

Radiation Safety procedure

Ondergetekenden verklaren inhoudelijk akkoord :

Opgesteld door:	Geautoriseerd door:	Vrijgegeven door:
Art. 5.1 lid 2 onder e)		
Gemandateerd Toezichhoudend Medewerker Stralingsbescherming	Gemandateerd Coördinerend Deskundige	QHSE Manager
Handtekening	Handtekening	Handtekening

CONTACT DETAILS

Radiation Protection Expert (RPE)

Art. 5.1 lid 2 onder e

+31 (0)6

RT Supervisor / RPO

Art. 5.1 lid 2 onder e

+31 (0)6

RPO Belgium

Art. 5.1 lid 2 onder e

+32 (0)

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1 PURPOSE

The purpose of this procedure is to describe how to handle ionizing radiation safely with regard to:

- + Working with radioactive substances and X-ray equipment in a bunker.
- + Working with radioactive substances and X-ray equipment outside a bunker.
- + The safe storage of radioactive substances.
- + Security around the storage of radioactive substances.
- + Transporting radioactive materials.

It also describes the tasks and responsibilities of personnel who work directly or indirectly with ionizing radiation, including the associated mandatory administration.

This handbook contains specific instructions applicable to: handling, transporting and storing isotopes and X-ray equipment.

The content of this instruction applies to all locations of Quality Inspection Services B.V. (trade name: Team Industrial Services – Inspections Netherlands).

2 REFERENCES

- + TEAM-NL-SV-BVP Security plan
- + QIS SV008.2 Tien geboden t.b.v. beveiliging radioactieve isotoop
- + SV200 Instructie new personnel
- + TEAM-NL-SV-RIEE Risk analyse

- + Toolbox Radiation
- + Bunkerprotocol

- + Vergunning 2017-0885-09 opslag en handelingen met toestellen en radioactieve stoffen
- + Vergunning ANVS-2017/6670 vervoer van radioactieve stoffen over de weg in Nederland

- + Besluit Basisveiligheidsnormen Stralingsbescherming
- + PRL Stralingsbescherming NDO (o.b.v. SSG-11)
- + Diverse Ministeriele Regelingen inzake stralingsbescherming
- + Besluit vervoer splijtstoffen, ertsen en radioactieve stoffen
- + Regeling Vervoer over Land Gevaarlijke stoffen(VLG)

- + Staatscourant 2018 - nr. 1349
- + Staatscourant 2018 - nr. 2035
- + Staatscourant 2018 - nr. 4952

3 COMPANY DETAILS

Nederland	
Quality Inspection Services B.V.	
Kuisel 11, 4703 RL Roosendaal	
+31 (0) 165 554849	
info@qis-ndt.nl	

3.1 Bunker location

Nederland	
Kuisel 11, 4703 RL Roosendaal	

3.2 Contact person

Nederland	
Radiation Protection Expert	Art. 5.1 lid 2 onder e Diploma Ioniserende Straling Niveau CD + 31 (0) Art. 5.1 lid 2 onder e
QHSE Manager	Art. 5.1 lid 2 onder e

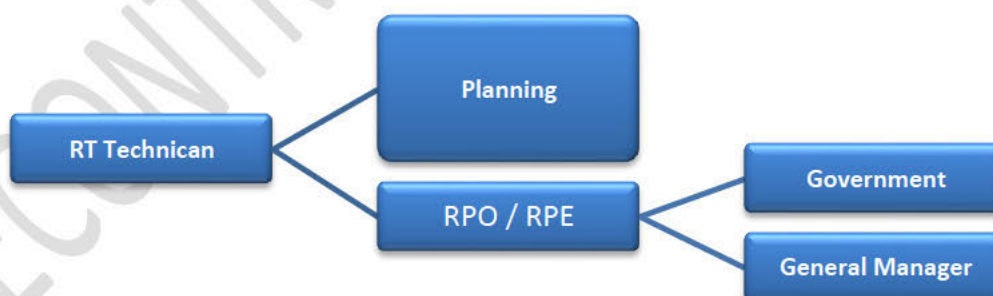
Nederland	
Radiation Protection Officer	Art. 5.1 lid 2 onder e Diploma Ioniserende Straling Niveau CD + 31 (0)6
Gemandateerd Toezichthoudend Medewerker Stralingsbescherming (TMS)	Art. 5.1 lid 2 onder e +32 Art. 5.1 lid 2 onder e Art. 5.1 lid 2 onder e, +31 (0) Art. 5.1 lid 2 onder e
Stralingsarts	

3.3 Calamiteiten team

In case of an emergency, the following persons will be contacted:

- + Art. 5.1 lid 2 onder e Radiation Protection Expert (RPE)
- + Art. 5.1 lid 2 onder e Supervisor RT / Radiation Protection Officer (RPO)
- + Art. 5.1 lid 2 onder e Radiation Protection Officer (Belgium)

Only the RPE or RPO will communicate with government agencies.



4 AUTHORITIES

The following authorities are only approached by the mandated supervisory employee for radiation protection after consultation with the coordinating expert.

4.1 Netherlands

Autoriteit Nucleaire Veiligheid en Stralingsbescherming (ANVS)

Adres	Bezuidenhoutseweg 67, 2594 AC Den Haag
Post	Postbus 16001, 2500 AB Den Haag
Plaats	Den Haag
Telefoon	+31 (0)70 348 74 25 / 088 – 489 0500

Inspectie SZW (Ministerie van Sociale Zaken en Werkgelegenheid)

Adres	Postbus 820, 3500 AV Utrecht
Contact persoon	Hr. Art. 5.1 lid 2 onder e
Melding sturen	Art. 5.1 lid 2 onder e @minszw.nl
Telefoon	+31 (0)800 51 51

Arbodienst/Stralingsarts

Naam	Arbo Unie bv
Arts	Art. 5.1 lid 2 onder e
Telefoon	+31 (0) Art. 5.1 lid 2 onder e of +31 Art. 5.1 lid 2 onder e

In geval van diefstal, vermissing met de colli Nederland

Naam	Bureau Conflict en Crisisbeheersing
Telefoon	112

5 RESPONSIBILITIES

5.1 Entrepreneur

The entrepreneur is responsible for applying for and obtaining the necessary permits for the possession and use of X-ray equipment and isotopes.

