**NUREG 1556 Vol. 6, Rev. 1 Appendix C**

## ITEM 5: Radioactive Material

### Sealed Sources and Devices

The G150 irradiator manufactured by Hopewell Design's, Inc. (HDI) was commissioned and approved for use by the NIST Ionizing Radiation Safety Committee (IRSC) and Radiation Safety Officer (RSO) under the SNM-362 license in 2015. This irradiator device will be moved from room XXXX to the new 10 CFR Part 36 facility in room XXXXXXX in Building 245. The G150 irradiator contains two Co-60 sealed sources in one encapsulation. The G150 irradiator housing is a custom-built device for NIST and consists of tungsten and lead shielding. The sealed sources are approved on the U.S. NRC Registry of Sealed Sources and Devices and are used with the conditions specified in the registration certificate. Each sealed source is registered with the National Source Tracking System.

| | Manufacturer or Distributor | Model | Radionuclide | Maximum Activity | Sealed Source and Device Registration Number |
|---|---|---|---|---|---|
| Irradiator Device | Hopewell Designs, Inc. | G150 | N/A | N/A | N/A |
| Sealed Source | International Isotopes Idaho, Inc. | INIS-SF-3.2-3-K | Co-60 | XXX TBq (XXXX Ci) | NR-1235-S-101-S |
| Sealed Source | International Isotopes Idaho, Inc. | INIS-SF-3.2-3-K | Co-60 | XXX TBq (XXXX Ci) | NR-1235-S-101-S |

### Irradiator Transfer, Installation, and Acceptance Testing Coordination

NIST shall coordinate with NRC Region 1 and NRC Headquarters in a timely manner to provide NRC inspectors the opportunity to participate in the G150 irradiator installation and commissioning project. NRC Region 1 and/or Headquarters representatives will be offered the opportunity to visit the NIST Gaithersburg campus to observe any aspect of the following: G150 irradiator transfer from room XXXX in building 245 to the new 10 CFR Part 36 facility in the H-Wing, XXXX, the installation of the G150 irradiator in XXXX, and/or the acceptance testing for the new Part 36 irradiator facility.

The transfer of the G150 irradiator from the old Part 36 facility to the new Part 36 facility, the installation of the G150 irradiator in XXXX, and the acceptance testing for the new Part 36 facility will all be performed by Hopewell Designs Inc. (HDI) under their state of Georgia agreement state license (GA 1434-1) and under NRC reciprocity on the NIST Gaithersburg campus via an approved NRC Form 241. The NIST Radiation Safety Officer and the Radiation Safety Division shall provide oversight of all HDI activities at NIST and associated radiation safety requirements to ensure all safety and security requirements are met in accordance with (IAW) 10 CFR 36 and 10 CFR 37.

**Financial Assurance and Recordkeeping for Decommissioning**

Pursuant to 10 CFR 30.35(g), NIST has and will continue to maintain records important to decommissioning and transfer these records to the NRC, before licensed activities are transferred or assigned, in accordance with10 CFR 30.34(b). Furthermore, pursuant to 10 CFR 30.51(f), prior to license termination, we will forward the records required by 10 CFR 30.35(g) to the appropriate NRC regional office before the license is terminated.

NIST has submitted evidence of financial assurance following the guidance of NUREG–1757, Volume 3, Revision 1, 'Consolidated Decommissioning Guidance: Financial Assurance, Recordkeeping and Timeliness'. The last submittal occurred in December 2019, which accounted for the G150 irradiator. The most recent financial assurance submission for the SNM-362 license was approved by the NRC on 4/3/2020 in ML20085G151.

**ITEM 6: Purpose(s) for Which Licensed Material Will Be Used**

NIST's primary mission is as a measurement science, standards, and technology laboratory. This SNM-362 license authorizes use of radiation sources for research and development, calibration and testing, and training activities. Authorized uses for the G150 irradiator are the irradiation of devices and dosimeters for the development and maintenance of radiation measurement standards, and the provision of radiation measurement services. There will be no irradiation of explosives and no irradiation of more than small quantities of flammable materials with a flash point below 60° C [140° F] without specific written authorization from the NRC.

**ITEM 7: Individuals Responsible for Radiation Safety Program**

**Radiation Safety Officer (RSO) Training and Experience**

The NIST Radiation Safety Officer for the SNM-362 license is Manuel Mejias. As indicated in the NRC issued Safety Evaluation Report ML17109A121, the NRC found that NIST had provided complete documentation, as required by License Condition 10, and that Mr. Mejias's extensive experience, education, and training in the radiation field, and at NIST's radiation safety program, adequately demonstrate that he possesses the qualifications and resources to oversee the safe operation of the facility. Manuel Mejias was approved as the NIST Radiation Safety Officer by the NRC on Amendment 8 of the SNM-362 license on 5/12/2017 in ML17109A117.

## ITEM 8: Individuals Working in or Frequenting Restricted Areas

**Initial Training and Experience for Irradiator Operators**

The training for irradiator operators at NIST Gaithersburg that operate 10 CFR Part 36 irradiators complies with the requirements of 10 CFR 36.51(a), (b), and (c), and the guidance from NUREG 1556 Volume 6.

The initial irradiator operator training, on-the-job training, annual safety reviews, means to test the operator's understanding, the experience and training for the trainers, and the experience required for irradiator operators at NIST Gaithersburg was previously submitted to the NRC with NIST's RAI response letter dated October 25, 2012 (ADAMS Accession No. ML12313A127). The irradiator operator training requirements at NIST were approved by the NRC in the last SNM-362 license renewal on 9/11/2013 in ML13207A206.

