encapsulated samples during irradiation.

B. Other Encapsulation Methods

Various other methods of encapsulation may also be suitable. However, before other methods may be used by experimenters they must be approved by the Reactor Supervisor and the Senior Health Physicist. This approval shall be based on actual testing of the proposed containment, or on other documented evaluations which conclude that a proposed encapsulation will provide an acceptable degree of containment when compared to encapsulations currently approved for the type of material involved, the irradiation time, and the irradiation facility. The Reactor Supervisor shall maintain records of tests or other evaluations used to determine the containment capability and/or general suitability of proposed encapsulations. The approval of encapsulations by the Reactor Supervisor and the Senior Health Physicist shall be documented by their signatures on the applicable Irradiation Request.

C. ROC Approved Reactor Experiments

If a specific experiment has been approved by the ROC then that experiment and its requirements regarding encapsulation, or lack of it, will take precedence over the encapsulation requirements described here.

D. Generic Statement on the Relative Adequacy of Various Encapsulations

This procedure provides guidance on the minimum acceptable encapsulations for each of the various OSTR irradiation facilities and requires documentation for deviations from the standard encapsulations given. The purpose of this statement is to allow a more rigorous encapsulation to be used in any of the OSTR irradiation facilities without further approval other than the signatures of the Senior Health Physicist and the Reactor Supervisor on the Irradiation Request Form. A more rigorous encapsulation is defined as the use of flame sealed quartz or sealed aluminum containers instead of polyethylene containers. Many years of experience and actual use have shown that there are no limitations to the use of sealed quartz containers or aluminum containers for irradiating samples in the OSTR. Therefore, substituting these containers in cases where polyethylene is allowed only increases the level of confidence in the containment integrity.

II. COMPLETING THE IRRADIATION REQUEST INFORMATION SHEET

A. Why an Information Sheet is Needed

The Information Sheet (IS) shall be completed by the experimenter each time an Irradiation Request is submitted. The IS is divided into two columns. The experimenter shall complete the left column. Radiation Center staff completes the right column. The form allows our staff to document the necessary checks prior to any sample irradiation. While some of the information requested helps the Radiation Center track your sample in an efficient manner, most of the information is needed to meet federal requirements enforced by the Nuclear Regulatory Commission. Essentially, we need to know what is going into the reactor, what is coming out, and who authorized the irradiation. It also documents that the experimenter is aware of what is in the sample and that it conforms to our requirements.

The IR is an important document for OSTR staff because it is the first line of defense for performing irradiations in a safe and responsible manner. By signing the IR, the experimenter is stating the follow conditions have been met (formerly call the TRIGA USER'S CERTIFICATION FORM):

1. The experimenter shall be familiar with the general scope, requirements and limitations of the reactor experiment specified on the IR. All personnel submitting IRs under their signed authorization shall also be familiar with the necessary details of the applicable reactor experiment.

2. Irradiation Requests submitted shall meet the conditions of the indicated reactor experiment.

3. The experimenter shall be authorized by a currently valid OSU or other appropriate radioactive materials license to perform the activities covered by the indicated reactor experiment and to possess any radionuclides generated in the course of the experiment.

4. All individual items or samples to be irradiated in the reactor, and all major radionuclides to be produced as a result of the irradiation have been clearly and accurately listed on the IR. No items shall be irradiated unless they are listed on the IR.

5. Changes may be made to an IR after one or more of the required approval signatures have been obtained only with the approval of the Reactor Supervisor and the Senior Health Physicist. The Reactor Supervisor and

the Senior Health Physicist shall indicate approval of a change by initialing it.

6. No explosive materials, such as gunpowder, TNT, and nitroglycerin; no hazardous organic compounds, solvents or highly flammable organics, such as gasoline; no special nuclear materials, such as enriched uranium; no natural uranium, depleted uranium, or natural thorium in excess of 1 mg of each substance per individual sample; no samples known or likely to exhibit potentially hazardous characteristics due to irradiation, such as excessive gas build-up in irradiation containers; and no materials known or likely to create undesirable conditions, such as unusually high dose rates or airborne radioactivity, have been submitted for irradiation without specifically alerting the reactor operations staff, and without determining that the materials to be irradiated are permissible within the limits of the reactor Technical Specifications and the designated reactor experiment.

B. General Information Block

1. Institution

Please enter the name of the university, company, institute, or other for whom the irradiation will be performed.

2. Individual User

Please enter the name of the individual for whom the irradiation will be performed. This name shall be the same individual who’s signature appears at the bottom.

3. Project Name

Please enter the name of the project under which this irradiation will be performed. This should be the same project name as that used for the initial project application. The project name helps the Radiation Center Staff make sure that samples to be irradiated correspond or are otherwise appropriate for the approved project and reactor experiment.

