

SENTINEL™

1075 SCAR*Pro*



Operating and Maintenance Manual





WARNING - IMPORTANT SAFTY INFORMATION

- Only trained and qualified radiographers who have read and fully understand this operating manual are allowed to use this system.
- Using this system without the proper training and not following the related safety procedures can result in life-threatening dangers.
- During use, this system will emit high levels of penetrating gamma radiation that cannot be detected by the human senses.
- High radiation exposure at close range can cause injury, sickness or death to anyone who is exposed to it even for a short period of time.
- Never assume the position of the radioactive source without using a calibrated survey meter.
- Always use a calibrated survey meter when using this system to avoid potentially dangerous levels of radiation exposure.
- Wear and use proper dosimetry including film badges or thermoluminescent dosimeters, direct reading pocket dosimeters, and audible alarm ratemeters while using this system and during all radiographic operations.
- Other than the source connector during hook up to the drive cable, the radiation emitting source assembly must never be touched by hand or handled unshielded up close.
- Special confirmatory surveys must be performed whenever using a low-activity isotope source.
- After performing radiography and with the source secured in the device, carefully and deliberately conduct the confirmatory survey on the following:
 - All surfaces of the exposure device,
 - Along the entire length of source guide tube and
 - On exposure head/collimator.
- A multitude of overexposure incidents are directly attributed to a failure of the radiographer to perform or supervise an adequate confirmatory survey.
- Failure to perform an adequate radiation survey can cause unnecessary exposure to personnel resulting in a reportable incident.
- Take advantage of the three basic radiation protection methods to minimize radiation exposure:
 - TIME: Spend less time near the radiation source.
 - DISTANCE: Increase your distance in a direction away from the radiation source.
 - SHIELDING: Whenever possible, always apply the use of effective shielding between you and the radiation source



Warranty and Limitation of Liability

QSA Global, Inc. (herein referred to as the manufacturer) warrants its product which it manufactures and sells to be 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, alteration, neglect, accident, abnormal conditions of operation, or use in any manner contrary to 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.

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The warranty on this device is specifically limited to its use only with sealed sources and connectors, parts, and accessories manufactured by QSA Global, Inc.

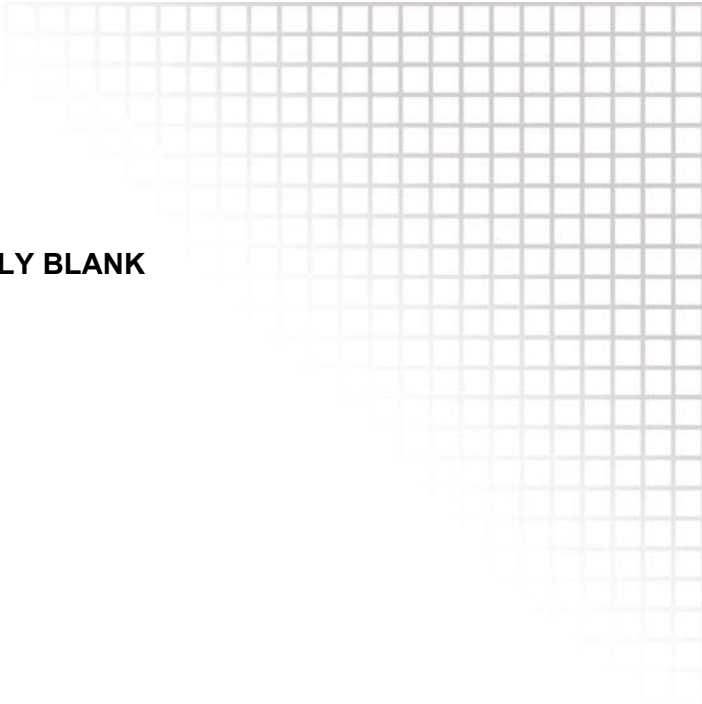
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SPECIAL NOTICE

This industrial radiography system is used as an exposure device and a Type A shipping container for QSA Global, Inc. source assemblies. The purpose of this manual is to provide information that will assist qualified radiographers in using the **1075 SCARPro** gamma radiography system. The user must be thoroughly familiar with this instruction manual before attempting operation and use of this equipment.

In order to use this equipment or perform source changes, users within the USA must be specifically licensed to do so. Applications for a license should be filed with the Materials Licensing Section of the appropriate U.S. Nuclear Regulatory Commission regional office or with the appropriate Agreement State office. All users within Canada must have a Canadian Nuclear Safety Commission license.

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



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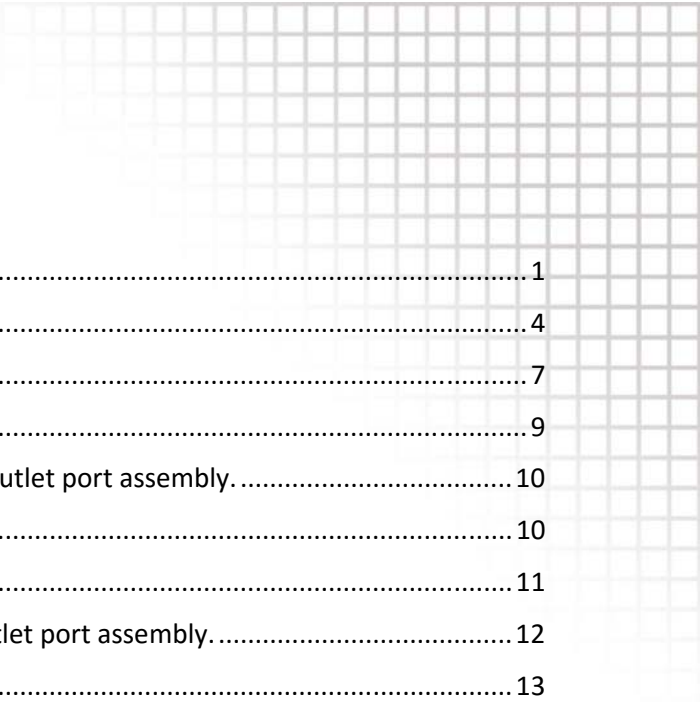
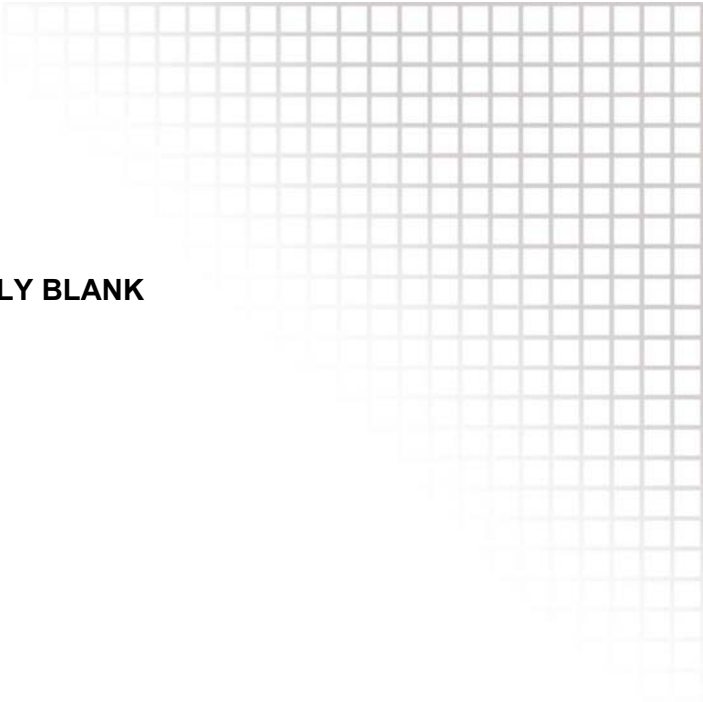


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SECTION 1: TECHNICAL SPECIFICATION

Table 1.1 Exposure Device Specifications		
Manufacturer	QSA Global, Inc., Burlington, Massachusetts, USA.	
Device Model	1075	
Primary Application	Industrial gamma radiography	
Device Configuration/ Mode	SCAR (with Collimator)	PROJECTOR
Device Weight (Maximum)	40 pounds (18 kilograms)	35 pounds (16 kilograms)
Device Overall Length	11.5 inches (292 mm)	11.2 inches (284 mm)
Device Overall Height	7.25 inches (184 millimeters)	
Device Overall Width	6.0 inches (152 millimeters)	
Device Capacity - Isotope	81 Curies Selenium-75	
Device Shielding Materials	Tungsten & Stainless steel	
Operating Temperature	-40°F to 300°F (-40°C to 149°C)	
Transport Approvals	Type A within the Model 1075A overpack meets 49 CFR173 and IAEA TS-R-1 (2009).	
Transport Package Weight	60 pounds (27 kilograms) maximum	
Compatible Sources	Refer to Table 1.2 below.	
Compatible Controls	Refer to Table 1.3 below.	
Compatible Guide Tubes	Refer to Table 1.4 below.	
Compatible Source Changers	Model 650L – See MAN-020 with applicable addendums.	

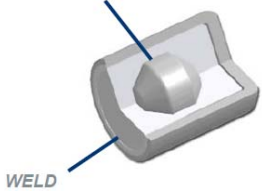
Table 1.2. Compatible Source Assembly Specifications – License Information		
Manufacturer	QSA Global, Inc., Burlington, Massachusetts, USA.	
Source Assembly	Model A425-6	
Capsule Design	Double Encapsulation	
Special Form Certificate	USA/0335/S-96	
Sealed Source and Device Registration Number	MA-1059-D-378-S	
ANSI/ISO Source Classification	97E64515	
Maximum Source Activity	81 Ci (3 TBq)	
Nuclide / Isotope	Selenium-75	<p>SELENIUM-75 METAL SELENIDE PELLETT IN VANADIUM INNER CAPSULE</p> 
Isotope Gamma Energy Range	66 – 401 keV	
Isotope Half Life	120 days	
Isotope Output at 1 meter per Curie (37 GBq)	0.203R/hr (2.03mSv/hr)	
Isotope Output at 1 foot per Curie (37 GBq)	2.2R/hr (22.0mSv/hr)	

Table 1.3. Compatible Controls Specifications

					
Manufacturer		QSA Global, Inc., Burlington, Massachusetts, USA.			
Standard Control Lengths in Feet (ft.) & Meters (m)		<ul style="list-style-type: none"> ➤ 25 ft.(7.6 m) ➤ 35 ft. (10.7 m) ➤ 50 ft. (15.2 m) 			
Product code	Model number	Style	Odometer	Housing length	Unit weight
TAN66425	66425	Reel	Yes	25 ft (7.6 m)	21 lb (10 kg)
TAN66435	66435	Reel	Yes	35 ft (10.7 m)	24 lb (11 kg)
TAN66450	66450	Reel	Yes	50 ft (15.2 m)	27 lb (12 kg)
TAN69325	69325	Pistol Grip	Yes	25 ft (7.6 m)	21 lb (10 kg)
TAN69335	69335	Pistol Grip	Yes	35 ft (10.7 m)	24 lb (11 kg)
TAN69350	69350	Pistol Grip	Yes	50 ft (15.2 m)	27 lb (12 kg)
TAN69225	69225	Pistol Grip	No	25 ft (7.6 m)	21 lb (10 kg)
TAN69235	69235	Pistol Grip	No	35 ft (10.7 m)	24 lb (11 kg)
TAN69250	69250	Pistol Grip	No	50 ft (15.2 m)	27 lb (12 kg)
SAN88225	88225	Pistol Grip	No	25 ft (7.6 m)	14 lb (6 kg)
SAN88235	88235	Pistol Grip	No	35 ft (10.7 m)	17 lb (8 kg)
SAN88250	88250	Pistol Grip	No	50 ft (15.2 m)	22 lb (10 kg)
SAN88225R	88225R	Pistol Grip	No	25 ft (7.6 m)	14 lb (6 kg)
SAN88235R	88235R	Pistol Grip	No	35 ft (10.7 m)	17 lb (8 kg)
SAN88250R	88250R	Pistol Grip	No	50 ft (15.2 m)	22 lb (10 kg)
SAN88525	88525	Reel	No	25 ft (7.6 m)	18 lb (8 kg)
SAN88535	88535	Reel	No	35 ft (10.7 m)	21 lb (10 kg)
SAN88550	88550	Reel	No	50 ft (15.2 m)	26 lb (12 kg)

Table 1.4. Compatible Guide Tubes Specifications



Manufacturer	QSA Global, Inc., Burlington, Massachusetts, USA.		
Product code	Length (See note)	Style	Description
TAN48906	7 ft. (2.1 m)	Standard	Fixed End Stop
TAN48931	7 ft. (2.1 m)	Standard	Fixed End Stop
TAN48907	7 ft. (2.1 m)	Standard	Extension
48998	21 ft. (6.4 m) 28 ft. (8.5 m) 42 ft. (12.8 m)	Standard	Single Guide Tube – Device Connect with End Stop
48999	7 ft. (2.1 m)	Standard	Device Connect Extension
95020	7 ft. (2.1 m)	Extreme	Fixed End Stop
95075	7 ft. (2.1 m)	Extreme	Fixed End Stop
95021	7 ft. (2.1 m)	Extreme	Extension
95073	21 ft. (6.4 m) 28 ft. (8.5 m) 42 ft. (12.8 m)	Extreme	Single Guide Tube – Device Connect with End Stop
95074	7 ft. (2.1 m)	Extreme	Device Connect Extension

NOTE: Non-standard lengths up to 42 feet available upon request.

WARNING – USE THE PROPER GUIDE TUBE COMBINED LENGTHS

Control Set Length	Guide Tube Set (Maximum quantity & length)			Combined Guide Tube Length
	Fixed End Stop	Extension	Device Connect Extension	
25 ft.	1 (7 ft.)	1 (7 ft.)	1 (7 ft.)	21 ft.
35 ft.	1 (7 ft.)	2 (14 ft.)	1 (7 ft.)	28 ft.
50 ft.	1 (7 ft.)	4 (28 ft.)	1 (7 ft.)	42 ft.

1.1. Exposure Device Description

The SENTINEL™ Model **1075 SCARPro** dual mode source exposure device is designed for gamma radiography applications using Selenium-75.

The 1075 exposure device can be configured in one of two radiography modes of operation. A collimator directly attached to the device allows for small controlled area radiography (SCAR) applications. When not performing SCAR, the collimator is replaced by a conventional front plate assembly for radiography applications requiring guide tubes.

Changing between the two configurations is quick, easy, and safe, but must only be done by qualified technicians with the proper tools and training.

Figures 1.1 & 1.2 shows the device in each of the two operational configurations.



FIGURE 1.1: 1075 SCAR

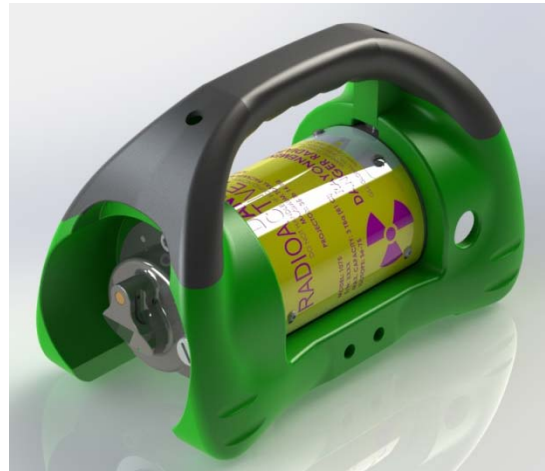


FIGURE 1.2: 1075 PROjector

The basic structure of the device has an all tungsten shield centrally located and securely mounted within a tubular stainless steel outer housing. The housing is oriented horizontally for stability and to provide easy access to the automatic source locking mechanism and the source assembly connector as well as the front plate or collimator. The automatic locking mechanism is fully compatible with all QSA approved remote controls and the front plate assembly is fully compatible with all QSA approved guide tubes/ projection sheaths listed in this manual.

The shield housing and nameplate is protected by a plastic jacket with integrated lifting handle and base supports and includes attachment provisions for mounting the exposure device to a pipe or some other work-piece for SCAR use.

To meet or exceed regulatory and performance standards for safety and reliability, the **1075 SCARPro** exposure device is designed, tested, and manufactured to the requirements of ANSI N432-1980, ISO 3999:2004(E), IAEA TS-R-1 (2009), USNRC 10CFR34, 10CFR71, and USDOT 49CFR173 requirements. Additionally the exposure device is designed, manufactured, and serviced under an ISO 9001 and USNRC 10CFR71 subpart H QA program. The QA program also includes the reporting requirements of USNRC 10CFR21 for suppliers of source and byproduct materials.

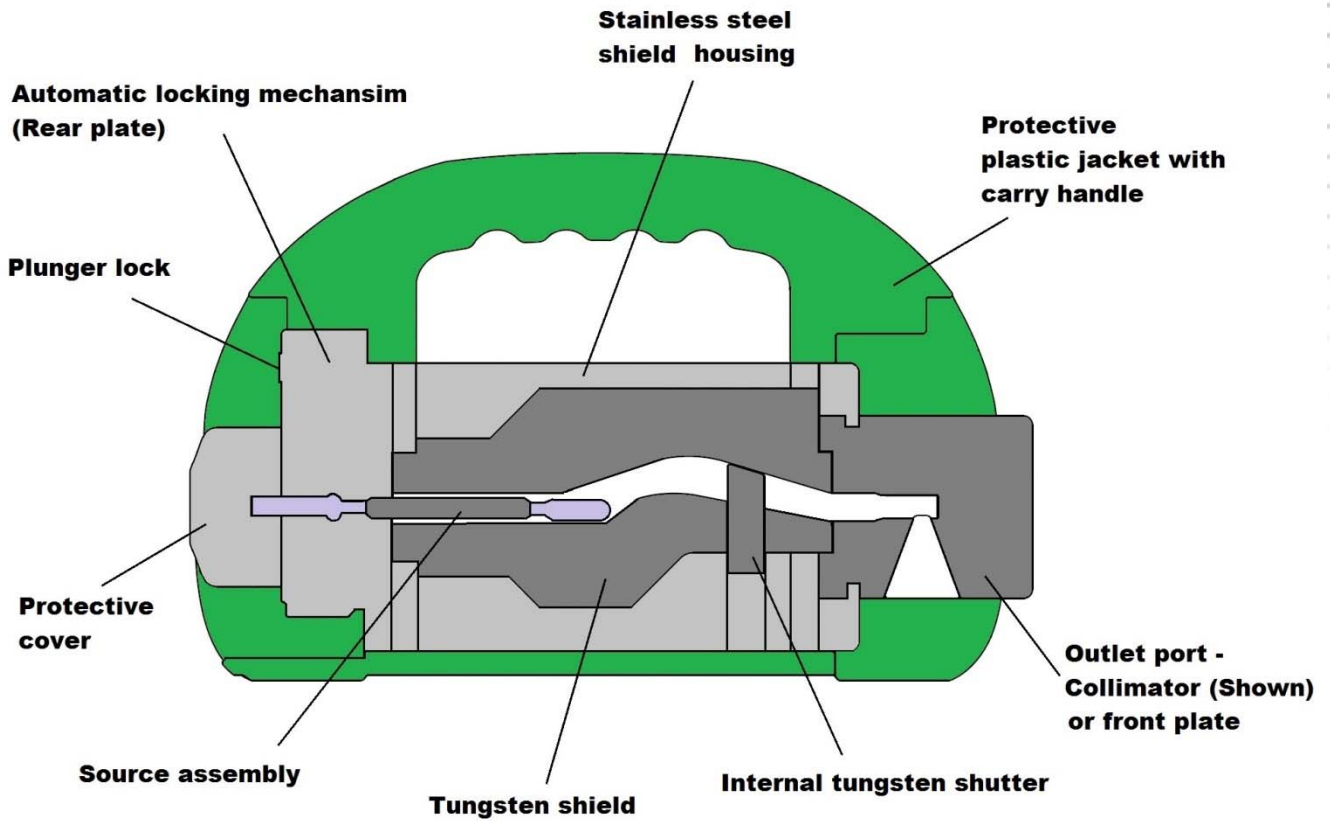


FIGURE 1.3: Model 1075 Exposure Device.

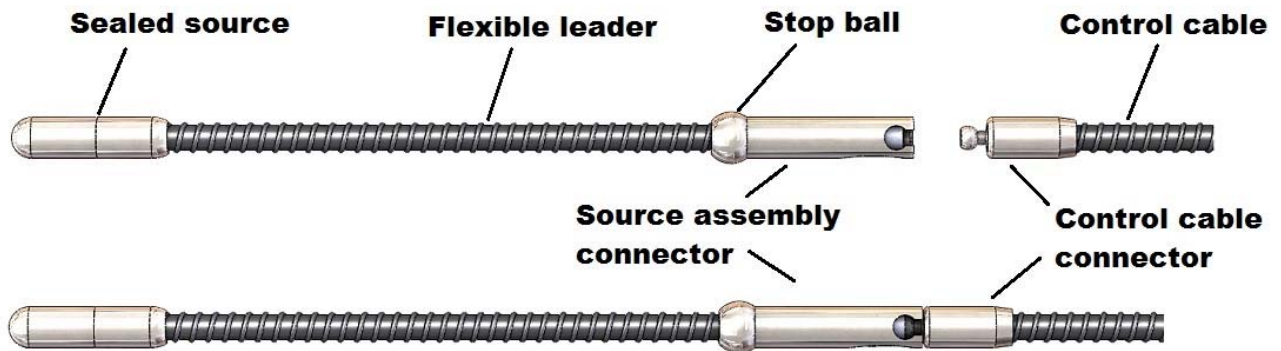


FIGURE 1.4: Source Assembly (Shields not shown) & Remote Control Cable Connectors.

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SECTION 2: OPERATING INSTRUCTIONS

Personnel operating this equipment must be completely familiar with this manual and they must read and understand these important safety alerts before proceeding.

IMPORTANT SAFETY ALERTS
NOTICE: Can cause minor problems and reminders.
CAUTION: Can cause equipment damage or potential problems.
WARNING: Can cause serious or fatal injury.
DANGER: Will cause serious or fatal injury.



WARNING

- ✓ Do not perform any unauthorized modifications to the radiographic exposure device or components of the radiography system.
- ✓ It is important that trained and qualified radiographers perform or supervise a daily safety inspection of the radiography system for obvious defects before using the system. Do not compromise on safety. Always perform the daily inspection of the exposure device, projection sheaths and remote controls prior to use.
- ✓ Any foreign material (dirt, mud, ice, etc.) must be removed before using the system. Inspect, clean, and test the equipment as described in this manual to ensure long term safety and reliability.
- ✓ Do not use any component that is not approved for use with this radiography system or any after-market component as they may compromise the safety features designed into the system.
- ✓ Defective equipment that is discovered during the daily inspection must be removed from service until repaired or replaced.
- ✓ The user of this equipment must follow the operating instructions, in the order shown, to ensure safe operations and compliance with government regulations.



WARNING: JOB SITE SAFETY PRECAUTIONS

Personal Safety Instruments

The radiographer and radiography assistants must at all times wear a film badge or TLD and pocket dosimeter with a range of 0-2mSv (0-200mRem). Regulatory requirements in the USA also require that an audible alarm ratemeter be worn at temporary jobsites. Specifically, those locations that are not permanent radiographic installations equipped with functional door interlocks and audible/visual alarms.

Radiographers in the USA must also have a survey meter capable of measuring in the range 20 μ Sv/hr (2mR/hr) up to 10mSv/hr (1,000mR/hr).

Canadian regulations require that survey meters used for industrial radiography be capable of measuring from 2 μ Sv/hr (0.2mR/hr) and up to 100mSv/hr (10R/hr).

In any regulatory jurisdiction, always verify survey meter requirements affecting the range and calibration requirements prior to engaging in industrial radiography operations.

An audible 'chirper' pocket alarm may be required in some countries.

Restricted Area

Radiography must only be performed in a restricted area that is marked with the appropriate radiation warning signs and secured against unauthorized entrance.

Distance

Since the source emits high levels of radiation it is good practice to operate the system from as great a distance as possible.

Shielding

Whenever possible, situate the radiographic exposure area in a room with suitably thick walls, floor, ceiling and doors. When using guide tubes with the 1075Pro configuration, whenever possible, the use of a collimator (beam limiter) provides effective shielding to reduce radiation levels outside of the central beam. It is recommended that collimators be used at temporary job sites to minimize occupational exposure to radiation.

Surveillance

Only trained and qualified radiographers or assistants working under their direct supervision may operate radiography systems. The radiographer must be physically present at the site and able to control and limit access to the restricted area.

Locking

Keep the exposure device locked while assembling the system and when not being used to perform radiography. Locked is defined as the exposure device's lock is fully engaged with the key removed. Store the key in a secured location.

2.1. Exposure Device Mode Change.

The operating mode of the exposure device can be changed by anyone trained and qualified to do so and by following the instructions provided in this section. One of the two styles of outlet port assemblies is normally already attached to the device.

