STANDARD OPERATING PROCEDURES
FOR RADIOACTIVE MATERIAL INVENTORY
MANAGEMENT IN NUCLEAR MEDICINE
DEPARTMENT

Medical Radiation Surveillance Division
Ministry of Health Malaysia
April 2017
STANDARD OPERATING PROCEDURES FOR RADIOACTIVE MATERIAL INVENTORY MANAGEMENT IN NUCLEAR MEDICINE DEPARTMENT

1) STANDARD OPERATING PROCEDURE FOR PURCHASING OF RADIOACTIVE MATERIAL RELATED TO APPROVAL BY THE APPROPRIATE AUTHORITY
2) STANDARD OPERATING PROCEDURE FOR RECEIVING OF RADIOACTIVE MATERIAL
3) STANDARD OPERATING PROCEDURE FOR TRANSPORTATION OF RADIOACTIVE PACKAGE
4) STANDARD OPERATING PROCEDURE FOR STORAGE OF RADIOACTIVE MATERIAL
5) STANDARD OPERATING PROCEDURE FOR MANAGEMENT OF RADIOACTIVE WASTE
STANDARD OPERATING PROCEDURE FOR PURCHASING OF RADIOACTIVE MATERIAL RELATED TO APPROVAL BY THE APPROPRIATE AUTHORITY

OBJECTIVE

To explain the method in purchasing of radioactive material related to approval by the appropriate authority.

SCOPE

This procedure applies to all purchasing process of all radioactive material for nuclear medicine usage including sealed and unsealed sources.

DEFINITIONS

1. Appropriate Authority – The Director General of Health where the activity to be licensed or licensed under this Act is in respect of medical purpose as determined by the Board.
2. Class A License – A license to manufacture, trade in, produce, process, purchase, own, possess, use, transfer, handle, sell or store radioactive material.
3. Class D License – A license to transport radioactive material, nuclear material, prescribed substances or their wastes.
4. Class E License – A license to export or import or radioactive materials, nuclear material, prescribed substances, irradiating apparatus or their wastes.
6. Letter of Undertaking – is a written promise of intention that outlines the terms and conditions between two parties who are usually entering into a work related agreement.
7. Radioactive material – Any nuclear fuel, radioactive product or radioactive waste.
8. Sealed sources – means a radiation source consisting of any radioactive material, nuclear material or prescribed substance firmly incorporated in solid and effectively inactive material, or sealed in an inactive container of sufficient strength to prevent any dispersion of its contents under normal conditions of use.
9. Unsealed sources – means a radiation source consisting of any radioactive material, nuclear material or prescribed substance which is not encapsulated or otherwise contained.
ABBREVIATIONS AND SYMBOLS

AELB  Atomic Energy Licensing Board
Bq  Becquerel
Ci  Curie
KKM  Kementerian Kesihatan Malaysia
RPO  Radiation Protection Officer
RPP  Radiation Protection Programme
RPS  Radiation Protection Supervisor
SOP  Standard Operating Procedure

WORK INSTRUCTION

1. Determine the details of the source
   1.1 Name of source
   1.2 Type of source (unsealed or sealed sources)
   1.3 Activity (Ci or/and Bq)
   1.4 List of suppliers

2. Register the radioactive material with appropriate authority by sending Letter of intention to and related document:
   2.1 Justify the objective of usage (medical therapy/medical diagnostic/calibration)
   2.2 Copy of supplier’s license by AELB which include (Class A, D, and E license)
   2.3 Letter of Undertaking from supplier or manufacturer (for sealed source which has an activity greater than 100 MBq)
   2.4 Catalogue of product
   2.5 Related SOP regarding the usage of purchased unsealed source (only for new procedure involving unsealed source)
   2.6 For first time application only:
      2.6.1 Radiation Protection Programme
      2.6.2 Layout plan and workflow of radioactive sources includes receiving, usage and disposal
      2.6.3 Storage facility
   2.7 Complete the LPTA/BP/1 form (only for private sector)

3. Get approval letter from the appropriate authority.
4. Get End User Statement form from the sealed source supplier, the form must be completed, signed by the Head of Department or RPO/RPS and returned to the supplier.

5. Make payment to KKM for license amendment (only for private sector).

6. Send original license to be amended (only for private sector).

7. Proceed purchasing according to local procedure.

8. Inform the appropriate authority regarding completion of purchase by returning:
   
   8.1 Copy of data sheet (only for sealed source)
   8.2 Form ‘LPTA/BM/3 - Penyata Pemilikan’ (only for private sector)

**RECORD**

<table>
<thead>
<tr>
<th>No.</th>
<th>Record Name</th>
<th>Record Keeping Period</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Approval letter</td>
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<td></td>
</tr>
<tr>
<td>2.</td>
<td>Letter of Undertaking</td>
<td>3 years after disposal</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>End User Statement</td>
<td>3 years after disposal</td>
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</tr>
<tr>
<td>4.</td>
<td>Local Purchase Order and Delivery Order</td>
<td>3 years after disposal</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Radioactive Material data Sheet</td>
<td>3 years after disposal</td>
<td></td>
</tr>
</tbody>
</table>
STANDARD OPERATING PROCEDURES FOR RADIOACTIVE MATERIAL INVENTORY MANAGEMENT IN NUCLEAR MEDICINE DEPARTMENT
REFERENCES

2. Atomic Energy Licensing (Licensing) Regulations 1986
3. Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010
STANDARD OPERATING PROCEDURE FOR RECEIVING OF RADIOACTIVE MATERIAL

OBJECTIVE

The objective is to ensure every radioactive material delivered in good conditions and received accordingly.

SCOPE

This procedure is applied to all the radioactive material purchased under the Nuclear Medicine Department, including both sealed and unsealed sources. For receiving Iodine 131, please refer to Standard Operating Procedures for Patients Undergoing Treatment of Iodine 131 in Nuclear Medicine Department.

DEFINITIONS

1. Survey meter – Portable radiation detection and measurement instruments used to check personnel, equipment and facilities for radioactive contamination or to measure external or ambient ionizing radiation fields (to evaluate the direct exposure hazard).
2. Wipe test – A procedure used to assess surface contamination when direct measurements using a surface contamination meter are not possible.

ABBREVIATIONS AND SYMBOLS

- µSv/hr microsievert per hour
- cm² centimeter square
- dpm disintegration per minute
- I-131 131-sodium or potassium iodide
- kBq kilobecquerel
- mCi microcurie
- MOH Ministry of Health
- mSv/hr millisievert per hour
- RPO Radiation Protection Officer
- RPS Radiation Protection Supervisor
- TI Transport Index
WORK INSTRUCTION

   1.1 Delivery of radioactive material package to the department should be done by a Class D licensed transportation company, in accordance to Atomic Energy Licensing Act 304: Radiation Protection (Transport) Regulations 1989.
   1.2 Receiving of the radioactive material package shall be done by medical physicist in the department.
   1.3 If appropriate, the delivery of the package must use the designated pathway approved by the appropriate authority, (e.g.) using staff corridor, instead of using public corridor. The package must be delivered to a designated area for receiving radioactive materials.
   1.4 The medical physicist shall inspect the package visually for any sign of damage (e.g. wetness) and contact the RPO / RPS if damage is noted. Damaged packages will remain in the receiving area until instructions are received from the RPO / RPS.
   1.5 Make sure the packing slip is attached along the package to its final destination.
   1.6 If the items listed on packing note do not match with ordering, the package shall not be received and RPO / RPS shall be contacted for further instruction.

2. Contamination Check
   2.1 It is the responsibility of all users to handle radioactive materials in a safe manner. Use appropriate personal protective equipment, e.g. lab coats, gloves, TLD ring and TLD badge.
   2.2 By using survey meter, obtain the exposure rate / dose rate at one meter and compare the reading with the limit specified in the Transport Index table. Unless the reading exceeds the limit, repeat the measurement for the surface of the package and record all readings.
   2.3 Perform wipe test on the outer surface of each package and repeat the procedure for the surface of inner package. Record all readings.
   2.4 Stop the procedures and report immediately to the RPO / RPS when any of the following incidents occur:
2.4.1 Exposure / Dose rate measurement from the package exceeds Maximum Exposure Limit (at surface / at 1 meter) in Transport Index table in Attachment 2.

2.4.2 Wipe test at surface exceeds the limit 2000 dpm or 30 kBq per 100 cm².

2.4.3 Incorrect package label.

2.4.4 Outer / Inner package damage.

2.5 RPO / RPS should be responsible for further action following the incidents specified in 2.4. RPO / RPS would decide any appropriate measures such as:

2.5.1 Minor damages (e.g. dent, slightly damp) on the surface of outer package are seldom indication of packaging failure. Most packaging has inner container and inner absorbent material. Therefore, in such cases RPO / RPS may instruct to proceed with exposure rate measurement and subsequent procedures.

2.5.2 Contaminated package should be transferred to radioactive storage room or radioactive waste room and treated according to SOP for Storage of Radioactive Materials or SOP for Management of Radioactive Waste.

2.5.3 The delivering personnel or the licensed transportation company must be notified.

2.5.4 MOH should be notified immediately if exposure / dose rate readings at surface / at 1 meter exceed 10 mSv/hr and 200 µSv/hr. In case of such high radiation exposure, immediate evacuation of that area should be considered.

2.5.5 Further action must be discussed with other related personnel in the department (e.g. Nuclear Medicine Specialist, Pharmacist, Technologist)

2.5.6 Return the damaged package to the licensed transportation company.
RECORD

<table>
<thead>
<tr>
<th>No.</th>
<th>Record Name</th>
<th>Record Keeping Period</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Radioactive Material Receipt Form</td>
<td>3 years after disposal</td>
<td></td>
</tr>
</tbody>
</table>

ATTACHMENT

Attachment 1: Radioactive Material Receipt Form
Attachment 2: Transport Index
WORK FLOW

Start

Medical physicist receive radioactive material package from Class D licensed transportation company.