The entrepreneur is also responsible for taking measures to ensure that maximum exposure values (effective dose) as a result of the activities under his responsibility are not exceeded.

These maximum values are:

- **A member of the population outside the location 0.1mSv in a calendar year**
- **A member of the population within the location 1mSv in a calendar year**
- **An "A-worker" exposed 20mSv in a calendar year**
- **An exposed "B worker" 6mSv in a calendar year**

The entrepreneur is legally responsible and has appointed a registered coordinating expert, under whose direct responsibility the radiation work is carried out.

The coordinating expert is sufficiently aware of:

- The dangers of ionizing radiation.
- The way in which sufficient shielding can be obtained and the monitoring of this.
- Statutory regulations, guidelines and permit regulations in the field of ionizing radiation.
- The way in which radiation protection is obtained and the monitoring thereof. The way in which protection can be obtained and the control of sufficient protection.
- The working methods and activities in which X-ray equipment or isotopes are used.
- The dangers of ionizing radiation.

Furthermore, the entrepreneur must provide clear work instructions which are laid down in the instruction QIS SV001 Radiation safety handbook.

Radiation supervisory staff and assistants receive a refresh course on radiation safety at least every two years.

5.2 Radiation Protection Expert (RPE)

The RPE is appointed by the entrepreneur in writing and must be registered in accordance with Art. 5.5 BBS. The RPE is regarded as an extension of the entrepreneur with regard to radiation expertise, radiation safety and monitoring.

The Coordinating Expert is responsible for:

- Annual check of the radiation safety system.
- Carry out annual contamination checks on isotope containers and accessories.
- Carrying out RI&E related to the entrepreneurial goal, taking into account the interests of employees and becoming part of the management system.
- Advising the entrepreneur on possible improvement of the radiation management system.
- Approval annual report.
- Annual control visits of main and regional locations.

5.3 Radiation Protection Officer (RPO)

A RT Technician is mandated as RPO. He is responsible for ensuring that the administration in the KEW is in order. He is the first point of contact in case of calamities. The tasks and responsibilities of the mandated RPO are described in his/her mandate

5.4 RT- Technician

The Radiographer is in possession of a valid TMS diploma or equivalent. In addition, this employee is in possession of a valid RT Level 2 certificate.

The Radiographer is assigned to carry out radiation work with due observance and strict compliance with these work instructions on Radiation and Safety.

5.5 Assistant

Employees who do not have a valid diploma as a radiation supervisor or equivalent, but who work as assistants, must have received sufficient written instruction about the dangers and risks associated with ionizing radiation. The assistant is supervised by the radiographer with at least a TMS or equivalent training.

All employees who work with equipment and/or isotopes that emit ionizing radiation are classified as category A employees due to the risk of a potential increased dose.

6 COMMUNICATION

All communication with clients and government agencies regarding the subject of Radiation Safety must be done exclusively via the RPO or RPE.

The radiographer reports radiation-hazardous situations to the Expert and officer by e-mail.

The RPE informs the employer (permit holder) annually through an annual report. These annual reports are directly accessible for inspection services or government agencies



7 ADMINISTRATION

The permit holder must keep records (legal requirement) that include the following:

- Registration of the number of exposures (the number of exposures is equal to the number of films used for that purpose, so in the case of use of a panoramic tube, the number of films is regarded as the number of exposures) stating the source strength or set current strength and tube voltage, radiation time, source, location and date. The registration takes place in QERP.
- Risk analysis.
- Registration of and removed highly active isotope.
- Registration of the cumulative dosimeter readings on the days that employees work. Keeping track of this cumulative dose is the responsibility of anyone working with ionizing radiation.
- Medical examinations and results TLDs must be registered and kept for at least 30 years.
- Overview of devices in use and isotope with technical data. This must be reported annually to the government.
- Annual renewal of the annual notification with an overview of the transports with isotopes from the previous year by sending the source registers (the Netherlands).
- Delivery and removal of used isotope and equipment including "Certificate of disposal" which must be provided by the supplier after receipt of the old isotope.
- Management of dosimeters and their calibration.
- Annual notifications for transport of radioactive materials and depleted uranium.
- Granted permits and permit applications.
- Letter regarding mandate registered RPO / RPE.

8 MEDICAL SUPERVISION

The entrepreneur ensures that employees classified as category A employees undergo a medical examination at least once a year by a recognized radiation expert as referred to in the Decree on Basic Safety Standards for Radiation Protection.

All category A employees must adhere to the agreements made by or on behalf of the entrepreneur and report for the inspection at the time set for this purpose.

If there is a suspicion or indication of a radiation overdose, the RPE will immediately contact the accredited physician and, if desired, take measures for an interim examination.

All employees who may come into contact with ionizing radiation are classified as category A employees.

9 APPLICATION

All actions involving radioactive sources and devices take place under the supervision of a (mandated) RPO.

All actions (transporting, working with and storing isotopes) involving ionizing radiation fall within the Basic Safety Standards for Radiation Protection Decree and may only be performed by or under the supervision of the radiographer.

All transport operations with the isotope outside the storage location are registered. There is a list (source register) in the isotope storage for this purpose. If an isotope is removed from storage, this is also indicated by means of the sliding board.

The transport of highly active sources is regulated annually by means of an annual notice reported to the government.

All radiation exposures are registered in QERP.

Data on radiation times and locations are used annually (in the annual report) to demonstrate to the permit holder and permit issuer what the radiation exposure has been at various locations. If it is estimated that more than 1000 exposures will be made per location, additional measures must be taken. If this is not feasible, the client and the Ministry of Housing, Spatial Planning and the Environment must be informed. Only the locations where more than 100 recordings were made are included in the annual report.