Annual Performance Evaluations

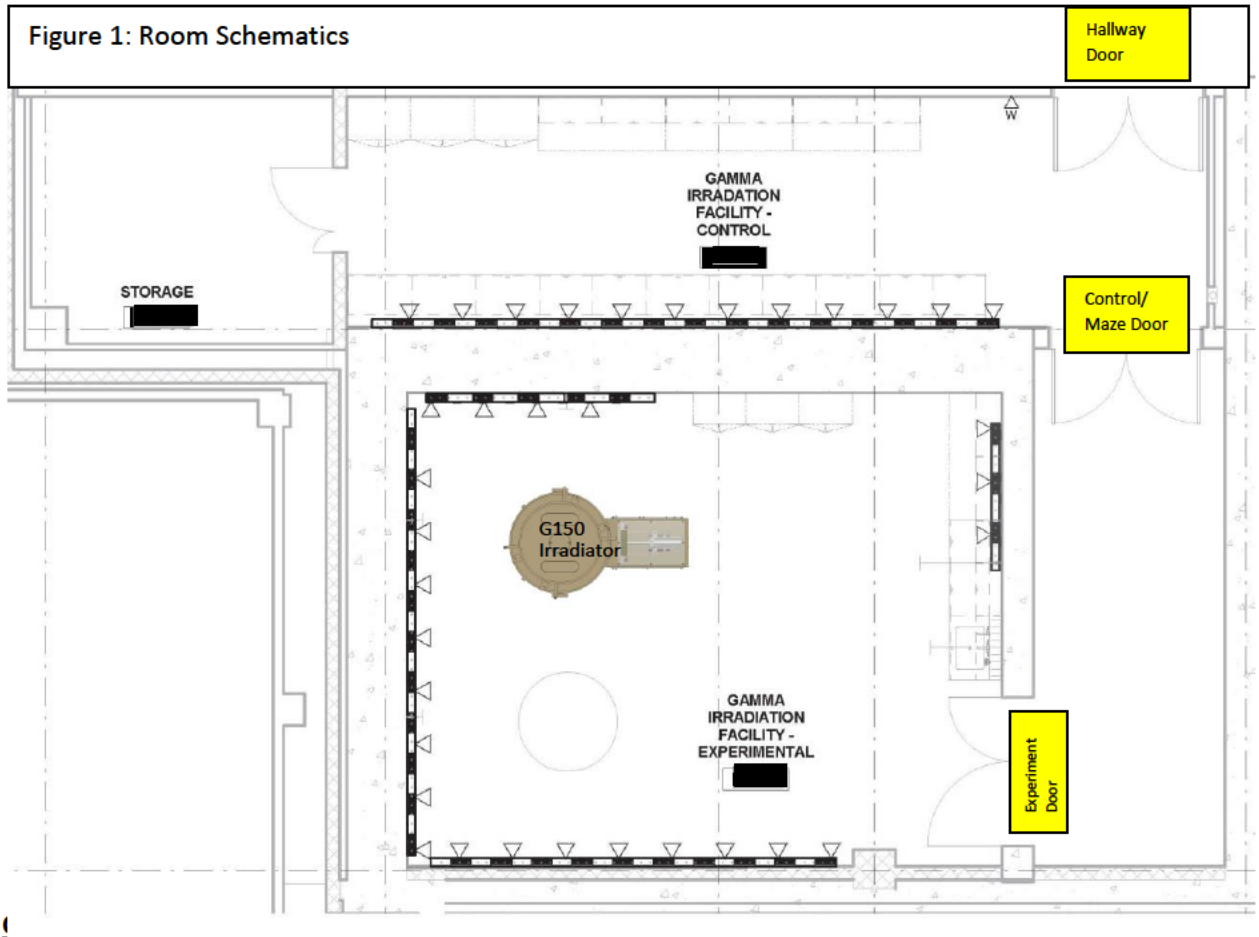
The annual performance evaluations of the Part 36 irradiator operators, required by 36.51(e), are conducted by the Source Custodian/Radiation Facility Owner for the Part 36 facilities. The performance evaluations observe for the safe operation of the irradiator to ensure, regulatory, license, procedural, and safety requirements are being met by the irradiator operator. These activities are overseen by the health physicists in the Radiation Safety Division.

## ITEM 9: Facilities and Equipment

### General Description of the Facility and Site

The G150 gamma-ray beam facility (also known as Gamma IR) is in room XXXX in the basement of the new H-Wing attached to building 245 on the NIST campus. The facility is accessed through a *Hallway Door* as shown in Figure 1. The facility is used for performing radiation measurements in support of the dosimetry program of the Radiation Physics Division. The room is divided in two main areas: a control room labeled H007 and the irradiator room labeled XXXX as shown in Fig. 1. Both the control and irradiator areas are connected through a narrow maze area shown in Figure 1 with one door between the control and maze area (referred to hereafter as *Control/Maze Door*) and a second door between the maze and irradiator area (referred to hereafter as *Experiment Door*). The irradiator area has two cylindrical pits in the floor of about 2 m deep and 1.4 m in diameter. Aluminum grates cover the pits and are placed at the finished floor level. The G150 irradiator, composed of the main shield and collimator assembly, is mounted from two parallel structural I-beams located near the ceiling with the bottom face of the I-beam located at a height of 3.2 m (126 inches) from the finished floor. The inner faces of the two parallel I-beams are separated by a distance of 1 m (39.5 inches). The I-beams are integrated with the room construction and were designed to hold the weight of two irradiators of 10,000 lb per unit centered with each one of the pits. The total weight of the G150 irradiator (irradiator shield and collimator assembly) is 8,000 lb. and it is centered at approximately 2.2 m above the pit next to the North Wall of the room (the wall that separates the irradiator area and the control area).

Figure 1: Room Schematics




Commencement of construction of the new Part 36 facility, the Gamma IR facility in the building 245 H-wing was previously approved by the US NRC via SNM-362 Amendment 9 on 11/21/2017 in ML17306A942.

**Site-specific testing frequency of all systems listed in 10 CFR 36.61, "Inspection and maintenance"**
The testing frequency of the safety systems IAW 10 CFR 36.61 is described in and was approved in Item 10 in SNM-632 license Amendment 5 IAW the application letter dated December 27, 2013. The site-specific testing IAW 10 CFR 36.61 was approved by the NRC on 1/27/2014 in ML14016A344.

## Access Control

The G150 gamma-ray beam facility has several access controls and safety alarms systems to prevent exposure and inadvertent entry into the radiation room when the sources are not in the shielded position. These access controls are listed below.

ACCESS CONTROLS

- The entrance to the G150 facility defined by the *Hallway Door* (see Figure 1) is equipped with a security system that is monitored 24/7 by the NIST police office. An alarm will be generated in the NIST Emergency Center (dispatch center) in the event of unauthorized access to rooms XXXX (control area) and/or room XXXX (irradiator area).

- The electrically operated *Experiment Door* (see Figure 1) is integrated with a radiation area monitor (ARM #2) whose purpose is to monitor continuously radiation and keep the door closed if there is radiation present in the irradiator room, preventing in this way access to the irradiator area when there is radiation in the room.

- An emergency push button is located in the irradiator area near the access door to allow opening at any time the *Experiment Door* separating the irradiator area from the maze area and prevent anyone from being trapped inside the irradiator area.

- The facility is designed so that the key that controls the *Experiment Door* connecting the irradiator and maze area is the same key that is used to enable the control panel that operates the irradiator. This key design ensures that the irradiator can only be operated if the key used to unlock the *Experiment Door* is inserted into the irradiator control panel. As a result, the doors cannot be opened if the irradiator is being operated and it is in the unshielded position (radiation present in the irradiator area) since the key that operates the door is captured at the console (cannot be removed). If the key is removed from the console the irradiator will return to the safe condition. Ref: 10 CFR Part 36 Section 36.31.

- The key that is used to operate the control panel and open the shutter is designed so it remains captured (cannot be removed from the control unit) when the irradiator is in the unshielded position. Ref: 10 CFR Part 36 Section 36.31.

