

SENTINEL

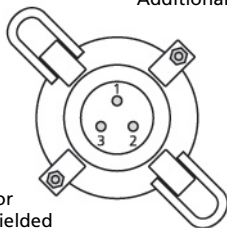
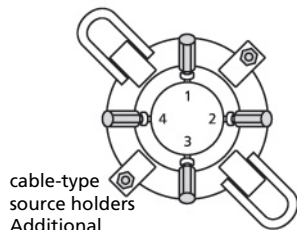
Gamma Radiography Sources

SAFETY INFORMATION AND GUIDANCE

Ir-192, Co-60, Yb-169, Cs-137, Se-75

FOR SAFETY AND TO ENSURE CORRECT USAGE,
READ THIS BOOKLET CAREFULLY BEFORE
UNPACKING, HANDLING, USING, STORING,
TRANSPORTING, TRANSFER AND
RETURN OF RADIOACTIVE MATERIAL

These instructions must always
accompany radiation sources
and be readily available
to all persons using them.



Insert for
back-shielded
source holders
Insert for

top plug for
sources without
holders



Different shielding inserts are used for the different types of source holders.

The way sources are arranged in these inserts is shown below.

The source positions are identified by numbers stamped on the inserts. The inserts can contain up to 10 individual source positions.

Position	Source serial number	Source holder number	Signature
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

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The general information and instructions for safe use in this leaflet are applicable wherever the sources are used. Guidance is given to help UK users to comply with UK regulations. In other countries the user should consider what additional steps may be needed to comply with their regulations.

1. Regulations

Before ordering or using radiation sources or any other radioactive material customers must take whatever actions are necessary to ensure that they are complying with their national or state regulations governing the use of such materials. In most countries regulations are closely related to the International Atomic Energy Agency (IAEA) regulations and codes of practice. If radiation sources have to be transported for use it is necessary to refer to the regulations as listed on the approval certificate.

Depending on the mode of transport, it is also necessary to comply with the regulations of:

ICAO, the International Civil Aviation Organisation

and the requirements of

IATA, the International Air Transport Association

or

IMO, the International Maritime Organisation

or

ADR, the European Road Regulations.

For road transport in Great Britain refer to the regulations as listed on the approval certificate.

UK regulations

In the UK, the principal legislation governing the keeping and use of radioactive substances (including radiation sources) is the Radioactive Substances Act 1993 (RSA), the Health and Safety at Work Act 1974 (HSWA), Management of Health and Safety at Work Regulations (1999) and the Ionising Radiations Regulations 1999 (IRR).

Specific guidance on compliance with UK regulations for site radiography is given in IRR99 Approved Code of Practice 'The protection of persons against ionising radiation arising from any work activity'.

Before obtaining any radioactive substances or for the first time undertaking work with ionising radiation in the UK, a person or organisation must:

apply for and obtain a Certificate of Registration from the appropriate Environment Agency in England and Wales, Scotland or Northern Ireland

and

notify the Health and Safety Executive (HSE) or the Department of the Environment in Northern Ireland of the intention to carry out the work at least 28 days before commencing the work

and

appoint a suitably qualified and experienced Radiation Protection Adviser (RPA) in writing.

Having appointed an RPA his advice must be sought on how the regulations are to be observed and, generally, as regards safety, in the work to be done.

2. On receipt of package

2.1 The package should be inspected on arrival and if any damage is observed which could have resulted in damage to the product then the package must not be opened. Actions to follow in the event of the package being damaged should be included in your contingency plans.

Actions to take should include the measurement of the surface dose rate on the package which should not exceed 2 mSv/hr (200 mrem/hr). A higher reading may indicate that the source is not in a safe position or that the shielding is damaged. If a reading in excess of 2 mSv/hr (200 mrem/hr) is obtained, all personnel must be kept at a safe distance from the package and the matter reported immediately to your RPA and to QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE.

2.2 If the package is undamaged, check that the description on the documentation and labelling agree with the acknowledgement of order. If there are differences do not open the package, place it in a secure area and notify QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE.

2.3 Notify the person responsible for radiation protection that the package has arrived. Update the official accountancy record for radioactive substances noting the identification, activity and date.

2.4 If the package is not opened immediately, it must be placed in a suitable secure store (see section 5.2 of these instructions). The shielding provided by transport containers is adequate to comply with the maximum dose rate levels specified in the IAEA Transport Regulations.

However, these levels may not be appropriate for storage of the package in places of work without additional shielding. Transport containers may be placed in a controlled area provided that the area is physically demarcated and access is restricted.

3. Unpacking

3.1 Sources must be unpacked in a specially designated area by trained, competent and authorised personnel. Sections 4, 5 and 6 of these instructions should be read carefully and preparations made for using the source or transferring it to a storage facility before unpacking it.

3.2 Radiation levels should be checked using a calibrated dose rate meter at each stage of unpacking. The exposure rate at the outer surface of the package may be as high as 2 mSv/hr (200 mrem/hr) and dose levels at each stage of unpacking will get progressively higher.

3.3 Various packing combinations are used depending on the type of source. Steel drums type 3746 or 976 are the most common form of packaging.

