HIGH TECHNOLOGY SOURCES LIMITED

**Handling Instructions**

**Gamma Radiography Sources of Ir-192, Se-75, Cs-137 and Yb-169**

## Warnings

**Gamma radiography sources containing Ir-192, Se-75, Cs-137 and Yb-169 emit harmful gamma rays and are capable of delivering potentially fatal doses of radiation if not used correctly. Read these instructions carefully before starting work.**

## Key Instructions

- Assess the risks associated with the work before starting.
- Plan effective control measures.
- Develop a contingency plan to cover foreseeable incidents.
- Consult with a qualified radiological safety professional to ensure the necessary measures are in place for safety and regulatory compliance.
- Ensure all staff involved in using, storing, transporting or disposing of gamma radiography sources have read and understood these instructions.
- Only suitably trained and qualified staff can work with gamma radiography sources.
- Staff working with gamma radiography sources must be adequately supervised.
- Ensure the source is protected from unauthorised access and theft at all times.
- Radiography devices and equipment must be fit for purpose and regularly maintained in accordance with the manufacturer's instructions.
- Follow the manufacturer's instructions for use of radiography devices and source changers.
- Do not modify gamma radiography sources, devices or equipment.
- Perform a survey with a portable radiation monitor after each exposure to ensure the source is fully shielded.
- Never handle gamma radiography sources with your hands.

**Contents**

# 1 Regulations

Before ordering or using gamma radiography sources customers must take whatever actions are necessary to comply with their national regulations governing the storage and use of such sources. In most countries regulations are closely related to the International Atomic Energy Agency (IAEA) regulations and codes of practice.

For customers in the UK the relevant legislation is as follows;

The Ionising Radiations Regulations 2017 (IRR17) apply in England, Wales and Scotland and are enforced by the Health and Safety Executive (HSE). In Northern Ireland the equivalent is the Ionising Radiations Regulations (Northern Ireland) 2017 (IRRNI2017) and is enforced by the Health and Safety Executive Northern Ireland (HSENI).

The Environmental Permitting (England and Wales) Regulations 2016 (EPR16), as amended in 2018, applies to England and Wales. In England this is enforced by the Environment Agency (EA) and in Wales by Natural Resources Wales (NRW).

The Environmental Authorisations (Scotland) Regulations 2018 (EASR18) applies to Scotland and is enforced by the Scottish Environmental Protection Agency (SEPA).

The Radioactive Substances Act 1993 (RSA93) and the Radioactive Substances Exemption (Northern Ireland) Order 2011 apply in Northern Ireland and are enforced by the Northern Ireland Environment Agency (NIEA).

Most gamma radiography sources will fall into the category of High Activity Sealed Source (HASS) and special requirements apply. These requirements will be detailed in the permit or registration.

For shipments by air the regulations are specified by the International Civil Aviation Organisation (ICAO) and enforced by the Civil Aviation Authority (CAA). The International Air Transport Association (IATA) publishes internationally recognised regulations that are intended to ensure compliance with national regulations.

For shipments by sea the International Maritime Organisation (IMO) publishes regulations that are intended to ensure compliance with national regulations.

The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG2009) is enforced by the Office for Nuclear Regulation (ONR).

The Export of Radioactive Sources (Control) Order 2006, as amended 2009, is enforced by HM Revenue and Customs.

Gamma radiography sources are often transported in packages that contain depleted uranium shielding. Movements of depleted uranium are covered by the UK Nuclear Safeguards programme and accountancy reports must be made to the UK Safeguards Office which is part of the Office for Nuclear Regulation (ONR).

Movements of gamma radiography sources between member states of the EU are covered by the Council Regulation (EURATOM) 1493/93.

Prior to receiving a gamma radiography source customers in the UK must;

Appoint a qualified Radiation Protection Adviser (RPA) and take their advice on compliance with the current regulations.

Obtain consent from the HSE to carry out industrial radiography.

Obtain an Environmental Permit from the EA, NRW or SEPA or a Registration from NIEA, as applicable, for the premises where the source will be used or a mobile Permit/Registration if it is to be used in multiple locations.