- The SNM-362 license currently has an approved exemption to 10 CFR 36.31(a) as follows:

| SNM-362 License Item No. | Regulatory Reference | Part 36 Exemption |
|---|---|---|
| 17 | 10 CFR 36.31(a) | the licensee is exempt from the requirements that (1) the console key must be attached to a portable radiation survey meter by a chain or cable, and (2) the door to the radiation room must require the same key used for source movement (i.e., control console key). |

- Both, the *Experiment Door* and the *Control/Maze Door* (see Figure 1) are equipped with a double set of door interlocks which form part of the door interlock safety system and will immediately return the shutter to its safe condition in the event that the doors are opened while the irradiator is in the unshielded condition (radiation present in the irradiator area). In addition, if the doors are opened when there is radiation present, a visible and audible alarm is activated to make the individual entering the room aware of the hazard. Ref: 10 CFR Part 36 Section 36.23 (b) and 36.23 (c)

- The SNM-362 license currently has approved exemptions to 10 CRF 36.23(b) and 36. 23(c) as follows:

| SNM-362 License Item No. | Regulatory Reference | Part 36 Exemption |
|---|---|---|
| 12 | 10 CFR 36.23(b) | the licensee is exempt from the requirements that: (1) detection of entry, by an independent backup access control, while the sources are exposed must cause the sources to return to their fully shielded position and must also activate a visible and audible alarm to make the individual entering the room aware of the hazard, and (2) the alarm must alert at least one other individual who is onsite of the entry. When an operator is not present the licensee shall arm the independent backup access control system identified in the licensee's letter dated March 5, 2013. |
| 13 | 10 CFR 36.23(c) | the licensee is exempt from the requirements that attempted personnel entry while the monitor measures high radiation levels, must activate the alarm described in 10 CFR 36.23(b). The license shall comply with 10 CFR 35.615(b). |

**SNM-362 License Exemptions**

NIST does not intend to request any changes to the approved exemptions to 10 CFR Part 36 in the SNM-362 license. The exemptions were approved by the NRC in the last SNM-362 license renewal on 9/11/2013 in ML13207A206.

**Site-specific testing frequency for the access control system IAW 10 CFR 36.61**

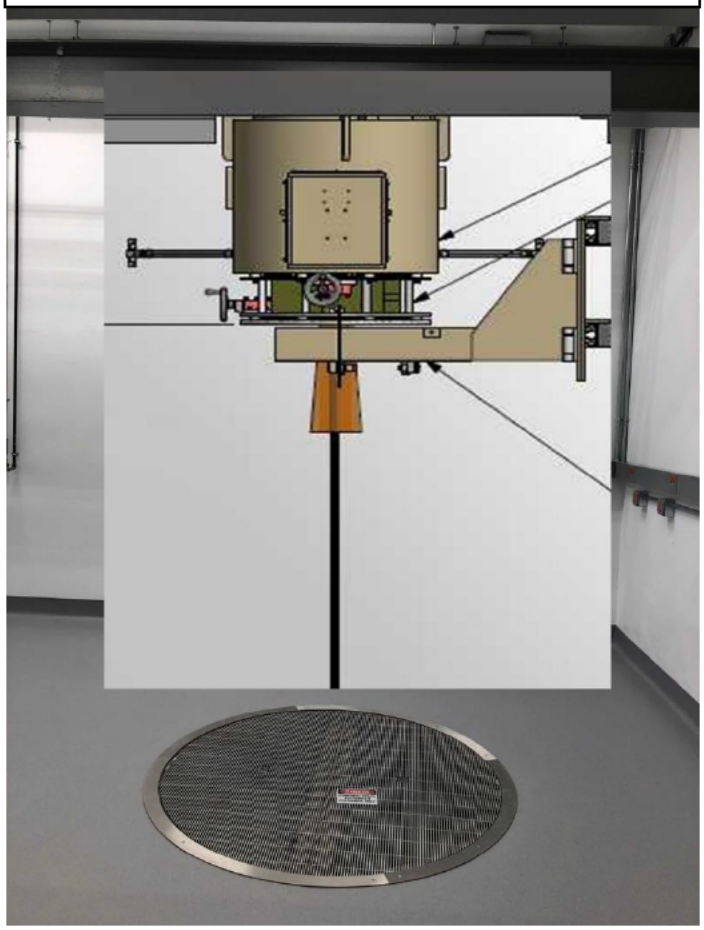
The site-specific testing frequency of the access control system IAW 10 CFR 36.61 as it relates to 10 CFR 36.23 is described in and was approved in Item 10 in SNM-632 license Amendment 5 IAW the application letter dated December 27, 2013. The site-specific testing IAW 10 CFR 36.61 was approved by the NRC on 1/27/2014 in ML14016A344.

**Shielding**

Fig. 2 shows a schematic of the G150 irradiator unit. In the unshielded position (radiation present), a vertical collimated beam of gamma-rays emerges from the bottom of the irradiator aiming towards the bottom of the pit. The field size of the gamma-ray beam is approximately 15 cm x 15 cm at a distance of 1 m from the center of the $^{60}$Co radioactive source located inside the irradiator housing.

The $^{60}$Co radioactive source is enclosed in a small welded shut doubly encapsulated stainless-steel tube that is permanently fixed inside the irradiator body. No parts of the source nor the source encapsulation can be accessed from the outside. The source in its doubly encapsulated tube is heavily shielded by the irradiator cylindrical housing shown in Fig. 2 which is mostly made of lead and tungsten material and provides the radiation shielding. The shielding is essentially the main contributor to the total 7,000 lb. weight of the irradiator housing. The cylindrical housing is approximately 29 inches high and 27 inches in diameter. The collimator assembly mounted immediately below the irradiator housing adds approximately an additional 8 inches in height to the irradiator unit. The unique design of the G150 irradiator combined with the heavy shielding of its housing provides practically no radiation leakage minimizing exposure to users when the irradiator is in its safe condition (source is unexposed). Radiation levels measured around the housing within a distance of less than 30 cm are well below 0.1 mR/h. The thick concrete walls separating the irradiator area from the control area and all contiguous areas have been designed to keep radiation levels below 0.05 mR/h.

Figure 2: G150 Irradiator



The G150 irradiator was installed at NIST in July 2015 and has been in operation since then to present (2021) in Building 245. The irradiator will now operate in new the H-Wing addition to Building 245 where the space and conditions of the room have been significantly improved relative to its original location in Building 245. Some of these room improvements include a larger space for effective and safe unloading and reloading of the source when replacement is needed, better ambient temperature and humidity controls, increased room shielding, reduced mechanical vibrations and reductions in the scattered radiation. During the time the G150 irradiator has been in Building 245 (2015 to the present 2021) it has been routinely inspected by the NIST Gaithersburg Radiation Safety Division (GRSD) staff and by NRC inspectors during both announced and unannounced site visits of the NIST Radiation Physics Division facilities. During these various inspections the G150 facility demonstrably met (and sometimes exceeded) NRC safety requirements. These inspections carried out by Radiation Safety staff at NIST and/ or NRC inspectors are to ensure that all safety controls systems are working correctly and that they meet the strict NRC requirements as described in CFR 10 Part 36.

