ES&H DIVISION
RADIATION CONTROL DEPARTMENT

Radiological Safety Analysis Document

Hall D Summer - Fall 2021 Run

E12-10-011 (PRIMEX-eta)

Liaison: L. Pentchev

August 12, 2021

RCD-RSAD-08.12.2021-HD

Priority review level	1
Document classification	4
Next review due	n/a

Submit for approval	☐ yes	☑ no

Thomas

Jefferson

National

Accelerator

Facility

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Hall D Summer - Fall 2021 Run

PRIMEX-eta

(E12-10-011)

RCD-RSAD-08.12.2021-HD

Approval

Keith Welch (Aug 12, 2021 08:10 EDT)

Keith Welch, Manager — Aug 12, 2021 — Date

Radiation Control Department

Preparer/ Reviewer

Pavel Degtiarenko (Aug 12, 2021 10:18 EDT)

Pavel Degtiarenko, Radiation Physicist — Aug 12, 2021 — Date

Radiation Control Department

Preparer/ Reviewer

Lorenzo Zana (Aug 12, 2021 11:03 EDT)

Lorenzo Zana, Radiation Physicist — Aug 12, 2021 — Date

Radiation Control Department

Preparer/ Reviewer

Lubomir Pentchev (Aug 12, 2021 11:43 EDT)

Lubomir Pentchev, Staff Scientist — Aug 12, 2021 — Date

Hall D

Contents

This Radiological Safety Analysis Document (RSAD) identifies the general conditions and controls with regard to production, movement, or import of radioactive materials.

1 DESCRIPTION

The summer-fall Hall D PRIMEX-eta run is scheduled from 08-23-2021 to 10-16-2021 with a total running time of 55 days. It will utilize up to 12 GeV electron beam. Maximum beam current will not exceed 600 nA, with most running at 320 nA or less (see Table 1).

The PRIMEX-eta experiment will run in a configuration different from the standard GlueX run. The differences include:

- the solenoid in Hall D will be turned off during much of the experiment; some data will be taken with the magnet switched on
- a beam pipe between the FCAL and CCAL filled with He will be installed downstream of the FCAL
- only aluminum radiators will be used
- liquid Helium 30 cm long (3.9% X_0), and Be 17.8 mm (5% X_0) targets will be used
- a lead shielding wall (4″ along the beam, 24″ in X and 18″ in Y) will be installed around the beam pipe in front of the solenoid magnet. The CompCal will be used similar to Dec 2019 run.

Table 1. Hall D fall 2021 run plan

Radiator	Current (nA)	Total Time	Comment*
$1x10^{-4}$ X_0 Al	$\leq$ 320	30.8 days	30 cm liquid helium target
$1x10^{-4}$ X_0 Al	$\leq$ 320	13.2 day	empty liquid helium target
$1x10^{-4}$ X_0 Al	$\leq$ 320	1 day	no target cell
$1x10^{-4}$ X_0 Al	$\leq$ 320	5 days	1.78 cm beryllium target
$0.2x10^{-4}$ X_0 Al	$\leq$ 2	3 days	CompCal and PS calibration
$1x10^{-4}$ X_0 Al	$\leq$ 600	0.5 days	30 cm liquid helium target

* standard running conditions

2 SUMMARY and CONCLUSIONS

The 2021 PRIMEX-eta Hall D run is not expected to produce significant levels of radiation at the site boundary. However, it will be continuously monitored by the Radiation Control Department (RCD) to ensure that the site boundary goal is not exceeded. Activation of targets, collimators, and beam line hardware must also be considered. As specified in Sections 4 and 7, the manipulation and/or handling of targets and beam line hardware (potentially radioactive material), the transfer of radioactive material, or modifications to the beam line downstream of the target assembly must be reviewed and approved by the RCD.

Adherence to this RSAD is vital.

3 CALCULATIONS of RADIATION DEPOSITED in the EXPERIMENTAL HALL

The radiation budget for a given experiment is the amount of radiation expected at the site boundary as a result of a given set of experiments. This budget may be specified in terms of mrem at the site boundary or

as a percentage of the Jefferson Lab design goal (10 mrem per year) for dose to the public. 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 RCD Manager (RCM), and the TJNAF Director.

Comparison of the 2019 and 2021 PRIMEX-eta beam configuration parameters, as well as those used in the *Shielding Basis for Hall D Complex* (JLAB-TN-08-033), indicate that PRIMEX-eta will have acceptably low contribution to the site boundary dose. Use of helium and beryllium targets is not standard in Hall D.

