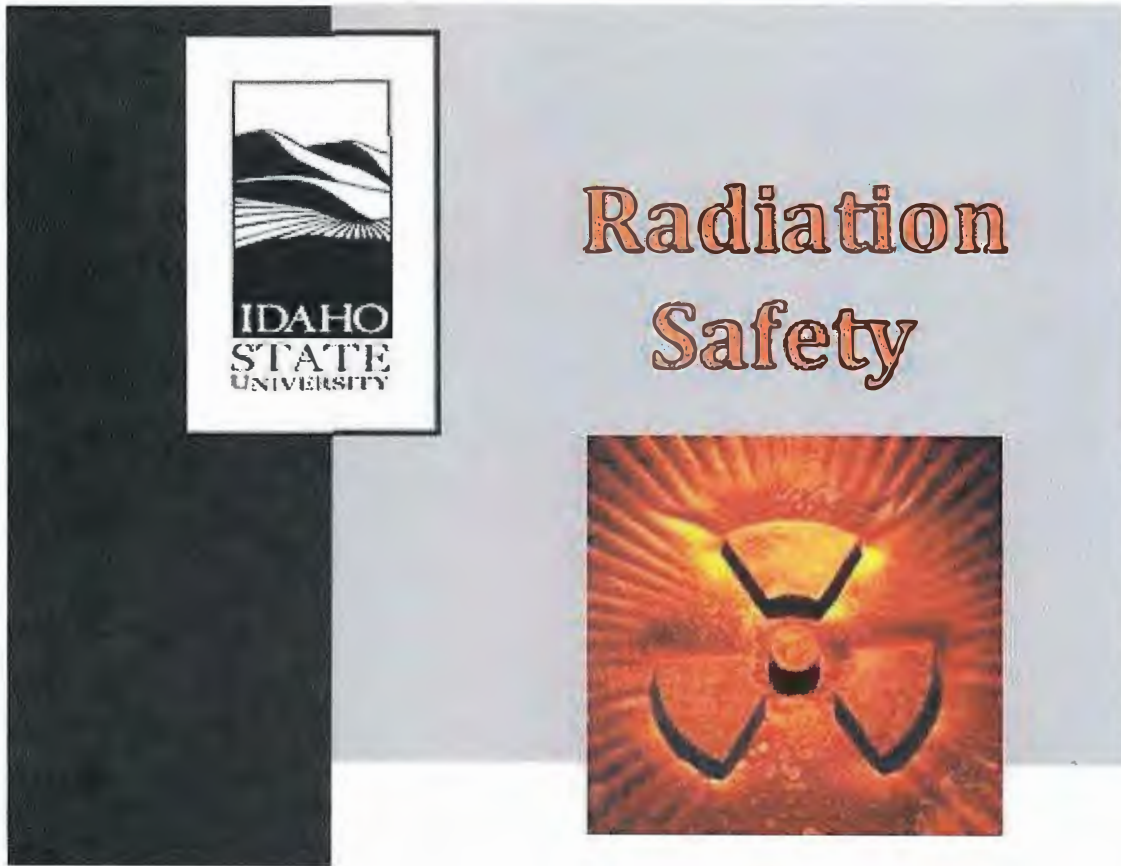




Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019



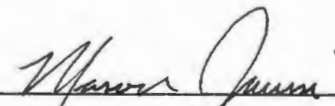
RADIATION PROCEDURES MANUAL

Procedure Cover Sheet

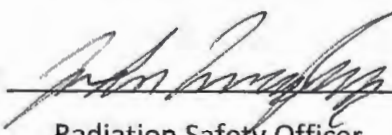
Procedure Title: Transfer and Transport of Radioactive Material

Procedure Number: RS-08 REV 0

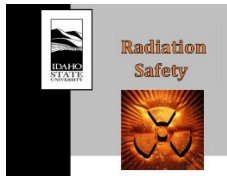
Effective Date: September 9, 2019

Reviewed By: 
Assistant Radiation Safety Officer

Date: 9-9-2019

Approved By: 
Radiation Safety Officer

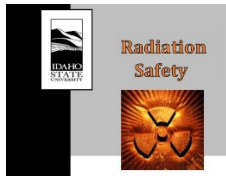
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Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