Inspect the package visually for any sign of damage

No damage

Proceed receiving

Visible sign of damage or leakage

Visible sign of damage or leakage

Stop procedure, place the package at secure area, receive decision and instruction by RPO / RPS.

Exceed Maximum Exposure limit

Stop procedure, place the package at secure area, receive decision and instruction by RPO / RPS.

Within acceptable limit

Proceed receiving

Measure exposure rate / dose rate at 1 meter and surface

Within acceptable limit

Perform wipe test procedure

Within acceptable limit

RPO/RPS takes further action

>2000 dpm per 100 cm²

Stop procedure, place the package at secure area, receive decision and instruction by RPO / RPS.

End
REFERENCES

1. Radiation Protection (Transportation) Regulations 1989
2. Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010
4. IAEA 2005 International Atomic Energy Agency, Applying Radiation Safety Standards in Nuclear Medicine, Safety Reports Series No. 40
### RADIOACTIVE MATERIAL RECEIPT FORM

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>ISOTOPE</th>
<th>BATCH NO.</th>
<th>ACTIVITY</th>
<th>CALIBRATION DATE</th>
<th>EXPIRY DATE</th>
<th>EXPOSURE / DOSE RATE (mSv/hr)</th>
<th>WIPE TEST (dpm/100cm²)</th>
<th>REMARK</th>
<th>PERFORMED BY</th>
<th>VERIFIED BY</th>
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</tbody>
</table>

**Note:**
1. Please keep the packing note.
2. Radiation limit: Please refer Transport Index Table. Wipe test radiation limit: 2000 dpm per 100 cm².
**TRANSPORT INDEX**

<table>
<thead>
<tr>
<th>Category</th>
<th>Label</th>
<th>Maximum Exposure Limit</th>
<th>Transport Index (TI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Surface (mSv/hr)</td>
<td>1 meter (μSv/hr)</td>
</tr>
<tr>
<td>Category I</td>
<td><img src="Image1" alt="Image" /></td>
<td>0.005</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5 μSv/hr)</td>
<td>Negligible</td>
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<tr>
<td>Category II</td>
<td><img src="Image2" alt="Image" /></td>
<td>0.5 mSv/hr (500 μSv/hr)</td>
<td>0.01 mSv/hr</td>
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<tr>
<td>Category III</td>
<td><img src="Image3" alt="Image" /></td>
<td>2 mSv/hr</td>
<td>0.1 mSv/hr</td>
</tr>
</tbody>
</table>

TI = (mSv/hr x 100) or (μSv/hr / 100)
STANDARD OPERATING PROCEDURE FOR TRANSPORTATION OF RADIOACTIVE PACKAGE

OBJECTIVE

The objective is to provide guidelines for transportation of radioactive materials within and outside the premises of nuclear medicine department.

SCOPE

Transfer of radioactive materials within and outside the premises of nuclear medicine department.

DEFINITIONS

1. Carrier – appointed personnel who must be a trained radiation worker.
2. Class D License – A license to transport radioactive material, nuclear material, prescribed substances or their wastes.
3. Consignee – receiver of radioactive material.
5. Inter-department – transfer to any other department in the same premise that uses radioactive materials for the purpose of nuclear medicine procedures.
6. Outside of Premises – any institution that use radioactive material for the purpose of nuclear medicine procedure.
7. Transporter – A worker of transportation company (with Class D license) that deals with the transport of radioactive material.
8. Within department – does not involve outside the area of nuclear medicine department.

ABBREVIATIONS AND SYMBOLS

PPE Personal Protective Equipment
RAM Radioactive Material

WORK INSTRUCTION

1. Within Department Transfer.
   
   1.1 The radioactive material should be properly packaged and transferred to a place with adequate protection by the carrier.

   1.2 Radioactive materials should be transported with a proper labels and container with adequate shielding to minimize exposure and to prevent contamination.
1.3 Transfer of package with higher radiation level may require a special approval from RPO/RPS.

1.4 Basic principle of radiation protection (shielding, time and distance) should be applied while transferring package of radioactive material to minimize the dose received.

2. Inter-Department Transfer.

2.1 Appointed personnel will prepare the radioactive materials for any clinical procedures needed.

2.2 The radioactive material should be properly packaged and transferred to a place with adequate protection by the carrier.

2.3 Radioactive materials should be transported with a proper labels and container with adequate shielding to minimize exposure and to prevent contamination.

2.4 Radiation level on external surface of packages should be below 2 mSv/hr.

2.5 Prepare transport document. The carrier shall fill-up all necessary information in the transportation form.

2.6 Movement of RAM should be recorded in the source inventory.

2.7 Transfer of package with higher radiation level may require a special approval from RPO / RPS.

2.8 Basic principle of radiation protection (shielding, time and distance) should be applied while transferring package of radioactive material to minimize the dose received.

3. Outside of Premises (Different Premises).

3.1 Require Class D license for those involve in transporting RAM

3.2 Consignor need to obtain an approval letter from appropriate authority before transporting the RAM.

3.3 All personnel involve in doing transportation RAM must wear a personnel dose monitoring device.

3.4 Measure external exposure at 1 meter and surface of package and record the reading. Repeat measurement for other surfaces (refer to Attachment 1).
3.5 The consignor shall ensure that all packages containing RAM comply with all the relevant requirements of Radiation Protection (Transport) Regulations 1989.

3.6 RAM must be packaged in unbreakable secondary containers with enough absorbent material that will absorb twice the amount of liquid.

3.7 Ensure the package is properly categorized, labelled, marked and packed according to Radiation Protection (Transport) Regulations 1989.

3.8 Prepare transport document. The transporter must fill-up all necessary information in the transportation form.

3.9 Ensure that radioactive material is received by consignee.

3.10 The consignor and consignee shall keep the records of transport document for reference.

**RECORD**

<table>
<thead>
<tr>
<th>No.</th>
<th>Record Name</th>
<th>Record Keeping Period</th>
<th>Location</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Packaging List Form</td>
<td>3 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transport Radioactive Material Form</td>
<td>3 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radioactive Source Inventory Record</td>
<td>3 years</td>
<td></td>
</tr>
</tbody>
</table>

**ATTACHMENT**

Attachment 1: Packaging List Form
Attachment 2: Transport Radioactive Material Form
Attachment 3: Radioactive Source Inventory Record
Within Department Transfer

Start

RAM properly packaged by the transporter

Transport RAM with proper container with an adequate shielding and label

Transfer of a package with higher radiation level may require a special approval from a responsible officer

Apply basic principle shielding, time and distance while transfer RAM

End
Inter-Department Transfer

Start

1. Appointed personnel prepared for RAM
2. RAM properly packaged by the carrier
3. Transport RAM with a proper container with adequate shielding and label
4. The radiation level on the external surface of a package ≤ 2 mSv/hr
5. The carrier prepare transport document and fill-up all information
6. Movement should be recorded in the source inventory
7. Transfer of a package with higher radiation level may require a special approval from a RPO / RPS
8. Apply basic principle shielding, time and distance while transfer RAM

End
Outside of Premises (Different Premises)

Start

Require Class D license for those involve in transporting RAM

Consignor need to obtain an approval from appropriate authority before transporting the RAM

All personnel involve in transporting RAM must wear a personnel dose monitoring device

Measure external exposure at 1 meter and surface of package and record the reading. Repeat measurement for other surfaces (refer to Attachment 1)

The consignor shall ensure that all packages containing RAM comply with all the relevant requirements of Radiation Protection (Transport) Regulations 1989

RAM must be packaged in unbreakable secondary container

Ensure the package is properly categorized, labeled, marked and packed according to Radiation Protection (Transport) Regulations 1989

Prepare transport document. The carrier fill-up all necessary information in the transportation form

Ensure that RAM is received by consignee

The consignor and consignee shall keep the records of transport document for reference

End
REFERENCES

1. Radiation Protection (Transport) Regulation 1989
2. IAEA Safety Standard; Regulation For The Safe Transport of Radioactive Material 2009 Edition
PACKAGING LIST FORM

Your Reference : 
Our Reference : 
Date : 

TRANSPORTATION OF RADIOACTIVE MATERIALS

To : (place for transport)

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Quantity</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>1</td>
<td>Product Name</td>
<td></td>
<td>** Upon Receipt</td>
</tr>
<tr>
<td></td>
<td>Radioactivity</td>
<td></td>
<td>Radioactivity (mCi) :</td>
</tr>
<tr>
<td></td>
<td>Volume</td>
<td></td>
<td>Time :</td>
</tr>
<tr>
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<td>Time</td>
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</tbody>
</table>

Acknowledgement of Delivered :
I/we hereby confirm that the good as described above are delivered in good order and conditions

( Signature and Company Stamp)

Name : 
I.C No : 
Date : 
Time :

Acknowledgement of Received :
I/we hereby confirm that the good as described above are received in good order and conditions

( Signature and Company Stamp)

Name : 
I.C No : 
Date : 
Time :
Data of Radiation Monitoring

1. Dose rate at the surface and 1 meter from Radioactive Container (µSv/h) :

<table>
<thead>
<tr>
<th>No</th>
<th>Surface (µSv/h)</th>
<th>1 meter (µSv/h)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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<td></td>
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<tr>
<td>B</td>
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</table>

2. Transport Index (TI) :

3. Dose Rate at the Transport Vehicle :

<table>
<thead>
<tr>
<th>No</th>
<th>Location</th>
<th>Surface (µSv/h)</th>
<th>1 meter (µSv/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rear Compartment - Right</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Rear Compartment - Left</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Rear Compartment - At the Back</td>
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<tr>
<td>4</td>
<td>Driver's Seat</td>
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<tr>
<td>5</td>
<td>Co-Driver's Seat</td>
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Done By   :

Date   :

Time   :

For the Radioactive container Measurement
## Transport Radioactive Material Form Nuclear Medicine To

<table>
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<tr>
<th>Date:</th>
<th>Physical of Radioactive:</th>
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<tbody>
<tr>
<td></td>
<td>The Radiation Exposure From:</td>
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<td></td>
<td>Type of Isotope:</td>
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<td>Surface Area:</td>
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<td>Type of Radiopharmaceutical:</td>
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<td>1 meter Distance:</td>
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<td></td>
<td>Total Activity:</td>
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</tbody>
</table>

Prepared by: | Time: | Sign: |
Transport by: | Time: | Sign: |
Receiver by: | Time: | Sign: |
## RADIOACTIVE SOURCE INVENTORY RECORD

<table>
<thead>
<tr>
<th>NO.</th>
<th>LOT NUMBER</th>
<th>RADIOISOTOPE</th>
<th>ACTIVITY / VOLUME</th>
<th>FORM</th>
<th>TRANSFER TO</th>
<th>TRANSFER BY</th>
<th>RECEIVED BY</th>
<th>RECEIVED DATE</th>
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</table>
STANDARD OPERATING PROCEDURE FOR STORAGE OF RADIOACTIVE MATERIAL

OBJECTIVE
The objective of this standard operating procedure is to prevent theft, loss, unauthorized withdrawal of radioactive materials or unauthorized access to the controlled areas.