Figure 2.1 shows the device with both outlet port assemblies removed. The removed front plate assembly is shown on the right in the figure and the removed collimator assembly is shown on the left.



DANGER



An internal shielded shutter must first be closed before removing either the collimator or front plate.

When the shutter is open, a safety interlock system prevents the removal of the collimator or front plate.

Tampering with or bypassing the interlock system in an attempt to move the shutter to the open position with assemblies removed will increase radiation levels at the front outlet port.

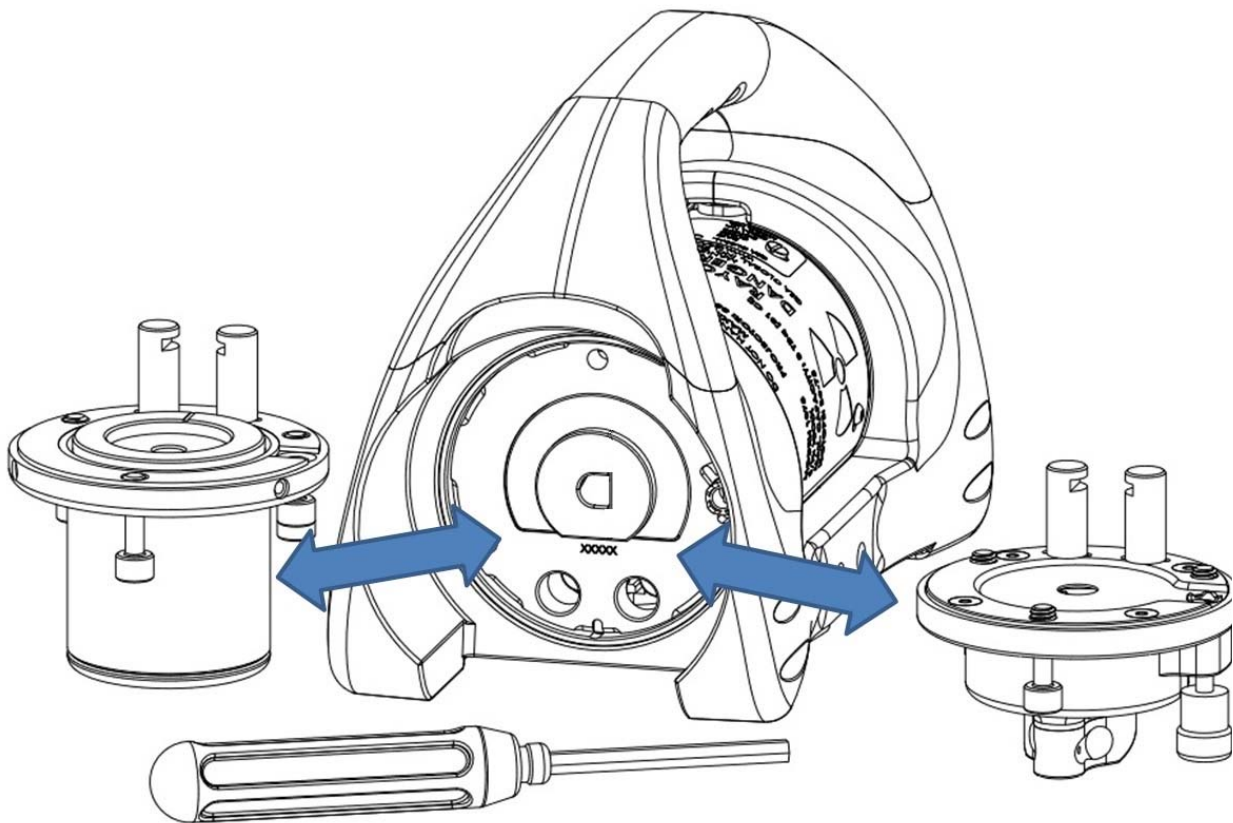
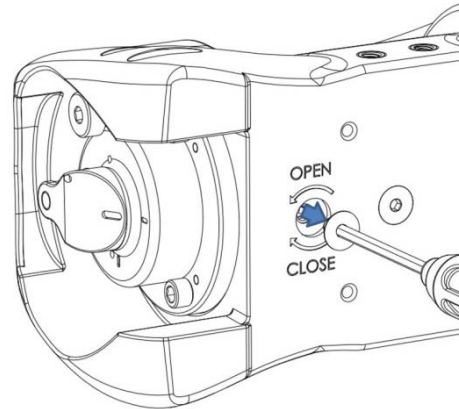


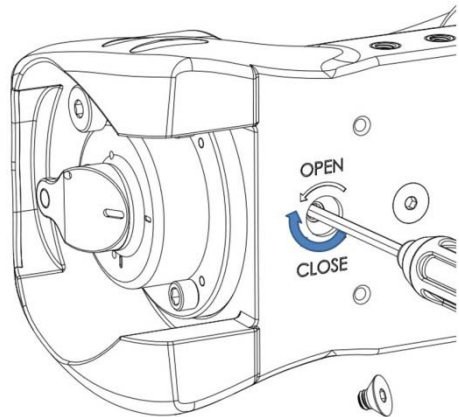
FIGURE 2.1: Exposure device with outlet port assemblies removed.

2.1.1. Close the internal shutter before removing an outlet port assembly.

1. Lay the exposure device on its side to access the base.
2. Locate the shutter adjusting screw identified by the "OPEN" & "CLOSE" markings. The shutter adjusting screw is protected under the flat head screw.
3. Remove the flat head screw with a 3/16 inch hex wrench. Install screw back after adjustments.



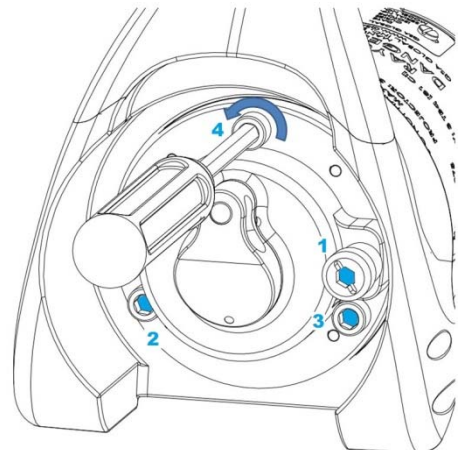
4. The shutter adjusting screw can now be accessed and adjusted.
5. Insert the 3/16 inch hex wrench into the shutter adjusting screw.
6. To close the shutter before a mode change, turn the screw clockwise until it stops turning. DO NOT force the screw to turn.



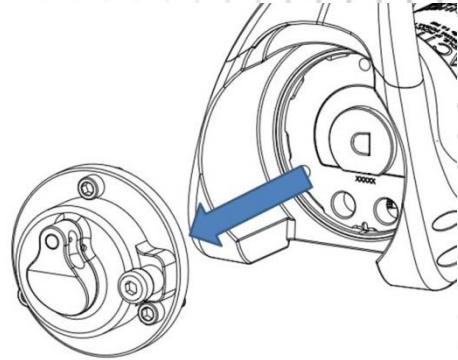
2.1.2. Remove an outlet port assembly

1. Both collimator and front plate assembly are removed from the device the same way. The instructions below show the removal of the front plate assembly as an example.
2. Place the device upright on its base.

3. Use a 1/4 inch hex wrench to loosen the four socket head screws. These screws are captive in the assembly and need not be removed from the plate assembly.



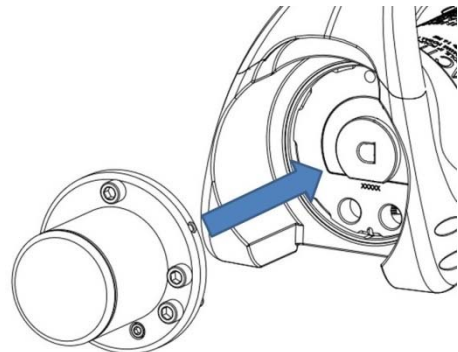
4. Pull the outlet port assembly straight out away from the end of the device.
5. Store the removed assembly in the carry case.



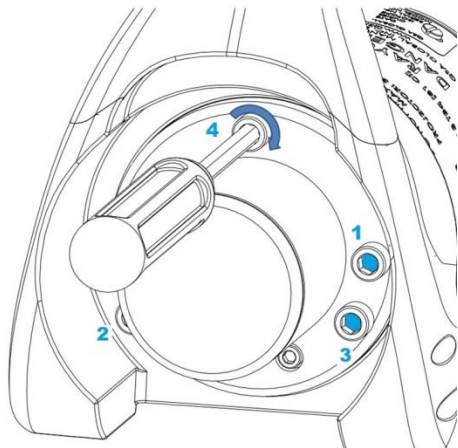
2.1.3. Attach an outlet port assembly

1. Both collimator and front plate assembly are removed from the device the same way. The instructions below show the attachment of the collimator assembly as an example.
2. Keep the device upright on its base.
3. Verify the beam port is directed as desired before installation.

4. Align the two pins on the collimator assembly with the holes in the mating face of the device.
5. Push the collimator assembly straight onto the end of the device against the mating face.

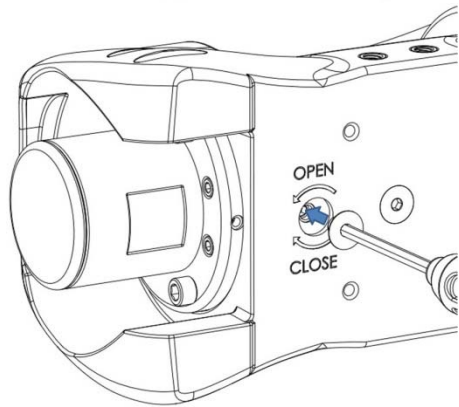
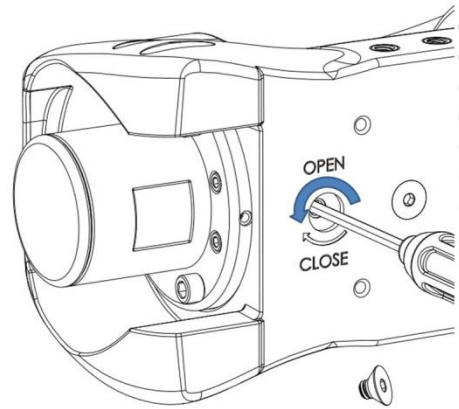


6. Use a ¼ inch hex wrench to tighten the four captive screws.



2.1.4. Open the internal shutter after attaching an outlet port assembly.

1. Lay the exposure device on its side to access the base.
2. Ensure the flat head screw is not covering the shutter adjusting screw.
3. Insert the 3/16 inch hex wrench into the shutter adjusting screw.
4. To open the shutter after a mode change, turn the screw counter-clockwise until it stops turning. DO NOT force the screw to turn.
5. Install the flat head screw with a 3/16 inch hex wrench to cover and protect the shutter adjusting screw.



2.2. Projector Mode Use.

The front plate assembly must be securely attached to the exposure device before using the device in projector mode. The following instructions describe the method for proper source guide tube attachment to the device. For collimator use in SCAR mode, refer to **Section 2.3**. For remote control attachment, refer to **Section 2.4**.

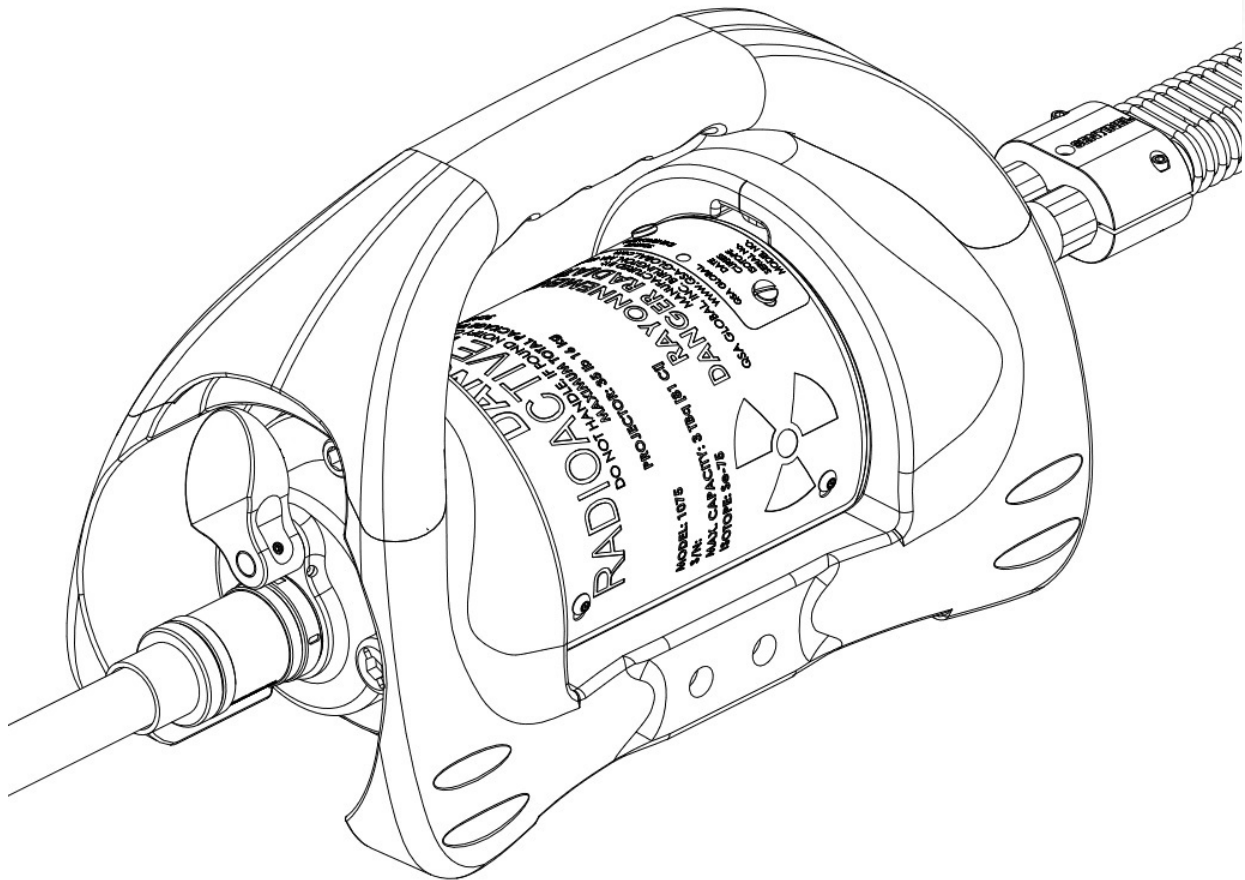


FIGURE 2.2a: Model 1075 in Projector Mode (with Front Plate Assembly).

2.2.1. Before use, perform a radiation survey of the exposure device.

1. Ensure the survey meter is calibrated and working properly.
2. Measure the surface of the exposure device to ensure any reading does not exceed 2mSv/hr (200mR/hr).
3. Use these initial readings for a later comparison with the confirmatory survey readings taken once the source has been retracted back into the exposure device after exposure.

2.2.2. Before use, perform an inspection of the equipment.

1. Visually inspect the equipment for damage, excessive wear, and any foreign material that could impair safe operation.
2. Remove the equipment from service if it does not operate safely.

2.2.3. Prepare the source guide tubes (projection sheaths) for use.

1. Before using the guide tubes, ensure they have been inspected per **Section 3.3** of this manual.
2. Position and secure the source stop (exposure head) guide tube at the radiographic focal location using either a tripod stand with swivel clamps or some other suitable means for securing the source stop.
3. Ensure there is a source stop on the guide tube.
4. Use a collimator (beam limiter) to direct the primary beam away from unwanted directions.
5. Find a stable location for the exposure device and lay down the guide tubes as straight as possible. Keep guide tube bends equal to or greater than 20 inches (0.5 meters) to avoid restricted source assembly movement.
6. The guide tubes must not contact any heated surface hotter than 140°F (60°C).
7. Prevent possible damage to the guide tubes by making sure the area is clear of any potential falling objects, vehicles, doorways, etc.

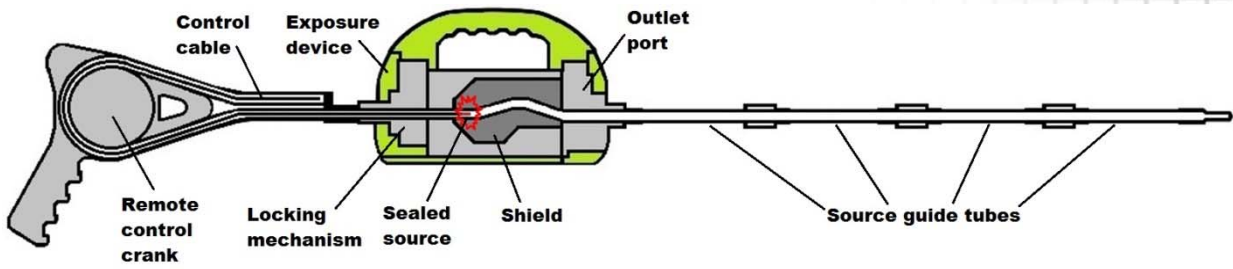


FIGURE 2.2b: Model 1075 in Projector Mode – Source secured.

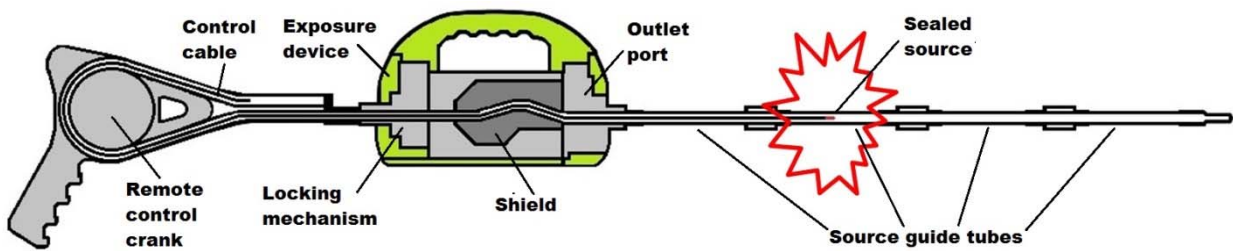


FIGURE 2.2c: Model 1075 in Projector Mode – Source in transit.

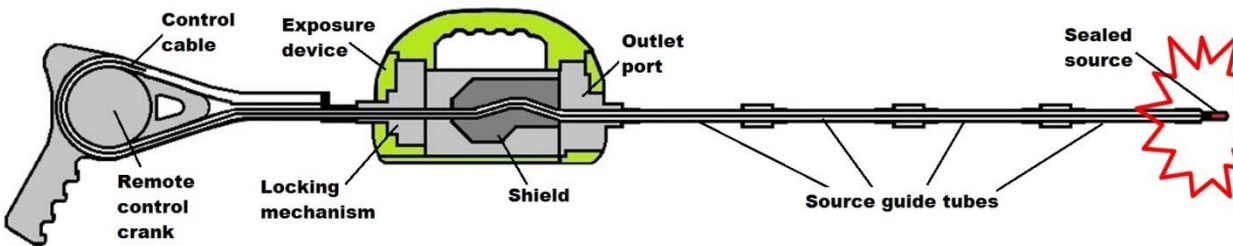
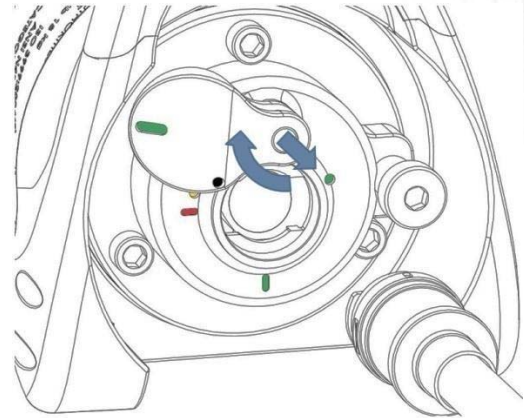


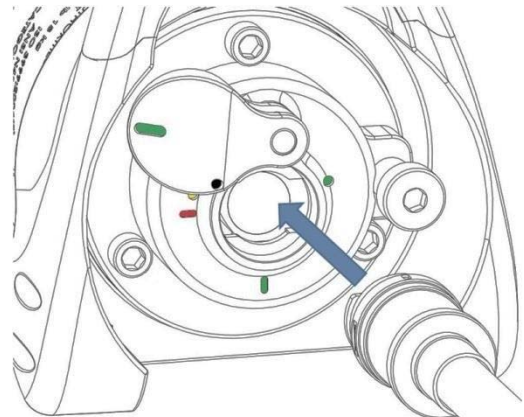
FIGURE 2.2d: Model 1075 in Projector Mode – Source exposed at end stop.

2.2.4. Connect the source guide tube(s) to the exposure device.

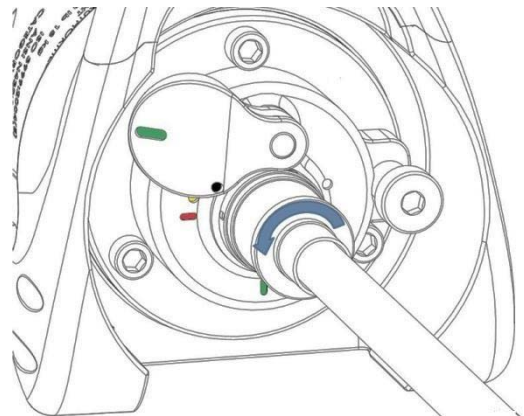
1. Before attaching the guide tubes to the device, ensure they have been inspected per **Section 3.3** of this manual.
2. Remove any protective caps from the guide tube ends if present.
3. With the outlet cover knob in the closed position (**BLACK** painted dot will be aligned with the **GREEN** painted dot), grip and pull the cover knob.
4. Rotate the knob 1/4 turn clockwise and release (**BLACK** dot will now be near the **YELLOW** (caution) dot on the plate).



5. Insert the guide tube bayonet fitting into the open port by aligning the **GREEN** slots.

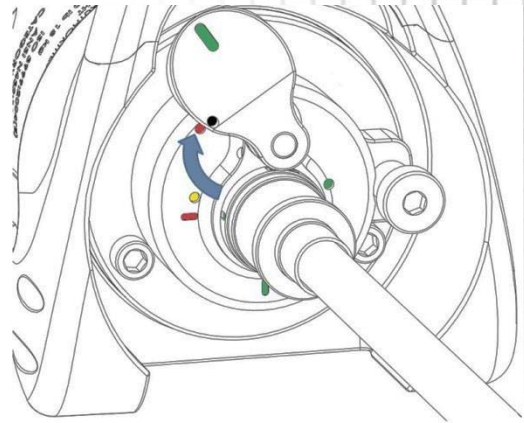


6. Rotate the guide tube fitting 1/4 turn counter-clockwise.



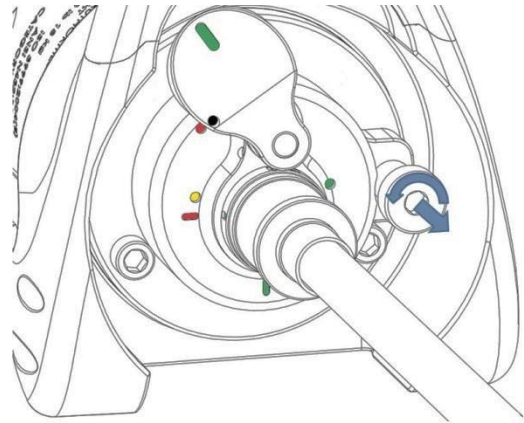
7. Rotate the port cover knob up clockwise until it stops at the 11 o'clock position.

The **BLACK** dot will now be near the **RED** (opened) dot on the plate indicating the outlet port shielding has moved to the open position.



8. Grip and pull the spring-loaded interlock knob. Rotate the knob 1/8 turn counter-clockwise and then release it into detent position. Push on the knob to ensure it is seated.

NOTE: This step will allow the lock slide on the automatic securing mechanism of the rear plate to move for source projection.



2.3. SCAR Mode Use.

The collimator assembly must be securely attached to the exposure device before using the device in SCAR mode. The following instructions describe the method for proper SCAR device setup. For projector mode use, refer to **Section 2.2**. For remote control attachment, refer to **Section 2.4**.