The personal safety and control equipment, which will be provided against a signed statement, consists of:

- Work instruction Radiation and Safety QIS SV001
- TLD (Thermoluminescent Dosimeter)
- Cumulative dosimeter, EPD (bleeper)
- Dose rate meter (e.g. PED blue)

The dose rate meter and bleeper (EPD) are effective between 45 keV and approximately 1.3 MeV. When working with low kV levels, consult your RPE about the use of correct dose rate meters.

During the work, the TLD, dose rate meter and cumulative dose meter (EPD) must be worn by the radiographer. The radiographer and assistant are in possession of a dose rate meter (one per person) to determine the radiation level at the deposit. It is also used to determine whether a source or device no longer emits radiation.

Calibration/verification of the dose rate meter is performed annually. An externally calibrated dose rate meter is used for this. The radiographer is responsible for exchanging (4 weekly) the TLD

10 STANDARD OPERATING PROCEDURE

- Always work in accordance with the radiation safety manual QIS SV001
- For radiation work outside the bunker, for example at a customer's site, at least 2 people are employed, of which at least 1 person is a certified radiation protection officer or equivalent.
- NEVER use an X-ray machine or isotope without a properly working dose rate meter, EPD and TLD. Make sure your EPD and dose rate meter have good batteries.
- Take a measurement using an active dose rate meter (on and readable) after each exposure to ensure that there is actually no more radiation (device is off and, in the case of isotope, the source has actually been turned on).
- When using isotopes, they must always be returned to storage after use. After use, the isotope container must be locked and the key must be removed (during transport and storage and after the end of work).
- Always use the personal control equipment provided to record the dose received. These means of control must be provided with a valid calibration sticker.
- Make use of the available materials to reduce unwanted radiation (e.g. use collimators, radiation screens, favorable possible radiation direction, etc.).
- Work safely, apply the ALARA principle.
- The start of a tube is done by a cat. A employee.
- Check the equipment to be used for soundness and proper functioning before starting the work. Damage or defects to the X-ray or isotope equipment must be immediately presented to the RPO and the planning. He will offer the equipment for repair to the competent authority. Give a clear description of the defect.
- If the barrier is ignored, stop the exposure and remain courteous and polite.
- All actions involving ionizing radiation must be carried out by or under the supervision of the radiographer. The assistant must have received sufficient written instruction (see Chapter 5, Responsibilities).
- Do not allow third parties to approach equipment that is in operation, nor leave this equipment unattended, with the key present.
- Persons under the age of 18 or pregnant women may not be involved in work involving ionizing radiation.
- Ensure that the dose rate on the outside of the bunker/deposit does not exceed 10 $\mu\text{Sv/h}$. With the exception of the permitted dose of 40 $\mu\text{Sv/h}$ at the tensioning (after acceptance of the RPE).
- Remember the terrain boundaries. The cumulative dose should not exceed 100 μSv per year.

The site boundary is usually the fence around the customer's property or the wall of the customer's building. Make sure you know what the terrain boundary is!
- Report undesirable behavior of third parties to your manager.
- Note the readings of the cumulative dosimeter for each day worked when handling ionizing radiation in the dose application. These positions must be demonstrable if requested by the RPE.
- If a cumulative dose of more than 100 μSv per day worked has been incurred with the EPD, the RPO or RPE will be notified in writing (email).

11 TECHNICAL INSTRUCTIONS

11.1 Isotope with remote controls

- Check whether the Go/No-Go test has been carried out, if not: carry out the Go/No-Go test prior to the work.
- Check whether the isotope container is in good condition.
- Check output hoses and mechanisms for kinks, damage and the like.
- Check the end and intermediate hoses for kinks and damage.
- Handle the isotope container with care. Avoid forcing the lock or latches.
- Remove the protective caps before use.
- Replace the protective caps after use.
- Make sure you know the correct activity of the isotope.
- Complete the source register if the source is used outside the location.
- Wear your TLD, cumulative dosimeter and dose rate meter when handling the isotope (including taking it in and out of the storage room) to guarantee the safety of yourself and others.
- Keep exposure times as short as possible due to the safety aspect (ALARA).
- Never leave the isotope container unattended.
- Make sure that the isotope container is locked during transport and after the work has been completed (key removed).
- Indicate radiation duration and used source with activity in the radiography reports.
- The isotope is always stored in the designated storage area after the end of the work.

11.2 X-ray tubes

- Include the equipment ID and radiation duration in the radiography reports.
- Take into account the radiation energy (kV), the effective dose increases exponentially with increasing radiation energy.
- Remove the key from the control panel after each shot.
- Remove the key from the control panel when the X-ray equipment is not in use.

11.3 PMI equipment

When using the PMI device, the instructions for use must be followed.

12 CHECKS ON EQUIPMENT

The specific instruction for performing checks on the X-ray and gamma equipment is included in the documents:

- "880 Manual MAN-027 NOVEMBER 2014" Sentinel 880 Delta,
- "MKT-MM-D120-2015-11-10-DRAFT-REV01-EN" Exertus Dual 120,
- "MKT-MM-RID-2015-11-06-DRAFT-REV01-EN" Gammamat RiD-Se4P,
- "SV006 WI Determination Leakage Radiation" X-ray equipment.

The maintenance actions performed are recorded in forms QMF-720, QMF-721, and QMF-2018. All maintenance of the source containers is done by a specialized company.

In general, the following is required:

The source container and accessories are checked daily before use by means of the Go/No-Go Gauge, see figure 1.



Figure 1. Go/No-Go Gauge

Gamma and X-ray equipment is visually checked at least once a year. X-ray tube is provided with a valid NEN3140 inspection. The stickers as in appendix 1, sign 1 cloverleaf and sign 3 "X-rays" must be visibly present.

13 SAFETY PRECAUTION RADIOGRAPHIC EXAMINATION

Wear your TLD, dose rate meter and your cumulative dosimeter on your upper body or front pocket when performing or handling ionizing radiation. The TLD must be returned to the NRG every four weeks. Every radiographer receives a new TLD every four weeks.

The cumulative dosimeter (EPD/bleeper) is intended for daily monitoring of the accumulated amount of effective dose. In case the effective daily dose exceeds 100 μ Sv, you must inform the mandated RPE or RPO in writing (email).

