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PHYSICS AND MATHEMATICS

PRELIMINARY TECHNICAL MANUAL

**Loading, Shipping and Testing Procedures for Task 2
Isotopic Powered Thermoelectric Generator**

By
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March 24, 1960

**Nuclear Division
Martin Company
Baltimore, Maryland**

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PRELIMINARY
TECHNICAL MANUAL
LOADING, SHIPPING
AND TESTING PROCEDURES
FOR
TASK 2 ISOTOPIC POWERED
THERMOELECTRIC GENERATOR

This report is prepared under
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TABLE OF CONTENTS

Section	Page
FOREWORD	ix
SAFETY PRECAUTIONS	x
I INTRODUCTION	1-1
1-1. General Information	1-1
1-3. Oak Ridge Operation	1-1
1-4. Cask	1-1
1-6. Shipping Skid	1-1
1-8. Equipment Required	1-3
II LOADING, SHIPPING, AND UNLOADING PROCEDURES	2-1
2-1. Preparation for Cask Shipment	2-1
2-3. Cask Shipment Requirements	2-2
2-5. Cask and Skid Unloading	2-2
2-7. Cask Preparation for Fuel Core Loading	2-3
2-9. System Checkout of Cask	2-6
2-10. Preparation for Isotope Block Loading	2-7
2-11. Cask Loading of Isotope Block	2-8
2-12. Cask Checkout and System Disassembly	2-9
2-14. Unloading Fuel Block from Cask	2-10
III MARTIN-NUCLEAR OPERATION	3-1
3-1. Special Handling Equipment	3-1
3-3. Unloading Cask and Skid	3-1
3-5. Fuel Block Transfer Operation	3-4
3-6. Equipment Required for Transfer	3-4
3-7. Equipment Required for Personnel	3-5
3-8. Special Precautions	3-5
3-9. Cask Stand Erection	3-5
3-10. Power Generator Preparation	3-6
3-11. Collar Shield Installation	3-6
3-12. System Integration	3-6
3-13. Generator Loading System Checkout	3-10
3-14. Leakage Test	3-10
3-15. Level Control Test	3-10
3-16. Shield Drain Test	3-10
3-17. Splash Pan Drain System Test	3-13
3-18. Collar Shield Test	3-13
3-19. Level Control System Test-Collar Shield	3-13
3-20. Preparation for Cask Installation	3-14
3-22. Cask Assembly and Installation	3-14
3-24. System Preparation for Fuel Block Transfer	3-15
3-25. Transfer Operation	3-16
3-27. Post-Transfer Operation	3-18

TABLE OF CONTENTS (cont)

Section	Page
IV TESTING PROCEDURES AND RESHIPMENT.	4-1
4-1. Test Operation.	4-1
4-2. Preparation for Generator Test	4-1
4-4. Generator Rotation.	4-1
4-6. Disposal of Fuel Block	4-2
4-8. Return of Fuel Block to Cask	4-2
4-9. Preparation of Cask for Reshipment	4-3
4-11. Return of Cask to Oak Ridge.	4-3

LIST OF ILLUSTRATIONS

Figure		Page
1.	Lead-shielded Cask	1-2
2.	Shipping Equipment.	1-4
3.	Cask Accessories.	2-4
4.	Wood's Metal System	2-5
5.	Integrated Transfer System	3-2
6.	Collar Shield.	3-3
7.	Gimbal Dolly.	3-7
8.	Collar Shield Mated to Stand.	3-9
9.	Electrical Schematic Diagram	3-11
10.	Plumbing System Schematic Diagram.	3-12

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F O R E W O R D

This manual is a preliminary report on the operations and procedures for handling a 125-watt thermoelectric generator and its isotopic heat source. Full-scale mockups have been used to develop the procedures. Some of the figures presented are photographs of mockups to demonstrate basic configurations and equipment arrangement. Sections II through IV are presented in chronological order. It is anticipated that some changes in operating procedures will result when the actual equipment is put through its functional tests.

SAFETY PRECAUTIONS

HANDLING OF FUEL BLOCK

1. The handling of a radioisotope fuel block or of mercury can be hazardous and under no circumstance should handling be attempted by unauthorized persons.

HEALTH PHYSICIST

2. A health physicist must be present at all times during transfer of the fuel block from the cask to the generator or during removal of the fuel block from the generator. In addition, all persons present when mercury is being handled must wear respiratory equipment specified by the health physicist.

RADIATION DEVICES

3. All persons present in the vicinity during the transfer of a fuel block, and all persons involved in the handling of the loaded shipping cask or generator must wear radiation monitoring devices specified by the Health Physics Group.

ASBESTOS GLOVES AND PROTECTIVE CLOTHING

4. All persons working with or near the shipping cask should wear asbestos gloves and long sleeved clothing because the surface of the cask will be in excess of 200°F.

SECTION I
INTRODUCTION

1-1. GENERAL INFORMATION.

1-2. A system has been devised for handling, loading, shipping, and testing an encapsulated radioactive isotope heat source and a thermoelectric generator. The first phase of the operation will be accomplished at Oak Ridge National Laboratory where a cylindrical metal block of Inconel X will be remotely loaded with the isotope; then sealed. The block will be loaded into a specially designed cask and shipped by rail to the Martin-Nuclear hot cell facility, where the second phase of the operation will be conducted. Equipment has been designed to transfer the block to the thermoelectric generator without using a hot cell. As an additional safety measure, however, the initial transfer operation will be accomplished in a hot cell.

1-3. OAK RIDGE OPERATION.

1-4. CASK. The major piece of handling equipment used during the loading operation at Oak Ridge is the 15,000-lb., lead-shielded cask. It will serve as a shipping and storage container for the radioactive isotope fuel block. Heat from the isotope is transmitted to the lead filled cask through Wood's metal, which is added to the inner container of the cask after the isotope block has been inserted. The heat is then dissipated by convection through cooling fins around the cask shell.

1-5. A mechanism for installing the isotope block into the power generator is built into the cask and must be engaged with the block during the loading operation. This is shown in figure 1. A locking device is provided to secure the fuel block to the built-in transfer mechanism. An access plug, designed to slide to the side, facilitates transfer of the block to the power generator. A mechanism is provided to actuate the plug and is driven by an air motor which is remotely controlled.