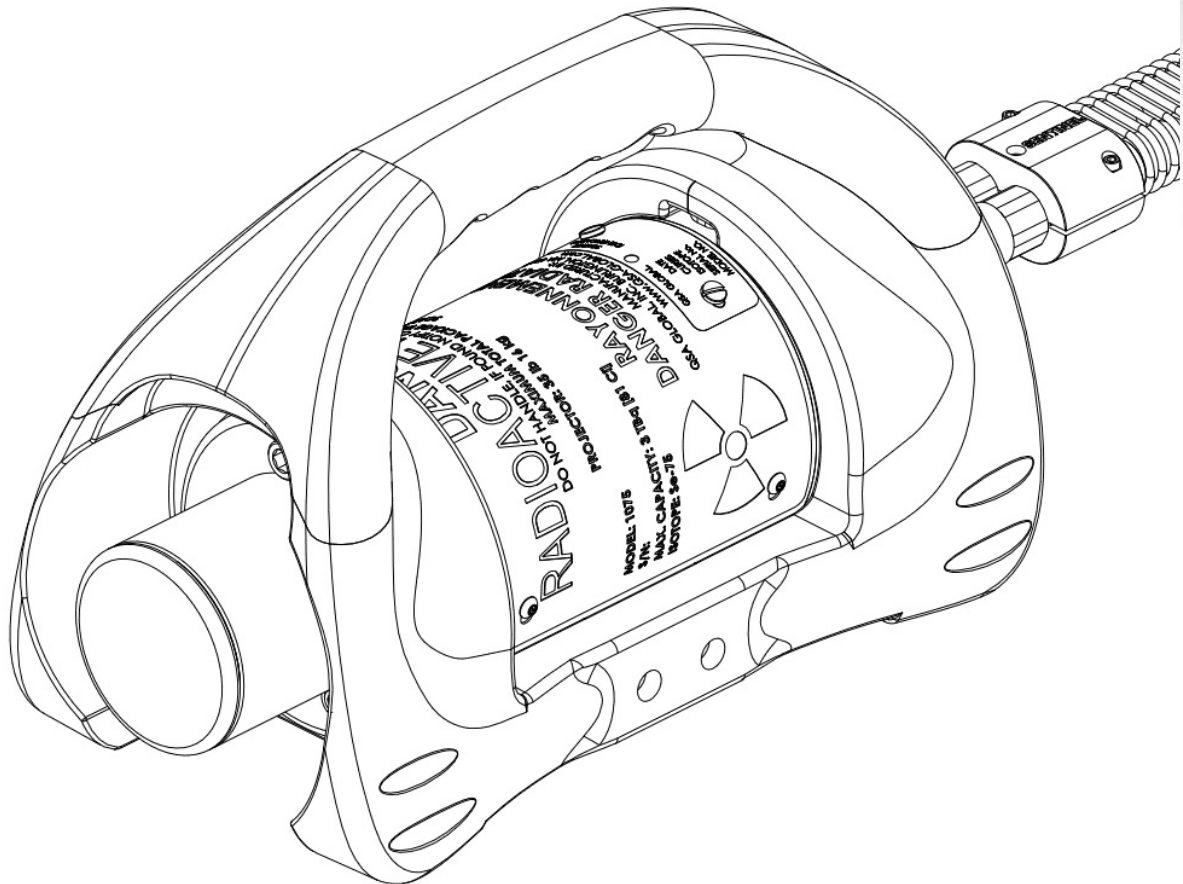


FIGURE 2.3a: Model 1075 in SCAR Mode.

2.3.1. Perform a radiation survey of the exposure device.

1. Ensure the survey meter is calibrated and working properly.
2. Measure the surface of the exposure device to ensure any reading does not exceed 2mSv/hr (200mR/hr).
3. Make note of the initial readings for comparison with the confirmatory survey readings taken once the source has been retracted back into the exposure device after exposure.
4. In addition to surveying the exposure device, the qualified radiographer must also survey the SCAR collimator (or entire length of guide tubes, if used).

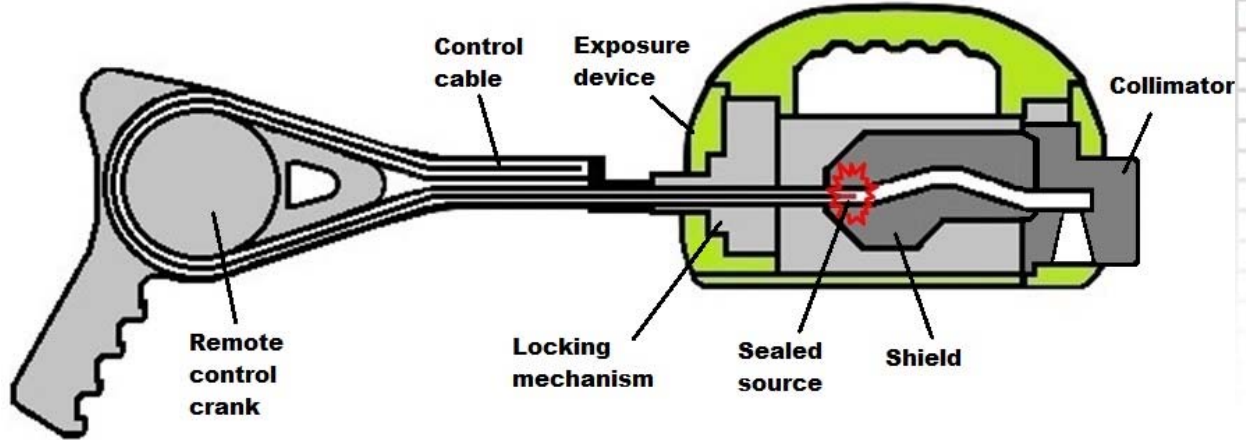


FIGURE 2.3b: Model 1075 in SCAR Mode – Source Secured.

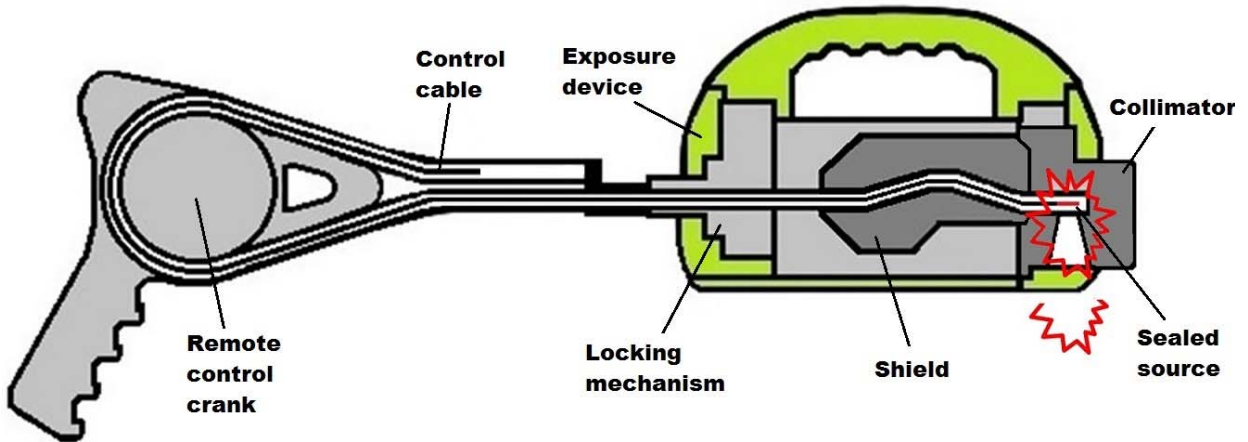


FIGURE 2.3c: Model 1075 in SCAR Mode – Source Exposed.

2.4. Source Projection and Retraction.

A safety interlock feature requires that either the collimator assembly or the front plate assembly must be securely attached to the exposure device before the source can be exposed. If neither assembly is present, the interlocks within the device will prevent movement of the source from the shielded/secured position.

A separate safety interlock feature requires a guide tube to be connected before the front outlet port can be opened fully.

The following instructions describe the method for proper remote control use with the device. For projector mode use, refer to **Section 2.2**. For SCAR mode use, refer to **Section 2.3**.

CAUTION

Ensure that the exposed length of the control cable is greater than the total length of the source guide tubes and projector. See the technical specifications section for recommended limits.

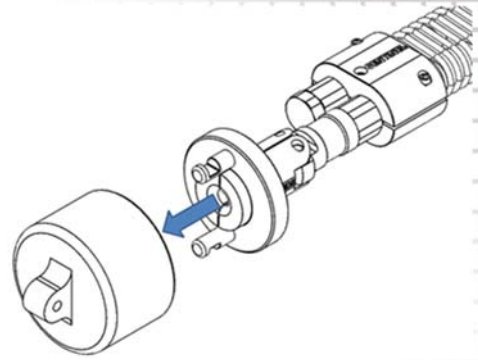
If the total guide tube length exceeds the exposed drive cable length, then:

- **The source assembly cannot be projected all the way to the source stop of the terminating source guide tube and be correctly positioned for the exposure.**
- **The source assembly may not reach a collimator; therefore, restricted area dose rates may be higher than expected.**
- **The control cable end may be cranked beyond the drive wheel of the remote controls if the drive cable is not fitted with a safety retaining spring. This scenario must be treated as an EMERGENCY.**

2.4.1. Prepare the remote controls for use.

1. Before using the controls, ensure they have been inspected per **Section 3.4** of this manual.
2. Lay out the control housings as straight as possible. Each bend radius, if present, must be approximately 3 feet (1 meter) or more.
3. Avoid any risk of damage to the control housings by falling objects, moving vehicles or closing doors, etc.
4. The control crank mechanism (operator's hand-crank) should be placed as far away from the source focal position as possible (preferably behind shielding).

5. Remove the protective rubber end-cap from the 661 safety connector.



CAUTION

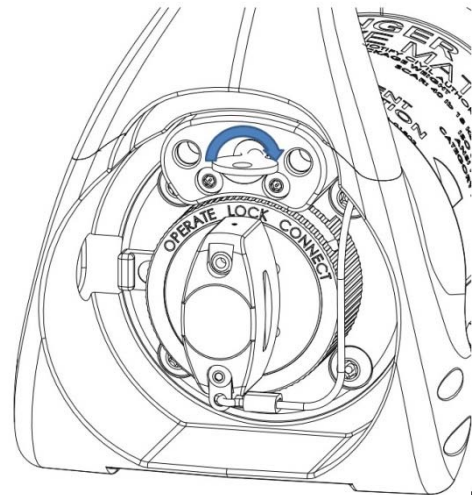
The control cable connector is made from hardened steel and should never be left unprotected. Do not force the control cable connector into source assembly connector. This could damage the connectors over time leading to possible breakage during use.

ALWAYS use the protective end-cap when the remote controls are not connected to the exposure device.

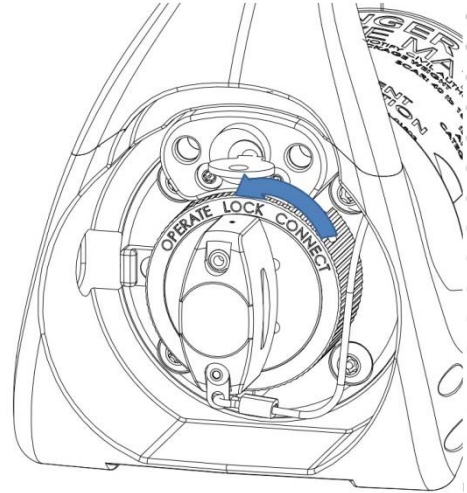
2.4.2. Connect the remote controls to the exposure device.

1. Visually inspect the controls before attaching them to the device per **Section 3.4** of this manual.

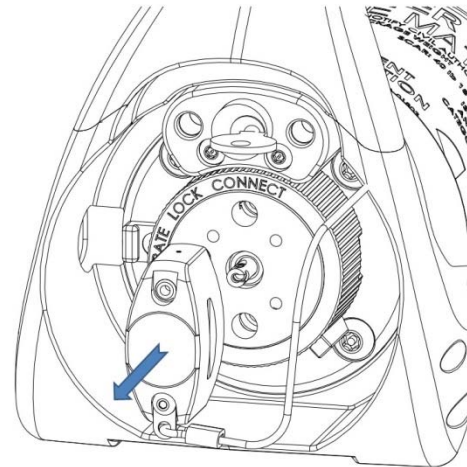
2. Unlock the spring loaded plunger lock with the key. Turn the key clockwise to unlock.



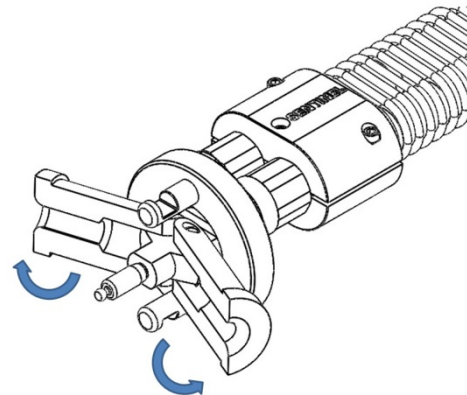
3. Turn the selector ring from LOCK to CONNECT.



4. The protective cover will disengage from the exposure device.



5. Slide the 661 safety connector collar back to open the jaws to access the control cable connector.

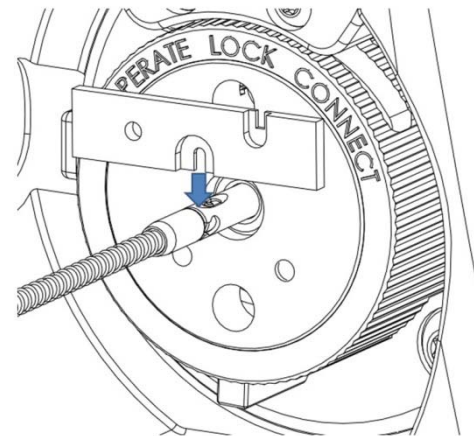
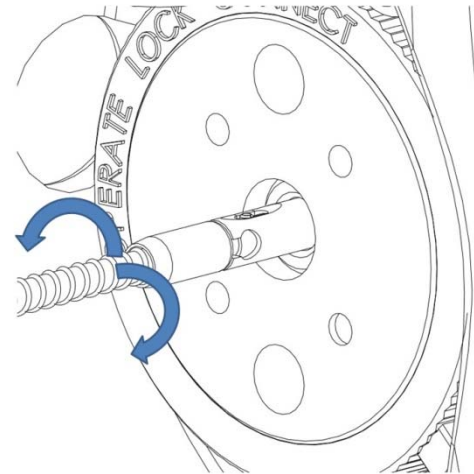
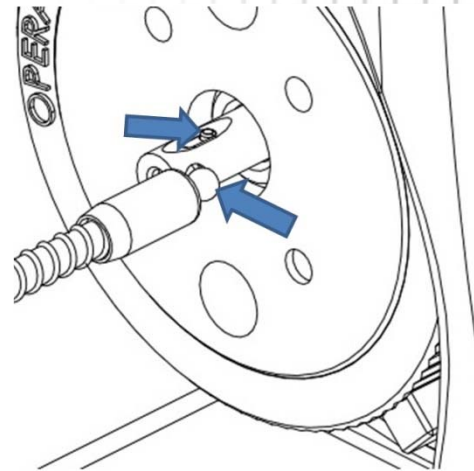


6. Slide your thumb-nail along the groove in the source connector pushing the spring pin until the internal sleeve slides back enough to allow the ball end of the control connector to enter the key slot of the source connector.
7. Release the spring pin of the source connector. Check that the sleeve has returned and captures the ball feature of the control connector making a secure connection.

NOTE: ALWAYS manually move the sleeve in the source connector to the OPEN position when attaching and removing the control cable connector.

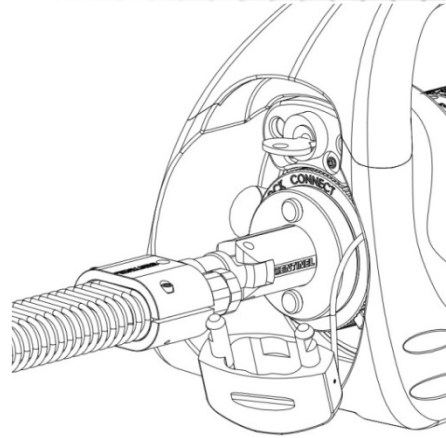
8. Check for a proper connection by lightly flexing (wagging) the control cable up and down and side to side, especially in low-light working conditions.

9. Use the NO-GO gauge to check the gap between the joined connectors.
10. The gage should not fit in the gap between the connectors for a proper connection.



11. Close the pivoting jaws of the 661 safety connector over the joined connectors.
12. Slide the 661 safety connector collar over the pivoting jaws.

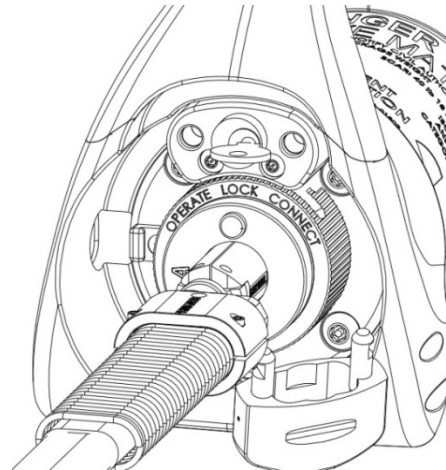
NOTE: When the selector ring is in the CONNECT position and the 661 safety connector is properly installed, the anti-rotation lugs inside the Posilok are pushed in to allow the selector ring to be rotated to the LOCK position and when required, to the OPERATE position.



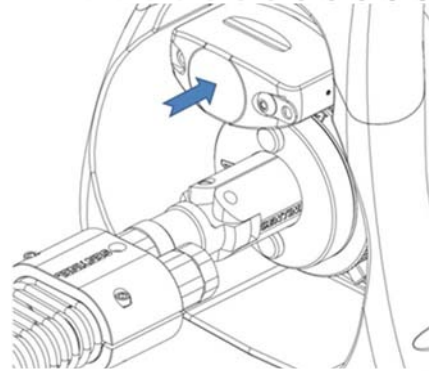
CAUTION

Ensure the exposure device is on stable footing and use some means to prevent the device from moving when attaching the 661 safety connector. Failure to do this may allow the device to slide away or fall causing potential damage to the control cable or connections.

13. Push and hold the 661 safety connector collar flush up against the exposure device's locking mechanism and rotate the selector ring from CONNECT to LOCK.
14. Engage the plunger lock until ready to make the first exposure.
15. The remote control 661 safety connector is now secured to the exposure device locking mechanism.



16. Insert the protective cover into the lock housing.

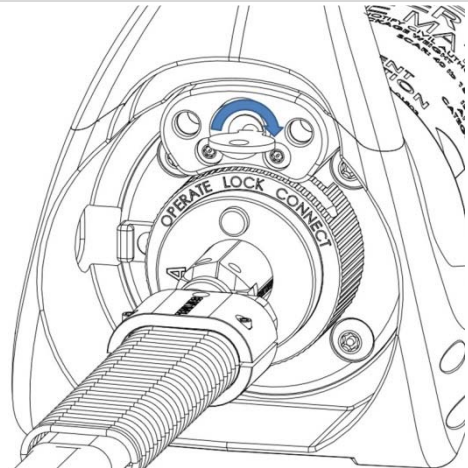


2.4.3. Checks before exposing the source.

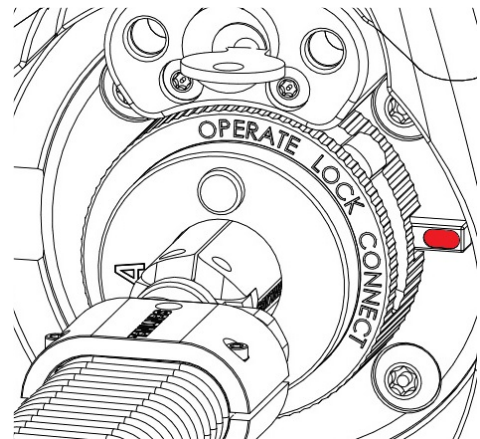
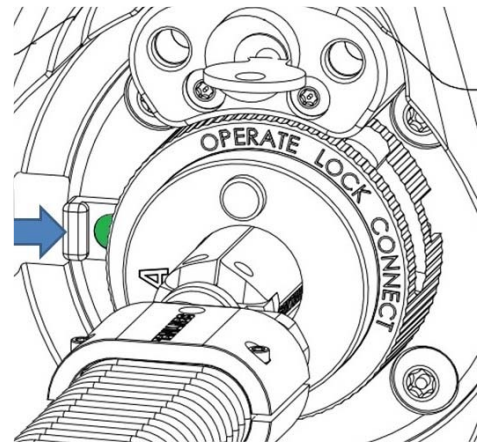
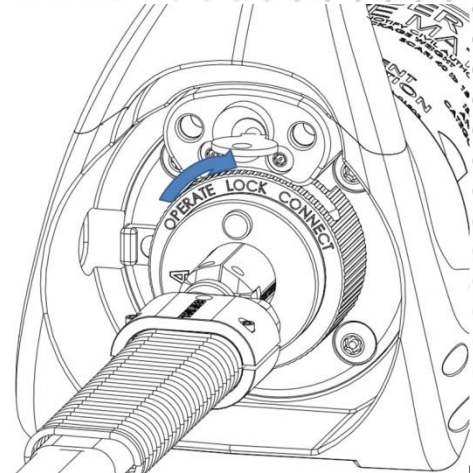
- ✓ Attach the source guide tubes to the outlet port of the front plate when used in the projector mode.
- ✓ Attach the controls to the locking mechanism of the rear plate.
- ✓ Remove all personnel from the restricted area or exposure room.
- ✓ Post the proper signs and activate required warnings.

2.4.4. Unlocking the source assembly before exposures.

1. Remove the protective lock cover, if in place.
2. Unlock the brass plunger lock with the key.



3. Turn the selector ring from LOCK to OPERATE.
4. Ensure the control crank is not pushing or pulling the control drive cable. The crank should be in a neutral tension (no force) condition.
5. When the **GREEN** mark appears on the lock slide, the source is in its secured and shielded position within the exposure device.
6. Push the lock slide, shown with **GREEN** mark, to the right towards the selector ring until the **RED** mark appears on the right side of the selector ring.
7. In low noise work areas, a click will be heard when the lock slide is pushed into the expose position.
8. When the **RED** mark appears, the source is now free to be projected from the shielded position. The source can now be exposed into the guide tube and/or collimator.
9. Ensure all personnel are removed from the immediate area before projecting the source.
10. For protection, always operate the remote control crank from a safe position distance away from the exposed source and device.
11. If the controls are fitted with an odometer, then adjust the reset knob to read zero.
12. The source is ready to be projected.



CAUTION

When retracting the source into the device to the secured position, (**GREEN** dot in view on lock slide) confirm the source is secure by applying a light force to the control crank handle in the expose direction. The crank handle should not move in either direction. Do not continue to force the control crank handle after the lock slide has tripped and source is secured.

When approaching projector always have meter in hand to confirm source has been secured in the stored position.

Leave the control crank and the control cable in a neutral tension position.

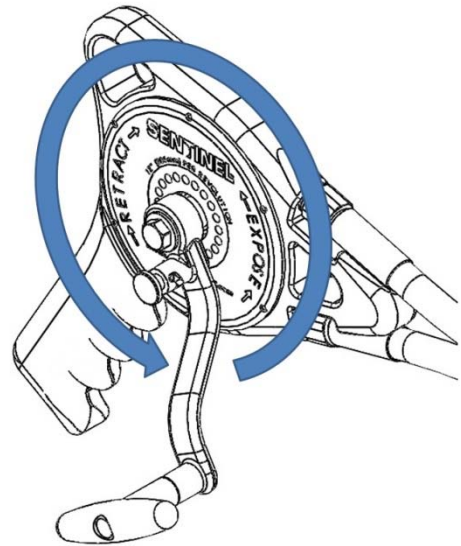
Do not apply the control crank brake after source retraction.

If the source cannot be secured when retracted after several attempts to expose and retract the source, determine if the source is exposed or shielded using a survey meter.

If the source is still exposed when it should be secured based on high survey readings and cannot be retracted into a shielded position, treat the situation as an emergency where the device or system may have been potentially damaged or malfunctioned. Contact your Radiation Safety Officer (RSO).

2.4.5. Projecting the source assembly for exposures.

1. At the controls, rotate the control crank rapidly in the EXPOSE direction. The label on the crank housing indicates the EXPOSE direction. This moves the source from the exposure device to the radiographic exposure location in the guide tube, source stop or collimator.

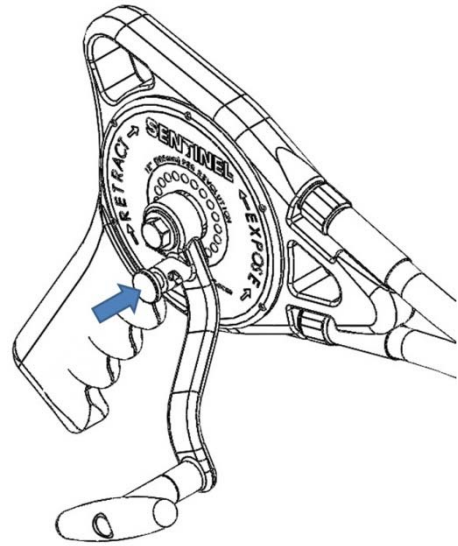


2. When the device is used in the projector mode, the survey meter readings during source projection should increase quickly from background levels to a high level as the source exits from the exposure device into the source guide tubes. The readings should fall as the source moves towards the exposure location, fall sharply as the source enters a

collimator (if used) and remain steady throughout the exposure. Use the brake if exposing uphill or to prevent source movement if needed.

