Criticality working group

F/2015/10, SSR-6, § 546(j)(i) / 417 / 674 / 675, fissile exception code

TRANSSC CORRESPONDENCE WG

The group acknowledges that the documentation requirement in para 546(j) should be simplified, especially regarding multimodal shipments. About half of the group agrees with the proposed solution of introducing a special code. The other half of the group prefers to keep searching for an alternative solution. As an alternative solution, the relaxation of the requirement itself has been mentioned, but there is no proposal for this solution in the current review cycle.

There is an additional document available containing more explanations including an example, how to complete the transport document using the proposed code, compared to the current way based on a reference table.

This proposal is closely linked to the proposal IATA/2015/01, which had been assigned to WG4 of the September meeting. IATA/2015/01 points to the same issue, asking, why the information about the para./subpara. number is required. IATA proposes to remove the requirement or to co-ordinate its use in the modal regulations. A specific wording is not proposed. The proposal seems to be covered by the discussion about the proposal F/2015/10.

SSR-6 (2018 Draft)

Particulars of consignment

548. The consignor shall include in the transport documents with each consignment the identification of the consignor and consignee, including their names and addresses, and the following information, as applicable, in the order given:

(j) For fissile material:
   (i) Shipped under one exception of subparagraphs 417(a)–(f), reference to that para.;
   (ii) Shipped under para. 417(c)–(e), the total mass of fissile nuclides;
   (iii) Contained in a package for which one of para. 674(a)–(c) or 675 is applied, reference to that para.;
   (iv) The CSI, where applicable.

Working group:

Mostly France and WNTI support having the subparas in form of the proposed code and masses of fissile nuclides in the transport document for reasons of enhanced authority control and emergency response. Most other participants support only having reference to 417 if shipped under one exception of 417 or reference to 674/675 if shipped applying one of these paras. (the CSI of cause is always necessary, if there is one)

Everybody agrees that simplification of transport documentation would be important.

Additionally wording is not clear. Does (i) really mean putting the subpara in the transport document? Why is the word subparagraph in (i) but para in (iii)?
UK/2015/02, SSG-26, § 676.2, large number of unknown parameters

TRANSSC CORRESPONDENCE WG

The group understands the issue. Assessment of criticality safety is in many cases quite complex. Not only combinations of parameters have to be taken into account, but also the neutron physical properties of the system, uncertainties, validation and other influences. There should be some flexibility for the criticality expert when considering this complete system. This may be reflected in the advisory material. However, attention should be paid to find a wording for the advisory that does not contradict the regulatory text and that prevents misunderstanding or misuse. The currently proposed text is not supported by the majority of the group.

SSR-6 (2018 Draft)

Contents specification for assessments of package designs containing fissile material

676. Where the chemical or physical form, isotopic composition, mass or concentration, moderation ratio or density, or geometric configuration is not known, the assessments of paras 680–685 shall be performed assuming that each parameter that is not known has the value that gives the maximum neutron multiplication consistent with the known conditions and parameters in these assessments.

New text proposed by UK for SSG-26

676.2 Where the number of possible parameters is very large the probability of them all achieving their most reactive value during normal or accident conditions of transport may be vanishingly small. In such cases it may not be necessary for a criticality safety assessment to assess all possible permutations provided the Competent Authority is satisfied that criticality safety has been adequately demonstrated.

Working group:

The proposed text explains how assessments are done already. The possibility for excluding extreme combinations arises from the words ‘consistent with the known conditions’ in the regulations. The wording of the proposed explanatory text seems adequate. Since this was a proposal to this review process it should not be too late for insertion into SSG-26. Due to need for multilateral approval it leaves freedom to each competent authority to limit the use of this guidance to the extent considered safe by the authority.
SSR-6 (2018 Draft)

683. For packages to be transported by air:

(a) The package shall be subcritical under conditions consistent with the Type C package tests specified in para. 734, assuming reflection by at least 20 cm of water but no water in-leakage.