1-6. SHIPPING SKID. Because of shielding considerations, the weight of the cask is concentrated in a relatively small area. A skid, approximately 6 x 8 feet, is provided to distribute the weight onto the floor of the conveying vehicle and permit shipment by air, rail, or truck. Tiedowns, designed to withstand an ultimate forward or aft load of 15 G, are provided to secure the cask to the skid. For rail shipment, the skid will probably be blocked to prevent shifting of the load. In the event of blocking at the ends, a forward or aft load of 1 1/2 G would upend the skid. Therefore, in addition to blocking, the skid must be tied down to the floor of the car. Since the vertical component of the 15 G forward load at the aft end of the skid would be 5 G or 80,000 pounds ultimate, the skid must be tied down to the conveyance so that the vertical tiedown have an 80,000 pound ultimate vertical load capacity at each end of the skid. Also, at each end, the blocking must have a 15 G or 240,000 pound ultimate load capacity. If blocking is not used, forward and aft loads can be taken by securing to tiedown rings located along the sides of the skid.

Figure 1. Lead-shielded Cask

1-7. The major equipment to be used for shipment is shown in exploded view in figure 2. Since calculations show that the surface temperature of the cask will be above a nominal maximum of 180°F, the protective cage shown will be placed around the cask to prevent immediate access to its surface.

1-8. EQUIPMENT REQUIRED. (See figure 2.) The following equipment is required for shipment and will be included in the shipment to Oak Ridge:

- a. Cask 356-1770070
- b. Skid 356-1770081
- c. Hoist Beam 356-1770076
- d. Protective Cage 356-1770061
- e. Block Lock 356-1770062
- f. Wood's Metal Overflow Container 356-1770096
- g. Wood's Metal Syst. 356-1770089
- h. Plug Actuator Controls 356-1770095
- i. Plug Actuator 356-1770072
- j. Fuel Block Tool 356-1770094

Section I
Figure 2

Figure 2. Shipping Equipment

SECTION II

LOADING, SHIPPING, AND UNLOADING PROCEDURES

2-1. PREPARATION FOR CASK SHIPMENT.

2-2. Items e through j of paragraph 1-8 shall be crated separately and shipped with the larger items. Items a through d shall be prepared for shipment in the following manner.

- a. Position skid (356-1770081) on a level surface. (See figure 2.)
- b. Remove all turnbuckles and place near skid.
- c. Attach hoist beam (356-1770076) to cask. (Cask to be sitting plug side up.) Place sling fittings over cask trunnions and attach drag brace to cask fin fitting. (See figure 1.)
- d. Install washers and lock pins on trunnions.
- e. Attach hoist beam to 10-ton crane. (See figure 2.)
- f. Hoist cask and position over skid.
- g. Orient cask over skid so that 2 locating holes in cask are over 2 locating pins on skid.
- h. Slowly lower cask onto skid so that locating pins engage holes in cask.
- i. Remove hoisting beam.
- j. Install 6 inner turnbuckles and fittings as shown on figure 2.
- k. Before connecting the 6 inner turnbuckles to the cask, slip protective covers 356-1770061-47 over the turnbuckles.
- l. Lock wire turnbuckles and nuts as shown on drawing 356-1770081.
- m. Hoist protective cage (356-1770061) with crane, (or may be manually lifted) and place over cask.
- n. Slide protective covers up turnbuckles and attach to protective cage as per drawing 356-1770061.
- o. Bolt protective cage to skid.
- p. Install hoist beam (356-1770076) on cask as per step 3 through 5 with the exception of attaching drag strut to cask. Drag strut is to be folded back against beam and secured.
- q. Hoist cask, skid and cage assembly and place into gondola rail car.
- r. Disconnect hoist beam, then lash it to skid.

- s. Install outer 4 turnbuckles and trunnion fitting as per drawing 356-1770081.
- t. Lock wire turnbuckles in place as per drawing 356-1770081.
- u. Block, chock, and tie down cask skid according to load requirement established in section 1.2. Cable or chain shall be used for vertical load tiedowns and shall be tied to the skid pipes. Point at which tiedowns pass over pipe shall not be greater than 6 inches from I-beam connections.

2-3. CASK SHIPMENT REQUIREMENTS.

2-4. The cask will be shipped by railroad. A gondola car has been recommended by the Pennsylvania Railroad for cask shipment and will be used. "Preferred rail handling" will be requested for shipment of the empty cask to Oak Ridge and also for the return shipment with the isotope. The use of humping for attaching cars will be avoided if at all possible. The Bureau of Explosives, New York 7, New York, shall be notified, two weeks in advance, of the following items:

- a. Point of origin
- b. Point of destination
- c. Date of shipment
- d. Type of transportation used
- e. Quantity of radioactive material being shipped in terms of curies.
- f. The principal type of radiation (alpha, beta, gamma, or neutron).
- g. B.E. Permit No. 898 has been issued for shipment.

2-5. CASK AND SKID UNLOADING.

2-6. A 10-ton capacity crane will be required for unloading from rail car. A truck or trailer with a 9-ton capacity will be required for transporting the cask to the isotope loading cell. The unloading procedure is as follows:

- a. Remove tiedowns between skid and rail car.
- b. Remove lockwire and turnbuckles attached to cask trunnions.
- c. Unlash hoist beam from skid and attach to cask trunnions. Drag brace is to remain lashed to I-beam.
- d. Attach washers and lock pins to trunnions.
- e. Using 10-ton crane, lift skid, cask, and cage assembly from rail car and place on truck or trailer. Long direction of skid must be oriented with long direction of truck or trailer.
- f. Tying down of skid to the truck or trailer is recommended, but will be left to the discretion of the Oak Ridge Transportation Office.

g. Complete assembly, plus crates containing accessories, shall be trucked to the multi-curie fission products pilot plant (Building 3517).

h. The truck will be backed into the building and unloaded by the overhead crane.

2-7 CASK PREPARATION FOR FUEL CORE LOADING.