3. When used in the SCAR mode, the survey meter readings during source projection should not increase except in the direction of the collimator beam port.
4. Actual survey meter readings will depend on the source activity, distance, collimators and shielding. The sequence of changes should be observed and the readings noted.
5. An abrupt stop will be felt in the crank when the source reaches its destination in the source stop/collimator. DO NOT use excessive force on the crank.
6. The odometer (if fitted) will indicate the approximate total distance traveled. Each standard guide tube section is 7 feet (2.1 meters) plus some travel within the device.

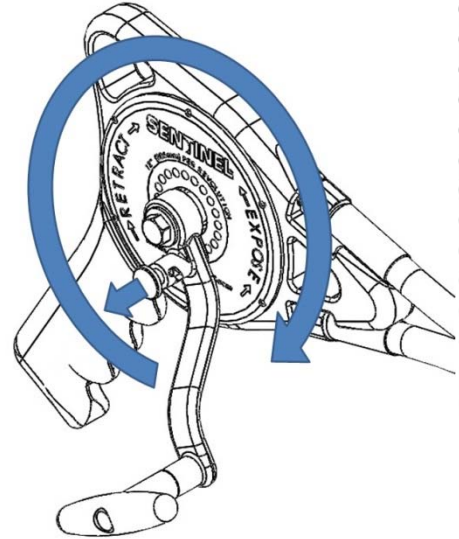
7. With the source at the radiographic exposure location, the brake can be set to prevent movement of the source assembly during the radiographic exposure.



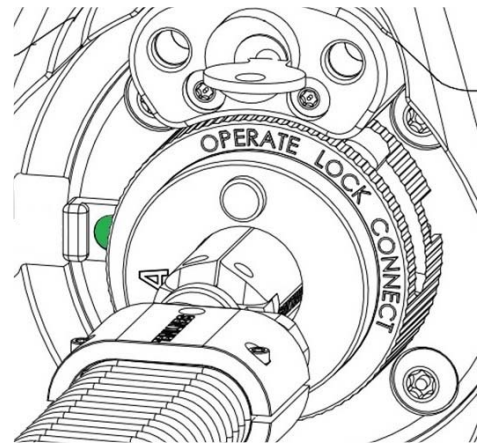
8. Start timing the radiographic exposure from the moment the source assembly reaches the exposure location.
9. During the radiographic exposure, use the survey meter to check the boundary dose rate, but spend as little time as possible in and near the restricted area to minimize personal exposure.
10. Once exposure time has lapsed, retract the source back to the exposure device by following the sequence as described in the next section.

2.4.6. Retracting the source assembly after exposures.

1. At the end of the required exposure time, unset the brake if used and rapidly turn the crank handle in the RETRACT direction until it stops. Again the label on the crank housing indicates the RETRACT direction.
2. The survey meter should increase as the source assembly is retracted back into the device and drop to background levels when the source assembly is secured back in the device.

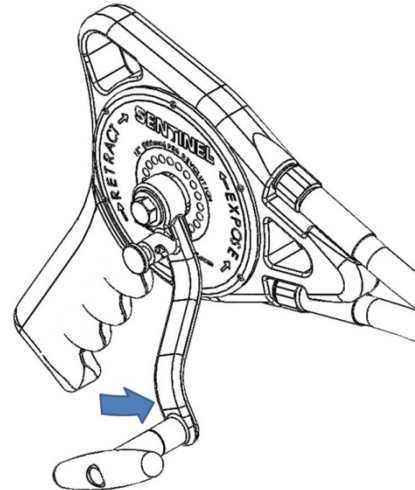


3. When the source assembly engages the automatic locking mechanism, you may hear the lock slide 'click' back into its lock position depending on the ambient noise levels at the job site.
4. From the control crank you may be able to see the **GREEN** marking on the lock slide.



5. Slowly turn the crank handle as if to expose the source. This checks to ensure the source is secured by the automatic locking mechanism.

The source should not be projected out of the device. If the source can be projected out when it should be secured, then consider the device as potentially damaged equipment and contact your RSO.



6. Release the crank handle to allow the control cable to return to a neutral (no force) position. At this point the source cannot be moved out of the stored position.

NOTE: Any residual force on the control cable from the crank when the source is locked could cause the source to move slightly after unlocking the lock slide for the next exposure.



WARNING

Always approach device with survey meter in hand to confirm source position.

If the lock slide does not return completely to the stored (**GREEN** showing) position, and the source cannot be exposed using the crank assembly, manually push lock slide into position from **RED** side or push back into **RED** operate and retract source again. Retracting too slowly is the likely cause.

If the condition persists, a weak or damaged return spring may be the cause. Perform annual maintenance on plate assembly after source is removed.

In the unlikely event the lock slide will not trip or trips prematurely with source still exposed or partially exposed, make additional attempts with control cranks to secure the source within the projector.

If survey meter reading is low indicating the source is shielded but not yet secured, push tripped lock slide back to red and attempt to retract again with control crank.

If lock slide is not tripped attempt to push slide manually from the **RED** side to the **GREEN** side while applying some retract pressure on the control crank.

If source cannot be secured or radiation readings are high indicating source is not shielded, one must suspect an accident condition in which the source assembly may have become disconnected or stuck outside the exposure device - giving rise to a very high radiation field.

Treat this situation as an **EMERGENCY** and notify the site radiation safety officer.

2.4.7. Perform a confirmatory survey.

1. Approach the exposure device while observing the survey meter.
2. Visually confirm the **GREEN** marking on the lock slide is shown while the exposure device is surveyed. The survey meter should indicate the same radiation level as observed before the exposure. Be particularly aware of the outlet port reading.
3. Survey the entire length of source guide tube (and collimator or J-tube if used). If the meter shows a sharp increase, the source assembly is not completely shielded.

4. If the source is still unshielded and the lock slide **RED** mark still appears, attempt to store the source by cranking the source a short distance towards the exposure head and retracting it, repeating if necessary.



DANGER



Special confirmatory surveys must be performed whenever using a low-activity isotope source.

After performing radiography and with the source locked in the device, carefully and deliberately conduct the confirmatory survey on the following:

- All surfaces of the exposure device,
- Along the entire length of source guide tube and
- On exposure head/collimator or SCAR collimator.

2.4.8. Lock the exposure device.

1. With the source assembly properly stored in the exposure device, rotate the selector ring from the OPERATE position to the LOCK position
2. Push in the brass plunger lock to secure the device.
3. Remove and safeguard the key.
4. See **Section 2.5** for instructions to dismantle and store the equipment.

2.5. Equipment Dismantle and Storage.

2.5.1. Remote Control Unit

1. Unlock the exposure device and then rotate the selector ring counter-clockwise from LOCK to CONNECT. The remote control 661 connecting collar will disengage from the exposure device's locking mechanism.
2. Completely disengage the remote controls from the exposure device by disconnecting the control cable connector from the source assembly connector.
3. Place the protective cover over the 661 safety connector assembly to protect the connector pins and control cable connector from damage and dirt.
4. Roll up the remote control housings loosely for easier handling and transport.
5. Reinstall the locking mechanism's protective cover, hold in place and rotate the selector ring clockwise to the LOCK position.
6. Push in the plunger lock and remove the key to secure the exposure device.

2.5.2. Source Guide Tubes

1. Remove the source guide tube attached to the exposure device outlet port by:
 - Grip and pull the spring-loaded interlock knob. While pulling the knob, rotate it 1/8 turn clockwise and then release or push the knob in until seated.
 - Rotate the outlet port knob counter-clockwise until it stops at about the 9 o'clock position.
 - Grip the source guide tube fitting and rotate it 1/4 quarter turn clockwise. Remove the source guide tube from the outlet port.
 - Grip and pull the outlet port knob slightly. Rotate the knob into the closed position and release. The port knob should now cover the front plate outlet port.
2. Replace protective covers where provided back onto the source guide tube fittings. Thread together extension fittings to protect the swaged fitting threads and keep dirt out.
3. Source guide tubes should be rolled up loosely for easier handling and transport.

2.5.3. Surveying

1. With all covers in place on the device, survey the entire surface of the device with the survey meter to ensure the source is fully shielded and properly secured.
2. The survey should not measure more than 2mSv/hr (200mR/hr) on any surface of the device and should indicate the same measurement as the initial survey.

2.5.4. Storage

1. Lock the exposure device.
2. Perform a storage survey on the surface of the exposure device to verify the dose rate is less than 2mSv/hr (200mR/hr) and record.
3. Place the locked device in the shipping case for protection when not in use.
4. Store and secure the case in a clean dry storage area where it cannot be tampered with or removed by unauthorized personnel.
5. A radioactive material warning notice must be posted on the door or entrance of the storage area.
6. The door or entrance must be locked to prevent access by unauthorized personnel. Activate security alarm requirements per national regulations.



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SECTION 3: DAILY INSPECTION INSTRUCTIONS

The USNRC and international regulations require routine inspections to ensure that industrial radiography equipment is operating safely and properly. The **1075 SCARPro** is designed with inherent safety features and quality construction to ensure the highest degree of quality, safety, reliability and durability.

Care should be taken to prevent radiological incidents that can occur from neglect, accidental damage, abuse and lack of inspection and maintenance.

The following instructions should be followed carefully to ensure safe and proper operation of this equipment.

 **DANGER** 

The sealed source in the source assembly contains radioactive material and must not be handled outside of the exposure device under any circumstances.

An unshielded source at close proximity can cause serious injury, sickness, or death to anyone exposed to it even for a short duration.

Suspected exposure to high radiation dose should be treated immediately as effects may not be readily apparent yet still be deadly.

3.1. System Daily Inspection

A daily inspection of the gamma radiography system for obvious defects is essential to ensure the equipment is in a safe and proper operating condition. It is important that all radiographers perform or supervise this inspection prior to the first radiographic exposure of the shift regardless of any previous inspections that may have been performed that day.

As an example, damage to a component of the system may occur during transport of the equipment to and from the job-site. If damaged equipment is used without detection, the result may be the inability to retract the source assembly into the exposure device and secure it.

The results of a daily inspection should be recorded to include the date, the name of the inspector and the specific equipment inspected. If any defective or damaged components are discovered during the daily inspection, the component must be removed from service and identified with a status indicator (tag, label, or tape) to prevent inadvertent use by other radiography personnel.

Defective or damaged components must be replaced or repaired before reuse in radiographic operations. The radiographic exposure device and transport case, remote controls and source guide tubes must all be inspected in addition to accessories such as lab stands, collimators, J-tubes, magnetic lab-stands and pipe-clamping apparatus.

Radiographers must take a proactive role in preventing incidents, by performing or directly supervising a simple, but thorough daily inspection of the radiography system. The implications that affect safety and the importance of the daily inspection must be emphasized and understood by the entire radiography staff.

3.2. Exposure Device - Daily Inspection

3.2.1. Radiation Survey Inspection

1. Survey the surface of the exposure device to ensure the radiation level is less than 2mSv/hr (200mR/hr), even when containing a source assembly with the maximum allowable activity.
2. This survey checks the operability of the survey instrument and its response to radiation, in addition to providing the radiographer with a reference measurement that can be compared to confirmatory surveys after terminating each radiographic exposure.

3.2.2. Label or Nameplate Inspection

1. The label or nameplate located on the exposure device and the transport case must be securely attached and the text and trefoil symbol must be clearly legible from a distance of at least 3-feet or about 1-meter.
2. The source identification tag must be securely attached to the exposure device and clearly legible.
3. The company name, address, and telephone number must appear somewhere on the exposure device.

3.2.3. Lock Inspection

1. Check the secure attachment of the locking mechanism by gripping it by hand and then shaking it while checking for movement and visually check for loose or missing fasteners.
2. Check the brass plunger lock by unlocking it with the key and then relocking by pushing it back into the plunger lock housing without the key inserted.
3. Unlock the plunger lock, rotate the selector ring, and remove the protective dust cover to check for functionality.
4. Re-install the protective dust cover back, rotate the selector ring, and engage the plunger lock to protect the source assembly connector until the unit is needed for radiography.

3.2.4. Outlet Inspection

1. Lift and rotate the outlet port cover to check for smooth operation.
2. Inspect the front plate and outlet port for signs of damage.
3. Ensure the port and mechanism is not clogged with dirt, mud, grease or sludge.

3.3. Source Guide Tube(s) - Daily Inspection**3.3.1. Fittings Inspection**

1. Inspect both swaged fittings to ensure the threads are not stripped or clogged with dirt, grease or sludge.
2. Inspect the bayonet connector for damage and ensure it rotates freely.
3. Inspect the source stop fitting is not crushed, cracked, or damaged.

3.3.2. Housing Inspection

1. Inspect the full length of each source guide tube using hands to feel for dents or inward depressions where core separation may be hidden.
2. Visually inspect the covering for cuts and heat damage.
3. Using the hands as the method for inspecting the housings is necessary because the flexible covering may retain its circular shape visually hiding dents or separations of the internal core metal conduit. Internal dents and loose shards of damaged metal core material are a major cause of source hang-ups.

3.3.3. Source Stop Inspection

1. Inspect the source stop (exposure head) to ensure there is no excessive wear, perforations, bends and inward dents.
2. Perform this visual inspection with the collimator removed from the source stop.
3. Inspect the collimator and the attachment of the collimator to the source stop (exposure head) if used during radiography.
4. Verify the original equipment brass thumb-screw is being used. The use of generic set-screws other than original equipment may damage the source stop. Typical damage may include; scoring as a result of rotating the collimator around the source stop during radiographic set-ups and inward dents as a result of over tightened steel set-screws.
5. Inspect the attachment of the collimator to the source stop (exposure head) if used during radiography. If collimator utilizes a thumb-screw to affix the collimator to the source stop, hand-tighten only. The use of tools may damage the source stop.

3.4. Controls - Daily Inspection

CAUTION

Always use the protective end-cap when remote controls are not connected to the exposure device. The cover protects the control cable connector from damage when not in use.

Always manually move the sleeve of the source assembly connector to the OPEN position when connecting the control cable to the source assembly. Forcing the control connector into the source connector could damage both connectors over time.

3.4.1. Crank Assembly Inspection

1. The crank handle and all crank assembly screws must be present and properly secured.
2. The control crank label must be present and clearly legible.
3. If the control crank assembly is equipped with an odometer, then it should be functional.
4. The control crank friction style brake must give resistance when rotating the crank handle with the brake in the ON position
5. Control housing fittings must be secured to the control crank housing.

3.4.2. Control Housing Inspection

1. Both control housings must be free of dents.
2. Cuts, bulges, and melted areas must be assessed by a qualified technician for continued use of the housing.
3. Small superficial cuts or burned area in the housing should be repaired with PVC tape to prevent the possible ingress of water and mud.

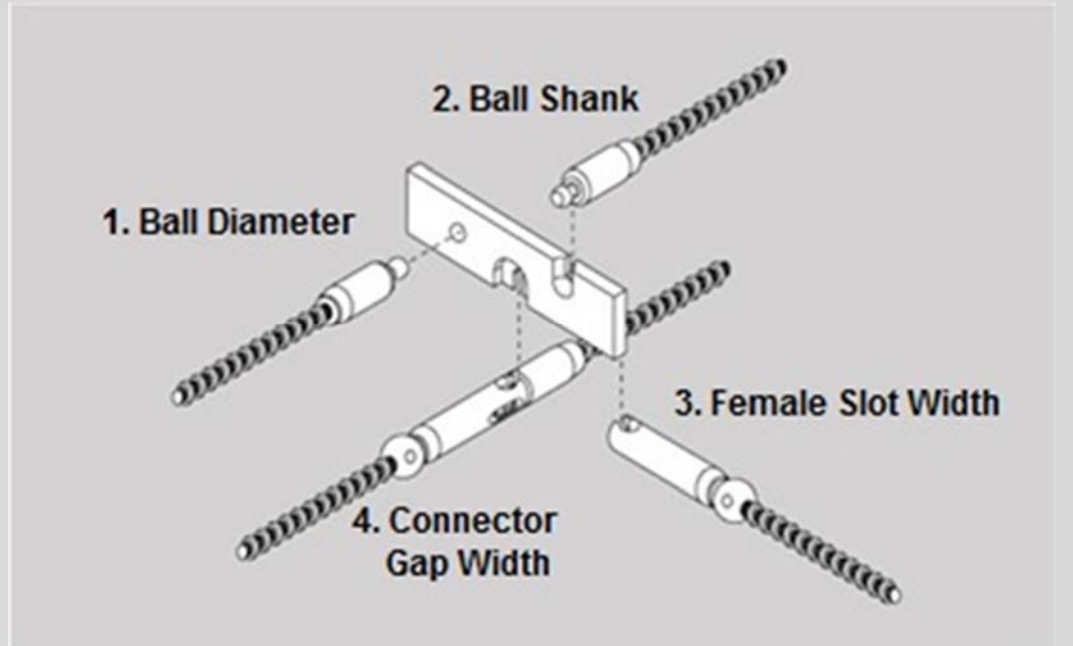
3.4.3. Model 661 Safety Connector Inspection

1. Remove the protective cover from the 661 safety connector assembly.
2. Inspect the 661 safety connector assembly to check the condition of the jaw pivoting pins and the connecting collar pins. These pins should not be bent, loose, or damaged.
3. Use only factory supplied replacement roll pins for 661 safety connector repairs.
4. Check the control sheath swage fittings to verify they are not loose where they are joined to the 661 safety connector assembly.

3.4.4. Control Cable Inspection

1. Inspect the control cable connector as it protrudes out from the 661 safety connector assembly. A control cable connector bend angle up to 15 degrees relative to the control cable centerline is acceptable. Connectors which may have been damaged in an accidental fall which exceeds 15 degrees should be removed from service and returned to a QSA service center for inspection and installation of a replacement connector.
2. Inspect the control cable connector to verify that the stem and ball of the connector are not bent or cracked. Using hand pressure, attempt to twist the control cable connector from the control cable. If the control cable connector can be twisted using hand pressure or appears bent or cracked, remove control cable from service and label as defective.
3. Pull approximately 12 in (30.5 cm) of control cable out of the 661 safety connector assembly and inspect for the following anomalies directly behind the connector:
 - Cuts, breaks, nicks or fraying of the spiral windings of the control cable, **especially behind the cable connector.**
 - Areas with kinks or permanent bends.
 - Rust (a red oxide) on the inner core of the control cable.
 - Uniformity of the spacing between the outer spiral windings. Also check for flattened areas and wear.
4. Bend the connector section of control cable back towards itself and release the cable to test for flexibility or 'spring' of the control cable. A cable that has been subjected to the flexibility test and remains in the bent position after the test provides an indication of internal corrosion and **must be removed from service.**
5. Verify that a light coating of mil-spec grease is present on the control cable. The light coating of grease is necessary to prevent the penetration of water and chemicals that can oxidize and permanently damage the control cable.
6. Check for freedom of movement of the control cable within the remote controls by moving the control crank handle back and forth approximately one-quarter turn. During this test, take care to avoid cranking the control cable onto the ground damaging the connector or exposing it to dirt and sand.
7. If any resistance is felt during this check, re-inspect the control housings for dents or depressions. If dents are not present on the remote control housings, the control cable may be rusted stiff somewhere within the control housings. Do not use remote controls that do not function properly or exhibit defects described above.
8. A final check of the control cable connector and source assembly connector is accomplished by use of a Model 550 NO GO gauge to check for significant wear on the connectors that would affect safety. Without using excessive force, check the following four positions (see **figure 3.4.5**):

3.4.5. NO-GO Gage Tests



Position	Test
1	Ball at the end of the control cable connector must NOT GO into the hole of the gage.
2	The shank or stem of the control cable connector must NOT GO into the smaller of the two notches located on the side of the gage.
3	The width of the gage must NOT GO into the female slot of the source assembly connector.
4	After a positive connection between the control cable and source assembly connectors has been accomplished, verify that the larger notch located on the side of the gage will NOT GO in the gap between the joined connectors.
<p>Do not use and replace any component that fails a NO-GO gage test. A failure indicates significant wear could allow designed-in safety features to be defeated.</p>	

SECTION 4: MAINTENANCE INSTRUCTIONS

Radiographic exposure devices and associated equipment must be maintained regularly by trained and qualified personnel to ensure consistent and safe operation of the radiographic system. The routine inspection and maintenance also ensures that the integrity of the transport packages are maintained in compliance with the package certification and approval requirements.

Trained and qualified individuals within the licensee's organization can perform equipment maintenance. QSA Global, Inc. service engineers are available to provide maintenance on the systems at the licensee's premises or at one of the service centers.

Manufacturers base the recommended inspection and maintenance requirements on the system's design, application, materials, anticipated work cycles, environmental factors of use under the normal and abnormal conditions of industrial radiography and while in the transport system.

A program of systematic maintenance will prolong the working life of the radiographic exposure device and associated equipment in addition to ensuring safety during use.

By most national regulations, **routine maintenance** of the systems is required at intervals **not to exceed 3 months** in addition to the radiographer's daily inspections for obvious defects. The **routine maintenance performed every 3 months or less** requires partial disassembly, cleaning, inspection, re-lubrication and operational checks of the system.

The complete annual servicing ensures the integrity of the system. The **complete maintenance performed once a year** involves a complete disassembly, cleaning, inspection, replacement of service parts (springs, seals, etc.) re-lubrication and operational tests of the entire system.

CAUTION

Maintenance program administrators 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.

Maintenance program administrators must ensure the systems are completely serviced immediately after certain jobs in severe environments and conditions. Extreme or severe environments and 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 or foundry green-sand.
- Subjected to hot radiography conditions.
- Subjected to salt-water conditions, caustic or acidic materials.
- Subjected to accidental drops or falling objects.
- Whenever subjected to extreme environmental conditions.
- **Subjected to more than 10,000 exposures in a 3-month period.**

4.1. Inspection & Maintenance Records

All equipment inspected and maintained during the maintenance period must be recorded and kept for 3 years after the date of the inspection/maintenance. Records should include:

- The date when the maintenance was performed.
- Names and signatures of the qualified individuals performing the inspection and maintenance.
- Model numbers and serial numbers of the equipment.
- Associated equipment model and/or part numbers also maintained.
- Record problems found and maintenance or repairs performed. Include results of misconnect tests on all remote controls and exposure devices by manufacturer, model number and serial number.
- Part numbers and lot or serial numbers (when applicable) of any replaced parts.

4.2. Tools and Materials for Maintenance

The tables below list the tools and materials needed to perform maintenance on the exposure device, remote controls, and source guide tubes.



WARNING

Personal safety equipment must be worn to prevent injury while performing equipment maintenance.

At a minimum, safety glasses and gloves must be worn for protection.

Ensure safety by following the manufacturer instructions of the tools and materials in the tables below.

4.2.1. Maintenance Tool List.

TOOL #	TOOL NAME	TOOL NUMBER OR SIZE	QUANTITY
MT1	Torque Wrench, Calibrated	IN-LB	1
MT2	SENTINEL U-Tool	SK1761	1
MT3	Mock Source Assembly, Inactive	A425-1XL	1
MT3	Allen Wrench	0.05-Inch	1
MT4	Allen Wrench	1/16-Inch	1
MT5	Allen Wrench	3/32-Inch	1
MT6	Allen Wrench	7/64-Inch	1
MT7	Allen Wrench	1/8-Inch	1

MT8	Allen Wrench	5/32-Inch	1
MT9	Allen Wrench	3/16-Inch	1
MT10	Allen Wrench	1/4-Inch	1
MT11	Nut Driver	1/4-Inch	1
MT12	Driver Bit, Tamper-Resistant TORX	T10, 1/4-Inch Hex Shank	1
MT13	Driver Bit, Tamper-Resistant TORX	T25, 1/4-Inch Hex Shank	1
MT14	Driver Bit, Tamper-Resistant TORX	T40, 1/4-Inch Hex Shank	1
MT15	Small Screwdriver, Slotted	1/4-Inch Tip Width	1
MT16	Open-end Wrench	11/16-Inch	1
MT17	Open-end Wrench	1/2-Inch	1
MT18	Open-end Wrench	3/8-Inch	1
MT19	Magnification Glass	X7	1
MT20	Micrometer	6-Inch	1
MT21	Tap & Die Set	1-18 UNS Thread	1
MT22	Control Cable, 7-Feet	55000-7	1

4.2.2. Maintenance Materials List.

MAT #	MATERIAL NAME	MATERIAL NUMBER	QUANTITY
MM1	Grease	MIL-G-23827B (or C) or MIL-PRF-23827C	AR (As Required)
MM2	Thread locker	LOCTITE 242	AR
MM3	Thread locker	LOCTITE 222	AR
MM4	Thread lubricant	PERMATEX ANTI-SEIZE	AR
MM5	Cleaning Solvent	Mineral Spirits	AR
MM6	Clean Lint-Free Rags	MCMMASTER-CARR# 7366T28 or similar	AR
MM7	Cotton Wipes, 3X3 Inch	MCMMASTER-CARR# 7492T3 or similar	AR
MM8	Large Pan	MCMMASTER-CARR# 4204T4 or similar	1
MM9	Bristle Brush	MCMMASTER-CARR# 63015T23 or similar	1
MM10	Polyvinyl Tape	Yellow or black	AR

4.3. Exposure Device Maintenance

See **Section 4.3.1** for routine (quarterly) device maintenance and see **Section 4.3.5** for complete (annual) device maintenance. See **Section 4.2** for the list of tools and materials needed for maintenance.