Part 36 shielding surveys are conducted triennially in accordance with 10 CFR 36.57. Radiation level measurements are performed on all contiguous areas of the Part 36 facility. Radiation level measurements are conducted at the door to the Part 36 facility, the shielded walls in the control room, the shielded walls in the hallway adjacent to the Part 36 facility , shielded walls in facilities adjacent to the Part 36 facility, and the floor above the Part 36 facility. The new Part 36 facility is located on the lowest level of the H-Wing (basement level) thus having earth below the facility and therefore a radiation level survey is not required below the Part 36 facility. Shielding testing has been conducted at the new Part 36 facility (H007-1) by a Building 245 renovation project subcontractor (Versant) using Co-60

radiography sources. This initial shielding testing has confirmed that all radiation levels are less than 2 millirem per hour at 30 cm from the shielding walls in accordance with 10 CFR 36.25(a). Radiation level measurements are performed around the G150 irradiator housing during the triennial shielding surveys. The G150 irradiator was installed at NIST in 2015 and all surveys of the irradiator housing to date have confirmed that the radiation levels outside of the irradiator housing are less than 2 mrem per hour at 1 meter and less than 20 mrem per hour at 5 cm from the irradiator housing in accordance with 10 CFR 36.25(c). Dose rate meters, including pressurized ion chambers, unpressurized ion chambers and energy compensated GM detectors, are used for the shielding surveys and are calibrated by the NIST Radiation Safety Division (RSD) in accordance with the manufacturer's recommendations and RSD procedures. The dose rate meters are evaluated at approximately 20 percent and 80 percent of each scale or decade as practicable. Instruments shall be removed from service if they cannot be adjusted to within 20 percent of the expected value.

## Fire Protection

Codes & Standards

The new addition to Building 245, H-wing, including the Gamma IR lab (H007-1) was designed and constructed in accordance with the following Codes & Standards:

1. 2015 International Code Council (ICC) suite of codes;
2. 2016 NFPA 13, Standard for the Installation of Sprinkler Systems;
3. 2016 NFPA 14, Standard for the Installation of Standpipe and Hose Systems;
4. 2013 NFPA 20, Standard for the installation of Stationary Pumps for Fire Protection;
5. 2016 NFPA 24, Standard for the installation of Private Fire Service Mains and their Appurtenances;
6. 2015 NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals
7. 2014 NFPA 70, National Electrical Code (NEC);
8. 2016 NFPA 72, National Fire Alarm and Signaling Code;
9. 2015 NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids;
10. 2015 NFPA 101, Life Safety Code; and
11. 2014 NFPA 801, Standard for Fire Protection for Facilities Handling Radioactive Materials.

Construction

H-Wing is noncombustible construction. Built to Construction Type-IB but was reclassified to Type-IIB with the following details:

1. Reclassification of addition to Construction Type II-B, with reintroduction of Building Separation (via 2 hour fire barrier on each side) between H Wing and existing structure;
2. The completion of the fire barrier on the existing side will be deferred until the next phase of construction, along with the addition of water curtains on the existing side and replacement of doors within fire barrier;
3. This classification provides a floor rating requirement of (0) hours, a (1) hour rating will still be maintained as indicated on the Life Safety Plans to provide required fire separation between Control Areas; and
4. The existing fire hose valve cabinets at the east C wing exit stair meet the distance requirement relative to the location of the horizontal exits, additional fire hose valve cabinets are not required.

More specifically, the Gamma IR lab, has a fire-rated separation of 2 hours with fire-rated door assemblies (90 minutes). Openings are all protected, and any HVAC penetrations have fire dampers as required by International Building Code.

The details for the construction of the H wing and Gamma IR facility can be seen in Enclosures 1 and 2 of SNM-362 license amendment 9 approved by the NRC on 11/21/2017 in ML17306A942.

Electrical

Design & Installed per NEC with emergency power via emergency generator and automatic transfer switches. Electrical distribution system also includes an on-line, solid state, double conversion type, parallel-redundant UPS system.

Emergency Lighting

Designed & installed per NFPA 101 requirements.

Life Safety/Egress

Designed in accordance with NFPA 101.

Ventilation

Designed and installed in accordance with the International Mechanical Code (IMC), NFPA 45, and NFPA 91.

Lightning Protection

A complete lighting system in accordance with IES Lighting Handbook, UL 924, NFPA 70, NFPA 780.

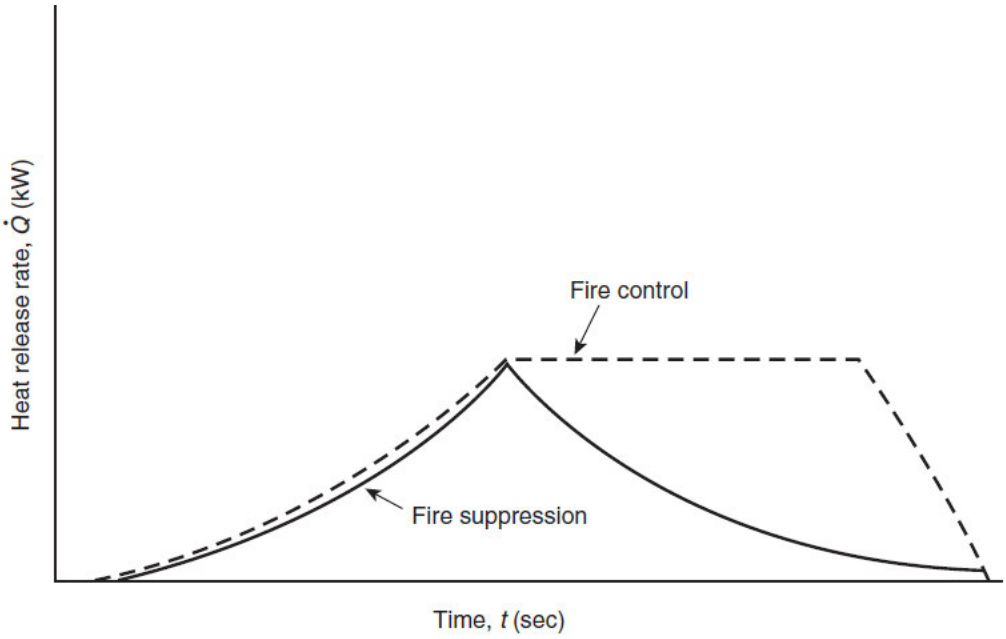
Fire Alarm

A fire alarm system capable of notifying building occupants inside the facility is provided in accordance to NFPA 72. This consists of a complete, electrically supervised, addressable intelligent, manual and automatic, annunciated fire alarm and detection system throughout the facility. Mass notification system will provide for audible messaging within the building and areas surrounding the building. An automatic detection system is only provided in areas required by IBC 2015 and NFPA 72. The system is capable of notifying building occupants by means of speakers and strobes. Speakers will meet the requirements per NFPA 72. The fire reporting portion of the system is compatible with the existing campus fire reporting system. The fire alarm system includes double action surface mounted manual pull stations and will reset with the use of a key, system smoke detectors, duct smoke detectors in accordance to IMC, speaker/strobes devices, electrical supervision of all sprinkler system alarm, and supervisory devices. The fire alarm system is connected to the campus system via fiber optic cable. Speakers conform to the intelligibility requirements of NFPA 72. Fire alarm circuiting shall be class A.