Advice on compliance with UK legislation can be found at www.gov.uk/guidance/regulatory-controls-for-radiation-protection-in-the-uk.

## 2 Radiological Safety

### 2.1 General principles

The techniques that can be used to reduce personal exposure to the external radiation from gamma radiography sources are;

- Reduce the activity of the source.
- Reduce the time exposed.
- Increase the distance between personnel and the source of the radiation.
- Provide shielding such as concrete, steel, lead or depleted uranium.

These techniques can be incorporated into appropriate control measures designed to reduce exposure to 'as low as reasonably achievable' (ALARA) or in the UK the term 'as low as reasonably practicable' (ALARP) is used. Control measures fall into three categories;

- Engineered controls such as shielded radiography bays with doors interlocked to a dose rate monitor.
- Systems of work such as operating procedures and contingency plans.
- Personal Protective Equipment (PPE).

It is preferable to use an engineered control such as a shielded radiography bay rather than relying on a system of work such as establishing an exclusion zone around an area where gamma radiography is taking place. If an engineered control is used then consideration must be given to how it is maintained and tested.

Systems of work would include the use of equipment such as electronic integrating dosimeters and portable radiation monitors as well as procedural controls. Electronic dosimeters and radiation monitoring equipment must be suitable for the task and be visually inspected and function checked regularly and subject to an annual calibration. The advice of a radiological safety professional should be taken on the correct instrumentation to use.

### 2.2 Advice and guidance

The advice of a qualified radiological safety professional should be sought before starting work with gamma radiography sources. In many countries this is a legal requirement e.g. in the UK you must consult with a qualified Radiation Protection Adviser (RPA). The radiological safety professional will specify the regulations you need to comply with and can advise on the adequacy of your arrangements to ensure safety and regulatory compliance.

In the UK the Health and Safety Executive (HSE) publish safety guidance for industrial radiography, 'HSE information sheet Industrial radiography - managing

radiation risks, Ionising Radiation Protection Series No. 1 (rev 2 - 2018)' which can be found at www.hse.gov.uk. Similar guidance is available in other countries.

2.3 Risk assessment

The risks associated with using, storing, transporting and disposing of gamma radiography sources should be assessed at each location where they may be used. The assessment should identify appropriate engineered controls, systems of work and personal protective equipment. In many countries it is a legal requirement to perform and document a risk assessment before starting work. Risk assessments should be reviewed by a qualified radiological safety professional.

2.4 Training and supervision

All staff working with gamma radiography sources and involved in processes such as storing, using, transporting or disposing should be suitably trained and qualified for the activities they are required to perform.

Adequate supervision must be provided to ensure that staff follow procedures correctly. In the UK it is a requirement to appoint one or more Radiation Protection Supervisors (RPS) to supervise work in controlled areas.

2.5 Contingency planning

Consider all likely incidents and develop a contingency plan to mitigate the consequences if these incidents occur. Two likely scenarios are as follows depending on the type of radiography device being used;

- Gamma radiography devices that are designed to project the source out of the radiography device into a guide tube pose a risk that the source may get stuck in the guide tube or may become disconnected from the drive cable.

- Gamma radiography devices that expose the source by the movement of a shutter mechanism with the source remaining in the device pose a risk of the shutter jamming so it is not possible to shield the source.

It is essential that you have a recovery procedure for dealing with these situations as the unshielded dose rate from gamma radiography sources is significant. The plan should include the provision of emergency equipment such as local shielding, emergency containers and handling equipment. Staff must be trained to carry out the recovery procedure and must periodically practice it.

Modern radiography devices are generally interlocked in such a way that it is not possible for the source to be lost outside of the device or guide tube. You should confirm that this is the case with the equipment you are using. If not then this risk must be mitigated, preferably by changing the equipment so it is not possible for the source to be lost outside of the device or guide tube. If the equipment cannot be changed then procedures must be introduced that ensure early detection and recovery of the situation. It is essential that all staff working in the vicinity know what the source looks like (a photograph is supplied with the source) so they would recognise it in the event of an incident and not attempt to handle it.