3.3.1 Remove the steel closing band and lid.

3.3.2 Check the enclosed documents.

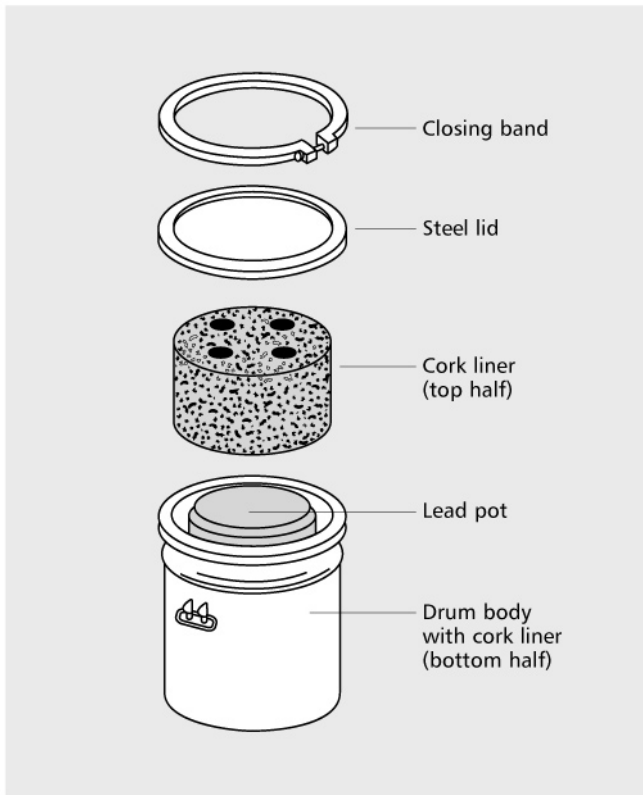
3.3.3 Remove cork lid and spacer, if fitted.

3.3.4 Lift the lead pot out of the drum, leaving the cork liner in place. Some lead pots have protruding source tubes to facilitate source transfer; care must be taken to avoid any form of impact (i.e. dropping, knocking) as damage may cause difficulties in source transfer.

Caution: lead pots are heavy and should not be lifted manually.

3.3.5 Place the lead pot on firm level ground.

Caution: the dose rate on the lead pot may be as high as 15 mSv/hr (1.5 Rem/hr) so contact time should be minimised.



3746 package make up

4. General precautions

4.1 All radioactive products are dangerous if not handled, used, stored, transported or disposed of properly and in accordance with the appropriate regulations. To avoid danger it is essential that these instructions be strictly observed.

4.2 These sources must be unpacked or used only by persons who are suitably qualified, experienced and competent and who have been authorised to work with gamma radiography sources.

4.3 These sources emit penetrating gamma radiation, and all personnel must be adequately shielded from this radiation (see section 6 of these instructions for guidance on the effectiveness of shielding materials).

Persons unpacking, using or transferring radiography sources must wear personal dose monitors. In addition, it is recommended that they should wear audible dose rate alarms.

4.4 Always treat the source carefully and avoid bending, dropping or crushing it.

Do not expose the source to risk of mechanical damage, corrosive environments, or to substances containing chlorine or sulphur.

4.5 Avoid using oil-based lubricants close to the radiation source.

The intense radiation will damage the oil forming a viscous product, which may cause components to stick.

Do not place any lubricant on the source, in the projector or in the guide tubes. Some plastics are also affected by radiation, which normally causes them to become brittle and may disintegrate.

4.6 Sources must not be modified, re-worked, cut open or otherwise interfered with.

4.7 If in doubt about how to proceed contact your RPA or QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE.

5. General Instructions

5.1 Use

It is essential to check that the source supplied is suitable for the intended application before it is used. Sources are designed for the specific uses described in QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE's literature or in some cases as agreed directly with the customer in writing.

5.2 Storage

5.2.1 Radioactive sources must be kept in a suitable receptacle in a store when not in use or being transported. This is a legal requirement in most countries.

A gamma ray projector unit (also known as an 'exposure container'), or a gamma radiography transport container is normally suitable as the 'receptacle' for the source while in the store.

5.2.2 The store should be reserved for radioactive materials only. It must be adequately shielded, correctly labelled and fully secured against any intrusion by unauthorised persons. The dose rate on the outside of the store should not normally exceed 2.5 $\mu\text{Sv/hr}$ (0.25 mrem/hr).

5.3 Damage or loss

If the package or source is damaged or has been involved in an accident or is exposed to adverse conditions then appropriate precautions must be taken according to your contingency plans. QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE must be informed and further advice sought from the appropriate radiological protection service. In certain circumstances the national regulatory authority will need to be informed. The radiation protection service should be able to advise. In any cases of doubt consult QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE.

If a source is lost, the person responsible for radiation protection must immediately inform the local and national regulatory authorities. Records of any investigations taken to locate the lost source must be kept for an appropriate period.

5.4 Transfer and disposal

5.4.1 Where a radiation source is re-sold, incorporated in other products or is transferred on in any other way, it is the responsibility of the source user to ensure that all subsequent users are made aware of the nature of the source and the specified use. Proper records must be kept of the transfer of the radioactive sources.

5.4.2 All users must be supplied with a copy of the test report, these instructions and any other relevant instructions that are required to ensure safe use, return and disposal of the source and any product into which the source is incorporated.

5.4.3 Instructions for the return of decayed radiography sources are described in section 10 of this document.

6. Radiological protection

6.1 Before any unpacking or source movement is attempted, a detailed plan of the actions contemplated must be prepared to assess any hazard, which may arise.

Contingency plans must be made to deal with any foreseeable accidents (see section 7 of these instructions). All source movements must be recorded and records maintained for an appropriate period as specified in local rules.

6.2 In the UK a 'Controlled Area' will be required where instantaneous dose rates could exceed 7.5 $\mu\text{Sv/hr}$ (0.75 mrem/hr). This must be subject to a prior risk assessment. A particular room or building may be designated or an area marked out. The boundary of this area must be suitably labelled. Customers should contact their qualified RPA for advice.

6.3 All persons must be adequately protected from the penetrating gamma radiation emitted by radiography sources.

6.4 Minimise personal exposure using:

Time
Distance
Shielding

Time: minimise time spent by personnel near to the source.

The total dose received in working with a source is directly proportional to the time taken to carry out the work. If the work takes twice as long then the dose is twice as great. Good planning helps to reduce exposure time to a minimum.

Distance: maximise the distance between sources and personnel.