Fire Suppression

The Gamma Irradiation room in the H wing addition is required to be provided with a fire extinguishing system to extinguish a fire without the entry of personnel into the room per NRC Regulation [10 CFR, 36.27 (b)]. Spray sprinklers are intended to provide fire control per NFPA 13 (2016), section 3.6.4.11. Fire

control is defined by NFPA 13 Section 3.3.11 as the action of limiting the size of a fire by decreasing the heat release rate of the fire and controlling the ceiling gas temperature to avoid structural damage. This is achieved by distributing water over the fire and prewetting adjacent combustibles. Fire suppression as defined by section 3.3.12 of the same code is achieved by sharply reducing the heat release rate of a fire and preventing its regrowth by applying the water directly through the fire plume to the burning fuel surface. Exhibit 3.3 of NFPA 13 (see below) shows the effect of both systems. Fire extinguishment (100% reduction of the heat release rate) can be reached in a different way by both fire control and fire suppression without the intervention of emergency personnel. In the fire control mode, shown in the dotted line, the fire is extinguished after the fuel is consumed following a controlled burning at a semi-steady heat release rate. In the fire suppression mode, shown in the solid line, the fire is extinguished by the accelerated reduction of heat release rate. Fire sprinkler systems such as ESFR are designed for fire suppression, while most of the other systems are designed for fire control.




The Gamma Irradiation room is used for operating the irradiator. The room has overhead ducts, crane and suspended equipment. The furniture consists of steel lab casework and an epoxy bench top. The sprinkler system design criteria to achieve fire extinguishment is based on the following assumptions:

Fuel load: The room will contain low combustible materials similar to a mechanical room without fuel equipment. The room will contain the gamma irradiation equipment, a ceiling crane, and HVAC ductwork, which is considered noncombustible equipment. The room will also contain a metal bench with a sink and metal cabinets along the wall which will be used for utensils, instruments and small equipment such as the ones used as in an electrical laboratory and office. The room is not intended for storage. No flammables or combustible liquids will be used in this room. It is assumed that most of the equipment is made of metal with very little or no plastic components. Most of the furniture is metal, except the epoxy bench top. No chairs with plastic or foam will be used in this room. The only electrical equipment in this room apart from the suspended equipment is the motor for the crane.

Fire size: Based on the previous description of materials present/used in the room, a fuel package for this room consist of metal bench a chair with limited cushion, a laptop computer, and metal cabinets similar to the one found in an office. The heat release rate for these elements will have a peak heat release rate of 950 kW [200 for the polypropylene computer (Figure 3-1.28), 150 kW for a stackable chair, polypropylene

with steel frame no padding (Figure 3-1.18), 200x3 kW for 3-shelf metal bookcase with X-ray films (Figure 3-1.15) from the SFPE Handbook]. Klote & Milke indicate a suggested value of 225 kW/m2 (20 Btu/s-ft2) for an area similar to an office space. Assuming the fuel load like an office occupancy is conservative due to the type and quantity of combustible materials anticipated in this laboratory. Using this value and assuming a floor area with fuel materials of 9.3m2 (100 ft2), the room is assumed to have a fire of 2.09 MW (2,000 Btu/s). We will use both the 950 kW and 2000 kW as the peak release rate for the fire scenarios and calculations.

Fire grow: The fire will behave as a T-squared fire of fast growth type due to the limited amount of combustible with a peak heat release rate of 2 MW, the biggest from the two fuel load scenarios. Sources of Ignition: There are no burners/open flame or any other source of ignition.
Sprinkler Activation Time: The sprinkler activation time is calculated using the CFAST t model with the following parameters:

| | |
|---|---|
| Heat Release Rate of the Fire (Q) (peak) | 2000.00 kW |
| Sprinkler Response Time Index (RTI) | 42(m-sec)1/2 |
| Activation Temperature of the Sprinkler (Tactivation) | 165 °F |
| Height of Ceiling above Top of Fuel (H) | 13.00 ft |
| Ambient Air Temperature (Ta) | 70.00 °F |

The calculated sprinkler activation time is 88 sec and 105 sec for the heat detector.

The water delivery is assumed to be not more than 50 sec (for Ordinary hazard sprinkler per NFPA 13). After the latest between either sprinkler activation or sensor (heat or smoke) activation Therefore, the water delivery time is estimated in 155 sec.

The heat release rate at water delivery time is calculated using the T-squared fire.

$$\dot{Q} = \alpha t^2$$

With α (growth factor in kW/s2) as 0.047 kW/s2 for fast fires, and t=155 sec, the water delivery time, the fire size at delivery time is 1,129 kW.

Water heat absorption: The heat flux removed from the surface of the burning materials by water in kW/m2, as a result of water vaporization is expressed as (Equation 125 from Section 3 Chapter 4 of the SFPE Handbook):

$$\dot{q}_w'' = \varepsilon_w \dot{m}_w \Delta H_w$$

Where:
ε is the water application efficiency, estimated in 25% for the sprinkler activation,
m_ is the water application rate per unit of surface area of the material in g/m2.s, and
ΔH is the heat of gasification of water (2.58 kJ/g).

The calculated heat flux removed by the water for the activation of one sprinkler head over 100 ft2 at Ordinary Hazard 1 (0.15 gpm/ft2) and Extra Hazard 1 (0.30 gpm/ft2) water application rates are as follows:

| | OH-1 Application | EH-1 Application |
|---|---|---|
| Water application rate | 0.15 gpm/ft2 | 0.30 gpm/ft2 |
| Water application rate | 101.84 g/m2-s | 203.69 g/m2-s |
| Water application efficiency | 25% | 25% |
| Effective water application | 0.0375 gpm/ft2 | 0.0750 gpm/ft2 |
| Effective water application | 25.46 g/m2-s | 50.92 g/m2-s |
| Heat of Gasification of water | 2.58 kJ/g | 2.58 kJ/g |
| Heat flux removed | 65.69 kW/m2 | 131.38 kW/m2 |
| total heat flux removed | 610.26 kW | 1220.52 kW |

Fire extinguishment: Fire extinguishment will be achieved when the quantity of energy absorbed by the water is higher than the fire size. The heat release rate at sprinkler activation is 1,129, while the calculated heat absorbed by the water is 610.26 kW and 1,220.52 kW for the Ordinary Hazard 1 and Extra Hazard 1 water applications respectively.