SCOPE
This procedure applies to all radioactive materials.

DEFINITIONS
1. Radioactive Material – Any nuclear fuel, radioactive product or radioactive waste.
2. Storage Area for Radioactive Material – a designated area for radioactive materials storage which can be accessed by the appointed personnel only.

ABBREVIATIONS AND SYMBOLS
mCi  millicurie
ml  millilitre
RAM  Radioactive Material
RPO  Radiation Protection Officer
RPS  Radiation Protection Supervisor

WORK INSTRUCTION
1. Radioactive materials should be stored in storage area or designated area or specific area.
2. Stored radioactive materials must be adequately shielded.
3. Medical physicist must ensure the storage area must be locked at all time and can only be accessed by appointed personnel.
4. Radiation warning sign must be displayed on the storage area door.
5. Only appointed personnel are allowed to mobilise the radioactive material from the storage area.
6. Radioactive materials that have been removed from the storage area have to be checked and ensure in a good condition.

7. The details of the radioactive materials including type of sources, activity, relocation and the name of person responsible must be recorded whenever the radioactive material is taken in/out from the storage area.

8. Storage area must be checked & monitored regularly to detect presence of the leakage or contamination. Perform leakage test if necessary.

9. In the event of fire breakout, RPO / RPS has to inform fire fighter the location of stored radioactive materials.

10. Record of all finding and investigation must be kept for future reference.

**RECORD**

<table>
<thead>
<tr>
<th>No</th>
<th>Record Name</th>
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<tbody>
<tr>
<td></td>
<td>Radioactive Materials Tracking Form</td>
<td>3 Years After Disposal</td>
<td></td>
</tr>
</tbody>
</table>

**ATTACHMENT**

Attachment 1: Radioactive Materials (Sealed Source) Tracking Form
WORK FLOW

Receiving Radioactive Materials For Storage

START

Receiving radioactive materials for storage purpose

Fill in the radioactive material tracking form

Identify room and location of storage

Put the radioactive materials in the identified location with proper shielding

Ensure location of storage is locked

Survey the room to prevent contamination (Refer Contamination Survey /Wipe Test Report Form)

Contamination Detected?

No

Yes

Refer SOP For Contamination and Decontamination for Workplace

Record

End
Transfer of Radioactive Materials

START

Transfer of radioactive materials (sealed source)

Obtain authorization from RPO/RPS

Fill in the radioactive material tracking form

Remove the radioactive material from the storage location with care

Has the radioactive material being returned?

Yes

Visually inspect the physical condition of the radioactive materials

Return the radioactive materials into its designated storage location

Update the radioactive material tracking form

END

No

Inform RPO for investigations (Refer SOP for Radiation Incident and Accident in Nuclear Medicine Department)
REFERENCES

2. IAEA Safety Report Series No. 40, Applying Radiation Safety Standards in Nuclear Medicine
# RADIOACTIVE MATERIALS (SEALED SOURCE) TRACKING FORM

<table>
<thead>
<tr>
<th>Receiving Date</th>
<th>Name of Radioactive Material</th>
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<tbody>
<tr>
<td>Location</td>
<td>Reference Activity</td>
</tr>
<tr>
<td>Storage Area</td>
<td>Reference Date</td>
</tr>
<tr>
<td>Usage</td>
<td>Concentration (if related)</td>
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<tr>
<td>Supplier (Name of Company)</td>
<td>Volume (ml) (if related)</td>
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<tr>
<td>Serial Number</td>
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**ATTACHMENT**

Attachment 1: Radioactive Materials (Sealed Source) Tracking Form
WORK FLOW

Receiving Radioactive Materials For Storage

START

Receiving radioactive materials for storage purpose

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Ensure location of storage is locked

Survey the room to prevent contamination (Refer Contamination Survey/Wipe Test Report Form

Contamination Detected?

No

Yes

Refer SOP For Contamination and Decontamination for Workplace

Record

End
Transfer of Radioactive Materials

START

Transfer of radioactive materials (sealed source)

Obtain authorization from RPO/RPS

Fill in the radioactive material tracking form

Remove the radioactive material from the storage location with care

Has the radioactive material being returned?

Yes

Visually inspect the physical condition of the radioactive materials

Return the radioactive materials into its designated storage location

Update the radioactive material tracking form

END

No

Inform RPO for investigations (Refer SOP for Radiation Incident and Accident in Nuclear Medicine Department)
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STANDARD OPERATING PROCEDURES FOR RADIOACTIVE MATERIAL INVENTORY MANAGEMENT IN NUCLEAR MEDICINE DEPARTMENT
STANDARD OPERATING PROCEDURE FOR MANAGEMENT OF RADIOACTIVE WASTE

OBJECTIVE
This procedure ensures that radioactive waste is disposed in accordance with the Atomic Energy Licensing Act 304 (Radioactive Waste Management) Regulations 2011.

SCOPE
This document applies only to radioactive waste and waste management arising from Nuclear Medicine services except for patients undergoing treatment of Iodine131 (refer to Standard Operating Procedures for Patients Undergoing Treatment of Iodine131 in Nuclear Medicine Department).

DEFINITIONS
1. Clearance levels – the values established by the appropriate authority and expressed in terms of activity concentration and/or total activity, at or below which the source of radiation may be released from the control of the appropriate authority.
2. Radioactive Waste – substance or article that contains or is contaminated with radionuclide at activity concentration or activities greater than clearance levels and for which no use is foreseen.

ABBREVIATIONS AND SYMBOLS
Bq  Becquerel
hr  hour
ml  milliliter
MOH  Ministry of Health
RPO  Radiation Protection Officer
RPS  Radiation Protection Supervisor
Sv  Sievert
TYPES OF RADIOACTIVE WASTE

Radioactive waste generated from sealed or unsealed sources in Nuclear Medicine is generally in a form of a solid or liquid. These include:

1. Liquid wastes.
   1.1 Unused radiopharmaceuticals and remains of labeled compounds from radioassay kits.
   1.2 Excreta from patients who have received radiopharmaceuticals in the course of diagnostic or therapeutic studies.
   1.3 Supernatant solution from radioassay kits.
   1.4 Water used to rinse or wash contaminated apparatus.
   1.5 Blood samples from patients undergoing blood volume determination or radionuclide haematological studies.
   1.6 Remains of radioactive stock and standard solution.

2. Solid wastes
   2.1 Contaminated syringes, swabs, needles, drip set, preparation vials, bottles and drinking straws used in nuclear medicine.
   2.2 Contaminated absorbent papers, towels, bed linens, patient’s gowns or hospital’s clothing, bed, syringe shields and disposable gloves.
   2.3 Contaminated glass wares used in in-vitro laboratory such as test tubes, pipettes, measuring flasks, cylinders, beakers and dishes.
   2.4 Contaminated disposable plastic tips, plastic tubes and media used in the separation of bound from free radioactive compounds in radioimmunoassay test.
   2.5 Used radionuclide generator ($^{99m}$Tc / $^{68}$Ga).

WORK INSTRUCTION

1. Responsibilities

   The RPO / RPS or appointed personnel is responsible for ensuring that these procedures are carried out and all trained staff must follow these procedures. Any problems relating to the storage and disposal of radioactive waste must be referred to the RPO / RPS or appointed personnel.

2. Disposal of Radioactive Wastes

   2.1 Solid Radioactive Waste

   2.1.1 Each radioactive waste should be separated according to half-lives of radionuclides.
2.1.2 All sharp items generated from radioactive waste (syringe, needle, vial, etc) shall be deposited into lead lined sharp bins with radioactivity hazard symbol outside the shielded bin at designated area.

2.1.3 All non-sharp items generated from radioactive waste (gloves, absorbent paper and etc) shall be deposited into lead lined radioactive waste bin with radioactivity hazard symbol outside the shielded bin at designated area.

2.1.4 After the waste bin is maximum two-third full, the bin shall be closed with lid and securely sealed and labelled properly.

2.1.5 The appointed personnel shall collect these radioactive waste and transfer into the designated radioactive waste room for decay process.

2.1.6 The radioactive waste shall be stored for decaying up to 10 half-lives. After 10 half-lives the dose rate shall be measured before send to third party for disposal process.

2.1.7 Otherwise the radioactive waste can be disposed if radiation level is below 5 µSv/hr on surface.

2.1.8 There are two options for radionuclide generators:
(1) Returning to the supplier after use or
(2) Waiting for decay and dismounting of the elution column afterwards. After a waiting time of 1.5 – 2 months, when the activity and the dose rate are so low that the elution column can be removed, the generator can be dismantled and the material be considered as non-radioactive. Labels should then be removed. Approval from appropriate authority must be obtained prior to dismantling.

