EXERTUS

FORTES

RUGGEDNESS SIMPLIFIED

Operating Manual

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1. DESCRIPTION

1.1. Terminology

ISO 3999: 2004	Also known as
Apparatus for Industrial Gamma radiography	Gamma radiography system
Automatic securing mechanism	Source Assembly Locking Mechanism
Beam limiter	Collimator
Control cable	Control Cable / Drive Cable
Control cable sheath	Drive Hose
Control Crank	Crank / Gearbox Handle / Crank Handle
Exposure container	Exposure Device / Projector / Camera
Exposure head	Source Terminal / Guide Tube Tip
Lock	Security Lock / Corbin Lock / Plunger Lock
Locked position	Locked
Maximum rating	Maximum rating
Projection sheath	Guide Tube
Remote control	Winding Mechanism / Winder
Reserve sheath	Return Hose
Sealed Source	Source / Pill
Secured Position	Safe / Shielded Position
Simulated source	Dummy Pigtail / Jumper
Source assembly	Pigtail / Link-type Pigtail
Source Changer	Transport / Transfer Container
Source holder	Source Holder Capsule
Working position	Point of Radiography

1.2. Introduction

The EXERTUS FORTES exposure container was designed to be used for Industrial Radiography to determine the internal soundness of materials and structures, without destroying the product's usefulness, thereby assuring the satisfactory performance for which the product was intended.

Non-Destructive Testing (NDT) is used in many spheres of industry, including but not limited to: Oil and Gas, Ship Building, Aviation, Power Generation and General Construction. With Industrial Radiography it is possible to detect defects and determine the integrity of steel in the thickness range 5mm to 200mm.

The EXERTUS FORTES meets the international requirements for exposure containers. It can accommodate both Ir-192 and Se-75 isotopes with a maximum capacity of 4.44TBq (120Ci) respectively.

The reliability and safe operation of this exposure container depends strongly on your knowledge as a qualified radiographer. It is the responsibility of the owner to ensure that all personnel using this equipment are appropriately trained by a licensed Institution.

Please ensure that the operator has read and fully understood this Operating Manual before using this equipment.

1.3. Certification

This exposure container and link-type source assembly meet the requirements of ISO 3999: 2004 and IAEA SSR-6 (2018) as well as the surface and 1m ambient dose rate measurement limits required by these Standards.

WARNING

The use of these radiographic exposure devices by unqualified personnel, or when safety procedures are not fully met, could result in life-threatening dangers.

1.4. Basic Details

The EXERTUS FORTES is a portable industrial radiographic exposure container. The 'Straight' tube design consists of a cast depleted uranium (DU) shield combined with a Tungsten source channel and Tungsten helicoidal labyrinth contained and secured within a 300 series stainless steel welded housing with source assembly (rear) and projection port (front) locking mechanisms bolted on. The assembly is further encased in a 300 series stainless steel sleeve for added protection.

The internal void space of the welded housing is open to atmospheric pressure.

The stainless steel sleeve, stainless steel housing containing the DU shield, source assembly locking mechanism, projection port, protective covers and required labels comprise the radioactive material transport package.

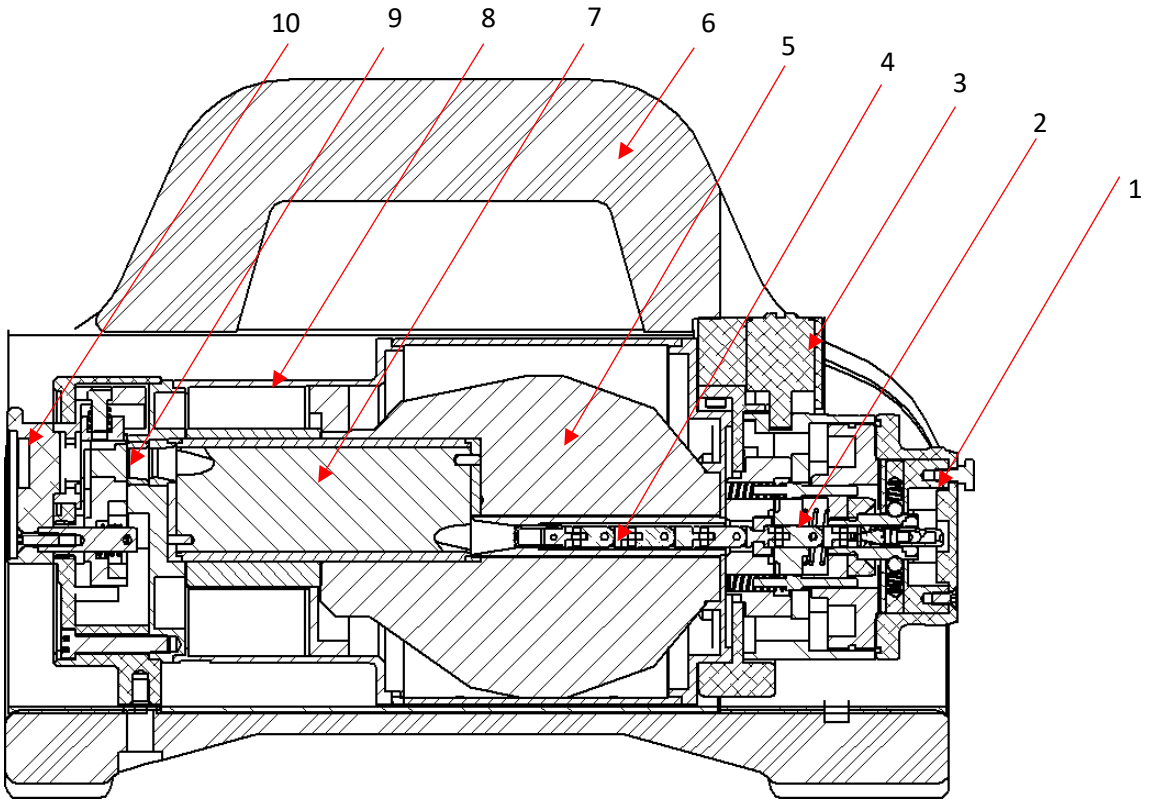
An optional blue coloured polyurethane jacket surrounds the stainless steel sleeve and serves as a protective barrier for the labels and provides the means for carrying and placement during use as a radiographic exposure device. The jacket contains pockets designed to house tracking devices.

Dimensions and weight of the package:

With jacket	310mm(L) x 150mm(W) x 230(H)mm	– Weight 23.0kg
Without jacket	310mm(L) x 125mm(Dia.)	– Weight 21.6kg

The EXERTUS FORTES exposure container is designed, tested, and manufactured to meet the requirements of ISO 3999: 2004 and IAEA SSR-6 (2018).

1.5. Main elements of the exposure container



1	Source assembly locking mechanism dust cover	6	Polyurethane jacket (Optional)
2	Source assembly locking Mechanism	7	Tungsten helicoidal labyrinth
3	Security Lock	8	Stainless steel housing
4	Source assembly	9	Projection Port
5	Depleted Uranium shield	10	Projection Port Dust Cover

Figure 1.5a: "EXERTUS FORTES" Package Assembly Drawing

1.6. Basic Operation

The locking mechanism requires several deliberate actions to enable projection of the source assembly. This is accomplished by:

- connecting the guide tube(s) to the projection port

  NOTE: When using more than one guide tube the combined length of the guide tubes must not exceed the length of the remote control, e.g., when using a 10m remote control only 4 x 2.1m guide tubes, or 3 x 3m guide tubes can be combined.

- coupling the control cable connector to the source assembly connector
- coupling the remote control coupling to the exposure container locking mechanism
- unlocking the security lock
- rotating the selector ring from the **GREEN** (lock) position to the **RED** (open) position
- pushing the locking slide from the **GREEN** (secured) position to the **RED** (unsecured) position

➢ The source assembly is now ready to be projected into the guide tube (Figure 1.6a).

NOTE: The source assembly must never be projected until the equipment is properly connected, and all personnel have exited the restricted area.

