IEC 63148

Edition 1.0 2021-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Tracking systems for radioactive materials – Requirements

Systèmes de suivi des matières radioactives – Exigences

IEC 63148:2021-07(en-fr)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.120.01

ISBN 978-2-8322-9931-9

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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TRACKING SYSTEMS FOR RADIOACTIVE MATERIALS – REQUIREMENTS

FOREWORD

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
45/924/FDIS	45/926/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Radioactive materials are widely used for industrial non-destructive testing, medical diagnosis and therapy, and nuclear facilities, etc., so the safe use of radioactive materials is very important to protect workers and to protect public health.

The tracking system includes two functions, namely the detection of radioactive materials and wireless communication.

Today all manner of products that we take for granted are dependent on the safe, secure and reliable transport of radioactive materials from manufacturer to the end user, or mobile use, for the purpose of non-destructive tests (NDT). As a result of the increased use of radioactive materials in, for example, industry, medicine and agriculture, shipments have become more frequent and larger in volume. In addition, transportation safety and security are vital during all stages of the nuclear fuel cycle – to and from nuclear power plants: at the front end, to transport uranium concentrates and new fuel assemblies; and at the back end, to transport radioactive waste and spent nuclear fuel for storage or disposal.

This document may also be useful for other dangerous materials and valuable goods to be transported and tracked.

TRACKING SYSTEMS FOR RADIOACTIVE MATERIALS – REQUIREMENTS

1 Scope

This document specifies the requirements of tracking systems for radioactive materials. Such systems identify and locate the position of the radioactive materials transported using global navigation satellite systems (GNSS) and radio frequency identification (RFID).

The system provides a set of safety controls of the radioactive material, by which the transporter can improve safety during transportation. This document may also be used as supplementary guidance to the regulatory body.

The tracking system consists of a measurement unit and a wireless communication unit. The measurement unit includes a radiation detector which measures radiation dose rate and may include a detector to measure the energy spectrum of photons emitted from radioactive materials transported, plus temperature and pressure sensors. The wireless communication unit includes mobile devices, base transceiver systems and mobile service providers.

Radioactive materials to be tracked include all radioactive materials, radioactive sources, radioactive waste and nuclear material, including nuclear fuel and spent fuel, transported using a Type B(U), Type B(M) or Type C package. Other criteria might be considered when the transport index is greater than 1.

This document does not apply to ambient or personal dose equivalent meters, which are covered in IEC 60846-1 or IEC 61526, respectively.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-395:2014, *International Electrotechnical Vocabulary (IEV) – Part 395: Nuclear instrumentation – Physical phenomena, basic concepts, instruments, systems, equipment and detectors*

IEC 60721-3-2:2018, *Classification of environmental conditions – Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and Handling*

ISO/IEC 27000, *Information technology – Security techniques – Information security management systems – Overview and vocabulary*

ISO/IEC 27001, *Information technology – Security techniques – Information security management systems – Requirements*

ISO/IEC 27002, *Information technology – Security techniques – Code of practice for information security controls*

ISO/IEC 27005, *Information technology – Security techniques – Information security risk management*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-395:2014, as well as the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
fissile material
material, other than natural or depleted uranium, that is capable of sustaining a thermal neutron chain reaction

[SOURCE: ISO 1709:2018, 3.3]

3.2
fissile nuclide
nuclide capable of undergoing fission by interaction with neutrons of any energy

[SOURCE: ISO 1709:2018, 3.4]

3.3
geographic information system
GIS
information system dealing with information concerning phenomena associated with location relative to the Earth

[SOURCE: ISO 19101-1:2014, 4.1.20]

3.4
global navigation satellite system
GNSS
comprises several networks of satellites that transmit radio signals containing time and distance data that can be picked up by a receiver, allowing the user to identify the location of its receiver anywhere around the globe

[SOURCE: ISO/TS 15638-19:2013, 4.25]

3.5
location
identifiable geographic place

Note 1 to entry: A location is represented by one of a set of data types that describe a position, along with metadata about that data, including coordinates (from a coordinate reference system), a measure (from a linear referencing system), or an address (from an address system).

[SOURCE: ISO 19133:2005, 4.10]

3.6
location-based service
LBS
service whose return or other property is dependent on the location of the client requesting the service or of some other thing, object or person

Note 1 to entry: Queries like “find the nearest restaurant” depend on the location of the questioner and are thus appropriate for an LBS.

[SOURCE: ISO 19133:2005, 4.11, modified – Note 1 to entry has been added.]

3.7
mobile service provider
MSP
company that offers transmission services to users of wireless devices (smartphones and tablet PCs) through radio frequency (RF) signals rather than through end-to-end wire communication

3.8
navigation
combination of routing, route traversal and tracking

Note 1 to entry: This is essentially the common term navigation, but the definition decomposes the process in terms used in the packages defined in this document.

[SOURCE: ISO 19133:2005, 4.15]

3.9
network
abstract structure consisting of a set of 0-dimensional objects called junctions, and a set of 1-dimensional objects called links that connect the junctions, each link being associated to a start (origin, source) junction and end (destination, sink) junction

Note 1 to entry: The network is essentially the universe of discourse for the navigation problem. Networks are a variety of one-dimensional topological complexes. In this light, junction and topological nodes are synonyms, as are link and directed edges.

[SOURCE: ISO 19133:2005, 4.17]

3.10
position
data type that describes a point or geometry potentially occupied by an object or person

Note 1 to entry: A direct position is a semantic subtype of position. Direct position as described can only define a point and therefore not all positions can be represented by a direct position. That is consistent with the “is type of” relation. An ISO 19107 geometry is also a position, but not a direct position.