2.1.9 All radioactive waste disposals shall be recorded.

2.2 Disposal of Liquid Radioactive Waste

2.2.1 Waste produced from short half-lives radionuclides like $^{99m}$Tc and $^{18}$F should be separated from those of longer half-lives and placed in the separate lead lined waste containers.

2.2.2 Waste produced from medium half-lives radionuclides like $^{131}$I, $^{125}$I, $^{201}$Tl, $^{67}$Ga, $^{99m}$Tc and $^{133}$Xe can be stored in the waste room for decay up to 10 half-lives.

2.2.3 Waste produced from long half-lives radionuclides like $^{51}$Cr, $^{58}$Fe, $^{57}$Co, $^{58}$Co and $^{125}$I should be stored for a longer period for decay.

2.2.4 Excreta from patients receiving radiopharmaceuticals for diagnostic scan can be discharged directly into the hospital sewerage system.

2.2.5 Rinsing water used for cleaning contaminated apparatus and supernatant solution from radioimmunoassay tests generally contain very low level of radioactivity and
2.2.6 The radioactive waste shall be stored for decaying up to 10 half-lives. After 10 half-lives the dose rate shall be measured before send to third party for disposal process.


2.2.8 All radioactive waste disposals shall be recorded.

2.3 Return and Disposal of Unused Sealed Source

2.3.1 Sealed sources such as $^{57}$Co, $^{137}$Cs, $^{68}$Ge, etc are used for calibration and quality control of Nuclear Medicine instrument.

2.3.2 Unused sealed source must be kept in the designated area / waste room for decay or until return back to manufacturer.

2.3.3 The user must write and get an approval from appropriate authority (MOH) for disposal purpose.

2.3.4 By practical approach the unused sealed source must be returned to the manufacturer. If a user is unable to return the used sealed source to its manufacturer, the user shall obtain a written approval from MOH prior to sending the used sealed source to the radioactive waste management facility. The radioactive waste management facility shall be approved by the appropriate authority (MOH).

2.3.5 The dose rate shall be measured and recorded before send to manufacturer.

**RECORD**

<table>
<thead>
<tr>
<th>No.</th>
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<td>Radioactive Waste Disposal Form</td>
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<td></td>
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</table>

**ATTACHMENT**

Attachment 1: Radioactive Waste Disposal Form
Solid and Liquid Waste Disposal

START

Appointed personal collect the radioactive waste and send to the Radioactive Waste Room

Dose concentration > Second schedule
Dose rate > 5 µSv/hr

Medical Physicist measure the dose rate of solid or dose concentration of liquid radioactive waste

The radioactive waste shall remain in the radioactive waste room

Dose concentration < Second schedule
Dose rate < 5 µSv/hr

Waste can be discharged

END

Radionuclide Generator Disposal

START

Unused radionuclide generator

Returning to the supplier after use

Waiting for decay and dismounting of the elution column afterwards

Medical Physicist measure, record and keep the dose rate of radioactive waste

END
Sealed Source Disposal

START

Unused sealed source

Keep in the designated area / waste room for decay or until return back to manufacturer

Get an approval from authority (MOH) for disposal purpose

Manufacturer feedback for disposal

No

Get approval from MOH to send the used sealed source to the radioactive waste management facility

Yes

Medical Physicist measure, record and keep the dose rate of radioactive waste

Send to manufacturer or waste management facility

END
## Radioactive Waste Disposal Form

<table>
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<th>Radionuclides</th>
<th>Waste Details (solid / liquid)</th>
<th>Date of Storage</th>
<th>Performed By</th>
<th>Date of Disposal</th>
<th>Disposal Level (Bq/ml or µSv/hr)</th>
<th>Performed By</th>
<th>Verified By</th>
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REFERENCES

STANDARD OPERATING PROCEDURES
FOR RADIOACTIVE CONTAMINATION
CONTROL IN NUCLEAR MEDICINE
DEPARTMENT

Medical Radiation Surveillance Division
Ministry of Health Malaysia
April 2017
STANDARD OPERATING PROCEDURES FOR RADIOACTIVE CONTAMINATION CONTROL IN NUCLEAR MEDICINE DEPARTMENT

1) STANDARD OPERATING PROCEDURE FOR CONTAMINATION AND DECONTAMINATION AT WORKPLACE
2) STANDARD OPERATING PROCEDURE FOR PERSONNEL CONTAMINATION
STANDARD OPERATING PROCEDURE FOR CONTAMINATION AND DECONTAMINATION AT WORKPLACE

OBJECTIVE

This guideline applies to personnel responsible for conducting contamination surveys and decontamination for workplace.

SCOPE

This document provides procedures to be applied to all radionuclide contamination surveys and decontamination of workplace in Nuclear Medicine Department.

DEFINITION

1. Contamination – The presence of radioactive material in or on a material, human body, environment or other place where there are undesirable or could be harmful.
2. Decontamination – The complete or partial removal of contamination by a deliberate physical, chemical or biological process.
3. Fixed Contamination – Is that which cannot be readily removed.
4. Removable Contamination – Is transferable to other surface that can result wide spread surface contamination and lead to internal contamination of employees.

ABBREVIATIONS AND SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>µSv/h</td>
<td>microSievert/hour</td>
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<tr>
<td>Bq/cm²</td>
<td>Becquerel per meter squared</td>
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<td>centimeter</td>
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<td>m</td>
<td>meter</td>
</tr>
<tr>
<td>RPO</td>
<td>Radiation Protection Officer</td>
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<tr>
<td>RPS</td>
<td>Radiation Protection Supervisor</td>
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1. Procedure for monitoring contamination.

1.1 Survey method using Calibrated Radiation Meter for fixed and removable contamination.

1.1.1 Set the instruments parameters. Cover the probe/radiation meter with plastic to avoid contact. Test the battery, reset the reading and measure background reading at about 3-5 m from the contaminated surface.

1.1.2 Assess the potential contaminant area.

1.1.3 Obtain a reading by hold the detector at a distance about 1 cm from the contamination surface.

1.1.4 Calculate the indicated total surface contamination by subtract the background from the surface reading.

1.1.5 If the reading exceeds 5 µSv/hr, proceed with decontamination procedure.

1.1.6 Record the result.

1.2 Wipe test method for removable contamination.

1.2.1 Use cotton swab or wipe test smears to take several samples from different areas.

1.2.2 An area of 100cm² is simply wiped.

1.2.3 Place sample in separate small vial, plastic or envelope.

1.2.4 Label each vial or envelope noting the location of the samples.

1.2.5 Samples are place in a liquid scintillation counter or well-counter.

1.2.6 If the reading exceeds Table 1, proceed with decontamination procedure.

<table>
<thead>
<tr>
<th>Class</th>
<th>Radionuclide</th>
<th>Surface &amp; equipment in controlled areas (Bq/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$^{75}$Se, $^{99}$Sr, $^{125}$I, $^{131}$I, $^{32}$P</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>$^{18}$F, $^{51}$Cr, $^{67}$Ga, $^{99m}$Tc, $^{201}$Tl, $^{123}$I</td>
<td>300</td>
</tr>
<tr>
<td>C</td>
<td>$^{3}$H, $^{127}$Xe, $^{133}$Xe</td>
<td>3000</td>
</tr>
</tbody>
</table>

Adapted from ICRP publication 57

The above levels are not appropriate for volatile compounds or radionuclide, which can readily penetrate the skin surface.
1.2.7 Record the result.

2. Procedure For Decontamination of Radioactive Spill.

2.1 Prepare decontamination supplies list as below:

a) Caution line tape mark off perimeters and areas of operation.
b) Radiation Contamination Meters.
c) Decontamination solution (Radiacwash / Soap / Detergent).
d) Disposable absorbent towels / paper towel / absorbent material.
e) Hazardous waste containers / plastic bags.
f) Tong or forceps.

2.2 There are two category of Radioactive spill:

a) Minor spill
b) Major spill

2.3 Minor spill happen if:

Those where small drops or easily cleaned spills are contained on absorbent pads and pose no major hazards to workers. All spills of radioactive material are classified as a minor spill unless any of the following conditions are met; in which case it would be defined as a major spill.

2.4 Minor spills procedure such as:

2.4.1 Notify all other persons in the room at once.
2.4.2 Keep the number of persons necessary to deal with the spill to a minimum.
2.4.3 Confine the spill immediately.
2.4.4 Decontaminate the area.
2.4.5 Monitor for residual loose contamination.
2.4.6 Repeat decontamination until monitoring shows less than 5 μSv/hr at surface in accordance with the local regulation.
2.4.7 If unable to decontaminate to acceptable levels, notify the RPO / RPS.
2.4.8 No person can resume work until decontamination is complete.
2.4.9 Consult RPO / RPS to determine if a bioassay is required.

2.5 Major spill happen if:

2.5.1 When a spill involves breakage of storage vial or contents spilled from vial or syringe.
2.5.2 When a spill involves any radioisotope of very high radiotoxicity.
2.5.3 When a spill involves release of volatile material.
2.5.4 When it is suspected that inaccessible areas are contaminated.
2.5.5 When reasonable efforts to decontaminate are not successful.
2.5.6 When there is any doubt about appropriate decontamination procedures.
2.5.7 Any rupture or suspected rupture of a sealed source.