The cumulative dosimeter (EPD/bleeper) should never replace the radiation monitor (e.g. PED blue) and is used to record the dose you receive. The start and end position of the EPD is recorded daily by the radiographer.

The dose rate meters are intended to determine the dose rate at the deposit. Therefore, the cumulative dose rate monitors may not be used for this!

The radiographer is obliged to take measures to prevent entry into the controlled area and to prevent barriers from being broken through.

When entering a controlled zone by third parties, you must immediately stop work.

Simple safety measures that significantly reduce the radiation dose are:

- Actions in situations with an increased dose rate (e.g. insufficient shielding equipment) for the Radiographer, walking quickly to and from the control panel or device.
- Avoid situations with very high kVs as much as possible. High kVs deliver a much higher radiation dose than lower kVs. See appendix 3 as an example of the influence of tube current and tube voltage on radiation dose.
- Shielding. Provide sufficient shielding for yourself and use collimators.

14 OPERATIONS IN THE BUNKER

Every radiographer must have knowledge of the bunker protocol that must be present at the bunker. Operations in the bunkers are always carried out under his direct supervision.

For bunkers equipped with a sliding door for loading the bunker, the door must be locked before radiation is started. The radiographer on duty is responsible for this.

In situations where it is unavoidable that the primary beam is directed towards the wicket door, measures must be taken to keep the radiation dose rate below 10 $\mu\text{Sv/h}$.

15 OPERATIONS OUTSIDE THE BUNKER

For radiation work outside the bunker, for example at a customer's location, at least 2 people are employed, of which at least 1 person is a certified radiation protection officer or equivalent.

Report the work to the contact person on site and ensure that no third parties are inside the barrier before the radiation work is started.

If radiation work cannot be carried out safely, please contact the mandated RPO/RPE or your direct manager.

Precautions which considerably limit the radiation dose are:

- Shielding: Use the collimator to keep the amount of radiation as small as possible. Use other shielding equipment if necessary.
- ALARA: Act according to ALARA. Remember that an increase in energy/activity increases the effective dose exponentially.
- Distance: Stay as far away from the radiation source as possible. The length of the cable or reel should not be regarded as a safe distance.
- Use lead screens, lead mats or other means to reduce the effective dose rate.
- Make sure that the radiation direction is directed downwards as much as possible.

Remember that distance and time are the best protection. Work quickly and carefully and avoid exposure to the primary bundle for yourself and third parties.

- Create a controlled area with the signs/flags as shown in Appendix 1.
- Check the barrier for dose rate (max 10 $\mu\text{Sv/h}$) with an active dose rate meter, the dose rate must also be checked when the set-up is changed.
- Use Appendix 5 as a guideline for making a proper barrier.
- Remove the barrier as soon as the radiation work has been completed.

16 REGISTRATION, TRANSPORT AND STORAGE

The storage of isotopes may only take place at licensed locations and where a source storage approved by a mandated RPO/RPE has been realized.

16.1 Registration

The arrival of new isotopes (at the Roosendaal site) is handled by or under the supervision of a supervisory employee for radiation protection.

The mandated RPO/RPE handles the administrative processing and reports to the government (ANVS).

When using an isotope for radiographic, the isotope is returned to the isotope storage area immediately after use. The source registration book is completed by the radiographer, before the start of work and after the end of the work, stating:

- Source,
- date in/out,
- location,
- User/carrier name,
- Activity (in GBq) and
- Initials.

The isotope is exchanged at the Roosendaal location. From this location, the isotopes are transferred to the other locations. QERP is included which resource is assigned to which site. The site to which the resource is assigned remains responsible for this resource at all times and ensures that this resource is exchanged if necessary.

On the outside of each storage space it is indicated which source is present/not present.

Each radiographer has access to his/her site's source storage. Access to the source storage is realized through a trickle system.

16.2 Storage

Unauthorized persons, pregnant women and people under the age of 18 are prohibited from staying in the immediate vicinity of the storage area. Every radiographer is responsible for proper storage of isotope and X-ray equipment. Ensure proper storage of isotopes and devices to prevent loss or theft.

The same safety regulations (PPE) apply to the storage of isotopes as during radiographic work.

16.3 Transport

The transport license for isotopes applies to transport on Dutch territory and transport to and from the Antwerp branch by a driver with a valid ADR class 7 authorization. The Antwerp branch is licensed for the transport of isotopes across Belgian territory.

The driver is responsible for the transport preparation and registration of the isotope.

The source container must be properly secured in such a way that it cannot come loose under accident conditions. The source container must be locked and the key removed during transport.



Placing signs on vehicle



Placing signs on vehicle

If the shape of the vehicle does not allow for a large sign to be installed, a small sign may be used.

The source holder must be provided with Type II or Type III labels stating the type of source and activity (in GBq) including Transport Index (TI).

For a ⁷⁵Se isotope, a Yellow II label must be affixed to both sides of the source holder (and on both sides of the transport case) at all times of transport.

For a ¹⁹²Ir isotope, a Yellow III label must be affixed to both sides of the source holder (and on both sides of the transport case) at all times of transport.

If the source is no longer in the car, the signs must be removed/folded (where applicable).

16.4 Radiation level with vehicle.

Radiation level may not exceed 2 mSv/h on the outer surface of the vehicle.

Radiation level must not exceed 0.1 mSv/h at a distance of 2 meters from the outer surface of the vehicle.

As a rule for the driver is used:

- At the level of the driver, the effective dose may not exceed 10 µSv/h.
- For exposure of the radiographer (during transport), a residence time of 50 hours per year applies at a distance of 0.5 m from the packages or 250 hours at a distance of 1 m from the packages. Assuming dose rate at surface of packages is 2 mSv/h

When the dose rate is equal to or greater than 0.0025 mSv/h, the driver and any accompanying person must wear an appropriate dosimeter.

No passengers may be taken along during transport.