4.3.1. Exposure Device – Routine Maintenance.

1. Record and keep all device inspection and repair history.
2. Clean and inspect the device. Check for obvious wear and damage.
3. Remove the device from service if it is excessively worn or damaged.
4. Survey the device. Remove the device from service if the dose rate exceeds 2mSv/hr (200mR/hr) on the surface and 20μSv/hr (2mR/hr) at 1 meter.
5. Check the source identification tag to ensure it is legible and securely fastened to the device. Do not cover the tag with any other labels.
6. Check the device label to ensure it is securely fastened to the device and the marking is legible from a distance of 3-feet (1-meter). The marking shows the device model number, serial number, and the trefoil with the warning 'Caution or Danger, Radioactive Material'. Do not cover the markings with any other labels.
7. Ensure the plastic jacket handle, base surfaces and sides are intact. If any substantial wear and tear is found, replace it at a QSA Global service center.
8. Check the device structure for weld failure (cracks, etc.) at the outlet port end behind the front plate or collimator. The collimator or front plate will need to be removed to check the weld.
9. Check all fasteners to ensure they are tight. Without removing the rear plate attachment screws, examine the screws for any signs of damage or fatigue cracking. Examine the front plate and collimator assembly attachment screws for signs of damage including thread damage. The fasteners must be replaced if they are no longer fit for use (e.g., threads stripped, unable to fully thread, signs of cracking, etc.)
10. Check the function of the rear plate locking mechanism. If the device is loaded with a source do not test the lock slide function. If the assembly does not function properly, then perform complete maintenance on the device per **Section 4.3.5**.
11. Check the front plate operation using the wipe test fitting. If the assembly does not function properly, then perform complete maintenance on the device per **Section 4.3.5**.
12. Check the control cable connector and the source assembly connector for damage and wear using the NO-GO test in **Section 3.4.5**. Replace components that fail any of these tests.
13. Perform the misconnect test per **Section 4.3.2**.
14. Perform the sealed source leak test per **Section 4.3.3**.

15. Check the function of the entire system during the first radiographic exposure of the work shift while within a restricted area. Operation of the radiographic system verifies both the locking mechanism and entire system operates smoothly and freely. If operation becomes unusual, faulty, and/or sluggish, then remove the exposure device and equipment from service and perform the complete annual maintenance.

4.3.2. Misconnect Test Instructions

The misconnect test ensures the controls cannot be attached to the device without first connecting the control connector to the source connector. Contact a QSA Global, Inc. service center if you have any questions regarding the misconnect test.

Only personnel who are formally trained, authorized, and thoroughly familiar with the maintenance procedures should conduct the misconnect test.

- ***Note: Component wear can occur to both the control assemblies and the device locking mechanisms. Therefore, to ensure acceptable equipment operation, the misconnect test must be performed on each device lock assembly and control assembly that will be used for radiographic operations.***

The test is conducted with the radioactive source assembly loaded into the exposure device.

1. Without connecting the control connector to the source connector, attempt to attach the 661 safety connector to the device locking mechanism.
2. If the 661 safety connector cannot be attached to the device locking mechanism without the control cable connected to the source connector, then the equipment passes the test.
3. If the 661 safety connector can be attached without the control to source connection, the equipment fails the test. Use extreme caution to prevent the selector ring from rotating beyond the "LOCK" position.
4. Equipment used in a failed test must be removed from service until it has been repaired to pass the test.
5. During the misconnect test, there is the **risk of losing control of the radioactive source assembly under the following circumstances:**
 - Components are excessively worn or damaged.
 - The selector ring is inadvertently rotated from the CONNECT position to the OPERATE position.
 - The lock slide is unintentionally pushed into the open (**RED**) position.

4.3.3. Sealed Source Leak Test Instructions.

Periodic sealed source leak tests are required by most national and international regulations.

The leak test confirms the integrity of the sealed source by measuring the contamination if leaked from the source.

1. Survey the exposure device with a calibrated survey meter. Dose rates must not exceed 2mSv/hr (200mR/hr) on the surface. If not already configured with the front plate assembly, then replace the collimator assembly with the front plate assembly as described in **Section 2.1**.
2. Prepare a Model 518 or SENTINEL Kowipe test swab according to the instruction sheet provided with the test swab.
3. Enter all required source information on the leak test form. Omission of the isotope, source model and serial number, etc. will delay processing of the wipe test.
4. Install the service bayonet fitting (part no. 88049) into the front plate outlet port to allow the wipe test swab to enter the 'S' tube.



DANGER



High radiation emits from the open outlet port when the knob is turned to the 11 o'clock position and the shutter is in the open position.

Perform the wipe test without delay to minimize dose to the hand.

5. Ensure the shutter is open to allow the swab to contact the source capsule.
6. When ready and without delay, open the outlet port and fully insert the wipe test swab into the 'S' tube and move back and forth to obtain the sample.
7. Carefully withdraw the wipe test swab without delay from the outlet port and close the outlet port knob.
8. Slide the plastic bag/envelope over the wipe test sample without touching it and close the bag. **Always assume the sample is contaminated.**
9. Remove the service bayonet fitting from the outlet port and rotate the outlet port cover into the closed position.
10. In a low background (no radiation) area, switch the survey meter to the lowest scale and obtain a background measurement.
11. Leaving the survey meter stationary, move the plastic wrapped swab towards the survey meter's detector to determine if significant contamination is on the wipe test sample.
12. If the survey meter measures greater than 1 μ Sv/hr (0.1 mR/hr), contact QSA Global, Inc. for instructions.

13. If there is no measurable increase above background, the sample may be sent to the SENTINEL™ laboratory for radio-assay. The SENTINEL™ laboratory will send a leak test certificate after performing the radio-assay. Retain this certificate in your records.
14. In the event you are informed by the radio-assay laboratory that your leak test results indicate greater than >185 Bq (0.005 μ Ci), you must immediately remove all equipment used with the source from service. This includes the radioactive sealed source, the exposure device and all remote controls, source guide tubes, collimators, lab stands, etc.
15. You must notify the regulatory agency (USA) within 5 days (check local regulations for reporting requirements). Contact the sealed source manufacturer for assistance.
16. All contaminated equipment must be decontaminated before it can be used again.



DANGER



Do not perform complete maintenance on the exposure device with a radioactive source assembly in the device.

The radioactive source assembly must be transferred to an approved source changer before complete maintenance can be performed on the device.

Cleaning solvents can be flammable. Precautions must be taken to follow the solvent manufacturer instructions.



WARNING

Personal safety equipment must be worn to prevent injury while performing equipment maintenance.

Safety glasses must be worn for protection.

Rubber gloves are recommended when handling solvents, lubrications, etc.

4.3.4. Source Transfer Instructions.

The source transfer can only be done with the front plate assembly and source guide tube extensions attached. The source transfer must only be performed by properly trained and licensed personnel.

1. Survey the device with a calibrated meter. Dose rates must not exceed 2mSv/hr (200mR/hr) on the surface and $20\mu\text{Sv/hr}$ (2mR/hr) at 1 meter.

2. Survey the loaded storage container to check the local dose rates and location of the source.
3. Inspect the controls and source guide tubes used for the source transfer. Do not use equipment that fails the inspection. Connect an extension guide tube from the outlet port to an open hole in the changer/container.
4. Connect the controls to the device after checking the source connectors with the Model 550 NO-GO gage. If the connection fails the gage, then do not proceed with transfer and contact a QSA Global, Inc. service center for further instructions.
5. Follow the instructions in the source changer manual for source transfer from the device to the changer.
6. Survey the device, changer and source guide tubes to confirm the source is in the changer.
7. Lock the source in the changer and disconnect the control cable from the source.
8. Remove the source identification tag on the device and place it on the source changer.
9. Use a dummy connector from the tool kit and attach it to the control cable connector. The dummy connector will trip the lock slide in the Posilok rear plate assembly when the drive cable is retracted. This will enable the controls to be removed from the device for servicing.

4.3.5. Exposure Device - Complete Maintenance.

Radiographic exposure devices used under normal conditions require complete maintenance once a year. See **Section 4.2** for the list of tools and materials needed for maintenance.

The inspection and maintenance must only be performed by individuals specifically trained, qualified and authorized for this work. QSA Global, Inc. service personnel can provide maintenance services for these systems conveniently during source reload at a service center or in the field upon request. Inspection & Maintenance classes are offered and held several times per year for companies wishing to perform maintenance in house. See the QSA training course schedule for class dates and locations.

- 1 Transfer the active source assembly from the device to a storage container according to **Section 4.3.4**.
- 2 Disconnect and remove the remote controls and source guide tubes.
- 3 Ensure the exposure device is empty before proceeding by using a survey meter to confirm. The lock assembly may contain a dummy source connector or a connector may be absent. If the device is empty, it should have an empty tag attached.
- 4 Remove the front plate assembly from the device and perform maintenance on the assembly according to **Section 4.3.7**.
- 5 If present, remove the collimator assembly from the device and perform maintenance on the assembly according to **Section 4.3.8**.
- 6 Remove the rear plate assembly from the device and perform maintenance on the assembly according to **Section 4.3.9**.

- 7 Clean the exterior of the device using a mild detergent spray solution and rags to remove all dirt and grime.
- 8 Visually inspect the device looking for damage and/or foreign material that may cause the device to malfunction. Contact a QSA Global service center for guidance on the approved damage repair procedure if damage is found.
- 9 Visually inspect the plastic jacket for cracks, ensure the handle and mounting points are intact, and the bottom contact surfaces are not excessively worn. Contact a QSA Global service center for guidance on replacing a damaged or worn jacket.
- 10 Visually inspect the device label or nameplate to ensure all information is legible. The trefoil and the warning, 'Caution or Danger, Radioactive Material', must be legible at a distance of 3-feet (approximately 1-meter).
- 11 Replace the label/nameplate if the information is not legible or likely not to be legible in the next twelve months.
- 12 Re-attach the front plate assembly.
- 13 Perform a front plate functional test according to **Section 4.3.10**.
- 14 Perform a rear plate functional test according to **Section 4.3.11**.
- 15 Re-attach the rear plate assembly (not already attached).
- 16 Perform a complete device functional test according to **Section 4.3.12**.

4.3.6. Device Replacement Parts – Complete Maintenance.

When ordering replacement or spare parts, quote the model and serial number of the exposure device as well as the part number to ensure correct replacement.

Exposure Device Safety Class A Components

Safety Class A Designation Items

Some items in the exposure device and associated equipment are critical for safe radiological operation. These items are classified as Class A items or components.

Class A items can be structures, components and systems whose failure or function could directly result in a condition adversely affecting public health and safety. This would include extreme conditions such as the loss of primary containment with a subsequent release of radioactive material and or a loss of shielding creating a substantial safety hazard.

Replacement parts that are sent to you with a safety Class A designation are clearly marked with lot or serial numbers and contain instructions to maintain traceability.

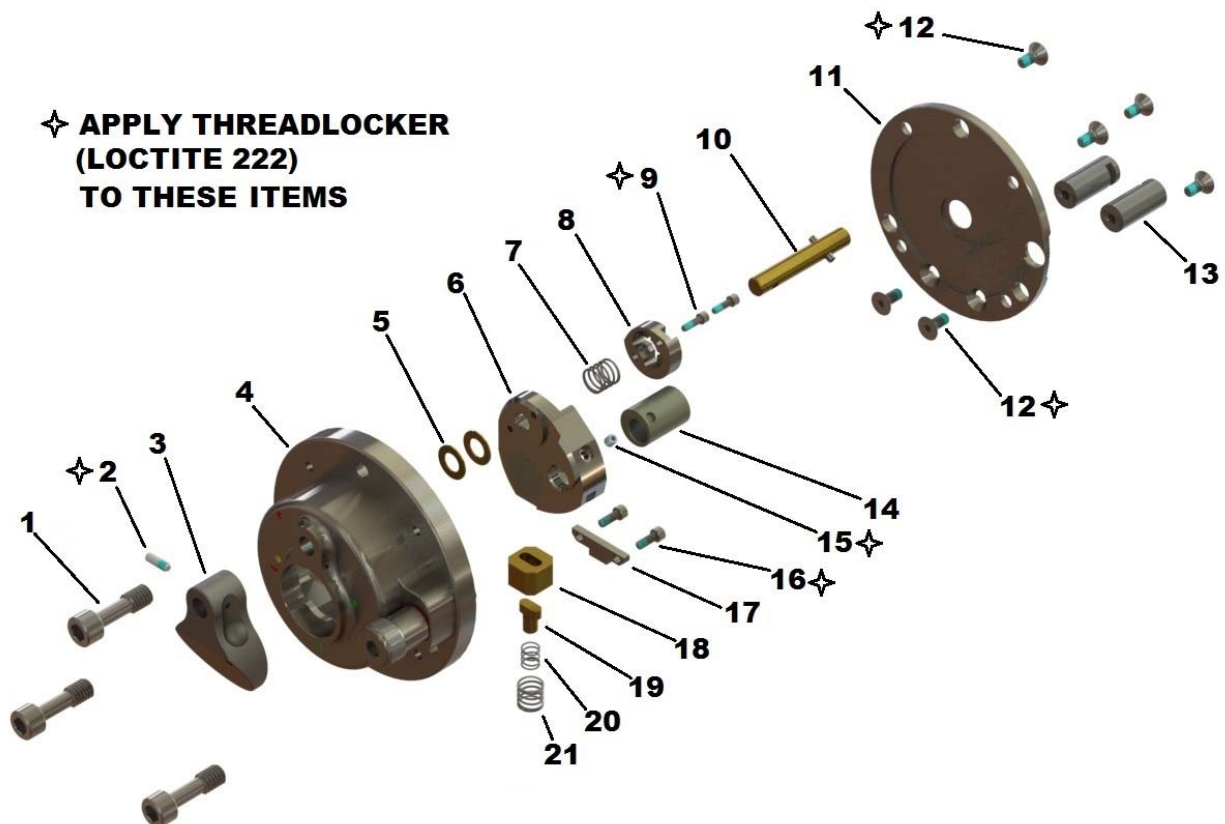
Considerations of Safety Class A Items

Users of the exposure device and associated equipment must recognize their responsibilities of maintaining the integrity of the exposure device and the control of Class A items.

The users responsibilities for Class A items are to:

- Maintain traceability of Class A replacement items or components to a specific exposure device or an associated component.
- Use the manufacturer specified items to maintain the integrity of the exposure device/transport package according to the certifications. Do not replace any item with generic or commercial grade components.
- Perform periodic inspections to verify the Class A items are not excessively worn from long term use or have been damaged from accidents. Do not modify the device or transport case. Unapproved repairs or modifications will invalidate the Type-A transport package.
- Use and handle the system consistent with its design and intended applications.
- Promptly notify the manufacturer in the event a Safety Class A item or component which contains a defect or deviates from the original design specifications. This action will initiate a formal evaluation of the defect or deviation.

4.3.7. Front Plate Assembly - Complete Maintenance.



ITEM #	PART NAME	PART NUMBER	QUANTITY
1	Screw, Front Plate	107530-13	3
2	Set Screw, Knob	SCR251	1

3	Knob	88033	1
4	Front Plate	107530-01	1
5	Washer	88036	2
6	Rotor Assembly	107530-09	1
7	Spring, Rotor	SPR033	1
8	Pivot Disc	107530-05	1
9	Screw, Pivot Disc	SCR160	2
10	Shaft Assembly	107530-14	1
11	Front Cover	107530-08	1
12	Screw, Front Cover	SCR392	6
13	Pin, Shutter Interlock	107550-01	2
14	Front Plate Sleeve	107530-07	1
15	Set Screw, Sleeve	SCR017	1
16	Screw, Slider Cap	SCR210	2
17	Slider Cap	107530-10	1
18	Slider	107530-02	1
19	Slider Insert	107530-15	1
20	Spring, Slider Insert	SPR004	1
21	Spring, Slider	SPR033	1

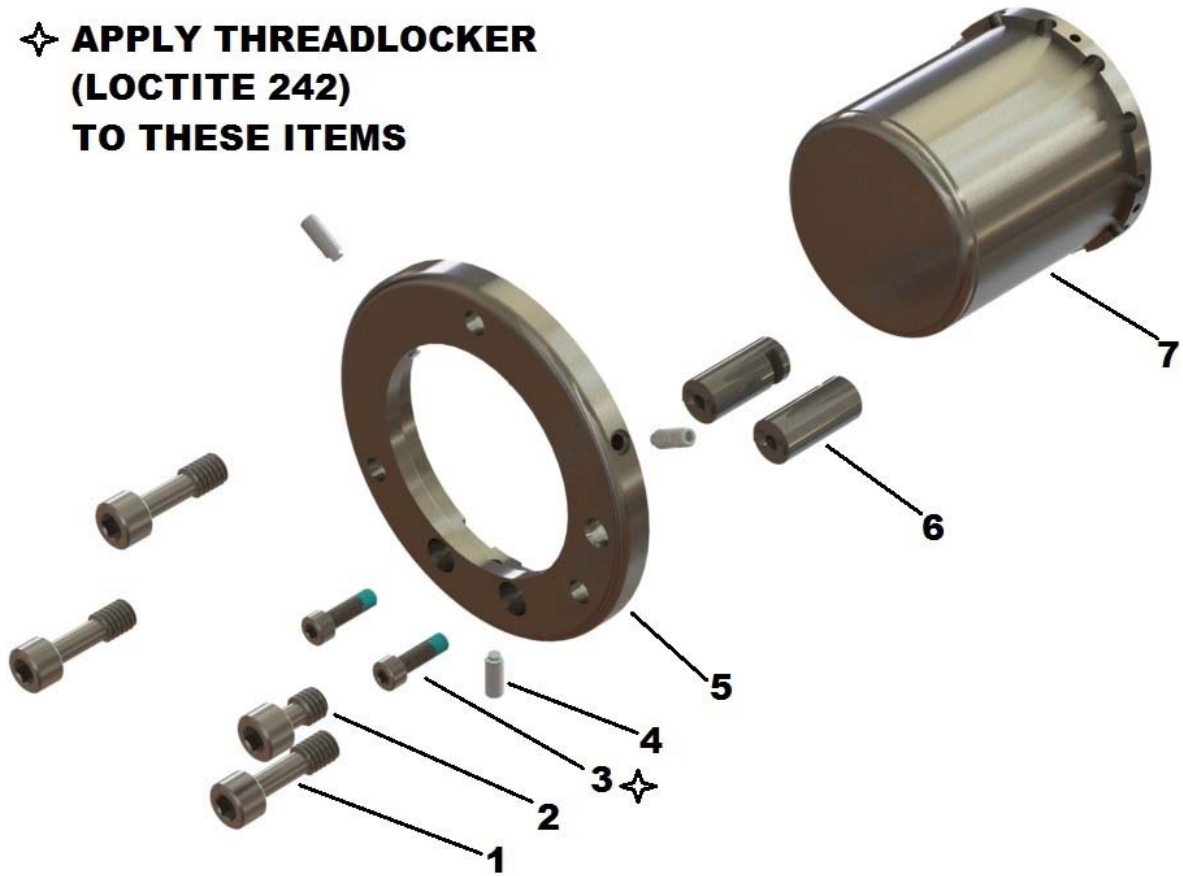
Front Plate Complete Maintenance Instructions

- 1 Remove the front plate assembly from the device by unthreading the three captive screws and interlock knob on the front plate. Shutter interlock mechanism must be closed to remove the front plate.
- 2 Place the front plate assembly with the port knob down on a clean surface.
- 3 With the inside of the front plate facing up, remove the four inside cover screws holding the front cover to the plate assembly.
- 4 Remove the front cover. The two shutter interlock pins should remain attached to the cover.
- 5 Flip the front plate over with knob facing up.
- 6 Remove the set screw in the knob.
- 7 Remove the knob from the shaft assembly.
- 8 Flip the front plate over again to access the internal mechanism.
- 9 Pull out the rotor and shaft assembly. Remove and inspect the bronze shaft for wear. Check the roll pin for looseness or damage, replace shaft assembly if needed.
- 10 Pull out the slider and slider insert together with their springs.

- 11 Remove and discard the springs from the slider and slider insert.
- 12 Unscrew the two screws holding the pivot disc to the rotor.
- 13 Remove and discard spring from pivot disc.
- 14 Wipe down all parts using a brush and solvent if needed to remove all dust and dirt.
- 15 Lightly lubricate shaft, slider parts, and rotor slot. Do not lubricate these if the device is used in an environment where sand and grit is present.
- 16 Inspect all parts for wear, damage, and burrs.
- 17 Inspect the rotor shield disc remains securely positioned. Shield rotation is normal.
- 18 Apply a small drop of low strength thread locker onto the last two threads of all small screws.
- 19 Assemble rotor with new pivot disk spring and lightly install screws.
- 20 Install shaft into pivot disc. Use the shaft to align and center the pivot disc before securing screws.
- 21 Install two brass washers.
- 22 Assemble the slider insert into the slider slot.
- 23 Place the slider insert spring onto the slider pocket.
- 24 Place the slider spring over insert spring and into the slider pocket.
- 25 Insert slider assembly with springs first into pocket with insert tab aligned with slot in rotor. Use finger inserted through outlet port to compress and hold assembly while inserting rotor assembly.
- 26 Install the rotor assembly into the front plate while ensuring the two washers remain in place on the shaft. Ensure slider assembly and springs are positioned and oriented correctly.
- 27 Install knob onto the rotor shaft and secure with set screw.
- 28 Install cover plate with four flat head screws.
- 29 Tighten the four cover plate screws.
- 30 A partial function test can be performed using a leak test fitting or bayonet fitting to check the outlet port function.
 - a. Hold assembly with large pins horizontally at the top.
 - b. Open knob to 3 o'clock position and insert fitting.
 - c. Rotate fitting $\frac{1}{4}$ turn CCW and rotate knob to 5 o'clock position.
 - d. Assembly should operate smoothly with slight drag when moving knob to open position.
 - e. Reverse steps to remove fitting.
 - f. Interlock can only be checked while installed on device.

