

QSA GLOBAL.



OPERATIONS & MAINTENANCE MANUAL. SI4050.CON May 2024

GammaMat TI – TI-F – TI-FF.

INDUSTRIAL GAMMA RADIOGRAPHY DEVICE & TRANSPORT CONTAINER

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DANGER – IMPORTANT WARNINGS

These transport containers must only be used for radiography sources that are approved for use. Please refer to section 2.1 for a listing of radioisotopes that are authorized for use in each design. The containers must be operated only by trained and qualified radiographers who have read and understand this Operating Manual or by trained assistants working under their direct supervision.

WARNING

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

Do not use these containers for unauthorized, damaged or cropped source assemblies.

The radioactive sources utilized in these containers emit high levels of highly penetrating radiation during use.

An unshielded radiation source at close range can cause injury, sickness or death to anyone who is exposed to it even for a short period of time.

A radiation source must not be touched by the hands under any circumstances.

Since gamma radiation cannot be detected by the human senses, strict operating and emergency procedures must be followed. The proper use of calibrated and operable survey meters must be employed to avoid potentially dangerous levels of radiation exposure.

Proper dosimetry including film badges or thermoluminescent dosimeters, optically stimulated luminescence badges (OSL); direct reading pocket dosimeters and audible alarm ratemeters must be worn during all radiographic operations.

It is imperative that the users of these containers perform adequate radiation surveys of the exposure device. Surveys must be performed using a calibrated survey instrument before, during and after source exchanges, source exposures, and before transport to determine if the source assembly is properly shielded within the container. The failure to perform an adequate radiation survey can cause unnecessary exposure to personnel resulting in a reportable incident.

It is very important, and required by national regulations, to prevent access by unauthorized persons to radiographic equipment and to the area where radiography is performed.

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: Use effective shielding between you and the radiation source.

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 prior to operation of the system.

Do not use any components that are not approved for use with the radiography system, or after-market components that may compromise the safety designed into the system.

1. CONTACT INFORMATION.

QSA Global, Inc. Headquarters

40 North Avenue, Burlington, MA 01803 USA

+1 781 272 2000 | +1 800 815 1383

EMEA + India Sales & Service

U Lomy 1069 334 41, Dobrany, CZ

+44 1296 435193

Asia Sales

3F Chunghae Building, 12 Sunrung-ro 103 Gil

Kangnam-Ku, Seoul 06145, South Korea

+82 2 558 3335

qsa-global.com



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1.1 Conditions of Warranty

QSA Global, Inc. (herein referred to as the design authority) warrants its replacements parts for this product, which it services and maintenance 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. Alterations and modifications to the original device are not authorized by end users or unauthorized service agents.

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The design authority'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 design authority's service center, transportation prepaid; or at its option, to returning the purchase price thereof.

The warranty on other manufacturer's components shall be that of the original manufacturer whose warranty shall be binding. In no event shall the design authority be liable for any incidental or consequential damages, whether or not such damages are alleged to have resulted from the use of such product in accordance with instructions given by or referred to by the design authority.

QSA Global, Inc. assumes no liability or responsibility for the usage of any radioactive material or device generating penetrating radiation used in connection with this product. The use of such material or generators in any manner other than prescribed in the U.S. Nuclear Regulatory Commission, Agreement State, International Licensing Authority, or permitted by any regulation of the U.S. Nuclear Regulatory Commission, Agreement State, or International Regulatory regulations may constitute a violation of such license terms.

All other warranties, except those warranties expressly stated herein, including without limitation warranties of merchantability and implied warranties of fitness, are expressly excluded. 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.

NOTE: The Models TI, TI-F and TI-FF are **not authorized** for use in the USA or approved for use in Canada. For additional information on compliance with Type A certifications please contact QSA Global, Inc. QSA Global, Inc. shall not be liable for any errors or omissions contained herein and the provision by QSA Global, Inc. of the information set out in this manual does not in itself constitute acceptance of any liability on the part of QSA Global, Inc.

2. INTRODUCTION.

Effective 8 March 2018, QSA Global, Inc. acquired the assets of NTP Radioisotopes (Europe) S.A. including the TI Series devices. Prior to 31 December 2018, the GammaMat TI, TI-F and TI-FF were certified as Type B(U) packages under their respected Type B(U) Certificate of Conformances listed below. These approvals expired 31 December 2018:

- D/2011/B(U)-85
- D/2012/B(U)-85
- D/2013/B(U)-85

Working with the German Bundesamt für die Sicherheit der nuklearen Entsorgung (BfE), QSA Global, Inc. reviewed the TI Series package/device histories and determined the design will not meet the IAEA SSR-6 requirements for Type B packages. **The Models TI, TI-F and TI-FF are currently authorized as Type A packages.**

2.1 Technical Data

Authorized contents: Special Form Ir-192

	Ir-192 ²
GAMMAT TI ¹	1 TBq (27 Ci)
GAMMAT TI-F ¹	
GAMMAT TI-FF ¹	

¹In historic revisions of the now obsolete Type B approvals, Cs-137, Yb-169 and Tm-170 were approved for transport within the GammaMat TI, TI-F and TI-FF packages. These sources were not evaluated or approved for transportation under the current Type A Manufacturer Certification.

²The only authorized special form sources for use in these devices are the QSA Global, Inc. Model 875XX Inners. These containers were evaluated to allow Type A transport when containing the Model G4, G6, or IR004 sources, but these sources are not approved for use in these devices.

Dose rate at the surface: max. 2 mSv/h

Basic construction standards: ISO 3999:2004(E), Class P and Category X

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Overall Dimensions and weight of Exposure Containers:

	Dimensions			Weight	
	Length (mm)	Wide (mm)	Height (mm)	Exposure Container (Kg)	DU shielding (Kg)
GAMMATI TI	252	110	156	13	9.4
GAMMATI TI-F	257	110	167	16	12.1
GAMMATI TI-FF	261	120	177	18.5	14

Materials used for shielding: outer shell: CrNi steel, aluminum casting
shielding: Depleted Uranium max. 0.4% U-235 (specific activity < 18.5 MBq/kg)

The GammaMat TI, TI-F and TI-FF meet all Type A package requirements according to IAEA SSR-6, 2018 Edition.

2.2 Accompanying documents

Each Exposure Container when originally distributed was accompanied by a service and maintenance file. The cover sheet included the GammaMat model and serial numbers.

- The file included:
 - Type A Manufacturer's Certificate
 - User Manual
 - Manufacturer's final QA Certificate
 - Certificates for annual inspections (filed by the customer after completed inspection)

If the unit is supplied with a sealed source, the following documents are included:

- Special form certificate
- Sealed source certificate with table of radioactive decay

2.3. Applicable standards, regulations and abbreviations

Applicable Standards

- DIN 54115, Part 4; 01/06. Production and testing of portable device for industrial gamma radiography.
- DIN 54115, Part 6; 01/06. Inspection, maintenance and functional tests of portable device for industrial gamma radiography.
- ISO 2919:2012(E), Radiological protection – Sealed radioactive sources – General requirements and classification.
- ISO 9978:1992(E), Radiation protection – Sealed radioactive sources – Leakage test methods

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- ISO 3999:2004(E), Radiation protection — Apparatus for industrial gamma radiography — Specifications for performance, design and tests

Regulations/Laws

- International Atomic Energy Agency, SSR-6, Regulations for the Safe Transport of Radioactive Material 2018 Edition
- International Civil Aviation Organization (ICAO), Technical Instructions for the Safe Transport of Dangerous Goods by Air.
- International Air Transport Association (IATA), Dangerous Goods Regulations
- International Maritime Organization (IMO), International Maritime Dangerous Goods Code.
- Regulations on transport of dangerous goods on roads – ADR.
- Regulations on transport of dangerous goods by rail – RID.

2.3.1. ISO 3999:2004(E) Compliance

The TI Series devices are designed to be ISO 3999:2004(E) Class P, Category X devices. Partial compliance to ISO 3999:2004(E) Category II is met.

