RA015 Radiation Risk Assessment No 15: TSI Aerosol Neutraliser

Assessment carried out by: Andrew Cowling	**Date:** 21/04/2009
Faculty/School/Service:	**RPS:**
Principal Investigator:	**Responsible person:**
Source handlers:	**Instrument users:**

PART 1: PROGRAMME OF WORK
1.1 Title of the project or procedure to which this assessment relates: Use of a TSI Aerosol Neutraliser..
1.2 Description of project or procedure: The neutraliser is used to neutralise aerosol charges and is installed in a SMPS type…………….
1.3 Persons likely to be exposed (i.e. principal radiation users): Source handlers and instrument users listed above.

PART 2: RADIATION HAZARD

2.1 Radionuclide and activity:	**2.2 Source details:**
Kr-85 (gaseous in sealed capsule), 370MBq	Type: 3012A; Serial: SSID:

2.2 Principle emissions and energies:

β: 0.67MeV (max) + γ: 0.514 MeV (<1%)

2.3 Dose rate data:

Specific gamma dose rate constant = 4.17x10^{-7} mSvh-1/MBq @1m (*ref ORNL*)
Beta dose rate = 1.04 mSvh^{-1}/MBq @ 0.1m (*ref Delacroix*)

Immersion in Kr-85 gaseous cloud source (*ref NRPB-W63*):

> Beta (equivalent) dose rate = 5.7x10^{-11} Svh^{-1}/Bqm^{-3}
> Gamma (effective) dose rate = no data
> '…the true effective dose would be about twice that calculated from the beta radiations alone because of the additional presence of photon radiations including bremstrahlung'. (*ref NRPB-W63, p27*)

2.4 External radiation hazard:

Kr-85 is mainly a beta emitter with <1% gamma emissions.

External radiation exposures at 10cm from an unshielded 370MBq source would be (from equations in 2.3 above) 385mSv/h (beta) and 15µSv/h (gamma).

However the beta and gamma emissions are shielded by the stainless steel walls of the source capsule (producing additional bremstrahlung) and measured dose rates from the source are as follows.

Dose rates measured using a Mini-instruments 900D (#M213): (beta+gamma+bremstrahlung)

@surface of source container = 30µSv/h

@10cm from source container = 6µSv/h

If the source leaked, immersion in a Kr-85 gas cloud would expose the skin to beta radiation and the whole body to gamma radiation. The beta and gamma dose rates in terms of specific activity of the gas cloud (Bqm^{-3}) are given in 2.3 above.

2.5 Internal radiation hazard:

If the source leaked, immersion in a Kr-85 gas cloud would result in a proportion of the gas being inhaled. However krypton is not absorbed into the body through the lung tissue and the contribution to the effective dose from Kr-85 gas within the lungs and airways is negligible compared to the dose from the gas external to the body and can be ignored (*ref NRPB-W63, p27*).

PART 3: RADIATION DOSE ASSESSMENT

3.1 Routine doses

The annual radiation doses received during routine work (following local rules, systems of work, and precautions identified in part 4) are as follows:

SOURCE INSTALLATION / REMOVAL:

Extremity dose:

'Extremity' dose rate at surface of source container = 30µSv/h
Total extremity dose to hands = 30/60*2 = 1µSv x 10 times per year = 10µSv/y
for 2 minute operation

'Whole body' dose rate:

Dose rates from source container are 6µSv/h at 10cm, therefore at 30cm this is 0.7µSv/h.
i.e. whole body doses from source handling operations are negligible (0.2µSv/y).

INSTRUMENT OPERATION:

During routine instrument operation the maximum accessible dose rate is less than 0.5µSv/h. Therefore the maximum annual dose if an operator was sitting next to the instrument for a working year would be <<1mSv/y.

3.2 Dose Constraint

The annual routine exposures from Part 3.1 compare with:

- the University dose constraint of **10 mSv/year** to the 'extremities'
- the University dose constraint of **1 mSv/year** to the 'whole body'

The dose constraint is a limit applied by the University of Leeds to restrict radiation exposures to levels that are the lowest that might practically be achieved. Where work is constrained to this limit adequate protection is provided for the foetus, women of child bearing age, members of the public (visiting researchers, contract staff, etc.) and de facto for University employees and students.

3.3 Accident Doses

The radiation doses that may be received in accident scenarios are as follows:

Accident not involving loss of source integrity:

Dropping source and recovery:
Extremity dose at surface = 30µSv/h, for 30second recovery extremity dose = 0.25µSv
Whole body dose at 0.3m = 0.7µSv/h, for 30second recovery whole body dose is negligible.

Accident involving loss of source integrity:

Releasing source contents into confined area (10m^3):
If all the source gas (370MBq) was immediately released into an area 10m^3 the resultant gas cloud would give an external dose rate of:
Beta (skin) equivalent dose = 5.7×10^{-11} x 370×10^{6} /10 = 2.1mSv/h
Tissue weighting factor for skin = 0.01 therefore Effective Dose = 21µSv/h
…and therefore total effective dose (including photons) = 42µSv/h

PART 4: EXPOSURE CONTROL MEASURES

4.1 Radiation facilities

When installed in the instrument the source should be used in an 'Undesignated Area' which is kept secure when not occupied.
The source should be stored in a secure storage safe when not installed in the instrument.

4.2 Source handling

The source housing can be handled directly during installation. To keep doses as low as reasonably practicable the time handling the source should be kept to a minimum. Local shielding further to the integral source housing is not required.

The source housing is designed to withstand foreseeable shock and temperature levels during routine handling operations.

4.3 Management arrangements

Competency and training
Persons handling or using the source should receive sufficient training.

Local rules and systems of work
Local rules detailing specific arrangements for the control of this source should be available to all users including emergency plans detailing procedures to limit exposures in accident situations.

Management of sources
Appropriate notifications, source checks, record keeping and leak testing should be undertaken as specified in the local rules.

References

Delacroix: 'Radionuclide and Radiation Protection Data Handbook 2002', D Delacroix, JP Guerre, P Leblanc, C Hickman, Nuclear Technology Publishing, 2002

NRPB-W63: 'Radiological Assessments for Small Users', McDonnell, NRPB (now HPA RP division), 2004.

ORNL: 'Specific Gamma-Ray Dose Constants for Nuclides Important to Dosimetry and Radiological Assessment', ORNL/RSIC-45/R 1, Oak Ridge National Laboratory, 1982.