A maximum of 3 packages may be transported per transport with a maximum TI of 1.0. So 2x ⁷⁵Se with a maximum of 80 Ci each or 1 x ¹⁹²Ir with a maximum of 80 Ci each.

NOTE:

Weather conditions (fog, snow and/or rain) where the visibility is less than 50 meters or with a slippery road surface, the transport of ADR-C7 is no longer permitted.

During transport with isotope, the transport box with accompanying transport documents (in the transport folder) must be present: (Keep the documents in the cabin)

- Transport document
- Permit for transport
- Permit for handling and storage
- Instruction Radiation and Safety (Dutch, English)
- Written instruction according to ADR and hazard card (see appendix 2) (English, Dutch and German)
- Certificates of the source to be transported

The ADR car must be equipped with:

- Wheel chocks sized to match vehicle weight and wheel diameter=,
- Warning signs or lamps (2x),
- Liquid to rinse the eyes,
- 1 safety jacket per crew member,
- 1 lamp/flashlight per crew member,
- 1 pair of protective gloves per crew member,
- 1 safety goggles per crew member,
- A valid proof of identification of each crew member,
- A valid ADR C7 certificate.

Furthermore, the vehicle must be equipped with two fire extinguishers of 2 kg each of fire extinguishing foam, 1x in the cabin and 1x in the cargo area, a fire blanket and first-aid kit. Always pay attention to the validity of your inspection.

Never leave the vehicle unattended if the source(s) are inside the vehicle.

17 EMERGENCY

17.1 General information

In dit hoofdstuk wordt omschreven hoe er gehandeld dient te worden in noodsituaties. De acties die genomen moeten worden en de handelingen die verricht moeten worden zijn hieronder beschreven.

Er is sprake van een noodsituatie indien:

- + Een buitenstaander de afzetting niet opmerkt of negeert en tijdens het stralen binnen het afzetgebied komt.
- + Er diefstal en/of vermissing van isotoop of röntgentoestel is
- + Er brand of een ongeluk(aanrijding) tijdens transport is
- + Er, ten tijde van de stralingswerkzaamheden, inklemming van de bron in de eindslag is, waarbij deze niet terug wil in de bronhouder

This paragraph describes how to act in emergency situations. The actions to be taken and the actions to be performed are described below.

There is an emergency if:

- An outsider does not notice or ignores the barrier and enters the barrier area during radiation.
- There is theft and/or loss of an isotope or X-ray machine
- There is a fire or an accident (collision) during transport
- At the time of the radiation work, the source is jammed in the guide tube, whereby it does not want to return to the source holder.

17.2 Authorisation and responsibilities.

In all cases described below, the following applies:

- The Assistant:
 - Increase the controlled or placing shielding if the dose rate is higher than permissible. Placing shielding in the bunker is not necessary.
 - Must send any third parties out of the controlled area.
 - Monitors the controlled area.
- The Radiographer:
 - Takes stock of the situation.
 - He contacts the mandated RPO or supervisor and provides a situation report.
 - Following the instruction of the RPO/RPE.
 - Performs i.c.w. the RPO/RPE performs the intervention if needed.
- The mandated RPE/RPO contacts the necessary government authorities (chapter 4).
- Training of all personnel who perform actions with ionizing radiation (device or isotope) takes place using the toolbox ionizing radiation.
- The mandated RPO/RPE provides reporting, recording and handling of the emergency. He is also the person who makes a referral to a medical expert

17.3 Actions in case of ignoring a barrier

In situations where people ignore the cordon, the following rules apply:

- Work will be stopped immediately.
- The person in question is addressed courteously and politely and the radiographer verifies this person's exposure and location relative to the source.
- If exposure is expected to exceed 100 µSv, please contact your mandated RPE/RPO.
- At all times a report about this incident will be made to your manager and to your client.

17.4 Emergency during transport

- Work according to the ADR instruction card.
- In case of a fire, if possible, remove the source from the car and NEVER leave it unattended. Also take the transport documents from the driver's cabin (for emergency services).
- Keep calm and act calmly. Make sure that unauthorized persons cannot enter the location. Any additional measures will be discussed in consultation with the RPE/RPO
- Stay in the vicinity of the accident site (you yourself are the most expert in the field of radiation present on site).

17.5 Theft, loss or accident

Procedure Theft, loss or accident with isotopes (as described in SV-001):

- Immediately contact a RPO/RPE.

Contact details of mandated experts:

1st line contact: [REDACTED]

2nd line contact: [REDACTED]

3rd line contact: [REDACTED]

- Explain the situation as specifically as possible, at least pass on:
 - Which source,
 - Activity of the resource,
 - Situation > Theft, loss or accident,
 - Location (in case of an accident) or place where theft/missing has been detected,
 - Time,
 - Characteristics perpetrators, in case of theft if noticed.
- Contact details of present Team employees + witnesses.
- Wait for further instructions from the RPO/RPE

17.6 Containment of the source

In situations where the source does not want to return to the safe position (in the source holder and locked), you act as follows:

- The Assistant
 - Increase the controlled or placing shielding if the dose rate is higher than permissible. Placing shielding in the bunker is not necessary.
 - Must send any third parties out of the controlled area.
 - Monitors the controlled area
- The Radiographer:
 - Takes stock of the situation.
 - He contacts the mandated RPO or supervisor and provides a situation report.
 - Following the instruction of the RPO/RPE.
 - Performs i.c.w. the RPO/RPE performs the intervention if needed.

- The RPO/RPE will:

If the isotope needs to be cut, always do this.

- Inform the client of this stagnation in work.
- Make a plan of action and apply the ALARA principle.
- The mandated RPE contacts the necessary government authorities (chapter 4).
- The mandated RPE provides reporting, recording and handling of the emergency. He is also the person who makes a referral to a medical expert.

17.7 Available resources during an emergency

- Lead (U-profile)
- Lead pot
- Pliers (0,5/3 meter lengte)
- Cutters
- Telescopic dose rate monitor to locate the source
- Additional lead, barrier tape

The emergency equipment is stored at the Roosendaal location.

Remember that when approaching the isotope/X-ray device, the square law is in effect. The table below shows the exposure at a distance of 1 metre.