Contents

1. INTRODUCTION.....	3
2. PURPOSE	3
3. SCOPE.....	3
4. ROLES AND RESPONSIBILITIES	3
5. REQUIRED MATERIAL(S).....	4
6. TRAINING	4
7. PROCEDURE	5
7.1. Transfer Authorization	5
7.2. Classification Computations.....	5
7.3. Exempt Quantity Material Shipments	5
7.4. Limited Quantity Normal Form by Public Highway (UN2910)	5
7.5. Limited Quantity Normal Form by Aircraft (UN2910).....	6
7.6. Radioactive Material Type A Package by Public Highway (UN2915)	7
7.7. Radioactive Material Type A Package by Aircraft (UN2915).....	9
7.8. Other UN Numbers	11
7.9. Performing a Shipment Survey	11
7.10. Driving Radioactive Material.....	11
8. References	12
9. Forms	12



Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

1. INTRODUCTION

ISU ships radioactive material for research, educational, and testing purposes. All ISU personnel who ship radioactive material must follow this procedure, DOT regulations specified in 49 CFR Chapter I, Subchapter C, Hazardous Materials Regulations, and if applicable the IATA Dangerous Goods Regulations.

2. PURPOSE

This procedure specifies instructions for safe and compliant transport of radioactive material from ISU. This procedure and accompanying quality assurance checklists ensure that radioactive materials are shipped properly.

3. SCOPE

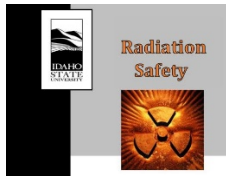
This procedure applies to radiation safety personnel who are trained as radioactive shippers by public highway and if applicable by aircraft. In addition this procedure applies to shipment of exempt quantity materials under exemption by DOT after formal approval by the Radiation Safety Officer.

Radioactive shippers may ship a limited group of radioactive material types including the following UN numbers by public highway (UN2908, UN2909, UN2910, UN2911, UN2912, UN2913, UN2915, UN3321, and UN3332). In addition, radioactive material shippers who are appropriately trained may ship UN2908, UN2909, UN2910, UN2911, and UN2915 by cargo aircraft. Radiation safety personnel may ship UN2915 on passenger aircraft following the instructions of IAC Procedure IAC-SOP-016. No other shipments on passenger aircraft are authorized. No ISU personnel are authorized to ship Type B packages or Fissile Type A packages (UN3327, UN3333).

If a radioactive material to be shipped meets the definition of hazard classes other than 7, the shipper must have additional training for that hazard class and mode of transport. Finally, this procedure applies to personnel who drive radioactive material packages in government vehicles.

4. ROLES AND RESPONSIBILITIES

- Exempt Quantity Material Shipper



Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

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- Shipping exempt quantity (10 CFR 30 Sch. B or 10 CFR 40.13 (a) and (b) materials in government vehicles as specifically authorize by the radiation safety officer.
 - Radioactive Material Shipper
 - Shipping radioactive material by public highway or by aircraft in accordance with their role specific training. Radioactive material shippers may ship the materials specified in the scope above. Verifying that the receiving facility is authorized to receive the material by reviewing the radioactive material license or receiving approval from the receiving facility for DOE facilities.

Authorized users

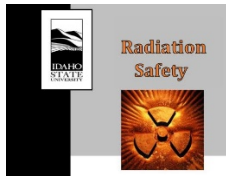
- Submitting Form RPR-14 requesting transfer of radioactive material and providing radiological characterization data to the radioactive material shipper.
- Radiation Safety Officer/Assistant Radiation Safety Officer
 - Performing quality assurance review of radioactive shipments
- Driver of radioactive material
 - Personnel who have completed radioactive material driver training may drive radioactive material packages on public highways provided placards are not required and the gross vehicle weight is less than 10,000 lb.