Exposure is greatly affected by distance in accordance with the inverse square law. For example if the distance is doubled the dose rate is reduced to one quarter of its original value but if the distance is halved the dose rate will increase fourfold.

Note that the dose rate at one metre will be 100 times greater than it is at 10 metres.

KEEP A SAFE DISTANCE

Table 1

Table 1 gives an estimate of the distance, in free air, from an unshielded source to give a dose rate of 7.5 $\mu\text{Sv/hr}$.

Radionuclide	Nominal activity (GBq)	~radius in metres to give 7.5 $\mu\text{Sv/hr}$
Ir-192	37	25
Co-60	37	42
Yb-169	37	15
Cs-137	37	20
Se-75	37	17

Actual dose rates at a distance may be higher than those predicted from the inverse square law due to scattering of radiation from walls and floors in the area.

To estimate the radius of a controlled area to give a dose rate of 7.5 $\mu\text{Sv/hr}$ for a source of different activity, multiply the appropriate radius from Table 1 by the square root of the ratio of the source activity to 37GBq.

For example, an Ir-192 source with an activity of 3.7TBq would require a controlled area of radius:

$25 \times 100 = \sim 250$ metres to give a dose rate of 7.5 $\mu\text{Sv/hr}$.

Shielding: use shielding between sources and personnel where possible.

The shielding required would depend, among other factors, on the radionuclide and the activity of the source but, in general, dense, high atomic number materials such as lead and concrete are preferred to reduce gamma radiation. Concrete must be much thicker to provide the same effective shielding as lead. Table 2 shows the thickness of lead and concrete required to reduce gamma radiation intensity by various transmission factors.

6.5 A suitable calibrated gamma dose rate meter must be used to check actual dose rates to persons in the vicinity.

6.6 A suitable personal dosimeter must be issued to persons using radiography sources (e.g. film badges, thermoluminescent dosimeters (TLDs), quartz fibre electroscope (QFE) or other appropriate monitors).

Radionuclide	Thickness of lead (mm)			Thickness of concrete (mm)		
	Transmission factor 0.5	0.1	0.01	Transmission factor 0.5	0.1	0.01
Ir-192	3.1	12	28	133	245	390
Co-60	15	47	87	137	325	541
Yb-169	0.3	2.0	7	20	100	245
Cs-137	8.0	24	45	140	300	450
Se-75	1.1	5.2	13	105	215	340

Table 2

7. Assessments and contingency plans

Certain countries require that a Prior Risk Assessment be carried out to identify hazards and prevent foreseeable accidents occurring, and to limit the consequences of any that do occur. This will enable the user to prepare a contingency plan. Possible hazards are listed below, together with the actions normally appropriate to deal with the contingency.

7.1 Source jams during transfer

This may occur due to mechanical damage or failure of equipment. All equipment must be inspected for damage before use (see section 11) and handling instructions followed to minimise this risk. If a source jams, secure the area by posting assistants as 'sentries' in safe positions. Local shielding may be used to surround the source, but this and other action must only be taken under controlled conditions agreed with your RPA. Radiographers should not attempt to rectify this fault themselves but should contact their RPA and QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE.

7.2 Fire hazard

The container, when packed for transport, is designed to withstand fire accident conditions (Type B (U) package). If lead is used as shielding and the container is outside its packaging, a serious fire may melt the lead with the resulting loss in the main gamma shielding. The risk should be minimised by ensuring, as far as practicable, that no flammable materials are stored nearby and that adequate means of fire control are available. If a source is involved in a fire, the emergency services must be warned of the possible radiation hazard, your RPA and QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE must be contacted.

7.3 Detached source

QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE recommends the use of equipment that meets BS5650: 1978 and ISO3999-1 2000(E) and is designed to minimise this risk. In the event of a source becoming detached the actions are the same as for a jammed source (see section 7.1 of these instructions).

7.4 Power failure

Consideration must be given to safety implications in the event of a power failure during source exchanges e.g. failure of alarms or lighting.

7.5 Source loading/unloading

High dose rates will occur in the vicinity of these operations, similar to those during normal radiography exposures. The proper use of remote operating equipment and the setting up of a controlled area will help ensure protection of all personnel.

7.6 Accidental exposure of the source

For equipment which meets BS5650: 1978 and ISO3999-1 2000(E) and is adequately maintained and where these handling instructions are followed, no accidental exposure should occur under normal operating conditions. Equipment must not be modified or interfered with unless agreed in writing by QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE.

7.7 Surface dose rate

The surface dose rate from the complete package meets transport regulations, but may be up to 2 mSv/hr (200 mrem/hr) on the surface. Higher dose rates will be encountered as the assembly is unpacked. When a drum is unpacked, the surface dose rate on the lead pot may be as high as 15 mSv/hr (150 mrem/hr) - this is dependent on the source activity. Minimise time spent close to the container and follow the normal precautionary measures listed in section 6.

7.8 Contamination risk

Radiography sources are manufactured in accordance with a quality assurance programme which meets the requirements of BS EN ISO9001(2000). Radiography sources are tested for leakage and contamination in accordance with ISO standards prior to despatch.

No significant contamination should be detected on the source or associated equipment.

No release of contamination should occur even from a breached capsule due to the non-dispersible nature of the metallic Ir-192 and Co-60 and the primary encapsulation of Yb-169, Se-75 and Cs-137.

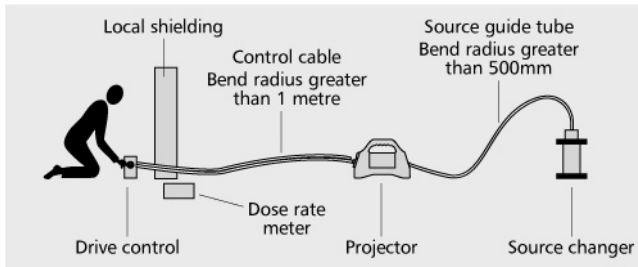
If routine monitoring reveals levels of contamination greater than 4Bq/cm² secure the area by posting 'sentries' and inform your RPA.