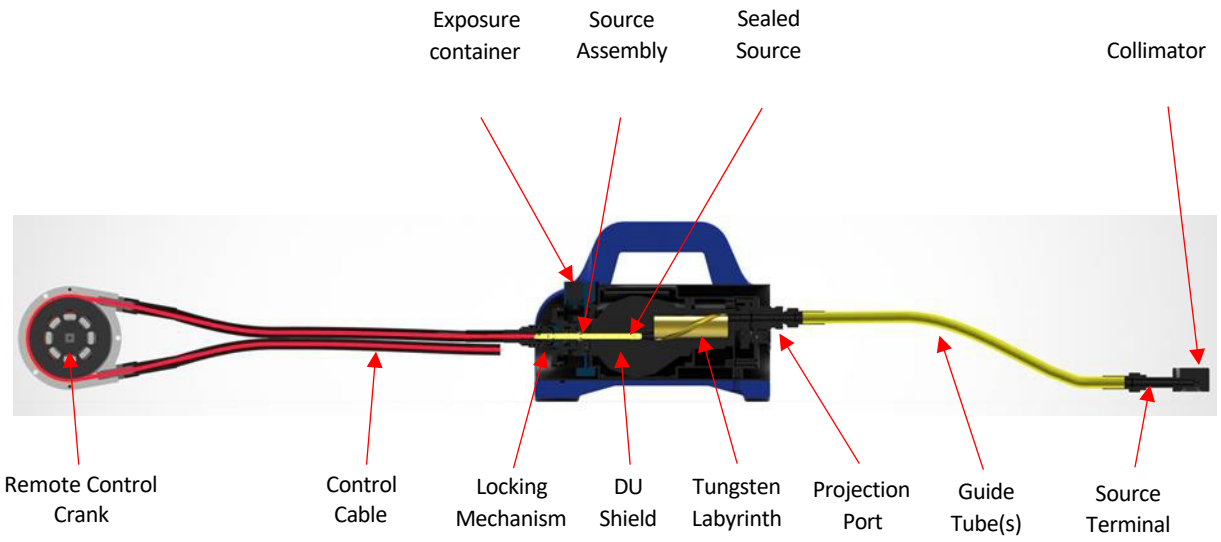


Figure 1.6a - Source assembly in shielded position – ready to expose.

Turning the remote control crank handle in the OUT (clockwise) direction moves the source assembly out of the shielded position in the exposure container and into the source guide tube(s) (Figure 1.6b).

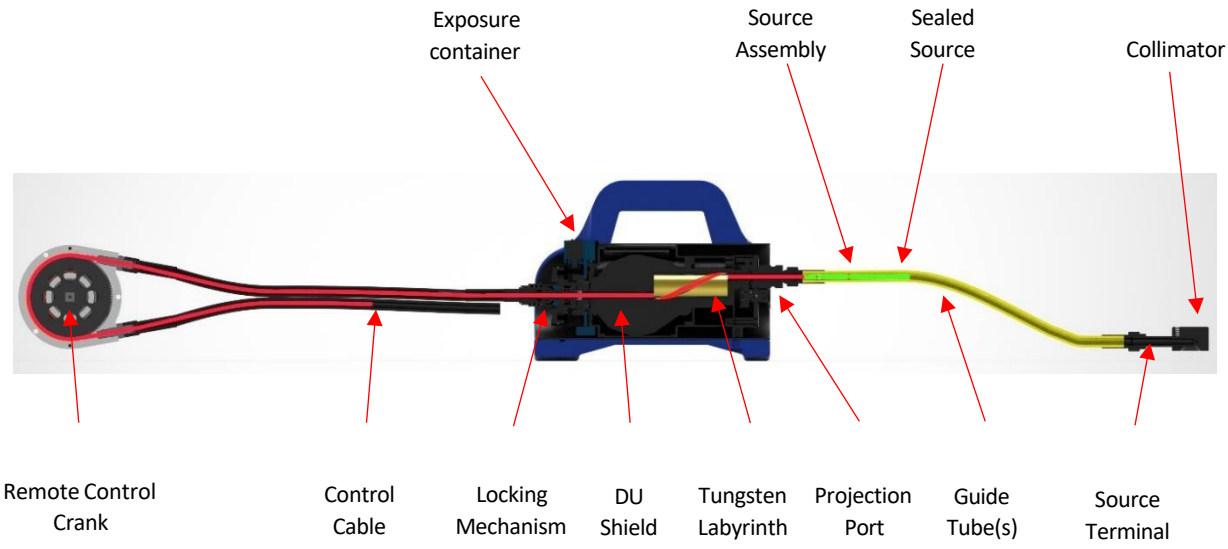


Figure 1.6b - Source assembly en route to source terminal

The radiographer will count the number of turns of the crank handle to verify that the source assembly has reached the source terminal.

Once the source assembly reaches the source terminal at the radiographic working position, the sealed source will remain in position for the duration of the exposure (Figure 1.6c).

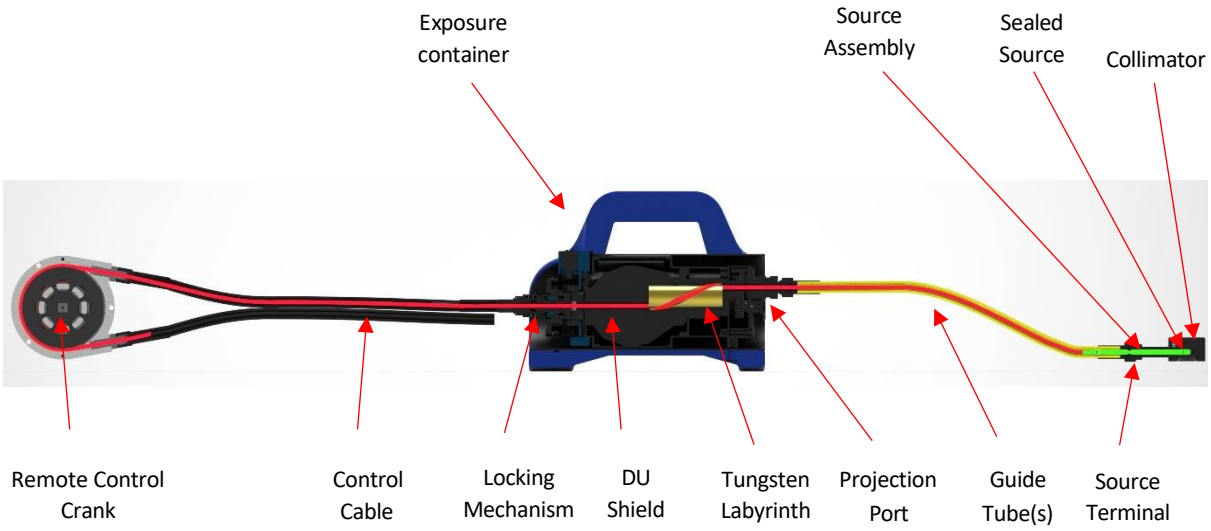


Figure 1.6c - Source assembly at the radiographic working position

To return the source assembly to the exposure container the crank handle is turned in the IN (anti-clockwise) direction.

When the source assembly is returned to the fully shielded position within the exposure container, the locking mechanism automatically secures the source assembly, and the locking slide moves from the **RED** (unsecured) position to the **GREEN** (secured) position.

The locking slide must be pushed from the **GREEN** (secured) position to the **RED** (unsecured) position prior to each exposure of the source assembly.

The remote control cannot be disconnected from the source assembly unless the source assembly is fully retracted into the secured position in the exposure container.

The complete radiography system consists of the exposure container with source assembly, the remote control, source guide tube(s), and collimator whenever possible.

1.7. Notice

This industrial radiography system is used as an exposure device and as a Type B(U)-96 shipping container for FORTES source assemblies.

The purpose of this manual is to provide information that will assist qualified radiographers in using the EXERTUS FORTES gamma radiography system. The user must be thoroughly familiar with this Operating Manual before attempting operation and use of this equipment.

For users in South Africa, an authority to Possess, Use, Convey or Cause to Convey radioactive sources in this equipment or perform source changes, must be obtained from the South African Health Products Regulatory Authority (SAHPRA): Radiation Control. In addition, authorization to Acquire, Possess, Use, Transport and Dispose of the Depleted Uranium shielding in this equipment must be obtained from the Department of Mineral Resources and Energy (DMRE).

It is the responsibility of users of this equipment outside of South Africa to comply with all local, national, and international regulatory, licensing and transportation rules and regulations as they apply in their respective countries.

1.8. Warranty and limitation of liability

The Manufacturer warrants its product, which it manufactures and sells, to be compliant to the requirements of ISO 3999: 2004 and IAEA SSR-6 (2018) and free from defects in material and workmanship for a period of one year from the date of shipment.

This warranty shall not apply to any product or parts which have been subjected to misuse, improper installation, repair and alteration, neglect, accident, abnormal conditions of operation, or use in any manner contrary to these instructions.

The manufacturer's liability under such warranty shall be limited to replacing or repairing, at its option, any parts found to be defective in such respects, which are returned to the manufacturer, transportation prepaid; or at its option, to returning the purchase price thereof.

The warranty on other manufacturer's components shall be that of the original manufacturer whose warranty shall be binding.

In no event shall the manufacturer be liable for any incidental or consequential damages, whether or not such damages are alleged to have resulted from the use of such product in accordance with instructions given by or referred to by the manufacturer.

The Manufacturer assumes no liability or responsibility for the usage of any radioactive material or device generating penetrating radiation used in connection with this product.

All other warranties, except those warranties expressly stated herein, are excluded.

The warranty on this device is specifically limited to its use only with connectors, parts, and accessories manufactured by the Manufacturer.