[SOURCE: ISO 19133:2005, 4.18]

3.11
radioactive material
material having the property of radioactivity

Note 1 to entry: For legal purposes material may be considered radioactive only if its activity or radioactive concentration exceeds a specified value.

Note 2 to entry: The material may contain radionuclides and stable nuclides.

[SOURCE: IEC 60050-881:1983, 881-06-01]

3.12
radio frequency identification
RFID
identification of objects or persons using special tags that contain information (such as demographics, serial number, etc.) that can be read using RF-based readers

[SOURCE: IEC TR 80001-2-3:2012, 3.56]

3.13
route
sequence of links, and/or partial links, that describe a path, usually between two positions, within a network

[SOURCE: ISO 19133:2005, 4.19]

3.14
routing
finding of optimal (minimal cost function) routes between locations in a network

[SOURCE: ISO 19133:2005, 4.22]

3.15
tracking
monitoring and reporting the location of vehicle

[SOURCE: ISO 19133:2005, 4.24]

3.16
transportation
movement of people, animals and goods from one location to another

Note 1 to entry: Modes of transportation include air, rail, road, water, cable, pipeline and space.

3.17
wireless local area network
WLAN
local area network that uses RF signals to transmit and receive data

[SOURCE: IEC TR 80001-2-3:2012, 3.85]

4 Tracking system for radioactive materials

4.1 General

Radiation detectors measure dose-rate or count rate or photon energy spectrum of leakage radiation from the container including radioactive materials; and sensors for temperature and pressure measurements, are used to monitor environmental conditions for safety of the transported container.

This system should receive the location information on a real-time basis of the radioactive materials using a national or regional communication network, and should display the exact location in connection with the related geographical information.

The tracking system shall be rigidly fixed at the outer surface of the container. The tracking system network consists of a remote mobile system, the control centre, a mobile service provider and users.

The remote mobile system consists of a container, a measuring device, a communication device including position locator, etc.. The control centre operates the system and provides data and communication servers and location determination service.

Figure 1 shows a typical tracking system for radioactive materials and the detection unit of the tracking system is attached at the radioactive container.

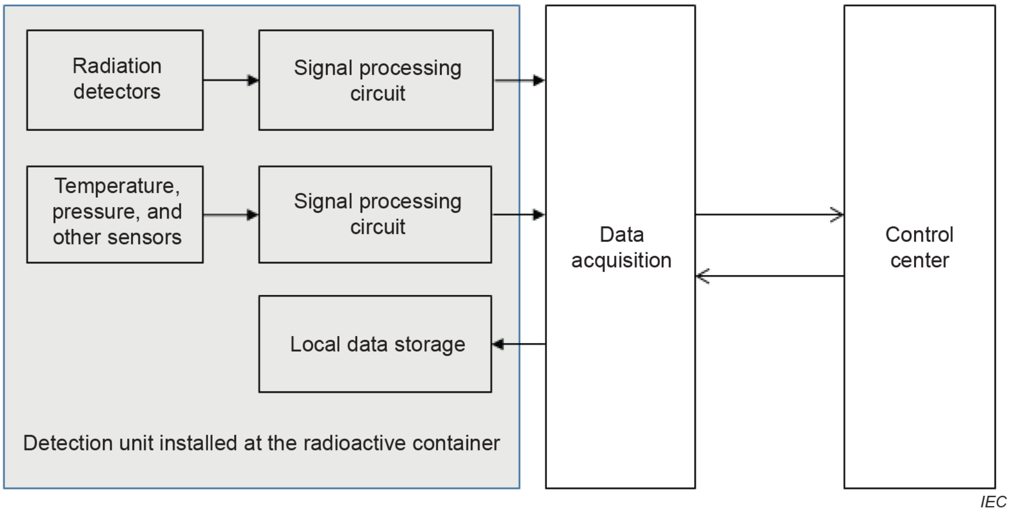

Figure 1 – Schematic diagram of tracking system for radioactive materials

4.2 Detector and sensor

4.2.1 Radiation detector

Radiation detector is used to measure dose-rate or photon energy spectrum on the outside surface of the container of radioactive materials. Types of radiation detectors used in tracking system are G-M tubes, ionization chambers, scintillation detectors (e.g. NaI(Tl), CsI(Tl) scintillators), and semi-conductor detectors (e.g. CdTe, CdZnTe). Scintillation and semi-conductor detectors are also used to measure photon energy spectra as well as dose-rate. Range of dose-rate to be measured shall be 0.1 μGy/h to 10 mGy/h.

4.2.2 Sensors

Temperature and pressure sensors are used to monitor environmental conditions outside the container of radioactive materials. During the transportation of the container, measurement ranges of the temperature and the pressure sensors should be −50 °C to 50 °C and 30 kPa to 106 kPa, respectively (see IEC 60721-3-2).

4.2.3 Local data storage

Data acquired from radiation detector, temperature sensor, pressure sensor, and other sensors are stored in local data storage for data security and simultaneously sent to the control centre.

4.3 Data acquisition

The power supplies for radiation detectors and sensors shall be part of the tracking system and shall be provided by the manufacturer.

The radiation level, temperature, pressure, position, and other environmental measurements should be acquired by the tracking system.

The raw data in accordance with 4.2.1 and 4.2.2 should be provided.

Any alarm should be provided to the control centre for early warning.