4.3.8. Collimator Assembly - Complete Maintenance.

✦ **APPLY THREADLOCKER
(LOCTITE 242)
TO THESE ITEMS**



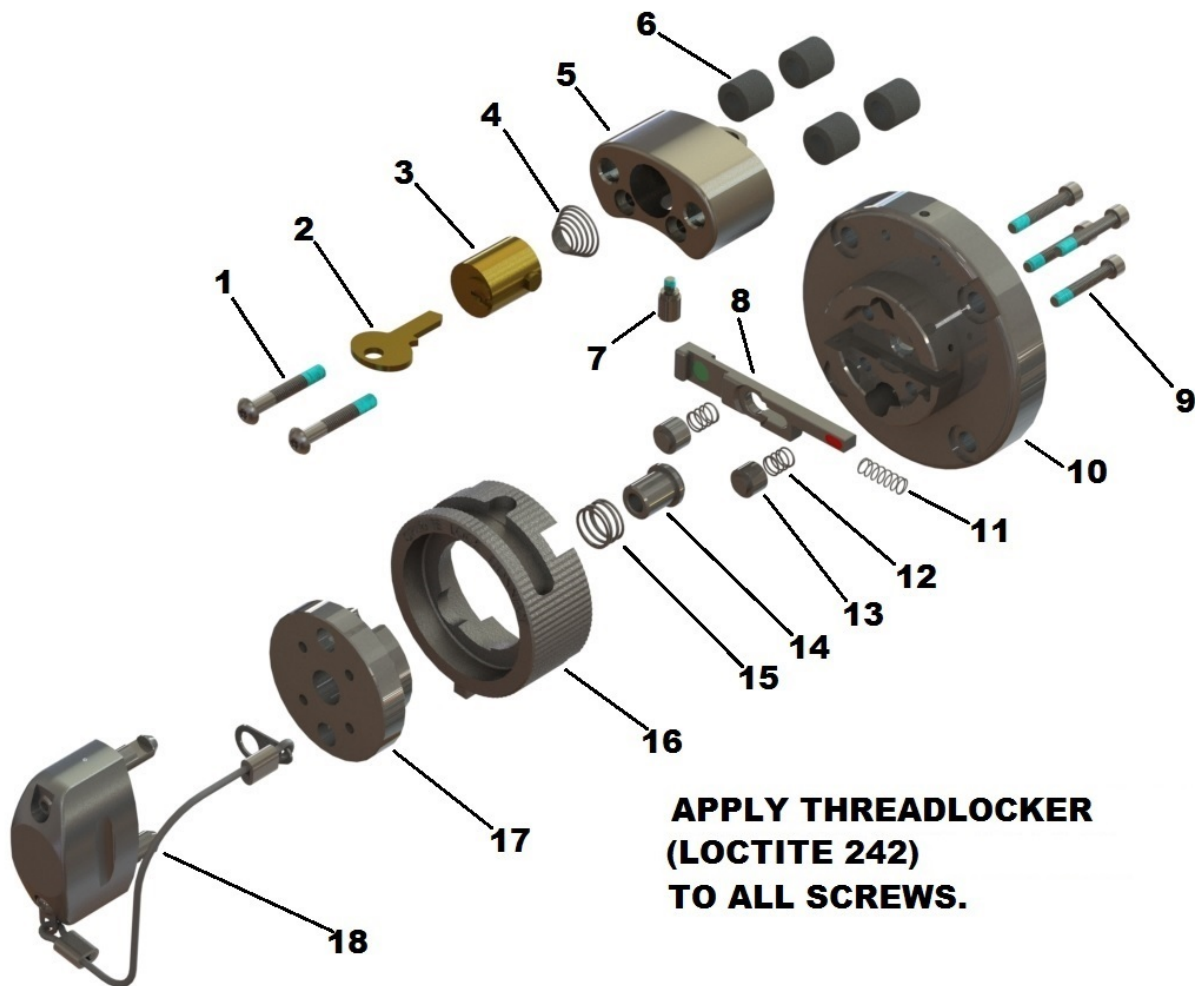
ITEM #	PART NAME	PART NUMBER	QUANTITY
1	Screw, Captive	107530-13	3
2	Screw, Collimator Lock	107560-03	1
3	Screw, Shutter Interlock	SCR015-07	2
4	Set Screw, Beam Port	SCR395	3
5	Collimator Ring	107560-04	1
6	Pin, Shutter Interlock	107550-01	2
7	Collimator Housing	107560-02	1

Collimator Complete Maintenance Instructions

- 1 Remove collimator from the device by unthreading the captive lock screw and the three other captive screws.
- 2 Unscrew and remove the three set screws from the collimator.
- 3 Slide the collimator housing away from the collimator ring.

- 4 The two shutter interlock pins can remain attached to the ring.
- 5 Wipe down all parts with rag lightly wetted with cleaning solvent. Use soft brush to remove dirt and dust.
- 6 Thoroughly dry all solvent cleaned parts.
- 7 Inspect all parts for damage or heavy wear.
- 8 Install collimator ring over collimator housing.
- 9 Install the three set screws into the collimator ring almost flush.
- 10 Adjust collimator housing beam port for desired orientation. (Typically down towards pin retaining screws) and secure screws.
- 11 Install all large captive screws into collimator ring.

4.3.9. Rear Plate Assembly - Complete Maintenance.



ITEM #	PART NAME	PART NUMBER	QUANTITY
1	Screw, Plunger Lock Mount	SCR388	2
2	Key	66001-811	1
3	Plunger Lock	107540-08	1
4	Spring, Plunger Lock	SPR063	1
5	Plunger Lock Mount	107540-06	1
6	Rubber Sleeve	SLV005	4
7	Plunger Lock Extension	107540-11	1
8	Lock Slide	107540-05	1
9	Screw, Selector Ring Retainer	SCR002	4
10	Rear Plate	107540-01	1
11	Spring, Lock Slide	SPR006	1
12	Spring, Anti-Rotate Lug	SPR004	2
13	Anti-Rotate Lug	66001-6	2
14	Sleeve	88025	1
15	Spring, Sleeve	SPR005	1
16	Selector Ring	107540-09	1
17	Selector Ring Retainer	85701-5	1
18	Lock Cover Assembly	107545	1

Rear Plate Complete Maintenance Instructions

- 1 Remove rear plate assembly by removing the four large button head retaining screws. Use the largest supplied TORX bit to engage the tamper-resistant screws. The TORX bit can be mounted in a socket for easy on, off, and torquing.
- 2 Unscrew and remove the two plunger lock mount screws holding the plunger lock mount to the rear plate. Use the smaller tamper-resistant TORX bit supplied in a holder.
- 3 Remove and inspect the four rubber sleeves from the plunger lock mount. Replace if worn or degraded.
- 4 Unscrew and remove the plunger lock extension using a large flat blade screwdriver.
- 5 Remove and inspect the plunger lock (conical shaped) spring. Replace if needed.
- 6 Unscrew and remove the four screws from the back of the rear plate holding the selector ring retainer.
- 7 Disassemble the remainder of the locking mechanism assembly. **Take care not to lose the spring loaded parts.**
- 8 Remove the lanyard from the lock cover assembly. Replace if worn or damaged.
- 9 Remove and discard the four springs of the lock assembly.

- 10 Place the unassembled parts, except the lanyard, into a pan filled with fresh cleaning solvent.
- 11 Clean all parts using a soft bristle brush to remove any dirt or grease.
- 12 Remove cleaned parts from the solvent bath, dry and place on a clean surface.
- 13 Ensure the plunger lock is thoroughly rinsed to remove all dirt and grit from the key tumblers.
- 14 Use compressed air to dry the plunger lock cylinder.
- 15 Lubricate the plunger lock barrel and tumbler using two drops of light viscosity oil.
- 16 Inspect all parts for wear.
- 17 Replace worn parts as necessary.
- 18 Apply medium strength thread locker to all screws pictured. The four large tamper proof screws (not pictured) will receive thread lubricant before rear plate installation.
- 19 Install the conical spring, wide end first. Push plunger lock into lock mount until secured by lock pin when correctly oriented. Secure with plunger lock extension screw. Do not over-tighten.
- 20 Check the plunger lock for proper function in the lock mount by using the key to unlock and engage several times. Ensure key inserts and turns easily in the lock cylinder.
- 21 Prepare the selector ring by applying a light coating of GRE002 packet grease to the inner most opposing surfaces of the selector ring only.
- 22 The remaining parts including the lock slide and sleeve are installed dry.
- 23 Place the rear (base) plate horizontally on bench with the two mounting holes for the plunger lock housing aligned at a 12 o'clock position.
- 24 With the narrow end of the lock slide slot located at the 3 o'clock position, install the new small spring and lock slide with **RED** painted slot facing right.
- 25 Insert new springs for the anti-rotation lugs into the rear plate spring pockets.
- 26 Place the anti-rotation lugs over the springs.
- 27 Position the selector ring onto center of the rear plate aligning the "OPERATE" at the 12 o'clock position. At this position, the anti-rotation lugs will be pushed down by the inner ring. Use finger to guide spring loaded lugs into pockets and hold lugs down using selector ring. Maintain pressure on ring until secured with first screw in step 33.
- 28 Push the lock slide inward slightly during placement of the selector ring. This will allow the selector ring to rest flush on the selector body.
- 29 Place the sleeve with the large diameter step facing downward in the center of the rear plate on the lock slide. Lock slide is in neutral position.
- 30 Place the new large spring over the sleeve.
- 31 Install the selector ring retainer with large three holes aligned vertically.
- 32 Allow the sleeve spring to insert into the larger center bore of retainer and press retainer down into selector ring until flush. Holding pressure can now be transferred to the retainer.
- 33 Hold assembly firmly together until one of four retaining screws can be installed. Spring compression must be maintained during assembly to keep lugs properly seated within pockets.

- Check basic operation before installing remaining screws. Selector ring will have slight clearance wiggle when assembled correctly.
- 34** Install the remaining screws and torque screws to 30-in/lb (3.39-Nm) \pm 5-in/lb (0.57-Nm) using a calibrated torque wrench.
 - 35** Insert four (two stacks of two) rubber sleeves back into the plunger lock mount pockets.
 - 36** Position the fully assembled plunger lock mount into place so sleeve will not fall out and install the two lock mount screws.
 - 37** Tighten screws using the TORX style tamper-resistant driver bit.

4.3.10. Front Plate Assembly - Functional Test.

- 1.** Install the front plate assembly back onto the device and secure retaining screws. Rear plate must be installed at this time to test interlock function.
- 2.** Perform the following functional test three times using a guide tube with integrated bayonet fitting. Always position port shutter in closed position during this functional test. Check for smooth operation of adjusting screw:
 - a.** Pull the port cover knob and rotate clockwise 90 degrees to open the outlet port. The knob movement should be smooth and limited to a clockwise 90 degree turn with tungsten port shield visible in opening.
 - b.** Insert a bayonet fitting into the outlet port and rotate the fitting 90 degrees in a counter-clockwise direction. The fitting insertion and rotation should be smooth and limited to a 90 degree turn.
 - c.** Rotate the port cover knob from the 9 o'clock position to the 11 o'clock position. This opens the source path at the outlet port – which would allow a source to travel in and out. The knob should hold its position and not fall back from gravity to the 6 o'clock position.
 - d.** Check the interlock knob function by pulling the knob out and rotating it 1/8 turn counterclockwise. Then release the knob into its seating position. Outlet knob must be fully open to pull out interlock knob. With interlock knob now in the unlocked position, the outlet port is now prevented from moving to the closed position thus preventing removal of the guide tube.
 - e.** Pull and turn to return the interlock knob back to locked position (all the way in) and check to ensure the lock slide cannot be moved to the operate (red showing) position.
 - f.** Return the outlet knob to 9 o'clock position to disengage the bayonet fitting. Close outlet port. If operation does not perform as described, then determine cause and make corrections.
 - g.** Safety interlocks are designed into the device to help prevent unintended accidental overexposures to individuals when the equipment is used improperly. Attempting to bypass or circumvent interlocks is a violation of operating procedures and can result in loss of time, expense, employment, injury or worse. Always operate the equipment in a safe manner using the appropriate safety equipment at all times. Poorly maintained equipment will eventually cause a loss of something.

4.3.11. Rear Plate Assembly - Functional Test.

- 1 Hold the rear plate assembly in one hand and unlock the plunger lock using the key. Rotate selector ring to the connect position. A click or clicks can be heard and will lock the selector ring from further movement.
- 2 Insert the 'U- tool' into the two outer holes in the selector ring retainer to depress the lugs and rotate the selector ring to the OPERATE position.
- 3 Push the lock slide (**GREEN** side) in until the spring-load sleeve snaps into place. The green mark is now hidden to indicate the source can now be exposed. The **RED** mark on the lock slide is now visible on the right side.
- 4 The lock slide is now positioned to align the source path and the large portion of the key hole in the lock slide. Attempt to trip the lock slide using a mock or dummy source wire assembly with a short length of control cable or jumper wire attached. Insert the cable end into the back end of the rear plate assembly.
- 5 Pull the dummy source wire assembly through the plate until the lock slide is tripped. The **GREEN** lock slide mark should be visible with a distinct click. The U-tool hook on one leg can also be used to trip the slide by retracting the sleeve away from the slide through the center hole.
- 6 Repeat steps 3 through 5 several times while observing the action of the mechanism. The action should be quick and smooth.
- 7 If the assembly does not operate smoothly as designed, determine malfunction and make correction.
- 8 When satisfied with the rear plate operation, attach the plate back onto the device.
- 9 Apply thread lubricant to the four mounting screws and torque the screws to 110 in-lbs (12.43 Nm), ± 5 in-lbs (0.57 Nm) in an opposing cross pattern.
- 10 After attaching the rear plate back onto the device, again perform the functional test to ensure the dummy source assembly moves smoothly in and out of the device and will lock securely. A standard dummy source assembly can be used for this test. The shutter will need to be in the open position to install the dummy source assembly and expose the dummy source using the control crank.

4.3.12. Exposure Device - Functional Test.

1. Install the dummy source connector into the rear plate assembly using a jumper wire or control assembly.
2. Connect all cleaned and serviced guide tubes to the device.
3. Connect the cleaned and serviced remote controls to the dummy source connector and device.
4. Pull and turn the interlock knob 1/8 turn counter clockwise and release.
5. Unlock the device and place the selector ring in the "OPERATE" position.
6. Push the lock slide to the EXPOSE (**RED** mark) position.

7. Crank the dummy source connector from the device into the guide tubes a short distance while carefully feeling for resistance and/or snags.
8. Crank the dummy source connector back into the device again checking for resistance until secured in the lock assembly.
9. Check to ensure the lock slide automatically secures the dummy source connector.
10. The lock slide trip movement should be quick and smooth. An audible 'snap' or "click" should be heard when the lock slide is tripped to the secured position.
11. Confirm the source is secure by attempting to crank the dummy source connector from the device with the lock slide **GREEN** mark showing. A secured source will not exit the device.
12. Repeat this testing several times.
13. If resistance or snags are felt and/or the lock slide movement is sluggish, inspect the entire system to determine the cause.
14. Repeat all functional tests if any additional servicing is performed or additional controls or guide tubes are tested.

4.4. Remote Control Maintenance

There are five models of remote controls compatible with the device. **Section 4.4.3** provides the general maintenance instructions for all models. However, the maintenance will differ slightly depending on the model being serviced. Refer to **Sections 4.4.1 and 4.4.2** for the different styles of remote controls.

4.4.1. Standard Remote Controls – Model 664, 692, & 693.



4.4.2. Extreme Condition Remote Controls – Model 882 & 885.



Extreme controls description: The lightweight, extreme controls were designed for operation in -40° Celsius/Fahrenheit to 100° Celsius or 212° Fahrenheit temperatures while providing users with rugged twin line, seam welded housings which are water-resistant, crush-resistant and matched with an ergonomically designed pistol style, lightweight hand crank.

The extreme remote controls are compatible with all QSA Global, Inc. crank-out radiographic exposure devices.



WARNING

Personal safety equipment must be worn to prevent injury while performing equipment maintenance.

Safety glasses must be worn for protection.

Rubber gloves are recommended when handling cleaning solvents, grease, etc.

CAUTION

Remote control maintenance is required to be performed at least quarterly or more frequently when subjected to heavy use or extreme environmental conditions.

Daily inspections and source exposure tracking are good indicators for knowing when to perform more frequent maintenance than every three months.

The control drive cable and connector are the most important components in the remote control system. The cable must be constantly monitored for wear, cleanliness, and lubrication. A well lubricated cable will increase the useful life of the equipment and reduce premature wear.

4.4.3. Remote Controls – General Maintenance.

1. Disconnect the controls from the exposure device to perform maintenance.
2. Remove excess dirt from the controls before moving the controls to a clean work surface.
3. Lay out the control housings in a straight line or large loop onto a clean work surface.
4. Refer to **Section 4.4.4** to perform maintenance on the **control drive cable**.
5. Refer to **Section 4.4.5** to perform maintenance on the **control conduit housings**.
6. Refer to **Section 4.4.6** to perform maintenance on the **661 safety connector**.
7. Refer to **Section 4.4.7 through Section 4.4.12** to perform maintenance on the **standard control crank (Models 664, 692 or 693)**
8. Refer to **Section 4.4.13 through Section 4.4.15** to perform maintenance on the **extreme control crank (Models 882 or 885)**.



WARNING

Wear eye protection when performing maintenance on the remote controls.

Rubber gloves are recommended when handling the grease covered control cable.

4.4.4. Control Cable – General Maintenance.

1. Remove the control cable from the remote control unit:
 - a. Without using excessive force, pull the control cable out from the 661 safety connector end until the cable stops. A “stop” spring installed on the end of the cable prevents the cable from passing through the drive wheel.
 - b. When pulling the cable out, coil the cable into loops approximately 12 inches in diameter and secure the cable loops with twist tie wraps or similar item to maintain control during and after removal.
 - c. Disconnect the control conduit fitting from the "RETRACT" side of the control crank using an 11/16 inch open-end wrench.
 - d. Rotate the crank handle to "RETRACT" one quarter turn to present the end of the control cable for stop spring removal.
 - e. Twist the “stop” spring off the cable.
 - f. Pull the remaining cable out through the 661 safety connector and again secure the looped cable.
2. Thoroughly clean the control cable using a bristle brush in a solvent degreaser bath. Be sure to follow the solvent manufacturer's safety recommendations.
3. After cleaning, use compressed air to thoroughly blow off all residual solvent.
4. The control cable connector is marked with a two digit alpha code lot number and also a two digit numerical date code beginning in 2014. The two digit date code is the last two digits of the year of manufacture.
5. Locate and verify the two digit date code on drive cable connector. The drive cable connector must be replaced if any of the following conditions apply:
 - a. The date code exceeds 5 years of service.
 - b. The connector is damaged or fails the NO-GO gage test.
 - c. The date code cannot be found on the connector.
6. Perform the following inspections on the control cable:
 - a. Test the connectors and their connection with the Model 550 NO-GO gage.

- b. Examine the connector for damage. The ball and shank features must be free of dents. The shank neck must be straight (not bent).

CAUTION

Damage to the cable or connector can lead to failure during use.

Any damage should be reviewed with site safety personnel and/or QSA Global, Inc. prior to continued use.

- c. Closely examine the cable at the connector. The cable fibers must not be separated, rusted, or broken. Use magnification if needed.
 - d. The connector must not be bent by more than 15 degrees relative to the axis of the control cable.
 - e. Inspect the connector attachment to the cable by attempting to twist or rotate the connector off the cable by hand. There must not be any movement between the connector and cable.
 - f. Carefully examine approximately 12 inches (300 mm) of cable from the connector end of the cable. The cable must not show signs of rust, corrosion or flat spots on the outer helical windings.
 - g. Inspect the remainder of the cable. It should be free of permanent kinks or bends, cuts, breaks, nicks, or fraying within the helical windings of the cable. The outer helical winding spacing should be uniform with no compressed or elongated areas.
 - h. Perform a cable flexibility test by holding the connector in one hand with the finger and thumb while allowing remaining cable to hang down. Grip the cable with other hand at about 12 inches down the cable. Bend the cable by pulling the connector down to meet other hand end and release the connector. The connector end of the cable should spring back freely to its vertical original position.
 - i. If the cable fails any of the inspection steps above, apply a red rejection tag on the cable, note the failures on the tag, and remove the cable from service. Make repairs before bringing the cable back into service or replace the cable.
- 7. Lightly lubricate the control cable with only QSA approved grease.
 - 8. **Apply additional grease** to the first 3-feet (1-meter) of cable from the connector end.

4.4.5. Control Conduit – General Maintenance.

- 1. Disconnect the control conduit from the 661 safety connector and control crank by using the 11/16 inch open-end wrench.
- 2. Clean the exterior of the conduit using clean rags and a detergent.

3. Remove all dirt and grease from the conduit and swaged fittings.
4. Carefully inspect the entire length of conduit for dents, cracks, and melted areas especially near the swage fittings.
5. Repairs to cut or melted areas can be done by taping the area with 3M™ (or equivalent) yellow polyvinyl tape (or black polyvinyl electrical tape). The tape will help keep water and other liquids from entering the conduit.
6. Replace any conduit with large dents or open cracks. Contact the service center for possible repair options.
7. Clean the inside of each conduit by flushing clean solvent through the hose from one end until the solvent appears clear.
8. Use compressed air to thoroughly dry the inside.
9. Check the swage connection of each fitting by attempting to twist or rotate the fitting by hand.
10. Damaged or loose fittings must be replaced at a QSA authorized service center.



WARNING

The Model 661 Safety Connector is designed to prevent a source assembly misconnection unless it is damaged or worn.

Before each use, check the condition of the Model 661 Safety Connector to ensure it is not damaged or worn.

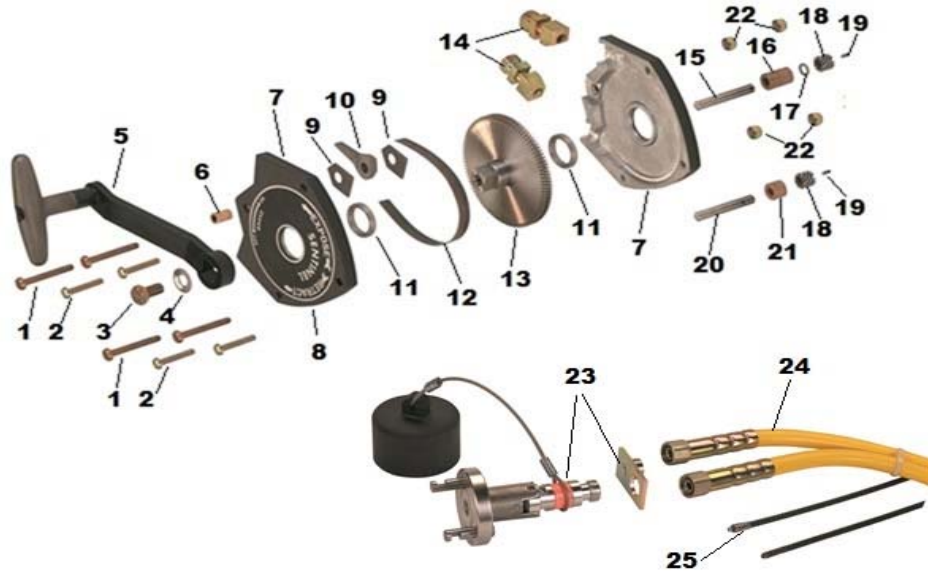
A damaged or worn Safety Connector could cause a source misconnect resulting in the loss of source control.

4.4.6. Model 661 Safety Connector – General Maintenance

1. Remove the 661 safety connector from the control conduit and clean the safety connector with clean solvent and a bristle brush.
2. Remove the solvent by wiping and/or blow drying the connector and examine the safety connector – looking for damaged and/or worn parts.
3. Replace any worn part including the jaws, collar, and pivot roll pins.
4. Use a 1/8 inch drift punch to apply light hand pressure to the end of each pivot roll pin attempting to push the pins out of the connector body. Replace the pivot pins if they are loose, rusted, or damaged.
5. Examine the connector collar (ring with notched pins) and replace the collar if the notched pins are bent, loose, or not fully seated against the ring.

- Examine the control cable exit hole on the safety connector body and replace the safety connector body if the exit hole is worn. The edge of the exit hole must not be worn.

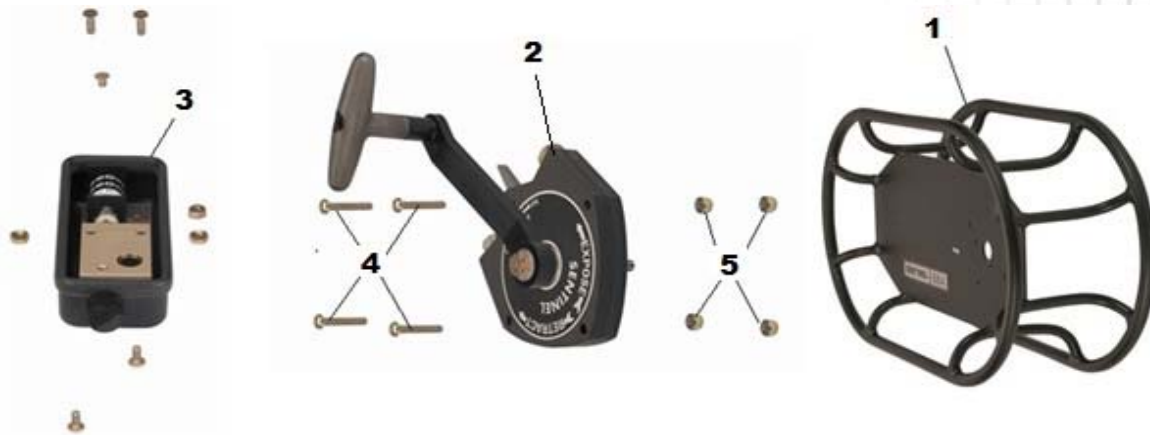
4.4.7. Standard Control Crank – Model 664, 692, & 693.