8. Source exchange procedure

Source changers are used to transport new sources from the manufacturer to the user. The changer is coupled to a source projector and the old source is transferred from the projector to an empty channel in the changer. (This allows an opportunity for the projector to be maintained by QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE'S service personnel.) The new source is then transferred from the changer to the projector and the old source is returned to the manufacturer in the changer. The general procedures described in section 8 must be read in conjunction with section 9 that details specific procedures for particular container types.

It is important that the complete procedure is thoroughly understood before any source unload is attempted.

8.1 Layout of equipment



Source exchanges must only be carried out in a controlled area. Use any available local radiation shielding e.g. a wall to reduce the dose to the operator at the control point.

8.1.1 Arrange the source changer (or lead pot) and the projector so that one length of guide tube will fit between them without any sharp bends or kinks in the tube.

Caution: any bends in the guide tube must have a radius of not less than 500mm (approximately 20 inches).

8.1.2 Lay out the drive cable between the projector and the drive cable control unit.

Caution: any bends in the control cable must have a radius of not less than one metre (approximately 39 inches).

8.1.3 Locate the drive cable control unit as far away as possible from the projector and source changer. Preferably the control point will be outside the Controlled Area.

Caution: if a TAN957 automatic unit is used the power must be switched off.

8.2 Assembling the equipment

8.2.1 Connect the guide tube to an empty hole in the source changer using an adapter as appropriate. With a 650L source changer close and latch the source guides.

Caution: the source changer must remain upright at all times. Do not place it on its side.

8.2.2 Connect the drive cable to the projector following the manufacturer's instructions.

Caution: do not unlock the projector at this stage.

8.2.3 Connect the other end of the guide tube to the projector as described in the manufacturer's instructions.

Caution: minimise time spent near to the projector or source changer.

8.2.4 Position a dose rate meter close to the control point to monitor continuously the dose rate to which the operator is exposed.

8.2.5 Check that any personnel necessarily remaining in the vicinity are wearing monitoring equipment as specified in the local rules (film badge, TLDS, dosimeter, QFE, etc.).

8.3 Transfer of decayed source into source changer

8.3.1 Unlock the projector and set to 'exposure'.

8.3.2 If appropriate, activate the audible and/or visual warning, device(s) for imminent source exposure.

8.3.3 Check that the area is clear of personnel and that all access points are secure.

8.3.4 Crank the decayed source rapidly from the projector to the source changer.

NOTE: the radiation intensity will increase greatly as the source is first exposed, decrease slightly as the source is cranked out, then drop to background level when the source is correctly loaded in the source changer.

8.3.5 Check the dose rate meter reading.

Caution: do not move towards the projector or changer if the reading remains high.

8.3.6 When satisfied that the source is located in the source changer, approach the equipment checking the dose rate with an appropriate dose rate meter.

The dose rate at 1 metre should be approximately 0.75 mSv/hr (75 mrem/hr) maximum for the supplied lead pot or 100 μ Sv/hr (10 mrem/hr) maximum for a type 650L unit.

Caution: if significantly higher dose rates are measured as you approach the equipment, STOP, check the operations and return to a low dose area. If in doubt, check with your RPA.

8.3.7 Check the dose rates on all sides of the projector, on the guide tube and on all sides of the source changer.

Caution: the maximum dose rate at the surface of a source changer should be less than 15 mSv/hr (1.5 Rem/hr) for the supplied lead pot, or 2 mSv/hr (200 mrem/hr) for a type 650L unit.

8.4 Disconnecting the source

8.4.1 When satisfied that the source is properly loaded, uncouple the guide tube from the source changer. For a lead pot type, carefully unscrew the guide tube, taking care not to pull it away from the source changer while unscrewing, as this may dislodge the transferred source from its shielded position. For type 650L units, open the latched source guide.

8.4.2 Disconnect the drive cable from the source holder assembly, taking care not to move the source. Sentinel sources are disconnected by moving the lock pin of the connector towards the source and sliding the drive cable out through the keyway. Do not bend or twist. For other equipment follow the manufacturer's instructions. Replace the closure nut on the source changers (if fitted) using firm finger pressure, or close the clamp. For 650L series units, disconnect the guide tube.

8.4.3 Wire the identity plaque for the old source to the source changer so that the position of the source can be traced.

8.5 Inspecting and maintaining the projector

When the old source has been removed the opportunity should be taken to inspect the empty projector. Routine maintenance work in accordance with the manufacturer's recommendations may conveniently be scheduled to coincide with the source replacement. To ensure safety always use manufacturer's parts when servicing, if in any doubt contact QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE.

To enable the drive cable to be disconnected from a 660 projector, it is necessary to fit a test connector to the drive cable before withdrawing it into the projector. Test connectors, 'jumpers' are normally fitted in the drive connector dust cap of the projector. The drive cable connector should be checked for wear using a 'GO/NOGO' gauge.

8.6 Transferring the new source into the projector

8.6.1 Identify the position in the source changer for the new source. Each source position is shown by marker tape and a source identification plaque or by a loading chart.

8.6.2 Remove the appropriate closure nut and connect the drive cable to the source holder. Attach the guide tube.

8.6.3 Couple the source connector to the drive cable. Most sources for QSA GLOBAL equipment are connected by depressing the lock pin with a thumbnail, sliding the drive cable connector into the keyway, then releasing the lock pin. Make sure that the connection is secure. For equipment other than Sentinel, follow the manufacturer's instructions.

Caution: the source must only be moved from its stored position by use of its drive cable and source exchange tube.

8.6.4 For the type 650L source changer, close and latch the source guide after attaching the guide tube and the drive cable to the source holder as above.