2.4. Abbreviations

ADR	European Convention on international road transport of dangerous goods (Accord européen sur le transport de matières dangereuses par route)
DIN	Deutsches Institut für Normung, Berlin (German Institute for Normalization)
RID	European Convention on international rail transport of dangerous goods (Règlement international concernant le transport des marchandises dangereuses par chemins de fer)
ICAO	International Civil Aviation Organization
IAEA	International Atomic Energy Agency, Vienna
ISO	International Standardization Organization, Geneva
U-235	Uranium-235
Ir-192	Iridium-192
DU	Depleted Uranium

2.5. Dose and activity units

mSv/h	milli Sievert per hour
TBq	Tera Becquerel
GBq	Giga Becquerel
MBq	Mega Becquerel
Ci	Curie (1 Ci = 37 GBq, 27 Ci ≈ 1TBq)

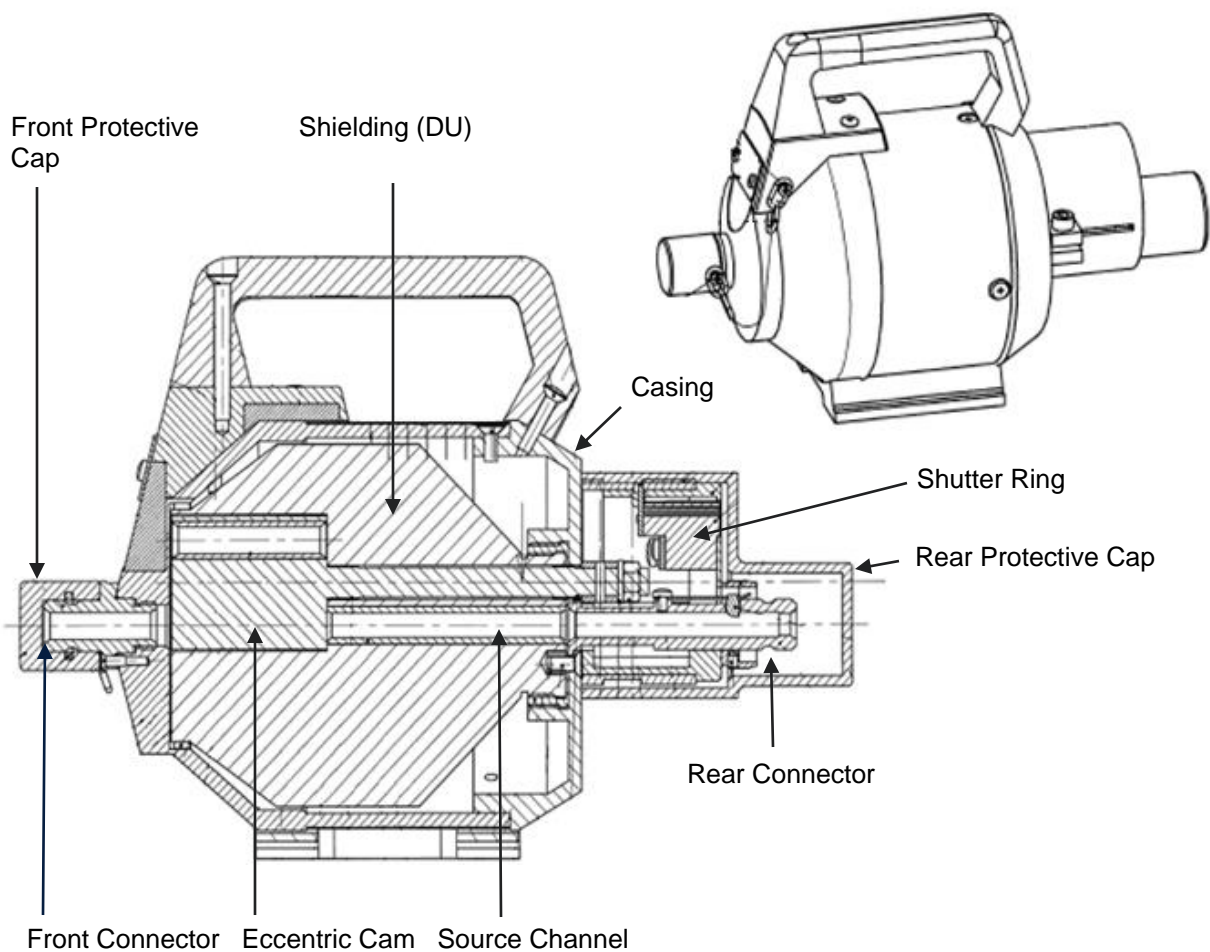
3. DESCRIPTION

The complete device for industrial gamma radiography consists of:

- the Exposure Container including a source assembly (sealed source in source-holder);
- the guide tube (including source terminal / collimator and the connector);
- the remote control.

The projector can only be operated if all of its components are properly connected.

Figure 1 View of the GammaMat TI device for industrial gamma radiography



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3.1 Description of the Exposure Container

The Exposure Container consists (see figure 1) of an uranium shielding and steel casing. When the source assembly rests in the secured position, the sealed source is located in the center of the source channel and is fully shielded in all directions. The source locking system (shutter ring) holds the source assembly in the secured position and prevents it from traveling out of the Exposure Container.

The source locking system (shutter ring) can be unlocked only when the guide tube and the remote control are properly attached.

If the guide tube and the remote control are not connected, the connectors must be covered with the protective plug on the front and the protective cap on the rear to protect the openings from dirt and mechanical damage.

3.2 Function of the Exposure Container

The eccentric provided on the exposure side and supported inside the casing can be actuated by rotation of the shutter ring after turning the key. By this actuation, the exposure channel in the eccentric is rotated in alignment with the source guide channel and the Exposure Container is opened.



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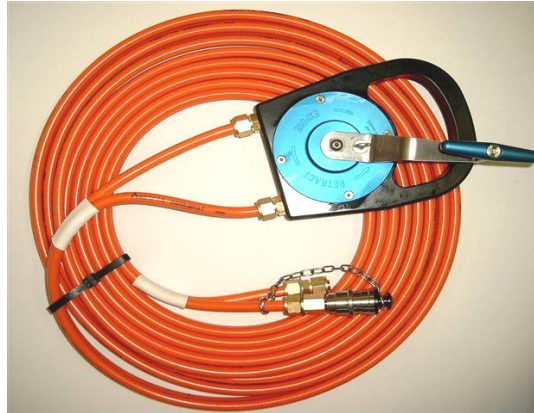


In this condition, as the source is in the center of the channel, a radiation beam appears on the front of the Exposure Container. For this reason, the gamma ray projector must always be operated from the rear of the container (Remote control side) to avoid radiation emitted by the source located in the Exposure Container.

3.3 Description of the remote control

The remote control is used to safely move the source assembly out of the device through the guide tube to and from its working position while standing back away from the exposure area. The remote control consists of the remote control connector, the drive cable including male connector, the cable hose and the gearbox with crank Handle.

Figure 2: remote control



Note that the length of the remote control hose must be longer than the selected guide tube to ensure that the source-holder reaches the end of it. Note: When providing a greater length of guide tube or using an exposure tip together with a pipe centering device or another accessory, it should be observed that when using the standard design of remote control of a length of 10 m, the maximum exposure length of 9.60 m is not exceeded .



IMPORTANT WARNING



Careful handling and regular inspection of the remote control prevents radiation accidents due to cable failure (See 4.2.1 and 6.1.2).

When connected to the Exposure Container, the remote control connector releases the source locking system interlocks.

The source assembly with the connected drive cable as a unit enables the operator safe movement from a distance of the radioactive source to and from the working position.

3.4 Description of the guide tube



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It is mandatory that the front end of the guide tube is always firmly closed with a source terminal or a collimator with an integrated source terminal. This prevents the source assembly from being extracted unguided out of the guide tube. Failure may result in radiation exposure.

The guide tube is used to safely guide the source assembly into its exposure position and back again.

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The complete guide tube includes the connector, the exposure sheath and the source terminal / collimator (see Figure 3)

The source terminal / collimator can also be connected directly to the device when using a guide tube connector and a threaded sleeve.

When connected to the device, the guide tube connector releases one of the two source locking system interlocks.

Figure 3: Complete guide tube



3.5 Source terminal and tungsten collimators

A source terminal is installed at the end of the guide tube to ensure an optimal position of the source-holder on the object which is being inspected by radiography. When the source terminal is reached by the source-holder, it is not possible to turn the remote control further in the exposure direction without applying an excessive force. In addition to source terminals, tungsten collimators can be used to concentrate the gamma radiation beam in a specific orientation, dependent on the specific application (see Figure 3).

3.6 Description of the source locking system

The shutter assembly on one side, the fixed stop on the other side, the rear locking and the lock positively prevent the radioactive source from being removed from the radiographic exposure system which includes the controls, the Exposure Container and the guide tube assembly with fixed stop. Furthermore, a key is mandatory to open the shutter.

A projection of the radioactive source can be done only after previous proper coupling of the guide tube and of the remote control to the Exposure Container, after having released the lock and opening of the shutter assembly by the shutter ring.

After projection and return of the radioactive source, closing is also performed by rotating the shutter ring of the shutter assembly.



IMPORTANT WARNING



The remote control connector actuates the rear locking by releasing the interlock keeping the source-holder inside the Exposure Container.

3.7. Size and direction of the useful beam of rays

After having actuated the shutter assembly, the Exposure Container is already in "Exposure position", although the radioactive source has not yet been ejected.

