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ISO International Standards and the transport of radioactive material

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ABSTRACT

ISO International Standards provide guidance and promote best practice for tackling many of today's global challenges. They strive to provide assurance that products and services are safe, reliable and of good quality. Such standards can have positive effects, not only on engineers and manufacturers, but also on society as a whole. The paper outlines the areas in which the International Organization for Standardization (ISO) is contributing to the packaging and transport of radioactive material.

ISO has published standards and guidance which are dedicated to the transport of radioactive materials (e.g. packaging of uranium hexafluoride and leakage testing). These standards are developed within the ISO framework, by ISO/TC 85, the Technical Committee whose scope includes the production of standards pertaining to "nuclear energy, nuclear technologies, and radiological protection". Other ISO standards, although not explicitly dedicated to the transport of radioactive material are relevant in this field (such as standards for freight containers, quality management, materials).

The paper focuses on the series of standards applying particularly to the packaging and transport of radioactive material: the most recent developments and the status of these standards are provided.

The paper also emphasizes the need for maintaining and developing the portfolio of ISO International Standards. The opportunity for and process of "upgrading" guidelines developed by industry organization, such as the World Nuclear Transport Institute (WNTI), or national standards to ISO International Standard status is explained.

1. INTRODUCTION

If there were no standards, we would soon notice. Standards make an enormous contribution to most aspects of our lives – although very often, that contribution is invisible. It is when there is an absence of standards that their importance is brought home. For example, as purchasers or users of products, we soon notice when they turn out to be of poor quality, do not fit, are incompatible with equipment we already have, are unreliable or dangerous. When products meet our expectations, we tend to take this for granted. We are usually unaware of the role played by standards in raising levels of quality, safety, reliability, efficiency and interchangeability – as well as in providing such benefits at an economical cost.

For example, the format of the credit cards and "smart" cards that have become commonplace is derived from an ISO international standard. Adhering to the standard, which defines such features as an optimal thickness (0,76 mm), means that the cards can be used worldwide.

International standards thus contribute to making life simpler, and to increasing the reliability and effectiveness of the goods and services we use.

ISO standards also have important economic and social repercussions. ISO standards make a positive difference, not just to engineers and manufacturers for whom they solve basic problems in production and distribution, but to society as a whole.

The international standards, which ISO develops, are very useful. They are useful to industrial and business organizations of all types, to governments and other regulatory bodies, to trade officials, to conformity assessment professionals, to suppliers and customers of products and services in both public and private sectors, and, ultimately, to people in general in their roles as consumers and end users.

The purpose of this paper is to show the benefit provided by international standards in the field of the transport of radioactive material and its safety.

2. WHAT IS ISO, THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION?

International standards are developed by ISO, the International Organization for Standardization.

International standardization began in the electrotechnical field: the International Electrotechnical Commission (IEC) was established in 1906. The International Federation of the National Standardizing Associations (ISA), which was set up in 1926, carried out pioneering work in other fields. The emphasis within ISA was laid heavily on mechanical engineering. ISA's activities came to an end in 1942.

In 1946, delegates from 25 countries met in London and decided to create a new international organization, of which the object would be "to facilitate the international coordination and unification of industrial standards". The new organization, ISO, officially began operations on 23 February 1947.

Now, ISO is a network of the national standards institutes of 163 countries (at 31 July 2013), on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. While the standardization work is the matter of several thousands of experts, there is only about one hundred and fifty full time staff in Geneva.

ISO is a non-governmental organization: its members are not, as is the case in the United Nations system, delegations of national governments. Nevertheless, ISO occupies a special position between the public and private sectors. This is because, on the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

Therefore, ISO is able to act as a bridging organization in which a consensus can be reached on solutions that meet both the requirements of business and the broader needs of society, such as the needs of stakeholders groups like consumers and users.

To illustrate the work produced by ISO and its members, at 31 December 2012, a total of 19573 International Standards and standards-type documents were published. And, in 2012, 1280 International Standards and standards-type documents were published.

3. WHAT IS AN INTERNATIONAL STANDARD?

Standards are documented agreements, containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions, to ensure that materials, products, processes or services are fit for their purpose.

One important characteristics of an ISO international standard is that it is achieved through consensus agreements, and this at two levels.