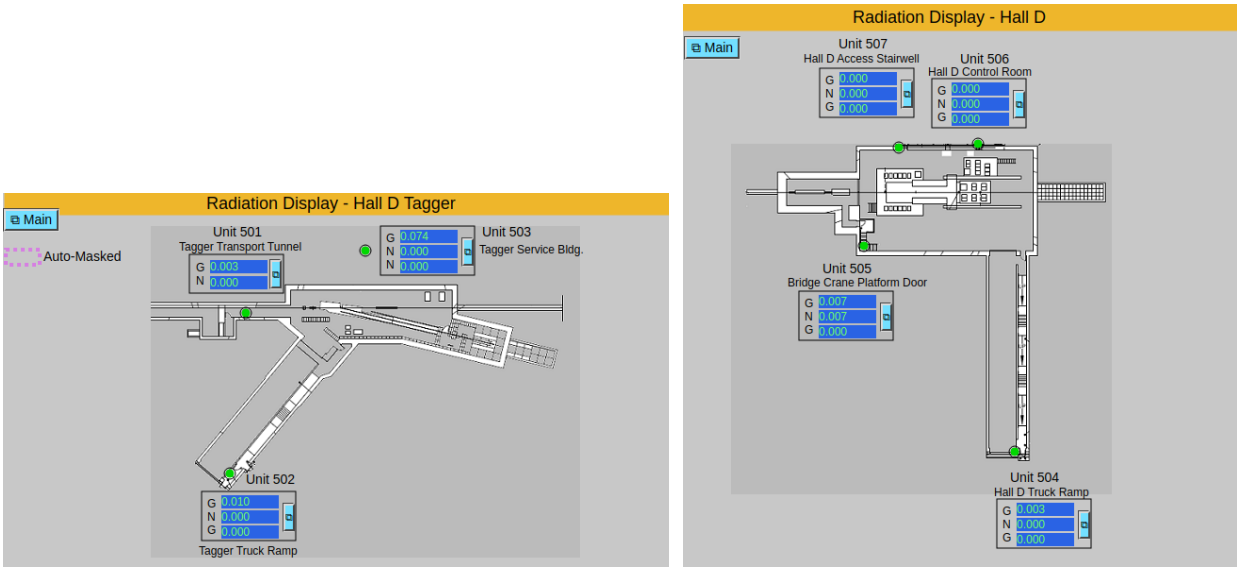

Figure 1. Hall D monitors and locations

Running Hall D with nuclear targets, and with the 300 cm-long vacuum section in the beam dump line removed, is expected to produce noticeably larger neutron dose rates per beam current (on the same radiator), compared with the standard LH2 target. However, the maximum beam current for these runs will be significantly lower than in the standard GlueX experiment conditions, and the contribution to the dose-rate accumulation at the boundary is expected to be small. Confirmation of these observations can be found in the 2019 PRIMEX-eta run that began around February 25, 2019 after a short run that used the standard GLUEX configuration with a 30 cm liquid hydrogen target. (Refer to Figures 1, 2 and 3.)

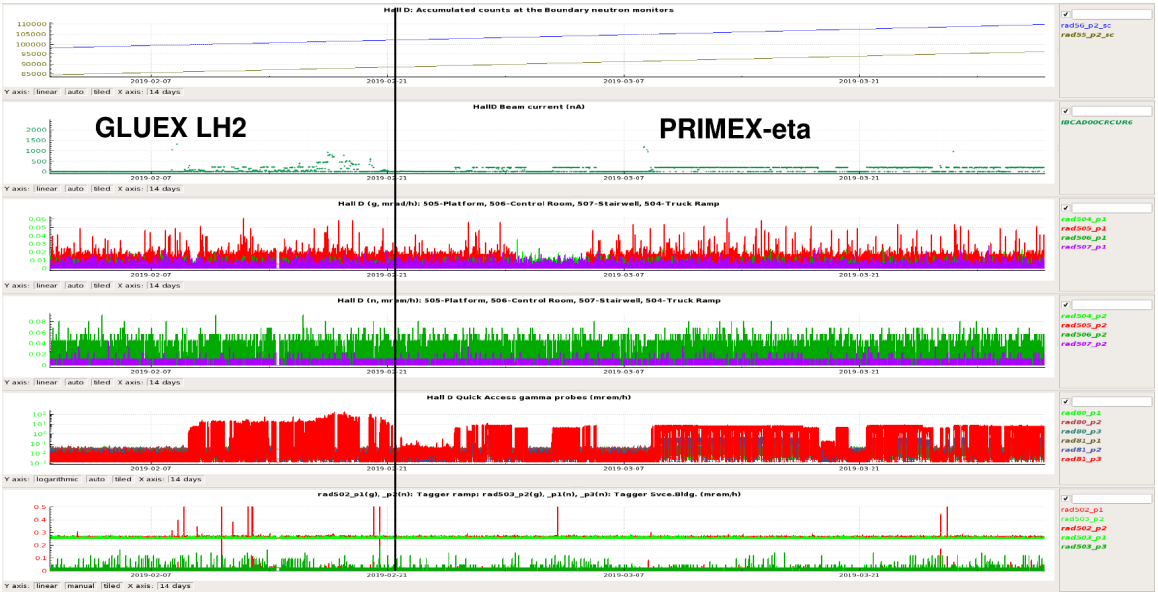

Figure 2. Radiation levels during standard GLUEX operation (2019) compared to PRIMEX-eta run (February 25, 2019; note that the only day with a beryllium target run was February 26, 2019).