Through the exposure channel of the Exposure Container a conical beam of rays of approx. 7,5° (without connected accessories) is then emitted forwardly; this beam of rays has a diameter of approx. 15 cm at a distance of 1 m.



DANGER IMPORTANT WARNING



For this reason, the gamma ray projector must always be operated from the rear of the container (remote control side) to avoid radiation emitted by the source located in the Exposure Container.



4. OPERATING INSTRUCTIONS.

4.1 Preliminary notice

4.1.1 Inspection and maintenance requirements

Routine inspection and maintenance ensure proper functionality and safe operation of the system. The inspection and maintenance requirements are summarized below.

4.1.1.1 Daily pre-operational Inspection

	IMPORTANT WARNING	
It is mandatory for the operator to verify that the device is fully functional and safe to use. Operators must test the functioning of the Exposure Container and all its associated equipment before every use.		

The operator is responsible for the safe and proper operation of the device. Some countries may require that a fully qualified authority inspect the device. **Check with your local authorities.**

4.1.1.2 Regular inspection

In addition to the daily inspection and depending on frequency of use some additional tests must be performed on the system. The regular inspection is described in section 6.1.

4.1.1.3 Annual Maintenance

The Exposure Container must be maintained regularly by trained and qualified personnel. The regular maintenance must be performed **at least once a year and is mandatory after each repair** (see 6.2).

The manufacturer highly recommends additional maintenance after using the system in harsh environmental conditions such as extreme temperature and/or humidity conditions; a muddy environment; sand.

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In case of hard shock on the device, accidental fall or any abnormal situation being able to impact the system integrity, immediately stop use of the device and contact QSA Global, Inc. immediately to arrange for inspection and complete maintenance. This inspection will include a dose rate survey to evaluate the shielding integrity. Do not return the container if secure transport conditions are not guaranteed, especially the maximum dose rate of 2 mSv/h.



4.1.1.4 Three years inspection

In addition to the annual inspections by the manufacturer or its authorized service agent, an inspection by a competent authority expert is required to be carried out every three years. This inspection covers the whole system for industrial gamma radiography including all its operational accessories. The parts are to be marked so that clear identification is always possible.

The inspection is carried out on the basis of the test list indicated in DIN 54115 part 6, annex A.



4.1.2 Working site safety precautions

Securing and operating the exposure system requires a great deal of skill, technical knowledge and expertise. Only trained and qualified radiographers or assistants working under their direct supervision may operate radiography systems.

	IMPORTANT WARNING	
All personnel shall be equipped with a suitable individual monitoring device such as film badge or TLD (Thermoluminescent dosimeter) with a range of 0-2 mSv and must carry a radiation survey meter capable of measuring dose rates of 0.02 mSv/h to 100 mSv/h.		

In some jurisdictions, regulations require a direct reading dosimeter to be worn in addition to the film badge or TLD. Others may also require wearing an audible dosimeter which emits a signal when radiation dose rate reaches or exceeds 5 mSv/h or when the total dose of radiation reaches or exceeds 2 mSv.

Check with your local authorities.

	IMPORTANT WARNING	
The Restricted area must be marked with the appropriate warnings and secured against unauthorized entrance.		
Use the system from as great a distance as possible.		

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Care should be taken to prevent the accidental dropping of the Exposure Container. Before operating the system, ensure that the Exposure Container is safely placed on a level surface, or strapped down when applicable.

4.2 Commissioning, Fastening the Exposure Container

Commissioning of the Exposure Container and its operation require a great deal of responsibility from the personnel. Apart from sufficient technical knowledge it is mandatory for the operator to be subject of “personal dose monitoring.”

Before commissioning, the Exposure Container must be safely fastened. For this purpose, different devices are available depending on the nature of work to be carried out. The fastening is to be effected in a way that the Exposure Container is always firmly positioned and cannot accidentally drop.

4.2.1 Daily pre-operational inspection

	IMPORTANT WARNING	
<p>For the safety of operators and members of public, it is mandatory for the operator to verify that the device is fully functional and safe to use. Operators must test the functionality of the Exposure Container and all its associated equipment before every use, even if a previous inspection has already been made the same day.</p> <p>Defective equipment discovered during the daily inspection must be removed from service until repaired or replaced.</p>		

	IMPORTANT WARNING	
<p>Ensure that personal radiation warning device(s) and a survey meter are switched “ON” and held ready before carrying out functional testing on each component as outlined below.</p>		

The operator is responsible for the safe and proper operation of the device. Some countries may require that a fully qualified authority inspect the device. **Check with your local authorities.**

QSA Global, Inc. recommends that the daily inspection be recorded for operational experience. These records may be sent to QSA Global, Inc. for technical evaluation and adequate consideration for further use. Such record should include the date of the inspection, the name of the inspector, the list of the equipment inspected and any useful information related to operational experience.

4.2.1.1 Daily inspection of the Exposure Container

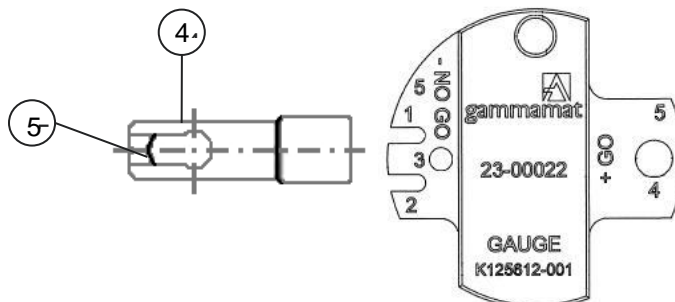


DANGER IMPORTANT WARNING



If there is no source identification label attached to the device it should be assumed that it is loaded to its maximum capacity.

1. Perform a radiation measurement on the surface of the Exposure Container. The highest radiation level must be less than 2 mSv/h;
2. Perform a visual inspection of the Exposure Container to ensure that:
 - The name plate and other labels and markings are clean and legible;
 - There is no damage on the surface of the device;
3. Clean the device if necessary;
4. Inspect the main external features of the device; including the lifting handle, the front and the rear protective caps. The handle must not have sustained damage that could prevent the safe lifting of the device and it should be properly secured to the main frame of the device;
5. The protective caps must properly secure on the device. Ensure that the protective caps can be easily removed and re-installed on the device. The rear cap should be locked within the device; the operator should not be able to move it. The protective cap must be fastened properly;
6. Inspect the exposure device's locking mechanism:
 - the remote control assembly cannot be attached to the Exposure Container if the drive cable is not connected to the source-holder;
 - the shutter ring can be rotated easily;
7. Inspect the female connector of the source-holder. It must not be worn, bent or damaged. The female connector must be checked using the Go-NoGo gauge as described below:



- The slot width (position 5 on female connector) must fit on the Go side AND NOT fit the NoGo side
- The outer diameter (position 4 on female connector) must fit through the hole on the Go side

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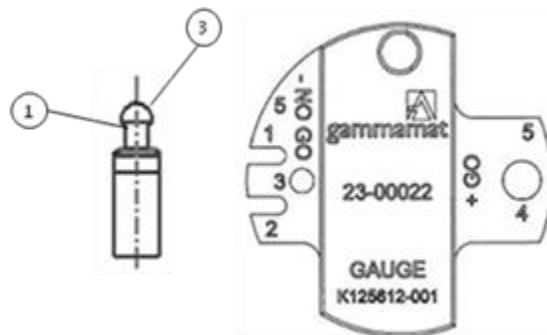
- Record all results on the inspection result form and maintain this record.

4.2.1.2 Daily Inspection of the guide tube

- Visually ensure that:
 - The source terminal end is not damaged. A damaged or excessively worn source terminal end may cause the source-holder to accidentally slip out;
 - The guide tube connectors are not damaged or deformed and it can be easily and safely attached to the exposure container;
 - The external surface of the guide tube has no cracks, kinks or dents.
- Check that the source terminal and connectors are properly attached to the guide tube hose and that they cannot be moved by applying hand force;
- Feel with hands to ensure that the guide tube is free of cracks and not deformed or flattened;
- Inspect the connection between the source terminal and the collimator (if used during this specific radiography work shift). Note that the collimator should only be installed by hand tightening only.

