

# Radiological Safety Analysis Document

**This Radiological Safety Analysis Document (RSAD) will identify the radiation budget for the experiment, the verification process for the radiation budget, and controls with regard to production, movement, or import of radioactive materials.**

## I. Description

Experiment E95-001, Precise Measurements of the Inclusive Spin-dependent Quasi-elastic Transverse Asymmetry  $A_T$  from  $^3\text{He}$  (e,e') at low  $Q^2$ , will be run in Hall A. The nominal current for this experiment is 5-10  $\mu\text{A}$ . Considering the small impact of this experiment on site boundary dose, small changes in energy or current will not affect the validity of this RSAD.

## II. Summary and Conclusions

There are three primary concerns with respect to this experiment - target type, contamination potential, and boundary dose. First, the target gas is He-3, which from Jefferson Lab experience, has created problems due to tritium (H-3) content. The gas to be used in this experiment is considerably less contaminated ( $<1 \times 10^{-11}$  mole %) than the "problem gas" that has been here before, and the target is still gas form at 10 atmospheres. The total calculated inventory of tritium is less than 4 nCi (147 Bq), so it is of no major concern.

Secondly, the area around the target and beamline may be contaminated after a run. If in the experiment there is a need to manually manipulate the target, there will need to be some Radiation Worker - II trained physics personnel present, who will be under close coverage by the Radiation Control Group. **Direct supervision by the Radiation Control Group is required for manual target manipulation, and this work should be preplanned.**

Lastly, the experiment is calculated to use **0.06%** of the annual design goal at the Jefferson Lab boundary for **305** hours run-time. The experiments will be periodically monitored by the Radiation Control Group to ensure that the site boundary goal is not exceeded. Since the dose expected is so far below limits, the validity of this RSAD will not be compromised if the budget form is not perfectly accurate. The experiment will likely cause Radiation Areas and High Radiation Areas in the Hall. **Adherence to this RSAD is vital.**

## III. Calculations of Radiation Deposited in the Experimental Hall (the Experiment Operations Envelope)

The radiation budget for a given experiment is the amount of radiation that is expected to be found at site boundary as a result of a given set of experiments. This budget may be specified in terms of mrem at site boundary or as a percentage of the Jefferson Lab design goal for dose to the public, which is 10 mrem per year. The Jefferson Lab design goal is 10% of the DOE annual dose limit to the public, and cannot be exceeded without prior written consent from the Radiation Control Group Head, the Director of Jefferson Lab, and the Department of Energy.

The radiation budget for experiment **E95-001**, with principal investigators **Haiyan Gao** and **Jens-Ole Hansen**, is approximately **0.006 mrem**, or **0.06%** of Jefferson Lab's annual design goal. The attached spreadsheet (Attachment A) details the budget calculations.

The budget will be verified during the experiment by using the active monitors at the Jefferson Lab site boundary to keep up with the dose for the individual setups. If it appears that the radiation budget will be exceeded, the Radiation Control Group (RCG) will require a meeting with the experimenters and the Head of the Physics Division to determine if the experimental conditions are accurate, and to assess what actions may reduce the dose rates at site boundary. If the site boundary dose approaches or exceeds 10 mrem during any calendar year, the experimental program will stop until a resolution can be reached.

#### IV. Radiation Hazards

The following controls shall be used to prevent the unnecessary exposure of personnel and to comply with Federal, State, and local regulations, as well as with Jefferson Lab and the Experimenter's home institution policies.

##### A. From Beam in the Hall

When the Hall status is Beam Permit, there are potentially lethal conditions present. Therefore, prior to going to Beam Permit, there are several actions that will occur. Announcements will be made over the intercom system notifying personnel of a change in status from Restricted Access (free access to the Hall is allowed, with appropriate dosimetry and training) to Sweep Mode. All magnetic locks on exit doors will be activated. Persons trained to sweep the area will enter by keyed access (Controlled Access) and search in all areas of the Hall to check for personnel.