5. REQUIRED MATERIAL(S)

Packaging, radioactive material labels, markings, address labels, tamper indicating devices or tape, torque wrenches, ionization chamber, Rem-ball, swipes, tape measure, packing tape, computer, and heat sealer.

6. TRAINING

- Exempt Quantity Material Shipper – Read and understand Section 7.3 of this procedure.
- Radioactive Material Shipper
 - Detailed classroom training for shipping Class 7 radioactive material by public highway. Repeat every 3 years.
 - Additional training for shipping Class 7 radioactive material by aircraft if shipping by that mode. Repeat every 2 years.
- Radioactive Material Drivers – Complete radioactive material driver training for non-commercial loads. Repeat every 2 years.



Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

7. PROCEDURE

7.1. Transfer Authorization

ISU personnel will verify that receiving facilities are authorized to receive the radioactive material by completing the following steps. This applies to all transfers of radioactive material, including those not regulated by DOT.

1. The authorized user will complete the RPR 14 form and will submit it to the RSO/ARSO for approval. The form must be signed by a representative from the receiving facility or an E-mail from the receiving facility must be attached stating that receipt is authorized.
2. The RSO/ARSO will verify that the facility has an appropriate NRC or agreement state license to receive the material. For a DOE facility the RSO/ARSO will verify that facility personnel have approved the receipt.

7.2. Classification Computations

Radioactive classification computations may be performed using the Rad Categorization Spreadsheet or Rad Calc DOE software. Perform the following steps to determine shipment categorization.

1. Enter radionuclides and activity in Ci in the green background cells.
2. Enter the net mass of the radioactive material in g.
3. The spreadsheet will compute fractions for the following parameters
 - a. Activity Limit for Exempt Consignment (ALEC)
 - b. Activity Concentration for Exempt Material (ACEM)
 - c. A2 Value
 - d. Reportable Quantity

7.3. Exempt Quantity Material Shipments

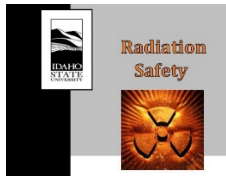
Radioactive materials that are exempt from licensing in 10 CFR 30 Schedule B or 10 CFR 40.13 a or b may be shipped in a government vehicle under the exemption for state employees, 49 CFR 171.1 (d) (5). The NRC regulations in 10 CFR 71.5 do not apply because the material is not licensed. Personnel must be state employees specifically authorized in writing by the Radiation Safety Officer for the material being transported. The following steps will be implemented for such shipments.

1. Verify the material to be shipped is an exempt quantity (10 CFR 30 Schedule B) and authorized by the RSO.
2. Place the material in a strong container such as a tool box for shipment.
3. Ship the material in a State of Idaho vehicle.
4. Immediately notify the RSO if the radioactive material is damaged or if radioactive material may have been released.

7.4. Limited Quantity Normal Form by Public Highway (UN2910)

Perform the following steps for a limited quantity shipment by public highway.

1. Ensure the material to be shipped does not meet the definition of any other hazard class and is not a hazardous waste. If it meets another hazard class or is a hazardous waste, contact a shipper who is trained for these materials.



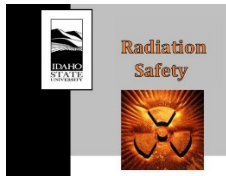
Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

