

Metals and Minerals Bulletin

Monitoring Bulk Cargoes for Radioactive Sources

Bulletin 19-01
Rev. 0

INTRODUCTION

The purpose of this Bulletin is to set out the general standards of the delivery of services by TIC Council member companies in the execution of their duties in relation to radio-activity services and testing.

It covers general duties of inspection services together with more detailed requirements.

TIC Council member companies are also expected to follow any requirements or recommendations contained in the Mineral Committee Bulletins published by the TIC Council from time to time and available on the TIC Council website.

Where any provision of this Bulletin is in contradiction with any terms and conditions or contract terms which exist between TIC Council member companies and their principals, those terms shall take precedence over, replace or supersede this Bulletin.

TIC Council has no responsibility or liability for the acts or omissions of members or others making use of this Bulletin.

1.0 SCOPE OF INVOLVEMENT

The TIC Council Member Company shall provide services at the time and place agreed with its Principal.

When providing services, the Member Company shall perform services within the scope agreed with the Principal and subject to the Member Company's General Terms and Conditions of Business.

The basis of the scope of services shall be the Principal's express instructions in writing received by the Member Company at the appropriate time.

The Member Company may also take some additional actions if such are necessary in the circumstances to perform the agreed services and such actions do not contradict the Principal's express instructions.

The fees for the services shall be agreed with the Principal prior to confirming the appointment. They may, however, be amended by mutual agreement at a later stage to reflect the actual circumstances of performance of services.

Revisions/Reaffirmations

Rev. 0 June 2019

The Member Company shall report to the Principal the information required by the agreed scope of services.

Reporting is to be done to the Principal only unless otherwise expressly instructed by the Principal.

The Member Company may also report on any additional points relevant to the inspection or testing performed if it considers such additional information relevant and of potential interest to the Principal but the Member Company shall not have any liability for not reporting on anything beyond the scope agreed with the Principal in the appointment.

Unless otherwise expressly agreed with the Principal, the involvement of the Member Company shall be limited to providing its statement(s) of opinion to the Principal. This statement of opinion shall be valid for the time and place of inspection only.

The Member Company shall not be or deemed to be a party in any sale, carriage etc. contract or to substitute any contractual party. Under no circumstances does the Member Company's involvement relieve any party to such a contract from its contractual responsibilities or other legal obligations.

2.0 HEALTH, SAFETY AND THE ENVIRONMENT

TIC Council Member Companies consider the safety of their personnel as paramount. Personnel are expected to operate diligently and not take actions that will subject themselves or others to unnecessary risk or harm.

Health and safety management systems operated by Member Companies meet national guidelines; contain clear policy objectives, assess risk, review procedures and measure performance.

Member Companies follow best practice developed internally by member companies or by the industry at large in order to create a system of continuous improvement with the objective of providing a safe place of work at all times for its employees.

The activities undertaken by Member Companies, whether on their own premises or that of third parties should be suitably risk assessed and the prescribed procedures duly followed. Where an individual believes that the task they are being asked to perform or the conditions under which they are being asked to work involves risk which are unacceptable or not suitably controlled they will exercise a 'stop work' authority. In such circumstances the task will not be undertaken until the conditions have been altered and an assessment confirms that it is safe to proceed.

Occasionally Member Company employees are requested to sign indemnities relieving the owner or operator of a material, site or vessel from their legal obligation to provide a safe place of work. It is the stance of Member Companies that their employees will not accept such waivers and will refuse to work under such conditions.

TIC Council Member Companies are professional and environmentally conscious organisations. They acknowledge the impact their operations may potentially have

on the environment and take all reasonable and practical measures to protect personnel and the environment within the sphere of their control.

3.0 RADIOACTIVITY OVERVIEW

Radioactivity results from changes within the structure of particular atoms called radionuclides.

All matter is made up of different elements each with its own chemical identity.

The atoms contained in any particular element are defined by an *atomic number* related to *electrons* and *protons* and how an element reacts chemically.

An element can contain many different *nuclides* with some nuclides being unstable called radionuclides.

There are many different radionuclides occurring both naturally and man-made.

With radionuclides containing unstable atoms; some of these atoms are undergoing a continuous spontaneous disintegration process commonly known as *radioactive decay*.

The decay of radionuclides results in the emission of some type of *radiation* and changes to the chemical structure of the nuclide forming a different element.

The process of radioactive decay will vary for different radionuclides, some being very short (i.e. seconds) whereas other very long (i.e. many years).

There is exposure to emissions of natural radioactivity in the earth, cosmic radiation reaching us from outside the earth's atmosphere and to man-made radiation.