The first one is the national level. Each national standards institute has the duty to seek for a consensus between all the stakeholders in its country.

At the second level, an ISO international standard can only be approved and published when a consensus is reached between all the involved national delegations.

ISO International Standards are developed in one of the 3368 ISO technical bodies comprising: 224 technical committees, 513 subcommittees, 2544 working groups and 87 ad hoc study groups (at 31 December 2012). Standards dealing with the transport of radioactive material are developed within ISO / TC 85 / SC 5 / WG 4, with:

- TC 85 = Technical Committee 85 “Nuclear energy, nuclear technologies, and radiological protection”,
- SC 5 = Sub-committee 5 “Nuclear fuel cycle”,
- WG 4 = Working Group 4 “Transport of radioactive material”.

4. WHAT ARE THE ROLES OF THE IAEA REGULATIONS AND OF THE ISO STANDARDS?

As regards the safe transport of radioactive material, the International Atomic Energy Agency (IAEA) has established the "Regulations for the Safe Transport of Radioactive Material", known now as SSR-6 <1>, which is the worldwide basis for all the national, regional and international regulations, such as:

- the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR),

- the Regulations concerning the International Carriage of Dangerous Goods by Rail (RID),

- the Technical Instructions (TIs) for the Safe Transport of Dangerous Goods by Air, set forth by the International Civil Aviation Organization (ICAO),

- the International Maritime Dangerous Goods (IMDG) code, set forth by the International Maritime Organization (IMO).

The IAEA Regulations acknowledge the importance of standards. Except for the lowest categories of packages, it is required, in its paragraph 640, that "the design and manufacturing techniques shall be in accordance with national or international standards, or other requirements, acceptable to the competent authority".

The IAEA Regulations is supported by a companion document, namely the "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material", known as TS-G-1.1 <2>. The rationale for the requirement to use standards is given in paragraph 638.1 of TS-G-1.1:

> "Many national and international standards exist covering an extremely wide range of design influences and manufacturing techniques, such as pressure vessel codes, welding standards or leaktightness standards, which can be used in the design, manufacturing and testing of packages. Designers and manufacturers should, wherever possible, work to these established standards in order to promote and demonstrate adequate control in the overall design and manufacture of packages. The use of such standards also means that the design and manufacturing processes are more readily understood by all relevant people, sometimes in different locations and Member States, involved in the various phases of transport; most importantly, package integrity is much less likely to be compromised."

Four ISO standards are included in the IAEA Regulations (SSR-6), while ten are mentioned in the "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material" (TS-G-1.1).

The four ISO standards included in SSR-6 are:

- Radiation Protection - Sealed Radioactive Sources - Leakage Test Methods (ISO 9978),

- Series 1 Freight Containers - Specifications and Testing - Part 1: General Cargo Containers for General Purposes (ISO 1496 - 1),

- Packaging of Uranium Hexafluoride (UF_6) for Transport (ISO 7195),

- Radiation Protection - Sealed Radioactive Sources - General Requirements and Classification (ISO 2919).

The ten ISO standards mentioned in TS-G-1.1 are:

- Series 1 Freight containers - Specifications and Testing - Part 1: General Cargo Containers (ISO 1496-1),

- Packaging of Uranium Hexafluoride (UF_6) for Transport (ISO 7195),

- Safe Transport of Radioactive Material - Leakage Testing of Packages (ISO 12807),

- Radiation Protection - Sealed Radioactive Sources - Leakage Test Methods (ISO 9978),

- Series 1 Freight containers - Specifications and Testing - Part 3: Tank Containers for Liquids, Gases, and Pressurized Dry Bulk (ISO 1496-3),

- Radioactive Materials - Packaging - Test for Contents Leakage and Radiation Leakage (ISO 2855),

- Sealed Radioactive Sources - Classification (ISO 2919),

- Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing (ISO 9001),

- Metallic Materials Discussions - Unified Method of Test for the Determination of Quasistatic Fracture Toughness (ISO 12135),

- Nuclear Energy - Fissile Materials - Principles of Criticality Safety in Storing, Handling and Processing (ISO 1709).