(b) In the assessment of para. 682, use of special features as specified in para. 680 is allowed provided that leakage of water into or out of the void spaces is prevented when the package is submitted to the Type C package tests specified in para. 734 followed by the water leakage test specified in para. 733.

SSR-6 (2012)

683. For packages to be transported by air:

…

(b) In the assessment of para. 682, allowance shall not be made for special features of para. 680 unless, following the Type C package tests specified in para. 734 and, subsequently, the water in-leakage test of para. 733, leakage of water into or out of the void spaces is prevented.

Working group:

The text is not easy to read. But if taken carefully it is clear how to apply. Probably the structure needs some more consideration. E.g., the interpretation of the regulations in Russia differs from the use in other countries. In Russia consideration of water in-leakage is required for the assessment of 683(a) and (b), which exceeds the IAEA requirements. Other countries do not take into account water in-leakage after the Type C tests of 683 (a), independently of the number of barriers. The problem is that no technical basis can be identified additionally to the wording in SSG-26. This definitely needs improvement.
Definition of the confinement system

The intention of the definition of the confinement system is not clear. Different competent authorities treat it differently. A discussion between authorities may be useful.

SSR-6 (2018 Draft)

Confinement system

209. Confinement system shall mean the assembly of fissile material and packaging components specified by the designer and agreed to by the competent authority as intended to preserve criticality safety.

Assessment of an individual package in isolation

681. It shall be assumed that the confinement system is closely reflected by at least 20 cm of water or such greater reflection as may additionally be provided by the surrounding material of the packaging. However, when it can be demonstrated that the confinement system remains within the packaging following the tests prescribed in para. 685(b), close reflection of the package by at least 20 cm of water may be assumed in para. 682(c).

682. The package shall be subcritical under the conditions of paras 680 and 681 and with the package conditions that result in the maximum neutron multiplication consistent with:

... 

REQUIREMENTS BEFORE THE FIRST SHIPMENT

501. Before a packaging is first used to transport radioactive material, it shall be confirmed that it has been manufactured in conformity with the design specifications to ensure compliance with the relevant provisions of these Regulations and any applicable certificate of approval. The following requirements shall also be fulfilled, if applicable:

(b) For each packaging intended for use as a Type B(U), Type B(M) or Type C package and for each packaging intended to contain fissile material, it shall be ensured that the effectiveness of its shielding and containment and, where necessary, the heat transfer characteristics and the effectiveness of the confinement system, are within the limits applicable to or specified for the approved design.

Working group:

An individual package should be subcritical independent of the definition of a confinement system.

Does confinement system mean some removable part of the package, including the fissile material, that should be subcritical on its own ('reflection by 20cm of water') or the complete package? Subcriticality of removable parts could be important during loading or in emergency response. Does this fit with the aim of the transport regulations? Or is it at least useful as a technical requirement (not safety requirement)
to support package design, emergency response? Do competent authorities apply this idea (questionnaire)? Do we want to keep this intention?

Confinement system also means an assembly (a list?) of criticality related package components. See para 501 (b), (c). Do we want to keep this? Do we want to reduce the meaning to this? Do we need a special term for this list?

 Additionally some transparency and clear description of intention is necessary. See presentation of Dennis Mennerdahl about a way to redefine the confinement system to identify clearly the intention.
Experience with Para 417(f) / 606 of SSR-6

The concept of Para 417(f) has been newly introduced in SSR-6. Since the beginning of 2015 it is included in the modal regulations and therefore may be used. The wording of Para 606 leaves room for interpretation. It would be nice to have an exchange about the experiences of the national authorities: examples for approved materials, important problems, open questions etc.

Working group:

The only application known to the group is from the UK. It is based on a ratio of fissile nuclides to certain non-fissile material. It is similar to the US domestic rules and to the discussion at IAEA before introduction of para 417(f). The application has not been approved yet.
Guide development

In 2014, the IAEA-TECDOC-1768 “Application of the Revised Provisions for Transport of Fissile Material in the IAEA Regulations for the Safe Transport of Radioactive Material” was developed. Starting from January 2015 the new regulations have been applied. There should be some experience in the competent authorities of the countries about the application of the guide: Feedback of users, problems, wishes for additional clarification. This should be discussed.