Based on these assumptions and above calculations it is our opinion that the potential fire scenario in the gamma irradiation room will be extinguished with a sprinkler system designed for a sprinkler application rate of 0.3 gpm/ft2 for Extra Hazard 1.

Sprinkler Protection: This room is classified as ordinary hazard group 1 and shall be protected with a double interlock pre-action sprinkler system as required per RFP section 5.6.3 and 5.6.3.2. The sprinkler system will be provided with a shut-off valve to control flooding into unrestricted areas. To provide the required fire extinguishment as required by 10 CFR 36.27 (b), the fire sprinkler system will be provided with additional safety factors including:

- The double interlock pre-action sprinkler system will be designed for Extra Hazard group 1 to provide at least 0.3 gpm over the entire room area, in lieu of 0.15 gpm for ordinary hazard group 1 to provide additional water discharge.
- The system will consist of K 11.2 quick response ordinary temperature sprinklers (rated at 135 °F) to provide higher water discharge and for prompt activation of the sprinkler system in case of fire.
- Sprinklers at the ceiling will be spaced at not more than 100 sq.ft per sprinkler, and obstructions to water discharge of more than 2 ft wide including suspended equipment will be provided with sprinklers underlead to ensure proper coverage, in a similar way as required for ESFR sprinklers. Special care will be taken to avoid obstruction by structural beams and support of the ceiling crane.
- The heat detectors will be fixed 135 Fahrenheit degrees temperature rating and the smoke detectors will be of the photoelectric type.

NIST Fire Department Capabilities, Qualifications, and Training

The NIST Fire Protection Group's (Fire Department) capabilities include the following:

- There is a minimum staffing five (5) full time federal employee firefighters on site per day with a maximum (6) per day.
- Two (2) class A engine pumpers which both carry 1000 gallons of water. One pumper has a 1250 gallon per minute pump, and the other has 2000 gallon per minute pump.
- One (1) Basic Life support ambulance, and
- One (1) Hazmat unit

All NIST Firefighters are certified Emergency Medical Technicians, Firefighter 2, Hazmat Materials Technicians , Confine Space Technicians for a baseline. Overall, each NIST firefighter has more training in other areas such as Rescue Technicians, Hazmat Incident Command, etc. All NIST Firefighters are certified Fire Inspectors (Certifications are thru Maryland University Maryland Fire and Rescue Institute). All

buildings on NIST Site Gaithersburg are inspected monthly, fire extinguishers, standpipes etc. are inspected at this time. All firefighting staff go thru the required Radiation Safety Training that is required by both building 245 and building 235. On-site training is given to all new NIST firefighters thru the Fire Departments in house requirements before a new firefighter is allowed to operate on site.

Pre-Fire Plan

The NIST Fire Department conducts both fire drills and shelter in-place drills annually for all buildings on the NIST Gaithersburg campus. The storm warning system is tested annually. NIST has a Mutual Aid agreement with Montgomery County (MC). Services are provided both ways (e.g., MC Fire Department assist in responses at NIST and the NIST Fire Department assists MC in fire responses). On weekends, the NIST Fire Department conducts different in-house training outlining response for the different buildings on site. The NIST Fire Department does different walk throughs in building 245 for information and response planning.

All buildings on site are broken down to wings and different entrances. For building 245, depending on the alarm and/or emergency, that will dictate what entrance is used. The Officer-in-Command (OIC) will take the command unit to the front side of building 245; obtain the Building keys in Knoxbox (located at the Bldg. 245 entrance); and serves as the point of contact for Building Evacuation Coordinators. Depending on time of incident, the Radiation Safety Division (RSD) will be notified if not on site already. Every NIST firefighter knows to use the RSD Call Down List that is located in fire house as well as in the command unit. Depending on the incident, the NIST Fire Department may not operate without having contact with an RSD representative. If and/or when Montgomery County is called for assistance: MC units come thru A-gate and get escorted to assigned area or staging area. The Montgomery County Chief Officer will meet up with the NIST OIC and a joint command will be set up. The county units will work with the NIST firefighters at that time.

Description of Heat and Smoke Detectors, Alarms, and Response

Separate heat and a smoke detector (smoke and heat detectors are separate units) perform the actions below:

- The smoke and heat detectors activate locally an audible and visible alarm if smoke or heat are detected

- The smoke and heat detectors provide a set of relay contacts that are integrated with the irradiator safety control panel of the G150 system to immediately fully shield the irradiator if fire is detected. See Figure 3 below for description.

- The smoke and heat detectors also send an alarm to the NIST Emergency Center that would initiate a response from the NIST Fire Department if a fire is detected.

Site-specific testing for the heat and smoke detectors and the fire extinguishing system IAW 10 CFR 36.61

The site-specific testing of the heat and smoke detectors and the fire extinguishing system and the testing frequency IAW 10 CFR 36.61(a)(8) are described in and was approved in Item 10 in SNM-632 license Amendment 5 IAW the application letter dated December 27, 2013. The site-specific testing IAW 10 CFR 36.61 was approved by the NRC on 1/27/2014 in ML14016A344.

The testing IAW 36.61(a)(8) as it relates to 36.27 was previously approved in Item 10 in SNM-632 license Amendment 5 IAW the application letter dated December 27, 2013. The site-specific testing IAW 10 CFR 36.61 was approved by the NRC on 1/27/2014 in ML14016A344. The testing of the fire extinguishing system shall be added to the annual testing frequency for the Gamma IR facility. The activation of the pre-action sprinkler system (without activating the sprinklers) shall be verified when both heat and smoke detectors are activated.

Ref: 10 CFR Part 36 Section 36.27 (a) and 37.23(b)

**Radiation Monitors**

SAFETY INDICATORS, ALARMS AND RADIATION MONITORS

- A red light is located on top of both, the *Experiment Door* and the *Control/Maze Door* (see Figures 1 and 3). The red light turns ON when the irradiator is in the unshielded position and there is radiation present in the irradiator area.

- A total of 4 light towers each made of 2 stacked lights, one green and one red are installed in the G150 facility in the following areas:
  - one in the irradiator area
  - one in the maze area
  - two in the control area

  The red light indicates that there is radiation present in the room while green means that there is no radiation.

- A rotating beacon in the irradiator room, turns ON when the irradiator is in the exposed position (shutter open) and there is radiation present.

- A radiation area monitor labeled ARM #1 in Figure 3, is located in the irradiator area with its readout in the Maze area monitoring 24/7 the radiation levels in the irradiator area.