2.6 Major Spill procedure such as:

2.6.1 Notify all persons not involved in the spill to vacate the lab at once.
2.6.2 If the spill is liquid take measures to contain the spill. Delineate outer margin of spill with tape.
2.6.3 Switch off all air circulating devices.
2.6.4 Vacate the room and immediately notify RPO / RPS.
2.6.5 Ensure persons vacating the lab remain in the immediate area to be monitor for personal contamination.
2.6.6 Take immediate steps to decontaminate personnel involved as necessary.
2.6.7 Post warning signs to prevent entry into contaminated area.
2.6.8 Proceed to decontaminate area, wipe test for loose contamination and survey for fixed contamination.
2.6.9 Prohibit any work in the area until survey results are known and approval is given by RPO /RPS.
2.6.10 Ensure the complete history of the incident is documented.
2.6.11 Surface contamination derived limit in Table 1.
2.6.12 Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

2.7 Decontamination procedure

2.7.1 The contaminated area should be decontaminated by using decontamination solution and disposable absorbent towels/paper towel or any absorbent material.
2.7.2 Allow the decontamination solution to settle on the contaminated area for several minutes before proceed with decontamination process.
2.7.3 If the contamination occurred on top of an absorbent material, remove the contaminated material, put it into plastic bag and dispose it as radioactive waste. Small objects such as tongs and glassware can be cleaned by agitated submersion in a hot water.
2.7.4 The RPO/RPS should be informed of the contamination incident as soon as possible.

3.1 Medical Physicist shall record all readings on Contamination and Decontamination Form.

**RECORD**

<table>
<thead>
<tr>
<th>No.</th>
<th>Record Names</th>
<th>Record Keeping Period</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contamination and Decontamination Form</td>
<td>3 Years</td>
<td>Nuclear Medicine Department</td>
</tr>
</tbody>
</table>

**ATTACHMENT**

Attachment 1: Contamination and Decontamination Form
WORK FLOW

Monitoring Workplace Contamination

Start

Obtain background reading using calibrated radiation meter

Fixed contamination

No

Take several wipe test sample

Samples are place in a liquid scintillation counter or well-counter

Exceed limit? (5μSv/hr or Table 1)

Yes

Decontamination process (Refer to decontamination workflow)

No

Clean?

Yes

End
Decontamination of Radioactive Spill at Workplace

Start

- Notify all persons to vacate the contamination area
- Prepare the decontamination supply kit
- Delineate the margin of contamination area
- Remove the contaminated material and put in plastic bag
- Use disposable absorbent towel and decontamination solution for several times
- Move the contaminated waste to waste room for decay process

End
REFERENCES

3. Manual on Radiation Protection in Hospitals and in General Practice, Volume 4: Nuclear Medicine (page 69)
**ATTACHMENT 1**

Contamination and Decontamination Form

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>PRE-CLEAN Survey / Wipe test reading</th>
<th>POST- CLEAN Survey / Wipe test reading</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mSv/hr</td>
<td>Bq/cm²</td>
<td>μSv/hr</td>
</tr>
</tbody>
</table>

Date: ____________________________

Time: ____________________________

The spill occurred at ________ : ________ am / pm

Decontamination completed at ________ : ________ am / pm

Performed by, ________________________________

Verified by, ________________________________

(________________________) (________________________)
STANDARD OPERATING PROCEDURE FOR PERSONNEL CONTAMINATION

OBJECTIVE

To ensure all internal and external decontamination procedures on personnel are carried out effectively.

SCOPE

This document provides procedures in managing all radionuclide internal and external contamination of personnel in nuclear medicine department.

DEFINITION

1. External contamination – radioactive material, as thus, solid particles, aerosols or liquid, becomes attached to victim’s skin or clothes.
2. External exposure – an exposure resulting from a radiation source outside the body.
3. Internal contamination – occurs when people ingest, inhale or are injured by radioactive material.
4. Internal exposure – an exposure resulting from a radiation source inside the body.
5. Personnel – worker / non-radioactive patient / member of the public / a person who knowingly assists in the support of a patient
6. Radioactive contamination – the contamination of any material, surface or environment of or any person, including both external skin contamination and internal contamination irrespective of the method of intake, by any radioactive material, nuclear material or prescribed substance.

ABBREVIATIONS AND SYMBOLS

- µCi microcurie
- Bq/m³ Becquerel per meter cubed
- DAC Derived Air Concentration
- IAEA International Atomic Energy Agency
- kBq kilobecquerel
- MBq Megabecquerel
- mCi millicurie
EXTERNAL CONTAMINATION

Proper monitoring of personnel can detect and measure alpha, beta or gamma emitters: radiation type depends on isotope in contaminant.

1. Localized Contamination:

1.1 Decontamination Procedures.

1.1.1 Remove contaminated clothing. Bag, label and store in radioactive waste room for decay.

1.1.2 Survey for any residual contamination on the body.

1.1.3 Cover uncontaminated body area with plastic sheet if necessary to avoid spread of contamination.

1.1.4 Wash affected area with running tap water and detergent.

1.1.5 Use mechanical action of flushing and/or friction of clothes, sponge or soft brush.

1.1.6 Rinse area with running tap water and gentle dry.

1.1.7 After drying, survey the contaminated body area to determine effectiveness of decontamination and record all readings.

1.1.8 Repeat steps (1.1.4) – (1.1.7) until contamination is removed.

2. Specific Contaminated Body Part:

2.1 Decontamination Procedure – General Body

2.1.1 Survey entire body and record all readings.

2.1.2 Visibly mark (e.g. with marker pen) the highly contaminated body area.

2.1.3 Contaminated personnel should shower using liquid soap or equivalent. Begin with the head and proceed to the feet.

2.1.4 Make an effort not to contaminate hairy areas if they are free of radioactivity initially.

2.1.5 Survey entire body again marking highest levels found.

2.1.6 Repeat (2.1.3) - (2.1.5) until contamination is removed.

2.1.7 Record all readings.

2.2 Decontamination Procedure - Eyes

2.2.1 Irrigate with copious amounts of water.

2.2.2 Survey the affected eye and record all readings.

2.2.3 Repeat (2.2.1) - (2.2.2) until contamination is removed.

2.2.4 After decontamination, treat irrigation induced conjunctivitis as usual.
2.3 Decontamination Procedure - Hair Areas

2.3.1 Survey and record all readings.
2.3.2 Wrap or position personnel to avoid spread of contamination.
2.3.3 Wash with plenty of water or equivalent.
2.3.4 Dry with clean uncontaminated towel. Do not shave hair – if necessary, hair may be cut, but do not injure skin.
2.3.5 Survey and record all readings.
2.3.6 Repeat (2.3.2) - (2.3.5) until contamination is removed.

INTERNAL CONTAMINATION

Internal Contamination Measurement.

1. Direct methods.
   1.1 Whole body counters.
   1.2 Thyroid uptake system.

Refer Standard Operating Procedures For Patients Undergoing Treatment of Iodine 131 In Nuclear Medicine Department Under Ministry of Health:

   a) Thyroid Bioassay on Nuclear Medicine Personnel Working with Iodine 131 (I-131).
   b) Thyroid Uptake System Manufacturer Technical Manual.

2. Indirect methods.
   a) Indirect measurement of contaminant includes nasal swipes to determine respiratory intake of radioactive aerosols, and also urine and faeces sampling to establish internal contamination.
   b) Alpha and beta emitter, the most hazardous internal contaminants, detected through bioassay sampling.
   c) Accurate bioassays require carefully executed sampling over time and knowledge of type and time of contamination. (For more details please refer Guidelines for Bioassay sampling, IAEA).

3. Medical physicist shall record all readings in Contamination Survey Report Form.

RECORD

<table>
<thead>
<tr>
<th>No.</th>
<th>Record Name</th>
<th>Record Keeping Period</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contamination Survey Report Form</td>
<td>3 Years</td>
<td></td>
</tr>
</tbody>
</table>
ATTACHMENT

Attachment 1: Contamination Survey Report Form
Attachment 2: Hazard and Routes of Contamination
Attachment 3: Management of Internal Contamination
External Contamination

Start

Received report of contamination incidents

Ensure survey meter works

Investigate to identify whether the body area are contaminated or clean

Contaminated clothing

Take off clothes/take shower. Put the clothing in a plastic bag in the radioactive waste room

Survey to locate contaminated area

Clean

Yes

Record in Contamination Report

End

No

Perform decontamination procedure
**WORK FLOW**

Internal Contamination

1. **Start**

2. Received report of contamination incidents

3. Investigate to identify radioactive source & type of internal contamination (Inhalation, ingestion, wound, absorption)

4. Ensure Whole Body Counter / Thyroid Uptake System Works

5. Measurement by using Whole Body Counter / Thyroid Uptake System

6. Perform decontamination procedure

7. Resurveyed after decontamination

   - **No**

   - **Yes**

8. Clean

9. Record in Contamination Report Form

10. **End**
REFERENCES


## Contamination Survey Report Form

<table>
<thead>
<tr>
<th>Date / Time</th>
<th>Personnel Name</th>
<th>Type of radionuclide</th>
<th>Location</th>
<th>Reading</th>
<th>Performed by</th>
<th>Verified by</th>
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<tr>
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</tbody>
</table>
Hazard and Routes of Contamination

Factors determining extent of contamination hazard:

a) Amount of radionuclide(s)
b) Energy of type of radiation
c) Biological and radiological half-life
d) Critical organ
e) Chemical and physical properties of radionuclide

In order of decreasing frequency, contaminants enter the body by four principle routes:

1. Inhalation
   - Particularly likely the explosion or fire.
   - Particle characteristics important (size, chemical composition, solubility in body fluids).
   - Fate of inhaled particles dependent on physicochemical characteristics (for more details please refer to IAEA document on external & internal Contamination).

2. Ingestion
   - Critical for general public after accidental environmental release.
   - All swallowed radioactive material enters digestive tract.
     - Primarily from contaminated food and water.
     - Secondarily for respiratory tract.
   - Absorption from gastrointestinal tract depends.
     - Chemical make-up and solubility of contaminant (for more details please refer to IAEA document on external & internal Contamination).
     - GI absorption < 10% for most elements.
     - Elements of high absorption.
       - Radium (20%)
       - Strontium (30%)
       - Tritium (100%)
       - Iodine (100%)
       - Caesium (100%)

3. Wound contamination
   - Any wound considered contaminated until proven otherwise.
4. Absorption

- Generally, radionuclides do not cross intact skin, so uptake by this route does not occur.
- More important exceptions are: tritium, iodine and caesium.
- Skin wounds, including acid burns, abrasive scrubbing, create portal for particulate contamination to subcutaneous tissue, bypassing epithelial barrier.
Management of Internal Contamination

First Action

1. Life threatening conditions have priority over considerations of radioactive exposure or contamination. Attention to vital functions and control of haemorrhage take priority.