Dose rate at 1 meter (x-ray tube)		
Source	Dosistempo(vuistregel)	Dosistempo
X-ray tube 250kV, 4 mA	2,7 Sv/h ¹	2,7 Sv/h ¹
Dose rate at 1 meter (isotope)		
Isotoop	$\dot{H}$ $\mu\text{Sv/h per GBq}$	$\dot{H}$ $\mu\text{Sv/h per Ci}$
⁷⁵ Se	72	2664
¹⁹² Ir	140	5180

Note: 1 Ci = 37 GBq

APPENDIX 1 - REGULATORY SIGNALS

Signals:



Bord Nr. 1 ioniserende straling

**RADIOACTIEVE
STOFFEN**

Bord nr. 2 bij gebruik- en opslag isotoop

**RÖNTGEN
STRALING**

Bord nr. 3 bij gebruik röntgentoestellen

Zone-waarschuwborden:

**GECONTROLEERDE
ZONE**

Bord nr. 1 bij ingang(-en) stralingsbunkers

**Geen toegang voor
onbevoegden****Dosistempo > 10 μ Sv/uur**

Bord nr. 3 bij ingang(-en) bunker en bij afzettingen

Voertuigborden:



Oranje voertuigbord nr. 1



Voertuigetiket model 7D, Bord nr. 2

Verpakking etiket:



Verpakkingsetiket Geel III (wel goed invullen)



Verpakkingsetiket Geel II (wel goed invullen)

Om de Transport index (TI) te bepalen wordt er gemeten op het oppervlak van de bronhouder en op 1 mtr afstand van de bronhouder.

Container	Nuclide	Etiket	TI
Gammamat RID-Se4P	⁷⁵ Se	Geel II	0,5
Gammamat DUAL 120	¹⁹² Ir	Geel III	1,0
Sentinel 880 DELTA	⁷⁵ Se	Geel II	0,1
Sentinel 880 DELTA	¹⁹² Ir	Geel II	0,5

APPENDIX 2 - ADR INSTRUCTION

INSTRUCTIONS BY WRITING ACCORDING TO ADR

Actions in the event of an accident or emergency

In the event of an accident or emergency that may occur or arise during carriage, the members of the vehicle crew shall take the following actions where safe and practicable to do so:

- Apply the braking system, stop the engine and isolate the battery by activating the master switch where available;
- Avoid sources of ignition, in particular, do not smoke, use electronic cigarettes or similar devices or switch on any electrical equipment;
- Inform the appropriate emergency services, giving as much information about the incident or accident and substances involved as possible;
- Put on the warning vest and place the self-standing warning signs as appropriate;
- Keep the transport documents readily available for responders on arrival;
- Do not walk into or touch spilled substances and avoid inhalation of fumes, smoke, dusts and vapours by staying up wind;
- Where appropriate and safe to do so, use the fire extinguishers to put out small/initial fires in tyres, brakes and engine compartments;
- Fires in load compartments shall not be tackled by members of the vehicle crew;
- Where appropriate and safe to do so, use on-board equipment to prevent leakages into the aquatic environment or the sewage system and to contain spillages;
- Move away from the vicinity of the accident or emergency, advise other persons to move away and follow the advice of the emergency services;
- Remove any contaminated clothing and used contaminated protective equipment and dispose of it safely.

Additional guidance to members of the vehicle crew on the hazard characteristics of dangerous goods by class and on actions subject to prevailing circumstances		
Danger labels and placards (1)	Hazard characteristics	Additional guidance (3)
Explosive substances and articles  1 1.5 1.6	May have a range of properties and effects such as mass detonation; projection of fragments; intense fire/heat flux; formation of bright light, loud noise or smoke. Sensitive to shocks and/or impacts and/or heat.	Take cover but stay away from windows.
Explosive substances and articles  1.4	Slight risk of explosion and fire.	Take cover.
Flammable gases  2.1	Risk of fire. Risk of explosion. May be under pressure. Risk of asphyxiation. May cause burns and/or frostbite. Containments may explode when heated.	Take cover. Keep out of low areas.
Non-flammable, non-toxic gases  2.2	Risk of asphyxiation. May be under pressure. May cause frostbite. Containments may explode when heated.	Take cover. Keep out of low areas.
Toxic gases  2.3	Risk of intoxication. May be under pressure. May cause burns and/or frostbite. Containments may explode when heated.	Use emergency escape mask. Take cover. Keep out of low areas.
Flammable liquids  3	Risk of fire. Risk of explosion. Containments may explode when heated.	Take cover. Keep out of low areas.
Flammable solids, self-reactive substances, polymerizing substances and solid desensitized explosives  4.1	Risk of fire. Flammable or combustible, may be ignited by heat, sparks or flames. May contain self-reactive substances that are liable to exothermic decomposition in the case of heat supply, contact with other substances (such as acids, heavy-metal compounds or amines), friction or shock. This may result in the evolution of harmful and flammable gases or vapours or self-ignition. Containments may explode when heated. Risk of explosion of desensitized explosives after loss of desensitizer.	
Substances liable to spontaneous combustion  4.2	Risk of fire by spontaneous combustion if packages are damaged or contents are spilled. May react vigorously with water	
Substances which, in contact with water, emit flammable gases  4.3	Risk of fire and explosion in contact with water.	Spilled substances should be kept dry by covering the spillages.

