Aim: To perform a radiological survey and surface contamination of a radioisotope laboratory.

Apparatus required:

1. Radiation Survey Instrument
2. Digital Contamination Monitor
3. PPE (Gloves, Lab Coat, Mask)

Theory:

Ionizing Radiation and radioactive substances have many applications, such as power generation, medicine, industry, agriculture, etc. In medicine, we use sealed and unsealed radioactive sources for diagnostic and therapeutic purposes. Sealed sources are used in external beam therapy and brachytherapy, and unsealed sources are used in diagnosis (e.g., PET and SPECT) and therapy. These unsealed sources are prone to emergency due to the chance of spillage, falling on the floor, leakage, etc., which can contaminate hospital workplace areas. So, the use of ionizing radiation, production, transport, and the management of radioactive waste must, therefore, be subject to safety standards.

Radiation cannot be sensed directly, and high radiation doses received by personnel may cause stochastic effects (probabilistic) and sometimes may result in death (Deterministic or non-stochastic). The stochastic effect should be paid attention to as it is probabilistic, where the probability of occurrence is proportional to the dose received. Since the stochastic effects have no lower limit, radiation monitoring of the radiation workers is necessary. Radiation monitoring involves the measurement of radiation dose or radionuclide contamination for reasons related to the assessment or control of exposure to radiation or radioactive substances and the interpretation of the results. Proper selection of monitoring instruments also plays a crucial role in an effective monitoring program.

The objectives of radiological monitoring are:

1. To assess the radiation and personnel exposure in compliance with regulatory requirements.
2. To identify abnormalities of radiation exposure in workplaces.
3. To verify the effectiveness of radiation protection programs in workplaces.

There are three types of radiological monitoring: -

1. Area monitoring
2. Workplace monitoring
3. Personnel Monitoring

Any workplaces which contain radioactive sources or radiation generating equipment are required to be monitored regularly to ensure the working environments are safe for radiation workers. Area monitoring is important to establish the classification of working areas accordingly. The area monitoring covers both radiation survey and contamination monitoring. In some places where radioactive aerosols (small particles) are present, surface airborne contamination monitoring should also be included in area monitoring. Personnel monitoring and workplace monitoring are executed to control the occupational exposure of radiation workers, while area monitoring is aimed at controlling radiation exposure in the public.

Classification of the areas is essential and is divided into three different categories, namely clean area, supervised area, and controlled area. These areas require different administrative control. For instance, clean areas can be accessed by everyone (public), while supervised and controlled areas are restricted areas that can only be accessed by radiation workers. It is important to know the radiation dose rate in the respective areas; hence, area monitoring is required.

Areas to be surveyed should include any locations where individuals may be exposed to radiation intensities that might cause the occupational radiation dose to exceed 10 percent of the annual limits or where an individual works with any radiation source that could produce radiation levels greater than 1.0 mR/h at 1 meter. These areas typically include shipping and receiving areas, radionuclide laboratories in nuclear medicine, diagnostic and therapy rooms in nuclear medicine, operating rooms, control (console) areas for teletherapy equipment rooms, waste packaging and disposal areas, radiation instrument calibration areas, and any other areas where persons might be exposed to ionizing radiation (e.g., areas occupied by technologists, nursing staff, visitors, patient attendant, or any other persons who may be exposed to radioactive materials handled by others).

Radioactive surface contamination is the deposition of radioactive material in an uncontrolled manner or on animate or inanimate objects, irrespective of their situations, that results in operational inconvenience or causes a radiological hazard. Contamination is further classified as being 'fixed' or 'loose.' 'Fixed' contamination is not transferred from a contaminated surface to an uncontaminated surface when the two surfaces accidentally touch; conversely, 'loose' contamination is that which may be readily transferred under some circumstances. Regular surveys of radioactive contamination that could be present on surfaces of floors, walls, furnishings, and equipment are a necessary part of the survey program. Control of surface contamination is necessary to limit external dose rates and the resuspension in air of loose radioactive materials that may enter the body through inhalation, ingestion, or skin absorption.

Procedure:

1. Radiation Survey

- Select a suitable radiation survey instrument, e.g. Radiation Survey Meter.
- Perform its response test with a known standard source. The display unit should be in mR/hr or µSv/hr. The difference in the measurement should be less than 10 percent. Wear PPE (Personal Protective Equipment) like gloves, Lab coat, Safety Shoes, and mask.
- Check the environmental radiation level (Background radiation level) before entering the radiation zone.
- Draw the layout of the radiation zone and tabulate the selected areas where the radiation survey will be done (Table given below).

2. Contamination Monitoring:

- Select a suitable Contamination monitoring instrument.
- Perform its response test with a known standard source. The display unit should be in Bq/cm^2. The difference in the measurement should be less than 10 percent. Wear PPE (Personal Protective Equipment) like gloves, Lab coat, Safety Shoes, and mask.
- Check the environmental radiation level (Background radiation level) before entering the radiation zone in Bq/cm^2 mode.
- Draw the layout of the radiation zone and divide this layout into various zones.
- Tabulate these grid areas where we want to check contamination level.

Equipment Details:

Equipment	Radiation Survey Meter	Contamination Monitor
Make & Model	Nucleonix [RM701N]	Nucleonix [CM710N]
Serial Number	22012162007	220121611558
Date of last Calibration		

Observation:

Background Radiation Level	Background Contamination Radiation
0.02mR/hr	40CPM

Sr. No.	Location (as indicated in the attached layout)	Radiation levels (µSv /hr)	Contamination levels
1	Hot Lab	0.18	74
2	Dose administration room	0.08	32
3	Post administration waiting	0.06	24
4	Low-dose post-administration waiting	0.02	00
5	Stress TMT	0.08	36
6	Scan room	0.14	80
7	Console	0.08	12
8	Recovery room	0.12	08
9	Reception	0.08	08
10	Physician room	0.00	00
11	Technologists room	0.00	00
12	Thyroid uptake room	0.12	32
13	Restricted corridor	0.04	12
14	UPS and battery room	0.00	00
15	Reporting room	0.00	16

Tolerance Limits:

Sr. No.	Category of areas	Limits of surface contamination
1	Monitored areas (e.g., inside the fume hood)	$10^{-3}\mu Ci/cm^2$ (37 Bq/cm^2)
2	Laboratory areas (Surveyed)	$10^{-4}\mu Ci/cm^2$ (3.7 Bq/cm^2)
3	Other non-active areas	$10^{-5}\mu Ci/cm^2$ (0.37 Bq/cm^2)

Precaution:

1. Handle the instruments carefully.
2. Instrument/ Detector should not be contaminated.
3. Use PPE properly.
4. Perform experiments carefully, such that contamination should not spread to other areas.
5. After the experiment all instruments and PPEs were kept at their desired place.