4.2.1.3 Daily Inspection of the remote control

- Uncoil the remote control and inspect approximately the first 30 cm of the drive cable assembly by turning the control crank in the expose direction to ensure that there is no mechanical damage to the cable/helical winding (i.e permanent bends, dents, flattened area, wear, rust or corrosion). Also look at the uniformity of the spacing between the outer spiral windings on the cable and any damage/breaks in the outer spiral winding and inner cable wires;
Little cuts and melted areas found on the cable hoses should be sealed with appropriate tape (e.g. 3M TM appropriate tape) to prevent water/debris penetration.
- Ensure that the drive cable connector is not bent at an angle exceeding 15 degrees relative to the drive cable centerline. If the bent angle exceeds 15 degrees, the male connector must not be straightened; it must be replaced .
- Ensure that the male connector is properly crimped. It cannot be moved by applying hand force. It must not be worn, bent or damaged. The male connector must be checked using the Go-NoGo gauge as described below:



- The neck (position 1 on male connector) must not fit the slot on the NoGo side
- The ball (position 3 on male connector) must not fit through the hole on the NoGo side



IMPORTANT WARNING



Replace any components that failed any of the GO-NO GO gauge tests. A failure indicates significant wear on a component that could be a risk for safety of the operator or member of the public.

4. Inspect the connection of the cable hoses to the gear box. Ensure they are properly installed and tightened.
5. Inspect the drive cable assembly to ensure that:
 - all screws are present and tightened properly
 - the crank handle is properly secured
 - arrows indicating the two directions of rotation (Retract and Expose) on the gearbox are legible. These instructions are critical for safety, and also are very important during training of assistants or during an emergency
6. The remote control connector is not deformed and is properly attached to the cable hose and can be safely attached to the rear of the Exposure Container.
7. Check the movement of the drive cable:
 - Rotate the control crank handle back and forth for approximately one-quarter turn. No resistance should be felt during this test.
 - The drive cable does not slip during operation of the crank.

4.3 Operating instructions



DANGER IMPORTANT WARNING



Ensure radiation measuring and warning devices are operational. Confirm that the radioactive source has been retracted properly into the exposure container by:

- Using the survey meter. The measured radiation level should not be higher than 2mSv/h.

- Checking that the source position indicator of the Exposure Container is GREEN (closed position);

Keep exposure area shut off from access of personnel and ensure the local regulations are met.

4.3.1 Preparation

Place or attach the Exposure Container and possible tripod stand, pipe saddle, exposure tip, collimator or other accessories and secure against dropping, tilting, wetness and dirt.

4.3.2 Connecting the guide tube



IMPORTANT WARNING



For maximum radiation protection, choose a guide tube as short as the location allows

1. Remove the front protective cap
2. Connect the guide tube using the guide tube connector: slide the central sleeve (spring sleeve) of the guide tube connector over the front of the Exposure Container, while withdrawing the outer sleeve (clamping sleeve) until the guide tube connector engages.

When providing a greater length of guide tube or using an exposure tip together with a pipe centering device or another accessory, it should be observed that when using the standard design of remote control of a length of 10 m, the maximum exposure length of 9.60 m is not exceeded.

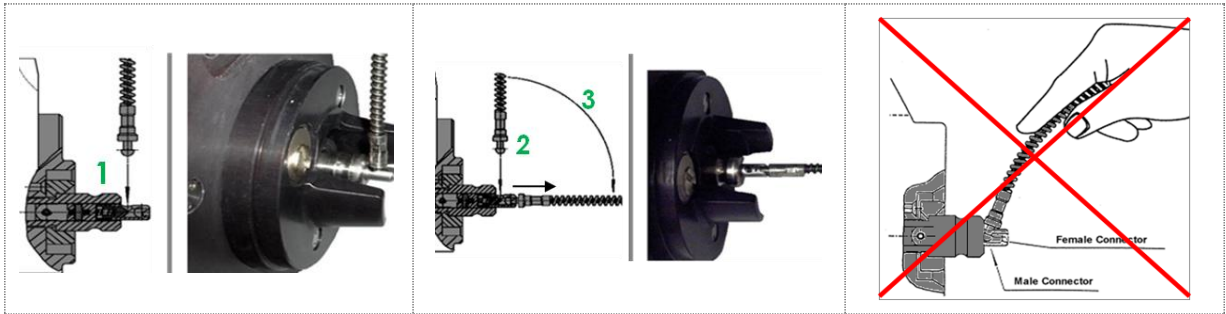
The guide tube connector and the source terminal must always be firmly attached to the guide tube. The guide tube should be arranged as straight as possible.

If the guide tube is laid in a bend, the bending radius should not be less than 500 mm. Avoid potential sources of damage (hot objects, doors, railways, roads, etc.) and position the device to minimize the risk of damage to the guide tube.

4.3.3 Connecting the remote control

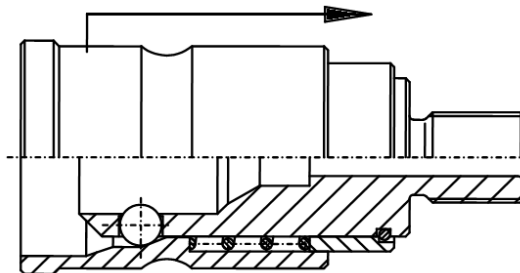
1. Remove the rear protective cap
2. Project the drive cable of the remote control for approx. 200 mm using the crank.
The cable hose must not be twisted. If necessary, turn the crank of the gearbox to pull back the slacking drive cable in the cable hose. Potential causes of damage such as hot objects, doors, railways, roads should be avoided.
3. Insert the male connector of the drive cable into the slot of the female connector of the source-holder vertically from the top and pull the cable back in the axial direction of the female connector and rotate the cable down 90°. – see figure 4.

Figure 4 Connection of the drive cable



4. Bring the remote control connector to the Exposure Container rear connector and retract the outer sleeve of the connector (see figure 5) and connect it to the rear end of the Exposure Container. The spring loaded connector couples automatically when released.

Figure 5 Connection of the remote control connector



If the remote control is laid in a bend the radius should not be less than 500 mm.

4.3.4. Exposing and retracting the source assembly

After connecting the guide tube and the remote control:

1. Unlock the safety lock of the Exposure Container and open the shutter assembly by rotating the shutter ring as far as the stop: the pointer points to the red symbol and the lettering "OPEN".



DANGER IMPORTANT WARNING



Never use force; the shutter ring must always be rotatable easily. The source assembly is released and ready for exposure. Make sure that the exclusion area is properly identified and marked. No individuals are allowed in this area.

Before ejecting the source ensure that you are protected from radiation.



IMPORTANT WARNING



For checking and handling the Exposure Container, always approach from the rear (remote control side) by using a ready-to-work radiation measuring or warning device. Never approach the Exposure Container from the front, as it might be open (operating condition "Exposure position") and the beam of rays described in section 3.7 could be emitted forwardly.

2. Extend the radioactive source into the guide tube by rotating the crank of the remote control in the "EXPOSURE" direction.

The exposure distance varies depending on the length of the guide tube. Turn the crank quickly to move the source assembly into the working position. Slow the turning movement down as you approach the end of the exposure distance, to prevent the source assembly from striking the source terminal with excessive impact.

3. Keep away from the radioactive source, well beyond the radiation field during the exposure. During the exposure time, always checking the radiation levels and restricted area boundary using the measuring device.
4. At the end of the exposure time, retract the source assembly by turning the crank in the "RETRACT" direction. Slow down rotation towards the end of the retraction travel so as to avoid in similar manner a too strong impact while retracting.



IMPORTANT WARNING



Check with the radiation meter that the radioactive source has returned fully into the Exposure Container and is well shielded. This includes checking dose rates on the exposure container and along the length of the guide tube and/or any collimators used to ensure the source has been fully retracted into the exposure container. Once conformed, close the shutter ring before doing anything else.

Extension and return of the radioactive source must always be easy-going. If actuation requires more force to be applied, the reason may be contamination by dust, sand, damage or wear. Discontinue operation immediately in such a case, eliminate the defect or contact QSA Global, Inc. for additional guidance regarding inspection prior to continued use.

4.3.5. Securing and locking the Exposure Container

Use the survey meter to check whether the source is in a secured position. The source is in a secured position when the dose rate measured at the surface of the container does not exceed 2 mSv/h. Close the Exposure Container by rotating the shutter ring of the shutter assembly in

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opposite direction (do not apply force) until the pointer points to the green symbol and the lettering "CLOSED". Then, actuate the safety lock.

4.3.6. Disconnecting the guide tube and the remote control

When the Exposure Container is closed, decouple the guide tube and the remote control and remove the key.

Withdraw remote control connector, rotate the source-holder such that the slot of the female connector points to the top, bend cable upwardly and decouple male connector of the drive cable while applying pressure in the direction of the source-holder axis.

Place protective caps.

4.3.7. Preparing the Exposure Container for Transport or Storage

Prior to transport of the Exposure Container always check that:

- the Exposure Container and the safety lock are closed;
- the key has been removed and;
- the rear and front protective caps have been placed in proper position.