This list will be updated for the next edition of TS-G-1.1:

- ISO 2855 “Radioactive Materials - Packaging - Test for Contents Leakage and Radiation Leakage” will disappear from the list as this standard is obsolete,

- the titles and the editions of the standards will be updated,

- ISO 10276 “Nuclear Energy – Fuel Technology – Trunnions for Packages Used to Transport Radioactive Material” will be included (this standard was not available when previous editions of TS-G-1.1 were published).

5. WHAT ARE THE DIFFERENT ASPECTS OF INTERNATIONAL STANDARDS IN SUPPORT OF THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL?

5.1 From requirements to guidance

According to ISO definitions:

- a standard is a document, established by consensus and approved by a recognized body, that provides rules, guidelines or characteristics for activities or their results, on a voluntary basis, and made available to the public, and

- a regulation is a document providing binding legislative rules, that is adopted by an authority.

Clearly, it belongs to the International Atomic Energy Agency (IAEA) and to the modal regulations, such as the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO), to establish the requirements which are necessary to assure the safe transport of radioactive material. ISO standards are not requirements by themselves. ISO standards are companions to the IAEA Regulations. The following examples illustrate how they support the IAEA Regulations. They can be directly associated to the requirements (though, as explained previously, not being intrinsic requirements) or be guidance.

5.1.1 Requirements

Uranium hexafluoride, or UF_6, is transported worldwide, with the same equipments, which are well adapted to all the facilities where this material is processed. There is a need for international standardization in this field, and there is an international standard for that topic, ISO 7195 standard: “Packaging of Uranium Hexafluoride (UF_6) for Transport”. In the course of its development, all the aspects, and particularly all the hazards of the transport of this material, were taken into account. As a consequence of the value of this standard, the IAEA Regulations require UF_6 to be transported in packagings that meet ISO 7195 standard. The compliance with ISO standards allows taking into account appropriately the chemical toxic hazard of the material.

In such a case the compliance with ISO standard is a requirement of the IAEA Regulations (paragraph 631).

5.1.2 Alternative requirements

The IAEA Regulations set forth requirements for what is called Industrial Packages, or IPs in short.

There is an ISO standard that deals with the freight containers which are commonly used to ship goods. This standard is ISO 1496 standard: “Series 1 Freight Containers – Specifications and Testing – Part 1: General Cargo Containers for General Purposes”.

The use of the containers which meet this standard provides an equivalent level of safety to Industrial Packages (IPs) for the transport of Low Specific Activity (LSA) material or Surface Contaminated Objects (SCOs). This is recognized in IAEA Regulations. In that case, the compliance with ISO standard is an alternative requirement to that of the basic IAEA Regulations, duly recognized in the latter (paragraph 629).

5.1.3 Guidance

Ten ISO standards are mentioned in the guide "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material" (TS-G-1.1) <2>.

For instance, one of them is the ISO best seller, ISO 9001, dealing with quality management systems. This is a good example of the guidance which is provided by ISO standards, guidance that is duly recognized in TS-G-1.1.

5.1.4 Additional guidance

Finally, beside IAEA Regulations (SSR-6) and their advisory material (TS-G-1.1), ISO international standards provide guidance and recognized methods in many fields.

ISO standards are used every day in manufacturing, whether it is for the radioactive material itself, or the packaging for this material, or the conveyance to carry the package. This is because ISO standards are available to cover for instance material and welding techniques, but also measurement, testing or control processes. The benefit provided by this situation has been previously explained in paragraph 4, supported by paragraph 638.1 of TS-G-1.1.

5.2 Domains covered by ISO standards

Another possibility to consider standards is to look at the domains they cover. ISO supports the safe transport of radioactive material through a large number of international standards, from the most general ones to very specific standards.

5.2.1 Transport of radioactive material

First of all, transport of radioactive material is a service, which has many common characteristics with other services. This is why general standards that apply to all services are also applicable to transport of radioactive material. The ISO 9001 standard, about quality management systems, is an example of these general standards also applicable to the transport of radioactive material.

5.2.2 TRANSPORT of radioactive material

Transport of radioactive material is also transport. Standards that apply to transport also apply to the safe transport of radioactive material. An example is provided by the standard about freight containers, ISO 1496 standard: "Series 1 Freight Containers – Specifications and Testing – Part 1: General Cargo Containers for General Purposes", already mentioned in paragraph 5.1.2.