Gamma radiography sources consist of robust welded capsules and are supplied with a certificate that confirms they have been leak tested. The risk of ingestion of radioactive material is low unless there is a risk of extreme mechanical damage.

Other potential incident situations may be possible depending on the local conditions of use and these should be identified through the risk assessment process and planned for accordingly.

# 3 Security

3.1 General

Gamma radiography sources pose a serious risk to health if handled by unauthorised persons and may be a potential target for terrorist organisations. Measures must be taken to ensure they are adequately protected at all times. Regular accountancy checks must be made on all gamma radiography sources to ensure early detection if a source is missing. The loss or theft of a gamma radiography source can have serious implications for your business including enforcement action and adverse publicity.

3.2 Advice and guidance

The International Atomic Energy Agency (IAEA) Code of Conduct for the Safety and Security of Radioactive Sources is available on the IAEA web site at www.iaea.org and forms the basis for security legislation for radioactive sources in many countries including the UK. National regulators often publish their own advice or specify the security standards that must be adopted. In the UK security requirements are specified in the Permit or Registration.

3.3 Security planning

A security plan should be developed to cover how the gamma radiography sources will be protected during use, storage, transport and disposal at all locations where they are used. The plan should consider physical measures such as secure cages and compounds, detections measures such as security guards, closed circuit TV and alarms and the response to a break in or theft. The measures need to take account of national regulations and the local threat situation. The plan should also consider the background checks that will be carried out as part of the recruitment process and the training given to staff on security awareness and procedures.

# 4 Receipt and Storage

4.1 On receipt of the gamma radiography source check that the package has not been damaged or tampered with. If in doubt then do not use the source and contact HTSL.

4.2 Monitor the dose rate on the surface of the package as soon as it arrives and ensure it is consistent with the label category and Transport Index (TI) marked on the package. If there is a discrepancy then do not use the source and contact HTSL. For reference;

- The TI is shown on the hazard label and is the dose rate in uSv/h at 1m from the surface of the package.
- White I label category means surface dose is not more than 0.005mSv/h.
- Yellow II label category means the surface dose > 0.005mSv/h and not more than 0.5mSv/h.
- Yellow III label category means the surface dose is > 0.5mSv/h and not more than 2mSv/h.

4.3 Gamma radiography sources must be stored in a secure storage area whenever they are not in use.

4.4 Monitor the dose rate on the outside of the store to ensure the dose rates comply with local requirements. The packages used to transport gamma radiography sources are adequately shielded to comply with international transport regulations but this may not be sufficient for storage and additional shielding may be required. Generally, dose rates outside the store should be less than 2.5 uSv/h, otherwise it would be necessary to designate the area outside the store as a supervised (or controlled) area.

4.5 Update records to show receipt of the gamma radiography source. Accurate records must be maintained showing receipts and disposals together with the location of all sources. Regular checks should be made to ensure these records are correct.

4.6 In addition to these handling instructions the gamma radiography source will be supplied with a metal tag with the source details engraved on it, a source certificate, decay chart, return labels and a picture of the source or source holder. If any of these items are missing then contact HTSL. The metal tag should be attached to any device that the source is transferred to. The source certificate should be retained as it will be required at time of disposal.

## 5 Source Transfer

5.1 The source may be supplied in a radiography device and is ready for use or it may have been supplied in a source changer and must be transferred into a radiography device before use. If the source is supplied in a source changer then proceed as follows;

5.2 Ensure you have the current version of the manufacturer's manual for the source changer. If in doubt contact HTSL.

5.3 Ensure you have the current version of the manufacturer's manual for the radiography device. If in doubt contact the supplier of the device.

5.4 Only suitable trained and qualified staff may transfer gamma radiography sources.

5.5 Wear the dosimetry and any PPE that has been specified.

5.6 Ensure the equipment required for the contingency plan is available before starting work.

5.7 Ideally the transfer should be done in a shielded radiography bay with a door interlocked to a radiation monitor. Local procedures must be established to cover testing and calibration of the monitor, testing and maintenance of the interlock and clearing personnel from the bay prior to closing the door. A qualified radiological safety professional should be consulted on the controls that should be applied.