Securely position the Exposure Container in the vehicle and **check with an appropriate measuring device that the local maximum dose rate doesn't exceed 2 mSv/h.**



DANGER IMPORTANT WARNING



If there is no source identification label attached to the device, it should be assumed that it is loaded at its maximum capacity until proven otherwise.

DO NOT move the Exposure Container when the remote control and guide tube are attached, or when the source locking system is released. If transported in this condition, the source assembly may move out of its shielded position and create a dangerous radiation field.

5. SOURCE EXCHANGE.

5.1 Introduction

Source exchange consists of exchanging an existing source assembly (source-holder loaded with a sealed source) with another source assembly.



IMPORTANT WARNING



**The source assembly exchange must be performed by qualified personnel who have had sufficient practical training with a simulated source.
It can be made by the user of the device if qualified or by QSA Global, Inc. or its authorized agent.**

The operating instructions of the corresponding transport container must be followed. Always observe the requirements of the handling license.

The steps are:

- Unloading the Exposure Container by transferring the loaded source assembly from the Exposure Container to an empty channel of a transport/storage container (see section 5.3);
- Loading the empty Exposure Container with a new source assembly from a transport/storage container (see section 5.4);

If the empty channel used to unload the exposure device and the new source assembly is located in the same transport/storage container, refer to section 5.5

5.2 Safety

The source exchange can be carried out on-site or in a shielded space protecting from ionizing radiation.

Principally, the safety officer of the user has to decide, if at all – and if yes – up to which activity of the radioactive source, a source changing as described may be carried out.

Always affix the proper source dates label to the Exposure Container.

5.3 Unloading of the Exposure Container



DANGER IMPORTANT WARNING



**Always follow the instructions of use of the concerned transport/storage container.
Ensure there is an empty channel in the transport/storage container.**

Always wear a dosimeter and have an appropriate radiation measuring device available to check the local dose.

1. Position the Exposure Container and the transport/storage container so that they are adjacent to one another.
2. Remove the rear protective cap of the Exposure Container.
3. Connect the transfer tube to the front connector of the Exposure Container.
4. Connect the other extremity of the transfer tube on the empty channel of the transport container (refer to the manual of the concerned transport container).
5. Remove the rear protective cap of the Exposure Container.
6. Connect the remote control as described in point 4.3.3.
7. Unlock the safety lock on the Exposure Container and open the shutter assembly by rotating the shutter ring.
8. By means of the remote control, eject the source assembly into the transport container to the stop.



IMPORTANT WARNING



Keep well behind the Exposure Container in the shadow of radiation provided by the shielding in this direction, during this procedure.

Always check the local dose rate with a measuring device. Check the dose on contact of the Transport Container. It must be below 2 mSv/h.

9. Secure the source-holder in the transport container¹ and disconnect the drive cable from the source-holder.
10. By means of the remote control, move back the drive cable into the Exposure Container.
11. Close the Exposure Container by turning the shutter ring and lock the safety lock.
12. Disconnect the transfer tube and the remote control.
13. Remove the keys.
14. Place the front and rear protective caps.

¹ Depending on the type of transport container used.

5.4 Loading the Exposure Container



DANGER IMPORTANT WARNING



Always follow the instructions of use of the concerned transport/storage container.

Always wear a dosimeter and have an appropriate radiation measuring device available to check the local dose

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Loading with a new source assembly is carried out in reverse sequence. The male connector of the drive cable is projected through the empty Exposure Container and through the transfer tube and connected to the female connector of the new source assembly.

1. Position the Exposure Container and the transport/storage container so that they are adjacent to one another.
2. Remove the front protective cap of the Exposure Container.
3. Connect the transfer tube to the front connector of the Exposure Container.
4. Remove the rear protective cap of the Exposure Container.
5. Connect the remote control as described in section 4.3.3.
6. Unlock the safety lock on the Exposure Container and open the shutter assembly by rotating the shutter ring.
7. By means of the remote control, eject a part of the drive cable through the Exposure Container and the transfer tube.
8. Connect the male connector of the drive cable on the female connector of the new source assembly and connect the transfer tube to the transport container.
9. According to the type of transport container, unlock the channel containing the new source assembly.
10. By means of the remote control, retract the new source assembly from the transport container into the Exposure Container as far as the stop.



IMPORTANT WARNING



Keep well behind the Exposure Container in the shadow of radiation provided by the shielding in this direction, during this procedure.

Always check the local dose rate with a measuring device. Check the dose on contact of the Transport Container. It must be below 2 mSv/h.

11. Use the survey meter to check whether the source is in a secured position. The source is in a secured position when the dose rate measured at the surface of the container do not exceed 2 mSv/h. Close the Exposure Container by rotating the shutter ring of the shutter assembly in opposite direction (do not apply force) until the pointer points to the green symbol and the lettering "CLOSED". Then, actuate the safety lock.
12. Disconnect the transfer tube from the transport container and from the Exposure Container
13. Place the front protective cap.
14. Disconnect the remote control.
15. Place the rear protective cap.
16. Affix label on device.
17. Close the transport container and remove or modify labels.

6. MAINTENANCE AND REGULAR TESTS.

6.1. Regular inspection

In addition to the daily inspection described in section 4.2.1, additional tests must be performed on the system.

6.1.1. Cleaning of the system

The Exposure Container, guide tubes and remote control are to be regularly cleaned. The length of the cleaning intervals and the extent of cleaning depend on the environmental conditions at the place of use.

Particularly thorough and frequent cleaning is required if fine sand and mud are involved. In such cases, it may be necessary to clean the guide tube and remote control every day.

Before every use, the connection ends on both the container and on the sheaths side are to be checked for cleanliness and should be cleaned, if necessary. Only suitable means such as fluff free cloths or brushes must be used. Wire brushes, water, solvating agents, oil or lubricants are not applicable.

Do not use wire brushes, water or oil to clean the exposure container, remote control or guide tube.

The control cable **must not** be lubricated because this may cause dirt particles to stick to the cable and enter the exposure container!

For cleaning purposes, the control cable can be pulled out of its sheaths after dismantling the stop spring. Observe the stop spiral at the end. Clean the cable on a clean surface using a brush. No dust must enter the exposure sheaths when the cable is reinserted. Without dismantle of the stop spring you can only clean the cable in the length of the remote control. The stop spring stops at the gear.

Cleaning procedures that require partial disassembly of the container may only be carried out by an accredited maintenance center. It is imperative to observe the requirements of the handling license.

6.1.2. Functional testing

6.1.2.1 Exposure Container:

The movable parts on the exposure container and the openings at the front and rear end as well as the locking mechanism are to be checked by the user at regular intervals depending on the frequency of use. If the unit is continuously in use with changing staff, the tests are to be carried out every day.

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6.1.2.2 Remote control:

Checks to be performed:

- The control cable of the remote control is to be checked for corrosion and stiffness and any mechanical damage. Replace the control cable if necessary.
- The four screws on the drive cable assembly are to be checked and retightened, if necessary.
- The smooth running of the driving wheel is to be checked (crank should turn easily). Any stiffness or slipping may be due to wear and tear. If this occurs, the remote control is to be returned to the manufacturer or its authorized agent (service representative) for repair or replacement.

If defects are identified, send the guide tube to the manufacturer or an authorized agent for repair or replacement.

6.1.2.3 Guide tube:

Checks to be performed:

- Check the absence of wear and kinks on the cable hose;
- Check that the connectors are properly attached to the guide tube hose. They cannot be moved by applying hand force.

If defects are identified, send the guide tube to the manufacturer or an authorized agent for repair or replacement.

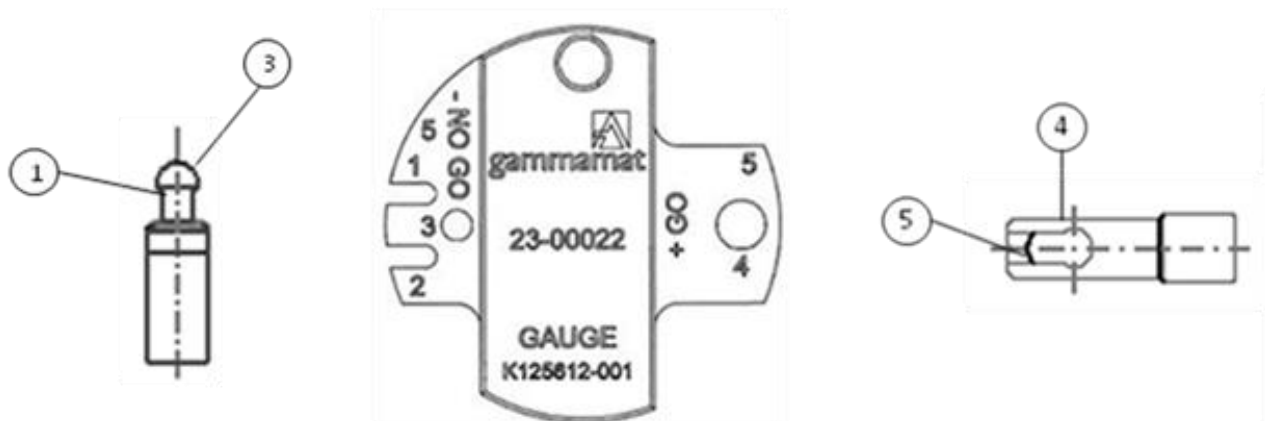
6.1.3. Source assembly maintenance

At least once a year, the source holder assembly must be subject to maintenance after removal of the radioactive source capsule.