2. Contamination levels almost never serious hazard to personnel for time required to perform lifesaving measures and decontamination.

Principles of treatment

1. The procedures recommended for the treatment of persons with acute of persons with acute internally deposited radionuclides are intended to reduce the absorbed radiation dose and hence the risk of possible future biological effects.

2. These aims can be accomplished by the use of two general processes:
   
   (i) Reduction of absorption and internal deposition and
   (ii) Enhances elimination or excretion of absorbed nuclides.

3. Both are more effective when begun at the earliest time after exposure.

4. Treatments are most effective if the uptake of the contaminants into the systemic circulation is prevented. Administration of diluting and blocking agents is effective in some instances because it may also enhance the elimination rates of the radionuclide or reduce the quantity of radionuclide deposited into tissue. Therapeutic measures that use mobilizing agents or chelating drugs are less effective when the radionuclide has already moved into the tissue cells.

5. The most important considerations in treatment are:
   
   (i) Selection of the proper drug for the particular radionuclide
   (ii) Timely administration after exposure
   (iii) Identification of radiation material
   (iv) Identification of antidote
PRECAUTION

External Contamination

Precaution During Elution / Transporting / Injection / Imaging / Branula Removal

1. All procedures involving radioactive materials must be performed only by trained and competent personnel.

2. Elution: - Always put the elution vial carefully in place to avoid dropping. The vial may broke if fallen, thus may causing major contamination. Avoid any distraction that may affect your concentration during performing elution or any procedures involving radioactive material.

3. Radiopharmaceutical Preparation:- Contamination may occur during expelling excess air in the syringe, while radiopharmaceutical has been drawn. First, needle cap must be put at the end of the needle, and hold the syringe with the needle facing upright. Then, draw the plunger slightly back to remove any residual solution from the needle and then push the plunger inwards to expel air. Later, cap the needle properly, while at the same time check the needle to ensure it is tightly attached to the syringe. This is important to avoid leaking/spillage during injection.

4. Transporting:- Use designated (lead-lined) syringe carrier to transport the injection syringe.

5. Injection - Test injection (IV) line first by flushing normal saline to ensure no blockage, before administrating the radiopharmaceutical. For procedures in which injection need to be performed with patient positioned ‘on table’, the collimator / floor area that possibly contaminated must be covered with absorbent paper the before the injection. Immediately after finish injection, turn the needle upwards and recap.

6. Imaging - Before patient positioning, couch must be covered with removable protective cover (e.g. absorbent paper).

7. Branula / cannula removal: First prepare the gauze and tape to be ready for use. Hold a piece of gauze over the insertion site while removing the branula / cannula, and immediately apply firm pressure to the site. The patient then instructed to continue applying the firm pressure for approximately five minutes or long enough to ensure that there is no subcutaneous leakage of blood. Dispose the branula / cannula in the designated lead-lined bin.

8. Staff handling radioactive material during any procedure (including all the above) must wear suitable PPE (glove etc.) in order to avoid personal
(skin / attire) contamination. Hand washing is necessary after finishing those procedures.

9. If any radioactive material spillage or contamination occurs, physicist must be notified immediately to proceed with decontamination procedures.

**Internal Contamination**

**Ingested, Inhaled, Wound Contamination, Absorption of Radionuclides**

1. Either after each procedure or before leaving the areas monitors your hands for contamination in a low-background area with a survey instrument.

2. Do not eat, drink, smoke, or apply cosmetics in any area where radioactive material is stored or used.

3. Do not store food, drink, or personal effects in areas where radioactive material is stored or used.

4. Pipetting by mouth are forbidden.

5. All operations involving radioactive gases or aerosols should be carried out in a fume hood or similar ventilated device to prevent airborne/radioactive gases, vapors or particulate material contamination (Refer SOP for management of thyroid bioassay on nuclear medicine). Exhaust vents must be situated well away from air intakes.

6. All such containers are to be adequately sealed and shielded at all times. Except for very small activities, containers are not to be handled directly and, if possible, tongs or forceps for vials and syringe shields should be used.
STANDARD OPERATING PROCEDURES
FOR MANAGEMENT OF INCIDENT,
ACCIDENT, EMERGENCY AND SPECIAL
PROCEDURES IN NUCLEAR MEDICINE
DEPARTMENT

Medical Radiation Surveillance Division
Ministry of Health Malaysia
April 2017
STANDARD OPERATING PROCEDURES FOR MANAGEMENT OF INCIDENT, ACCIDENT, EMERGENCY AND SPECIAL PROCEDURES IN NUCLEAR MEDICINE DEPARTMENT

1) STANDARD OPERATING PROCEDURE FOR RADIATION INCIDENT AND ACCIDENT
2) STANDARD OPERATING PROCEDURE IN THE EVENT OF EMERGENCY
3) STANDARD OPERATING PROCEDURE FOR SPECIAL PROCEDURES IN NUCLEAR MEDICINE
STANDARD OPERATING PROCEDURE FOR RADIATION INCIDENT AND ACCIDENT

OBJECTIVE
This procedure serves as a guide to individuals and nuclear medicine centres when handling radiation incident and accident. It is recommended that good radiation practice should be implemented in the interests of reducing radiation exposure and risks.

SCOPE
This document applies to incident and accident in the Nuclear Medicine Department.

DEFINITIONS
1. Sealed source – a radiation source consisting of any radioactive material, nuclear material or prescribed substance firmly incorporated in solid and effectively inactive material, or sealed in an active container of sufficient strength to prevent any dispersion of its contents under normal conditions of use.
2. Unsealed source – ionizing radiation in the form of radioactive material which is not encapsulated or otherwise contained.

ABBREVIATIONS AND SYMBOLS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOD</td>
<td>Head of Department</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>RPO</td>
<td>Radiation Protection Officer</td>
</tr>
<tr>
<td>RPS</td>
<td>Radiation Protection Supervisor</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry of Health</td>
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</tbody>
</table>

WORK INSTRUCTION

Types of radiation incidents and accidents.

A variety of incidents and accident may occur in nuclear medicine practice which can result in the inadvertent radiation exposure of a patient, a member of the public or a staff member. All incidents should be investigated, including ‘near misses’, to minimize the likelihood of such incidents occurring again. These include:
1. Operating errors.

1.1 Operating errors are due to:

1.1.1 Human Factors.

a) Staff.
   - Administration problems (e.g. failed administration, incorrect labeling of pharmaceutical, incorrect dosage of radiopharmaceutical or extravasation etc).
   - Acquisition problems (e.g. incorrect field, inadequate counts obtained, inadequate views obtained, artefacts etc).
   - Computer problems (e.g accidental deletion of patient studies).

b) Patient.
   - Mainly movement due to (e.g inadequate instructions to patient, inadequate sedation especially in children or unable to image child).

1.1.2 Machine factors

a) Power interruption.
b) Computer problems (e.g component damage).
c) Mechanical problem.

1.2 If operating error is detected by any staff, he or she should inform RPO/RPS.
1.3 RPS will investigate and confirm the error.
1.4 If problem persists, inform HOD and all the staffs involved and stop all related procedures immediately.
1.5 RPO/RPS should contact the related equipment engineer to investigate and rectify the fault, if necessary.
1.6 Record the event by filling up the repeat study form.
1.7 Any incident involving major contamination need to be reported to appropriate authority (MOH) (refer to item 2.6, SOP for Contamination and Decontamination at Workplace).

2. Loss, Theft or Sabotage of Radioactive Source.

It is critical to have an up-to-date inventory so that it can be determined immediately which source(s) is (are) missing, what its type and activity are, when and where it was last known to be, and who last took possession of it.

2.1 Inform directly to RPO, and record the incident.
2.2 RPO, with the help of RPS, will conduct a local search.
2.3 Check all possibilities in the hospital.
2.4 If still not found, notify the appropriate authority (MOH) of such theft, loss or sabotage within 24 hours after discovering the theft, loss or sabotage.

2.5 Submit a complete report of the theft, loss or sabotage in writing to MOH within 30 days after the notification to MOH.

2.6 The report shall contain:

2.6.1 A description of the radiation source, including its quantity and its chemical and physical forms.

2.6.2 A description of the circumstances under which the theft/loss/sabotage occurred.

2.6.3 Location or probable location of the radiation source.

2.6.4 The possible radiation exposure to individuals, circumstances under which the exposure may occur and the extent of potential hazard to members of the public.

2.6.5 The action which has been taken or will be taken to recover the radiation source.

2.6.6 The procedures or measure have been or will be adopted to prevent a recurrence of the theft, loss or sabotage of the radiation source.

2.6.7 Any other information as the necessary.

3. Rupture or Damage of Sealed/Unsealed Sources.

3.1 Evacuate the area immediately.

3.1.1 Inform the RPO, who should confirm the spillage or radiation leakage and supervise the decontamination and monitoring procedures (refer to SOP for Contamination and Decontamination at Workplace).

3.1.2 Record the event and make a report to MOH.

4. Emergency Transfer of Patient Containing Radionuclide.

4.1 RPO/RPS will confirm the defect related with the diagnostic equipment.

4.2 With permission from the HOD, carry out the contingency arrangement which is coordinated by RPO/RPS.

4.3 Arrange appointment at other nuclear medicine centers.

4.4 Follow local procedure of transferring patient to other center.

4.5 Before transporting the patient, RPO/RPS should survey the dose rate of the patient or group of patient at 1 meter distance and the reading should not exceed 50µSv/hr.

