1. Introduction

The goal of the radiation surveys is to verify that no radiation from AMO operation is detectable outside the Hutch 1 shielding or penetrations.

A minimum of two surveys are required: one upon initial beam operation (“first light”), and one comprehensive survey when full beam intensity has reached the downstream end of the AMO beamline. Additional surveys may be required, if the time needed to reach full intensity at the end of the beamline exceeds one day.

2. Requirements for the Survey

2.1 Time requirement

Each survey will require approximately 1 hour of beam time.

2.2 Personnel requirements

Four personnel from Radiation Protection (all located in the field) are required. At least one member of this team must be from Radiation Physics.

2.3 Posting requirements

RPFO is responsible for posting and deposing. The areas to be posted (see Figures 1 and 2) are as follows:
1. NEH Hutch 1.
2. NEH Hutch 2. (Alternatively, just the west-most one meter of NEH Hutch 2.)
3. The NEH sub-basement hallway within one meter of the lateral wall of Hutch 1.
4. Mechanical Room 2.
5. The Laser Bay. (Alternatively, just the west-most 7.5 feet of the Laser Bay.)

The sign used shall be the new design that addresses the findings of the RIR for the FEE survey incident (see Figure 3). It shall specify that only those personnel with written authorization from the NEH Area Manager or the AMO Primary Instrument Scientist may enter the posted areas. A list of the personnel authorized to enter (including Radiation Protection) shall be posted alongside the sign. The proposed template for this list is shown in Figure 4.

2.4 Sweeping requirements

There will be no guards posted during the survey. The Floor Coordinators and Laser Bay personnel will be asked to make periodic sweeps to check for unauthorized personnel inside the posted areas.

2.5 Requirements for safety of personnel entering the posted area

1. The laser safety shutters between the Laser Bay and Hutch 1 shall be closed during the survey.
2. For entry to the Laser Bay, the surveyors shall be escorted by a Qualified Laser Operator and shall wear all required laser PPE.
3. Access Requirements: Every person entering the posted area must have written authorization from the NEH Area Manager or the AMO Primary Instrument Scientist. In addition, personnel performing the survey must have:
   a. RWT-I training.
   b. Any additional training (e.g., Green Dot) required for NEH entry at the time of the survey.
   c. Attendance at the Pre-Job Briefing or an escort who attended the Pre-Job Briefing.
   d. The dosimetry prescribed in item 4 below.
   e. All PPE required for NEH access at the time of the survey.
4. Dosimetry: All surveyors shall wear a Rados electronic dosimeter along with their personnel dosimeter. The Radoses shall be set to alarm at a dose rate of 1.0 mrem/h.

2.6 Hold Points

The Hutch 1 stoppers shall be inserted, survey activity shall cease, the survey area shall be vacated, and the procedure re-examined, if any of the following hold points are reached:
1. A dose rate \( \geq 1.0 \) mrem/h is measured.
2. An unauthorized person is found within the posted area.

2.7 Active monitoring requirements

For the Comprehensive Survey, a thin-window GM probe shall be placed inside Hutch 1, on the vacuum chamber in which the beam terminates (this is most likely the Diagnostics Chamber). A readout instrument shall be placed outside the hutch, and a cable long
enough to connect the probe to the readout instrument (minimum length 20 feet) shall be included.

2.8 Survey Instruments, Materials and Supplies

1. Five thin-window GM-detector survey instruments with energy threshold below 2 keV [exact devices to be determined].
2. One (or two, if available) telescoping pole(s), one (or two, if available) ~13 foot GM probe cable(s), and two stepstools to allow GM probes to reach the Hutch 1 penetrations that are just below the ceiling.
3. One Inovision 450-B or 451-B ion chamber (with open window).

2.9 Recording Requirements

Any count rate or dose rate above background shall be recorded, along with the beam conditions in effect at the time of the measurement.

2.10 Dose estimates

Given the hold point (1.0 mrem/h), the number of surveyors (4), and the length of the survey (1 hour), the maximum collective dose for each survey is 4 mrem. The maximum individual dose is 1 mrem. The expected dose is negligible.

2.11 Beam Conditions

1. For first-light survey and mid-tuning surveys: whatever beam conditions are in effect at the time (with AMO beam on).
2. For the comprehensive survey after tuning is complete:
   a. For the main part of the survey:
      i. FEL fundamental at 2 keV.
      ii. Full electron beam power allowed by the undulator BAS.
      iii. Full bunch repetition rate allowed by the undulator BAS.
      iv. Full FEL production (all possible undulators in the beam).
      v. Full photon beam intensity (no attenuation).
      vi. Pulse Picker set to allow all pulses to pass through.
      viii. KB mirrors in nominal configuration (or out of the beam entirely).
      ix. Beam terminating on beam stop in Diagnostics Chamber, if possible. Otherwise, beam terminating anywhere between the Pulse Picker and the Diagnostics Chamber.
   b. For additional measurements from the in-hutch GM probe:
      i. Beam terminating on Four-Jaw Slits for 5 minutes.
      ii. Beam (all pulses) terminating on Pulse Picker for 5 minutes.

2.12 Areas to be Surveyed

The areas to be surveyed (shown in yellow in Figures 1 and 2) are as follows:

1. Hutch 1 lateral (north) wall.
2. Hutch 1 downstream (east) wall. (Inside Hutch 2.)
3. Hutch 1 roof (floor of Mechanical Room 2, and upstream-most 7.5 feet of floor of Laser Bay).

Special attention shall be paid to Hutch 1 doors, penetrations, seams, and the bottom edge of the Hutch 1 lateral wall.
Figure 1. Location of survey posting on Experimental Floor (NEH sub-basement). The posting is shown as a dashed red line. The area to be surveyed is highlighted in yellow.
Figure 2. Location of survey posting on NEH basement level (floor above hutches). The posting is shown as a dashed red line. The area to be surveyed is highlighted in yellow.
Figure 3. Example posting to be used for AMO radiation surveys.
I authorize the following personnel to enter the posted radiation survey area.

_____________________________________             ____________________
Hal Tompkins or John Bozek                                  Date

1. Zoe Van Hoover
2. Hal Tompkins
3. John Bozek
4. The Radiation Protection Department
5.
6.
7.
8.
9.
10.
11.
12.

Additional personnel authorized to enter:

_________________________________             _______________________________
Name                                              Authorized by (signature)

_________________________________             _______________________________
Name                                              Authorized by (signature)

_________________________________             _______________________________
Name                                              Authorized by (signature)

_________________________________             _______________________________
Name                                              Authorized by (signature)

_________________________________             _______________________________
Name                                              Authorized by (signature)

Figure 4. Proposed template for list of personnel authorized to enter posted area. The numbered list is populated in advance of the survey by the NEH Area Manager and/or the AMO Primary Instrument Scientist. The spaces at the bottom of the form allow for additional personnel to be authorized at a later time if the need arises.