ITEM	PART NO.	QTY	DESCRIPTION
1	SCR125	4	1-5/8 BINDING HEAD SCREW ●
2	SCR008	4	1-1/4 BINDING HEAD SCREW ○
3	BLT008	1	HEX HEAD SCREW
4	WSH019	1	WASHER
5	68901	1	CRANK ARM
6	BBS-004	1	BRAKE BUSHING
7	81800-10	2	CONTROL CRANK HOUSING
8	68900-8	1	CRANK DECAL
9	68900-4	2	BRAKE JAW
10	68900-3	1	BRAKE ARM
11	BBS-001	2	BALL BEARING ASSEMBLY
12	68900-7	1	WEAR STRIP
13	81800-1	1	DRIVE WHEEL
14	68900-2	2	CABLE ADAPTER
15	69302-1	1	GEAR SHAFT

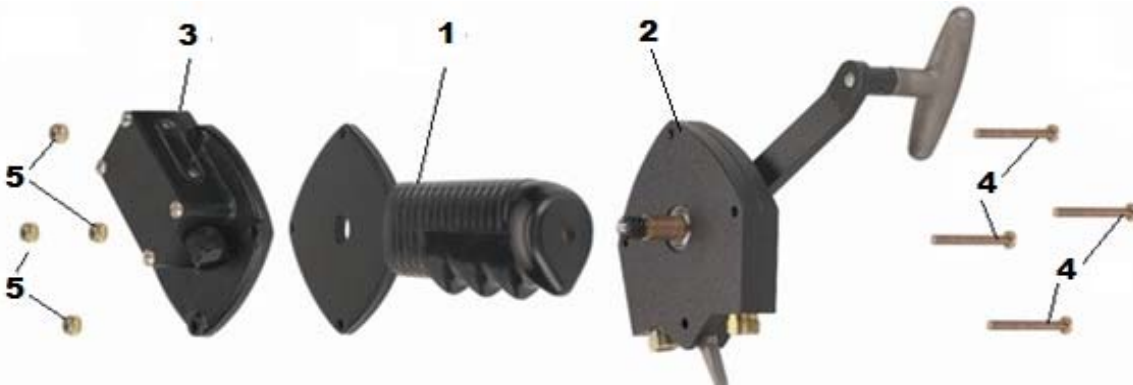
ITEM	PART NO.	QTY	DESCRIPTION
16	BBS-007	1	OILITE BEARING
17	PIC-003	1	WASHER
18	GEA-002	1	HELICAL GEAR
19	PIN008	1	ROLL PIN
20	66404-1	1	GEAR SHAFT ○
21	BBS-005	1	OILITE BEARING ○
22	NUT025	4	STOP NUT
23	66103	1	661 SAFETY CONNECTOR
24	59125	2	25ft (7.6m) CONDUIT
	59135	2	35ft (10.7m) CONDUIT
	59150	2	50ft (15.2m) CONDUIT
25	55005	1	50ft (15.2m) CONTROL CABLE
	55010	1	70ft (21.3m) CONTROL CABLE
	55009	1	100ft (30.5m) CONTROL CABLE
		●PISTOL TYPE	○ REEL TYPE

4.4.8. Standard Control Reel with Odometer – Model 664.



ITEM	PART NO.	QTY	DESCRIPTION
1	66410	1	FRAME
2		1	CONTROL CRANK
3	66403	1	ODOMETER ASSEMBLY
4	SCR008	4	1-1/4 BINDING HEAD SCREW
5	NUT025	4	STOP NUT

4.4.9. Standard Control Pistol with Odometer – Model 693.



ITEM	PART NO.	QTY	DESCRIPTION
1	69201-3	1	HANDLE
2		1	CONTROL CRANK
3	69303	1	ODOMETER ASSEMBLY
4	SCR125	4	1-5/8 BINDING HEAD SCREW
5	NUT025	4	STOP NUT

4.4.10. Standard Control Crank – General Maintenance.

1. Disassemble the control crank for maintenance.
 - a. Unscrew and remove the center 5/16 inch hex head screw and washer.
 - b. Remove crank arm.

**WARNING**

Wear eye protection when servicing controls. The wear strip may fly out when removing the crank housing cover.

- c. Unscrew the four binding head screws from the stop nuts.
 - d. Remove the crank housing cover.
 - e. Keep the two cable adapters in the bottom crank housing after removing the cover.
 - f. Remove the drive wheel, the wear strip, the two cable adapters, the two brake jaws, the brake arm, and the brake bushing.
 - g. Reinstall the drive gear bearing spacers where present.
 - h. If the control crank is fitted with an odometer, then perform this step, otherwise skip to the next step:
 - i. Remove the reset knob by loosening the two Allen set screws.
 - ii. Remove the odometer cover by removing the two binding head screws that fasten it to the mounting plate.
 - iii. Do not disassemble the odometer.
2. Clean the control crank all parts using clean solvent and a bristle brush.
 3. Wipe and/or blow dry all cleaned parts.
 4. Remove any light rust from the wear strip using fine sandpaper and machine oil.
 5. Inspect all parts for damage and wear.
 6. Replace any damaged or worn part.
 7. Replace the drive wheel if any teeth are found broken or bent.
 8. Lightly grease the drive wheel hub, the wheel bearings and the wear strip.
 9. If fitted with an odometer, check the operation:
 - a. Turning the gear should turn the odometer but the odometer shaft should still be able to turn when the gear is held fixed (for zeroing the odometer).
 10. Reassemble the control crank after cleaning and inspection:

- a. Place one of the cable adapters in the lower control crank housing.
 - b. Place one end of the wear strip against the cable adapter then fit the rest in the track of the housing.
 - c. Fit the other cable adapter in place to retain the wear strip.
 - d. Place the drive wheel in the bottom housing making sure any spacer rings where present are between the gear and the wheel bearings if applicable.
 - e. Install the two brake jaws, brake bushing and brake arm. The angled sides of the brake jaws should be facing the retract side of the control crank housing.
 - f. Place the upper control crank housing over the assembly while keeping them level and press them together.
 - g. If the control crank is fitted with an odometer, then reassemble as needed according to **Section 4.4.11**.
11. Check that the control crank mechanism is properly assembled by turning the shaft. It should spin freely.
 12. Check the operation of the friction brake while holding both halves of the control crank housing together tightly. If it does not function correctly, check for faulty assembly or excessively worn brake jaws.
 13. As applicable, mount the control crank housing on the frame or handle with the four binding head screws and stop nuts.
 14. Secure the crank arm to the shaft center with the 5/16 inch hex head screw and washer.

4.4.11. Standard Control Crank with Odometer – Reassembly.

1. For reel type controls, secure the odometer cover to the mounting plate with two binding head screws.
2. Secure the odometer's reset knob to the shaft by tightening the two Allen head screws, leaving clearance between the knob and the cover.
3. After assembly, perform a check to ensure the control crank will turn freely.
4. Set the brake lever to the ON position and attempt to turn the handle using moderate pressure. Do not apply excessive force.
5. Run a section of the control cable through the control crank to ensure the control crank operates easily without snags or resistance.
6. If applicable, make sure the odometer turns when the crank handle is turned. If the odometer does not function during this test, check for improper assembly or damaged parts.

4.4.12. Standard Control Unit - Reassembly.

1. Attach the serviced 661 safety connector and stop plug to the serviced control conduit.
2. Use only light force to hand-tighten the control conduit fittings.
3. Attach one control housing conduit to the “EXPOSE” side of the serviced control crank. Leave the “Retract” housing off for now.
4. Lay out the remote controls in a straight line or a large loop.

CAUTION

Maintain control of the greased cable to prevent sand or grit contaminates from sticking to the clean grease.

5. Place clean paper or plastic under the 661 plug connector when installing freshly greased control cable.
6. Feed the cleaned and greased control cable into the 661 connector and control conduit until it reaches the crank gear.
7. As the control cable is being fed into the control conduit, feel for any resistance that might indicate damage or obstruction.
8. Engage the cable into the gear and turn the crank handle in the retract direction about one turn until about an inch or two of cable protrudes from the pistol fitting.
9. Screw the safety stop spring onto the end of the control cable.
10. Connect the retract control conduit to the pistol grip and tighten by turning the crank handle slightly to pull the cable in. Also test to confirm the cable stop spring cannot get past the gear by attempting to expose the cable.
11. Tighten the housing fitting nuts. DO NOT overtighten.
12. Install the remaining drive cable by retracting the cable while again feeling for any binding that may indicate damage or blockage in the control conduit.
13. If applicable, reset the odometer to zero with the control cable fully retracted.
14. Replace the protective rubber cap over the end of the 661 safety connector assembly.
15. Record all inspections conducted, all maintenance performed and components that were replaced on the remote controls.

4.4.13. Extreme Control Crank – Models 882 & 885.



ITEM	PART NO.	QTY	DESCRIPTION
1	95008	1	CRANK ARM ASSEMBLY
2	SCR219-03	1	HEX HEAD SCREW
3	WSH045	1	FLAT WASHER
4	95006-01	1	SAN882 LABEL
5	RIN024	1	SEAL
6	95002-6	1	DRIVE GEAR COVER
7	RIN026	1	O-RING
8	BBS032	2	BEARING
9	95005	1	DRIVE GEAR WELDMENT
10	95003	1	GRIP HANDLE

ITEM	PART NO.	QTY	DESCRIPTION
11	95003-6	6	TUBULAR SPACER
12	WSH047	6	FLAT WASHER
13	SCR252	6	SOCKET HEAD SCEW
14	66103	1	661 SAFETY CONNECTOR
15	95039	1	PLUG
16	95037-2	1	CLAMP, BOTTOM HALF
17	95037-1	1	CLAMP, TOP HALF
18	95050-XX	1	DRIVE CABLE XX-LONG
19	95038	1	STRAIN RELIEF SPRING
20	95035-XX	1	CONTROL CONDUIT

4.4.14. Extreme Control Crank – General Maintenance.

1. Inspect crank handle brake assembly function.
 - a. Engage the plunger pin into the cover holes and ensure the detent holds the pin down securely.
 - b. Check the spring tension to ensure it adequately holds pin clear of cover when not engaged.
2. Disassemble the control crank for maintenance:
 - a. Remove the center 5/16 inch hex head screw, washer and crank arm.
 - b. Remove the six small socket head screws and washers using a 1/8 inch Allen wrench.
 - c. Remove the crank housing cover from the plastic housing.
 - d. Remove the O-ring and seal from the cover.
 - e. Remove the drive gear and bearings from the plastic housing.
3. Thoroughly clean the drive gear using a bristle brush in a solvent degreaser bath. Be sure to follow the solvent manufacturer's safety recommendations.
4. After cleaning, use compressed air to thoroughly blow off all residual solvent.
5. Clean and wipe down the plastic grip handle, the cover, O-ring, seals, and bearings.
6. Inspect the control crank:
 - a. Replace the "Expose" & "Retract" direction label if damaged or illegible. Ensure the "Expose" marking is pointed toward the yellow housing fitting side of the molded grip handle.
 - b. Check the plastic grip handle for cracks and damage. Ensure the metal tubular spacers and washers are all present. The tubular spacers are needed to prevent the plastic grip handle from distorting when tightening the six socket-head screws.
 - c. Check the ball bearings for smooth and free movement by holding the inner hub stationary and rotating the outer hub. These are sealed ball bearings and do not require additional lubrication.
 - d. Check the two drive gear cover seals, 15mm seal and the large O-ring seal for cracks, cuts or abrasion. If the rubber seals are in good condition, apply a light coating of grease to the seals.
 - e. Check the drive gear for broken or bent teeth.
 - f. Check the crank arm for damage and wear.
7. Reassemble the control crank:
 - a. Lightly grease the wear strip before reassembling.

- b. Install one ball bearing into the steel insert of the plastic grip handle.
 - c. Insert and center the drive gear in the ball bearing.
 - d. Install the second ball bearing onto drive gear shaft.
 - e. Install the lubricated large diameter O-ring seal into the groove in the cover.
 - f. Install the small seal into the center hole of the cover.
 - g. Install the cover over the gear shaft and seat into the plastic grip handle.
 - h. Position the cover with the serial number at the 6 o'clock position relative to the plastic grip handle which is at the 7 o'clock position.
 - i. Apply Loctite 242 onto the first four threads of six socket head screws.
 - j. Ensure the tubular spacers are all present in the plastic grip handle
 - k. Install the six socket head screws with flat washers into the tubular spacers from the back of the molded grip handle body and lightly hand tighten using a 1/8 inch Allen wrench.
 - l. Install the crank arm onto the drive gear shaft with screw after the drive cable has been installed at approximately the 4 to 7 o'clock position relative to the 7 o'clock position of the hand grip.
 - m. Apply Loctite 242 at final assembly to the first four threads of the 5/16 inch hex head screw with washer and tighten by hand using a 1/2 inch socket wrench.
8. The drive wheel should turn freely.
 9. Insert and feed a short section of the control cable through the control crank to ensure smooth operation without any resistance.
 10. For reel type control handles, apply Loctite 242 to the first four threads of the two flat head socket mounting screws used for attachment to the reel.
 11. Use replacement label, 95006-04, if needed for reel style control assemblies.
 12. Mount the control crank housing on the reel type frame and install the flat head socket screws with the two thrust plate washers.

4.4.15. Extreme Control Unit - Reassembly.

NOTE: Always install the yellow side of the duplex control housings to the "EXPOSE" side and connect to the fitting matching the direction label.

1. The duplex strain relief spring and clamp can be relocated to the opposite end of the control conduit to promote even wear. Slide the spring along the housing to the opposite end and reinstall.

2. Apply heavy-duty shrink wrap or PVC tape under the spring if not present to prevent the spring from chafing the control conduit.
3. Attach the 661 safety connector onto the yellow side of the control conduit and stop plug onto the black side.
4. Use only light force to hand-tighten the control conduit fittings.

CAUTION

Over-tightening the control housing fittings can strip the fitting nuts or crack the molded grip handle.

5. Lay the control conduit out in a straight line or in a wide loop for cable installation.
6. Place clean paper or plastic under the 661 plug connector when installing freshly greased control cable.
7. Feed the greased control cable into the 661 connector and control conduit until it reaches the crank gear.
8. As the control cable is being fed into the control conduit, feel for any resistance that might indicate damage or an obstruction.
9. Engage the cable into the gear and turn the crank handle in the retract direction about one turn until about an inch or two of cable protrudes from the control crank fitting.
10. Screw the safety stop spring onto the end of the control cable. Also test to confirm the cable stop spring cannot get past the gear by attempting to expose the cable.
11. Connect the RETRACT control conduit (black side of the joined housings) to the control crank housing.
12. Install the remaining drive cable by retracting the cable while again feeling for any binding that may indicate damage or blockage in the control conduit.
13. Perform a freedom of movement test as described in part two of this section.
14. Perform a “misconnect test” of the serviced remote controls according to **Section 4.3.2**.
15. Always replace the protective rubber cover over the end of the 661 safety connector assembly.
16. Record date of maintenance and technician performing repairs. Identify any replaced components and lot numbers if applicable on the maintenance record.
17. Identify the remote controls with the serial number that is etched on the stainless steel drive gear cover. See “Inspection & Maintenance Records” **Section 4.1**.

4.5. Source Guide Tube Maintenance

Use the instructions below to perform maintenance on the source guide tubes.

4.5.1. Standard Source Guide Tubes – Model 489.



4.5.2. Extreme Source Guide Tubes – Model 950.



4.5.3. Source Guide Tubes - General Maintenance.

1. Inspect the guide tube for obvious damage beyond repair.
2. Discard any guide tube considered to be unserviceable or heavily worn.
3. Clean the outside surfaces of the source guide tube hose and fittings a clean cloth and cleaning solution.
4. Clean the inside of each guide tube by flushing cleaning solvent through the tube.
5. Shake the guide tube back and forth to help the solvent to wash the inside of the guide tube.
6. Pour the solvent from the guide tube into a used solvent container.

- 7.** Refill the guide tube with clean solvent and repeat the cleaning operation.
- 8.** Repeat the cleaning process until the guide tube is clean.
- 9.** Use compressed-air to remove residual solvent from the guide tube.
- 10.** Carefully inspect the entire length of each guide tube for depression, dents, cuts and melted areas.
- 11.** Repairs to minor cut or melted areas can be accomplished by taping the area with 3M™ (or equivalent) yellow polyvinyl tape (or black polyvinyl electrical tape). Taping the damaged area of the polyvinyl sheath will prevent the ingress of water and other liquids that would cause corrosion to the remote control cable.
- 12.** Even a small inward dent in the guide tube could jam the source assembly resulting in emergency operations. A dummy source connector attached to a section of control cable that is pushed through the entire length of guide tube provides additional confirmation the guide tube is suitable for use.
- 13.** Inspect the swage fittings of each guide tube for damage.
- 14.** Check the bayonet fitting to ensure it rotates freely.
- 15.** Twist the swaged fittings by hand to check the connection strength to the guide tube.
- 16.** Damaged guide tube fittings or exposure heads can be replaced at a QSA Global service center.
- 17.** Remove any guide tube from service that fails the visual or operational inspections.
- 18.** Be sure to attach a red tag onto any guide tube removed from service.

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SECTION 5: SAMPLE TRANSPORT INSTRUCTIONS

The following instructions are samples for the transport of this radiographic exposure device/transport container and source assembly within the United States and are based on current transport regulations. Shippers of radioactive materials in regulatory jurisdictions outside the USA must ensure full compliance with all current and applicable transport regulations. Listed are the regulations that should be referenced for the legal transport of radioactive materials:

- International Atomic Energy Agency requirements No. TS-R-1 (2009), 'Regulations for the Safe Transport of Radioactive Materials' and the IAEA 'Code of Conduct on the Safety and Security of Radioactive Sources' - IAEACODEOC/2004.
- International Air Transport Association, 'Dangerous Goods Regulations'.
- International Civil Aviation Organization, 'Technical Instructions for the Safe Transport of Dangerous Goods by Air'.
- International Maritime Organization, 'International Maritime Dangerous Goods Code'.
- U.S. Department of Transportation, Title 49 Code of Federal Regulations Parts 171 through 178.
- U.S. Nuclear Regulatory Commission, Title 10, Code of Federal Regulations, Parts 20, 34 & 71.
- Canadian Nuclear Safety Commission, Nuclear Safety and Control Act, 'Packaging and Transport of Nuclear Substances Regulations'; 'Nuclear Substances and Radiation Devices Regulations'.
- Transport Canada, 'Transport of Dangerous Goods Regulations'.
- Transport in the United Kingdom: Refer to the regulations as listed on the ADR approval Certificate.

5.1 Transport Package

The **1075 SCARPro** when shipped inside the Model 1075A package is approved as a Type A transport package.

Note that the Model 1075 device must be transported only when assembled with the exposure device front plate assembly attached. If the collimator assembly is installed on the Model 1075, it must be replaced with the front plate assembly in accordance with the instructions in Section 2.1 prior to shipment in the Model 1075A package.

As a shipper of radioactive material, you must perform a pre-shipment inspection to verify conformance to the Type A approval for each individual shipment of radioactive material. This verification assures the package's integrity is not compromised, which may cause a reduction of safety while in the transport system.

Visually inspect the transport package:

- Assure the source assembly is properly secured in the locked position. The selector ring must be in the LOCK position, the protective cover in place, the plunger lock engaged and the key removed.
- Assure all screws are present and secured.
- Assure the front port is properly secured.
- Assure the seal wire is properly installed, if used.

- Assure the 'Danger, Radioactive Material' label is securely attached and visible on the package. Assure that the label is legible and not defaced.
- Assure the other information on the label is legible (the warnings and trefoil, the model number and serial number and the Type A specification identification).
- Assure all the conditions of the Type A approval are met and the transport package is assembled as required by the Type A approval.
- Wipe test the transport package over an area of 300 cm² and assure the level of removable contamination is less than 0.0001 µCi per cm².

If the package fails any of the inspections described, remove the container from use until it can be brought into compliance with the Type-A approval as appropriate.

5.1.1. Model 1075A Transport Package for Shipment of the Model SCARPro.



5.2 Receipt of Radioactive Material

NOTE

1. A radioactive material package must be accepted from the carrier at the time it is delivered. [10CFR20.1906(a)(1)]
2. If a radioactive material package is to be held at the carrier's terminal for pickup, arrangements must be made to receive notification from the carrier of the arrival of the package at the time of arrival. The package must be picked up expeditiously upon receipt of notification (within three hours if practicable). [10CFR20.1906(c)]
3. Monitoring as described below must be performed as soon as practicable but at least within three hours if received during normal working hours or within three hours of the next work day if received after normal working hours. [10CFR20.1906]
 - Upon receipt of a package of radioactive material, the package shall be placed in a restricted area. Assure appropriate personnel are notified.
 - Survey the entire exterior surface of the package at the time of receipt and assure that the maximum radiation level does not exceed 2mSv/hr (200mRem/hr). Survey all sides of the device at 1m from the exterior surfaces of the packages and assure that the maximum radiation level does not exceed 0.1mSv/hr (10mRem/hr). If either of these limits are exceeded, notify the Radiation Safety Officer immediately. Record the maximum radiation levels measured at the package surface and at 1m from the package surface on the Receiving Report. [10CFR20.1906(d), 10CFR71.47]
4. **Note: If any of these limits are exceeded, the Radiation Safety Officer must immediately notify the USNRC (or applicable governing agency) and the final delivering carrier.**
5. Inspect the package for any evidence of physical damage. Record the results of this inspection on the Receiving Report. Also record on the Receiving Report the date, source model number, source serial number, radionuclide, activity, the individuals name making the record, transport package model number, mass or activity of the depleted uranium and the package serial number. [10CFR34.63]
6. Assure that the package is locked or place the package into an outer locked container and secure the package in accordance with your license requirements. [10CFR34.35, 10CFR34.23]
7. Keep a copy of the Type A approval and the Model 1075 Operating Manual on file to assure you have the proper opening and handling instructions. Assure that the instructions are followed and any noted special precautions are performed. [10CFR20.1906(e)]
8. **Note: For licensees transporting special form sources in licensee owned or operated vehicles to and from a work site are exempt from the contamination monitoring requirements. The radiation survey required upon receipt must still be performed. [10CFR20.1906(f)]**
9. If you are receiving a nationally tracked source (Category 1 or 2 quantities) from another licensee, complete the report: USNRC form 748 and submit the report by the close of the next

business day after the transaction. [10 CFR 20.2207 and appendix E]. Verify current national regulatory and security requirements to ensure compliance.

5.3 Shipment of Radioactive Material

1. Pre-shipment training requirements:

Prior to shipping hazardous materials, personnel must be trained in accordance with 49CFR172, Subpart H and be retrained every three years. Training shall include:

- General awareness/familiarization training.
- Function specific training.
- Safety training, providing:
 - Emergency response information.
 - Measures to protect employees from potential hazards associated with hazardous material to which employees may be exposed in the workplace, both radioactive and chemical hazards.
 - Employer safety measures implemented to protect employees.
 - Methods and procedures for accident avoidance, i.e. proper procedures for handling hazardous material packages.
 - OSHA or EPA training, MSDS information.
 - Transportation security training for organizations that are required to have a security plan. Haz-Mat employees must be trained in the security plan and its implementation, including awareness of security risks and how to recognize and respond to security threats. [49CFR172.800, 10CFR30, IAEA CODEOC/2004]
 - If shipments involve use of a Declaration of Dangerous Good form, all personnel involved with the shipment must be trained in IATA/ICAO/IAEA requirements every two years.

An appropriate test must be administered and the following documentation must be kept:

- Employee name.
- Date of most recent training.
- Description, copy or location of the training methods.
- Name of person performing training.
- Certification that person has been trained and tested.




Documentation should be kept in one file, i.e. all radiation safety related training used as part of the Hazmat training should be included.

2. Prior to shipment maintain copies on file of the most current Type A and Special Form certifications and assure the package and its contents meet the following requirements:
 - The radioactive contents and form are authorized for use in the package.
 - The package is in good physical condition for transport.
 - All locks and outlet port fittings are properly installed and seal wired where required.
 - All conditions of the Type A approval are met [10CFR71.87]. Maintain copies of the current Type A and special form certifications on file. Current copies must also include the applicable drawings.
4. Assure that the source is secured in the proper shielded position in the shipping package as described in **Section 2** of this operations manual. Perform a pre-shipment inspection as described in **Section 5.1** under the “Transport Package” requirements and verify the package is assembled as described in the Type A approval.
5. Attach a padlock to the package closure that serves as a tamper indicator. [49CFR173.412(a)]
6. If the shipping package is to be packaged inside a crate or other outer packaging, the outer packaging must be strong enough to withstand the normal conditions of transport and must not reduce the safety of the package. The shipping package must be placed within the outer package with sufficient blocking to prevent shifting during transportation. [49CFR173.25]
7. Survey the entire exterior surfaces of the package and assure that the maximum radiation level does not exceed 2mSv/hr (200mRem/hr). Survey 1m from all sides of the exterior surfaces of the package and assure that the maximum radiation level does not exceed 0.1mSv/hr (10mRem/hr). Determine the proper shipping labels to be applied to the package using the criteria of Table 1. [49CFR172.403]

Note:

If shipping the container inside an overpack or convenience box in the back of a vehicle, survey and label both the exposure device and the overpack. Placarding the vehicle is dependent on the category of label applied to the overpack if used. [49CFR173.448]

Table 1

	Maximum Radiation Level at Surface	Maximum Radiation Level at 1 Meter
Radioactive White I 	0.5 mRem/hr (0.005 mSv/hr)	None
Radioactive Yellow II 	50 mRem/hr (0.5 mSv/hr)	1.0 mRem/hr (0.01 mSv/hr)
Radioactive Yellow III 	200 mRem/hr (2 mSv/hr)	10 mRem/hr (0.1 mSv/hr)

For a package, both the transport index (TI) and the surface radiation level conditions shall be taken into account in determining which is the appropriate category of radioactive material label. Where the TI satisfies the condition for one category but the surface radiation level satisfies the condition for a different category, the package shall be assigned to the higher category of the two. For this purpose, category White-I shall be regarded as the lowest category.