Additional guidance to members of the vehicle crew on the hazard characteristics of dangerous goods by class and on actions subject to prevailing circumstances		
Danger labels and placards	Hazard characteristics	Additional guidance
(1)		(3)
Oxidizing substances  5.1	Risk of vigorous reaction, ignition and explosion in contact with combustible or flammable substances.	Avoid mixing with flammable or combustible substances (e.g. sawdust).
Organic peroxides  5.2	Risk of exothermic decomposition at elevated temperatures, contact with other substances (such as acids, heavy-metal compounds or amines), friction or shock. This may result in the evolution of harmful and flammable gases or vapours or self-ignition.	Avoid mixing with flammable or combustible substances (e.g. sawdust).
Toxic substances  6.1	Risk of intoxication by inhalation, skin contact or ingestion. Risk to the aquatic environment or the sewerage system.	Use emergency escape mask.
Infectious substances  6.2	Risk of infection. May cause serious disease in humans or animals. Risk to the aquatic environment or the sewerage system.	
Radioactive material  7A 7B 7C 7D	Risk of intake and external radiation.	Limit time of exposure.
Fissile material  7E	Risk of nuclear chain reaction.	
Corrosive substances  8	Risk of burns by corrosion. May react vigorously with each other, with water and with other substances. Spilled substance may evolve corrosive vapours. Risk to the aquatic environment or the sewerage system.	
Miscellaneous dangerous substances and articles  9 9A	Risk of burns. Risk of fire. Risk of explosion. Risk to the aquatic environment or the sewerage system.	

NOTE 1: For dangerous goods with multiple risks and for mixed loads, each applicable entry shall be observed.

NOTE 2: Additional guidance shown in column (3) of the table may be adapted to reflect the classes of dangerous goods to be carried and their means of transport.

Additional guidance to members of the vehicle crew on the hazard characteristics of dangerous goods, indicated by marks, and on actions subject to prevailing circumstances		
Mark	Hazard characteristics	Additional guidance
(1)	(2)	(3)
 Environmentally hazardous substances	Risk to the aquatic environment or the sewerage system	
 Elevated temperature substances	Risk of burns by heat.	Avoid contact with hot parts of the transport unit and the spilled substance.

**Equipment for personal and general protection
to carry out general actions and hazard specific emergency actions
to be carried on board the transport unit in accordance with section 8.1.5 of ADR**

The following equipment shall be carried on board the transport unit:

- for each vehicle, a wheel chock of a size suited to the maximum mass of the vehicle and to the diameter of the wheel;
- two self-standing warning signs;
- eye rinsing liquid^a; and

for each member of the vehicle crew

- a warning vest;
- portable lighting apparatus;
- a pair of protective gloves; and
- eye protection.

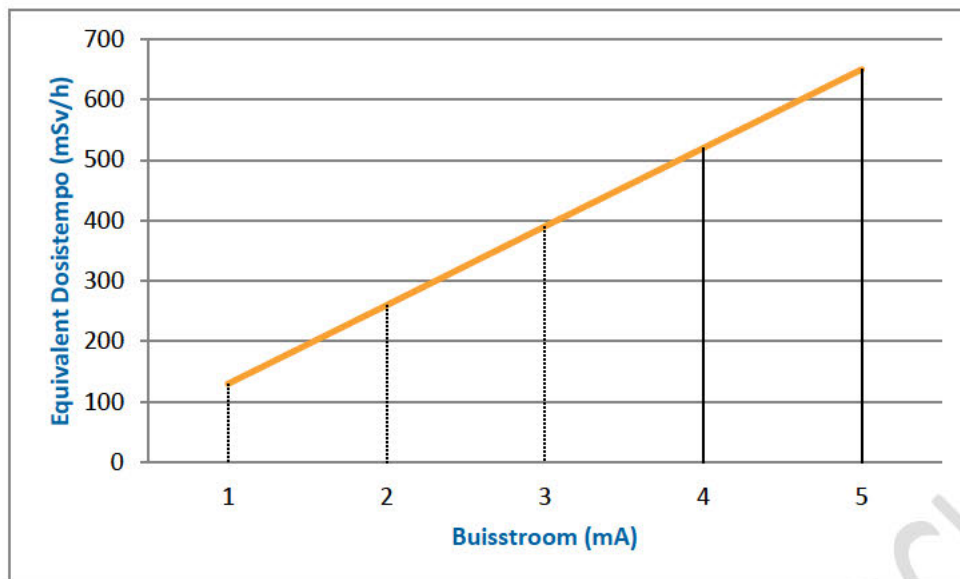
Additional equipment required for certain classes:

- an emergency escape mask for each member of the vehicle crew shall be carried on board the transport unit for danger label numbers 2.3 or 6.1;
- a shovel^b;
- a drain seal^b;
- a collecting container^b.

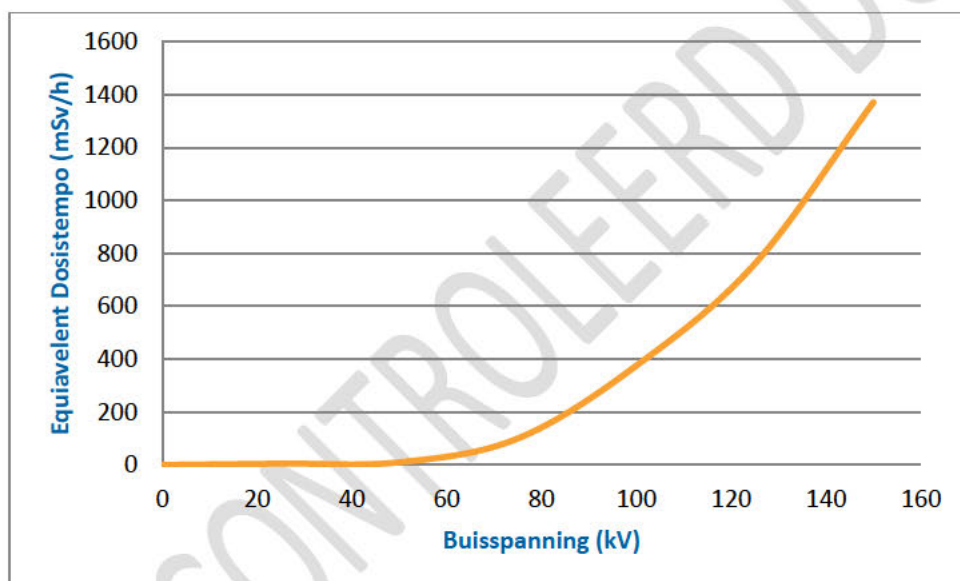
^a Not required for danger label numbers 1, 1.4, 1.5, 1.6, 2.1, 2.2 and 2.3.