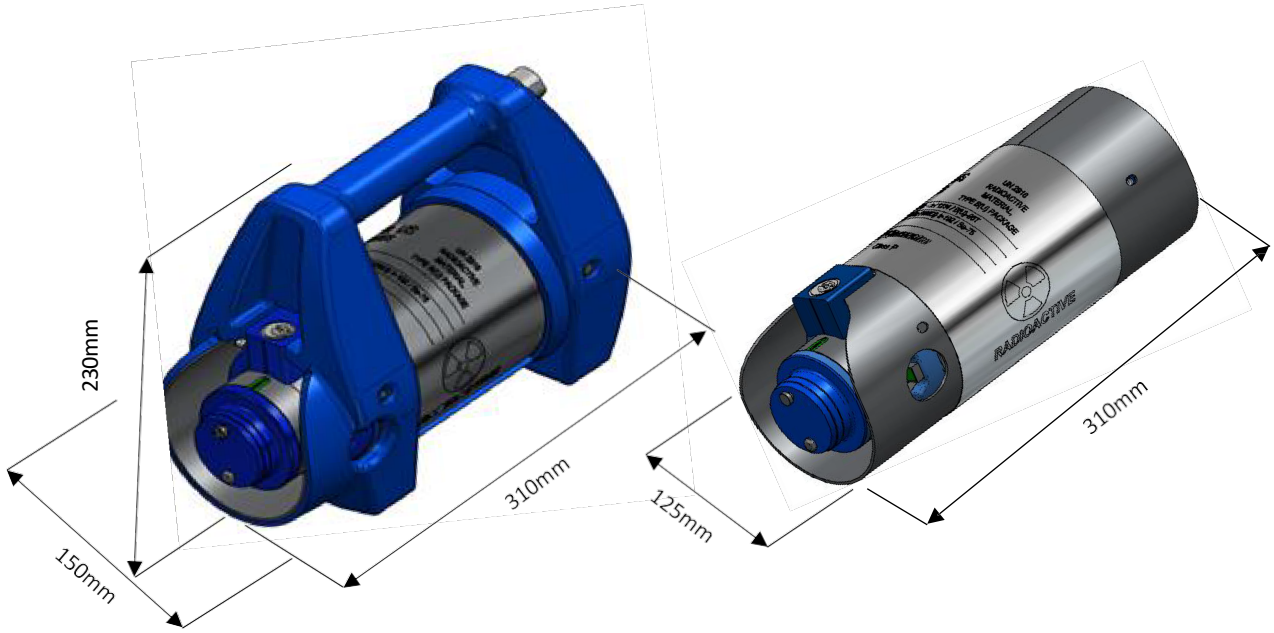
The Manufacturer shall not be liable for any errors or omissions contained herein and the provision by the Manufacturer of the information set out in this manual does not in itself constitute acceptance of any liability on the part of the Manufacturer.

2. TECHNICAL CHARACTERISTICS

2.1. Technical Specifications

Manufacturer:	Gammatec NDT Supplies SOC Ltd Vision 21 Industrial Park Steel Road, Peacehaven, Vereeniging 1939 Republic of South Africa
Name and Model:	Exertus Fortes
Dimensions:	With jacket - 310mm(L) x 150mm(W) x 230(H)mm Without jacket - 310mm(L) x 125mm(Dia.)
Weight:	With jacket – Weight 23kg Without jacket – Weight 21.6kg
Weight of Depleted Uranium shielding:	14kg

Activity of Depleted Uranium shielding:	4.7mCi (174MBq)
Authorized contents:	**Isotope Half Life Energy range Assembly** Ir-192 74 days 206-612 keV NCP0428 Se-75 120 days 66-401 keV NCP0438
Maximum activity:	Ir-192 4.44TBq (120Ci) Se-75 4.44TBq (120Ci)
Type A Approval:	The Exertus Fortes meets the requirements of IAEA SSR-6 (2018)
Type B(U) certification:	ZA/SAHPRA 0001/b(U)-96
Special Form Certificates:	Ir-192 - ZA/004/S-96 Se-75 - RUS/6508/S-96 Or any other certified Special Form Capsules approved
Shielding materials:	Depleted Uranium and Tungsten encased in a stainless steel housing.
Temperature range:	-40 °C to +70 °C with relative ambient air humidity of 95% at a temperature of +35 °C.
Materials of Construction:	Tungsten source channel and labyrinth, DU shield, 300 series stainless steel housing and mechanisms, Aluminum, Brass, Titanium, and Polyurethane (optional Jacket).
Remote Controls	**Stock Code Length Type Weight** NCW0376 10m Reel 9.5kg NCW0377 10m Pistol Grip 7.0kg NCW0378 15m Reel 11.5kg NCW0379 15m Pistol Grip 9.0kg **Minimum bend radius: 0.75m**
Guide Tubes	**Stock code Length Type** NCT0039 2.1m Yellow NCT0035 3.0m Yellow **Minimum bend radius: 0.3m**
Guide Tube Connectors	**Stock Code Type** NCC0644 M18 x 1.5
Guide Tube Source Terminals	**Stock Code Type** NCT0266 65 Ir/Se M18 x 1.5
Source Assembly:	**Stock Code Type** NCP0428 Link Type – Ir.192 NCP0438 Link Type – Se.75
Projection Lengths **NCW001 and NCW0012** **NCW0036 and NCW0037**	 4 x NCT0039 and 3 x NCT0035 6 x NCT0039 and 4 x NCT0035



2.2. Source Assembly

The source assembly is a link-type device constructed of 321 stainless steel and Tungsten links. The source holder link is situated at the front end of the assembly and consists of a Tungsten male threaded link section and a Titanium female threaded capsule into which the Special Form sealed source is inserted. The capsule is then screwed and pinned to the Tungsten link section.

The exposure container automatic securing mechanism is activated by an oversized link which engages with a bush to activate the keyhole shaped locking slide which then prevents projection of the source assembly until the locking slide is disengaged.

The source assembly connector socket provides the means to attach the control cable connector to enable remote projection and retraction of the source assembly. A shoulder on the connector prevents the source assembly from being extracted from the rear of the exposure container.

The source assembly connector and exposure container locking mechanism are designed so that the sealed source cannot be projected from the exposure device unless the source assembly has been properly coupled to the control cable connector (Figures 2.2a & b) and the remote control properly coupled to the exposure container.

The complete Source Assembly consists of the following components:

Source Assembly Connector / Stainless Steel Links / Tungsten links / Sealed Radioactive Source Holder Capsule / Coil Pins.

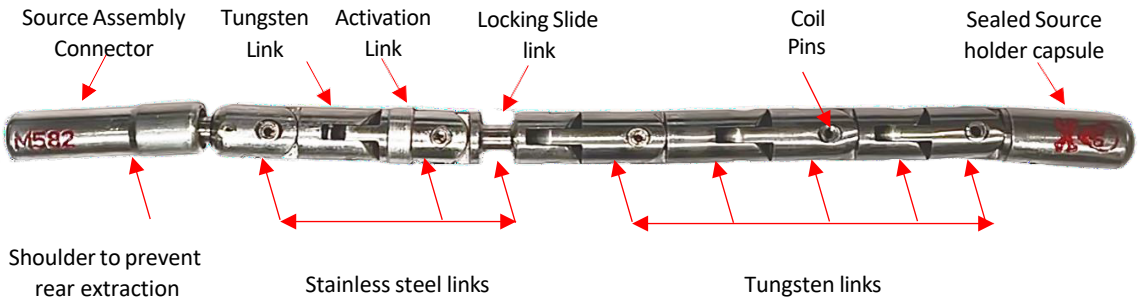


Figure 2.2a

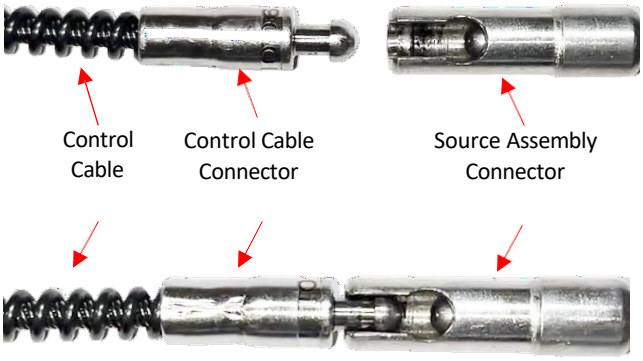


Figure 2.2b

3. OPERATING INSTRUCTIONS

WARNING

The use of these radiographic exposure devices by unqualified personnel, or when safety procedures are not fully met, could result in life-threatening dangers.

Before operating this equipment, it is of utmost importance to take note of the safety precautions.

3.1. Personal Safety and Dosimetry

The radiographer and all assistants are required to wear a TLD, OSLD, pocket dosimeter or suitable monitoring device with a range of 0-2mSv (0-200mR) while work is performed.

A calibrated radiation survey meter, capable of measuring in the range 0.02mSv/hr - 10mSv/hr (2mR/hr - 1000mR/hr) must also be used at all times. Some local authorities may also require the wearing of a direct reading dosimeter or EPD (Electronic Personal Dosimeter).

3.2. Equipment

Utmost care should be taken to prevent accidental dropping or mishandling of the exposure container. Upon set-up of the radiographic system care should be taken to safely secure all of the components, including the Guide Tube and Collimator. Special attention should be paid to this when working overhead or in elevated positions.

