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

Experiments E06-010, Measurement of Single Target-Spin Asymmetry in Semi-Inclusive Pion Electroproduction on a Transversely Polarized ^{3}He Target, and E06-014, Measurement of the Neutron d_2, Towards the Electric χ_E and Magnetic χ_M Color Polarizabilities, will be run in Hall A from approximately October 24, 2008, to March 11, 2009. The two experiments utilize the same targets and experimental setup. The current for these experiments is nominally 30 microamps on a gaseous ^{3}He target and up to 100 microamps on carbon and other solid targets. The energy will be approximately 1.23, 2.4 and 5.9 GeV. Descriptions of the experiments may be found at: http://hallaweb.jlab.org/experiment/transversity and http://hallaweb.jlab.org/experiment/E06-014/index.html.

II. Summary and Conclusions

These experiments together are calculated to use 7.9% of the annual design goal at the Jefferson Lab boundary for a total of **1944** hours run-time. Refer to the attached radiation budget sheets for details. The experiment will be periodically monitored by the Radiation Control Department to ensure that the site boundary goal is not exceeded. The experiment will cause Radiation Areas and may cause High Radiation Areas in the Hall. Periodic access to the target platform during the experiment is expected, and target cell replacement is planned for at least two occasions. **Adherence to this RSAD is vital.**

III. Calculations of Radiation Dose at Site Boundary

The radiation budget for a given experiment is the amount of radiation that is expected at site boundary as a result of a given set of experimental conditions. 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 Department Head, the Director of Jefferson Lab, and the Department of Energy.

The radiation budget for experiment **E06-010, and E06-014**, with Physics Spokesperson Xiaodong Jiang is approximately **0.8 mrem**, or **8%** of Jefferson Lab's annual design goal. The attached spreadsheets detail the calculations.

The Hall's 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 Department (RCD) 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, several actions 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. The RadCon Department will monitor the CARMs and make surveys as necessary to assess the impact of the experiment on radiation levels around the hall.

Any indication that radiation levels outside the hall may exceed the Operations Envelope – 5 mrem/hr dose rate in an occupied space – will require immediate mitigation, with continued operations contingent on a formal review of conditions and operational parameters, and final approval of operations which may exceed this threshold by the Jefferson Lab Facility Manager.

B. From Activation of Target and Beamline Components

1. **Special conditions associated with ^{3}He target cells.** The glass target cells used for this experiment are fragile, and may rupture at any time during the experiment. In an effort to preclude this, based on previous experience with the cells, at least two target cell replacements are planned during the course of the program. These tasks will be coordinated with the RadCon Department. In the event of a cell rupture, mildly activated/contaminated glass fragments may be spread throughout the target enclosure and inside the target oven. Special care is taken to ensure the target enclosure is sealed so that debris does not escape during a rupture event. **In such event, the RadCon department will be notified immediately, and access to the target platform shall be prevented until RadCon assesses the conditions.**

In addition, since the targets are not in a vacuum chamber, an air gap of several tens of cm exists in the target enclosure. This will result in the local production of moderate levels of airborne radioactivity within the target enclosure. **A HEPA-filtered exhaust ventilation system is installed on the enclosure to prevent this radioactivity from having an impact beyond the enclosure, and must be in operation at all times during beam operations. Buildup of contamination inside the enclosure is expected. RadCon will assess contamination levels inside the enclosure each time access is made.**

2. **The Radiation Control Department shall be consulted for all movement of used targets, collimators, and shields.** The Radiation Control Department will assess the radiation exposure conditions and will implement controls as necessary based on the radiological hazards.

3. **There shall be no local manipulation of activated target configurations without direct supervision by the Radiation Control Department.** Remote movement of target configurations is permitted using appropriately reviewed and approved methods.

4. **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 by the Radiation Control Department.

5. **The target chamber area and downstream beamline are expected to become moderately to significantly activated.** No work on this portion of the beamline is to be conducted without RCD review.