After the sweep, another announcement will be made, indicating a change to Power Permit, followed by Beam Permit. The lights will dim and Run-Safe boxes will indicate "OPERATIONAL" and "UNSAFE". IF YOU ARE IN THE HALL AT ANY TIME THAT THE RUN-SAFE BOXES INDICATE "OPERATIONAL" AND/OR "UNSAFE", IMMEDIATELY HIT THE BUTTON ON THE BOX.

Controlled Area Radiation Monitors (CARMs) are located in strategic areas around the Hall and the Counting House to ensure that unsafe conditions do not occur in occupiable areas.

##### B. From Activation of Target and Beamline Components

**All radioactive materials brought to Jefferson Lab shall be identified to the Radiation Control Group.** These materials include, but are not limited to radioactive check sources (of any activity, exempt or non-exempt), previously used targets or radioactive beamline components, or previously used shielding or collimators. The RCG inventories and tracks all radioactive materials onsite. The Radiation Control Group will survey all experimental setups before experiments begin as a baseline for future measurements.

**All movement of used targets, collimators, and shields will be coordinated by the Radiation Control Group.** The Radiation Control Group will assess the radiation exposure conditions and will provide close coverage for Jefferson Lab Radiation Workers to move them.

**All activated experimental targets will be retained in a Jefferson Lab-provided security box when not in the target chamber.** The security box is in the experimental hall, and is well shielded. The lock for the box will be controlled by the Radiation Control Group.

**There shall be no local movement of activated target configurations without direct supervision by the Radiation Control Group.** Remote movement of target configurations shall be permitted, providing the method of movement has been reviewed and approved by the Radiation Control Group.

**No work is to be performed on beamline components which could result in dispersal of radioactive material** (e.g., drilling, cutting, welding, etc.). Such activities must be conducted only with specific permission and control of the Radiation Control Group.

**The Radiation Control Group may be reached at any time through the Accelerator Crew Chief (269-7050).**

**V. Incremental Shielding or Other Measures to be Taken to Reduce Radiation Hazards**

None is necessary.

**VI. Operations Procedures**

**All experimenters must comply with experiment-specific administrative controls.** These controls begin with the measures outlined in the experiment's Conduct of Operations Document, and also include, but are not limited to, Radiation Work Permits, Temporary Operational Safety Procedures, and Operational Safety Procedures, or any verbal instructions from the Radiation Control Group. A general access RWP is in place that governs access to the Halls and the accelerator enclosure, which may be found in the Machine Control Center (MCC); it must be read and signed by all participants in the experiment. Any individual with a need to handle radioactive material at Jefferson Lab shall first complete Radiation Worker (RW I) training. Radiation Worker - II training must be completed prior to working in or on Contamination Areas.

**There shall be adequate communication between the experimenter(s) and the Accelerator Crew Chief and/or Program Deputy** to ensure that all power restrictions on the target are well known. Exceeding these power restrictions may lead to excessive and unnecessary contamination, activation, and personnel exposure.

**No scattering chamber or downstream component may be altered** outside the scope of this RSAD without formal Radiation Control Group review. Alteration of these components (including the exit beampipe itself) may result in increased radiation production from the Hall and a resultant increase in site boundary dose.

## **VII. Decommissioning and Decontamination of Radioactive Components**

**Experimenters shall retain all targets and experimental equipment brought to Jefferson Lab for temporary use during the experiment.** After sufficient decay of the radioactive target configurations, they shall be delivered to the experimenter's home institution for final disposition. All transportation shall be done in accordance with United States Department of Transportation Regulations (Title 49, Code of Federal Regulations) or International Air Transport Association regulations. In the event that the experimenter's home institution cannot accept the radioactive material due to licensing requirements, the experimenter shall arrange for appropriate funds transfers for disposal of the material. Jefferson Lab cannot store indefinitely any radioactive targets or experimental equipment.

**The Radiation Control Group may be reached at any time through the Accelerator Crew Chief (269-7045).**