3.3. Daily Functionality Testing of Equipment

A daily Inspection, prior to the first exposure of each workday / shift of the radiography apparatus is important in order to detect possible defects and/or equipment damage. Even when it was recorded at the end of the previous shift that all equipment was in good working order, there is always the possibility of damage occurring during transport to the jobsite.

IMPORTANT NOTICE

If all of the below criteria are not met this equipment must not be used under any circumstances and must be taken out of service. Defective equipment must be repaired by Authorized Persons or returned to the Manufacturer or Authorized Service Centre for the necessary repairs and maintenance prior to being returned to service.

3.3.1 Exposure container – check that:

3.3.1.1 The surface dose rate of the exposure container is less than 2mSv/hr (200mR/hr).
This survey also provides a function check that the calibrated radiation survey meter is responding to radiation.
Make note of the surface readings in order to use them as a reference after each radiographic exposure and before storage of the exposure container.

3.3.1.2 The general condition of the exposure container is good with no broken parts, missing screws, etc.

3.3.1.3 All protective covers are in place and in good working condition.

3.3.1.4 The projection port cannot be fully opened if the guide tube is not connected.

3.3.1.5 The projection port and source assembly locking mechanism are clean.

3.3.1.6 The security lock key and plunger are operating correctly.

3.3.1.7 The selector ring cannot be rotated if the remote control is not connected.

3.3.1.8 The locking slide cannot be pushed to **RED** (unsecured) if the selector ring is not rotated to **RED** (open).

3.3.1.9 The source assembly is properly secured and cannot be moved forward or backward more than a few millimeters.

3.3.1.10 The source assembly connector passes the Go/No-Go test described in **Section 4.2.**

3.3.1.11 All required identification labels and warning signs are attached to the exposure container and legible as required by the relevant local authority.

3.3.2 Guide Tube and Collimator – check that:

3.3.2.1 The stainless steel fittings at either end are tightly crimped to the guide tube.

3.3.2.2 The source terminal is not damaged or excessively worn and is secured in the guide tube fitting.

3.3.2.3 The guide tube connector is not damaged or severely worn and is secured in the guide tube fitting.

3.3.2.4 The are no dents, kinks, or other damage that may prevent proper operation of the guide tube.

3.3.2.5 The collimator is not cracked or damaged in such a way as to reduce its effectiveness.

3.3.2.6 The source terminal fits snugly into the collimator recess and the thumbscrew operates correctly to secure the assembly.

3.3.3 Remote Control – check that:

3.3.3.1 The control cable connector passes a Go/No-Go test as described in **Section 4.2.**
3.3.3.2 There is no damage or excessive wear to the control cable and the connector is still properly crimped to the control cable.
3.3.3.3 The remote control coupling is not damaged or severely worn, and the spring loaded outer shell works smoothly.
3.3.3.4 The drive hoses have no permanent bends, dents, or other damage that may prevent proper operation of the remote control and the stainless steel fittings are tightly crimped to the hoses.
3.3.3.5 The control cable does not slip over the Gear.
3.3.3.6 The control cable moves freely through the hoses when winding.

3.4. Operating the equipment

It is important that the following steps are performed accordingly, and in the exact sequence as set out below.

Step 1 - Positioning the exposure container
Step 2 - Connecting the guide tube
Step 3 - Connecting the remote control
Step 4 - Projecting and retracting the source assembly
Step 5 - Confirmation survey and locking of the exposure container
Step 6 - Dismantling of equipment
Step 7 - Storage of equipment

Step 1 – Positioning the Exposure Container

Where possible always place the exposure container on a level surface. In the event where this is not possible or in the case of overhead or elevated work, secure the exposure container with suitable clamps, straps or similar to prevent it from falling.

Step 2 – Connecting the Guide Tube

Ensure that the guide tube to be used has been inspected. Secure the guide tube source terminal, with the collimator (if used) correctly attached to the point of radiographic exposure by means of a magnetic base stand or similar device.

Lay out the guide tube, with no bend with a radius less than **0.3m**, to ensure the source assembly can move freely through the guide tube without any restrictions. To prevent the guide tube being damaged whilst in use, ensure that it is not laid out in walkways, driveways or where there is a danger of falling objects. Also avoid contact with hot surfaces at all times.

Important Notice
As there are various lengths of guide tube available always ensure that the selected guide tube is shorter than the length of the remote control hose to prevent the control cable running off the gear.

Ensure that the guide tube Connector is tightly secured to the Guide Tube and proceed as follows:

Simultaneously pull and rotate the spring-loaded projection port cover a quarter of a turn in a clockwise direction (3-o-clock position) (Figures 3.4a and b).

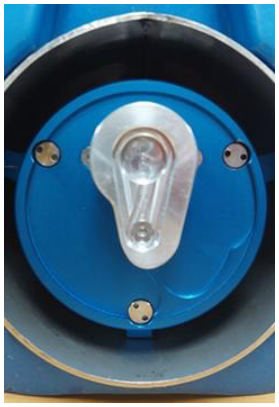


Figure 3.4a

Figure 3.4b

Figure 3.4c

Figure 3.4d

Insert the bayonet fitting of the guide tube connector into the exposed port and rotate it a quarter of a turn in a clock-wise direction until the **RED** mark is at 12-o-clock (Figure 3.4c).

Now rotate the spring-loaded projection port cover an additional 60 degrees in a clockwise direction until it stops (5-o-clock position) (Figure 3.4d).

Step 3 – Connecting of the Remote Control

Ensure that the remote control to be used has been inspected**.** Remove the source assembly locking mechanism dust cover and secure it by inserting it into its holder in the Polyurethane jacket (Figures 3.4e and f).

Figure 3.4e

Figure 3.4f

Lay out the remote control hoses as straight as possible ensuring maximum distance between the exposure container and operator with no bend with a radius less than **0.75m**.

Remove the dust cover from the remote control coupling and expose approximately 200mm of the control cable by turning the remote control crank handle in the OUT (clockwise) direction.

WARNING

The control cable connector is made of stainless steel and should never be left unprotected or forced into connection with the source assembly as this could damage the connector over time leading to possible breakage during use.

Hold the control cable perpendicular to the source assembly and push the control cable connector ball into the socket of the source assembly connector. In this position, move the control cable connector towards the back of the source assembly connector socket and swivel it downwards (90˚) to a horizontal position (Figures 3.4g and h).

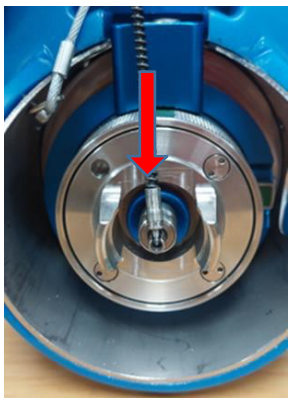


Figure 3.4g

Figure 3.4h

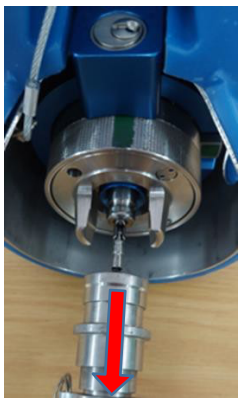


Figure 3.4i

Figure 3.4j

Retract the control cable by turning the remote control crank handle in the IN (anti-clockwise) direction until the remote control coupling is close to the exposure container mounting. Now, pull back the outer shell of the coupling (Fig. 3.4i) and push the coupling over the exposure container mounting.

Release the outer shell, the coupling will connect automatically (Fig. 3.4j). Check manually if the coupling is connected properly by pulling back on the drive hose. If not properly connected, check that the control cable connector is properly connected to the source assembly connector and then re-connect the coupling.

WARNING

The remote control coupling, control cable and source assembly connectors are designed so that the remote control coupling cannot be properly connected to the exposure container mounting if the control cable is not properly connected to the source assembly. Wear and tear and lack of inspection and maintenance can cause these tolerances to be exceeded leading to a situation where a mis-connect is possible (See Mis-connect Test in 4.3).

Step 4 – Projecting and retracting of the Source Assembly

To prevent the remote control hoses being damaged whilst in use, ensure that they are not laid out in walkways, driveways or where there is a danger of falling objects. Also avoid contact with hot surfaces at all times.

Before exposing, ensure that the following is in place: radiation control area barriers, no person/s inside these barriers and all legislative requirements are in place and met.

Insert the key into the lock and turn clockwise to unlock the exposure container (Figures 3.4k, l & m).

Figure 3.4k

Figure 3.4l

Figure 3.4m

WARNING

When the remote control coupling is properly connected to the exposure container mounting it will depress security pins which will allow the Selector Ring to be rotated from the GREEN (lock) to the RED (open) position. If the selector ring will not rotate DO NOT FORCE IT, instead check that the security lock is unlocked and, if so, ensure that the control cable connector is properly connected to the source assembly and then re-connect the remote control coupling to the exposure container mounting ensuring it is also properly connected.