6. **This experiment may produce low levels of airborne radioactivity in the hall.** The airborne radioactivity action level (as determined by the AMS-4 monitor for the hall) is 1.0 E-6 uCi/ml. If this level is exceeded, the RadCon Department will meet with the experimenters, the Physics Division Safety Officer and Hall Leader to assess actions that may be needed to ensure airborne radioactivity releases to the environment and the buildup of radioactivity in the hall are minimized.

NOTE: Work planning for all radiological work shall be coordinated through the hall work coordinator (E. Folts) using the ATLis work planning tool.

C. Other Sources

All radioactive materials brought to Jefferson Lab shall be identified to the Radiation Control Department. These materials include, but are not limited to radioactive check sources (of any activity, exempt or nonexempt), previously used targets or radioactive beamline components, previously used shielding or collimators, or He-3 containers. The RCD inventories and tracks all radioactive materials onsite. The Radiation Control Department may survey the experimental setup before experiments begin as a baseline for future measurements if significant residual activity levels are present.

Tanks or cylinders of He-3 containing more than 10 mCi of tritium (H-3) shall not be stored or used in an experimental hall without the express, written permission of the RadCon manager. Any containers of He-3 brought on site shall be assessed for the tritium content before use. Additionally, He-3 containers should not be stored in the experimental hall when not in use.

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

None appears to be necessary. It is up to Physics Division management to consider the potential dose from this experiment and its impact on the annual dose budget.

The RCD Head will notify the Hall Leader and Physics Division Safety Officer of any identified trends which might impact access to the hall or create conditions requiring broad changes to radiological working standards (i.e. General Access RWP revision). The RCD head will recommend engineered or other controls considered necessary to prevent significant degradation of the radiological conditions in the hall.

VI. Operations Procedures

1. **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 Department. A general access RWP governing access to the Halls and the accelerator enclosure must be read and followed by all participants in the experiment. This RWP can be read and electronically signed online at: http://www.jlab.org/div_dept/train/Knowledge_Docs/GAPelec.pdf

2. Any individual with a need to handle radioactive material at Jefferson Lab shall first complete Radiation Worker (RW I) training.

3. **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.

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

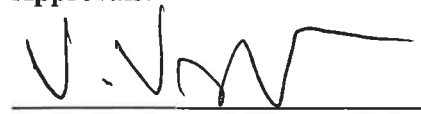
5. **Any requested changes outside of the experimental parameters submitted for the calculation of the radiation budget (i.e., current, energy, target material, target thickness, run time)** for this experiment shall require a formal review by the Radiation Control Department, and a new revision to the RSAD.

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 Civil Aviation Organization (ICAO) 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 Department may be reached at any time through the Accelerator Crew Chief (269-7045) or directly by calling the RadCon Cell Phone (876-1743). On Weekends, Swing Shift, and Owl Shift, requests for RadCon support should be made through the Crew Chief. This will ensure that there is prompt response with no duplication of effort.

Approvals:



Radiation Control Department Head

10/15/2008

Date

Hall: A

RADIATION BUDGET FORM

Exp. # E06-010 **rev:** **run dates: 2008** **name of liaison: Xiaodong Jiang**

setup number			1	2	3	4	5	6	7	8	9	10	11	12	
beam	energy	GeV	1.230	1.230	1.230	1.230	2.400	2.400	2.400	2.400	5.900	5.900	5.900	5.900	*totals:*
	current	uA(CW)	100.0	30.0	30.0	30.0	100.0	30.0	30.0	30.0	100.0	30.0	30.0	30.0	
exp't	element		C	N	H	He[3]	C	N	H	He[3]	C	N	H	He[3]	
target	thickness	mg/cm2	200	465	34	50	200	465	34	50	200	465	34	50	
add'l	element			Si	Si	Si		Si	Si	Si		Si	Si	Si	
target 1	thickness	mg/cm2		24	24	24		24	24	24		24	24	24	
add'l	element			O	O	O		O	O	O		O	O	O	
target 2	thickness	mg/cm2		28	28	28		28	28	28		28	28	28	
add'l	element		Be	Be	Be	Be	Be	Be	Be	Be	Be	Be	Be	Be	
target 3	thickness	mg/cm2	155	155	155	155	155	155	155	155	155	155	155	155	
time	run time	hours	120	48	72	72	48	48	72	48	48	48	72	600	1296
	(100% eff.)	days	5.0	2.0	3.0	3.0	2.0	2.0	3.0	2.0	2.0	2.0	3.0	25.0	54.0
	installation	hours													0
	time	days	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
dose rate at	method 1	urem/hr	0.85	0.57	0.16	0.18	0.95	0.63	0.17	0.20	1.25	0.80	0.22	0.26	
the fence post	method 2	urem/hr													
(run time)	conservative	urem/hr	0.85	0.57	0.16	0.18	0.95	0.63	0.17	0.20	1.25	0.80	0.22	0.26	
dose per setup		urem	102.4	27.4	11.3	13.1	45.8	30.0	12.1	9.7	60.0	38.5	15.6	158.9	524.84
% of annual dose budget		%	1.024	0.274	0.113	0.131	0.458	0.300	0.121	0.097	0.600	0.385	0.156	1.589	5.2484
% of allowed dose for the total time															35.476
% of allowed dose for the run time only															35.476

If > 300%, discuss result with Physics Research EH&S officer

date form issued: July 3, 2008 *authors:* P.Degtiarenko

Hall: A

RADIATION BUDGET FORM

Exp. # E06-014 rev: A run dates: 2008 name of liaison: Xiaodong Jiang

setup number			1	2	3	4	5	6	7	8	9	10	11	12	
beam	energy	GeV	1.230	1.230	1.230	1.230	2.400	2.400	2.400	2.400	5.900	5.900	5.900	5.900	*totals:*
	current	uA(CW)	100.0	30.0	30.0	30.0	100.0	30.0	30.0	30.0	100.0	30.0	30.0	30.0	
exp't	element		C	N	H	He[3]	C	N	H	He[3]	C	N	H	He[3]	
target	thickness	mg/cm2	200	465	34	50	200	465	34	50	200	465	34	50	
add'l	element			Si	Si	Si		Si	Si	Si		Si	Si	Si	
target 1	thickness	mg/cm2		24	24	24		24	24	24		24	24	24	
add'l	element			O	O	O		O	O	O		O	O	O	
target 2	thickness	mg/cm2		28	28	28		28	28	28		28	28	28	
add'l	element		Be	Be	Be	Be	Be	Be	Be	Be	Be	Be	Be	Be	
target 3	thickness	mg/cm2	155	155	155	155	155	155	155	155	155	155	155	155	
time	run time	hours	60	24	36	36	24	24	36	24	24	24	36	300	648
	(100% eff.)	days	2.5	1.0	1.5	1.5	1.0	1.0	1.5	1.0	1.0	1.0	1.5	12.5	27.0
	installation	hours													0
	time	days	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
dose rate at	method 1	urem/hr	0.85	0.57	0.16	0.18	0.95	0.63	0.17	0.20	1.25	0.80	0.22	0.26	
the fence post	method 2	urem/hr													
(run time)	conservative	urem/hr	0.85	0.57	0.16	0.18	0.95	0.63	0.17	0.20	1.25	0.80	0.22	0.26	
dose per setup		urem	51.2	13.7	5.6	6.5	22.9	15.0	6.1	4.8	30.0	19.3	7.8	79.5	262.42
% of annual dose budget		%	0.512	0.137	0.056	0.065	0.229	0.150	0.061	0.048	0.300	0.193	0.078	0.795	2.6242
% of allowed dose for the total time															35.476
% of allowed dose for the run time only															35.476

if > 200%, discuss result with Physics Research EHAS officer

date form issued: July 7, 2008 *authors:* P.Degtiarenko