5.2.3 Transport of RADIOACTIVE MATERIAL

Transport of radioactive material deals with radioactive material. Standards about, for instance, radioactive sources are relevant. This is the case of ISO 2919 standard “Radiation Protection – Sealed Radioactive Sources – General Requirements and Classification” (ISO 2919), which provides alternative requirements to those of the basic IAEA Regulations, duly recognized in the latter (paragraph 709), in a similar manner as the standard about freight containers, as explained in paragraph 5.1.2.

5.2.4 TRANSPORT OF RADIOACTIVE MATERIAL

At last, there are a few standards dedicated to the transport of radioactive material.

A first typical example is ISO 7195 standard “Packaging of Uranium Hexafluoride (UF_6) for Transport”, for which the compliance with is a requirement included in the IAEA Regulations.

Another example is ISO 12807 standard “Safe Transport of Radioactive Material – Leakage Testing of Packages”. This is a standard mentioned in TS-G-1.1.

The last example is ISO 10276 standard “Nuclear Energy – Fuel Technology –Trunnions for Packages Used to Transport Radioactive Material”. It will be included in the next edition of TS-G-1.1.

5.3 Equipments or methods

It is also interesting to distinguish two kinds of standards: the first category describes materials and equipments, whilst the second describe methods. The first category describes **what** is a material; the second one describes **how** to reach a target.

The first category includes standards like ISO 7195 “Packaging of Uranium Hexafluoride (UF_6) for Transport”, already mentioned several times previously: it provides, among other things, a specification (geometry, materials, components…) for the manufacturing of the cylinders to transport uranium hexafluoride.

In the second category (methods) falls ISO 12807 “Safe Transport of Radioactive Material – Leakage Testing of Packages”. It describes several methods, which are recognized as appropriate. It does not describe the equipment, but it specifies the performances which are expected.

6. WHY TO USE INTERNATIONAL STANDARDS FOR THE TRANSPORT OF RADIOACTIVE MATERIAL?

An international standard is the result of a large consensus (within each country, and between countries). The direct consequence is that the contents of the standards are widely recognized, and the benefits of this situation are several.

First, using standards allows demonstrating to the authorities that the overall operations are mastered. This can be true for all phases of transport, ranging from packaging design, to packaging manufacturing, from preparation of shipment to effective realization of transport.

Second, the use of standards facilitates understanding by all directly involved organizations. Transport is an activity where many people intervene: they have different positions, and are also in different countries. An international standard is a tool that is easily shared by all these people.

Lastly, using international standards can also increase public confidence in the safety of the transport of radioactive material. Using an international standard is using a tool which has been largely discussed and finally widely accepted.

7. WHICH CHALLENGES FOR THE FUTURE?

The content of a standard is the best practices, or the highest recommendation, of what is known when it is issued. In the mean time the techniques and know-how are still progressing. The first challenge is to keep the door open to innovative solutions, even when requiring explicitly or implicitly the implementation of a standard.

The second challenge stems directly from the first one. When new solutions are enough developed, it is important that the existing standards are updated rapidly, or that new standards are developed in a short time.

Finally, it has been mentioned several times that the strength of a standard is largely due to its elaboration process: an ISO standard is the result of a consensus. But a consensus is only valid if there are enough people involved when it is prepared. That means that we can progress if many experts are interested. The last challenge is not the least: to prepare a standard must provide attractive perspectives to the most knowledgeable experts.

8. WHAT IS THE STATUS OF THE PORTFOLIO OF ISO INTERNATIONAL STANDARDS ON TRANSPORT OF RADIOACTIVE MATERIAL?

8.1 Maintaining the portfolio of ISO International Standards

As mentioned earlier, the portfolio of ISO International Standards which are dedicated to the transport of radioactive material includes three standards. They are considered by ISO / TC 85 / SC5 / WG 4. The scope of Working Group 4 is "to develop and maintain international standards associated with the equipment and procedures used for the transport of all radioactive material, including material from the nuclear fuel cycle, research activities, the industry, and for medical use, in order to improve safety, consistency and efficiency".

According to ISO rules, every ISO International Standards is valid for a period of five years. After that period of time, it has to be reviewed and, subsequently, confirmed, revised or withdrawn.