Such maintenance and repair must be performed by the manufacturer or an authorized agent. Following the inspection, required maintenance or repair, and documentation of the process, the Source holder assembly may be re-loaded.

6.1.4. Testing with the Go NoGo gauge

The female and male connectors are to be, at least, daily checked as follow:



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- The slot width (position 5 on female connector) must fit on the Go side AND NOT fit on the NoGo side.
- The outer diameter (position 4 on female connector) must fit through the hole on the Go side.
- The neck (position 1 on male connector) must not fit the slot on the NoGo side.
- The ball (position 3 on male connector) must not fit through the hole on the NoGo side.

If one of the above criteria is not met, the applicable connector requires immediate replacement. When checking the male connector on the control cable, ensure that the control cable at the end of the shaft is not bent or cracked.

6.1.5. Annual check of Go NoGo gauge

The Go NoGo gauge is an inspection tool that requires regular checks to ensure a correct dimensional analysis of the tested parts. It is recommendable to return the gauge along with the other equipment to the manufacturer or authorized service agent for annual inspection.

6.2. Annual maintenance

The maintenance ensures proper condition and safe operation of the system.

In order for the Exposure Container to adhere to the highest standards of technical safety, it is imperative that regular maintenance be performed.

Regular maintenance can only be performed by QSA Global, Inc. or by an authorized service agent, must be carried out at least once a year, and is mandatory after each repair.

Please contact QSA Global, Inc. for further information.

6.3. Three years inspection for German End Users

In accordance with DIN 54115, Part 6; 01/06

In addition to the annual inspections by QSA Global, Inc. or its authorized service agent as described above, an inspection by a competent authority expert is required to be carried out every three years. This inspection covers the whole device for industrial gamma radiography including all its operational accessories. The parts are to be marked so that clear identification is always possible.

For inspection the device must be accompanied by the following documentation:

- Type A Manufacturer's Certificate.
- Certificate of design testing acc. to DIN 54115 part 4, or customs approval certificate.
- Certificate of the last source change and source support test.
- Test report of the last test carried out by the competent authority.
- Operating instructions.

The inspection is carried out on the basis of the test list indicated in DIN 54115 part 6, annex A. The results are summarized in a test report.

Table 1: Plan for Regular Inspection

Exposure container		
a.1	Safety lock	Check as to function and wear, if necessary replace
a.2	Shutter assembly	Check as to function and wear, if necessary replace defective parts
a.3	Pinion and toothed segment	Check as to firm position and wear, if necessary replace defective parts
a.4	Pointer and symbol marking	Check as to damage, if necessary restore
a.5	End Tube	Check rear bore 6.4 mm dia., if oversized replace
a.6	Exposure channel	Check as to wear and damage, if necessary replace
a.7	Front and rear locking	Check as to function and wear, if necessary replace
a.8	Tension and pressure pin	Check as to function and wear, if necessary replace
a.9	Eccentric bearing	Check as to wear, if necessary replace
a.10	Source channel	Check as to wear and damage, if necessary replace
a.11	All other parts	Check, if necessary replace
a.12	Exposure Container	Re-assemble, secure screws with Loctite, function-check
Guide tube, source terminal		
b.1	Source terminal	Remove dirt, check as to wear, if necessary replace
b.2	Source guide tube	Check as to wear, corrosion, ruptures, bending, compressions, and damage, replace if necessary
b.3	Guide Tube connector	Remove dirt, check as to wear, if necessary replace
b.4	Provisional check by	Checker
b.5	Source guide tube, guide tube connector, source terminal	Re-assembly, tighten threads
b.6	Final check by	Checker: A source holder must be able to slip freely from the guide tube connector through to as far as the exposure tip
Remote control		
c.1	Remote Control connector	Detach, remove dirt, check as to wear, if necessary replace
c.2	Cable with ball end	Clean, check as to wear, corrosion, ruptures and length, if necessary replace; check the ball end as to wear and tight seat (use gauge), if necessary replace
c.3	Cable hoses	Check as to wear, corrosion, ruptures, bendings and compressions and damage, if necessary replace
c.4	Drive cable with crank	Clean, check as to wear, lubricate drive cable, if necessary replace worn parts or exchange completely
c.5	All other parts	Visual check, if necessary replace
c.6	Provisional check by	Checker
c.7	Remote Control	Re-assemble, tighten nuts and screws
c.8	Final check by	Checker; also check cable length (function check)
Source Holder		
d.1	Single links:	Clean, check as to fissure and wear, if necessary replace
d.2	Cap, resp.cap compl.:	Check as to wear, if necessary replace
d.3	Ball cup	clean, check as to wear (use gauge), if necessary replace check marks, if necessary, restore
d.4	Provisional check by	Checker
d.5	Link-type source holder	Re-assemble, secure ball cup, use new clamping sleeves and new Cu-pin
d.6	Final check by	Checker, check length

6.4. Leak testing

6.4.1. Leak test for sealed source

According to ISO 2919 and ISO 9978 norms, each sealed source shall be tested after manufacture to ensure freedom from surface contamination and from leakage. These tests are performed by the manufacturer before delivery. The customer receives a source certificate which describes the results of the leak and contamination test. The result of the test must be less than 185 Bq (0.005 μ Ci).

If the source is suspected to be leaking, e.g. if contamination is detected on the guide tube, the source is to be checked for leakage. For the test, the sealed source must be removed from the Exposure Container. Source and Exposure Container are separately tested for contamination by means of wipe tests.

Some national regulations require performing periodic leak tests on the sealed sources to confirm the integrity of the weld.

Check with your local authorities and perform the checks according to the applicable regulatory requirements.

6.4.2. Leak test for shielding

Some national regulations require performing leak test on shielding. **Check with your local authorities** and perform the checks according to the applicable regulatory requirements.

7. DISPOSAL FOR SEALED SOURCE AND DEVICE.

It is the responsibility of the owner of the GammaMat TI Series device to store the device in an adequate way to avoid any unauthorized manipulation and any damage to the device.

7.1 Disposal of the Sealed Source

If the Exposure Container is loaded with a new source, the user is responsible for the disposal of the decayed source. The disposal can be carried out by QSA Global, Inc. The customer receives a certificate of disposal for the returned source.

Please contact QSA Global, Inc. for information and assistance.

7.2 Disposition of Exposure Container and Components

Since depleted uranium is used as shielding material in the Exposure Container, the unit must be properly disposition by transfer to a licensed recipient. QSA Global, Inc. will accept the device for disposition and issue a Certificate of Acceptance.

Please contact QSA Global, Inc. for information and assistance.

8. PACKAGING AND TRANSPORT.

The GammaMat TI devices should be transported according to the current revision of IAEA SSR-6, Regulations for the Safe Transport of Radioactive Material.

Note: The TI Series package is certified as a Type A package. The use of an overpack may be permitted. Overpack containers serve exclusively as additional protection during transport and shall not be equated with the execution of industrial radiography.

8.1. Responsibilities

1. The shipper is responsible for preparing the radioactive package according to International Regulations for the Safe Transport of Radioactive Material (IAEA SSR-6). The shipper is also responsible to check the presence of mandatory marking.
2. The carrier is responsible to refuse a package non compliant with the International Regulations for the Safe Transport of Radioactive Material.

8.2. Receiving the device

1. Measure the level of radiation. This level shall not exceed 2 mSv/h (200 mrem/h) on contact of the surface of the container and 0.1 mSv/h (10 mrem/h) at 1 meter. If the radiation level exceeds 2 mSv/h (200 mrem/h), put the device in quarantine and immediately inform the Radiation Safety Officer.
2. Visually inspect the package for any evidence of physical damage.
3. Ensure that the source is properly secured into the Exposure Container.