4.6 Record the reading of the patient in the Emergency Transfer of Patient form.

4.7 The RPO/RPS should provide adequate radiation monitoring device for staff involved in the transporting of the patients.
4.8 The dose rate of the staff involved to the patient should be recorded.

**RECORD**

<table>
<thead>
<tr>
<th>No.</th>
<th>Record Name</th>
<th>Record Keeping Period</th>
<th>Location</th>
</tr>
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<tr>
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<td>Repeat Study Form</td>
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<tr>
<td></td>
<td>Emergency Transferring of Patients Containing Radionuclide Form</td>
<td>3 years</td>
<td></td>
</tr>
</tbody>
</table>

**ATTACHMENT**

Attachment 1: Repeat Study Form
Attachment 2: Emergency Transferring of Patients Containing Radionuclide Form
OPERATING ERRORS

Start

Inform RPO/RPS regarding the fault.

RPS investigate and confirm the error.

If problem persists, inform HOD and all the staffs involved and stop all related procedures immediately.

RPO/RPS should contact the related equipment engineer to investigate and rectify the fault, if necessary.

Record the event by filling up the repeat study form.

Any incident involving major contamination need to be reported to MOH.

END
Theft, Loss or Sabotage

Start

Inform directly to RPO, and record the incident.

RPO, with the help of RPS, will conduct a local search.

Check all possibilities in the hospital

If still not found, notify the MOH of such theft, loss or sabotage within 24 hours after discovering the theft, loss or sabotage.

Submit a complete report of the theft, loss or sabotage in writing to MOH within 30 days after the notification to MOH.

END
Rupture or Damage of Sealed/Unsealed Sources

Start

Evacuate the area immediately.

Inform the RPO, who should confirm the spillage and supervise the decontamination and monitoring procedures.

Record the event and make a report to MOH.

END
Emergency Transfer of Patient Containing Radionuclide

Start

RPO/RPS will confirm the defect related with the diagnostic equipment.

With permission from the HOD, carry out the contingency arrangement which is coordinated by RPO/RPS.

Arrange appointment at other nuclear medicine centers

Follow local procedure of transferring patient to other center

Measure dose rate of patient at 1 meter distance

Record and keep the reading in Emergency Transferring of Patient Containing Radionuclide form

END
REFERENCES


## Repeat Study Analysis Form

<table>
<thead>
<tr>
<th>No.</th>
<th>RN</th>
<th>Type of Study</th>
<th>Date</th>
<th>Human Factors</th>
<th>Technologist's Level</th>
<th>Doctor's Level</th>
<th>Repeat Study date</th>
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</table>

### Numerator
- Total number of repeat studies per year

### Denominator
- Total number of cases done per year

### Rate of Repeat Study
- \( \frac{\text{Numerator}}{\text{Denominator}} \times 100 \%

### Prepared by
- Head of Department

### Verify by
- Name

### Repeat by
- Responsible person/ Licensee

### Date
- : 

---

STANDARD OPERATING PROCEDURES FOR MANAGEMENT OF INCIDENT, ACCIDENT, EMERGENCY AND SPECIAL PROCEDURES IN NUCLEAR MEDICINE DEPARTMENT
EMERGENCY TRANSFER OF PATIENT CONTAINING RADIOACTIVE TO OTHER NUCLEAR MEDICINE CENTRE

<table>
<thead>
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<tbody>
<tr>
<td>Day</td>
<td>:</td>
</tr>
<tr>
<td>Reason transferring of patient</td>
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<tr>
<td>Transfer patient to</td>
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**PATIENT’S DOSE RATE AT 1 METER**

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<th>No.</th>
<th>Patient’s Name</th>
<th>Patient’s ID</th>
<th>Scan Procedure</th>
<th>Dose rate at 1m distance (μSv/hr)</th>
<th>Time of measurement</th>
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**EXPOSURE DOSE RATE OR ABSORBED DOSE RECEIVED BY STAFF INVOLVED**

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<th>No.</th>
<th>Staff Name</th>
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<th>Absorbed Dose (if applicable)</th>
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<td></td>
<td></td>
<td></td>
<td>Reading (μSv/hr)</td>
<td>Distance from patient</td>
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Done by: 
Verified by:

_________________  ___________________
Name: Name:
STANDARD OPERATING PROCEDURE IN THE EVENT OF EMERGENCY

OBJECTIVE

This procedure is a guideline for RPO/RPS to assist related emergency team / related agencies such as Police and Fire Department with facility specifications and radiation protection in the events of emergency.

SCOPE

This document applies to the event of earthquakes, tornados, floods, explosions, and epidemic and fire emergencies involving the Nuclear Medicine Department.

DEFINITION

1. HAZMAT team – personnel specially trained to handle dangerous good, which include materials that are radioactive, flammable, explosive, corrosive, oxidizing, asphyxiating, biohazardous, toxic, pathogenic or allergenic.
2. Major fire – classified as fires which cannot be contained and promptly put out by a regular fire extinguisher, or which create a threat for hazardous materials in storage.
3. Major natural disaster – earthquakes, tornados, floods, explosions, epidemic
4. Minor fire – classified as local fires (e.g., waste container fire) which can be contained and promptly put out using a regular fire extinguisher and which do not create a threat to hazardous materials in storage.

ABBREVIATIONS AND SYMBOLS

HAZMAT Unit Hazardous Material
RPO Radiation Protection Officer
RPS Radiation Protection Supervisor

WORK INSTRUCTION

1. Minor Fire.

In order to handle a Minor Fire effectively, the following procedure shall be followed:

1.1 The first person who discovered the fire shall immediately attempt to put out the fire by approved methods (e.g. fire extinguisher) if other fire hazards or radiation hazards are not present.
1.2 If the attempt is failed and fire category move from minor to major, follow procedures for Major Fire.
1.3 After the minor fire is put out, notify all persons present to vacate the area and have one individual immediately call the RPO / RPS.
1.4 Once the fire is put out, isolate the area to prevent the spread of possible contamination.

1.5 RPO/RPS will survey all persons involved in combating the fire for possible contamination.

1.6 Persons involved, if contaminated, need to remove contaminated clothing and flushing contaminated skin with warm water, then washing with a mild soap (refer to SOP for Personnel Contamination).

1.7 RPO and his team will then determine a plan of decontamination and the types of protective devices and survey equipment that will be necessary to decontaminate the area.

1.8 Allow no one to return to work in the area unless approved by the RPO.

1.9 RPO will supervise decontamination activities.

1.10 RPO needs to consult with Hospital Emergency Team to ensure that there are no other possibilities of another fire starting and to assist in conducting investigation for root cause of fire.

1.11 RPO will consider the need for bioassays if radioactive material is suspected to have been ingested, inhaled, or absorbed through the skin.

1.12 Appropriate authority needs to be informed verbally within 24 hours and written report is submitted within 30 days of incident.

2. Major Fire and Natural Disaster.

The following general guideline shall be followed:

2.1 The first person who discovered the event shall notify all persons in the area to stop, secure their work and leave immediately.

2.2 Notify the Police/Fire Department and briefly describe the nature of the situation.

2.3 Notify the RPO and Hospital Emergency Team (Refer to hospital emergency action plan).

2.4 Upon arrival of the Police/Fire Department personnel, RPO shall inform them where radioactive materials are stored or where radioisotopes were being used, inform them of the best possible entrance route to the radiation area, as well as any precautions to be taken to avoid exposure or risk of creating further radioactive contamination.

2.5 Police/Fire Department take charge upon arrival and proceed with the assistance of hospital RPO.

2.6 Allow no one to return to work in the area unless clearance has been made by the Police/Fire Department.

2.7 RPO will consult HAZMAT team to set up a controlled area for personnel decontamination. Radioactive patient shall be separated from non-radioactive patient, public and staff.
2.8 All the involved person (medical emergency response team, any victim that contaminated) should follow the instructions of the RPO (e.g., survey, decontamination techniques, provision of bioassay samples, requested documentation).

2.9 RPO needs to make sure maximum dose limit for all persons involved in the rescue shall comply with Regulation 76, Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010.

2.10 RPO will determine necessary corrective actions, consider need for bioassays if radioactive material is suspected to have been ingested, inhaled, or absorbed through the skin.

2.11 RPO will assist Police/Fire Department to investigate the root cause of the incident.

2.12 RPO needs to notify appropriate authority verbally within 24 hours and written report is submitted within 30 days of incident.

**RECORD**

<table>
<thead>
<tr>
<th>No.</th>
<th>Record Name</th>
<th>Record Keeping Period</th>
<th>Location</th>
</tr>
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<tr>
<td></td>
<td>Standard Operating Procedure in the Events of Emergencies</td>
<td>3 years</td>
<td></td>
</tr>
</tbody>
</table>
WORK FLOW

Minor Fire

Start

The first person discovering the event immediately attempt to put out fire

Fire is contained and promptly put out?

Yes

Refer to major fire and natural disaster

No

Notify all persons to evacuate and immediately inform RPO

RPO will survey all persons for possible contamination

All personnel involved, if contaminated needs to remove contaminated clothing and flushing contaminated skin

No one is allowed to return to work unless approved by RPO

RPO and his team will determine decontamination plan and equipment needed for the procedures

RPO needs to supervise decontamination procedures

RPO must consult Hospital Emergency Team to ensure there are no other possibilities for another fire starting and assist in fire root cause investigation

Notify appropriate authority verbally within 24 hours of the incident and written report submitted within 30 days

END
Major Fire and Natural Disaster

Start

1. The first person discovering the event notify everyone to stop work, secure their work and evacuate immediately.

2. Notify Police / Fire Department and describe nature of situation and notify RPO.

3. RPO will inform whereabouts of radioactive sources, their natures and precautions to be taken to avoid exposure and risk of creating radioactive contamination.