Remove the key from the lock and store it in a safe place (Figure 3.4m). Now, rotate the selector ring clockwise to the **RED** (open) position (Figure 3.4n). Push the locking side from the **GREEN** to **RED** position (Figures 3.4o & p). The exposure container is now ready for operation and the source assembly is free to be projected from, and retracted to, the exposure container.

The locking slide must be pushed from the GREEN (secured) position to the RED (unsecured) position prior to each exposure of the source assembly.

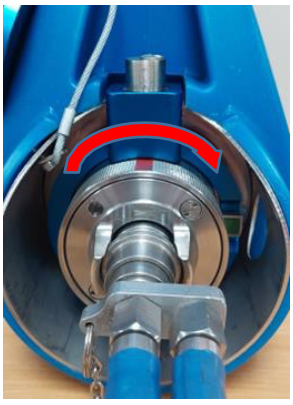


Figure 3.4n

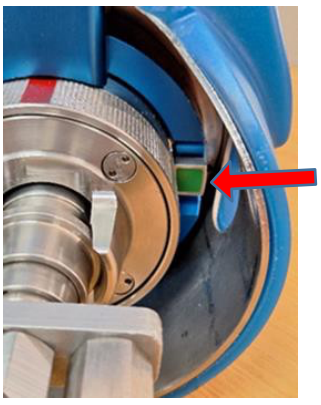


Figure 3.4o

Figure 3.4p

Checks before exposure of the Source

Verify that the guide tube(s) are attached to the projection port.

Ensure that no personnel are inside the Restricted Area or exposure room.
Ensure that the proper signs are posted and required warnings are in operation.

WARNING

The assembly sequences and operating instructions in this Section must be followed in order to ensure safe operation of the equipment. There is a risk of radiation exposure that may result from non-observance of these instructions.

Rapidly turn the remote control crank handle in the OUT (clockwise) direction in order to move the source assembly to the point of radiography. Ensure not to use excessive force and to slow down prior to reaching the source terminal.

When the source assembly is projected from the exposure container it will be observed that the radiation survey meter reading increases dramatically from a background radiation level to a high radiation level. This should decrease sharply once the source assembly and sealed source enter the collimator (if used) and should remain constant throughout the exposure. The same principle will apply in reverse when the source assembly is retracted.

Actual survey meter readings will depend on the source activity, distance, collimators, and other shielding. The sequence of changes should be observed, and the readings noted.

Once the required exposure time has elapsed the source assembly is retracted by rapidly turning the remote control crank handle in the IN (anti-clockwise) direction. Ensure not to use excessive force and to slow down as the source assembly enters the exposure container.

The source assembly locking mechanism will automatically lock the source assembly in the secured position. The locking slide now shifts from **RED** to **GREEN** with an audible '**click**'.

Apply a slight 'OUT' force to the remote control crank handle to ensure that the source assembly locking mechanism has indeed engaged. Allow the crank handle to return to the neutral position.

In the unlikely event the locking slide does not activate or moves toward the **GREEN** (secured) position before the source is fully retracted in the automatic securing mechanism see **emergency instructions in Section 8.**

Step 5 - Confirmation survey and locking of the exposure container

Approach the exposure container cautiously while observing the radiation survey meter. Ensure that the **GREEN** (secured) flag is visible on the locking slide when approaching the exposure container.

Measure the dose rate on the surface of the exposure container, paying particular attention to the projection port reading. The readings obtained should be the same as the readings observed prior to the exposure.

If this is not the case treat the situation as an emergency and follow the emergency instructions in Section 8.

If the reading is satisfactory rotate the selector ring anti-clockwise to the **GREEN** (lock) position and depress the security lock plunger until it locks in place.

If the key is still in the security lock, remove it and store it in a safe place.

Step 6 – Dismantling of equipment

The dismantling of equipment must always take place in reverse sequence to the connecting procedure.

Detach the remote control coupling from the exposure container mounting by pulling back on the outer shell. Expose approximately 200mm of the control cable. Now, follow the control cable to source assembly connection procedure in reverse sequence.

Retract the exposed control cable back into the hose, insert the dust cover in the remote control coupling and roll up the hoses for storage.

Replace the dust cover in the exposure container locking mechanism.

Swivel the projection port dust cover upwards to the 3-o-clock position, rotate the guide tube connector anti-clockwise and disconnect it from the projection port. Swivel the projection port dust cover upwards to the 12-o-clock position and plug it into the projection port orifice.

Place the dust cover on the guide tube connector and roll up the guide tube for storage.

Ensure that all dust covers of the exposure container, remote control and guide tube(s) are in good working condition and in place when the equipment is not in use so as to prevent ingress of dirt and moisture and damage to the components.

IMPORTANT NOTICE
Although it is highly unlikely for the source assembly to be radioactively contaminated, it is good practice to monitor the remote control and guide tube for signs of radioactive contamination after use.

WARNING

Always ensure that the exposure container is locked prior to moving or transporting. Never leave the remote control and/or guide tube connected when moving or transporting the exposure container. This could cause damage to the exposure container and/or the apparatus and cause a malfunction, possibly leading to a radiation emergency.

Step 7 – Storage

Lock the exposure container and secure it in a clean dry storage area where it cannot be tampered with or removed by unauthorized personnel. Perform a storage survey on the surface of the exposure container to verify the dose rate is the same as that recorded at the start of the workday and record.

A radioactive material warning notice must be posted on the door or entrance of the storage area. The door or entrance must be locked to prevent access by unauthorized personnel.

A list of personnel to be contacted in the event of an emergency should be posted on the storage facility.

4. MAINTENANCE

Please pay special attention to this Section. It is of utmost importance that all inspection procedures are followed and adhered to in full. Failing to do so could result in premature equipment failure, thus compromising safety and productivity.

Do not lubricate the equipment with oil as dust and dirt will stick to the oil and get transferred into the remote control, exposure container and guide tube.

Radiographic exposure containers and associated equipment must be maintained regularly by trained and qualified personnel to ensure consistent and safe operation of the radiographic system.

By most national regulations, routine maintenance of the systems is required at 3 month intervals in addition to the radiographer's daily inspections for obvious defects. There is also a requirement to ensure that the exposure container is “fit for service” whenever a source change is done.

Managers and Radiation Safety Officers must recognize the need for maintenance intervals that are less than the required 3-month interval especially in cases where the systems are used in severe environmental conditions. Managers and Radiation Safety Officers must ensure the systems are completely serviced immediately after certain jobs in severe conditions.

Extreme or severe conditions may include, but are not limited to conditions where the equipment was:

- Immersed in water or mud.
- Subjected to high-concentrations of particulate such as fly ash, sand, dust, etc.
- Subjected to hot and/or humid conditions.
- Subjected to salt-water conditions, caustic, or acidic materials.
- Subjected to accidental drops or impacts from falling objects.
- Whenever subjected to extreme environmental conditions.

4.1 Quarterly maintenance

A quarterly inspection and maintenance of the Radiography apparatus is important in order to detect possible defects and/or equipment damage.

If any equipment fails to comply with all the criteria in the checklists, the equipment is no longer fit for field use. The equipment must be taken out of service immediately, labelled accordingly and reported to the Radiation Safety Officer.

Defective equipment must be repaired by Authorized Persons or returned to the Manufacturer or Authorized Service Centre for the necessary repairs and maintenance prior to being returned to service.

4.1.1 Maintenance of exposure container

In addition to the Functionality tests in Section 3.3, pay particular attention to the following:

4.1.1.1 Survey the surface of the exposure container to ensure the radiation level is less than 2 mSv/hr (200 mR/hr).

4.1.1.2 Clean the source assembly locking mechanism and projection port mechanism using a soft bristle brush and thinners (or other non-oil-based solvent / alcohol, etc) and allow to dry thoroughly.

If partial dis-assembly is required in order to clean some parts ensure this is done by Authorized Persons.

4.1.1.3 Inspect the projection port dust cover for damage and ensure that it rotates smoothly to the fully open position with the guide tube connected.

4.1.1.4 Inspect the source assembly dust cover and ensure that the cover is attached to the container, the 'O' ring is in good condition and the cover remains in place to protect the mechanism and prevent ingress of dirt and moisture.

4.1.1.5 Inspect the locking mechanism and source assembly connector (see 4.2) and ensure that they are undamaged and not excessively worn. Ensure that the plunger of the security lock is working correctly and engages properly with the selector ring.

4.1.1.6 Ensure the selector ring rotation is smooth with no undue force necessary to rotate the ring.

4.1.1.7 Ensure the locking slide works smoothly and locks in place in the **RED** (unsecured) position and snaps back to the **GREEN** (secured) position when the source assembly is retracted.

4.1.1.8 Inspect the label to ensure that the warning trefoils are visible from at least 1m.

4.1.1.9 Check that all screws are in place and securely tightened.

4.1.1.10 Report observations and ensure that any deficiencies found during the process are reported and repaired by Authorized Persons or returned to the Manufacturer or Authorized Service Centre for the necessary repairs and maintenance prior to being returned to service.