Types of radiation emissions such as *electromagnetic waves* or energetic particles have different categories, for example, based on frequency, energy etc.

The level of frequency, energy etc. can be further categorized into *non-ionizing* and *ionizing* radiation. However, the boundaries of each type are not clearly defined as different radionuclides decay at different energies and speeds.

Types of radiation are differentiated from one another by frequency of waves which directly correlates with the energy carried (as below). However, the classification is somewhat arbitrary as classes can overlap at meeting points.

ALPHA: - are highly ionizing forms of particle radiation and have low penetration depths.

BETA: - are high-energy and high-speed electrons or *positrons* emitted by certain types of radioactive nucleus with the beta particles emitted creating a form of ionizing radiation.

GAMMA: - electromagnetic radiation of an extremely high frequency and high energy *photons*. Gamma rays are ionizing radiation and are thus biologically

hazardous. They are classically produced by the decay of atomic nuclei as they transition from a high energy state to a lower state known as gamma decay, but may also be produced by other processes.

NEUTRON: - is a kind of ionizing radiation which consists of free neutrons. A result of nuclear fission or nuclear fusion, it consists of the release of free neutrons from atoms; these free neutrons react with nuclei of other atoms to form new isotopes which in turn may produce radiation.

ULTRAVIOLET: - is electromagnetic radiation with a wavelength shorter than that of visible light but longer than X-rays.

X-RAY: - is a form of electromagnetic radiation with wavelengths shorter than those of Ultra Violet rays and typically longer than those of gamma rays.

In general, everything is radioactive to a minimal extent and exposure to radiation does have an impact associated with levels of exposure and periods of exposure.

From a safety perspective, it is necessary to consider how radiation may reach somebody at risk, normally described as the exposure pathway.

There are no blanket rules to establish the exposure pathway due to many different situations. For instance, a given amount of radiation dispersed throughout a solid metal would present a much lower risk compared to the same amount of radiation dispersed throughout another commodity such as food products.

The measurement of radioactivity within materials is dependent on various parameters considering the source of activity (nuclide), the distance from the source, the period (time) of exposure, the effect of any shielding, the amount of radiation absorbed and the subsequent impact of radiation absorbed.

In summary, different units of measurement to determine the *count rate* and *dose rate* are used in consideration of these varying parameters: (i) activity (ii) *absorbed dose* and (iii) *effective dose*.

The table provides an overview of the commonly used international (SI System Units) and non-commonly used measurement units and comparisons.

Main Definitions	International (SI System Units)	Non-Common Units
Activity of a Radioactive Substance	Becquerel (Bq) 1 Bq = 0,027 nCi	Curie (Ci) 1 Ci = 3,7*10 ¹⁰ Bq
Absorbed Dose	Gray (Gy) 1 Gy = 100 rad	Rad (rad) 1 rad = 0,01 Gy

Exposure Dose	Coulomb (C)/kg $1\text{C/kg} = 3,86 \cdot 10^3 \text{ R}$	Roentgen (R) $1\text{R} = 2,58 \cdot 10^{-4} \text{C/kg}$
Equivalent and Effective Dose	Sievert (Sv) $1 \text{ Sv} = 100 \text{ rem}$	Rem (rem) $1 \text{ rem} = 0,01 \text{ Sv}$
Absorbed Dose Rate	Gy/s $1 \text{ Gy/s} = 100 \text{ rad/s}$	Rad/s $1 \text{ rad/s} = 0,01 \text{ Gy/s}$
Exposure Dose Rate	Ampere/kg (A/kg)	The roentgen per sec. $1 \text{ R/s} = 2,58 \cdot 10^{-4} \text{A/kg}$
Effective Dose Rate	Sievert/s	Rem/hour

Once measurements have been taken it is impossible to reach firm conclusions based on instrument readings. The practical approach taken is to determine the strength of an unknown radiation source and what is the perceived effect any radiation present will have on surroundings.

A general rule is that exposure to radioactivity must be ALARA – As Low As Reasonably Achievable.

4.0 GENERAL OVERVIEW

TIC Council Member Companies acknowledge that in the provision of services related to radioactivity testing there are various international and national governing organizations and associations which provide stipulated guidelines on procedures and practices to be taken into consideration.

It is acknowledged that interpretations can differ between countries.

In the absence of an appropriate governing organization or direct instruction from the Principal relating to a specific material, location, vessel etc. presented for testing, subject to agreement between contractual parties, Member Companies will follow the guidelines of this Bulletin as the minimum standard required in provision of associated services.

TIC Council Member Companies cannot establish at which level a material is considered as ‘not radioactive’ for regulatory purposes as unfortunately there is no international agreement on such levels.