2-8. Cask skid may be towed along floor to the side for preliminary preparations if area under crane is being used for other operations. Cask preparation is as follows:

- a. Remove bolts holding protective cage to skid.
- b. Disconnect protective covers in turnbuckle areas.
- c. Hoist protective cage from skid.
- d. Remove lock wire from turnbuckles.
- e. Loosen turnbuckles and remove bolts through ends attached to cask.
- f. Attach hoist beam, 356-1770076, to cask trunnions and install washers and lockpins.
- g. Unlash drag strut from I-beam and attach end to fin fitting on cask.
- h. Hoist cask from skid.
- i. Remove block locking mechanism from packing crate and install it on bottom and side of cask as per drawing 356-1770062. Cask may be rotated 180° on hoist beam to facilitate installation of block lock mechanism. If the cask is rotated, disconnect drag strut from cask fin fitting and reconnect to cask fin fitting on diagonally opposite corner of cask after rotating.
- j. After installation of lock mechanism, check to see if fuel block engaging coupling is in the open position by rotating handle a few turns clockwise toward lock position and then rotating handle counterclockwise until it will no longer turn.

CAUTION

Do not exert more than 4 pounds pressure on handle.

k. Return cask to vertical position with sliding plug on the top side and engage drag strut of hoist beam.

NOTE

See figures 3 and 4 in the following steps.

l. Remove cask plug lock plate (356-1770072).

m. Remove cask plug jack mechanism and air motor drive from shipping crate and install them on cask as shown on drawing 356-1770072. (See figure 3.)

Figure 3. Cask Accessories

Figure 4. Wood's Metal System

- n. Remove Wood's metal furnace from shipping crate and install on cask as shown on drawing 356-1770087 and 356-1770089. (See figure 3.)
- o. Remove protective cover from both Wood's metal valves on cask. (See figure 4.)
- p. Install heated hose from Wood's metal furnace to lower Wood's metal valve on cask.
- q. Open both Wood's metal valves on cask.

CAUTION

Do not open valve on Wood's metal furnace.

NOTE

Steps l through q may be performed after lowering cask into hot cell if sufficient space is available.

- r. Hoist cask with overhead crane and lower through top plug into hot cell.
- s. Place cask on platform in bottom of hot cell.

CAUTION

Platform must be made with a cutout that will allow clearance of the block locking shaft which extends from bottom center of cask to the side and up side of cask. (See drawing 356-1770062.) Lower cask onto platform without damaging this mechanism.

- t. Remove hoist beam from cask.
- u. Attach Wood's metal heater line to 110 volt a.c. source.
- v. Attach Wood's metal temperature pickup to temperature indicator outside hot cell.
- w. Attach heated hose element to 110 volt a.c. source.
- x. Attach heated hose temperature pickup to indicator outside hot cell.
- y. Attach airlines to plug actuator air motor and to air control system (356-1770095). A 90 psi air source is required.
- z. Install Wood's metal overflow container on cask vent valve.

2-9. SYSTEM CHECKOUT OF CASK. Before loading the fuel block into the cask, the following checks must be made:

- a. Place manipulator fingers on the Wood's metal furnace valve and check for clearance. Do not rotate valve as it is frozen with Wood's metal.

- b. Actuate sliding plug by turning airvalve to PLUG OPEN position.
- c. Check for full travel of plug.
- d. Turn air valve to PLUG CLOSE position.
- e. Check for full closure of plug.
- f. Return plug to full open position.
- g. Check loading of fuel block with manipulators by using dummy block. Grip block with manipulators, knob end down. Lower into cask. (Special gripper fingers will be supplied by ORNL.)

CAUTION

Do not drop block into cask as lock mechanism may be damaged. In event block is inadvertently dropped, remove block and check mechanism.

- h. Release manipulator gripper fingers when block has bottomed in cask.
- i. Check for full bottoming of block by inserting check tool (356-1770094) with manipulator on top of block and view for maximum clearance of 1/16 inch between top of cask and tool.
- j. If greater than 1/16 inch clearance exists, remove tool and engage block with manipulator grippers and rotate block until octagonal knob is inserted in lock mechanism.
- k. Repeat steps i and j until full bottoming is achieved.
- l. Rotate block lock handle with manipulator approximately eleven (11) turns clockwise to secure block in cask.

CAUTION

Do not exert more than 4 pounds of pressure on handle.

- m. If less than 10 turns are required to tighten lock, rotate handle counter-clockwise to full unlocked position and remove fuel block with manipulator. Repeat steps g through l until satisfactory alignment and full locking is achieved.
- n. Unlock block lock mechanism and remove dummy fuel block from cask.

2-10. PREPARATION FOR ISOTOPE BLOCK LOADING.

- a. Secure hot cell openings and check electrical and air sources.
- b. Turn on Wood's metal furnace heater.
- c. Allow 30 minutes for Wood's metal to become molten.

d. Check Wood's metal temperature before proceeding with loading. Temperature shall be a minimum of 190°F.

e. Check for plug in full open position.

f. Check for block lock handle in full counterclockwise position.

g. Apply electrical power to Wood's metal heated hose element.

2-11. CASK LOADING OF ISOTOPE BLOCK.

a. Grasp isotope block with manipulators, knob end down. Lower into cask. (Special gripper fingers will be supplied by ORNL.)

CAUTION

Do not drop block into cask as lock mechanism may be damaged. If block is inadvertently dropped, remove block and check mechanism.

b. Release manipulator gripper fingers when block has bottomed in cask.

c. Check for full bottoming of block by inserting check tool (356-1770094) with manipulator on top of block and view for maximum clearance of 1/16 inch between top of cask and tool.

d. If greater than 1/16 inch clearance exists, remove tool and engage block with manipulator grippers and rotate block until octagonal knob is inserted in lock mechanism.

e. Repeat steps c and d until full bottoming is achieved.

f. Rotate block lock handle with manipulator approximately eleven (11) turns clockwise to secure block in cask.

CAUTION

Do not exert more than 4 pounds of pressure on handle.

g. If less than 10 turns are required to tighten lock, rotate handle counterclockwise to fully unlocked position and remove fuel block with manipulator. Repeat steps g through l until satisfactory alignment and full locking is achieved.

h. Remove check tool (356-1770094) from cask and turn sliding plug control valve to PLUG CLOSE position.

i. Check plug visually for full closure.

j. Rotate Wood's metal furnace valves counterclockwise to full on position.

k. Place manipulator on Wood's metal vent valve on cask.

l. Allow Wood's metal to fill up cask inner container until it begins to flow from vent line valve into overflow container.

- m. Close vent valve with manipulator.
- n. Close Wood's metal furnace valve.
- o. Close lower Wood's metal valve on cask. (Step n and o may be performed with manipulator or performed manually after checking radiation level in cell.)
- p. Check radiation levels around cask at various points and especially in plug area and under cask where block lock shaft extends through bottom of cask.