8.6.5 Retire to the control point, sound the warning devices and take precautions as for source unloading.

8.6.6 Crank the new source rapidly from the source changer to its storage position in the projector.

Caution: observe the dose rate meter during the operation. The radiation intensity should increase as the source exits the source changer, increase as it approaches the projector, and drop to a low level when the source is properly stored in the projector.

8.6.7 Monitor the projector and the guide tube with the dose rate meter to ensure that the transfer has been properly completed. The dose rate at the surface of the projector should be less than 2 mSv/hr (200 mrem/hr) and less than 100 μ Sv/hr (10 mrem/hr) at one metre.

8.6.8 When satisfied that the source is properly stored, lock the projector and remove all guide tubes and controls. Attach the new source identification plaque to the projector.

8.6.9 Remove the guide tube from the source changer. Replace the lock nut or hold down the cap. Ensure adequate means of identifying loaded positions.

9. Specific container types

Specific features of three of the main source changer types are described in this section. Details of their construction and operation should be read in conjunction with section 8 of these instructions.

9.1 650L Source changer

9.1.1 Remove the cover from the 650L by breaking the seal wire and removing the four bolts.

9.1.2 Remove the source 'hold down' caps by unthreading the caps.

9.1.3 Open the lock above the empty chamber of the source changer by inserting the key, turning clockwise until it releases, and pull the slide out.

9.1.4 Connect one end of the guide tube extension to the exposure device and the other end to the outlet fitting above the empty chamber.

9.1.5 Close and latch the source guides to secure the tube. Follow the general procedure for source transfers described in section 8 of these instructions.

9.1.6 Lock the spent source in the source changer by pushing the lock slide in and rotating the key counter clockwise and depressing the lock.

9.1.7 Disconnect and pull back the guide tube to expose the source/drive cable connection.

9.1.8 Disconnect the drive cable from the source assembly by moving the lock pin of the source connector down towards the source and slide the drive cable out through the keyway.

9.1.9 Without locking the source, couple the drive cable to the new source by depressing the lock pin and sliding the drive cable connector into the keyway and releasing the lock.

Caution: ensure that the connection is secure before continuing.

9.1.10 Connect the guide tube to the outlet fitting of the lock. Unlock the new source by inserting the key and turning clockwise until it releases. Pull the slide out.

9.1.10 At the exposure device controls, crank the new source from the source changer to its storage position in the exposure device.

Caution: observe the dose rate meter during the operation. The radiation intensity should increase as the source exits the source changer, increase as it approaches the projector, and drop to a low level when the source is properly stored in the projector.

9.1.12 When satisfied that the source is properly stored, lock the projector and remove all guide tubes and controls.

9.1.13 Attach a source 'hold down' cap over the spent source in the projector. Attach the identification plate of the old source to the 'hold down' cap and attach to the empty chamber.

9.1.14 Bolt the source changer cover in place and seal with wire.

9.2 Cable type source holders (3746/976 source containers)

Follow the general procedure for source transfers described in section 8 of these instructions.

Caution: follow all the safety precautions and monitoring procedures, use a dose rate meter at every stage to check that the source is correctly located.

9.2.1 To open the lead pot, unscrew the single cap head retaining screw and remove the cover plate.

Caution: the shielding insert containing the source holder is now loose. Do not remove the insert from the pot, as this will give rise to dose rates greater than 1 Sv/hr (100 Rem/hr).

9.2.2 Select an empty storage position in the pot and remove the closure nut. Check visually that the selected location is empty.

Note: a storage position is identified by not having a source identification plaque attached or radioactive label tape on the closure nut.

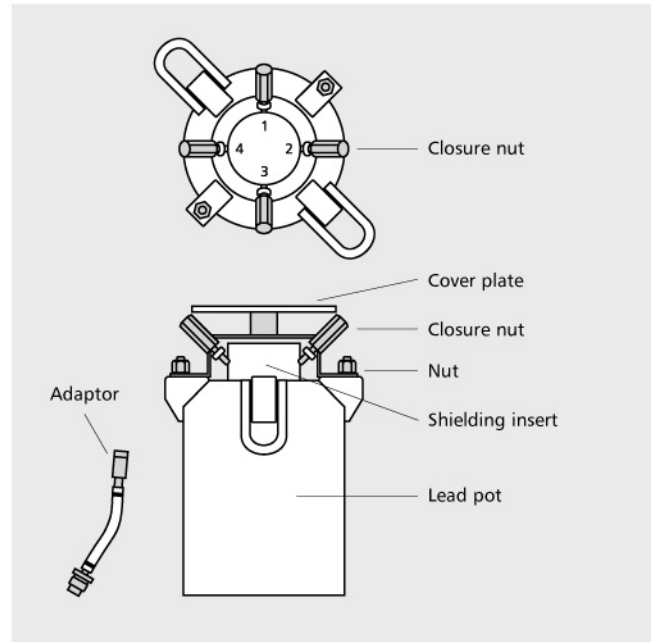
9.2.3 Connect the adaptor on to the source tube. Connect the source guide extension tube (open at both ends) to the adapter.

9.2.4 When the old source has been fully wound into the lead pot, remove the adapter and disconnect the drive cable, taking care not to pull the source out of the source storage tube. Replace the closure nut using firm finger pressure only.

9.2.5 Determine the position of the new source by reference to the loading chart on the front page of these instructions. Remove the corresponding closure nut, connect the drive cable to the source holder. Connect adapter on to the source tube.

9.2.6 Move away to the drive control unit and wind the new source into the projector. Secure the source in the projector. Follow safety and monitoring procedures as described in section 8 of these instructions.

9.2.7 Replace the closure nut or close the clamp. Replace the cover plate and tighten the cap head screw to clamp it securely in position. Replace the lead pot in the transport drum.



Insert for cable-type source holders

9.3 Back shielded holders (3746/976 source containers)

Follow the general procedure for source transfers described in section 8 of these instructions.

