



# The Measurement of Gamma Radiation from Zircon and other NORM\* in Transport - a best practice guide

\*(Naturally Occurring Radioactive Material)



# The Measurement of Gamma Radiation from Zircon and other NORM in Transport - a best practice guide

## Background

Like many rocks and minerals, zircon (zirconium silicate) contains natural radionuclides in very low concentrations, making zircon a NORM (naturally-occurring radioactive material). By determining the concentration of radionuclides it is possible to calculate the radioactive concentration of the material measured in Becquerels per gram (Bq/g). A NORM with an activity level <10 Bq/g is exempt<sup>‡</sup> from the regulations for the safe transport of radioactive materials and can be shipped as general cargo.

## The need for gamma radiation measurements

The measurement of gamma radiation levels from a container or truck loaded with NORM is advisable because:

- Almost all containers / trucks are scanned at border crossings, so radiation data can be presented to the relevant authority in advance. Such data can also be used to assess the extent of any protection measures if the radiation level is higher than the natural background.
- If the calculated activity level is only slightly above the 10 Bq/g limit, the consignment may be classified as an *excepted\** package (not exempted) and all regulations still apply, except signage. Measurements of gamma radiation at the container's surface are then required.

For example, if the activity concentration (U+ Th) is calculated to be 12-15 Bq/g, transport regulations shall apply. However, if the container's surface gamma radiation readings are all <5 µSv/hour, the package can be excepted, and radioactive signage is then placed only on the inside of the package.

- If it is determined that the material is classified as radioactive, radiation measurements at 1 m distance are required to determine the Transport Index (TI)<sup>†</sup> for the consignment.

## Best practice procedure for measuring gamma radiation

Special qualifications are not required to operate a simple gamma radiation meter; however, the following shall be observed: -

- A) The equipment must be properly calibrated in a locally-authorized laboratory and each monitor must have a calibration sticker attached to demonstrate that it was calibrated less than 12 months prior to the date of the measurements.
- B) The equipment's manual must be thoroughly studied by the operator before use; e.g. some monitors provide almost instant readings (less than 5 seconds), whereas others collect data for 30 or 60 seconds and provide the average result after the time period.
- C) Attention needs to be paid to the equipment's technical characteristics; e.g. some monitors may fail at extreme temperatures above +40°C and/or below -30°C).
- D) Batteries must be in good order and all applicable functions of the instrument must be checked and working prior to use.
- E) Some monitors are supplied with check sources (usually caesium-137 or radium-226), which emit gamma radiation at a known level. Performing a check confirms that the equipment will provide an accurate reading.
- F) Results should be fully and correctly documented in accordance with local requirements.

\*The main criterion for the determination of the excepted package is given in the Regulations as follows 'The radiation level at any point on the external surface of an excepted package shall not exceed 5 µSv/h.'

† UN 2912 packages should have the Transport Index determined by measuring the highest radiation dose rate in milli Sievert per hour around the package at 1m, and multiplying this value by 100 to obtain the TI.

‡ IAEA Regulations for the Safe Transport of Radioactive Materials, 2018 Edition (Rev.1)

## Types of gamma radiation measurement

There are three types of gamma radiation measurement -

- A) At the surface of the container or truck (Figs 1.3 and 1.4). This is to determine whether the consignment can be shipped as an *excepted package*.
- B) At a distance of 1m from the container or truck (Fig 1.1). This is done to determine.
  - i. The transport index (TI) if the material is classified as radioactive
  - ii. The level(s) likely to be measured by a border crossing radiation detector.
- C) Walking away from the container or truck in different directions until the gamma radiation measured is the same as background levels (Fig 1.2, 1.5 and 1.6). Once measurements A and B have been completed, this is to establish if a radiation protection program is required and to determine the extent of such a program.

Measurement in practice: a practical guide to monitoring (including results) is provided in Figures 1.1 to 1.6. Measurements were performed on containers of a NORM material with activity concentrations (U+Th) in the range of 4 - 11 Bq/g.



Figure 1.1. Gamma radiation measurement at 1m from the container surface

‡ Ensure that the readings taken will be acceptable as many national regulatory authorities only recognize readings obtained by equipment calibrated in their country (e.g. readings obtained by a gamma monitor calibrated in Australia may not be acceptable in the USA, and vice-versa.)

Measurements in microSv/hour  
(background = 0.12 - 0.18)

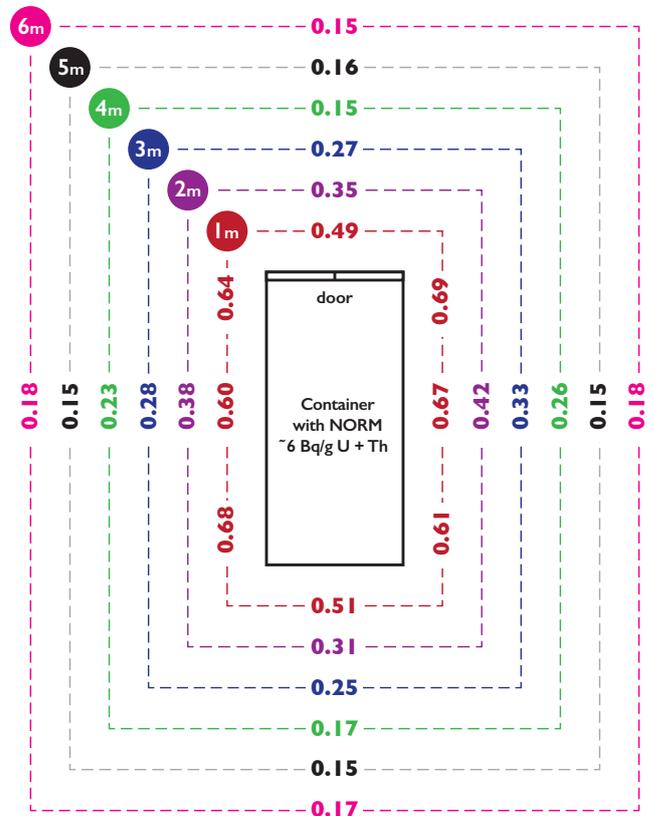


Figure 1.2. Gamma radiation measurements around a container of NORM (U+Th = ~6 Bq/g)