NOTE

Decontamination and monitoring procedures
are to be established by Oak Ridge.

2-12. CASK CHECKOUT AND SYSTEM DISASSEMBLY.

2-13. After completion of the radiation level checks and decontamination, removal of the cask from the hot cell can proceed as follows:

- a. Close Wood's metal valves on cask and on furnace if not accomplished by manipulators.
- b. Disconnect all wiring and air lines.
- c. Attach hoist beam to cask trunnions and drag brace to fin fitting.
- d. Hoist cask from hot cell.
- e. Before placing on skid, visually check bottom of cask at penetration of block lock shaft for evidence of Wood's metal leakage. No leakage is permitted from this area. If there are indications of a slight leak, tighten locking device by rotating block lock handle clockwise. Force on handle knob shall not exceed 4 pounds or 24 inch pounds of torque on shaft. In event leak persists return cask to hot cell and unload isotope as described in para. 2-14 and replace O-ring seals in block lock mechanism 356-1770068.
- f. Remove Wood's metal furnace and flexible hose from cask. In event Wood's metal solidifies in hose and valve making removal difficult, connect hose heater element to electrical power source until Wood's metal melts.

CAUTION

Protective gloves shall be worn at all times while working with Wood's metal system or cask after loading with the isotope as high surface temperatures will be encountered.

- g. With cask suspended on hoist beam disconnect drag brace from beam and rotate cask 180°.
- h. Check area around plug for Wood's metal leakage. If slight leak occurs tighten plug by rotating jack with 1/2-inch socket wrench. A maximum of one drop per minute leakage is acceptable. If leakage in excess of this occurs, return cask to hot cell and unload isotope as described in para. 2-14 and replace O-ring seal in cask sliding plug 356-1770067.

- i. Before rotating cask remove block lock mechanism (356-1770062) (See figure 3.)
- j. Safety-wire fuel block lock shaft 356-1770068.
- k. Rotate cask 180° to its vertical position and reconnect drag brace.
- l. Remove sliding plug actuator mechanism.
- m. Install plug lock plate (356-1770072-59).
- n. Lock wire and seal in accordance with drawing 356-1770072.
- o. Load cask onto skid in accordance with paragraph 2-1 steps a through u.
- p. Ship cask to Martin-Nuclear in accordance with paragraph 2-2.

2-14. UNLOADING FUEL BLOCK FROM CASK.

2-15. In event of leaks or other malfunctions, a procedure is required for unloading the fuel block from the cask. This procedure will also be used when the fuel block is returned to Oak Ridge after completion of the test program. The unloading procedure will be preceded by the same procedures described in paragraphs 2-4 and 2-6 up to point where the cask is placed in the hot cell. Remaining procedures are as follows:

- a. Wood's metal furnace is removed from side of cask and placed on floor of cell. Hose remains connected to lower Wood's metal valve.
- b. Open Wood's metal furnace valve. (See figure 4.)
- c. Open Wood's metal vent valve and drain valve on cask.
- d. Allow 15 minutes for Wood's metal to drain.
- e. Rotate fuel block lock handle counterclockwise approximately eleven (11) turns (4 pounds maximum pressure).
- f. Actuate sliding plug by turning air valve to PLUG OPEN position.
- g. Check for full travel of plug.
- h. Insert manipulators with special gripper fingers into cask. Grasp fuel block and remove from cask.

NOTE

Decontamination and radiation monitoring will be left to the discretion of Oak Ridge personnel.

SECTION III

MARTIN-NUCLEAR OPERATION

3-1. SPECIAL HANDLING EQUIPMENT.

3-2. Special handling equipment will be provided at the Martin Nuclear Facility to transfer the fuel block from the cask to the thermoelectric generator and to perform test, check out, and servicing of the generator. For the fuel block transfer, the cask is installed in an inverted position on a structural steel stand as shown in figure 5. The generator is placed on a gimbaled dolly which is positioned under the cask. Figure 6 shows a tank termed the collar shield, which is shaped to fit the contour of the generator and to mate with the cask. This shield is placed between the generator and cask and filled with mercury to provide a continuous biological shield in the transition area. Transfer of the fuel block is accomplished by sliding the cask plug to the open position and lowering the block into the mercury filled generator unit. The following sections describe the detailed operating procedures for fuel block transfer used before, during, and after transfer.

3-3. UNLOADING CASK AND SKID.

3-4. A 10-ton crane will be required for unloading from the railroad flat car. A truck or trailer with a 9-ton capacity will be required for transporting the cask from the rail siding to the Martin Nuclear hot cell facility. The unloading procedure is as follows:

- a. Remove tiedowns between skid and rail car.
- b. Remove lockwire and turnbuckles attached to cask trunnions.
- c. Unlash hoist beam from skid and attach to cask trunnions, protective cage to remain in place and drag brace on hoist beam to remain lashed to beam.
- d. Attach washers and lock pins to trunnions.
- e. Using 10-ton crane lift skid, cask, and cage assembly from rail car and place on truck or trailer. Long direction of skid must be oriented with long direction of truck or trailer.
- f. Tying down of skid to the truck is recommended but shall be the responsibility of the transportation office. Paragraphs 1-6 shall be used as a guide to determine type and manner of tiedown.
- g. Deliver cask, skid, and cage assembly to the Martin Nuclear hot cell facility. Speed of conveyance shall be limited to 10 miles per hour maximum and bumps shall be avoided. Cask accessory crates shall also be delivered with the cask.
- h. Furnish a 10-ton crane at the Martin Nuclear hot cell facility. Hoist the cask on its skid from its conveyance and place them on a hard level surface.

Figure 5. Integrated Transfer System

Section III
Figure 6

Figure 6. Collar Shield

- i. Remove bolts holding protective cage to skid.
- j. Disconnect protective covers in turn-buckle areas.
- k. Hoist protective cage from skid.
- l. Remove lockwire and turn-buckles.
- m. Attach hoist beam, 356-1770076, to cask trunnions and install washers and lock pins.
- n. Unlash drag strut from I-beam and attach end to fin fitting on cask.
- o. Place cask dolly, 356-1770090 beside skid. Position dolly such that locating pins are on same end as locating pins on skid.
- p. Hoist cask from skid with 10-ton crane and place on cask dolly.

CAUTION

Lower cask slowly to engage locating pins on dolly.

