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 E05-115, Spectroscopic investigation of Λ Hypernuclei in the wide mass region using the (e, e'K^+) reaction will run in Hall C approximately from August 21, 2009 to October 19, 2009. The current for this experiment is up to 50 microamps with Be, C, Li, B, V, Y, Si Cr, Pb, CH_2 and H_2O targets. The energy is 2.344 GeV. A description of the experiment may be found at: http://www.jlab.org/exp_prog/proposals/05/PR05-115.pdf

II. Summary and Conclusions

The experiment is calculated to use **16%** of the annual design goal at the Jefferson Lab boundary for **821** hours run-time. It is anticipated that several manual target element changes will occur, requiring access to the target deck area. The experiment will be periodically monitored by the Radiation Control Group to ensure that the site boundary goal is not exceeded. The experiment is likely to cause Radiation Areas and High Radiation Areas in the Hall. **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 **E05-115**, with Physics Spokespersons J. Reinhold and S.N. Nakamura is approximately **1.6 mrem**, or **16%** of Jefferson Lab's annual design goal. The attached spreadsheet details 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 "UNSAFE", IMMEDIATELY PRESS THE "PUSH TO SAFE" 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. This experiment may create regions of increased radiation outside the hall in areas not normally controlled for radiological purposes. 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.

NOTE:
Calculated dose rates for this experiment are somewhat higher than the design average dose rate goal. Any indication that the levels may exceed the Operations Envelope – 5 mrem/hr dose rate in an occupied area – 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 and Other Materials in the Hall

1. **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.

2. **There shall be no local manipulation of activated target configurations without direct oversight by the Radiation Control Department.** Two or more occasions are planned for the exchange of solid target assemblies. **The Spokesperson or his designee will coordinate these events in advance with the RadCon department Field Operations Coordinator (at least 48 hours) at 876-1743. An RWP will be written for this work which will address the radiological conditions at the time. Persons conducting this work shall have RW-II training.** Remote movement of target configurations is permitted using appropriately reviewed and approved methods.

3. **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.

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

5. **Given the conditions for this experiment, it is expected that High Radation Areas will develop near the target area and beam dump/hall interface.** It is possible that these areas may contain dose rates > 1 rem/hr at 30cm. If such conditions occur, special, positive access control procedures shall be used for all entries to the hall (even if the hall is in Restricted Access). In addition, if general area dose rates in the hall exceed the threshold for Radiation Area posting (5 mrem/hr), the radiological status of the entire hall will be upgraded to that of "Radiation Area", and work in the hall will be governed by specific RWPs.

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

6. This experiment is expected to produce low levels of airborne radioactivity which may impact environmental effluent standards and produce localized or generalized buildup of surface contamination in the hall. Airborne radioactivity concentration in the hall is measured continuously. **If airborne radioactivity concentration as monitored by the AMS-4 air monitor in the experimental hall exceeds an average of 1.0E-6 microCurie/cm^3 for a period of greater than 5 consecutive days**, 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 airborne radioactivity levels to ensure that Jefferson Lab dose to the public from release of airborne radioactivity limits are not exceeded.

7. **Low levels of surface contamination are expected in some areas.** The RCD will monitor for the presence of this hazard as appropriate, and will require administrative controls and/or PPE commensurate with the conditions. **All posted guidance for contamination control must be observed.** Refer to the General Access RWP for details regarding controls for potentially affected systems.

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

This experiment employs an in-hall photon dump, which is locally shielded. This shielding provides mitigation for boundary dose, background rates for experimental equipment, and radiation from residual activation. Alteration to the shielding, or access to the shielded area requires RadCon notification and oversight. Residual activation inside the shielded cave may be significant, and require supplemental shielding around gaps in the main shield. Radiation surveys will be conducted during each access to assess this condition.

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.

This experiment utilizes beryllium, lithium and lead targets, which must remain segregated from other materials upon disassembly. These materials require specific labeling, and when determined to be no longer needed, require special waste disposal processing, and must not be comingled with other wastes. Disposal shall be coordinated with RadCon and Industrial Hygiene as appropriate.

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	8/14/09 Date

RSAD E05-115
Attachment A

Hall: C

RADIATION BUDGET FORM

Exp. # E05-115 /E08-002 rev: A run dates: 2009 name of liaison: S. N. Nakamura

setup number			1	2	3	4	5	6	7	8	9	10	11	12	
beam	energy	GeV	2.344	2.344	2.344	2.344	2.344	2.344	2.344	2.344	2.344	2.344	2.344	2.344	*totals:*
	current	uA(CW)	2.0	10.0	30.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	10.0	10.0	
exp't target	element		CH2	H2O	C	Li	B	Be	Si	Cr	V	Y	BeO	Pb	
	thickness	mg/cm2	460	500	100	100	100	100	100	100	100	100	150	100	
time	run time (100% eff.)	hours	70	40	100	80	60	30	30	150	150	100	1	10	821
		days	2.9	1.7	4.2	3.3	2.5	1.3	1.3	6.3	6.3	4.2	0.0	0.4	34.2
	installation time	hours													0
		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 the fence post (run time)	method 1	urem/hr													
	method 2	urem/hr	0.20	1.01	0.61	0.54	0.60	0.65	1.72	3.06	3.06	4.03	0.22	1.18	
	conservative	urem/hr	0.20	1.01	0.61	0.54	0.60	0.65	1.72	3.06	3.06	4.03	0.22	1.18	
dose per setup		urem	14	40	61	43	36	20	52	459	459	403	0	12	1598.7
% of annual dose budget		%	0.14	0.40	0.61	0.43	0.36	0.20	0.52	4.59	4.59	4.03	0.00	0.12	15.987
% of allowed dose for the total time															170.58
% of allowed dose for the run time only															170.58

If > 200%, discuss result with Physics Research EH&S officer

date form issued: August 10, 2009 *authors:* P Degtiarenko