C. Payment Information Block

1. (OSU) Index Number

For projects by experimenters at OSU, mark this box and enter the index number to charge the irradiation costs against.

2. (Non-OSU) Purchase Order Number

Mark this box for irradiations performed for experimenters not at OSU. Enter the purchase order number to be charged against.

3. DOE Reactor Sharing Fund

Mark this box if the irradiation is to be funded through the DOE Reactor Sharing Fund. The ability to charge against this fund must be approved by Radiation Center staff in advance.

4. Unfunded (Not Applicable)

Mark this box if the irradiation is unfunded (pro bono) or funding is not applicable. Radiation Center staff must approve pro bono irradiations in advance.

D. OSU Radiation Safety Approval Block

1. Not Required

Mark this box if you are not a researcher/experimenter at OSU. OSU Radiation Safety approval is only required for experimenters affiliated with OSU. It is also not required for irradiations performed under Experiment A-1 because this experiment involves irradiations that do not produce any radioactive material.

2. Radiation Safety Approval Number

Check this box if you are a researcher/experimenter at OSU. To obtain an approval number, simply contact OSU Radiation Safety (737-2227) and ask for one. They will ask for the approximate date of irradiation, the isotopes to be produced, and the total activity at the time of transfer. After checking against your Radiation Use Authorization (RUA), they will issue the approval number. On the IS, enter the approval number, your RUA number, the isotopes produced, and the activity produced. The isotopes and activity listed here must match what was given to OSU Radiation Safety to obtain the approval number.

E. Irradiation Information Block

1. Power/Time

Mark this box if you know the power and time needed for the irradiation. Enter the reactor power in units of kW and the irradiation time in units of hours.

2. Total Fluence

Mark this box if you know the total fluence needed for the irradiation. Enter the total fluence in units of neutrons cm^{-2}. Radiation Center staff will calculate the needed reactor power and time for you based on the desired irradiation facility and the location of the sample in the encapsulation.

3. 1 MeV Equivalent Fluence

Mark this box if this irradiation is for analysis of radiation damage to materials as defined in ASTM E722-94. Enter the total fluence in units of 1 MeV equivalent neutrons cm^{-2}.

4. Reactor Irradiation Facility:

Enter the reactor facility in which you would like the irradiation to take place. Authorized Facilities include:

CLICIT (Cadmium-Lined In-Core Irradiation Tube)
ICIT (In-Core Irradiation Tube)
SHDFE (Sample Holding Dummy Fuel Element)
Rotating Rack (Lazy Susan)
Thermal Column
Pneumatic Transfer System (Rabbit)
Argon Production Facility

F. Encapsulation Block

Encapsulation is the primary means we have to prevent contamination from occurring both in and out of the reactor. Typically a facility will require both a primary and secondary encapsulation. Specific encapsulation requirements are listed in Tables 18.1 through 18.6 below. Some examples of encapsulation descriptions include, but not limited to, the following:

"Sealed quartz in aluminum TRIGA tube"
"Polyethylene TRIGA tube"
"Sealed aluminum TRIGA tube"
"Double encapsulated heat-sealed poly vial in polyethylene TRIGA tube"

G. Brief Project Description Block

Enter a brief description of the project under which this irradiation will be performed. This should be the same project description as that used for the initial project application. The project description may seem redundant (similar to the project name), but it helps the Radiation Center Staff make sure that samples to be irradiated correspond or are otherwise appropriate for the approved project and experiment.

H. Experimenter Signature Block

The experimenter must sign and date here. By signing, the experimenter is stating that the irradiation follows the guidelines set forth in *Procedures for Irradiating Samples in the Oregon State TRIGA Reactor* (this procedure).

1. Experimenter License Number

Mark this box if your work falls under the jurisdiction of OSU Radiation Safety. Also please fill in your RUA number.

2. Other

Mark this box if you are not a researcher/experimenter at OSU. Additionally, please enter the appropriate radioactive material license number.

III. COMPLETING THE STANDARD AND PNEUMATIC TRANSFER SAMPLE INFORMATION FORM

A. Process Overview

The intent of the sample information forms is to collect information from the experimenter on the composition of the samples. There is a standard and a pneumatic transfer irradiation form. The Pneumatic Transfer Irradiation Form is different because it assumes that the sample is immediately transferred to the experimenter following the irradiation. There are three important reasons for collecting this information:

1. Reactivity Effects

Samples containing elements like U, B, and Cd can have dramatic effects upon the core. In some cases, more neutrons are produced than anticipated (e.g., U, Pu and Th) and in other cases, more neutrons are absorbed than is desirable (e.g., B and Cd). These can cause changes in neutron flux and ultimately, core reactivity (a measure of changes in neutron population across the entire core)

2. Radiation Safety

Even small samples can potentially be a radiological concern. Typically, we handle each irradiated sample twice; once when the sample is removed from the reactor and again when it is prepared for shipping or analysis. It is important that we understand what may be produced such that we can anticipate samples that create significant radiation fields. For example, if a sample produces a significant quantity of a radioisotope with a half-life on the order of 6 hours, we may choose to time the irradiation to end on a Friday afternoon so that we remove the sample from the reactor on Monday morning.