4.2 GO/NO-GO testing of control cable and source assembly connectors

The safe working of the radiography system relies heavily on the soundness of the connection between the source assembly and control cable connectors. Therefore, it is very important to monitor these two components for wear and tear and other damage.

Permissible tolerances can be checked using the supplied "Go/No-Go" Gauge as follows:

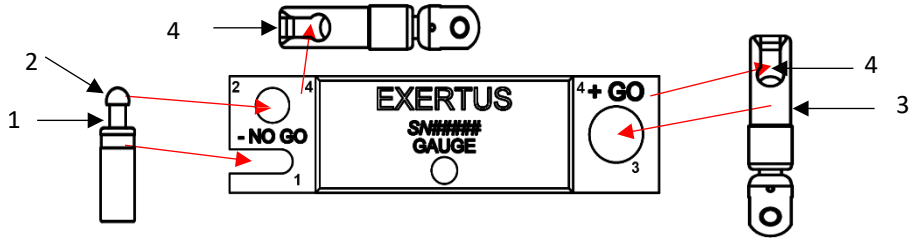


Figure 32 - "Go/No-Go" Gauge

The gauge has two sides, one marked GO and the other marked NO-GO. Use the above diagram to test the various elements of these components by using their corresponding numbers on the gauge.

- The neck (1) of the connector must NOT FIT into the slot.
- The ball (2) of the connector must NOT PASS through the hole.
- The source assembly connector (3) MUST PASS through the hole.
- The slot width on both sides of the gauge must be used test the slot in the source assembly connector (4). The "GO" side MUST FIT in the slot and the "NO-GO" side MUST NOT FIT in the slot.

Replace any components that fail any of the NO-GO gauge tests, because a failure indicates significant wear that could allow safety features of the design to be compromised.

4.2.1 Certification of the "Go/No-Go" gauge

This gauge is an inspection tool and, as such, has been made with precision. The gauge is supplied with a checklist indicating acceptable tolerances and with dimensions verified by the Manufacturer or Authorized Maintenance Center. Over time and with use the gauge will suffer wear and tear and periodic verification of the gauge dimensions against the checklist is recommended to ensure correct operation and safe use of the equipment.

4.3 Mis-connect Test

4.3.1 A mis-connection is defined as "the ability to connect the remote control coupling to the exposure container without connecting the control cable connector to the source assembly connector such that the source assembly locking mechanism can be disengaged thereby allowing the source assembly to be projected out of the exposure container".

4.3.2 To verify the integrity of the source assembly locking mechanism in the Exertus range of projectors and remote controls it is important to periodically perform a "mis-connect test".

4.3.3 During the mis-connect test the security lock and the source assembly locking mechanism must remain locked.

- Ensure the source assembly is in the secured position and the locking slide is in the **GREEN** (secured) position.
- Ensure the selector ring is in the **GREEN** (lock) position
- Ensure the plunger of the security lock is depressed to lock the selector ring in place.

4.3.4 Ensure the control cable connector is fully retracted into the drive hose coupling recess.

4.3.5 Without connecting the control cable connector to the source assembly, attempt to connect the remote control coupling to the exposure container mounting.

4.3.6 The coupling MUST NOT be able to snap fully into position on the exposure container mounting.

WARNING
If the coupling could be connected successfully in step 4.3.5 it is an indication that excessive wear or damage is present in either (or both) the coupling and exposure container. Both items should be removed from service immediately and sent to an approved maintenance centre for assessment and repair.

4.4 Annual Maintenance

IMPORTANT NOTICE
In addition to the inspections described in this Section, and where specified by National Regulations, the owner of this equipment may be required to send the equipment for Certification Inspection at specified intervals.

4.4.1 Maintenance of exposure container

4.4.1.1 In order for the Exertus Fortes exposure container to maintain its high safety standards, it is important that in-depth maintenance be performed annually or immediately after any major repairs are carried out on the exposure container.

4.4.1.2 This maintenance may only be performed by the Manufacturer, Authorized Service Centre or other Authorized Persons who have been trained and certified.

4.4.1.3 Guides to the components of the projection port and source assembly locking mechanisms are shown in Figures 4.4.1a & b.

5. LEAK TESTING

5.1 Leak Test of the Radioactive Sealed Source

Periodic leak tests of the radioactive sealed source are required by most national and international regulations. The leak test provides confirmation of the integrity of the hermetically welded sealed source by determining the amount of removable contamination.

In most regulatory jurisdictions, a leak test of a sealed source must be performed every 6 months or prior to its first use after removal from storage.

It is good practice to regularly monitor remote control drive hoses and guide tubes for signs of radioactive contamination.

5.1.1 This leak test can be performed with or without the source assembly present in the source channel.

5.1.2 Equipment required is as follows:

5.1.2.1 Swab Kit
5.1.2.2 Calibrated Survey/Contamination meter
5.1.2.3 Latex gloves
5.1.2.4 Hazardous waste disposal container

5.1.3 Use latex/rubber gloves when performing the test so as to prevent skin contact with possible contaminated exposure device surface or the test swab.

5.1.4 Survey the entire exterior surface of the exposure container to ensure the dose rates are less than 2mSv/hr (200mR/hr).

5.1.5 Install a guide tube connector into the projection port and rotate the dust cover to allow the test swab to enter the source channel.

5.1.6 Fully insert the test swab into the source channel and move back and forth to obtain the sample.

5.1.7 Carefully withdraw the test swab from the projection port while observing the survey meter. Insert the test swab into its plastic tube or Ziploc bag without touching the cotton pad. **Always assume the swab is contaminated**.

5.1.8 Remove the connector from the projection port and rotate the dust cover into the closed position.

5.1.9 In a low background (no radiation) area, switch the survey meter to the lowest scale and obtain a background measurement. Leaving the survey meter stationary, move the plastic wrapped swab towards the survey meter's detector to determine if a gross quantity of contamination is present.

5.1.10 Record all required information on the **PM/GSA/LOG-005.01.073.001 Exposure Device Test Report.**

5.1.11 If the survey meter measures greater than 1µSv/hr (0.1 mR/hr) above the background measurement the exposure container must immediately be removed from service, wrapped in a sturdy plastic bag (to prevent the spread of any contamination) and placed in a quarantine area. Remote controls, guide

tubes and collimators that were used with the exposure container must also be removed from service and quarantined.

Inform immediately.

Do not send the contaminated swab unless instructed to do so.

5.1.12 Contamination of equipment from a leaking radioactive source can have serious consequences so it is important to carry out a thorough investigation to ensure that the contamination has not spread to other areas. You must cause all the equipment to be investigated for contamination and, if found, you must extend the investigation to other areas such as personnel who were using the equipment, equipment storage areas, etc.

If evidence of wide scale contamination is detected notify the regulatory agency (check local regulations for reporting requirements) and any other entities that may be affected. Contact the sealed source supplier for assistance.

5.2 Leak Test for Depleted Uranium (Du)

Some regulatory jurisdictions require periodic leak tests every twelve months of all projection-type exposure containers that utilize DU for shielding. The purpose of the leak test is to detect the long-term wear-through of the container's source channel that may consequently expose the DU shielding (virtually impossible with the Exertus Fortes straight and helicoidal Tungsten source channel).

5.2.1 This leak test can be performed with or without the source assembly present in the source channel.

5.2.2 Use latex/rubber gloves when performing the test so as to prevent skin contact with possible contaminated exposure device surface or the test swab.

5.2.3 A test swab that is both flexible and long enough to reach a bend radius or a wear point is required to perform the leak test. The swab enables direct contact with the DU where the container’s source channel has worn through. A direct wipe of the DU is required due to the low specific activity of depleted uranium.

5.2.4 Follow the process in 5.1.6 to 5.1.10.

5.2.5 The analysis performed on the swab must be capable of detecting the presence of **185Bq (0.005µCi)** of radioactive material on the test sample. If a higher reading is obtained proceed as per 5.1.11 to 5.1.12.

5.2.6 If you are subsequently informed that the leak test results indicate greater than 185Bq (0.005µCi) proceed as per 5.1.11 and 5.1.12.

5.2.7 DU shielded devices do not have to be tested for DU contamination while in storage and not in use. Before using or transferring a container that has been in storage for more than 12 months, the container must be leak tested for DU contamination prior to use or transfer.

6. SOURCE CHANGING

A new source assembly may be transported in a multi-channel transport container which will always have an empty channel into which the old source assembly can be transferred, in order to load the exposure container with the new Source Assembly.

The transfer of the source assemblies can be carried out on-site in a controlled environment, or at the Manufacturer's or it's Distributor's facilities as described in **Section 7**.

Once the transfer is complete the old source assembly can be shipped back to the Manufacturer or its Local Distributor for disposal of the decayed sealed source.

Once the decayed source has been disposed of the source assembly goes through a process of inspection and re-certification. After re-certification the source assembly is ready to be re-loaded with a new sealed source.

IMPORTANT NOTICE
The Source Change procedure may only be carried out by properly trained and Authorized Persons under constant dosimetry control.