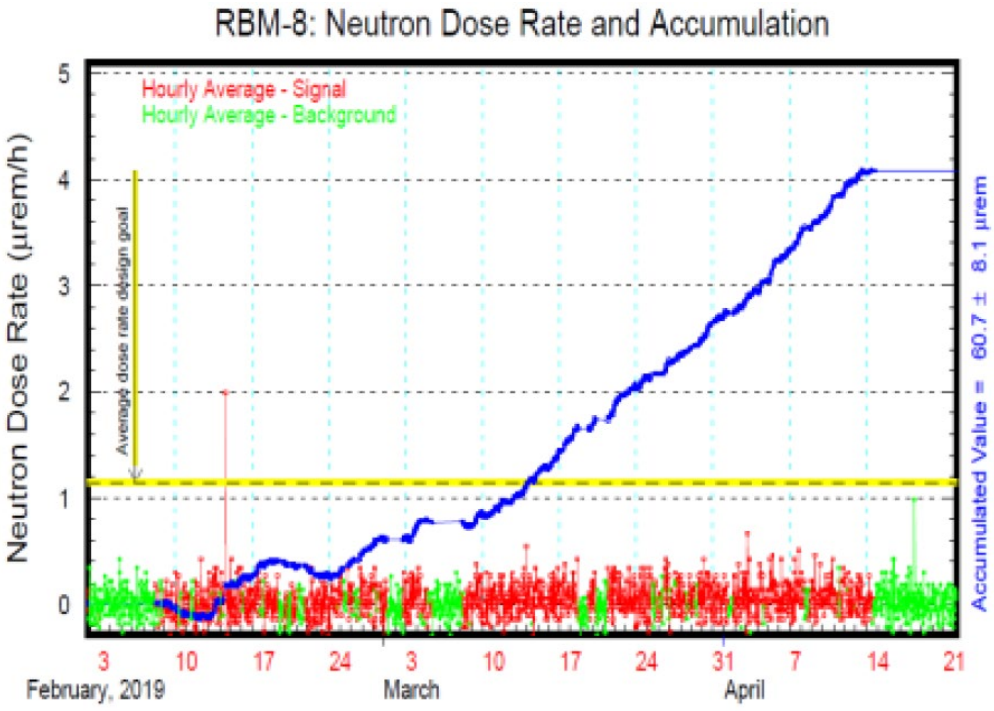

Figure 3. Boundary dose at RBM-8 (placed specifically to monitor HD radiation production) during 2019 PRIMEX-eta run

- yellow: design limit for dose-rate hourly average
- blue: accumulated dose (60.7+/- 8.1µrem) at boundary during full experimental period which included PRIMEX-eta run
- accumulated dose was well below Jefferson Lab limit of 10 mrem for the year

Expectation of the small contribution of Hall D runs to the boundary dose accumulation will be verified during the experiment using active site boundary monitors. If the measured radiation levels at the boundary are significantly higher than expected, the RCD will require a meeting with the experimenters and the Head of the Physics Division to determine if the run conditions are accurate, and to assess what actions may reduce dose rates at the site boundary. If the site boundary dose approaches or exceeds 10 mrem during any calendar year, the run program will cease until a resolution can be reached.

4 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 TJNAFs and the experimenter's home institution policies.

4.1 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 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. The Radiation Control Department will monitor the CARMs and make surveys as necessary to assess the impact of the experiment on radiation levels around the hall.

> **Note:** Any indication that the levels may exceed 5 mrem/h 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 exceeding this threshold by the Jefferson Lab RCM, in consult with Physics and Accelerator Division Safety Officers.

4.2 Activation of Target and Beamline Components and with Other Materials in the Hall

All radioactive materials brought to Jefferson Lab shall be identified and reported to the RCD. These materials include, but are not limited to radioactive check sources (of any activity, exempt or non-exempt), previously used targets or radioactive beam line components, or previously used shielding or collimators. The RCD inventories and tracks all radioactive materials onsite.

The RCD will coordinate all movement of used targets, collimators, and shields; and, will assess the radiation exposure conditions and implement controls, as necessary, based on the radiological hazards.

There shall be no local movement of activated target configurations without direct supervision by the RCD.