The TI is the maximum radiation level measured in mRem/hr at a distance of 1m from the external surfaces of the package. When recording the TI, the dose rate units of mRem/hr are not listed, for example a reading of 20 μ Sv/hr (2 mrem/hr) would indicate a TI = 2.0. (Note that the TI is rounded to the nearest tenth value.)

8. Properly complete two shipping labels indicating the contents (e.g. Se-75), the activity of the source (in Becquerels or multiples of Becquerels, e.g. GigaBecquerels (GBq)) and the transport index. The transport index is used only on Yellow II and Yellow III labels and is defined as the maximum radiation level in mRem/hr at 1m from the package surface (see Table 1). [49CFR172.403(g)]
9. Assure that any old shipping labels have been removed from the package. Apply two properly completed labels to two opposite sides of the package (excluding the bottom surface). [49CFR172.403(f)]

10. For air shipments within the USA, the package must be labeled with ‘Cargo aircraft only’ labels. Ensure that these labels do not cover any other package markings or labels.
11. Mark the outside of the package with the proper shipping name and identification number (e.g., ‘Radioactive Material, Type A Package, Special Form, UN3332’ for a Type A shipment) if not already marked. Place the letters RQ (stands for Reportable Quantity) next to the proper shipping name when shipping more than 10 Ci (370GBq) of Se-75. [49CFR172.300] If the shipping package is inside a crate or other outer packaging, mark the outside package with ‘RQ’ (if applicable), the ‘UN Identification Number’, followed by the ‘proper shipping name’. The word ‘OVERPACK’ must be marked on the outside package. The required markings must be in letters a minimum of ½ inch (13 mm) high. [49CFR172.310; 49CFR173.471; 49CFR173.25]
12. Assure that the levels of removable radioactive contamination on the outside surface of the outer package do not exceed 0.37Bq (10^{-5} μCi) per cm². [49CFR173.443]
13. Properly complete the shipping papers indicating:
 - United Nations identification number, Proper shipping name, Class Number ‘7’, and (e.g. ‘Radioactive Material, Type A Package, Special Form, UN3332’).
 - The letters RQ must appear before or after the proper shipping name when shipping more than 10 Ci (370 GBq) of Se-75.
 - Name of the radionuclide (e.g., Selenium-75).
 - Physical and chemical form (i.e. Special Form).
 - Activity of the source in Becquerels or other appropriate multiples of Becquerels on the DOT label and the shipping papers. Note: number of Curies x 37 = number of GigaBecquerels (GBq).
 - Category of label applied (i.e. Radioactive Yellow II).
 - Transport Index.
 - DOT Type A Specification 7A.
 - Shipper’s certification: ‘This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transport according to the applicable regulations of the Department of Transportation.’ [49 CFR 172.204(a)].
 - **NOTE:** For shipments in company vehicles to and from job sites within the USA, the shipper’s certification is not required.
 - The shipping papers must indicate your company's emergency telephone number. The telephone number must have 24-hour coverage in case of an emergency concerning your shipment. The telephone number must be clearly visible on the shipping paper

and must be answered by a person that can provide immediate emergency response information. Beepers and pagers are not acceptable.

14. For air shipments, the shipping papers must meet the requirements specified in IATA for a Shipper's Declaration for Dangerous Goods. In addition to the information listed in **Step 13** of this part, the following information needs to be specified:
- Air waybill number: Enter the number of the air waybill to which the declaration form will be attached. (This may be amended by the carrier.)
 - Aircraft limitations: Specify that the shipment is within the limitations for 'Cargo aircraft only.'
 - A notation can be added in the handling information box of the Shipper's Declaration which states 'This shipment may be carried on passenger aircraft outside U.S. jurisdiction'.
 - Airport of departure: Enter the full name of the airport of city of departure, which may be amended by the carrier.
 - Airport of destination: Enter the full name of the airport or city of destination, which may be amended by the carrier.
 - Shipment type: Specify the shipment type as 'Radioactive'.
 - Under quantity and type of dangerous goods, specify the number of packages (of same type and content), their type of package and activity in Becquerels or multiples thereof (units used must be clearly indicated) in each package, including packages in overpacks.
 - (If relevant) Indication of use of overpack and dimensions of the overpack (including dimensional units). When an overpack is used, the wording '**Overpack used**' must be inserted on the declaration form immediately after all the relevant entries relating to the packages within the overpack. In such cases, packages within overpacks must be listed first. Dimension units must be in sub-multiples of meters.
 - The 24-hour emergency number required by **Step 13** of this part, must appear in the 'Additional Handling Information' section of the Declaration for Dangerous Goods.
 - For air shipments within the USA, the following statement must be included:
"This shipment is within the limitations prescribed for cargo aircraft only."
 - For shipment of special form radioactive material, the Special Form Certificate of Competent Authority for the radioactive source must be included. (e.g. USA/0335/S).
 - The shipper's certification must be as follows:

'I hereby certify that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport

according to applicable International and National governmental regulations. I declare that all of the applicable air transport requirements have been met.'

The information on the Declaration for Dangerous Goods must be entered strictly in accordance with the order specified in the latest edition of the International Air Transport Association, Dangerous Goods Regulations. Questions regarding completion of a Shipper's Declaration for Dangerous Goods should be directed to the Radiation Safety Officer.

If you are shipping a nationally tracked source (Category 1 or 2 quantities) to another licensed recipient, complete the report: USNRC form 748 and submit the report by the close of the next business day after the transaction. [10 CFR 20.2207 and appendix E, IAEA CODEOC/2004]. Verify current national regulatory and security requirements to ensure compliance.

5.4 Carriage of Radioactive Material

1. Assure that the vehicle used is in good condition and carries the normal complement of safety equipment including Radiation Area signs, a length of rope, spare tire, fire extinguisher, a set of vehicle tools and a set of flares. Assure that the glove compartment contains the vehicle registration certification and an operating flashlight. Additionally, assure that the operator has a calibrated and operable survey meter and assure that all individuals traveling in the vehicle are wearing both a film badge and a direct reading pocket dosimeter.
2. Assure that the transport package is properly packaged, marked and labeled and assure that the proper shipping papers are completed in accordance with the instructions for shipping radioactive material. The shipping papers must be accessible from the driver's seat.
3. Place the transport package in the vehicle. Properly brace and secure the package against movement in the vehicle. [49CFR177.842(d)]
4. Survey the driver's compartment to assure that the radiation level does not exceed 0.02mSv/hr (2mRem/hr). [49CFR177.842(g)] Note: This requirement is mandatory only for exclusive use shipments by a common carrier. [49CFR173.441(b)(4)]
5. If the vehicle is transporting a package bearing a Radioactive Yellow III label, the vehicle must be placarded on all four sides with a Radioactive placard.

Note: Operation of a vehicle which is required to be placarded requires compliance with the Federal Motor Carrier Safety Regulations of 49CFR Parts 390-397 and the Driver Training requirements of 49CFR177.827; 49CFR177.804.

6. Complete the Radioactive Material Transport Checklist (see attached example). Forward a completed copy to the Radiation Safety Officer upon completion of the carriage.

7. If the vehicle becomes disabled on the road, do not leave the vehicle unguarded when going for help. A message for help may be sent by a passing motorist or the police may be enlisted to guard the vehicle.
8. Should any kind of accident occur, make an immediate radiation survey to determine if any radiation levels are unusually high. If unusual radiation levels exist, establish the boundary of the restricted area. Keep all persons out of this area and get police assistance, if possible. Notify the Radiation Safety Officer as soon as possible, but do not leave the scene without assuring that the police or some other responsible party will keep people out of the area.
9. Collect information pertinent to the accident, such as names of witnesses, names of people involved, and names of police, license numbers and circumstances of the accident. Call the Radiation Safety Officer promptly and give him as much information as possible.
10. If a source should escape from the packaging, the vehicle operator should make no attempt to restore the source by himself. He should wait for assistance from the Radiation Safety Officer.
11. If the vehicle is going to be used for storage of radioactive material at a temporary job site:
 - a. The vehicle's storage access entrance must be posted with 'Caution Radioactive Material' signs.
 - b. The vehicle must be secured/locked so that there is no unauthorized access.
 - c. Radiation levels must be below 20 μ Sv/hr (2mR/hr) outside the vehicle to meet unrestricted area requirements.
 - d. Vehicle must meet new security requirements where applicable.
12. In the event of a transport emergency or accident involving this package, follow the guidance contained in "2012 Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident", or equivalent guidance documentation.
13. **Security during transport in company vehicles:**
 - a. Whenever portable and mobile radiographic exposure devices are removed from the permanent facility's approved storage area and placed into the transportation system, company trustworthy and reliable (T&R) employees that have been Haz-Mat trained will perform the following security duties during transport of radioactive materials:
 - b. After the radioactive material package is prepared in accordance to current transport regulations, the package must be secured and locked in the designated area of the transport vehicle. The door to the storage area of the vehicle is closed locked to prevent unauthorized access to the darkroom during transport from the facility to the job-site. Shipping or receiving radioactive materials shall be accomplished in a designated area of the permanent facility.

- c. While containing radioactive material packages, the vehicle is also a temporary storage area (whenever the package is not under continuous, direct surveillance by a T&R employee). The package must be locked in the vehicle as described above and the driver / passenger doors of the vehicle are to be locked. The alarm system and the transport vehicle disabling devices are activated.
- d. Whenever the transport vehicle is stopped for refueling, coffee stops, etc. the ignition keys are removed from the vehicle. If the T&R employee(s) leave the vehicle unattended, the vehicle must be completely locked and alarmed as described above.
- e. During transport to and from job-sites, T&R employees informed to:
 - Minimize the number of vehicle stops for fueling, beverages, meals, etc to minimize exposure to security risks.
 - Do not engage in any conversation with strangers concerning vehicle contents or job-site destinations.
 - Be aware of their surroundings and the people during stops, a car-jacking usually takes place at traffic lights.
 - Know what action is required under the security plan by the T&R employee if a car on the highway is following them, photographing their truck, if the truck is disabled on a highway, if the truck was involved in an accident and cannot be driven away.
 - Know what immediate response is required by a T&R employee if the vehicle is stolen or the radioactive material package is lost or stolen.
 - Have the ability to communicate immediately with the Trustworthy and Reliable Official (TRO) should they need assistance or have a security related question.
 - Know to report immediately to the TRO if an unauthorized party attempts to steal or gain access to the radioactive material being transported.
 - Know what actions are required if the vehicle's alarm is triggered while parked, indicating an attempted intrusion.
 - Know that all T&R employees are to safeguard all transport security documents and information regarding shipments of RAM from unauthorized disclosure.
 - Know that whenever the radioactive materials are removed from the transport vehicle at the job-site, the radioactive material must be under continuous, direct surveillance by the T&R employees until it is returned to the designated area of the transport vehicle.
 - Know the purpose and reason for the increased security requirements of the USNRC, USDOT and Department of Homeland Security agencies.

T&R employees returning from job-sites will unload the radioactive material from the transport vehicle. They will secure the radioactive material in the facility's designated storage area and activate the storage area's security alarm system.

5.5 Radioactive material transport checklist

Date _____ Operator _____

Destination _____

Transport Container Model _____ Serial Number _____

Device Model _____ Serial Number _____

Radionuclide _____ Activity _____

Type of Label Applied _____ Transport Index _____

Survey Meter Model _____ Serial Number _____

Calibration Date _____ Film Badge _____

Dosimeter Serial Number _____ Initial Reading _____

Final Reading _____

Radiation Area Signs _____ Packing List _____

Rope _____ Bill of Lading _____

Radioactive Material Sign _____ Emergency Equipment _____

Radiation Survey _____ Driver's Compartment _____ mRem/hr

(Record highest reading) Vehicle (18 in from surface) _____ mRem/hr

Packages properly marked and labeled (including transport index) _____

Packages secured in vehicle _____ Vehicle Placarded _____

Shipping papers properly completed _____

Remarks: _____

Operator's Signature _____

SECTION 6: DEFINITIONS AND TERMS

Area alarm

An area radiation level monitor that provides a highly visual warning when the radiation level exceeds a pre-set threshold. Commonly referred to as Gammalarms, use is required by most jurisdictions in permanent radiographic installations and they are often used in conjunction with door interlocks and audible alarms. Portable area alarms are required by some jurisdictions for radiography performed at temporary job-sites.

Alarm ratemeter

An alarm worn by radiography personnel that provides a continuous audible warning when the alarm ratemeter detects a radiation level in excess of a pre-set threshold of 5mSv/hr (500mR/hr). This redundant safety alarm is required by regulation for temporary job-site radiography within the USA.

Apparatus for industrial gamma radiography

Apparatus including an exposure device, a source assembly as applicable, a remote control, a projection sheath, an exposure head and accessories designed to enable radiation emitted by a sealed radioactive source to be used for industrial gamma radiography purposes. Also known as: isotope radiography system, isotope radiography kit.

Automatic securing mechanism

An automatically activated mechanism located on the radiographic exposure device designed to restrict the source assembly in the secured position.

Beam limiter

A shielding device for confining the elements of a beam of radiation to an assigned solid angle. Beam limiters are generally manufactured from lead, tungsten and depleted Uranium and are pre-positioned over/on the radiation source's working position. Also known as: collimators.

Control crank

A control cable cranking device that is a component of the remote controls. The control crank is used at a distance by the radiography personnel to move the radiation source to and from the device, through projection sheaths to and from the exposure position. Manual control crank mechanisms are commonly used, but automatic exposure controllers are available which can be operated from a greater distance and allows preset timing and automatic expose and retract modes. Also known as: wind-outs, crank-outs and hand-cranks.

Control cable

A cable or other mechanical means used to project and retract the source assembly out from and into the radiographic exposure device by means of remote control. The control cable includes the means of attachment to the source holder. Also known as: remote control cable, drive cable, Teleflex™ cable.

Control housing

Rigid or flexible tube for guiding the control cable from the remote to the radiographic exposure device and providing physical protection to the control cable. The control cable sheath includes the necessary connections for attachment to the radiographic exposure device and to the remote control. Also known as: control cable sheath or conduit.

Exposure device (container)

Radiographic exposure devices are used to remotely project the radiation source to a predetermined exposure position when required and to securely maintain it and shield it when it is not in use. Current equipment requirements require devices be designed and tested to ISO/ANSI standards and pertinent transportation regulations for transport containers. Also known as: projector, gamma ray projector (G.R.P.), camera, pill-box, source-box, exposure container.

Exposure head

Device which locates the sealed source included in the source assembly, in the selected working position and prevents the source assembly from projecting out of the projection sheath. Also known as: source stop, end stop, snout, head-hose, collimator assembly.

Locked position

Describes the condition when the lock on a radiographic exposure device or transport container is fully engaged to lock the source assembly in place and the key is removed from the lock. This condition prevents unauthorized personnel access to the sealed source assembly locked within the device.

Maximum rating

The maximum activity expressed in Bequerels and Curies that cannot be exceeded, of a sealed source specified by radionuclide by the manufacturer when contained within a radiographic exposure device or a transport container.

Plunger lock

A mechanical device with a key used to lock or unlock the radiographic exposure device or transport container.

Projection sheath

A flexible or rigid tube for guiding the source assembly from the radiographic exposure device to the working position, having the necessary connections for attachment to the radiographic exposure device and the exposure head or including the exposure head itself. The projection sheaths also provide protection of the source assembly and attached control cable from water, dirt, sand and other foreign materials usually present at radiography environments. Also known as: source guide tubes, guide tubes, source tubes, head-hoses. Examples of rigid projection sheaths include j-tubes, probes, jet engine probes

Remote control

The mechanical device that enables the source assembly to and from a working position by operation from a distance away from the radiographic exposure device. The remote control includes the control crank mechanism (normally a hand-crank), and where applicable, also the control cable, the control cable sheath and the necessary connections and attachments. See additional description under 'control crank'.

Reserve sheath

Remote control sheath (conduit) containing the length of control cable, necessary for the projection of the source assembly.

SCAR exposure device

The small controlled area radiography (SCAR) exposure device is an ISO 3999 category I and ANSI N432 type 2 device used in performing radiography in areas where local radiation levels around the projector can be kept to a minimum during radioactive source exposure. There is no significant increase of measureable radiation levels when the source assembly is projected from the shielded position into the collimator and back during retraction.

Sealed source

Radioactive source sealed in a capsule or having a bonded cover, the capsule or cover being strong enough to prevent contact with and dispersion of the radioactive material under the conditions of use and wear for which it was designed. Commonly referred to as: the 'source' or the 'pill'.

Secured position (shielded position)

Condition of the radiographic exposure device and source assembly, when the sealed source is fully shielded and restricted to this position within the radiographic exposure device.

Note: When in the secured position during radiographic operations, the radiographic exposure device may be unlocked.

Simulated source

A sealed source whose structure is such as that of the sealed radioactive source, but not containing any radioactive material. Also known as: mock source, dummy source, phantom source, dummy pill.

Source assembly

A source holder with a sealed source attached or included. In cases where the sealed source is directly attached to the control cable without the use of a source holder, the source assembly is the control cable with the sealed source attached. In cases where the sealed source is not attached to the control cable nor included within the source holder, the sealed source is the source assembly.

In the case where a simulated source is attached to or included with a source holder or control cable, this becomes a simulated source assembly.

Flexible type source assemblies are also known as 'pigtailed'. The source assembly is most commonly referred to as the 'source'.

Rigid or chain link type source assemblies are also known as: source rods, source pencils, source trains, source chains.

Source holder

A holder or attachment device, by means of which a sealed source or simulated source can be:

- directly included in the radiographic exposure device (category I apparatus - an exposure device in which the source assembly is not removed for exposure).
- fitted at the end of the control cable (category II apparatus - an exposure device from which the source assembly is projected out through a projection sheath to the exposure head for exposure. The exposure is remotely operated.)

Source holders may be an integral part of the source assembly or may be capable of being dismantled for sealed source replacement.

Source changers

A lockable Type A or Type B transport container used to transport new sealed source assemblies, exchange them and return depleted sealed source assemblies to the manufacturer. Source changers are also utilized for storage of sealed source assemblies. Also known as: source exchangers, storage containers.

Working position

Condition of the exposure container and source assembly when in the position intended for the Performance of industrial gamma radiography.

SECTION 7: EMERGENCIES AND PERSONNEL SAFETY**Emergencies**

During the termination of a radiographic exposure, observation of the survey meter provides an indication of source movement while cranking the remote control handle. After retracting the sealed source into the exposure device, radiographers are required to perform a confirmatory survey of the exposure device, the projection sheaths and beam limiter when used. Performing a confirmatory survey after a radiographic exposure is required by regulation and is the only method that the radiographer should rely on to determine if a source assembly is in the fully shielded position within the exposure device. If the radiographer measures any radiation level that indicates the sealed source is not fully shielded while performing the confirmatory survey, the radiographer must first recognize that problem exists and then follow his company's emergency procedures. Emergency conditions are those problems in which the source assembly cannot be returned to the shielded position by normal means, specifically the remote control crank mechanism. The majority of problems experienced by radiographers are where the source assembly becomes disconnected or when the source assembly becomes jammed in the projection sheath while in an exposed position. The important safety points for radiographers to follow are:

- Always perform a confirmatory survey after each exposure.
- If higher than expected radiation levels are measured, recognize that an emergency exists.
- Follow emergency procedures.
- Do not attempt to retrieve the sealed source. Secure the area and notify the Radiation Safety Officer.

The radiography crew is limited to the following basic steps that must be adhered to under regulations in the USA (verify national regulations for controlled and supervised areas) :

- 1 Immediately leave the area and maintain continuous surveillance of high radiation area.
- 2 Adjust the restricted area boundary to ensure the measured dose/rate is < 2 mR/hr.
Do not allow anyone into the area.
- 3 Immediately notify the Radiation Safety Officer.
- 4 Do not leave the area unattended under any circumstances. Maintain security of the area until the Radiation Safety Officer arrives at the site.

Do not, under any circumstances, attempt to retrieve the source. Performing source retrieval is a licensed activity that allows only specially trained RSOs to respond to an emergency. This regulatory requirement is the result of overexposures to radiographers attempting to handle emergency retrievals by themselves.

**DANGER**

An unshielded source must not be picked up or handled at close range under any circumstances. An unshielded source at close range can cause serious injury or death to anyone who is exposed to it, even for a short duration of time.

Training

Formal classroom training in radiation safety, supervised hands-on training and certification by an independent certifying organization of radiographers are essential components for radiological safety in isotope radiography and is a regulatory requirement in the United States and Canada.

Sentinel™, QSA Global, Inc. provides radiation safety, inspection & maintenance and retrieval training at the Baton Rouge, Louisiana and Burlington, Massachusetts facilities. On-site training is available by arrangement.

Access to Restricted Areas

The site where radiography is performed must be separated from other work areas by as much distance as possible. If applicable, check for occupation of the areas above and below the radiography site.

Clearly defined boundaries must be set up and warning signs displayed to provide warning and prevent access to the radiography site by unauthorized personnel before any exposure begins.

No one should enter the boundary marking a 'Restricted Area' or 'Controlled Area' without a film badge or TLD, direct reading pocket dosimeter (or electronic pocket dosimeter) and alarm ratemeter (if required).

A pocket 'chirper' alarm is required in some countries to provide radiography personnel with an immediate audible warning of a high radiation intensity.

United States Regulations

'High Radiation Area' signs must be posted where a dose of 1 mSv (100 mRem) could be received in any one hour. The radiographers must provide continuous direct surveillance of the area or when a permanent installation is used, the entrance must be equipped with door interlocks, audible and visual warnings.

'Radiation Area' signs must be posted where dose of 5 μ Sv (5 mRem) could be received in any one hour.

'Restricted Area' must be identified and posted where a dose of 20 μ Sv (2 mRem) could be received in any one hour or 1 mSv (100 mRem) in one year.

In practice, the 'Radiation Area' and 'Restricted Area' are combined and identified by the use of a rope barrier. The area is posted with the 'Radiation Area' signs where the maximum dose will not exceed 20 μ Sv (2 mR) in any one hour or 1 mSv (100 mRem) in a year. The practice of using the 'Radiation Area' sign at the 'Restricted Area' boundary clearly defines why the area has been restricted. Additionally, the trefoil (radiation) symbol provides a visual warning for those individuals who cannot read.

During a radiographic exposure, a calibrated and operable survey meter must be used to confirm the dose rate at the 'Restricted Area' boundary and adjusted if the dose rate exceeds the limit of 20 μ Sv (2 mRem) in one hour.

During the radiographic exposure, the radiographers must maintain continuous direct surveillance of the 'High Radiation Area' in addition to ensuring that no one enters their posted 'Restricted Area'.

EU Regulations

A 'Controlled Area' must be marked with a barrier at a distance where the radiation intensity will not exceed 7.5 $\mu\text{Sv/hr}$ (0.75 mR/hr). The boundary dose rates must be noted and the record kept for 2 years. During radiographic operations, only classified radiation workers are allowed inside this area.

A 'Supervised Area' is defined as the area where the boundary dose rate limit must not exceed 2.5 $\mu\text{Sv/hr}$ (0.25 mR/hr). No barriers or notices are required here, but the radiographer must be vigilant to ensure that personnel in this area do not enter the 'Controlled Area'.

Personnel Monitoring

All personnel who enter a 'Restricted' or 'Controlled' area or are present during radiographic operations are required to wear the appropriate personnel monitoring devices as required by the regulatory jurisdiction. These devices can include; film badges; thermoluminescent dosimeters (TLD); optically stimulated luminescence badges; direct reading pocket dosimeters; electronic pocket dosimeters; alarm ratemeters; and audible alarms. Calibrated and operable survey meters must be used to determine radiation levels when conducting radiographic operations.

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SECTION 8: INSTRUCTIONS FOR DISPOSAL

By international regulations, radioactive materials that are no longer required must be transferred to a licensed recipient for final disposition. Radioactive source assemblies that have depleted beyond their useful working life may be returned to authorized recipients using a source changer or other Type A transport package authorized for the specific model source assembly (and/or device).

Authorized recipients will provide any specific conditions 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. Notify the authorized recipient for specific instructions in these circumstances.



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