6.1. Unloading and loading of the exposure container

6.1.1 Refer to **WI/GSA/LOG-005.01.051.000 Field Source Exchange Procedure** (issued with this Instruction Manual) for instructions on source transfer for a particular transport container (there is more than one model of container that the source assembly can be transported in).

6.1.2 Ensure that the exposure container, remote control, and transfer tube (or guide tube) to be used have been inspected.

6.1.3 Align the exposure container and transport container adjacent to one another.

6.1.4 Connect the transfer tube, accompanying the transport container, to the exposure container as described in **Section 3.4 – Step 2**.

6.1.5 Connect the remote control to the exposure container as described in **Section 3.4 – Step 3.**

6.2. Unloading of the exposure container

6.2.1 Follow the steps outlined in **WI/GSA/LOG-005.01.051.000 Field Source Exchange Procedure** for the particular transport container.

6.2.2 Once the transfer setup is ready, proceed to project the source assembly as described in **Section 3.4 – Step 4**, into the transport container.

6.2.3 Use a calibrated survey meter to confirm that the source assembly is secured inside the transport container. Take surface readings on the transport container to assure that the maximum radiation level does not exceed 2 mSv/hr (200 mRem/hr). If this limit is exceeded, or if any unusually high readings are noted, notify the Radiation Safety Officer immediately.

6.2.4 Disconnect the control cable from the source assembly and lock the source assembly in place.

6.2.5 If the exposure container is to be re-loaded proceed with **Step 6.3.**

6.2.6 If the exposure container is not to be re-loaded with another source assembly, proceed with **Step 6.4.**

6.3. Loading of the exposure container

6.3.1 Follow the steps outlined in **WI/GSA/LOG-005.01.051.000 Field Source Exchange Procedure** for the particular transport container.

6.3.2 Once the transfer setup is ready, proceed to retract the source assembly as described in **Section 3.4 – Step 4**, into the exposure container.

6.3.3 Use a calibrated survey meter to confirm that the source assembly is secured inside the exposure container. Take surface readings on the exposure container to assure that the maximum radiation level does not exceed 2 mSv/hr (200 mRem/hr). If this limit is exceeded, or if any unusually high readings are noted, notify the Radiation Safety Officer immediately.

6.3.4 Dismantle the equipment as described in **Section 3.4 – Step 6**.

6.4. Storage of an unloaded exposure container

If the exposure container is not to be re-loaded and will be stored empty, it is necessary to connect a **"Dummy Source Assembly"** (jumper) to the control cable in order to activate the automatic securing mechanism. Proceed as follows:

6.4.1 Unload the exposure container as described in **Step 6.2.**

6.4.2 Remove the emergency shipping plug from its housing in the exposure container jacket handle by rotating the fitting 90° clockwise and withdrawing the plug (Figures 6.4a, b and c).

Figure 6.4a

Figure 6.4b

Figure 6.4c

Figure 6.4d

6.4.3 Now disconnect the dummy source assembly from the emergency shipping plug (Figure 6.4d) and attach it to the exposed control cable connector (Figure 6.4e). Now retract the dummy source assembly as described in **Section 3.4 – Step 4**, into the exposure container.

Figure 6.4e

6.4.4 Plug the emergency shipping plug back into the jacket handle.

6.4.5 Dismantle the equipment as described in **Section 3.4 – Step 6.**

7. SHIPMENT OF RADIOACTIVE MATERIAL

7.1 Package Consignment

7.1.1 Prior to shipment of a Type B container to the Manufacturer or its Authorized Distributors, assure that you are a registered user of the radioactive material package you wish to ship. Also, assure that you have appropriate quality assurance procedures in place for preparing and shipping Type B packages.

7.1.2 As the consignor of the goods YOU are responsible for ensuring that the container is correctly packed and labelled as per IATA guidelines and the Dangerous Goods Declaration (if required) has been correctly completed.

7.1.3 Prior to any shipment taking place ensure you have the following documentation ready:

7.1.3.1 Current Type B(U) certificate.

7.1.3.2 Decay chart(s) of the radioactive source(s).

7.1.3.3 Special Form Certificate for documentation preparation and labelling as per IATA guidelines.

7.1.4 Prior to any shipment taking place ensure the container and Its contents meet the following requirements:

7.1.4.1 The contents of the container are Special Form Ir.192 and/or Se.75 radioactive sources.

7.1.4.2 The container is in good physical condition for transport.

7.1.4.3 The source assembly(ies) is/are in the secured position.

7.1.4.4 All covers, channel caps, lids, bolts, etc., are in place and the container is locked (and the key removed) and seal wired if required.

7.1.4.5 The Overpack (if used) is in good physical condition for transport and is locked or screwed closed.

7.1.5 REFERENCES

7.1.5.1 Regulatory requirements applicable to your Company.

7.1.5.2 Current IAEA and IATA Regulations for the Transport of Radioactive Materials.

7.1.6 DEFINITIONS

7.1.6.1 **Package** - A Type B(U) certified container for radioactive materials. This package may be transported with or without an “Overpack”.

7.1.6.2 **Overpack** – A box made of metal/wood/plastic used to house a container or projector for the purposes of transportation.

7.1.7 PROCEDURE

7.1.7.1 DETERMINE THE TRANSPORT INDEX OF A PACKAGE (TI)

7.1.7.1.1 Take readings with a calibrated survey meter at 1m distance on all sides of the Package or Overpack.

7.1.7.1.2 In 99% of cases the Package measures less than 1m² and therefore the reading must be multiplied by a factor of 1, e.g.

Reading in mR/hr		**Reading in µSv/hr**	
Reading at 1m	= 0.5 mR/hr	Reading at 1m	= 5 µSv/hr
Container Factor	x 1	Container Factor	x 1
Therefore, Ti	= **0.5**	Convert to mR/hr	= 5 µSv/hr / 10
		Therefore, Ti	= **0.5**

7.1.7.2 DETERMINE THE CATEGORY OF A PACKAGE

7.1.7.2.1 Take readings with a calibrated survey meter on all surfaces of the Package or Overpack.

7.1.7.2.2 The readings can be taken in mR/hr but must be converted to µSv/hr for recording on any documentation. Compare the reading to the table below. The reading should (but may not) fall in the same row as the Ti in Table 1, e.g.

Reading in mR/hr	
Highest reading on surface	= 40 mR/hr
Convert to µSv/hr	= 40 mR/hr x 10
Therefore, surface reading	= **400 µSv/hr**

7.1.7.2.3 Based on the table below, a Ti of **0.5** and a surface reading of **400µSv/hr** means that the Package would require Category II – Yellow labels.

7.1.7.2.4 If, for example, the Ti was **0.9** (Cat II – Yellow), but the surface reading was **520 µSv/hr** (Cat III – Yellow), the Package would require Category III – Yellow labels with a Ti of 0.9.

7.1.7.2.5 If the Ti is **0** and the surface reading is **5 µSv/hr** or less, the Package would require Category I – White labels. However, if the surface reading is more than **5 µSv/hr** the Package would require Category II – Yellow labels.

Table 1 – Transport Index and Category

Transport Index	Maximum Radiation Level at any point on External Surface	Category
	≤ 5 µSv/hr ≤ 0.5 mR/hr	
> 0 - ≤ 1	> 5 µSv/hr - ≤ 500 µSv/hr > 0.5 mR/hr - ≤ 50 mR/hr	
> 1 - ≤ 10	> 500 µSv/hr - ≤ 2000 µSv/hr > 50 mR/hr - ≤ 200 mR/hr	

7.1.7.2.6 So, remember: -

The **Transport Index** (Ti) is *always* determined by the method in 7.1.7.1.

The **Category** is *most often* determined by taking a surface reading; however, the surface reading *must* be compared with the Ti and the *highest value* will determine the category.

All packages shipped to Consignee shall be shipped under the following UN code UNLESS OTHERWISE AUTHORIZED :

UN 2916 RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, non-fissile or fissile-excepted.

ALL UN2916 Packages MUST be documented on an IATA Dangerous Goods Declaration which must accompany the shipment and must be supplied to the Consignee prior to shipping.

7.2 Consignors Responsibilities

7.2.1 The Consignor is the License Holder who is duly authorized by the Regulator to possess, use, convey and cause to convey the radioactive source and remains **legally responsible** for the source until a disposal certificate is issued by the supplier of the source.

7.2.2 By causing the source to be conveyed by a 3rd Party (the Freight Agent or Courier) the Consignor is **legally responsible** to ensure that the 3rd Party has been authorized to ship **Dangerous Goods Category 6 Class 7.**

7.2.3 The Consignor is **legally responsible** for the correct packaging of the radioactive source and the measurement of radiation levels to determine the **Ti and Category** of the Package.

7.2.4 The Consignor **MUST** provide Consignee with a correctly completed "Authorization" form prior to shipment, which Consignee will acknowledge and return indicating the UN code under which the package **MUST** be shipped.

7.2.5 The Consignor is **legally responsible** for ensuring that the 3rd Party shipper is given the correct information for **Documentation and Labelling** of the Package and is responsible for ensuring that the 3rd Party shipper has documented and labelled the Package correctly **PRIOR** to shipment.