Please refer to ANNEX A.

5.0 SERVICE REQUIREMENTS

It is important for the Principal to provide the Member Company with full details for any material that they request to be tested for radioactivity levels including: -

- Complete background information of the material (i.e. origin).
- Total tonnage of material.
- Location where operations are to be carried out.
- Description of packing condition of the material.
- Related transit/transportation details.

Upon receipt of service enquiry from a Principal, the Member Company shall clearly establish the requirements for which services related to 'radio-activity testing' are required.

It is important for the Member Company to completely understand the commercial and legislative requirements of the Principal related to the services to be provided including: -

- To conform to local legal and legislative requirements.
- To conform to transportation requirements.
- To conform to Letter of Credit (L/C) requirements.
- To conform to Health & Safety (HSE) requirements.
- Dispute Resolution (i.e. cargo rejection).

6.0 MATERIALS

TIC Council Member Companies may be requested by a Principal to test a wide spectrum of different types of materials to check for the presence of radioactivity.

The types of materials we may be asked to perform radioactivity inspection generally fall into two (2) categories: -

- (i) Materials with naturally occurring radioactive isotopes (NORM).

This group consists of minerals, ores, concentrates and some secondary materials. The most common substances within the group include: - wolframite, tantalite, niobium, columbite, coltan, tin concentrates/slugs and rare earths.

In these types of materials the radioactivity is normally due to the presence of Thorium (Th) and Uranium (U) which occur naturally with the main elements of the material and as such they tend to be distributed homogeneously throughout the material.

- (ii) Materials which have been contaminated by one or more radioactive elements.

The most common material in this case is ferrous scrap and the presence of radioactivity is usually due to the inclusion of foreign substances which

could include a single radioactive isotope such as caesium, cobalt, americium and cadmium.

The radioactivity in these commodities tends not to be homogeneous and it is unlikely to be found throughout the whole consignment of material.

7.0 INSPECTION PROCEDURES

The purpose of inspection services to be provided by TIC Council Member Companies is to attempt to 'Identify the presence of dangerous radioactivity levels/sources/elements within the advised material'.

Safe and unrestricted access to all accessible parts of the material in question and the places where they are stored shall be granted (or caused to be granted) to the Member Company by its Principal.

Findings with regard to the apparent condition of the stored goods and their storage places reported by the Member Company shall be limited to the readily accessible and verifiable parts therefor.

During the provision of inspection services, the Member Company will follow the below basic good practice and principles: -

- All equipment to be used to take measurements will be checked to be functioning correctly, the battery levels are operational and official calibration period is still valid.
- Where practical, the equipment to be used to take measurements should be routinely checked with controlled calibrated radioactive sources.
- Clearly identify the material to be inspected and the respective background area where measurements are to be taken.
- Consider the packaging of the material (if applicable) and surrounding areas (i.e. buildings, steel shelters etc.) for sources or elements that may influence the measurements to be taken.
- Where practical, the material to be tested should be spread in a thin layer.
- Prepare a plan to identify the points of measurement, which should be taken minimum 5 – 10cm above the material and at intervals of every 1m, subjective the equipment sensitivity.
- Each and every individual reading should be recorded and reported to the client.
- A minimum of 3 background measurements should be taken at various intervals and distances such as 50m – 25m – 10m – 5m -1m; subjective to equipment sensitivity.

- Each and every individual reading should be recorded and reported to the client.

8.0 EQUIPMENT

There are a wide range of different types of equipment used for the measurement of radio-activity from portable hand-held detectors, static gate detectors, dosimeters to sophisticated spectroscopy systems.

Different types of equipment have different capabilities sometimes dependent on the type of radiation to be detected. For example, gamma radiation is fairly simple to detect whereas alpha radiation, beta radiation or to establish specific nuclides requires the more sophisticated systems.

In the provision of services related to radioactivity testing services the objective of TIC Council Member Companies will be to generally identify a measure of the total radiation; unless specialized testing is otherwise requested by the Principal.

Any requests made by the Principal for specialized testing will be subject to the mutual agreement and individual capabilities of individual Member Companies.

The most common type of equipment used in the provision of measurement services is usually a 'portable hand-held dose-rate monitor with a digital readout' normally reporting results in either Sievert/Hour (SV), Rem/Hour (rem) or Gray/Hour (uGy/h).

Member Companies will ensure they select the most appropriate measuring equipment using only reliable manufacturers meeting the specification of associated international standards and regulatory authorities. (i.e. European CE Certification).