Caution: gamma radiography sources that are supplied without source holders must only be unloaded from the shipping container in a suitably shielded facility. Follow all the safety precautions and monitoring procedures using a dose rate meter at every stage, to check that the source is correctly located.

9.3.1 To open, slacken the two nuts securing the cross bar. Raise the cross bar, turn and lift off the lid.

Caution: the shielding insert containing the source holder is now loose. Do not remove the insert from the pot as this will give rise to a dose rate greater than 1 Sv/hr (100 Rem/hr).

9.3.2 Remove any top shielding to reveal the shielded ends of the source holders.

Caution: monitor for radiation beams from source positions.

9.3.3 Select an empty storage position in the pot by monitoring for minimal radiation and then confirm by visual examination.

9.3.4 Connect the source guide extension tube (open at both ends) to the empty position using an adapter if necessary.

9.3.5 When the old source is fully wound into the lead pot, remove the adapter and disconnect the drive cable, taking care not to pull the source out of the source storage tube. Replace the closure nut using firm finger pressure only, or close the clamp and insert the wire seal.

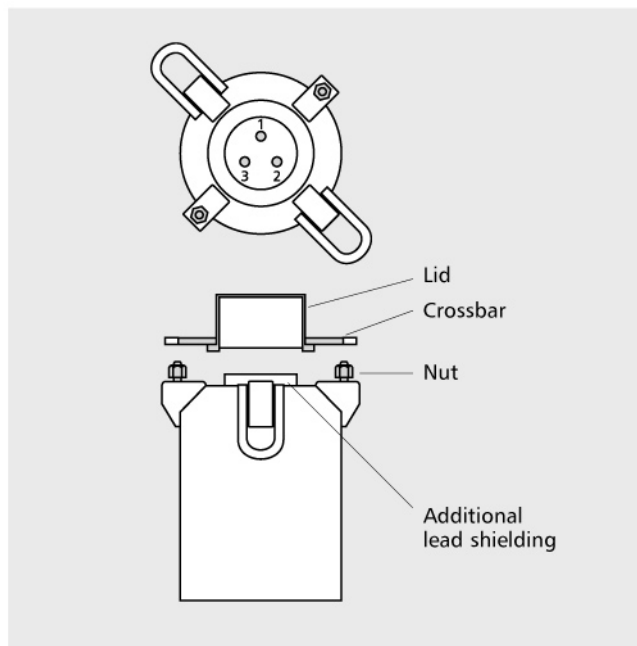
9.3.6 Determine the position of the new source by reference to the loading chart on the back page of these instructions. Remove the corresponding closure nut, connect the drive cable to the source holder and lift the clamp lever.

9.3.7 Move away to the drive control unit and wind the new source into the projector. Secure the source in the projector.

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Follow safety procedures and monitoring as described in section 8 of these instructions.

9.3.8 Disconnect the guide tube, keeping any adapter in a safe place. Replace top shielding (if fitted). Replace the lid, turn until it drops into position and bolt securely.



Insert for back shielded source holders

Overleaf is a typical example of the Approval sheet to return a radioisotope container to one of QSA Global's authorised distributors (High Technology Sources Ltd - HTSL)

**Approval to return a radioisotope transport container to
High Technology Sources Limited**

Instructions – ONE SHEET PER CONTAINER

Please fill in details in block capitals, or type and fax to:
High Technology Sources Limited at (international code) 44 (0) 1235 514219
before giving the container to the carrier for return.

The container must be prepared for shipping following the instructions
included in this package.

The container may be returned only when you receive back a fax copy of this
form from High Technology Sources Limited marked 'Approved'.

Contact (name) (fax number)

(full address) inc Company name (phone number)

Container reference and serial number as marked on container

Container is empty Container contains source(s) (enter details below) Container Transport Index



Unit 6 Moorbrook
Southmead Industrial Estate
Didcot Oxfordshire OX11 7HP
Tel: 01235 514200 Fax: 01235 514219
Web: www.hightechsource.co.uk
e-mail: info@hightechsource.co.uk

Source Details

Radio-isotope	Source Serial No.	Activity	Manufacturer	Date of Manufacture	Special Form No.

Approved for return by High Technology Sources Limited

Signed
Dated

Sources received by High Technology Sources Limited

Signed
Dated

HASS Source Yes No Tick Appropriate

IMPORTANT NOTICE TO CUSTOMERS

The relevant source certificate (decay chart) and/or source identity tag MUST accompany ALL sources being returned to HTSL.

10. Returning the container

10.1 General considerations

Before attempting to dispatch radioactive material, you should be familiar with ICAO, IATA, IMO and ADR regulations.

Note: ICAO Technical Instructions 6-1-1 require you to employ trained staff.

For road transport in Great Britain refer to the regulations as listed on the approval certificate.

Caution: failure to comply with the relevant legal requirements could make you and/or your company liable to prosecution.

With each shipment QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE provides an information package which details the return procedures for containers and radioactive sources. This information can be found inside a plastic wallet on top of the cork packaging material inside the transport container. Written approval must be obtained from QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE before any return shipments can be made.

10.2 Notification of return

An 'Approval to return a radioisotope transport container to QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE' form is enclosed in the package of documents and must be completed and a copy sent to QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE. A copy of the form will be sent to you once approval has been given for the return shipment.

Note: the customer is responsible for arranging transport and ensuring that the shipment complies with all relevant regulations.

10.3 Return of EMPTY container

10.3.1 Ensure that the container is empty. Do not return spent sources in containers labelled as empty.

10.3.2 Ensure the container and any other packaging is undamaged and complete. If any components are damaged contact our local QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE'S office or distributor for advice.

Ensure closure nuts and/or source transfer tubes are returned. A charge may be made for missing items.