- A second radiation area monitor, labeled ARM #2 in Figure 3, is located in the irradiator area and monitors continuously the radiation level in this area. Both the probe and readout are part of a single unit. This second detector is electrically integrated with the access control (OPEN/CLOSE door control) of the Experiment Door (see Figure 3) with the sole purpose to keep the door automatically closed when the ARM#2 detects radiation in the irradiator area. This ARM is located in the irradiator area near the irradiator unit.

- A Search and Evict button is located in the irradiator area near the access door which has 2 purposes:

  - it provides a short-preset time period of about 1 minute to allow the operator to search and evict the irradiator room prior to operating the shutter.

- After pressing the Search and Evict button, a visible and a low intensity audible alarm are activated for a period of 1 minute to alert all occupants to leave the room.

- The console is equipped with a source position indicator that indicates when the source is in the fully shielded position, when it is in transit, and when the source is exposed.

FIGURE 3 ABREVIATIONS

Figure 3 shows a schematic with approximate location of alarms, radiation area monitors and controls. Below are the abbreviations for the symbols shown in the figure for these items

TL: Tower light (green and red stacked lights on a vertical tower)

SE: Search and Evict button

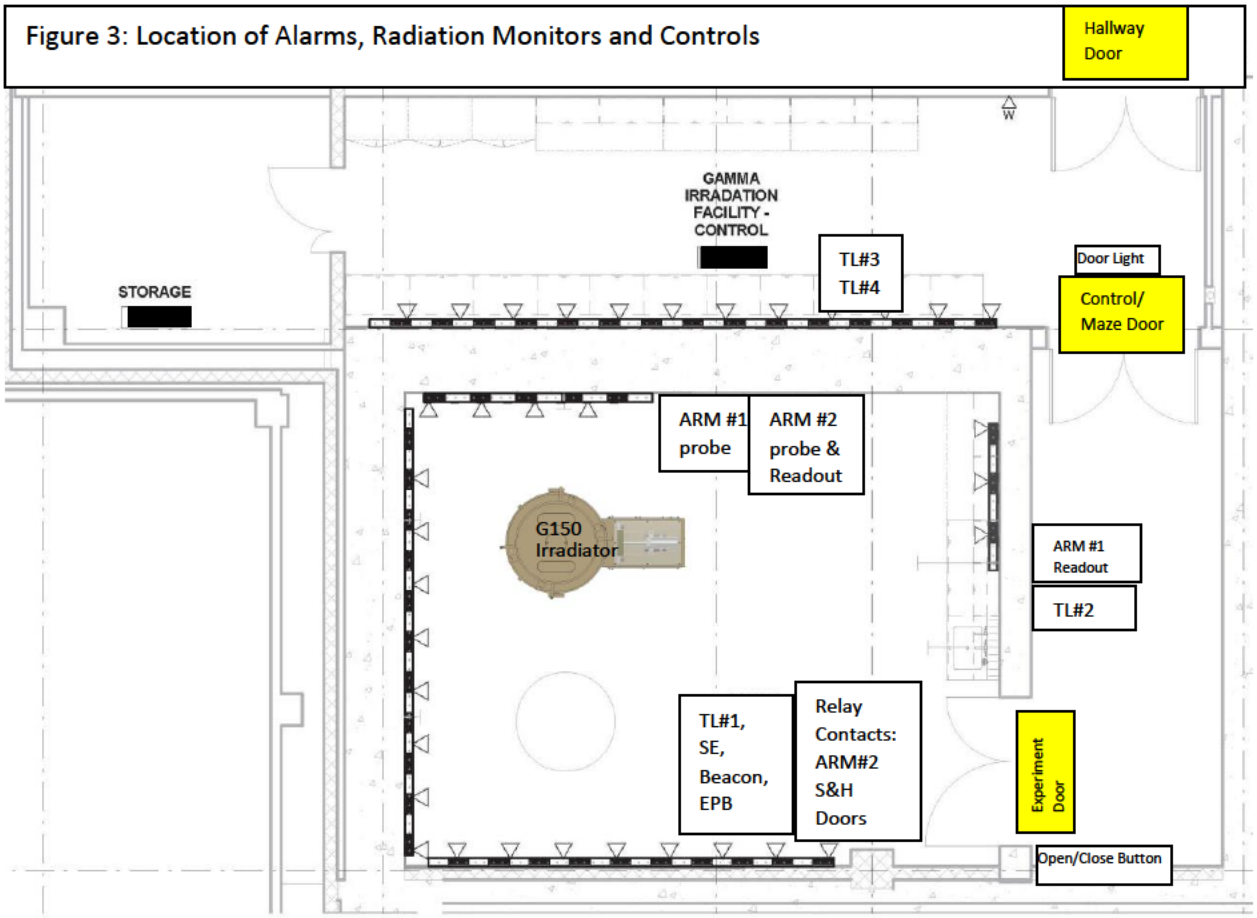
Beacon: Rotating Beacon

EPB: Emergency Push Button (This allows to open the door at all times form the irradiator room)

S&H: Smoke and Heat relay contacts

ARM: Area Radiation Monitor

Figure 3: Location of Alarms, Radiation Monitors and Controls



**Power Failures**

- In the case of power failure, the G150 is designed to return the irradiator to the fully shielded condition. This feature is tested annually.

- Both, the *Experiment Door* and *Control/Maze Door* (see Figures 1 and 3) are electrically operated. The doors are connected to a backup power generator that will restore electrical power to the doors within less than 10 seconds. This feature is tested annually.

- Per standard operating procedures, no person shall be in the irradiator area while the doors are closed.

Ref: 10 CFR Part 36 Sections 36.37 (a) and 36.37 (b)

## ITEM 10: Radiation Safety Program

There have been no changes to the radiation safety program items related to 10 CFR 36 since the SNM-362 license approval issued on 9/11/2013 in ML13207A206.

**Radiation Monitoring Instruments**

There have been no changes to the radiation monitoring instruments for the 10 CFR Part 36 facilities IAW the SNM-362 license approval on 9/11/2013 in ML13207A206.

Radiation Survey Instruments

We will use survey instruments that meet the criteria in the section entitled 'Radiation Safety Program - Instruments' in NUREG–1556, Volume 6, Revision 1, 'Consolidated Guidance About Materials Licenses: Program-Specific Guidance About 10 CFR Part 36 Irradiator Licenses.