5.8 If a shielded radiography bay is not available then the use of local shielding and/or suitable exclusion zone can be used. In the UK exclusion zones must be designated as 'controlled areas' with specific 'local rules'. In the UK controlled areas will be required where dose rates exceed 7.5 uSv/h. Similar requirements will apply in other countries. Local procedures must be developed to establish the size of the exclusion zone, how the exclusion zone will be cleared of personnel and how personnel will be prevented from entering during transfers.

5.9 Follow the instructions in the manufacturer's manual for the radiography device and source changer during the transfer process.

5.10 Attach the guide tube to the radiography device and to an empty hole in the source changer. Any bends in the guide tube must have a radius of more than 500mm.

5.11 Place a dose rate meter in a position where it can be observed close to the transfer tube.

5.12 Follow local procedures to close the door on the radiography bay or to clear and protect the exclusion zone, as applicable.

5.13 Transfer source into source changer.

5.14 Observe the dose rate increase as the source passes through the guide tube and then decrease as the source becomes shielded in the source changer. If this pattern is not observed then do not proceed, initiate contingency plan.

5.15 Check that the source has transferred fully into the source changer by surveying the guide tube with a portable radiation monitor. Note that gamma radiography sources containing Yb-169 emit lower energy gamma rays than Ir-192 or Se-75 and it is not always possible to detect the source if it is within a heavily shielded container. It is essential therefore to monitor the entire length of the guide tube to confirm the source has fully retracted into the shielding. Monitoring the source changer or radiography device may detect low dose rates (up to 20uSv/h) due to the depleted uranium shielding that could mask the presence of a source.

5.16 Disconnect the guide tube at the source changer.

5.17 Disconnect the source from the drive cable by moving the pin on the source connector towards the source and then sliding the ball on the end of the drive cable out through the slot in the source connector.

5.18 Secure the old source in the source changer as per the manufacturer's manual.

5.19 Attach drive cable to new source.

5.20 Attach guide tube to source changer at new source location.

5.21 Follow local procedure to close the door on the radiography bay or clear and protect the exclusion zone, as applicable.

5.22 Transfer new source into radiography device.

5.23 Observe the dose rate increase as the source passes through the guide tube and then decrease as the source becomes shielded in the radiography device. If this pattern is not observed then do not proceed, initiate contingency plan.

5.24 Check that the source has fully transferred into the radiography device using a portable monitor as per step 5.15.

5.25 Disconnect transfer tube from radiography device and source changer.

5.26 Fit the source tag onto the radiography device and update records.

## 6 Use

6.1 Only suitably trained and qualified staff may use gamma radiography sources.

6.2 Ensure you have the current version of the manufacturer's manual for the radiography device. If in doubt contact the supplier of the device.

6.3 Do not modify the gamma radiography source or device as this may cause it to malfunction.

6.4 Do not use the gamma radiography source or device in a corrosive environment as this may cause the equipment to malfunction.

6.5 Do not use oil based lubricants as the oil may be affected by the radiation and cause the device to malfunction.

6.6 Do not misuse gamma radiography devices and equipment or expose them to risk of mechanical damage as this may cause the equipment to malfunction.

6.7 Radiography devices that are designed to project the source outside of the shielding must be used with a guide tube with a closed end to prevent any risk of the source being lost outside of the guide tube.

6.8 Ensure the equipment required for the contingency plan is available before starting work.

6.9 Wear the dosimetry and any PPE that has been specified.

6.10 Ensure the radiography device and equipment is fit for purpose and has been maintained in accordance with the manufacturer's instructions.

6.11 Follow the instructions for the radiography device shown in the manufacturer's manual.

6.12 Radiography may be carried out in a shielded radiography bay with a door interlocked to a radiation monitor. Local procedures must be established to cover testing and calibration of the monitor, testing and maintenance of the interlock and clearing personnel from the bay prior to closing the door. In the UK the radiography bay must be designated as a 'controlled' area with specific 'local rules'. Similar requirements will apply in other countries. A qualified radiological safety professional should be consulted on the controls that should be applied.

