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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Reactor Administrator

Procedures for Irradiating a Sample in the Oregon State TRIGA® Reactor

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

OSTROP 18
Appendix A
Procedures for Irradiating a Sample 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 (Figure 1) 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 required Irradiation Request (IR) forms. 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 Reactor Administrator for irradiation. Samples and IR forms should be submitted 24 hours 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 will be made by 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-29 Reactivity Worth of Fuel

B-31 TRIGA® Flux Mapping

B-36 Irradiation of Fissionable Materials in the OSTR

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. (Administrative limit is 1000 kW.)

3. The reactivity inserted for pulse operation shall not exceed $2.30. (Administrative limit is $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 half 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.

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. 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.

    c. Anything containing mercury or gallium.

D. OSTR Encapsulation Limitations

1. Specifically-Approved Minimum Encapsulation Methods

   The methods of encapsulation detailed in Tables 18.1 through 18.4 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 will be evaluated under “Other Encapsulation Methods.” All polyethylene vials, except those designated as “vented,” and all Nalgene liquid scintillation bags will be heat-sealed. Other containments will 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 sample tube or rabbit tube used to hold encapsulated samples during irradiation.

2. 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 will 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 will 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 will be documented by their signatures on the applicable Irradiation Request.

3. 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.

4. 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 Irradiation Request (IR) Information Sheet shall be completed by the experimenter each time an Irradiation Request is submitted. The Irradiation Request Information Sheet is divided into two columns. The experimenter will 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:

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

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

3. The experimenter is 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 may 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 will indicate approval of a change by initialing and dating the change.

6. The following items require notifying the Reactor Supervisor and Senior Health Physicist before irradiation:

   a. Explosive materials, such as gunpowder, TNT, and nitroglycerin;
   b. Hazardous organic compounds, solvents or highly flammable organics, such as gasoline;
   c. 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;
   d. Samples known or likely to exhibit potentially hazardous characteristics due to irradiation, such as excessive gas build-up in irradiation containers; and
   e. Materials known or likely to create undesirable conditions, such as unusually high dose rates or airborne radioactivity.

   These materials to be irradiated must be permissible within the limits of the reactor Technical Specifications and the limits specified within 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.

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. 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 or the material remains on license R-106. OSU Radiation Safety approval is only required for experimenters affiliated with OSU performing an irradiation that produces material that moves to the State of Oregon license. 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. The isotopes produced and activity produced will also be entered on the Sample Information Form. After checking against your Radiation Use Authorization (RUA), they will issue the approval number. Enter the approval number in this block on the Irradiation Request Information Sheet.

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 E722-14. 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): B-Ring or F-Ring
ICIT (In-Core Irradiation Tube): F-Ring only
Rotating Rack (Lazy Susan)
Thermal Column
Pneumatic Transfer System (Rabbit)
NRF (Neutron Radiography Facility)
PGNAA (Prompt Gamma Neutron Activation Analysis 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 18.4 below. Examples of encapsulation descriptions include, but are 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 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 Sample Information Form and a Pneumatic Transfer Sample Information Form. The Pneumatic Transfer Sample Information 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 sample 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 at 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 isotope irradiated (Bq) (3.7E7 Bq = 1 mCi)
N_{av} = Avogadro's Number (6.02E23 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 (s)

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 $^{65}Cu + n \rightarrow {}^{66}Cu$:

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

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

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

G. Major Radionuclides at 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 (N/A 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 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

Table 1- Minimum Encapsulation for the Rotating Rack (Lazy Susan)

Cadmium Covers	Physical Form of Material	Integrated Power (MWh)	Minimum Containment	
			Primary	Secondary[1]
Without Standard Cadmium Covers	Stable Solid	< 25	Polyethylene Vial	Not required
		25-35	Flame-sealed quartz or sealed container	Not required
		> 35	Flame-sealed quartz or sealed container	Not required
	Liquid, Powder or Other Loose Solid Material	< 25	≤2 dram polyethylene vial	≤4 dram polyethylene vial
		> 25	Flame-sealed quartz or welded aluminum container	Approved sealant on an aluminum TRIGA® tube
With Standard Cadmium Covers(2)	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(3)	≤1	≤2/5 dram polyethylene vial inside Cd container	4 dram polyethylene vial outside the Cd cover

Footnote:

(1) The standard carriers for LS irradiations are the poly or aluminum TRIGA® Tube for irradiations less than 25 hours and the aluminum TRIGA® tube for irradiations greater than 25 hours. These tubes are not considered secondary containment.