- q. Remove hoist beam from cask.
- r. Move cask dolly into hot cell building by powered vehicle.

CAUTION

Do not exceed 2 miles per hour speed and do not run cask dolly over floor obstructions in excess of 1/2 inch in height.

3-5. FUEL BLOCK TRANSFER OPERATION.

3-6. EQUIPMENT REQUIRED FOR TRANSFER. The equipment has been designed to perform the transfer operation without the use of a hot cell. However, as a safety precaution the initial loading will be performed in a hot cell. The equipment to be used will be as follows:

Cask Support Stand	356-1770088
Collar Shield	356-1770077
Power Unit Dolly	356-1770056
Gimbal Fixture	356-1770027
Mercury Level Control	356-1770053
Gimbal Ring	356-1770054
Lateral Adjuster	356-1770055
Ram Extension Rod	356-1770068-39
Shipping Cask	356-1770070

Plug Actuator	356-1770072
Cask Hoist Beam	356-1770076
Wood's Metal Drain System	356-1770063
Power Generator Sling	356-1770097
Collar Shield Sling	356-1770098
Installation Arrangement	356-1770051
Radiation Monitoring Equipment	

3-7. EQUIPMENT REQUIRED FOR PERSONNEL.

Asbestos Gloves
Respiratory Equipment (Mercury Vapor)
Radiation Badges and Dosimeters
Socket Wrenches
Torque Wrench

3-8. SPECIAL PRECAUTIONS. Refer to page following FOREWORD.

3-9. CASK STAND ERECTION. The cask stand 356-1770088 is designed to be readily disassembled to form a compact package, thereby being capable of shipment by air, rail, or truck to a site where the power generator would be fueled. I-beam sections from which the stand is constructed are light enough to be lifted manually. Bolts are used to assemble the sections. The stand can be assembled on its side by hand. However, a light crane is required to upright the assembly. Another method would be to assemble the platform and to hoist it while the legs were added. This latter procedure will be used in the hot cell test for which the assembly steps are as follows. (See figure 5.)

- a. Place 4 side beams of platform on floor of hot cell. Beam marked FRONT to be placed toward the door.
- b. Assemble at corners with bolts.
- c. Hoist platform to upper portion of hot cell by suspending sling through plug opening from overhead crane.
- d. Erect legs under platform and attach with bolts.
- e. Attach diagonal braces with bolts.
- f. Lower stand to ground and check for level.
- g. Add shims under legs to level if necessary.
- h. Remove hoist sling.

3-10. POWER GENERATOR PREPARATION.

- a. Attach power generator sling (356-1770089) to generator.
- b. Hoist generator to arm height.
- c. Using two men, pick up 1/2 section of Gimbal ring (356-1770054), open toggle clamps, and place around side of power generator such that support blocks are inserted in generator mounting sockets. Ring to be oriented with generator such that Gimbal axis is parallel with shutter hinge line.
- d. Actuate toggle clamps until lock pins are inserted into generator support holes. All toggle handles must be in the fully closed (down) position.
- e. Install second half of Gimbal ring such that locating pins mate with holes in other half of ring.
- f. Actuate toggle clamps as in step d.
- g. Fasten two halves of ring together with bolts.
- h. Hoist generator and position over Gimbal fixture on dolly.
- i. Lower power generator into Gimbal fixture until Gimbal ring trunnion holes are in line with fixture trunnion holes.
- j. Insert Gimbal trunnion shafts through fixture and Gimbal ring and insert bolt through ring and shaft on both sides.
- k. Install air motor and gears on trunnion shaft in accordance with drawing 356-1770052.
- l. Rotate motor shaft by hand until Gimbal ring is level with respect to Gimbal fixture base 356-1770027.

3-11. COLLAR SHIELD INSTALLATION.

- a. Hoist collar shield with sling 356-1770087. (See figure 6.)
- b. Place over power unit and mount on Gimbal ring 356-1770054. (See figure 7.) Align feet on collar shield with pads on Gimbal ring. Pins in collar shield feet shall be inserted in Gimbal ring pads.
- c. Remove level control 356-1770083 to clear cask support stand.

3-12. SYSTEM INTEGRATION.

- a. Roll test dolly with power generator and collar shield installed (as described in paragraphs 3-10 and 3-11) into hot cell and position under cask support stand so that the two locating pins protruding from the top of the collar shield are toward the right side of the cell as viewed from the door. Align dolly so that collar shield mounting brackets are directly below the attach points on the cask support stand.

Figure 7. Gimbal Dolly

- b. Attach two air lines to dolly jack drive motor.
- c. Attach anti-rotating bars between pairs of jack pads or rotate jack pads until jacks extend to floor.
- d. Apply air to system (90 PSI source).
- e. Turn air motor control valve to UP position. (Located on right hand side of dolly base.)
- f. Elevate test dolly until collar shield support brackets are within 1/8 inch of cask support stand.
- g. Apply bubble level to top surface of dolly, check, and level.
- h. To level dolly with motorized jacks, disengage drive shafts of 2 jacks on low corner by sliding spring loaded collars toward center of dolly approximately 1/2 inch and turning to either side to lock.
- i. Turn air control handle to down position thereby lowering high corner until level bubble is centered.
- j. Check for level on all sides of dolly, repeating steps h and i until dolly is level.
- k. Minor adjustments can be made by disengaging all drive shafts and turning jacks by hand using a wrench.
- l. Engage all jack drive shafts.
- m. Readjust height of dolly so that collar shield bracket is within 1/16 inch of cask support stand (as shown in figure 8) by turning jack air motor control valve to UP position.
- n. Attach hand cranks to lateral adjustment screws at base of Gimbal fixture.
- o. Adjust screws until holes in collar shield support bracket are aligned with holes in cask support stand. If holes are misaligned in excess of one inch before lateral adjustment is attempted, lower dolly and move dolly for better alignment and repeat steps g through m.
- p. Attach collar shield to cask support stand with 12 bolts.
- q. Turn jack air motor control valve to DOWN position until 1/4 inch + 1/16 is obtained between the collar shield support feet and the Gimbal ring pads. Clearance is necessary to prevent the mercury load from passing into the Gimbal ring.

Figure 8. Collar Shield Mated to Stand

r. Attach the following lines to the dolly. (See Drawing 356-1770086 and figure 10.)