8.1.1 ISO 7195 "Packaging of Uranium Hexafluoride (UF_6) for Transport"

"Packaging of uranium hexafluoride (UF_6) for transport" (ISO 7195) was published (revised) in 2005. It specifies requirements for packaging of uranium hexafluoride (UF_6) for transport. It applies to:

- packages designed to contain uranium hexafluoride in quantities of 0.1 kg or more,
- design, manufacture, inspection and testing of new cylinders and protective packagings,
- maintenance, repair, inspection and testing of cylinders and protective packagings,
- in-service inspection and testing requirements for cylinders and protective packagings.

ISO 7195 is of primary importance, as compliance with this standard is a requirement of the IAEA "Regulations for the Safe Transport of Radioactive Material" and all the modal regulations based on.

This standard has been developed from and is based on ANSI N14.1 standard. ANSI N14.1 has been used internationally as an accepted procedure for packaging UF_6. The standard cylinders included in ANSI N14.1 standard have been used widely as accepted designs for international transport of UF_6. A revised ANSI N14.1-2012 standard was approved on 3 December 2012, and the revision of ISO 7195 is on progress to maintain as much as possible consistency between both standards. There is a strong need for the future to have both standards as close as possible; this will be reached step by step, the revision of each standard having an influence on the other one.

8.1.2 ISO 12807 "Safe transport of radioactive material - Leakage testing on packages"

"Safe transport of radioactive material - Leakage testing on packages" (ISO 12807) was published in 1996. It describes a method for relating permissible activity release rates of the radioactive contents carried within a containment system to equivalent gas leakage rates under specified test conditions. It pertains specifically to Type B(U) and Type B(M) packages for which the regulatory containment requirements are specified explicitly.

This standard is being renewed, reviewed and revised:

- to take into account the latest edition of the IAEA "Regulations for the Safe Transport of Radioactive Material",
- to include a new method for justification,
- to include quality assurance requirements,
- to consider up-dated references and subsequent consequences on the text,
- to up-date the standard.

8.1.3 ISO 10276 "Nuclear Energy – Fuel Technology – Trunnions for Packages Used to Transport Radioactive Material"

This International Standard covers trunnions fitted to radioactive material transport packages that are subject to the approval and licensing by competent authorities in accordance with SSR-6 <1>. It covers trunnion systems used for tie-down during transport and trunnions used for tilting and/or lifting.

ISO 10276 has been produced to enable package owners, designers, users and regulatory organizations to have at their disposal a comprehensive document covering all aspects of trunnions. Aspects included are design, manufacture, maintenance and quality assurance. Subject to agreement between the interested parties, it can also be applied to packages that are not subject to the approval by competent authorities.

Experience has been drawn from the extensive knowledge of owners, designers, users and competent authorities. Contained in the standard are the recommended minimum criteria covering various aspects of trunnions.

This standard was published in August 2010. No further work is planned on this topic for the short term.

8.2 Developing the portfolio of ISO International Standards

To develop the portfolio of ISO International Standards dedicated to the transport of radioactive material, the standards which exist in the national standardization bodies and which have value for the international community are considered. For instance, some preliminary work will be initiated to consider the possibility to transform the recently published ANSI N14.36 standard "Measurement of radiation level and surface contamination for packages and conveyances" in an ISO standard.

While national standardization bodies are members of the Working Group, other organizations may have a "liaison" with ISO. This is the case of WNTI, the World Nuclear Transport Institute. This global industrial organization, whose goal is "to represent the collective interests of the radioactive materials transport sector, and those who rely on safe, effective and reliable transport", is developing guides and best practices. It has been agreed that a standard could be developed about the transport of uranium ore concentrate. To this end, WNTI committed to pursue the development of a draft on this subject, to be used later as preliminary document to initiate the process towards an international standard. The WNTI draft will be based on its:

- Industry Good Practice for ISO Containers in Multimodal Transport,
- Good Practice for the Securing of Drums of Uranium Ore Concentrates in 20' ISO Containers,
- Best Practice for Checking Shipping Containers Prior to Loading Drums of UOC and Before Dispatch.

REFERENCES

<1> International Atomic Energy Agency, *Regulations for the Safe Transport of Radioactive Material*, 2012 Edition, Specific Safety Requirements No. SSR-6, IAEA, Vienna (2012).

<2> International Atomic Energy Agency, *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material*, Safety Guide No. TS-G-1.1 (Rev.1), IAEA, Vienna (2008).