3. License Responsibility

We are required by law to verify that each institution we send samples to is licensed (authorized by the appropriate regulatory agency) to possess the isotopes and activity found in each shipment. This form allows us to verify, in advance, that the license will cover the types and amounts of radioisotopes produced for the irradiation.

The experimenter is responsible for entering all applicable information into the shaded section of the form. Below is a brief description of the information that is necessary for the experimenter to properly complete the form

B. Sample Number Column

Enter the sample number here. A sample can be defined as anything that requires encapsulation. Here are a couple of examples. Fission track users will typically have 20-30 different specimens acquired from different geological formations. We (OSU) would consider this to be one sample because all 20-30 specimens will easily fit into one polyethylene TRIGA tube (the encapsulation method). For INAA irradiations, there may be two 2/5-dram vials in one 2-dram vial. We (OSU) would consider this to be two samples, each requiring an entry into the form. For material science or $^{39}Ar/^{40}Ar$ irradiations, each sample would be defined by what fit into the quartz tube.

C. Physical Form Column

Enter the physical form of the sample. For most samples solid, liquid, gas or powder will suffice. The physical form will, in many cases, determine the type of encapsulation required

D. Chemical Form Column

Enter the chemical form of the sample. Common examples include “NaCl”, “apatite”, “zircon”, “metal foil”, “ceramic”, and “plastic”.

E. Sample Amount Column

Enter the mass of each sample in units of grams.

F. Estimated Radioactivity EOB

Enter the estimated radioactivity of the sample at the end of bombardment (EOB). The equation for determining the activity of an isotope after an irradiation is:

$$A(t) = \frac{N_{av}\, m}{AW}\left(\frac{\sqrt{\pi}}{2}\sigma_{th}\phi_{th} + RI\,\phi_{epi}\right)\left(1 - e^{-\frac{(\ln 2)t}{t_{1/2}}}\right)$$

where

A	=	Activity of radioactive progeny of the isotope irradiated (Bq) ($3.7X10^{7}$ Bq = 1 mCi)
N_{av}	=	Avogadro's Number (atoms mol^{-1})
m	=	Sample mass (g)
AW	=	Atomic weight (g mol^{-1})
σ_{th}	=	Neutron absorption cross section for thermal neutrons (cm^{2})
ϕ_{th}	=	Thermal neutron flux (neutrons cm^{-2} s^{-1})
RI	=	Resonance Integral for epithermal neutrons (cm^{2})
ϕ_{epi}	=	Epithermal neutron flux (neutrons cm^{-2} s^{-1})
t	=	Irradiation time (s)
$t_{1/2}$	=	Half-life of the radioactive progeny of the isotope irradiated

Numbers for σ_{th}, RI, $t_{1/2}$, and AW can be obtained from a number of sources, the most common being the Chart of the Nuclides. Values for the thermal and epithermal fluxes can be obtained by contacting the Radiation Center directly. The following is an example of how to calculate the activity of ^{66}Cu from the reaction $^{65}Cu + n \rightarrow {}^{66}Cu$:

$$AW = 64.928$$
$$m = 0.00315\ g$$
$$\sigma_{th} = 2.17\ b = 2.17X10^{-24}cm^{2}$$
$$RI = 2.2\ b = 2.2X10^{-24}cm^{2}$$
$$t_{1/2} = 5.10\ min$$
$$\lambda = \frac{\ln 2}{5.10\ min} = 0.136\ min^{-1}$$
$$t = 5\ min$$
$$\phi_{th} = 1X10^{10}cm^{-2}s^{-1}$$
$$\phi_{epi} = 3X10^{9}cm^{-2}s^{-1}$$

$$A_{^{66}Cu} = \left(\frac{6.02X10^{23}(0.00315)}{64.928}\right)\left[\frac{\sqrt{\pi}}{2}2.17X10^{-24}\left(10^{10}\right) + 2.2X10^{-24}\left(3X10^{9}\right)\right]\left(1 - e^{-0.136(5)}\right)$$

$$A_{^{66}Cu} = 3.72X10^{5}dps = 10.1\ \mu Ci$$

G. Major Radionuclides EOB

List the major radionuclides that will be present in the sample at EOB. This information allows the Radiation Center staff to identify samples that may create high radiation fields if immediately pulled. The most common example is samples that produce a large amount of ^{24}Na. We typically time these irradiations such that the irradiation terminates on Friday afternoon and the sample is allowed to decay over the weekend before pulling the sample from the reactor Monday morning.