- Mercury supply (1/2 inch diameter)
- Mercury drain (1 inch diameter)
- Shield mercury drain (1/2 inch diameter)
- Coolant water supply and return (3/8 inch diameter)
- Electrical and instrumentation lines

s. Attach mercury lines between dolly, generator, collar shield and mercury reservoir as shown on Drawing 356-1770078, 085 and 086. (See figure 10.)

t. Attach electrical lines to dolly systems.

u. Install collar shield mercury level control 356-1770083.

3-13. GENERATOR LOADING SYSTEM CHECKOUT. Before the cask is installed on the support stand, the mercury system in the collar shield and the power generator shield shall be checked out for leaks and proper functioning of level controls, valves, dumps, etc. Refer to Dwg. 356-1770051 for installation arrangement.

3-14. LEAKAGE TEST.

a. Close manual shield valve, located on base of dolly, right hand side. (See 356-1770086 and 356-1770085.)

b. Turn on electrical power to system and open mercury supply manual shut-off valve, located on hot-cell control panel. Shield should fill with mercury and level control should cut off when level reaches within 1" + 1/8 of the top of the shield. (See 356-1770053.) Green indicator light on control panel should light to indicate full. (See figure 9.)

c. Carefully inspect the entire shield for signs of mercury leakage.

3-15. LEVEL CONTROL TEST.

a. Test level control operation by simulating leak. With shield filled and mercury supply valve open, open manual shield drain valve 1/2 to 1 turn.

b. Open solenoid operated drain shut-off valve from hot cell control panel. The level control system should cycle the mercury supply solenoid valve on and off, and the red and green indicator lights on the hot cell control panel should simultaneously cycle between the low and full indications.

3-16. SHIELD DRAIN TEST.

a. With shield in full condition, close the mercury supply manual shut-off valve located on the hot-cell control panel.

Figure 9. Electrical Schematic Diagram

Figure 10. Plumbing System Schematic Diagram

b. Completely open the shield drain manual shut-off valve located on the base of the handling dolly (Right hand side).

c. Open the solenoid operated drain shut-off valve from the hot-cell control panel. The shield will drain. When the shield is empty, the mercury empty indicator will cause an amber indicator to light on the hot-cell control panel.

d. Close the solenoid operated, valve and the manual shut-off valve.

3-17. SPLASH PAN DRAIN SYSTEM TEST.

a. Open manual shut-off valve, located on the base of the dolly (left-hand side).

b. Manually pour a quantity of mercury (no more than a quart) into the splash pan. The sump level control unit should start the drain pump and a red indicator light on the hot cell control panel should indicate a LEAK condition, while there is mercury remaining in the sump.

3-18. COLLAR SHIELD TEST.

a. Close drain line shut-off valve (1" valve) and mercury supply line manual shut-off valve (1/2" valve).

b. Open three 1/2-inch diameter manual shut-off valves. Located on bottom of collar shield.

c. Turn on electrical power to collar shield level control system. Red control panel indicator light will indicate LOW condition. (See figure 9.)

d. Open mercury by-pass shut off valve. Collar shield will be filled with mercury thru the bottom drain connections. This is necessary in order to vent the air thru the level control.

e. Close the supply line by-pass shut-off valve when mercury LOW level indicator light goes out on the hot cell control panel.

f. Close the 3 drain shut-off valves and open the mercury supply line shut-off valve.

g. Carefully inspect the entire collar shield for signs of leakage. In the event of leaks, check the plumbing system. Leakage in the plumbing connections is more probable as the collar shield is of welded construction.

3-19. LEVEL CONTROL SYSTEM TEST-COLLAR SHIELD.

a. With the collar shield filled with mercury, open the main drain line shut-off valve.

b. Open 1 of the 3 drain shut-off valves, on the bottom of the shield, 1/2 to 1 turn. The mercury supply solenoid shut-off valve should cycle on and off. Simultaneously the red and green FULL and LOW indicator lights should cycle between their respective positions.

c. Drain collar shield after completing test by closing mercury supply line manual shut-off valve and opening the three drain line manual shut-off valves.

3-20. PREPARATION FOR CASK INSTALLATION.

3-21. After completion of systems checkout test, after all corrections have been made to wiring, plumbing and mechanisms and the mercury has been drained from the collar shield and power generator shield, the final preparations can be made for isotope cask installation. Proceed as follows:

a. Elevate dolly by turning control handle to UP position until collar shield feet are within 1/16 inch of Gimbal ring pads.

b. Remove bolts from collar shield support brackets allowing collar shield to rest on Gimbal ring.

c. Lower dolly by turning control handle to down position until a 2-inch space (+ 1/4) exists between cask support stand and collar shield brackets. Wheels should not touch the ground.

d. Allow all wiring and plumbing to remain connected to the dolly system and collar shield.

e. Remove concrete plug from top of hot cell.

3-22. CASK ASSEMBLY AND INSTALLATION.

3-23. Extreme caution must be exercised in handling the cask due to its weight, high surface temperature and radioactive contents. Asbestos gloves must be used in handling the cask. A health physicist shall monitor the handling procedures with radiation monitoring equipment. The following procedure shall be used to prepare the cask and to install it on the support stand.

a. Roll the cask dolly with the cask, up to a point near the cell where the cask will be loaded into the cell with the overhead hoist.

b. Remove cask plug lock plate and 4 bolts.

c. Remove cask plug jack mechanism and air motor drive from shipping crate and install on cask as shown on Dwg. 356-1770072. (See figure 3.) Insure jack pressure against plug by rotating jack drive clockwise with wrench.

d. Attach hoist beam 356-1770076 to cask trunnions and install washers and lock pins.

e. Unlash drag strut from I-beam and attach end to fin fitting on cask.

f. Hoist cask from dolly with overhead crane.

g. Disengage drag brace from cask and rotate cask 180° such that side with jack installation rotates down, away from hoist beam. Insufficient clearance exists under hoist beam for jack mechanism to rotate up.