Surface measurements readings in microSv/hour

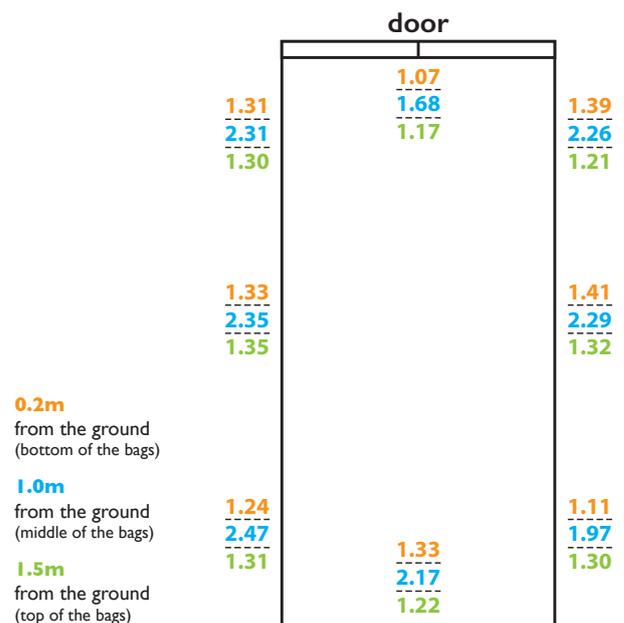


Figure 1.3. Gamma radiation measurements at the container surface (U+Th = ~6 Bq/g)



Figure I.4. Taking gamma readings from a surface of the container (U+Th = ~4 Bq/g)

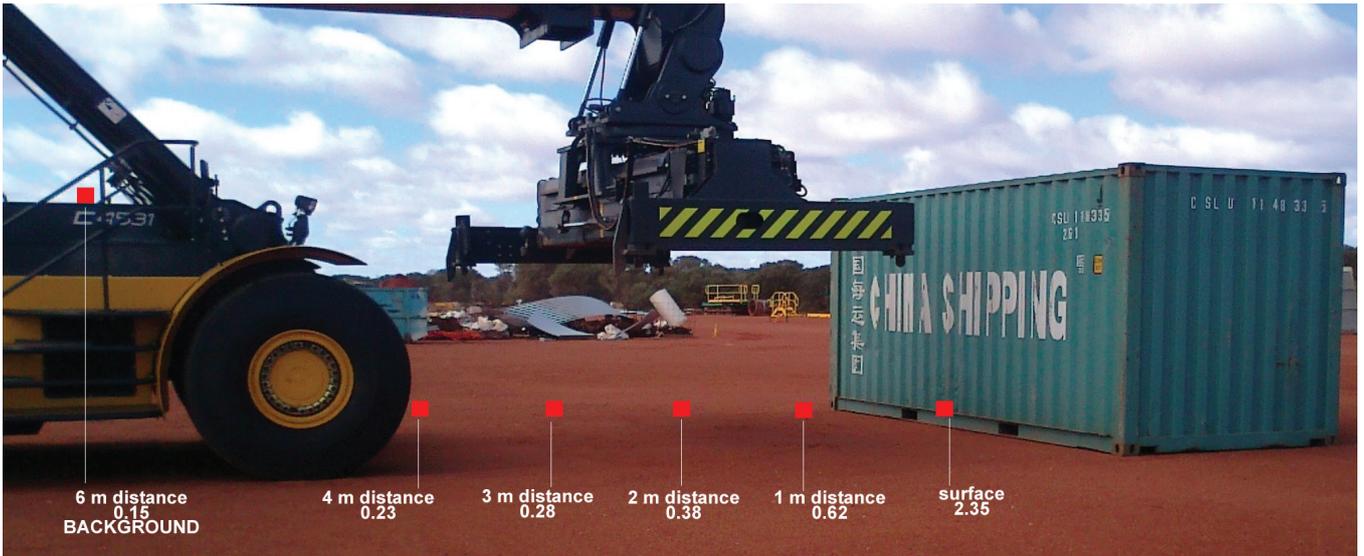


Figure I.5. Representation of gamma radiation levels from a container of NORM, (U+Th = ~11 Bq/g) classified as radioactive, Class 7



Figure I.6. Representation of gamma radiation monitoring from a container of NORM, (U+Th ~11 Bq/g) classified as radioactive Class 7, but transported as an excepted package without radioactive signage because surface gamma radiation levels are <math>< 5 \mu\text{Sv/hr}</math>

Zircon Industry Association Limited

Email: [admin@zircon-association.org](mailto:admin@zircon-association.org)

Tel: +44 (0)78 00 85 06 92

[www.zircon-association.org](http://www.zircon-association.org)