H. Estimated Radioactivity at Transfer (Not required for Pneumatic Transfer Sample Form)

Enter the activity of the sample after a decay period of two weeks. This is the standard time we allow samples to decay before packaging them for shipping. The reason we wait is twofold. First, the activity and dose rate on the package surface for most samples would be much higher than allowed by federal regulations to transport. Second, this is the best way to maintain our personnel dose as low as reasonably achievable due to the number of samples handled by our staff. Only in unusual circumstances we will we prepare a shipment before the two-week decay period has elapsed. The equation for radioactive decay is:

$$A = A_o e^{-\left(\frac{\ln 2}{t_{1/2}}\right)t}$$

where

A = Activity of isotope after decay
A_o = Original activity of the isotope
t = Time of decay
$t_{1/2}$ = half-life of isotope

I. Estimated Radionuclides at Transfer (Not required for Pneumatic Transfer Sample Form)

Please enter the isotopes that would remain after the two-week decay period. These are the isotopes you would expect to receive when your samples are shipped.

Table 18.1 – Minimum Encapsulation for the Rotating Rack (Lazy Susan)

Cadmium Covers	Physical Form of Material	Integrated Power (MWh)	Minimum Containment	
			Primary	Secondary
Without Standard Cadmium Covers	Stable Solid	≤1	≤4 dram polyethylene vial	Not required
		≤13	≤2 dram polyethylene vial	Not required
		≤35	Flame-sealed quartz or sealed container	Not required
	Liquid, Powder or Other Loose Solid Material	≤1	≤2 dram polyethylene vial	≤4 dram polyethylene vial
		≤13	≤2 dram polyethylene vial, half full (Normally 2/5 dram polyethylene vial)	Normally 2 dram polyethylene vial; but 10 mL Nalgene liquid scintillation bag is ok when 2 dram vial is primary container
		≤35	Flame-sealed quartz or welded aluminum container	2 dram polyethylene vial or sealed aluminum container. Vented 4 dram polyethylene vial with maximum use of 21 MWh
With Standard Cadmium Covers(1)	Stable Solid	≤1	≤2/5 dram polyethylene vial, or aluminum foil wrap inside cadmium cover inside ≤4 dram polyethylene vial	Not required
		≤35	Flame-sealed quartz or sealed aluminum container	Vented 4 dram polyethylene vial to hold cadmium covers with maximum use of 21 Mwh
			Aluminum foil wrap inside cadmium cover inside sealed aluminum container	Not required
	Liquid, Powder or Other Loose Solid Material	≤1	≤2/5 dram polyethylene vial	4 dram polyethylene vial
		≤13	Flame-sealed quartz or welded aluminum container	Vented 4 dram polyethylene vial
		≤35	Flame-sealed quartz or welded aluminum container	Sealed aluminum container

Footnote:

(1) A standard cadmium cover referenced in Table 18.1 consists of a small cadmium box and cover which is capable of holding a conventional 2/5 dram or 2/27 dram polyethylene vial.

Table 18.2 – Minimum Encapsulation for the Pneumatic Transfer Tube (Rabbit)

Cadmium Covers	Physical Form of Material	Integrated Power (kWh)	Minimum Containment	
			Primary	Secondary
Without Cadmium Covers	Stable Solid	≤1000	≤2 dram polyethylene vial	Not required
	Liquid, Powder or Other Loose Solid Material	≤1000	≤2/5 dram polyethylene vial	≤2 dram polyethylene vial
With Cadmium Covers(1)	Stable Solid	≤100	≤2/5 dram polyethylene vial, or aluminum foil wrap inside cadmium cover inside ≤2 dram polyethylene vial	Not required
	Liquid, Powder or Other Loose Solid Material	≤100	≤2/5 dram polyethylene vial	≤2 dram polyethylene vial

Table 18.3 – Minimum Encapsulation for the Thermal Column and Beam Ports

Cadmium Covers	Physical Form of Material	Minimum Containment	
		Primary	Secondary
With or Without Cadmium Covers(1)	Stable Solid	Polyethylene TRIGA tube or other equivalent plastic containment	Not required
	Liquid, Powder or Other Loose Solid Material	Sealed polyethylene container	Polyethylene container
	Stable Gas	Impervious container known to be leak-tight or sealed in a conservative manner. Gas samples shall not be compressed or pressurized.	Sealed plastic bag, or equivalent (bag may be heat sealed or zip-lock)

Footnote:(1) Cadmium covers referenced in the above table have no specific shape or form requirements other than those imposed by the dimensions of the primary and secondary containment.