- h. Reconnect drag brace to cask.
- i. Hoist cask over hot cell wall and lower through plug opening.
- j. Orient cask such that plug is pointing toward the left wall when looking at the cask from the cell outside door.
- k. Using extreme caution, lower cask onto support stand such that locating pins on stand engage holes in cask support brackets.
- l. Attach cask to stand with bolts.
- m. Install Wood's metal furnace and heated drain lines as per Dwg. 356-1770063.
- n. Connect airlines to plug jack drive motor.
- o. Connect power and instrumentation wiring to Wood's metal furnace and heated lines. (See figure 9.)
- p. Insert thermocouples probes into cask. (See figure 9.)
- q. Connect coolant lines to cask and open coolant valves.
- r. Install concrete slab on top of hot cell. A 4-inch diameter hole is provided in the slab for the fuel block transfer mechanism extension rod.
- s. Insert extension rod 356-1770068-39 through hole in slab and connect to end of ram protruding from top of shipping cask.

CAUTION

End of ram is hot.

Extension is attached in the following manner:

- t. Slide the tangs on the end of the rod into the slots in the end of the ram until they are in the bottom of the slots.
- u. Rotate the extension rod clockwise and insert the two keys (356-17700688-11) into the slots.
- v. Screw the sleeve (356-1770068-25) down until it bottoms on the shoulder at the end of the ram.
- w. Two handles (356-1770068-41) are screwed into place on the upper end of the extension rod (356-1770068-39).

3-24. SYSTEM PREPARATION FOR FUEL BLOCK TRANSFER.

- a. Elevate dolly by turning control handle to UP position and raise until collar shield mounting brackets are within 1/16 inch of cask support stand.

b. Check dolly for level on all sides of top surface. Dolly should have maintained level and alignment. However, if it is not level or aligned repeat steps h through o of paragraph 3-12.

c. Attach collar shield to cask support stand with 12 bolts.

d. Turn jack air motor control valve to DOWN position until $1/4$ inch + $1/16$ is obtained between the collar shield support feet and the Gimbal ring pads.

e. Turn off air source to jack motor so that the jacks are not inadvertently actuated.

f. Fill the power generator shield with mercury as described in paragraph 3-14.

g. Fill the collar shield with mercury per paragraph 3-18.

h. Check power unit shield manual drain line shut-off valve and three manual collar shield drain line shut-off valves to be sure that they are CLOSED.

i. Check the mercury supply line manual shut-off valves for the collar shield and power unit shield to insure that they are full OPEN.

j. Check the splash pan drain manual shut-off valve to be sure that it is OPEN.

k. Attach shield coolant lines to dolly and start flow of coolant through power unit. Coolant will be circulated at all times the fuel block and mercury are in the power unit.

l. Attach coolant lines to cask and start flow of coolant.

3-25. TRANSFER OPERATION.

3-26. The fuel block is ready for transfer into the power generator as soon as the cask temperature at the inner container indicates 200°F and all indicator lights on the control panel are green. Proceed with the transfer operation as follows:

a. Check vent on Wood's metal furnace for open position.

b. Open drain valve on Wood's metal furnace.

c. Open Wood's metal vent valve on cask.

d. Open Wood's metal drain valve on cask.

CAUTION

Wood's metal may be contaminated. Leave hot cell as soon as drain valve is opened.

e. Monitor Wood's metal furnace with radiation detection equipment to determine amount of surface contamination which may have been picked up by the Wood's metal.

f. Contamination if any, should be minor. However, if it is excessive portable shielding should be placed around the furnace.

g. Two men required on top of the hot cell slab to operate the extension handle for making the fuel block transfer. The handle shall be held in an up position by attaching a cable or rope to the handle and passing the rope over a pulley mounted above hot cell.

h. Manually remove three lock bolts 356-1770068-21 from the cask at the point where the fuel block support rod extends through the cask.

i. Clear the hot cell of personnel and close the doors.

j. Turn sliding plug actuator air valve, located on control panel, to OPEN position.

k. Observe when plug is in full open position and release air valve control to neutral position.

l. The lanyard attached to the transfer handle is released by the two men on top of the hot cell as each man holds one side of the "T" handle.

m. The handle is lowered slowly until the block enters the mercury. At this point the block will begin to float and a slight force must be exerted to submerge the block in the mercury.

n. Record radiation levels at critical points during the transfer operation.

o. Continue to force the block down into the mercury until block is bottomed. Mercury will begin to over flow into the splash pan due to block displacement.

p. While maintaining pressure on the handle, rotate the handle counterclockwise until the block is felt to drop into the locking slot.

q. Turn the handle clockwise 1/4-turn to engage the block in the locking device.

r. Pull lightly on the handle in a vertical direction to check if block is locked in the power generator.

s. To release the transfer rod from the block an extension wrench is used. The extension wrench assembly (356-1770068-49) is inserted into the extension rod. Make sure that the wrench engages the locking screw within the ram assy, by turning the wrench while pushing down lightly.

t. Turn the locking screw in the ram counterclockwise for approximately 11 turns, until the screw bottoms. The fuel block locking mechanism is then completely freed from the fuel block.

u. Withdraw the entire assembly of the extension rod and extension wrench up into the cask and secure handle in up position by attaching cable. (356-1770068-21)

v. Turn plug actuator control valve to CLOSE position until plug is fully closed.

w. The fuel block transfer has been completed. After a radiation check, personnel are free to enter the hot cell. Radiation levels recorded during the transfer should indicate that the levels encountered during the transfer are within safe tolerances permitting transfer without the use of a hot cell.

3-27. POST-TRANSFER OPERATION.

3-28. After completing fuel block loading into the power generator, the loading equipment must be removed from the hot cell so that the power generator test can be performed in the same hot cell. Remove the equipment by the following procedure:

a. Install three lock bolts (356-1770068-21) in cask at point where loading rod extends through cask.

b. Disconnect extension rod 356-1770068-39 and remove through hole in hot cell slab.

c. Drain collar shield as described in paragraph 3-16.

d. Remove all mercury lines and instrumentation wiring from collar shield.

e. Elevate the Gimbal dolly by turning air valve handle to UP position until collar shield support feet are within 1/16-inch of the Gimbal ring pads.

f. Remove 12 bolts from collar shield and allow it to rest on Gimbal ring and remove level control 356-1770083.

g. Lower dolly by turning air motor control handle to DOWN position until dolly is lowered until wheels touch the ground.

h. Remove concrete slab from top of hot cell.

i. Remove Wood's metal plumbing from cask.

j. Remove electrical and instrumentation lines from cask and Wood's metal furnace.

k. Remove furnace.

l. Remove cask plug actuator.

m. Install lock plate 356-1770072-59 with 4 bolts.

n. Install cask hoist beam to cask trunnions and drag brace to fin fitting.