10.3.3 Check that the non fixed contamination on the external surfaces of the container and the levels do not exceed 4.0Bq/cm² (beta/gamma) and 0.4Bq/cm² (alpha) when averaged over any area of 300cm². These values are specified in the IAEA Safety series TSR-1 and should be stated in your local rules.

10.3.4 Ensure the container is securely closed.

10.3.5 Remove all previous shipping labels.

10.3.6 Attach 'Empty having contained Radioactive Materials' label (see figure 1).

Note: for containers using depleted uranium shielding (e.g. 650L source changer) special documents are required for transport purposes. These containers can be transported empty as 'Radioactive Material, Excepted Package, UN2909, Articles manufactured from Depleted Uranium' provided that the surface dose rate is less than 5 µSv/hr (0.5 mrem/hr) and the conditions specified in 10.3.1-10.3.5 apply.

If the surface dose rate is >5 µSv/hr (0.5 mrem/hr), return container as section 10.4, except the proper shipping name should be 'Radioactive Material, Low Specific Activity (LSA-1), and the UN number should be UN2912.

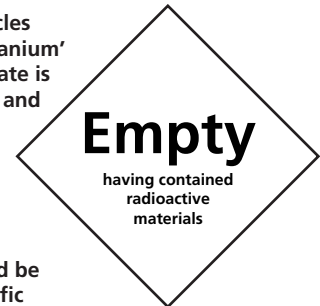


Figure 1

10.3.7 Complete and firmly attach the address label (see **figure 2**) on to the container. The address label must include the correct UN number for the package and the identification of the consignor or consignee, including excepted and empty packages. The example in **Figure 2** is for one of QSA Global's authorized distributors.


From	
Date	Contents
to	
High Technology Sources Limited	UN _____
Unit 6, Moorbrook, Southmead Industrial Estate, Didcot, Oxfordshire OX11 7HP United Kingdom	
SENTINEL	<small>HIGH TECHNOLOGY SOURCES LTD</small>

Figure 2

10.3.8 Pass the container to the carrier for return to QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE. If the container is being despatched from overseas, consign the shipment to QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE through their UK agents:

10.3.9

DHL Global Forwarding
Danzas House
Kestrel Way
Dawley Park
Hayes
Middx UB3 1HJ

Radioactive Customer Service
DHL Global Forwarding

Telephone +44 (0)1753 765 487
Facsimile +44 (0)1753 765 498

Returnable containers must be returned at the customer's expense otherwise a charge will be made. If the container is being returned from within Great Britain the customer may either arrange despatch or QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE can arrange collection. Where applicable QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE will charge for carriage.

If there are any problems which result in you not being able to return the container promptly please contact your local QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE'S office immediately.

10.4 Shipping instructions for Type B packages outside the USA
(Only applicable to non-fissile packages carrying Special Form material.)

Written authority from QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE must be obtained before any source may be returned. All packaging and return instructions, as included with the returnable container, must be followed without exception, so that the return is made safely and in compliance with all regulations.

Important: If you are returning a container with radioactive material, it is your legal responsibility to properly label the container and complete the required shipper's declaration or certificate and to ensure that the provisions of the transport regulations are observed.

Shipment of radioactive material must be performed in accordance with the most recent revision of the IAEA Regulations for the Safe Transport of Radioactive Material, (IAEA TS-R-1). Below is a summary of these regulations to assist the user to ship a Type B package of radioactive material properly. The consignor must assure compliance with these requirements in addition to any local regulatory requirements.

10.4.1 All required inspection and maintenance for the Type B package must be performed in accordance with the instruction manual provided for the Type B package.

10.4.2 Load the source into the container as defined in the handling and packaging instructions supplied with the container.

Note: Gamma radiography sources that are supplied without source holders are shipped in an insert. The source will be located in a blind hole in the lower half of the insert, or in a screw-top can which is self-locating in the lower half of the insert. The top half of the insert (top plug) ensures that the source is retained in the shielding during transport.

When returning sources, it is essential that the returned source is loaded in the same insert (top and bottom half, and screw-top can if used) as used to supply the original source. The source must be correctly located in the insert.

10.4.3 Using appropriate dose rate meters measure the dose rate on all surfaces, and at a distance of one metre from the container. The maximum surface dose rate must be less than 2 mSv/hr (200 mrem/hr). If a higher dose rate is detected anywhere on the surface of the container then check that the sources are correctly positioned in the lead pot or source changer and that all shielding components are properly in place.

Determine the maximum radiation level in units of millisieverts per hour (mSv/hr) at a distance of one metre from the external surfaces of the package, overpack, freight container, or unpackaged LSA-1 and SCO-1. The value determined shall be multiplied by 100 and the resulting number is the transport index (TI).

10.4.4 Prior to shipment ensure the package and its contents meet the following requirements:

- a. The contents are authorised for use in the package.
- b. The package is in good physical condition for transport.
- c. All locks or required shipping plugs are properly installed.
- d. All conditions of the Type B and Special Form certificates are met.
- e. A copy of the Special Form certificate for the sealed source is on file.

10.4.5 Ensure that the source is secured in the proper shielded position in the shipping package.

10.4.6 Attach a security seal with an identification mark to the package closure.

10.4.7 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.

10.4.8 Survey the exterior surfaces of the package and ensure that the maximum radiation level does not exceed 2 mSv/hr (200 mrem/hr). Survey one metre from the exterior surfaces of the package and ensure that the maximum radiation level does not exceed 0.1 mSv/hr (10 mrem/hr). Determine the proper shipping labels to be applied to the package using the criteria given in **Table 1**.