Table 18.4 – Minimum Encapsulation for the Cadmium-Lined In-Core Irradiation Tube (CLICIT)

Cadmium Covers	Physical Form of Material	Minimum Containment	
		Primary	Secondary
Without Cadmium Covers	Stable Solid	Flame-sealed quartz or sealed aluminum container	Not required
	Liquid, Powder or Other Loose Solid Material	Flame-sealed quartz or sealed aluminum container	Sealed aluminum container

Table 18.5 – Minimum Encapsulation for the Sample Holding Fuel Element (Dummy)

Cadmium Covers	Physical Form of Material	Minimum Containment	
		Primary	Secondary
Without Cadmium Covers	Stable Solid	Flame-sealed quartz or sealed aluminum container	Gasket-sealed dummy element
	Liquid, Powder or Other Loose Solid Material	Flame-sealed quartz or sealed aluminum container	Gasket-sealed dummy element

Table 18.6 – Minimum Encapsulation for the In-Core Irradiation Tube (ICIT)

Cadmium Covers	Physical Form of Material	Minimum Containment	
		Primary	Secondary
Without Cadmium Covers	Stable Solid	Flame-sealed quartz or sealed aluminum container	Not required
	Liquid, Powder or Other Loose Solid Material	Flame-sealed quartz or sealed aluminum container	Sealed aluminum container

Note:
Irradiation of electronic devices in the ICIT, in conjunction with the BNC end cap, shall be for pulse irradiations only. Reactor steady state power shall not exceed 20W and only for the purpose of setting up for a pulse. For these irradiations, no encapsulation is required of electronic devices.

IR #:	
Project #:	
Run #:	
Page ___ of ___	

OSU TRIGA REACTOR
IRRADIATION REQUEST
INFORMATION SHEET

GENERAL INFORMATION

Institution: ____________

Individual User: ____________

Project Name: ____________

PAYMENT INFORMATION

☐ (OSU) Index Number: ____________

☐ (Non-OSU) Purchase Order Number: ____________

☐ DOE Reactor Sharing Fund ____________

☐ Unfunded (Not Applicable) ____________

OSU RADIATION SAFETY APPROVAL

☐ Not Required (Non-OSU Experimenter or A-1 Experiment Only)

☐ Radiation Safety Committee Approval Number: ____________

IRRADIATION INFORMATION

Facility: ____________

☐ Reactor Power/Time: ______ [kW] ______ [hours]

☐ Total Neutron Fluence: ____________ [n cm^{-2}]

☐ 1 MeV Equivalent Fluence: ____________ [n cm^{-2}]

Remarks:

ENCAPSULATION

____

BRIEF PROJECT DESCRIPTION

____

EXPERIMENTOR SIGNATURE

The experimenter for this IR declares that this irradiation requested falls under the guidelines of requirements given in *Procedures for Irradiating a Sample in the Oregon State TRIGA Reactor*.

Experimenter Signature ____________ Date ______

Experimenter License Number: ☐ ORE 90005 RUA #: ____________

☐ Other: ____________

RECEIPT OF RADIOACTIVE MATERIAL PRIOR TO IRRADIATION (Staff Use Only) dB☐

☐ N/A (Non-radioactive material)

☐ Transferred From License ORE 90005 RUA #: ____________

☐ Transferred From License Other: ____________

Isotopes: ____________

Activity: ____________

Physical / Chemical Form: ____________

Date: ______ Time: ______

Receiver's Signature: ____________

OPERATIONS STAFF APPROVAL (Staff Use Only)

Senior Health Physicist Signature: ____________ Date: ______

Reactor Supervisor Signature: ____________ Date: ______

Experiment Number: ______

REACTOR TIME (Staff Use Only) dB☐

Required Irradiation Time: ______ [hrs]

Date				
Power (kW)				
Start Time				
End Time				
Δ Time				

Total Irradiation Time: ______ [hrs]

Remarks:

MATERIAL TRANSFER (Staff Use Only) dB☐

Material transferred from License R-106 to:

☐ ORE 90005 RUA #: ____________

☐ Other: ____________

Total Radioactivity Transferred: ____________

RAM Transfer Record Number: ____________

Transfer Date: ______ Transfer Time: ______

Shipped/received by: ____________

Remarks:

Figure 1 – Information Request Standard Sheet

IR #: ....

Project #: ....

Run #: ....

Page .... of ....