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

Some sections of beamline may contain indium gaskets/seals. These components should always be considered potentially contaminated. Always consult with RCD prior to disassembling any beamline components incorporating indium seals.

5 INCREMENTAL SHIELDING or OTHER MEASURES to REDUCE RADIATION HAZARDS

None

6 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, Radiological Work Permits (RWP), 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: https://misportal.jlab.org/railsForms/rad_work_permits/108811/briefing.

- Any individual with a need to handle radioactive material at Jefferson Lab shall first successfully complete Radiation Worker Level 1 (RW-I) training.

- 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 radiator and the target are well known. Exceeding these power restrictions may lead to excessive and unnecessary contamination, activation, and personnel exposure.

- The radiator assembly and the downstream beam line components may not be altered outside the scope of this RSAD without formal RCD review. Alteration of these components may increase radiation production in the Hall and subsequently increase dose at the site boundary.

- Radiological work permits are the standard work authorization documents used to control radiological work. RadCon will require RWPs based on established trigger levels.

- Standard RSAD controls apply; the RCD shall be contacted for any of the following activities.
  - Entry to Radiation Areas or High Radiation Areas
  - Movement of shielding or collimators
  - Breaching the target chamber physical envelope
  - Any work on beamline components downstream of the target
  - Maintenance of known or potentially contaminated systems
  - Any destructive modifications to activated components (drilling, cutting, welding, etc.)

All posted guidance and instructions for contamination controls, shielding configuration, and access to radiological areas must be adhered to.

Note: Work planning for all radiological work shall be coordinated through the hall work coordinator using the ATLis work planning tool.

7 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 returned to the experimenter's home institution for final disposition.

All transportation shall be conducted in accordance with United States Department of Transportation Regulations (Title 49, Code of Federal 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 transfer of funds for disposal of the material. TJNAF cannot indefinitely store radioactive targets and experimental equipment.

8 RADIATION DAMAGE to HALL D ELECTRONICS

Due to the low overall beam power planned to be delivered to the Hall during the PRIMEX-eta 2021 run, no problems are anticipated with respect to radiation damage to the electronics, including the most vulnerable silicon photomultipliers.

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, and owl shifts, requests for RadCon support should be made through the Crew Chief. This will ensure prompt response with no duplication of effort.

Final RCD-RSAD-08.12.2021-HD PRIMEX-eta KW PD LZ LP ja

Final Audit Report 2021-08-12

Created:	2021-08-12
By:	Jennifer Allen (allenj@jlab.org)
Status:	Signed
Transaction ID:	CBJCHBCAABAAY1-kXgUwzeN3cUjB3f66qNtrAq8nKu4W

"Final RCD-RSAD-08.12.2021-HD PRIMEX-eta KW PD LZ LP ja" History

Document created by Jennifer Allen (allenj@jlab.org)
2021-08-12 - 11:15:35 AM GMT- IP address: 129.57.82.228

Document emailed to Keith Welch (welch@jlab.org) for signature
2021-08-12 - 11:17:48 AM GMT

Email viewed by Keith Welch (welch@jlab.org)
2021-08-12 - 12:08:37 PM GMT- IP address: 108.17.152.205

Document e-signed by Keith Welch (welch@jlab.org)
Signature Date: 2021-08-12 - 12:10:14 PM GMT - Time Source: server- IP address: 108.17.152.205

Document emailed to Pavel Degtiarenko (pavel@jlab.org) for signature
2021-08-12 - 12:10:16 PM GMT

Email viewed by Pavel Degtiarenko (pavel@jlab.org)
2021-08-12 - 2:18:01 PM GMT- IP address: 129.57.236.141

Document e-signed by Pavel Degtiarenko (pavel@jlab.org)
Signature Date: 2021-08-12 - 2:18:48 PM GMT - Time Source: server- IP address: 129.57.236.141

Document emailed to Lorenzo Zana (zana@jlab.org) for signature
2021-08-12 - 2:18:50 PM GMT

Email viewed by Lorenzo Zana (zana@jlab.org)
2021-08-12 - 3:00:58 PM GMT- IP address: 74.99.91.241

Document e-signed by Lorenzo Zana (zana@jlab.org)
Signature Date: 2021-08-12 - 3:03:37 PM GMT - Time Source: server- IP address: 74.99.91.241

Document emailed to Lubomir Pentchev (pentchev@jlab.org) for signature

2021-08-12 - 3:03:39 PM GMT

Email viewed by Lubomir Pentchev (pentchev@jlab.org)

2021-08-12 - 3:32:51 PM GMT- IP address: 129.57.50.167

Document e-signed by Lubomir Pentchev (pentchev@jlab.org)

Signature Date: 2021-08-12 - 3:43:09 PM GMT - Time Source: server- IP address: 129.57.50.167

Agreement completed.

2021-08-12 - 3:43:09 PM GMT