7.2.6 The 3rd Party shipper must submit the documentation to Consignee **PRIOR** to shipment.

8. EMERGENCIES

IMPORTANT NOTICE
The emergency situations below are based on foreseeable accidents under normal operating conditions. Your organisation must develop comprehensive emergency procedures based on the hazards associated with your operations.

Emergency situations occur during operation when the Source Assembly fails to fully return to the secured position within the exposure container, causing high levels of radiation to be emitted. Since a confirmatory survey is required after every exposure, it would immediately become apparent when such an emergency does occur due to the higher-than-average reading obtained during the survey procedure.

When an emergency situation arises **DO NOT PANIC – REMAIN CALM!**

8.1. Two basic emergency scenarios are as follows:

8.1.1 YOU DO NOT HAVE control of the source assembly/sealed source

In these scenarios the source assembly/sealed source is exposed in the guide tube and is either a) not connected to the control cable (mis-connect) or b) unable to be retracted into the exposure container due to damage to the guide tube or remote control. In these scenarios:

a. Evacuate the area immediately to a distance that does not pose such a significant risk of exposure. Establish and adjust the Restricted Area Boundary (if possible) to ensure that the measured dose rate does not exceed 20µSv/hr (2mR/hr) at the boundary lines. Do not allow anyone to enter this area.

b. **NOTIFY THE RADIATION SAFETY OFFICER IMMEDIATELY**

c. If at all possible attempt to shield the radiation without taking undue risk.

d. Do not attempt to retrieve the source assembly, this should only be done by the RSO or designated personnel who have received special training in this regard. Maintain security of this area until the RSO arrives.

WARNING
Never attempt to pick up or touch an unshielded source assembly without the appropriate equipment. Never allow the source assembly to have any contact with the human body. A Source Assembly in its unshielded state can cause serious injury or even death to anyone exposed to it, even for a short duration of time.

8.1.2 YOU HAVE control of the source assembly/sealed source

In these scenarios the source assembly/sealed source remains attached to the control cable and is able to be retracted into the exposure container. Examples of these scenarios are dealt with in 8.2.

8.2. Source Assembly Securing Mechanism fails to lock

8.2.1 Situation 1

After retracting the source assembly the locking slide fails to engage and lock the source assembly in the secured position.

8.2.1.1 Action

8.2.1.1.1 Using the remote control crank handle move the source assembly forward and sharply back two or three times in an attempt to activate the locking slide.

8.2.1.1.2 If the above fails to activate the locking slide the emergency shipping plug must be fitted as described in 8.3 in order to transport the exposure container to a maintenance facility.

8.2.1.1.3 The control cable can now be disconnected from the source assembly; however the selector ring will not be able to be rotated to the **GREEN** (lock) position as the locking slide will still be in the **RED** (unsecured) position.

8.2.1.1.4 **The exposure container must be shipped back to the Manufacturer or Authorized Service Centre for maintenance.**

8.2.2 Situation 2

The source assembly is projected from the exposure container and the locking slide disengages from the **RED** (unsecured) position and moves towards the **GREEN** (secured) position.

8.2.2.1 Action

8.2.2.1.1 The Control Cable is able to pass through the keyhole slot of the locking slide. Complete the exposure and retract the source assembly back into the container. Note that the source assembly connector cannot pass through the slot in the locking slide so the sealed source will not be in the optimal safe position and dose rates around the container will be higher than usual.

8.2.2.1.2 Approach the exposure container, from the rear, with a survey meter. The survey meter will measure approximately **550µSv/hr (55mR/hr)** at the rear locking mechanism when a 4.44TBq (120Ci) Ir.192 source is in use.

8.2.2.1.3 Remaining behind the exposure container, reset the locking slide to the **RED** (unsecured) position. Return to the control crank and turn the crank handle in the IN (anti-clockwise) direction and secure the source assembly in the normal manner.

8.2.2.1.4 This situation may be due to a weak or broken spring that controls the locking bush. **Do not continue to use the container in this case.**

8.2.2.1.5 **The exposure container must be returned to the Manufacturer or Authorized Service Centre for maintenance.**

8.3. Fitting of the Emergency Shipping Plug

8.3.1 Do a survey confirmation check to ensure that the source assembly/sealed source is in the exposure container, ensure that it then remains in that position by maintaining positive IN (anti-clockwise) pressure on the source assembly by means of the remote control crank handle.

8.3.2 Approach the exposure container, from the rear, with a survey meter. The survey meter will measure approximately **550µSv/hr (55mR/hr)** at the rear locking mechanism when a 4.44TBq (120Ci) Ir.192 source is in use.

8.3.3 Remaining behind the exposure container survey the projection port area to determine radiation levels. If it appears that the sealed source is in the safe position inside the exposure container disconnect the guide tube from the projection port.

8.3.4 Remove the emergency shipping plug from its housing in the exposure container Jacket Handle by rotating the connector 90° clockwise and withdrawing the plug (Figures 8.3a, b and c).

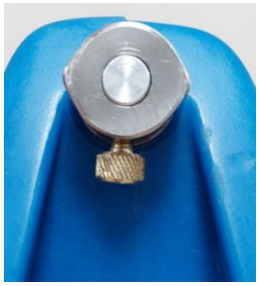


Figure 8.3a

Figure 8.3b

Figure 8.3c

8.3.5 Loosen the thumbscrew and remove the plug from the connector (Figure 8.3d).

Figure 8.3d

8.3.6 Now insert the connector in the projection port, rotate the connector 90°, and swivel the projection port dust cover to the 5-o-clock position (Figures 8.3e, f and g).

Figure 8.3e

Figure 8.3f

Figure 8.3g

8.3.7 Insert the emergency shipping plug through the connector and push it in until it makes solid contact with the source assembly. Tighten the thumbscrew to hold the plug in place (Figures 8.3h, i and j). The plug will now hold the source assembly/sealed source in place in the safe position.

Figure 8.3h

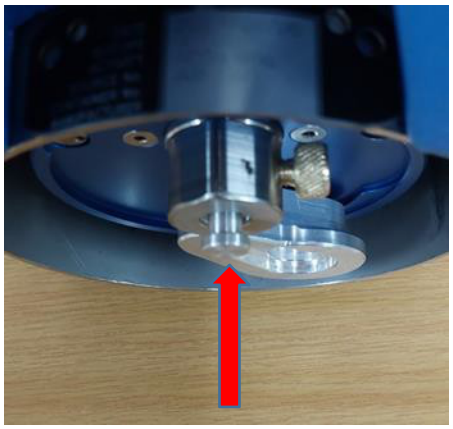


Figure 83.i

Figure 8.3j

8.3.8 Carry out a confirmatory survey to check surface and 1m radiation levels around the exposure container in preparation to transport it to a maintenance facility.

NB!! Remember to reverse the sequence from Figure 8.3j to Figure 8.3e in order to remove the emergency shipping Plug.

9. DISPOSAL OF RADIOACTIVE MATERIAL

By international regulations, radioactive materials that are no longer required must be transferred to a licensed recipient for final disposition. The **IAEA "Guidance on the management of disused radioactive sources 2018 edition"** states:

"A disused source could be returned to its original supplier, to the supplier of the replacement radioactive source or replacement device, or to any other supplier, provided the supplier is authorized to manage the disused source safely and securely, and has an agreement in place to receive the disused source".

Radioactive sources that have depleted beyond their useful working life may be returned to their Manufacturer or other Authorized Recipients using a transport container authorized for the specific model source assembly(ies) and following the process outlined in **Section 7.**"

The Manufacturer or other Authorized Recipients will provide specific conditions for transport to the shipper as required by regulatory authorities. As a minimum, sources that are transferred for a final disposition must be within a current leak test and properly secured within an authorized package before shipment.

Damaged, cropped, modified, or contaminated source assemblies may require special handling and special transport containers. It is YOUR responsibility to notify the Manufacturer or other Authorized Recipients for specific instructions in these circumstances.

Exertus Fortes exposure containers that are removed from service due to severe damage or decommissioning reasons must be sent back for final disposition.

If the Type B or Type A transport status of a damaged exposure container is impaired, the exposure container must be transported without radioactive source assemblies. Type B exposure containers where the B(U) license has expired must be transported without radioactive source assemblies.

DU shielded exposure containers sent for final disposition must be properly packaged, surveyed, marked, and labelled before placement into the transportation system. After final disposition, a "Radioactive Material Disposal Certificate" will be issued.

10. APPENDICE

This is to certify that

The Exertus Fortes Exposure container
And Link-Type Source Assembly
Have Been Assessed Against

ISO 3999: 2004
Apparatus for Industrial Gamma Radiography – Specifications for Performance, Design and Tests

and

SSR-6 (2018)
IAEA Regulations for the Safe Transport of Radioactive Material

Full scale testing and engineering analysis has demonstrated that this Exposure Container and Link-Type Source Assembly meet the performance requirements of the standards, when used in accordance with

WI/GSA/LOG-007.01.006.001
Exertus Fortes Operating Manual

Research & Development	**Quality Control**