IRRADIATION REQUEST
STANDARD SAMPLE INFORMATION FORM

(Shaded columns must be completed by the Experimenter)

Sample Number	Physical Form	Chemical Form	Sample Amount (g)	Estimated Radioactivity At EOB (mCi)	Major Radionuclides At EOB	Estimated Radioactivity At Transfer (mCi)	Major Radioactivity At Transfer	Rotating Rack Position	Remarks	WC at 1ft* (mR h^{-1})
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
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35										
36										
37										
38										
39										
40										

*Initial Radiation Survey Instrument Information

Date	Time	Instrument / Serial Number	BSCF

Final Release Survey

Group Number	Date	Time	Instrument / Serial Number	Uncorrected Contact (mR h^{-1})		Uncorrected @ 1 ft (mR h^{-1})			BSCF	Estimated Radioactivity [6CEN] (mCi)
				WO	WC_1	WO	WC_1	WC_2		
1										
2										
3										
4										
									Estimated Activity Transferred (mCi) =	

Figure 2 – Standard Sample Information Form

IRRADIATION REQUEST
PNEUMATIC TRANSFER
SAMPLE INFORMATION FORM
(Shaded columns must be completed by the Experimenter)

IR #: ....
Project #: ....
Run #: ....
Page ...... **of** ......

Sample Number	Physical Form	Chemical Form	Sample Amount (g)	Estimated Radioactivity At EOB (mCi)	Major Radionuclides At EOB	Area Radiation Monitor (mR h^{-1})	Uncorrected WO at Contact (mR h^{-1})	Corrected WC at 1ft (mR h^{-1})	Remarks
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
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Radiation Survey Instrument Information

Date	Time	Instrument / Serial Number	BSCF

Figure 3 – Pneumatic Transfer Sample Information Form

IRRADIATION REQUEST
IRRADIATION TIME
TRACKING FORM

IR #: ....

Project #: ....

Run #: ....

Page .... **of** ....

Required Irradiation Time ______ [hrs]

Date	Time Began	Time Ended	Δ Time	Reactor Power (kW)	Cumulative Power History (kWh)	Remarks

Figure 4 – Irradiation Time Tracking Form

IR #: ....
Project #: ....
Run #: ....
Page ..... of .....

OSU TRIGA REACTOR IRRADIATION REQUEST INFORMATION SHEET

GENERAL INFORMATION

Institution: Bologna University

Individual User: John Doe

Project Name: Fission Track

PAYMENT INFORMATION

☐ (OSU) Index Number: ....

☒ (Non-OSU) Purchase Order Number: T21354

☐ DOE Reactor Sharing Fund ....

☐ Unfunded (Not Applicable) ....

OSU RADIATION SAFETY APPROVAL

☒ Not Required (Non-OSU Experimenter or A-1 Experiment Only)

☐ Radiation Safety Committee Approval Number: ....

IRRADIATION INFORMATION

Facility: Thermal Column

☐ Reactor Power/Time: ..... [kW] ..... [hours]

☒ Total Neutron Fluence: 1E16 [n cm^{-2}]

☐ 1 MeV Equivalent Fluence: ..... [n cm^{-2}]

Remarks:

ENCAPSULATION

Polyethylene TRIGA tube

BRIEF PROJECT DESCRIPTION

Use of fission track analysis to determine U content in the Rhine Graben uplift.

EXPERIMENTOR SIGNATURE

The experimenter for this IR declares that this irradiation requested falls under the guidelines of requirements given in *Procedures for Irradiating a Sample in the Oregon State TRIGA Reactor*.

Experimenter Signature: John Doe Date: 2/14/04

Experimenter License Number: ☐ ORE 90005 RUA #: ....

☒ Other: GA-T-1035

RECEIPT OF RADIOACTIVE MATERIAL PRIOR TO IRRADIATION (Staff Use Only) dB☐

☐ N/A (Non-radioactive material)

☐ Transferred From License ORE 90005 RUA #: ....

☐ Transferred From License Other: ....

Isotopes: ....

Activity: ....

Physical / Chemical Form: ....

Date: .... Time: ....

Receiver's Signature: ....

OPERATIONS STAFF APPROVAL (Staff Use Only)

Senior Health Physicist Signature: .... Date: ....

Reactor Supervisor Signature: .... Date: ....

Experiment Number: ....

REACTOR TIME (Staff Use Only) dB☐

Required Irradiation Time: .... [hrs]

Date				
Power (kW)				
Start Time				
End Time				
Δ Time				

Total Irradiation Time: .... [hrs]

Remarks:

MATERIAL TRANSFER (Staff Use Only) dB☐

Material transferred from License R-106 to:

☐ ORE 90005 RUA #: ....