Kui: ^b Only required for solids and liquids with danger label numbers 3, 4.1, 4.3, 8 or 9.

APPENDIX 3 - INFLUENCE OF TUBE CURRENT AND TUBE VOLTAGE ON RADIATION DOSES



The influence on the dose rate with an increase in the tube current at a set tube voltage of 100 kV.



The influence on the dose rate with an increase in the tube voltage at a set tube current of 3 mA.

APPENDIX 4 - STATEMENT

The undersigned:

Personal information	
Name	
Adresse	
City	
Date of Birth	

Hereby declares that he has read and understood all guidelines and safety instructions, as mentioned in this document "QIS SV001 - Radiation and Safety", and that he will behave and act accordingly.

Furthermore, he declares to have received:

Item	Ontvangen / Serienummer / QIS ID
Cumulatieve Dosimeter	
Dosistempometer	
Toegang tot SV001 – Radiation safety procedure	
TLD-Badge	

Signature:

Date:

¹⁾ Bijlage 4 wordt opgenomen in persoonlijk dossier.

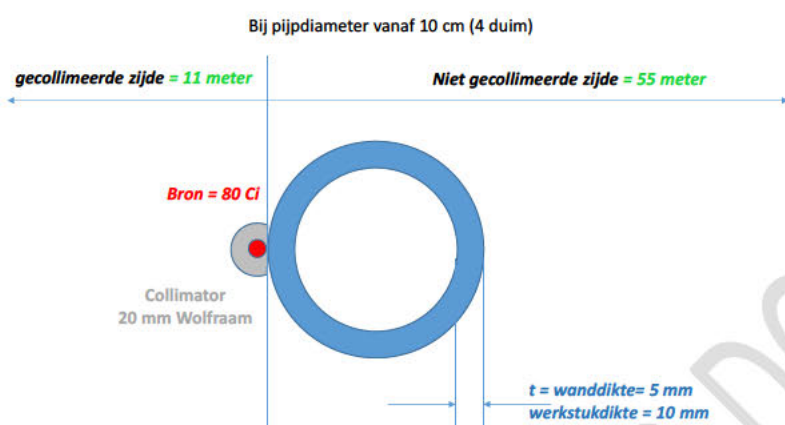
APPENDIX 5 - GUIDELINE DISTANCES FOR A SAFE DOSE RATE AT THE BARRIER

A work area must be cordoned off where the maximum dose rate at the deposition limit is lower than 10 µSv/h. Perform the following actions:

- Assess the work area with regard to radiation safety (access roads, doors, platforms).
- Determine size of area to be deposited using source strength/distance table for ⁷⁵Se and ¹⁹²Ir.

Example; Source: ⁷⁵Se 80 Ci without product shielding, deposition limit is 110 m!

- Place warning signs (as shown in appendix 1) at the distance determined by you and at access doors, landings and stairs.
- Check that no one is working in the area you have cordoned off



Bron ⁷⁵ Se		A ₁₀ : Barrier to 10 µSv/h not collimated source				A ₁₀ : Barrier to 10 µSv/h collimated source
[Ci]	[TBq]	(A ₁₀) [m]	A ₁₀ bij t _{Fe} =10 mm	A ₁₀ bij t _{Fe} =15 mm	A ₁₀ bij t _{Fe} =20 mm	(A ₁₀) [m]
90	3,33	119	61	43	31	12
85	3,15	116	60	42	30	12
80	2,96	110	58	41	29	12
75	2,78	109	56	40	28	11
70	2,59	105	54	37	26	11
65	2,41	101	52	37	26	11
60	2,22	97	50	35	25	10
55	2,04	93	48	34	24	10
50	1,85	89	44	31	22	9
45	1,67	84	43	31	22	9
40	1,48	79	41	29	21	8
35	1,30	74	38	27	20	8
30	1,11	69	35	25	18	7
25	0,93	63	32	23	16	7
20	0,74	56	29	20	14	6
15	0,56	49	25	18	13	5
10	0,37	40	20	14	10	4
5	0,19	28	14	10	7	3

Bron ¹⁹² Ir		A ₁₀ : Barrier to 10 µSv/h not collimated source				A ₁₀ : Barrier to 10 µSv/h collimated source
[Ci]	[TBq]	(A ₁₀) [m]	A ₁₀ bij t _{Fe} =15 mm	A ₁₀ bij t _{Fe} =20 mm	A ₁₀ bij t _{Fe} =30 mm	(A ₁₀) [m]
90	3,33	194	130	114	87	20
85	3,15	189	126	11	85	19
80	2,96	183	123	107	82	19
75	2,78	177	119	104	80	18
70	2,59	171	115	100	77	17
65	2,41	165	111	97	74	17
60	2,22	159	106	93	71	16
55	2,04	152	102	89	68	15
50	1,85	145	97	85	65	15
45	1,67	137	92	81	62	14
40	1,48	129	87	76	58	13
35	1,30	121	81	71	54	12
30	1,11	112	75	66	50	11
25	0,93	102	69	60	46	10
20	0,74	92	61	54	41	9
15	0,56	79	53	47	36	8
10	0,37	65	43	38	29	7
5	0,19	46	31	27	21	5

The tables above are intended as a guideline. Practical situations may vary, requiring different deposits.

APPENDIX 6 – THE GOLDEN RULES

1. Necessity: To minimize the chance of source theft by third parties (dirty bomb)
2. Be aware that you may be a potential target of terrorist acts
3. Radioactive isotopes are always stored at the designated location after the end of working hours.
4. Always store behind a minimum of 3 locks with a minimum delay of 5 minutes.
5. Avoid suspicious situations and report to your manager and/or emergency services (112).
6. In the event of a direct threat from third parties, think about your own safety. No heroics!
7. In the event of an increased threat (example Belgium), keep in touch with the level 3 radiation expert.
8. Never leave a radioactive source unattended. This applies to both the workshop and during transport.
9. Immediately report missing key (source holder, storage areas, etc.) to manager
10. If isotope from car, remove ADR signs.