- o. Hoist cask from hot cell with overhead crane and place cask on dolly using care to align holes in cask with locating pins on dolly.
- p. Roll generator dolly just outside hot cell door allowing all hose and instrumentation lines to remain connected.
- q. Attach sling to collar shield and hoist shield from Gimbal ring.
- r. Attach sling to cask support stand and overhead crane. Lift with the crane until the sling is supporting a partial load.
- s. Remove bolts attaching support stand legs to platform and remove legs and diagonal bracing.
- t. Lower platform to floor and dismantle by removing bolts at corner connections.
- u. Remove all sections from hot cell.
- v. Roll power generator dolly back into hot cell.

SECTION IV

TESTING PROCEDURES AND RESHIPMENT

4-1. TEST OPERATION.

4-2. PREPARATION FOR GENERATOR TEST.

4-3. The generator test will be described in another report. However, the handling and servicing procedures required during the test will be covered here to a limited degree.

a. Orient dolly in hot cell such that the center line of the beam tube passes through the centerline of the dolly and is perpendicular to the rotating Gimbal axis.

b. Elevate dolly in accordance with procedure described in paragraph 3-12, steps d through l.

c. Elevate dolly until centerline of power generator coincides with centerline of beam tube.

d. To prevent radiation damage, remove rubber-tired wheels from dolly by removing axle bolts.

e. Attach air lines to Gimbal rotation drive motor. (See 356-1770052)

f. Attach instrumentation lines to Gimbal position transmitter. (See figure 9.)

g. Open shield drain manual shut-off valve.

h. Withdraw all personnel from hot-cell and secure hot-cell door.

i. Close mercury supply line manual shut-off valve at hot-cell control panel.

j. Open solenoid operated shield drain shut-off valve (from hot-cell control panel). When shield EMPTY amber indicator light goes on the shield is empty.

4-4. GENERATOR ROTATION.

4-5. The generator is rotated in front of the spectrographic beam tube in order to determine the flux at various quadrants around the fuel block. A remote reading position indicator is provided to determine the angular position of the generator. The transmitter consists of a potentiometer mounted on the Gimbal shaft. Changes in angular position vary the voltage which is indicated on a voltmeter that has been modified to read angular displacement in degrees. (See figure 9.) The rotating procedure is as follows:

CAUTION

Do not rotate Gimbal while shield contains mercury.

a. Energize instrumentation system.

- b. Check indicator on control panel which should indicate 90°.
- c. Open air valve to 90-pound air source.
- d. Turn Gimbal rotating control handle on control panel to the left until indicator indicates 0° degrees. The test is ready to begin at this point.
- e. Turn control handle to the right until prescribed degree increment is reached. If the indicator reads above the desired angle, turn control handle to the left to reverse rotation until the exact angle is indicated.
- f. After completing test, rotate power generator to the vertical position until indicator indicates 90°.
- g. Fill generator shield with mercury as described in paragraph 3-14 after completion of test if access to the hot cell is required. Subsequent tests can be performed after draining the mercury. Mercury shall be installed in the generator shield after completion of each test.

4-6. DISPOSAL OF FUEL BLOCK.

4-7. After completion of all tests, the fuel block will be returned to the cask and shipped to Oak Ridge for disposal. Most procedures required to return the isotope to the cask will be a reverse of the procedures described for loading. The shipping procedures will be the same as shipment from Oak Ridge.

4-8. RETURN OF FUEL BLOCK TO CASK.

- a. Install wheels and roll power generator dolly from hot cell with mercury, cooling and instrumentation lines remaining attached, to a point just outside the hot cell door.
- b. Erect cask support stand as described in paragraph 3-9.
- c. Remove fuel block hold down device and install collar shield as described in paragraph 3-11.
- d. Roll power unit dolly under cask support stand, center and elevate as per paragraph 3-12.
- e. Install hoist sling on cask, hoist from dolly and rotate as described in paragraph 3-22.
- f. Install Wood's metal furnace and plumbing and sliding plug actuating mechanism as described in paragraph 2-20.
- g. Remove concrete slab from top of hot cell and hoist cask through opening and install on support stand as described in paragraph 3-22.
- h. The slab may be replaced or left off the hot cell as the level of safety for transferring the isotope without the use of a hot cell will have been established.

- i. Elevate power generator dolly so that the collar shield brackets are within 1/16-inch of the cask support beam.
- j. Attach collar shield to beam with 12 bolts and lower dolly to provide 1/4-inch clearance between shield support feet and pads.
- k. Install all instrumentation, power and plumbing lines and fill collar shield with mercury as described in paragraph 3-18.
- l. Install extension rod and handle to cask as described in paragraph 3-24.
- m. Check to see if fuel block engaging device is unlocked (locking shaft in center of extension rod turned fully counterclockwise).
- n. Remove three lock bolts which secure loading rod to cask and lower rod into power unit.
- o. Check scribe mark on rod to insure full engagement with fuel block knob. If it is not aligned with corresponding mark on cask, turn rod clockwise slowly until locking device drops onto fuel block hex knob and scribe marks are aligned.
- p. Using 1/2-inch socket wrench turn locking shaft in center of extension rod approximately 14 turns clockwise.
- q. Turn extension rod 1/4-turn counterclockwise to unlatch fuel block from power unit.
- r. Hoist extension rod raising fuel block through collar shield and into cask. Overhead pulley can be used for this operation.
- s. When block is in full-up position, install three lock-bolts at point where rod extends through cask.
- t. Remove extension rod.
- u. Close sliding plug by turning air motor control to CLOSE position.
- v. Open both Wood's metal valves on cask.
- w. Check temperature of Wood's metal furnace for minimum of 190° and open valve on furnace allowing Wood's metal to drain into cask. Close valves as soon as Wood's metal begins to pour from vent valve.
- x. Disconnect all systems and equipment from cask and attach hoist beam.
- y. Drain approximately 10cc of Wood's metal from the cask by opening the lower valve. Hoist cask from hot cell, rotate 180° and place on dolly.

4-9. PREPARATION OF CASK FOR RESHIPMENT.

4-10. Installation of cask on shipping skid and installation of protective cage will use the same procedure as described in paragraph 2-1.

4-11. RETURN OF CASK TO OAK RIDGE.

4-12. The shipping procedure to Oak Ridge will be the same as described in paragraph 2-3.