☐ Other: ....

Total Radioactivity Transferred: ....

RAM Transfer Record Number: ....

Transfer Date: .... Transfer Time: ....

Shipped/received by: ....

Remarks:

Figure 5 - – Example Information Sheet for Fission Track Irradiations

IR #: ....
Project #: ....
Run #: ....
Page ...... of ......

OSU TRIGA REACTOR
IRRADIATION REQUEST
INFORMATION SHEET

GENERAL INFORMATION

Institution: Oregon State University
Individual User: John Doe
Project Name: Cross Section Calculation

PAYMENT INFORMATION

☒ (OSU) Index Number: ENE 333
☐ (Non-OSU) Purchase Order Number: ....
☐ DOE Reactor Sharing Fund ....
☐ Unfunded (Not Applicable) ....

OSU RADIATION SAFETY APPROVAL

☐ Not Required (Non-OSU Experimenter or A-1 Experiment Only)
☒ Radiation Safety Committee Approval Number: 1935

IRRADIATION INFORMATION

Facility: Rabbit (pneumatic)

☒ Reactor Power/Time: 10 [kW] 0.1 [hours]
☐ Total Neutron Fluence: .... [n cm^{-2}]
☐ 1 MeV Equivalent Fluence: .... [n cm^{-2}]

Remarks:

ENCAPSULATION

Sealed 2/5 dram polyvials inside 2 dram polyvials

BRIEF PROJECT DESCRIPTION

Determination of ^{198}Au thermal neutron cross section

EXPERIMENTOR SIGNATURE

The experimenter for this this IR declares that this irradiation requested falls under the guidelines of requirements given in *Procedures for Irradiating a Sample in the Oregon State TRIGA Reactor*.

Experimenter Signature: John Doe Date: 2/19/04
Experimenter License Number: ☒ ORE 90005 RUA #: 999
☐ Other: ....

RECEIPT OF RADIOACTIVE MATERIAL PRIOR TO IRRADIATION (Staff Use Only) dB☐

☐ N/A (Non-radioactive material)
☐ Transferred From License ORE 90005 RUA #: ....
☐ Transferred From License Other: ....

Isotopes: ....
Activity: ....
Physical / Chemical Form: ....
Date: .... Time: ....
Receiver's Signature: ....

OPERATIONS STAFF APPROVAL (Staff Use Only)

Senior Health Physicist Signature: .... Date: ....
Reactor Supervisor Signature: .... Date: ....
Experiment Number: ....

REACTOR TIME (Staff Use Only) dB☐

Required Irradiation Time: .... [hrs]

Date				
Power (kW)				
Start Time				
End Time				
Δ Time				

Total Irradiation Time: .... [hrs]
Remarks:

MATERIAL TRANSFER (Staff Use Only) dB☐

Material transferred from License R-106 to:

☐ ORE 90005 RUA #: ....
☐ Other: ....

Total Radioactivity Transferred: ....
RAM Transfer Record Number: ....
Transfer Date: .... Transfer Time: ....
Shipped/received by: ....
Remarks:

Figure 6 – Example Information Sheet for OSU Experimenter with Rabbit Irradiation

IR #: ....
Project #: ....
Run #: ....
Page ..... of .....

OSU TRIGA REACTOR
IRRADIATION REQUEST
INFORMATION SHEET

GENERAL INFORMATION

Institution: Portland College

Individual User: John Doe

Project Name: Ar/Ar Geochronology

PAYMENT INFORMATION

☐ (OSU) Index Number: ....

☐ (Non-OSU) Purchase Order Number: ....

☒ DOE Reactor Sharing Fund ....

☐ Unfunded (Not Applicable) ....

OSU RADIATION SAFETY APPROVAL

☒ Not Required (Non-OSU Experimenter or A-1 Experiment Only)

☐ Radiation Safety Committee Approval Number: ....

IRRADIATION INFORMATION

Facility: CLICIT

☒ Reactor Power/Time: 1000 [kW] 7 [hours]

☐ Total Neutron Fluence: .... [n cm^{-2}]

☐ 1 MeV Equivalent Fluence: .... [n cm^{-2}]

Remarks:

ENCAPSULATION

Sealed quartz tube inside Al TRIGA tube

BRIEF PROJECT DESCRIPTION

Ar/Ar analysis for age dating of geologic materials

EXPERIMENTOR SIGNATURE

The experimenter for this IR declares that this irradiation requested falls under the guidelines of requirements given in *Procedures for Irradiating a Sample in the Oregon State TRIGA Reactor*.

Experimenter Signature John Doe Date 2/14/04

Experimenter License Number: ☐ ORE 90005 RUA #: ....