6.13 Radiography may be carried out using local shielding and/or suitable exclusion zone to restrict exposure to personnel. In the UK exclusion zones must be designated as 'controlled areas' with specific 'local rules'. Similar requirements will apply in other countries. Local procedures must be developed to establish the size of the exclusion zone, how the exclusion zone will be cleared of personnel and how personnel will be prevented from entering during exposures.

6.14 A dose rate monitor should be placed in a visible location close to the guide tube. Each time the source is exposed the reading on this meter should be observed to increase. Each time the source is retracted the reading should be observed to fall. If this pattern is not observed then do not proceed with further exposures and initiate contingency plan.

6.15 After each exposure check that the source is fully shielded by surveying the area with a portable radiation monitor. This must be done even if the work is being carried out in a shielded bay with an installed gamma alarm as the source may be partially shielded from the detector by the radiography container or the test piece.

6.16 For radiography devices that project the source outside of the shielding the guide tube must be monitored to ensure the source has fully retracted. Note that gamma radiography sources containing Yb-169 emit lower energy gamma rays than Ir-192 or Se-75 and it is not always possible to detect the source if it is within a heavily shielded container. It is essential therefore to monitor the entire length of the guide tube to confirm the source has fully retracted into the

shielding. Monitoring the source changer or radiography device may detect low dose rates (up to 20uSv/h) due to the depleted uranium shielding that could mask the presence of a source.

6.17 Never attempt to pick up a gamma radiography source with your hand. A picture of the source is supplied and all staff working with gamma radiography sources should be familiar with what it looks like.

6.18 The gamma radiography source must be continuously supervised when in use even if it is retracted into the radiography device.

## 7 Transport

7.1 Ensure you have a current Type A or Type B certificate for the radiography device or source changer that is being transported. If in doubt then consult the supplier.

7.2 Ensure you have a current special form certificate for the source being transported. If in doubt consult HTSL.

7.3 Only suitably trained and qualified staff my prepare gamma radiography sources for transport.

7.4 Ensure that the radiography device or source changer is prepared for transport in accordance with the manufacturer supplied Operating and Handling Instructions.

7.5 Monitor and label the container in accordance with national regulations for the mode of transport i.e. road, sea or air.

7.6 Ensure the carrier used is authorised under national regulations to carry radioactive materials.

7.7 Ensure the driver is suitably trained and qualified to carry radioactive materials and has a contingency plan in case of emergency. In the UK it is also a requirement that the consignor has a suitable contingency plan for transport.

7.8 Plan the security measures to be taken during transport including provision for driver rest breaks and overnight stops.

7.9 Ensure the vehicle is placarded and marked in accordance with national regulations.

7.10 Update source accountancy records each time a source is moved.

## 8 Return of Decayed Sources

8.1 To return a decayed gamma radiography source to HTSL complete an 'approval to return form' that is available from HTSL's web site at www.hightechsource.co.uk.

8.2 HTSL will review the information on the form and then send a confirmation that the source can be accepted back by HTSL.

8.3 If HTSL are unable to accept the source back then they will contact you to discuss arrangements to dispose of the source locally.

8.4 Use the return labels provided and follow the instructions in section 7 to prepare the source for transport.

8.5 If you are based in the UK then HTSL will arrange for an approved courier to collect the source.

8.6 If you are outside of the UK then you need to arrange to return the source to HTSL via a UK port or airport. You are responsible for shipping the source to the UK port or airport. HTSL will arrange customs clearance and collection from there. Note that regulations for shipment by sea or air differ from road transport and there may be a requirement to obtain an export licence to ship the source out of the country you are in. HTSL will need a copy of the air waybill or bill of lading in advance.

8.7 Upon receipt at HTSL the source details will be checked and a confirmation of receipt sent to you for your records.

## 9 Contact HTSL

Contact HTSL at info@hightechsource.co.uk

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