8.3. Package preparation for transport

1. Ensure that the source is properly secured into the Exposure Container.
2. Wipe test the external surfaces of the container to ensure it is free from contamination. The maximum allowable value is 4 Bq/cm² (10⁻⁴ µCi/cm²). If the level of non-fixed contamination exceeds 4 Bq/cm² (10⁻⁴ µCi/cm²), immediately inform the Radiation Safety Officer and do not attempt any corrective measures until the reason for the contamination has been identified and the Exposure Container has been fully decontaminated;
3. Measure the level of radiation. This level shall not exceed 2 mSv/h (200 mrem/h) on contact of the surface of the container and 0.1 mSv/h (10 mrem/h) at 1 meter. If the radiation level exceeds 2 mSv/h (200 mrem/h) the package cannot be shipped. Put the device in quarantine and immediately inform the Radiation Safety Officer.
4. Determine the Transport Index by multiplying the measured level of radiation at 1 meter by 100 (if the units of measure are in mSv/h).
5. Label the Exposure Container with category labels according to Table 2. The labels must be completed with:
 - Contains : Isotope contained in the device

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- Activity: Maximum activity during transport expressed in Bq or multiple of this unit (see Table 4)
- Transport Index: Value determined according to point 4.

The labels must be affixed to two opposite sides of the outside of the device. If not possible, these labels can be glued on the plate fixed to the container by a metallic chain or equivalent.

6. In order to facilitate the handling and transport, an overpack can be used. If it's the case, the following marking must be done on the overpack. If this is not the case, the following marking must be done directly on the Exposure Container:
 - The identification of the consignee or the consignor or both;
 - For each package, the United Nations number (see Table 3), preceded by the letters "UN", and the proper shipping name (see Table 3) shall be legibly and durably marked on the outside of the packaging.

8.4. Shipping documents

1. The consignor shall include in the transport documents with each consignment the identification of the consignor and consignee, including their names and addresses and the following information, as applicable, in the order given:
 - The proper shipping name (see Table 3);
 - The United Nations Class number "7";
 - The United Nations number assigned to the material (see Table 3);
 - The name or symbol of each radionuclide contained in the package;
 - A description of the physical and chemical form of the material, or a notation that the material is special form radioactive material;
 - The maximum activity of the radioactive contents during transport expressed in units of Becquerel (Bq) with the appropriate SI prefix symbol (see Table 4);
 - The category of the package, i.e. I-WHITE, II-YELLOW, III-YELLOW;
 - The transport index (i.e., categories II-YELLOW and III-YELLOW);
 - The identification mark for each competent authority approval certificate (special form radioactive material, low dispersible radioactive material, special arrangement, package design or shipment) applicable to the consignment;
 - For packages in an overpack, a detailed statement of the contents of each package within the overpack.
2. The consignor shall include in the transport documents a declaration in the following terms or in terms having an equivalent meaning:

"I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packed, marked and labeled, and are in all respects in proper condition for transport by (insert mode(s) of transport involved) according to the applicable international and national governmental regulations."

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3. The consignor shall provide in the transport documents a statement regarding actions, if any, which are required to be taken by the carrier. The statement shall be in the languages deemed necessary by the carrier or the authorities concerned, and shall include at least the following points:
 - Supplementary requirements for loading, stowage, carriage, handling and unloading of the package, overpack or freight container including any special stowage provisions for the safe dissipation of heat or a statement that no such requirements are necessary;
 - Restrictions on the mode of transport or conveyance and any necessary routing instructions;
 - Emergency arrangements appropriate to the consignment.
4. The applicable competent authority certificates need not necessarily accompany the consignment. The consignor shall make them available to the carrier(s) before loading and unloading.

8.5. Document for air shipment




In case of air shipment, a “Shipper’s declaration for dangerous goods” form must be filled out and added to the shipping documents. The template of this IATA required document is presented below:

SHIPPER'S DECLARATION FOR DANGEROUS GOODS

(Provide at least two copies to the airline.)

Shipper 					Air Waybill No. 			
Consignee 					Page of Pages Shipper's Reference No. (optional)			
<i>Two completed and signed copies of this Declaration must be handed to the operator.</i>					WARNING Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder, or an IATA cargo agent.			
TRANSPORT DETAILS This shipment is within the limitations prescribed for: Airport of Departure: <i>(delete non-applicable)</i>								
<div style="border: 1px solid black; display: inline-block; padding: 2px 5px;">PASSENGER AND CARGO AIRCRAFT</div>		<div style="border: 1px solid black; display: inline-block; padding: 2px 5px;">CARGO AIRCRAFT ONLY</div>			Shipment Type: <i>(delete non-applicable)</i>			
Airport of Destination:					<div style="border: 1px solid black; display: inline-block; padding: 2px 5px;">NON-RADIOACTIVE</div>		<div style="border: 1px solid black; display: inline-block; padding: 2px 5px;">RADIOACTIVE</div>	
NATURE AND QUANTITY OF DANGEROUS GOODS								
Dangerous Goods Identification								
UN or ID No.	Proper Shipping Name	Class or Division	Packing Group	Subsidiary Risk	Quantity and Type of Packing	Packing Inst.	Authorization	
ADDITIONAL HANDLING INFORMATION: "Prior arrangements as required by IATA Dangerous Goods Regulations 1.3.3.1 have been made." Prepared according to ICAO/IATA.								
24hr. Emergency Contact No.								
I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packaged, marked, labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national government regulations.				Name/Title of Signatory				
FOR RADIOACTIVE MATERIAL SHIPMENT ACCEPTABLE FOR PASSENGER AIRCRAFT: THE SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN OR INCIDENT TO RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.				Place and Date				
				Signature (see WARNING above)				

Table 2: Category Labels

Conditions		Category	Label
TI	Maximum radiation level at any point on external surface		
0^3	$< 0.005 \text{ mSv/h}$	I-white	 <p>The diagram shows a diamond-shaped label with a white background. At the top is a radiation symbol. Below it, the word "RADIOACTIVE" is printed in bold, followed by a vertical red bar. Underneath, there are fields for "CONTENTS" and "ACTIVITY". The label is surrounded by a double-line border. Dimensions are indicated: 4 mm for the symbol, 6 mm for the top border, and 100 mm for the minimum dimension. A small number '7' is at the bottom.</p>
≤ 1	$0.005 \text{ mSv/h} < x \leq 0.5 \text{ mSv/h}$	II-yellow	 <p>The diagram shows a diamond-shaped label with a yellow background. It features the radiation symbol, "RADIOACTIVE", and a vertical red bar. Below are fields for "CONTENTS", "ACTIVITY", and "TRANSPORT INDEX". The label has a double-line border. Dimensions include 4 mm for the symbol, 6 mm for the top border, and 100 mm for the minimum dimension. A small number '7' is at the bottom.</p>
≤ 10	$0.5 \text{ mSv/h} < x \leq 2 \text{ mSv/h}$	III-yellow	 <p>The diagram shows a diamond-shaped label with a yellow background. It features the radiation symbol, "RADIOACTIVE", and three vertical red bars. Below are fields for "CONTENTS", "ACTIVITY", and "TRANSPORT INDEX". The label has a double-line border. Dimensions include 4 mm for the symbol, 6 mm for the top border, and 100 mm for the minimum dimension. A small number '7' is at the bottom.</p>
> 10	$2 \text{ mSv/h} < x \leq 10 \text{ mSv/h}$	III-yellow and under exclusive use	

³ If the TI is not greater than 0.05, the value may be considered as equal to zero.

Table 3: UN codes

UN Number	Proper shipping name	Most used
2911	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE INSTRUMENTS <i>or</i> ARTICLES	
2909	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE ARTICLES MANUFACTURED FROM NATURAL URANIUM <i>or</i> DEPLETED URANIUM <i>or</i> NATURAL THORIUM	When device is not loaded with a radioactive source
2908	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE EMPTY PACKAGING	
2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I), <i>non fissile or fissile excepted</i>	
2915	RADIOACTIVE MATERIAL, TYPE A PACKAGE, <i>non-special form, non fissile or fissile</i>	
3332	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, <i>non fissile or fissile excepted</i>	Device loaded with a radioactive source
2916	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, <i>non fissile or fissile excepted</i>	

Table 4: SI Prefix Symbol

Multiplier	Prefix	Symbol
10 ¹⁸	exa	E
10 ¹⁵	peta	P
10 ¹²	tera	T
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	k
10 ²	hecto	h
10	deca	da

9. EMERGENCY INSTRUCTIONS

Fully read this chapter prior to taking any emergency action

The handling of radiation units may involve safety relevant events. Particular care should be taken during the operation and transportation of the unit. Equipment failure is often due to human error or inadequate maintenance.

If the source assembly cannot be returned into the Exposure Container you are dealing with a failure.

KEEP CALM!

After the survey has been measured, the control area size may have to be extended. Special care is to be taken that the operating staff or other individuals in the vicinity of the event are not exposed to excessive radiation.