☒ Other: CA-32512

RECEIPT OF RADIOACTIVE MATERIAL PRIOR TO IRRADIATION (Staff Use Only) dB☐

☐ N/A (Non-radioactive material)

☐ Transferred From License ORE 90005 RUA #: ....

☐ Transferred From License Other: ....

Isotopes: ....

Activity: ....

Physical / Chemical Form: ....

Date: .... Time: ....

Receiver's Signature: ....

OPERATIONS STAFF APPROVAL (Staff Use Only)

Senior Health Physicist Signature: .... Date: ....

Reactor Supervisor Signature: .... Date: ....

Experiment Number: ....

REACTOR TIME (Staff Use Only) dB☐

Required Irradiation Time: .... [hrs]

Date				
Power (kW)				
Start Time				
End Time				
Δ Time				

Total Irradiation Time: .... [hrs]

Remarks:

MATERIAL TRANSFER (Staff Use Only) dB☐

Material transferred from License R-106 to:

☐ ORE 90005 RUA #: ....

☐ Other: ....

Total Radioactivity Transferred: ....

RAM Transfer Record Number: ....

Transfer Date: .... Transfer Time: ....

Shipped/received by: ....

Remarks:

Figure 7 – Example Information Sheet for Ar/Ar Geochronology Irradiations

IR #: ....
Project #: ....
Run #: ....
Page ..... of .....

IRRADIATION REQUEST
STANDARD SAMPLE INFORMATION FORM
(Shaded columns must be completed by the Experimenter)

Sample Number	Physical Form	Chemical Form	Sample Amount (g)	Estimated Radioactivity At EOB (mCi)	Major Radionuclides At EOB	Estimated Radioactivity At Transfer (mCi)	Major Radioactivity At Transfer	Rotating Rack Position	Remarks	WC at 1ft* ($mR\ h^{-1}$)
1	Solid	k-spur	0.300	122.000	Na-24, K-41,	20.000	Fe-55, Ca-45,			
2		Plag.	0.100	23.000	Si-31, Ca-54,		Mn-59, Rb-86,			
3		Biotite	0.100	12.000	Ca-49, Sc-49,		Zn-65			
4		Basalt	0.500	186.000	Fe-55, Fe-59,					
5		Al foil	16.000	41972.000	Mn-56, Mn-54,					
6		Cu foil	0.100	1.000	Ca-64, Al-28,					
7		Al tube	48.000	47162.000	Zn-65, Rb-86					
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*Initial Radiation Survey Instrument Information

Date	Time	Instrument / Serial Number	BSCF

Final Release Survey

Group Number	Date	Time	Instrument / Serial Number	Uncorrected Contact ($mR\ h^{-1}$)		Uncorrected @ 1 ft ($mR\ h^{-1}$)			BSCF	Estimated Radioactivity [6CEN] (mCi)
				WO	WC_1	WO	WC_1	WC_2		
1										
2										
3										
4										
									Estimated Activity Transferred (mCi) =	

Figure 8 – Example Sample Information Form for Ar/Ar Geochronology Irradiations

IR #: ....

Project #: ....

Run #: ....

Page ...... of ......

IRRADIATION REQUEST
STANDARD SAMPLE INFORMATION FORM
(Shaded columns must be completed by the Experimenter)

Sample Number	Physical Form	Chemical Form	Sample Amount (g)	Estimated Radioactivity At EOB (mCi)	Major Radionuclides At EOB	Estimated Radioactivity At Transfer (mCi)	Major Radioactivity At Transfer	Rotating Rack Position	Remarks	WC at 1ft* ($mR\ h^{-1}$)
1	Solid	PE Foil	0.400	20.000	Na-24, K-41,	1.000	Na-24, Fe-59,			
2		Parafilm	0.300		Fe-59, Hf-181,		Hf-181, Zr-97,			
3		Tape	0.200		Zr-95, Zr-97,		Zn-65			
4		Teflon	8.000		Zn-65					
5		Glass	0.500							
6		Mica	0.300							
7		Zircon	0.100							
8		Nat U	0.001							
9		Nat Th	0.001							
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*Initial Radiation Survey Instrument Information

Date	Time	Instrument / Serial Number	BSCF

Final Release Survey

Group Number	Date	Time	Instrument / Serial Number	Uncorrected Contact ($mR\ h^{-1}$)		Uncorrected @ 1 ft ($mR\ h^{-1}$)			BSCF	Estimated Radioactivity [6CEN] (mCi)
				WO	WC_1	WO	WC_1	WC_2		
1										
2										
3										
4										
									Estimated Activity Transferred (mCi) =	

Figure 9 – Example Sample Information Form for Fission Track Irradiations