Based on the specific requirements of the Principal, the appropriate measuring equipment should be selected in consideration to: -

- The type of material to be tested.
- The location and environment where testing is to be performed; control operating temperatures.
- The type of measurement required: a single inspection or continuous monitoring.
- The type of Ionizing Radiation to be detected. (i.e. alpha, beta, gamma, x-ray etc.)
- The type of detector output to measure either the dose rates or the count rates.
- The detector sensitivity and measuring range.

Member Companies will operate best practice procedures and principles to ensure the reliability of all equipment used for provision of services to the Principal for detection of radioactivity including: -

- Operational and maintenance schedules and disciplines.
- Appropriate packaging case during transportation/storage.

- Regular calibration schedules. (Minimum every 12 months)
- Sufficient training programs for personnel.

9.0 REPORTING AND CERTIFICATES

9.1 REPORTING

The TIC Council Member Company may report to its Principal using various means such as telephone, e-mail, original documentation certification and by other methods agreed with the Principal.

These reports may include for example: -

- Date of Issue.
- Principal Name and Address.
- Principal Unique Job Reference Number.
- Member Company Unique Job Reference Number.
- Advised Material.
- Advised Tonnage.
- Location of Operations.
- Date of Operations.
- Measuring Equipment Details.
- Procedure of Inspection and Testing.
- Results of Measurements Taken Against the Advised Material.
- Results of Measurements Taken Against the Standard Background Levels.
- A Summary of any Restrictions Presented During the Inspection.
- Relevant Caveats and Disclaimers.
- Authorised Signatory.

Reports and Certificates should NOT state or make reference to: -

- Non Radioactivity
- Free From Harmful Radiation

The Member Company shall clearly state in its reports the method of verification used and which elements of its report, if any, are inferred from those that could be directly verified.

9.2 CERTIFICATES

When requested to do so, the TIC Council Member Company will issue a Certificate of Inspection. This certificate may be in paper or electronic format. In either case the certificate will be fully traceable in order to prevent fraud, so far as this is feasible.

The Member Company may issue a Certificate of Inspection according to the scope of work, the terms of the Letter of Credit or the contract concerned etc. as applicable. All should preferably be issued in a standard format used solely for this purpose by the Member Company.

When dealing with complex materials for testing, Member Companies should always take into consideration the heterogeneity and complexity of the material under study including any potential access restrictions.

If there are any doubts or concerns, it is recommended to issue a 'Report' rather than use the term 'Certificate' including appropriate caveats and disclaimers listing the facts and circumstances experienced during provision of services.

9.3 GENERAL

All Reports and Certificates are intended for the Principal of the Member Company, or are transmitted according to the Principal's instructions and should not be disclosed to any third party without the Principal's prior agreement.

Under normal circumstances, Member Companies will not issue 'To whom it may concern' Reports or Certificates.

Member Companies may include caveats and disclaimers as part of their Reports and Certificates. The issuance of Reports and Certificates does not relieve any party of its legal obligations. Any party relying on a Report and Certificate must understand that it is issued subject to contractual Terms and Conditions; and disclaimers which form an integral part of any Report or Certificate to which they are appended.

Where the Member Company has adopted Terms and Conditions of Business based on the Model Terms and Conditions recommended by TIC Council, these will include provisions which limit the amount of damages for which the Member Company may be liable.

10.0 MATERIAL REJECTION / ISOLATION

The TIC Council Member Company are not responsible for material rejection / isolation procedures.

The TIC Council Member Company inspectors are not typical 'radiation workers' and their training is for the checking for the presence of radioactivity only; and not to quantify radioactivity for cargoes that are known to have elevated radioactivity levels.

During the provision of services the TIC Council Member Company will monitor and control radioactivity measurements taken in the event a concern is identified that may present a risk using the below guidelines: -

Dose Rate <i>micro-Sievert</i> <i>per hour</i> (μ Sv/hour)	Risk
Above 10,000,000	Lethal
1,000,000	Severe
100,000	Severe: Radiation Poisoning
1,000	High Danger: Evacuate Immediately
100	High Danger: Heightened Risk
20	High Danger: Sickness
10	Danger: Relocate Immediately
5	Danger: Relocate ASAP
2	Elevated Risk: Take Safety Precautions
1	Safe: Short Term Exposure Only
0.5	Safe: Medium to Long Term Exposure Only
Below 0.2	Safe: Normal Levels

In the event a concern and risk is identified with radioactivity levels during the provision of services, the Member Company has a 'duty of care responsibility' and will take appropriate action in consideration of the safety requirements of their personnel (please refer to section 3.0) and, should it be deemed necessary, alert respective third-parties that may also be present during the inspection and measurement service.