4. Police / Fire Department will take charge and co-operate with RPO (Investigation, decontamination procedure, surveys, provision of bioassay samples, documentation).

5. Allow no one to enter the area.

6. HAZMAT will set up a controlled area to perform personnel decontamination.

7. Separate radioactive patient from non-radioactive patient, public and staff.

8. All the involved person should follow the instructions of the RPO (e.g., survey, decontamination techniques, provision of bioassay samples, requested documentation).

9. Maximum dose limit for all persons involved in the rescue shall comply with Regulation 76, Atomic Energy Licensing (Basic Safety Radiation Protection).

10. RPO will determine necessary corrective actions, if radioactive material is suspected to have been ingested, inhaled, or absorbed through the skin.

11. RPO assist Police/Fire Department to investigate the root cause of the incident.

12. Notify appropriate authority verbally within 24 hours and written report is submitted within 30 days of incident.

END
REFERENCES

2. Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010
STANDARD OPERATING PROCEDURE FOR SPECIAL PROCEDURES IN NUCLEAR MEDICINE

OBJECTIVE
This procedure serves as a guide to individuals and Nuclear Medicine Departments when handling special procedures in Nuclear Medicine Department. It is recommended that good radiation practice should be implemented in the interests of reducing radiation exposure and risks.

SCOPE
This document applies to special procedures in the Nuclear Medicine Department.

DEFINITIONS
Types of special procedures
A variety of special procedures may occur in nuclear medicine practice which can result in the inadvertent radiation exposure of a patient, a member of the public or a staff member. These include:

1. Medical emergencies involving radioactive patients
2. Need for urgent patient attention and including surgery
3. Death of the patient
   • Death of the patient following a nuclear medicine scanning
   • Organ donation
   • Precautions during autopsy
   • Preparation for burial and visitation
   • Cremation

ABBREVIATIONS AND SYMBOLS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>HOD</td>
<td>Head of Department</td>
</tr>
<tr>
<td>RPO</td>
<td>Radiation Protection Officer</td>
</tr>
<tr>
<td>RPS</td>
<td>Radiation Protection Supervisor</td>
</tr>
<tr>
<td>O &amp; G</td>
<td>Obstetrics and Gynaecology</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry Of Health</td>
</tr>
<tr>
<td>GL</td>
<td>Guarantee letter</td>
</tr>
</tbody>
</table>
WORK INSTRUCTION

1. Medical emergencies involving radioactive patients.

1.1 For patient who required resuscitation:

- Responsible medical personnel should notify the relevant people (e.g., staff involved in resuscitation in the hospital).
- Notify RPO/RPS and inform the emergency situation.
- RPO/RPS will provide the disposable gloves, gowns and pocket dosimeters to the staff involved in resuscitation.
- RPO/RPS should measure the radiation level of the patient and estimate the time of exposure allowed to the staff involved in resuscitation. Rotation of staff should be carried out during the resuscitation.
- Do not apply direct mouth-to-mouth resuscitation.
- Materials/equipment that has come into direct contact with the patient should be checked for contamination after the resuscitation and handled accordingly.
- All the detail regarding radiation exposure from patients containing radionuclide and personnel involved must be recorded.

2. Need for urgent patient attention.

2.1 Attention should be paid to the following points:

- The RPO/RPS shall advise and supervise on radiation safety issues to the relevant staff in the ICU/CCU/operation theatre.
- If a transfer is required, the fact that the patient may still contain radioactive source should not interfere with the clinical management of the case.
- In the case of patient administered with radioactive source for whom intubation, catheterization or use of a nasogastric tube may be necessary, staff should wear protective gowns and gloves when handling the patient in order to avoid radionuclide contamination.
- Spillage of body fluid should be contained as far as possible by means of absorbent pads, and the pads should be discarded in the waste bag label with radiation signage.
2.1.5 Any suction bottles or urine bags used must not be discarded until checked for contamination by RPO/RPS.

2.1.6 RPO/RPS shall check all the contaminated items before dispose as normal clinical waste.

3. Death of patient.

3.1 Death of the patient following a nuclear medicine scanning.

3.1.1 If a patient dies during the scanning, the Nuclear Medicine Specialist shall consult the RPO/RPS on how to minimize exposure to the person handling the body. The movement of the body should be minimised, using strict procedures for prevention of contamination from body fluid, until the RPO/RPS arrive.

3.1.2 Body fluid may be radioactive and catheterisation of the cadaver should only be performed under the direct supervision of the RPO.

3.1.3 Deceased body released for autopsy, embalming, cremation or burial should have a label identifying the radionuclide and its activity at the time of release, together with a release statement signed by the RPO.

3.1.4 Transportation of a deceased body containing radioactive source shall follow the As Low As Reasonably Achievable (ALARA) concept.

3.1.5 Other practical measures for dealing with deceased body shall include:

a) Notify the relevant people who will be handling the deceased body.

b) Staff involved in handling a deceased body should wear disposable gloves, gowns and pocket dosimeter.

c) RPO/RPS shall measure the radiation level from the deceased body and estimate the time of exposure allowed to the staff.

d) Material/equipment that has come into direct contact with the dead body shall be checked for contamination at the end of the procedure.

e) Prepare relevant documentations and notify the appropriate authority within 24 hours.
f) All details regarding radiation exposure from the deceased body containing radioactive source and personnel involved shall be recorded.

3.2 Organ donation.

It is not advisable to donate the organs to avoid any unnecessary radiation exposure to member of public.

3.3 Precautions during autopsy.

3.3.1 Procedures for personal protection normally observed during an autopsy to provide adequate protection against external radiation exposure or contamination with radioactive material.

3.3.2 The pathologist should be informed of the radiation levels likely to be encountered and of the hazards involved. The methods employed and the precautions adopted should be chosen accordingly in consultation with the RPO/RPS.

3.3.3 The fluids from the procedure shall be disposed via the sewerage system.

3.3.4 The equipment used in autopsy should later be decontaminated by thorough rinsing in a detergent solution followed by washing in running water.

3.4 Preparation for burial and visitation.

3.4.1 The physician involved should identify a radioactive patient (the date, type of radionuclide, and the amount of administered activity) and attach a label to the body.

3.4.2 The body should be surveyed by using radiation survey meter and probe sweeping 1 inch away from the body surface.

3.4.3 If the level of radiation is less than 1 mSv/hr, there is no need for personal dose control of the staff or of the relatives of the deceased. Preparations for burial and any contact between relatives and the body should be controlled by a competent person, who will label the body with the radiation symbol. There is no need to label the coffin. All objects, clothes, documents, etc. that have been in contact with the deceased must be tested for contamination only if it is not sent for burial or cremation.

3.4.4 If the level of radiation is higher than 1 mSv/hr, relatives must be prevented from coming into contact with the body, and people must not be allowed to linger near the body. The hospital staff, the coroner, the persons washing and preparing the corpse for burial, the staff of the
undertaker, and the transportation and cemetery staff must be instructed by the RPO/RPS and monitored for their personal dose rate by means of pocket dosimeters. All objects, clothes, documents, etc. must be tested for contamination only if it is not sent for burial or cremation. It is expedient to wrap the body in plastic foil immediately after death has occurred, and it should never be handled unless with disposable protective gloves.

3.5 Cremation.

The body may be cremated only if the dose rate at the time of cremation is less than 1 mSv/hr. If the dose rate is higher, prior authorization should be obtained from the relevant authority. If the body is prepared for burial, proceed with normal burial.

**RECORD**

<table>
<thead>
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<th>No.</th>
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<td></td>
<td>Radiation Exposure Received By Personnel.</td>
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</table>

**ATTACHMENT**

Attachment 1: Radiation Exposure Received By Personnel
WORK FLOW

Medical Emergencies Involving Radioactive Patients

Start

Medical personnel notify the staffs involved in resuscitation

Notify RPO/RPS and inform the emergency situation

Staffs involved in resuscitation wear disposable gloves, gowns and pocket dosimeters supplied by RPO/RPS

PRO/RPS measured the radiation level of the patient and estimate time of exposure allowed to the staffs involved in resuscitation

All materials/equipment direct contact with the patient should be checked for contamination after the resuscitation and handled accordingly.

Record the detail regarding radiation exposure from patients containing radionuclide and personnel involved.

END
Need For Urgent Patient Attention

Start

RPO/RPS advises and supervises on radiation safety issues to the relevant staff in the ICU/CCU

If a transfer is required, the patient may still contain radioactive source should not interfere with the clinical management of the case

Staff should wear protective gowns and gloves when handling patient administered with radioactive source for whom intubation, catheterization or use of a nasogastric tube in order to avoid radionuclide contamination

Spillage of body fluid should be contained as far as possible by means of absorbent pads, and the pads should be discarded in the waste bag label with radiation signage

Any suction bottles or urine bags used must not be discarded until checked for contamination by RPO/RPS

RPO/RPS shall check all the contaminated items before dispose as normal clinical waste

END
Death of Patient

Start

Death confirmation by physician

RPO/RPS brief the relevant staff regarding safety precaution when managing deceased body containing radionuclide

RPO/RPS will check the current exposure rate from the deceased body

RPO/RPS will determine maximum time the relevant personnel can handle the deceased body inside the isolation room

RPO/RPS ensure relevant staff wearing appropriate Personal Protective Equipment (PPE) and personal dosimeter

RPO/RPS shall ensure the body is wrapped and labeled with radionuclide information before release for burial or cremation.

RPO/RPS records the radiation received by relevant personnel in all stages

RPO/RPS prepares the report

END
### Attachment 1

**Exposure rate of received by personnel**

Date:  
Patient name:  
Radioactive material:  
Type of procedure:

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<th>Personnel Name</th>
<th>Max Allow Time (min)</th>
<th>Task</th>
<th>Start Time</th>
<th>End Time</th>
<th>Initial Dosimeter Reading (µSv/hr)</th>
<th>Final Dosimeter Reading (µSv/hr)</th>
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