2. Ensure the package meets the general design requirements of 49 CFR 173.410
3. Ensure the radioactive contents meet the limits of 49 CFR 173.425 specifically less or equal to 10^{-3} A2 for normal form solids and gases and 10^{-4} A2 for normal form liquids.
4. Ensure the material is fissile excepted in accordance with 49 CFR 173.453.
5. Package the material according to the manufacturer instructions.
6. Mark the inner package "Radioactive". If there is no inner package mark the exterior of the package "Radioactive."
7. Mark the exterior of the package "UN2910".
8. Perform a shipment survey on the package as specified in Section 7.9.
 - o The dose rate on contact with the package must be less than 0.5 mrem/hr. The measurement must account for all radiation types (e.g. photon and neutron).
 - o The non-fixed contamination on the exterior of the package must not exceed the limits specified in 49 CFR 173.443(a), 7200 dpm beta-gamma per 300 cm² and 720 dpm per 300 cm² alpha.
9. If the material is a hazardous substance (RQ fraction is greater than or equal to 1) perform the following steps.
 - o Mark the package "RQ".
 - o Prepare a bill of lading for the shipment (49 CFR 172 Subpart C). Specific radioactive material provisions from 49 CFR 172.202 (a) (5) and (6), 49 CFR 172.203 (d), and 49 CFR 172.204 (c)(4) do not apply.
10. Complete the quality assurance checklist for shipment of UN2910 by public highway.

7.5. Limited Quantity Normal Form by Aircraft (UN2910)

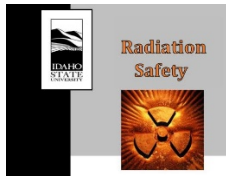
Perform the following steps for a limited quantity shipment by aircraft.

1. Ensure the material to be shipped does not meet the definition of any other hazard class and is not a hazardous waste. If it meets another hazard class or is a hazardous waste, contact a shipper who is trained for these materials.
2. Ensure the package meets the general design requirements of IATA 10.6.0 and 10.6.1.
3. Ensure the radioactive contents meet the limits of IATA Table 10.3.C specifically less or equal to 10^{-3} A2 for normal form solids and gases and 10^{-4} A2 for normal form liquids.
4. Ensure the material is fissile excepted in accordance with IATA 10.3.7.2.
5. Package the material according to the manufacturer instructions. Either the container or a 95 kPa bag must be used to meet the pressure requirement of 10.6.1.3. Drums rated for liquids will give a pressure test rating in association with the UN specification marking.
6. Mark "Radioactive" such that it is visible upon opening the package. If this is not practical mark the exterior of the package "Radioactive."
7. Label the package with the Radioactive Material Excepted Package Label (IATA 10.7.8.A) with UN2910.
8. Perform a shipment survey on the package as specified in Section 7.9
 - o The dose rate on contact with the package must be less than 0.5 mrem/hr. The measurement must account for all radiation types (e.g. photon and if applicable neutron).



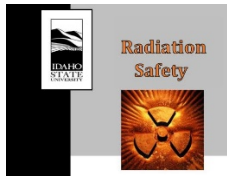
Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

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- The non-fixed contamination on the exterior of the package must not exceed the limits specified in IATA 10.5.3.2, 7200 dpm beta-gamma per 300 cm² and 720 dpm per 300 cm² alpha.
9. Mark the package as follows (IATA 10.7.1.3.2).
 - UN Number on Excepted Package Label.
 - Full name and address for the shipper and consignee.
 - Permissible gross weight if the gross weight exceeds 50 kg.
 10. Ensure the following is recorded on the FedEx Airbill (non-hazardous substance). IATA 10.8.8.3
 - Enter the name and address of the shipper and consignee in the form and to sections of the Airbill.
 - Enter “UN2910, Radioactive material, excepted package, limited quantity of material” in the Your Internal Billing Reference section.
 - Under Special Handling check the box “Yes Shipper’s Declaration not required” under Does this shipment contain dangerous goods?
 - Enter the Total Packages at the bottom of the Airbill.
 11. If the material is a hazardous substance (RQ fraction is greater than or equal to 1) perform the following steps.
 - Mark the package “RQ”.
 - On the Airbill, check Yes As per Attached Shippers Declaration box under Special Handling Instructions. Do not enter UN number and proper shipping name in the Your Internal Billing section.
 - Prepare a Dangerous Goods Declaration including the following information.
 - Shipper and Consignee name and full address. IATA 10.8.3.1 and 10.8.3.2.
 - Page X of Y.
 - XXX out Cargo Aircraft Only IATA USG-10.
 - “RQ UN2910” under UN or ID No. IATA USG-04.
 - XXX out Non-Radioactive IATA 10.8.3.8
 - “Radioactive Material, Excepted Package – Limited Quantity of Material” under Proper Shipping Name. IATA 10.8.3.9.1
 - “7” under Class or Division. IATA 10.8.3.9.1.
 - Dims (L) XX x (W) XX x (H) XX under Packaging Inst.
 - 24 – hour emergency response phone number under Additional Handling Information. IATA 2.8
 - Name, Signature of the shipper, Place, and Date at the bottom of the page.
 - Provide three signed copies of the red-hatched Dangerous Goods Declaration and Emergency Response Guide 161 in the sleeve with the Airbill.
 12. Complete the quality assurance checklist for shipment of UN2910 by aircraft
- 7.6. Radioactive Material Type A Package by Public Highway (UN2915)
Perform the following steps for shipping a Radioactive Material. Type A Package by public highway.
1. Ensure the material to be shipped does not meet the definition of any other hazard class and is not a hazardous waste. If it meets another hazard class or is a hazardous waste, contact the RSO who will identify a shipper who is trained for these materials.



Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

2. Ensure the packaging meets the USA DOT-7A Type A (49 CFR 178.350) specification and that test data and closure instructions are available.
3. Ensure the radioactive contents do not exceed the A2 value for normal form or the A1 value for special form.
4. If the material is special form, ensure that an IAEA Certificate of Competent Authority is available (49 CFR 173.476)
5. If fissile materials (U-233, U-235 in enriched uranium, Pu-239, and Pu-241) are present, ensure the material is fissile excepted in accordance with 49 CFR 173.453.
6. Inspect the packaging to ensure it is in good condition, especially gaskets.
7. Package the material according to the manufacturer instructions.
8. Perform a shipment survey on the package as specified in Section 7.9.
 - The dose rate on contact with the package must be less than or equal to 200 mrem/hr and the dose rate at 1m must be less than or equal to 10 mrem/hr. The measurement must account for all radiation types (e.g. photon and neutron). If dose rates are greater than these values the shipment must be made exclusive use. Contact the RSO for direction.
 - The non-fixed contamination on the exterior of the package must not exceed the limits specified in 49 CFR 173.443(a), 7200 dpm beta-gamma per 300 cm² and 720 dpm per 300 cm² alpha.
11. Mark the package in accordance with 49 CFR 172 Subpart D.
 - Proper shipping name and UN number (see Subpart D for size requirements)
 - Consignee's or Consignor's name and address unless the package will not be transferred from one motor carrier to another.
 - Gross weight and unit if greater than 110 lb.
 - USA DOT 7A TYPE A.
 - If the material is a hazardous substance (RQ fraction is greater than or equal to 1), mark the package "RQ".
12. Label the package in accordance with 49 CFR 172 Subpart E.
 - Determine the radioactive label category based on the shipment survey results.
 - Determine the radionuclides to enter based on the A2 fractions in accordance with 49 CFR 173.433(g).
 - Enter the total activity in the package in Bq multiples.
 - For Yellow II or Yellow III labels, enter the Transport Index (dose rate at 1 m rounded up to the next tenth).
 - Apply labels to two opposite sides of the package.
13. Prepare a bill of lading for the shipment (49 CFR 172 Subpart C) using either the ISU form or the form for the selected carrier. Ensure the following information is present.
 - X or RQ in the hazardous material column
 - UN number
 - Proper shipping name
 - Hazard class
 - Number and type of packages
 - Radionuclide names determined based on A2 fractions and 49 CFR 173.433 (g)



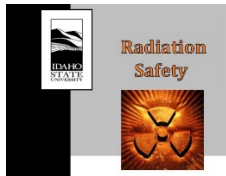
Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