The Member Company will take immediate action to notify their Principal of all the respective details and facts as soon as possible; in order for the Principal to provide further instructions and take appropriate further actions.

11.0 DEFINITIONS

Please refer to ANNEX B with associated definitions with radioactivity measurement.

ANNEX A

The Bulletin is aware of the following *International* governing organizations and associations providing guidance in relation to radioactivity:

International Atomic Energy Agency (IAEA)	www.iaea.org
International Energy Agency (IEA)	www.iea.org
Nuclear Energy Agency (NEA)	www.oecd-nea.org
Bureau of International Recycling (BIR)	www.bir.org
ISO International Standards (ISO)	www.iso.org
International Radiation Protection Association (IRPA)	www.irpa.net
International Commission on Radiological Protection (ICRP)	www.icrp.org
International Electro-Technical Commission (IEC)	www.iec.ch
World Nuclear Association (WNA)	www.world-nuclear.org

The Bulletin is aware of the following *National (Country)* governing organizations and associations providing guidance in relation to radioactivity:

- Radiation Protection Authorities (RPA)
- Radiation Protection Departments (RPD)

ANNEX B

Absorbed Dose	The physical dose quantity representing the mean energy imparted to matter per unit by ionizing radiation.
ALARA	As Low As Reasonably Achievable in consideration of economic, commercial and social factors.
Atom	The smallest unit into which an element can be subdivided and remain characteristic of the element. The description for atoms normally follow the model a central heavy nucleus composed of protons and neutrons and lighter electrons orbiting around the nucleus.
Atomic Number	The chemical property of an atom is defined by the atomic number which indicates the total number of protons and electrons within the atom.
Becquerel (Bq)	The international (SI) unit for the quantity of radioactive material that has a decay rate of 1 nuclear disintegration per second. The number of falling units.
Count Rate	See decay rate.
Curie (Ci)	The quantity of a radioactive material that has a decay rate of 3.7×10^{10} nuclear disintegrations per second.
Decay Rate	The rate at which nuclear disintegrations occur often measured per minute. Thus disintegrations (decay) per minute (dpm) or counts per minute (cpm)
Dose Rate	The absorbed, effective or equivalent dose delivered per unit per time.
Effective Dose	A measure of the effect on health risk that a radiation does internal or external will have on part of the whole body.
Electromagnetic Waves	A continuous spectrum of radiation with wavelengths between thousands of kilometres and millionths of a micrometre. Electromagnetic waves also have the characteristics of a stream of particles, called photons. The shorter the wavelength the greater the photon energy.
Elements	A small number of materials of various states either (i) solid - (ii) liquid - (iii) gaseous of which the universe is composed.
Equivalent Dose	The sum of the equivalent doses to different body tissues or organs; each weighted by the appropriate tissue weighting factor.

Electrons	Part of an atom consists of electrons orbiting a central nucleus. Electrons are a particle of very small mass having a negative unit charge
Gray	The international (SI) unit for absorbed dose. The number of absorbed units.
Ionizing	Radiation that carries enough energy to facilitate changes to the chemical structure of the nuclide forming a different element. (i.e. gamma rays)
Neutrons	Part of an atom that form the nucleus together with protons. Neutrons are considered as the close combination of a proton and an electron; thus electrically neutral.
Non-Ionizing	Radiation that does not carry enough energy to facilitate changes to the chemical structure of the nuclide forming a different element. (i.e. microwave)
NORM	Naturally Occurring Radioactive Materials
Nucleus	Part of an atom composed of protons and neutrons; surrounded by relatively light orbiting electrons.
Nuclide	A species of atom characterised by its mass number (A), atomic number (Z) and nuclear energy state.
Photons	A photon is an elementary particle, the quantum of light and all other forms of electromagnetic radiation.
Positrons	The positron (or antielectron) is the antimatter counter part of the electron.
Protons	Part of an atom that form the nucleus together with neutrons. Protons are particles carrying single units both of positive charge and of mass.
Radioactive Decay	The process by which a nucleus of an unstable atom loses energy by emitting radiation.
Radiation	The emission and propagation of radiant energy such as electromagnetic waves or energetic particles.
Radionuclides	An unstable nuclide which emits radioactivity.
SI	The international and coherent system of units based on the metre kilogram second.
Sievert	The international (SI) unit for effective or equivalent dose The effect based on the size of the units.

TIC Council Metals and Minerals Committee
Head office: Rue de Commerce 20-22 B-1000 Brussels

secretariat@tic-council.org
www.tic-council.org

TIC Council is registered in Belgium. VAT no. BE0724 881 295