Working group:

The guide (or parts of it) has been translated to some languages, but there is no feedback from its application. There is no need for revision at this time.
Criticality at low temperatures

Criticality safety needs to be demonstrated even for temperatures as low as -40°C. Calculations for such low temperatures are difficult due to lacks in data libraries. There is some discussion among criticality experts about the effect of these temperatures. A common understanding of competent authorities of the problem (if there is any) and possible ways to a solution would be helpful.


According to paragraphs 673(a)(vi) and 679 of the IAEA Transport Regulations, SSR-6, and paragraph 673.8 of the IAEA Transport Guidance, SSG-26, temperatures resulting from ambient conditions of -40°C to +38°C should be considered unless the Competent Authority specifies otherwise in the certificate of approval. Package temperatures resulting from the thermal tests should also be considered.

Temperature variations in a transport package will result in changes in both the physical and nuclear properties of the package materials. Until very recently, it has not been practicable to assess the effects of temperature on the criticality safety of transport packages. Preliminary studies using the latest nuclear data library JEFF3.1.2, which has only recently become available to the industry, indicate that temperature variations may lead to a change in neutron multiplication.

The IAEA Transport Regulations require the impact of temperature on criticality safety to be assessed. Applicants for a transport license must consider both the nuclear and physical effects of temperature changes (e.g. reactivity changes from contraction/expansion).

Suitable methods to estimate the impact on criticality safety of low temperatures should be used, for example considerations based on nuclear and physical data and/or suitable extrapolations from data obtained at higher temperatures and supported by reasoned arguments. For those packages with a large criticality safety margin being transported solely in the UK, reasoned argument may be sufficient.

For existing package approvals, the evidence so far does not indicate that temperature variations will compromise criticality safety. ONR is currently discussing this issue with a number of international competent authorities, and establishing research needs in this area.

ONR encourages early engagement in order to discuss package approval applications on a case by case basis; for some applications a temperature restriction or a Special Arrangement may be appropriate. ONR will take a proportionate approach in assessing applications.

Working group:

For low (and also high temperatures) three influences on neutron multiplication may exist:
1. The material properties of the packaging or content may change leading to changes in the assumptions made for the criticality safety demonstration. This is usually taken into account.

2. The density of moderating material may change (e.g. formation of ice)

3. The neutron cross sections vary with temperature. The current versions of cross section databases do not contain data for low temperatures.

The influences 2 and 3 are often not taken into account. 3 is difficult because of missing cross sections. There have been reported extreme cases where $k_{eff}$ changes by up to 2% due to temperature changes.

It is considered that the uncertainty due to not accounting for 2 and 3 is covered by conservatism and margins in the criticality safety assessment. But the situation should be improved by taking into account all influences. To this aim cross sections for low temperatures will be introduced in the ENDF/B-VIII.0 cross-section library. Countries investigating the influence of low temperatures are strongly encouraged to present results in meetings and conferences (next PATRAM).
Determination of threshold value for fissile material definition and rounding down of CSI values

Introduced by Dennis Mennerdahl. These topics are directly related. What about allowing application-dependent rounding down of package design CSI values (of course subject to competent authority acceptance)?

Dennis Mennerdahl presented own thoughts on rounding down of CSI values (see presentation) for further discussion.
CSI limitation onboard ships

Introduced by Bruno Desnoyers. There is a need to clarify what is really needed for safety, and what are the assumptions considered for justification of these CSI limits per container, per hold and per total ship.

Working group:

The reason for the CSI limits for total seagoing vessels are not clear. There is no clear benefit for criticality safety of using containers, independently of being closed or not closed containers. The question from IMO about the need to have a closed character of container for applying higher CSI limits cannot be answered.

There should be initiated investigation for analyzing these limits. It would be useful if WNTI could lead this investigation, collecting some results and discussing them with the group.