THE RADIATION SAFETY OFFICER MUST BE INFORMED

At the next step the source position is to be determined by

MEASURING THE DOSE RATE

In order to localize the source position a special survey meter with telescope detector or with attachable detector and additional shielding are applicable. The expected equivalent dose is to be reduced to the minimum by applicable means. If the source is stuck in the exposure sheath, for example, it is recommendable to extract it back to the collimator. This will give precise information about its position. If this is applicable, check in the next step, if the defect of the guide tube can be temporarily eliminated, by straightening kinks or excessive bends. Before taking any measures for the elimination of defects, the cause of failure is to be localized as accurately as possible.



DANGER IMPORTANT WARNING



No retrieval activity must be carried out by unauthorized or untrained individuals. During all measures it is imperative to ensure that the source has no contact with the human body.

Never touch the source assembly with your hands. Tools like pliers or remote tongs must always be used.

An unshielded source must not be picked up or handled at close range. Exposure to an unshielded source by handling at close range can cause serious injury or death.

The main principles of radiation protection are applicable: **DISTANCE, TIME AND SHIELDING.**



DANGER IMPORTANT WARNING



Never try to disassemble the shutter ring. The source assembly could be released.

9.1. Shutter ring system failure

9.1.1. Shutter ring system cannot be released

Situation:

The shutter ring System cannot be released.

Measures:

- Check if the lock is open.
- Check if the guide tube and the remote control are properly attached to the Exposure Container.

If the shutter ring system still cannot be released, the complete device should be returned to the manufacturer or authorized agent for inspection and repair.

9.1.2. Shutter ring system does not lock



DANGER IMPORTANT WARNING



The beam of rays as described under section 3.7 still emerges.

Situation:

The Exposure Container cannot be closed after retraction of the radioactive source.

Measures:

STOP WORKING IMMEDIATELY

The following steps must be completed to prevent the source assembly from slipping out of the Exposure Container:

- Quarantine the area.
- Inform the Radiation Safety Officer immediately.
- Shield off the beam of rays as far as possible by placing lead bricks or steel pieces in front.
- If possible, transfer the source assembly into a transport container and ship back the empty Exposure Container.
- Contact QSA Global, Inc. or its authorized agent.

The complete device should be returned to the manufacturer or authorized agent for inspection and repair.

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In both cases do not apply force. The shutter ring must always be easily rotatable.

9.2. Problems with the guide tube

Situation:

The source assembly cannot be retracted into the Exposure Container.

Measures:

- Quarantine the area.
- Use the survey meter to establish a restricted area and adjust boundaries, if necessary.
- Inform the Radiation Safety Officer immediately.
- Determine with the survey meter whether the source is stuck in the source terminal/collimator or in the guide tube itself.
- If the source is located in the source terminal/collimator, determine whether dirt or a sharp bend in the guide tube causes the malfunction. Both would restrict the source assembly from any back and forward movement. Repetitive movement of the crank may resolve the situation.
- If these actions are unsuccessful, you may have to cut off the guide tube to retrieve the source assembly. Adequate shielding measures are mandatory since this procedure would occur in close proximity to the source. Lead shot sacks might be used, since they can be thrown on the source from a long distance.
- Standard recommendations cannot be given without detailed information on the actual scenario. Such an incident requires consultation with the manufacturer or authorized agent (service representative).

9.3. Problems with the remote control

9.3.1. Extraction of source assembly is not possible due to remote control failure

Situation:

The remote control cannot be cranked to extract the source assembly to the working position.

Measures:

Check if the shutter ring is opened and the source position indicator displays “OPEN” (**red**). Rule out any malfunction of the device as described in section 9.1.1. Try with another remote control. If the failure cannot be solved the complete device including all operational accessories should be sent to the manufacturer or authorized agent (service representative) for inspection and repair.

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9.3.2. Retraction of source assembly is not possible due to remote control failure

Situation:

The remote control cannot be cranked to retract the source assembly from its working position.

Measures:

This could be due to different reasons: the drive cable is stuck in the cable hose or the gearbox is defective.

Step1

- Check the cable hose (is there any cracks or bends?).
- Straighten the cable hose as much as possible and try to move the crank again.

Step 2

- Retract the drive cable manually after detaching the cable hose from the gearbox.
- Detach the cable hose from the gearbox.
- Take the now uncovered drive cable and retract the source assembly by pulling back the drive cable by hand.

Emergency Retrieval

Drive cable is stuck in the cable hose.

If the above described retrieval steps failed, perform the following Emergency Retrieval under appropriate safety precautions and the direction of the Radiation Safety Officer. All measures to prevent personal dose rates from being exceeded should be taken. The expected personal dose rate has to be estimated. No other individuals are allowed in this area.

- Approach as far as possible to the Exposure Container from remote control side.
- Disconnect the male connector from the Exposure Container.
- Leave the Exposure container -as quickly as possible- while holding the male connector in your hand retracting the source assembly during this process.



IMPORTANT WARNING



During these measures, local radiation levels might temporarily increase. Use the survey meter to check if the source assembly has been successfully retracted before approaching the Exposure Container. Send the complete device including its operational accessories to the manufacturer or authorized agent (service representative) for inspection and repair.

9.4. Source assembly disconnected from the drive cable

Situation:

Male connector is detached from drive cable

The drive cable can be fully cranked back, the source position indicator displays “OPEN” (red) and excessive survey reading is monitored.

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Measures:

The following measures require thorough planning and prior consultation with the Radiation Safety Officer. All measures to prevent personal dose rates from being exceeded should be taken. The expected personal dose rate has to be estimated. No other individuals are allowed in this area.

Inspect the retracted drive cable to verify that the male connector is detached.

According to the appearance of the fracture it might be possible that the source assembly is still movable inside the guide tube.

- Visually inspect the guide tube for kinks and excessive bends from a safe distance.
- Determine the position of the source assembly by using a special survey meter with a telescope detector or an attachable detector.
- Use additional shielding as required.
- Try to lift the collimator and guide tube to let the source assembly slip back through the guide tube to the shielded position. Close the shutter ring.
- Disconnect the guide tube and secure the Exposure Container

Situation:

Guide tube is damaged and/or the source assembly is damaged or broken and cannot be moved as a unit through the guide tube.

Measures:

Standard recommendations for retrieval actions cannot be given without a detailed description of the current situation.

The following measures require thorough planning and prior consultation with the Radiation Safety Officer. All measures to prevent personal dose rates from being exceeded should be taken. The expected personal dose rate has to be estimated. No other individuals are allowed in this area.

Retrieval Actions:

Aim of any retrieval actions should be to move the source assembly to the shielded position of the Exposure Container.

To isolate the source assembly you may have to cut off the guide tube/source terminal. Adequate shielding measures are mandatory since this procedure would occur in close proximity to the source. Lead shot sacks might be used, since they can be placed on the source from a long distance.

Disconnect the guide tube to be able to put the retrieved source assembly back into the Exposure Container.

Before storing the retrieved source in the Exposure Container, insert, if possible, the remaining parts of the source assembly. **Take care of the direction - Insert the female connector of the source assembly first).**

DANGER IMPORTANT WARNING
<p>The beam of rays as described under section 3.7 still emerges.</p>

Once the source is retrieved in the Exposure Container and secured for transport, the system is to be returned to the manufacturer or authorized agent (service representative) for inspection and repair.

9.5. Transport accidents/incidents involving radioactive Material

Keep unnecessary people away. Keep upwind, isolate hazard area (at least 50 meters - 164 ft.). If a source breach is suspected, wear self-contained breathing apparatus and full protective clothing. Delay cleanup until arrival of qualified radiation monitoring assistance. Stop the engine. No smoking, avoid any possible flame. Mark the road by placing the signals and warn the other drivers and other passing-by. Alerts police and fire brigade as soon as possible.

FIRE	Small fire: Dry Chemical or CO2 Large fires: Foam or Water Fight fire from maximum distance. Move undamaged packages from fire area if without risk. DO NOT move damaged packages.
SPILL OR LEAK	1) Do not touch spilled material or leaking or damaged packages. 2) Small Spills: If it can be performed quickly, limit the spread of the spill by using earth or other noncombustible absorbent material. 3) Large Spills: Dike for later decontamination and disposal. Do not enter the spill area unless absolutely necessary to save life. Limit entries to the shortest possible time. Alternate the entry of personnel, if possible.
FIRST AID	Call physician. Use standard first aid procedures. Remove contaminated clothing and shower with soap and water. Advise rescue personnel and physicians that person or equipment may be radioactively contaminated. Immediately request medical assistance

Notify competent Authorities.

Check transport documents in order to find out the implicated packages in the accident. The remained undamaged packages may be loaded into another vehicle only with the agreement and under the responsibility of the local Authorities in which country the accident took place.

For all emergencies, contact QSA Global, Inc.