	Maximum radiation level at surface	Maximum radiation level at 1 metre
Radioactive White I	0.005 mSv/hr (0.5m Rem/hr)	None
Radioactive Yellow II	0.5 mSv/hr (50 mrem/hr)	0.01 mSv/hr (1.0 mrem/hr)
Radioactive Yellow III	2 mSv/hr (200 mrem/hr)	0.1 mSv/hr (10 mrem/hr)

Table 1

Properly complete two shipping labels indicating the contents (iridium-192, cobalt-60, etc.), the activity of the source in becquerels or multiple of becquerels and the transport index. The transport index is the dimensionless number (rounded up to the first decimal place) expressing the maximum radiation level (in mSv/μr) measured at one metre from the package surface and multiplied by 100.

10.4.9 Ensure that any old shipping labels have been removed from the package. Apply two properly completed labels to two opposite sides of the package.

10.4.10 If the package is shipped in an outer crate or other container, you must ensure that the outside of the package is marked with the proper shipping name and identification number (Radioactive Material, Type B(U) Package UN 2916), the words “inner package complies with prescribed specifications of Type B(U)” and the Type B identification number if not already marked.

10.4.11 If the package exceeds 50kg, ensure the outside surface of the package is marked with its gross mass in kilograms.

10.4.12 The non-fixed contamination on the external surfaces of any package shall be kept as low as practicable and, under routine conditions of transport, shall not exceed the following limits:

a) 4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters, and

b) 0.4 Bq/cm² for all other alpha emitters.

These limits are applicable when averages over any area of 300 cm² of any part of the surface.

10.4.13 Complete the shipping papers properly in accordance with the IAEA TS-R-1 regulations indicating:

- a. The UN class number (7) included by the consignor in the transport documentation.
- b. Proper shipping name and identification number (i.e. Radioactive Material, Type B(U) Package UN 2916).
- c. Name of the radionuclide (i.e. iridium-192, cobalt-60, cesium-137).
- d. Activity of the source in becquerels or multiple of becquerels, (i.e. Giga, Tera, Mega).
- e. Category of label applied (i.e. Radioactive Yellow II).
- f. Transport index.
- g. Type B(U)-** (current certificate i.e. -96) issued for Type B package.
- h. The Special Form certificate number for the capsule.
- i. The shipping papers must indicate the consignor’s signature and declaration using the following terms or equivalent:
‘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 labelled, and are in all respects in proper condition for transport by (insert mode of transport, i.e. air, road) according to the applicable international and national regulations’.

Note: for carriage of radioactive material packages requiring a White I, Yellow II or Yellow III label the vehicle carrying the package must be placarded on all four sides of the vehicle.

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 mSv/hr at a distance of one metre from the external surfaces of the package, multiplied by 100. When recording the TI, the dose rate units of mSv/hr are not listed. For example: a reading of 0.02mSv/hr would indicate a TI = 2.0. (Note that the TI is rounded to the nearest tenth value.)

10.4.14 Pass the container to the carrier for return to QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE. If the container is being despatched from overseas, consign the shipment to QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE through their UK agents:

DHL Global Forwarding
Danzas House
Kestrel Way
Dawley Park
Hayes
Middx UB3 1HJ

Radioactive Customer Service
DHL Global Forwarding

Telephone +44 (0)1753 765 487
Facsimile +44 (0)1753 765 498

Returnable containers must be returned at the customer's expense otherwise a charge will be made. If the container is being returned from within Great Britain the customer may either arrange despatch or QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE can arrange collection. Where applicable QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE will charge for carriage.

If there are any problems which result in you not being able to return the container promptly please contact your local QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE'S office immediately.

11. Inspection and testing

11.1 All guide tubes, cable connectors and other associated equipment must be inspected before use, as described in the equipment Operating and Maintenance Manual. Any damage or other causes for concern must be reported immediately to the person responsible for radiation protection and, for Sentinel equipment, to your local QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE'S office.

11.2 Capsule designs are assessed for their suitability for typical applications in accordance with the requirements of the International Organisation for Standardisation (ISO). The ISO classification is quoted in the Test Report provided with the source.

Please obtain advice from your local QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE office if in doubt as to the suitability of a source for a particular application.

11.3 Sources are tested for leakage and contamination in accordance with ISO standards before despatch. Results of the tests performed are quoted in the test report provided with the source.

11.4 Leak tests must be carried out regularly and at intervals required by local regulations. In the UK, IRR 1999 requires that a leak test be performed at least once every 24 months. A test to BS 5288 on the source itself is not possible unless shielded, remote handling facilities are available. To test for source leakage, the exit port of the projector or storage/transport container should be wipe tested and results recorded:

source identity
method used
date of test
result (numerical)
pass/fail statement (limits)
reason for test
remedial action if failure
testing organisation and signature.

11.5 Direct inspection of the source assembly is not possible (or safe) without specialised equipment. If normal source movements are difficult or impeded, damage can be inferred. In this case inform the person responsible for radiation protection and QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE. Seek further advice from your local radiological protection service.

Records of inspection and testing must be maintained for an appropriate period as specified in your national regulations.

12. Recommended working life

12.1 The 'Recommended Working Life' (RWL) is QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE's recommendation of the period within which the source should be replaced.

The period has been assessed on the basis of such factors as toxicity of nuclide, total initial activity, source construction, half-life of nuclide, typical application environments, and operational service experience and test performance data. The RWL is quoted in the test report provided with the source.

12.2 At the end of the RWL the source will normally be sent for disposal (see section 5.4 of these instructions). In some circumstances related to conditions of use, routine inspections performed and records kept, an independent examination of the source may lead to an extension of the RWL. The examination must be performed by QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE or by another recognised competent authority.

13. Feedback

QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE strives at all times to provide products and services that are suitable for the required applications together with information which will ensure safe use of these products. Information from users regarding the performance of sources in their specified or agreed applications is important to QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE's continuing programme of development and the company welcomes such information.

All goods and services are sold subject to the terms and conditions of sale of QSA GLOBAL OR THEIR AUTHORISED REPRESENTATIVE. A copy of the terms and conditions is available on request.

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