(2) The 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.

(3) Cd covered irradiations exceeding 1 MWhr should be conducted within the CLICIT.

Table 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 3 - Minimum Encapsulation for the Thermal Column and Beam Ports[(2)]

<table>
<tr><th rowspan="2">Cadmium Covers</th><th rowspan="2">Physical Form of Material</th><th colspan="2">Minimum Containment</th></tr>
<tr><th>Primary</th><th>Secondary</th></tr>
<tr><td rowspan="3">With or Without Cadmium Covers[(1)]</td><td>Stable Solid</td><td>Polyethylene TRIGA® tube or other equivalent plastic containment</td><td>Not required</td></tr>
<tr><td>Liquid, Powder or Other Loose Solid Material</td><td>Sealed polyethylene container</td><td>Polyethylene container</td></tr>
<tr><td>Stable Gas</td><td>Impervious container known to be leak-tight or sealed in a conservative manner. Gas samples shall not be compressed or pressurized.</td><td>Sealed plastic bag, or equivalent
(bag may be heat sealed or zip-lock)</td></tr>
</table>

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.

(2) Radiography samples, at the discretion of the Senior Health Physicist and the Reactor Supervisor, may be exempt from this requirement

Table 4 - Minimum Encapsulation for the In-Core Irradiation Tubes (ICIT/CLICIT)

<table>
<tr><th rowspan="2">Cadmium Covers</th><th rowspan="2">Physical Form of Material</th><th colspan="2">Minimum Containment</th></tr>
<tr><th>Primary</th><th>Secondary</th></tr>
<tr><td rowspan="2">Without Cadmium Covers</td><td>Stable Solid</td><td>Flame-sealed quartz or sealed aluminum container</td><td>Not required</td></tr>
<tr><td>Liquid, Powder or Other Loose Solid Material</td><td>Flame-sealed quartz or sealed aluminum container</td><td>Sealed aluminum container</td></tr>
</table>

PROJECT APPLICATION FORM

This form will be used to create a project in our projects database. Please fill out the following information fields.

Principal Investigator (PI)

First Name:

Last Name (Surname/Family Name):

Email Address:

Organization Name:

Address Line 1:

Address Line 2:

City:

State:

Postal Code:

Country:

Phone Number:

Fax Number (if applicable):

Invoicing

Invoice Email (if different from PI):

Invoice First and Last Name (Surname/Family Name):

Invoice Address Line 1:

Invoice Address Line 2:

Invoice City:

Invoice State:

Invoice Postal Code:

Invoice Country:

Project

Project Name:

Project Description (3 sentences maximum):

Figure 1 – Project Application Form

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: ....

☐ Unfunded (Not Applicable) ....

OSU RADIATION SAFETY APPROVAL

☐ Not Required (Non-OSU Experimenter, no RAM transfer, or A-1 Experiment)

☐ Radiation Safety Committee Approval Number: ....

IRRADIATION INFORMATION

Facility: General Reactor Use

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

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

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

Remarks:

ENCAPSULATION

Other

....

....

BRIEF PROJECT DESCRIPTION

....

....

....

EXPERIMENTER SIGNATURE

The experimenter for this IR declares that this irradiation requested falls under the guidelines of requirements given in OSTROP 18 Appendix A *"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)

Isotopes: ....

Activity: ....

Physical/Chemical Form: ....

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

Receiver's signature: SHP..........

Receiver's signature: Rx Sup ....

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:

Time conversion (for CLOCIT irradiations):

Requested B1 CLICIT Time __________ [hrs]
x 1.8

= F20 CLOCIT Equivalent Time__________ [hrs]

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 2 - Information Request Information 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 Radionuclides 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 3 - Standard Sample Information Form

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

IRRADIATION REQUEST
PNEUMATIC TRANSFER
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	Area Radiation Monitor (mR h^{-1})	Corrected WC at 1ft (mR h^{-1})	Remarks
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
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Radiation Survey Instrument Information

Date	Time	Instrument / Serial Number	BSCF

Figure 4 - Pneumatic Transfer Sample Information Form

Irradiation # Page _3__ of _3__

User Name

Facility:

TC irradiation calculation

Average sample Cl (cm) =

Total MWHR required = Required Irradiation flux =

Time of irradiation (hr) = **N/A**

	Time				Calculated values		
Date	Begin	End	Power	Delta	MWHR	Time remaining	S/D Time

Figure 5 - 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
☐ Unfunded (Not Applicable) ....