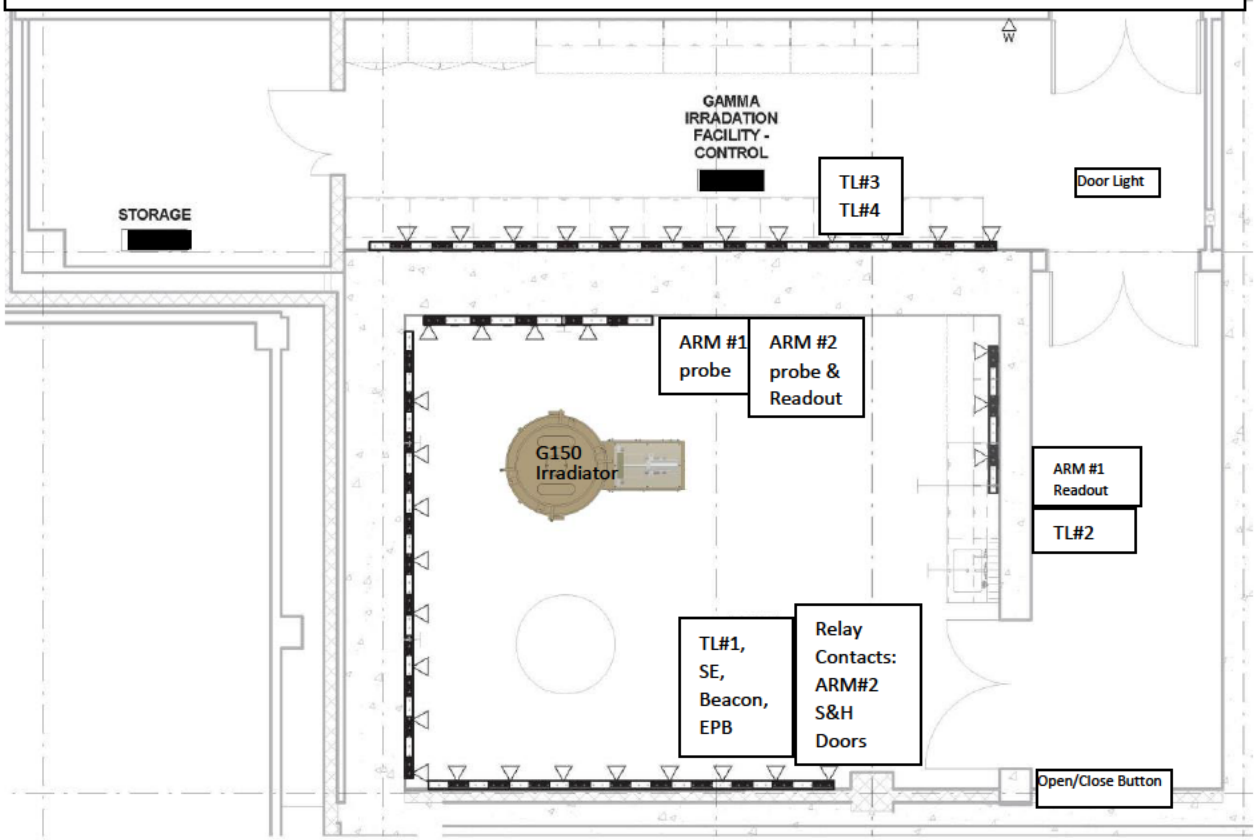
We are currently approved under our SNM-362 license to calibrate our radiation survey meters in house. The RSD radiation survey meter calibration program is implemented in accordance with the model survey meter calibration program published in Appendix J "Model Radiation Survey Instrument Calibration' in NUREG–1556, Volume 6, Revision 1, 'Consolidated Guidance About Materials Licenses: Program-Specific Guidance About 10 CFR Part 36 Irradiator Licenses

Radiation Monitors

- A radiation area monitor labeled ARM #1 in Figure 3, is located in the irradiator area with its readout in the Maze area monitoring 24/7 the radiation levels in the irradiator area.

- A second radiation area monitor, labeled ARM #2 in Figure 3, is located in the irradiator area and monitors continuously the radiation level in this area. Both the probe and readout are part of a single unit. This second detector is electrically integrated with the access control (OPEN/CLOSE door control) of the Experiment Door (see Figure 3) with the sole purpose to keep the door automatically closed when the ARM#2 detects radiation in the irradiator area. This ARM is located in the irradiator area near the irradiator unit.

Figure 3: Location of Alarms, Radiation Monitors and Controls




## Material Receipt and Accountability

The material receipt and accountability program continues to be maintained IAW the SNM-362 license approval on 9/11/2013 in ML13207A206.

NIST has developed, implements, and maintains procedures for ensuring accountability of licensed materials at all times.

NIST complies with the NSTS reporting requirements as described in 10 CFR 20.2207.

## Occupational Dosimetry

The dosimetry program continues to be maintained IAW the SNM-362 license approval on 9/11/2013 in ML13207A206.

TLD, or other dosimetry devices are processed and evaluated by an NVLAP-accredited processor.

TLD, or other personnel dosimetry devices are exchanged at the required frequency and are assigned to and worn by irradiator personnel.

Other individuals, including visitors, entering a radiation room are provided dosimetry in accordance with regulatory requirements.

**Operating Procedures**

Routine Operations

Routine irradiator operations continue to be conducted IAW the SNM-362 license approval on 9/11/2013 in ML13207A206.

Routine irradiator operations are performed as described in the IRSC approved Safety Evaluation, *SE-0020 Irradiation of Devices and Dosimeters in Vertical Ranges*.

Non-Routine Operations

The irradiator manufacturer or other person authorized by the NRC or an Agreement State will perform nonroutine operations, such as source loading, unloading and repositioning, electrical troubleshooting of the control console, clearing stuck source racks, investigating and remediating removable contamination or leaking sources, (re)installing source cables, and other critical operations requiring special skills or having the potential for radiation overexposures.

**Emergency Procedures**

Emergency procedures continue to be conducted IAW the SNM-362 license approval on 9/11/2013 in ML13207A206.

Emergency procedures are described in the IRSC approved Safety Evaluation, *SE-0020 Irradiation of Devices and Dosimeters in Vertical Ranges* and the RSO approved RSD procedure RSI 1-3, *Response to Radiological Incidents*.

**Leak Tests**

The leak test program continues to be maintained IAW the standing SNM-362 license approval on 9/11/2013 in ML13207A206.

NIST currently implements a leak test program that meets or exceeds the model leak test program published in Appendix M of NUREG–1556, Volume 6, Revision 1, 'Consolidated Guidance About Materials Licenses: Program-Specific Guidance About 10 CFR Part 36 Irradiator Licenses.

**Inspection and Maintenance Checks**

Inspection and maintenance checks are conducted on either a daily per use frequency or an annual frequency in accordance with SNM-362 License Item 10 and license renewal letter dated December 27, 2013 (SNM-362 Amendment 5).

The inspection and maintenance checks IAW 10 CFR 36.61 was approved by the NRC on 1/27/2014 in ML14016A344.

## ITEM 11: Waste Management

**Sealed Source Disposal and Transfer**

The disposal and transfer of sealed sources continues to be maintained IAW the SNM-362 license approval on 9/11/2013 in ML13207A206.