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- For normal form material the physical and chemical form
 - For special form material the words special form are included in the proper shipping name.
 - The total activity in the package in Bq multiples.
 - The label category e.g. Radioactive Yellow II
 - For Yellow II or Yellow III labeled packages the Transport Index
 - If the package contains fissile radionuclides, "fissile excepted".
 - Shipper's certification 49 CFR 172.204.
 - Signature and date.
 - Enter your cell phone number for the emergency response number. Note you must be available 24 hours a day at the number until the shipment arrives.
14. Complete the quality assurance checklist for shipment of UN2915 by public highway
 15. Provide a copy of the emergency response guide 163 to the carrier.
 16. If the label is Yellow III, provide radioactive placards to the carrier if they do not have them.

7.7. Radioactive Material Type A Package by Aircraft (UN2915)

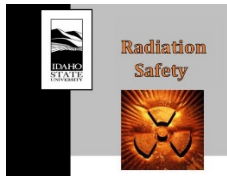
Perform the following steps for shipping a Radioactive Material. Type A Package by aircraft.

1. Ensure the material to be shipped does not meet the definition of any other hazard class and is not a hazardous waste. If it meets another hazard class or is a hazardous waste, contact the RSO who will identify a shipper who is trained for these materials.
2. Ensure the packaging meets the USA DOT-7A Type A (IATA 10.6.2.4) specification and that test data and closure instructions are available.
3. Ensure the radioactive contents do not exceed the A2 value for normal form or the A1 value for special form.
4. If the material is special form, ensure that an IAEA Certificate of Competent Authority is available (49 CFR 173.476) and that it meets the requirements of IATA 10.3.4.2.
5. If fissile materials (U-233, U-235 in enriched uranium, Pu-239, and Pu-241) are present, ensure the material is fissile excepted in accordance with IATA 10.3.7.2.3.
6. Inspect the packaging to ensure it is in good condition, especially gaskets.
7. Package the material according to the manufacturer instructions.
8. Perform a shipment survey on the package as specified in Section 7.9.
 - The dose rate on contact with the package must be less than or equal to 200 mrem/hr and the dose rate at 1m must be less than or equal to 10 mrem/hr. The measurement must account for all radiation types (e.g. photon and neutron). IATA 10.5.1.15.
 - The non-fixed contamination on the exterior of the package must not exceed the limits specified in IATA 10.5.3.2, 7200 dpm beta-gamma per 300 cm² and 720 dpm per 300 cm² alpha.
17. Mark the package in accordance with IATA 10.7.1.3.
 - Proper shipping name and UN number (see 10.7.1.2.4 for size requirements)
 - Shipper and Consignee's name and address.
 - Permissible Gross weight and unit if gross weight exceeds 50 kg.
 - USA DOT 7A TYPE A. IATA 10.7.1.3.4



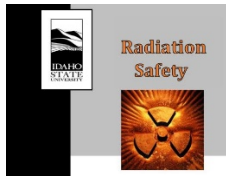
Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

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- If the material is a hazardous substance (RQ fraction is greater than or equal to 1), mark the package "RQ". USG-4
18. Label the package in accordance with IATA 10.7.3.
- Determine the radioactive label category based on the shipment survey results.
 - Determine the radionuclides to enter based on the A2 fractions in accordance with IATA 10.7.3.3.1 (b).
 - Enter the total activity in the package in Bq multiples.
 - For Yellow II or Yellow III labels, enter the Transport Index (dose rate at 1 m rounded up to the next tenth).
 - Apply labels to two opposite sides of the package. One label must be on the same surface as the proper shipping name mark. IATA 10.7.4.2.
 - Apply Cargo Aircraft Only labels adjacent to the radioactive labels.
19. Prepare the FEDEX US airbill for the shipment.
- Enter the date.
 - Enter shippers name for Sender's name.
 - Enter account number, company, phone, and address are pre-printed.
 - Enter Recipients Name
 - Enter Phone for recipient
 - Enter Company
 - Enter Address
 - Check desired delivery type for Express Package Service
 - Check Other for packaging
 - Check No Signature Required for Special Handling
 - Check Yes as per Attached Shipper's Declaration for Does this shipment contain dangerous goods?
 - Check Sender for Payment bill to:
 - Enter 1 for total packages.
 - Weigh the package and enter the total weight in lbs.
 - Enter 0 for Total Declared Value
20. Complete the FEDEX Dangerous Goods Declaration IATA 10.8
- Enter shipper name, address, and phone number.
 - Enter Consignee name, address, and phone number.
 - Overwrite Passenger and Cargo Aircraft with XXXs.
 - Enter the appropriate city for Airport of Departure
 - Enter the appropriate city for Airport of Destination
 - Enter Air Waybill No.
 - Enter 1 of 1 for Pages
 - Overwrite NONRADIOACTIVE with XXXs.
 - Enter UN2915 for UN No.
 - Enter "Radioactive Material, Type A Package" for Proper Shipping Name.
 - Enter 7 for Class



Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

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- Leave Packing Group blank.
 - Enter the following for Quantity and type of packaging for mixtures of radionuclides. For individual nuclides packaged together see IATA 10.8
 - Name of radionuclides in mixture.
 - Physical and chemical form
 - 1 Type A Package
 - Activity in Bq units
 - Enter the following for Packaging Inst.
 - Label category e.g. II-Yellow
 - TI: value for transport index on Yellow II and Yellow III.
 - Dims (L) XX cm x (W) XX cm x (H) XX cm
 - Leave Authorization blank.
 - Enter shipper's cell phone number for Emergency Telephone Number
 - Enter shipper's name and title.
 - Enter City, ID and date for place and date.
 - Shipper signs the form.
21. Attach the documents to the package.
- Attach a FedEx documents sleeve to the top of the package.
 - Place Emergency Response Guide 163, 3 signed copies of the Declaration for Dangerous Goods with red hatching, and the FedEx US Airbill in the sleeve.
 - Do not seal the sleeve.
22. Complete the quality assurance checklist for shipment of UN2915 by aircraft
- 7.8. Other UN Numbers
- Shippers may ship other UN numbers as specified in the scope above using the DOT regulations. All such shipments must be reviewed by the RSO/ARSO prior to shipment.
- 7.9. Performing a Shipment Survey
1. Ensure survey instruments (ion chamber that will measure to $\mu\text{R/hr}$ and Rem ball if neutron emitting material is included) are calibrated and source checked.
 2. Measure the photon and if necessary neutron dose rate on the external surfaces of the package. Record on the shipment survey form.
 3. Collect 300 cm^2 swipes and measure them on the appropriate instrument for the radiations emitted by the shipped material. Record or attach the results to the shipment survey form.
- 7.10. Driving Radioactive Material
- Personnel authorized to drive radioactive material will complete the following actions to drive a non-excepted package in a government vehicle.
- Ensure the vehicle is in good condition.
 - Secure the package to prevent movement in the vehicle.



Procedure #: RS-08 REV 0
Procedure Title: Transfer and Transport of Radioactive Material
Approval Date: September 9, 2019
Effective Date: September 9, 2019

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- Maintain the shipping document and emergency response guide within arms-reach in the vehicle cab.

Radiation safety personnel may drive excepted packages in government vehicles between or within ISU campuses. Packages must be appropriately packaged, marked, and in good condition. This includes moving excepted packages from shipping and receiving to other campus locations.

8. References

- 49 CFR Chapter I, Subchapter C – Hazardous Material Regulations (most recent)
- IATA Dangerous Goods Regulations (most recent)
- IAC-016-SOP Packaging and Shipping of Cu-67

9. Forms

- Shipment Survey Form
- RPR 55A – QA Checklist UN2910 by Public Highway
- RPR 55B – QA Checklist UN2910 by Aircraft
- RPR 55C – QA Checklist UN2915 by Public Highway
- RPR 55D – QA Checklist UN2915 by Aircraft
- RPR 14 Radioactive Material Transfer Authorization