OSU RADIATION SAFETY APPROVAL

☒ Not Required (Non-OSU Experimenter, no RAM transfer, or A-1 Experiment)
☐ Radiation Safety Committee Approval Number: ....

IRRADIATION INFORMATION

Facility: Thermal Column

☐ Reactor Power/Time: ...... [kW] ...... [hours]
☒ Total Neutron Fluence: 1 E16 [n cm^{-2}]
☐ 1 MeV Equivalent Fluence: ...... [n cm^{-2}]

Remarks:

ENCAPSULATION

Poly TRIGA Tube

BRIEF PROJECT DESCRIPTION

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

EXPERIMENTER SIGNATURE

The experimenter for this IR declares that this irradiation requested falls under the guidelines of requirements given in OSTROP 18 Appendix A *"Procedures for Irradiating a Sample in the Oregon State TRIGA Reactor."*

Experimenter Signature John Doe Date 7/20/18

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)

Isotopes: ....
Activity: ....
Physical/Chemical Form: ....
Date: .... Time: ....
Receiver's signature: SHP............
Receiver's signature: Rx Sup ....

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:

Time conversion (for CLOCIT irradiations):

Requested B1 CLICIT Time ________ [hrs]
x 1.8

= F20 CLOCIT Equivalent Time________ [hrs]

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 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: ....
☐ Unfunded (Not Applicable) ....

OSU RADIATION SAFETY APPROVAL

☐ Not Required (Non-OSU Experimenter, no RAM transfer, or A-1 Experiment)
☒ Radiation Safety Committee Approval Number: 1935

IRRADIATION INFORMATION

Facility: Pneumatic Transfer

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

Remarks:

ENCAPSULATION

2/5 Dram Sealed Poly Vial inside 2 Dram Sealed Poly Vial

BRIEF PROJECT DESCRIPTION

Determination of ^{198}Au thermal neutron cross section

EXPERIMENTER SIGNATURE

The experimenter for this IR declares that this irradiation requested falls under the guidelines of requirements given in OSTROP 18 Appendix A *"Procedures for Irradiating a Sample in the Oregon State TRIGA Reactor."*

Experimenter Signature: John Doe Date: 7/20/18

Experimenter License Number: ☒ ORE 90005 RUA #: 999
☐ Other: ....

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

☐ N/A (Non-radioactive material)

Isotopes: ....
Activity: ....
Physical/Chemical Form: ....
Date: .... Time: ....
Receiver's signature: SHP..........
Receiver's signature: Rx Sup ....

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:

Time conversion (for CLOCIT irradiations):

Requested B1 CLICIT Time __________ [hrs]
x 1.8

= F20 CLOCIT Equivalent Time__________ [hrs]

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 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: ....

☒ Unfunded (Not Applicable) ....

OSU RADIATION SAFETY APPROVAL

☒ Not Required (Non-OSU Experimenter, no RAM transfer, or A-1 Experiment)

☐ Radiation Safety Committee Approval Number: ....

IRRADIATION INFORMATION

Facility: CLICIT (B1)

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

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

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

Remarks:

ENCAPSULATION

Sealed Quartz inside Sealed Aluninum TRIGA Tube

BRIEF PROJECT DESCRIPTION

Ar/Ar analysis for age dating of geologic materials

EXPERIMENTER SIGNATURE

The experimenter for this IR declares that this irradiation requested falls under the guidelines of requirements given in OSTROP 18 Appendix A *"Procedures for Irradiating a Sample in the Oregon State TRIGA Reactor."*

Experimenter Signature John Doe Date 7/20/18

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)

Isotopes: ....

Activity: ....

Physical/Chemical Form: ....

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

Receiver's signature: SHP..........

Receiver's signature: Rx Sup ....

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:

Time conversion (for CLOCIT irradiations):

Requested B1 CLICIT Time ________ [hrs]
x 1.8

= F20 CLOCIT Equivalent Time________ [hrs]

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 8 - 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 Radionuclides 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 9 - 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 Radionuclides 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 10 - Example Sample Information Form for Fission Track Irradiations