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EXAMPLE FOR AN APPROVAL PROCEDURE FOR FISSILE MATERIAL EXCEPTED ACCORDING TO 417 (f)

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ABSTRACT

With the 2012 Edition of the Transport Regulations [1], the IAEA has introduced a new provision para. 417(f), which offers an additional possibility to except a material from the classification as "FISSILE". Following the transfer of the IAEA Transport Regulations to the UN Model Regulations and to the regulations for the different transport modes, the national regulations in Europe have applied this requirement since 2015. Recently, the competent authorities in Switzerland and Germany received for the first time an application for an approval of fissile material excepted according to para. 417 (f). We report on the experiences with applying para. 417 (f) to irradiated non-enriched natural uranium and the considerations made for describing the material in the certificate of approval from a competent authority's point of view.

INTRODUCTION

In preparation of the decommissioning of a Swiss research reactor, the rods of the so-called buffer fuel surrounding the core are intended to be transported to an external site for further use of the material. The research reactor has been moderated by heavy water and the fresh buffer fuel rods had a natural isotopic composition. Due to its isotopic composition the irradiated material does no longer meet the requirements of unirradiated natural uranium in para. 246 SSR-6. Since in addition the neutron spectrum during operation has not been exclusively thermal the slightly irradiated material is not excluded from the definition of a fissile material in para. 222 SSR-6. Thus, for the foreseen international transport criticality safety considerations have to be taken into account. In the Transport Regulations, however, the provisions in para. 417 allow exceptions from the classification as a fissile material. The operator of the research reactor considered the applicability of those exceptions to the buffer fuel and subsequently took the decision to launch an application for an approval of the fissile material excepted according to para. 417 (f) to the competent authorities of the neighboring countries, Germany and Switzerland. Both CAs agreed to collaborate closely during this approval procedure and to harmonize both, the communication with the applicant as well as the design of the certificate of approval.

EXCEPTIONS PER PARA 417 (f)

Generally, fissile material has to be transported in a package bearing a CSI label in order to ensure accumulation control during shipment. The provisions in para. 417 of the Transport Regulations allow to except materials that are fissile materials per para. 222 from the classification as FISSILE. Such fissile-excepted materials are transported using the same UN numbers as non-fissile material.

The provisions in para. 417 (a) to (e) are very specific regarding the properties and the amount of material permitted. Materials meeting these provisions are safe from a criticality safety point of view given that they are transported respecting provisions and limits in paras 570 and 636. Competent authority approval for the exception is not necessary in these cases. For materials excepted in accordance with para. 417 (f), however, SSR-6 requires to also meet the paras 606 and 802. According to para. 606 the materials have to provide criticality safety without accumulation control even after they have been subject to the test procedures required for packages containing fissile material. Per para. 802 the user has to seek competent authority approval to classify a material as fissile-excepted in accordance with para. 417 (f).

MATERIAL SPECIFICATION, APPLICATION AND DISCUSSIONS

Samples of the buffer fuel have been analyzed for their isotopic composition and their nuclide specific activities. As mentioned above, the plutonium content is very low as it lies in the order of ten milligrams per ton of heavy metal. The plutonium content has no significant impact on the neutron multiplication capability of the material, regardless of the moderation conditions. Practically, regarding criticality safety the irradiated uranium metal still has the properties of natural uranium, but it misses its definition in SSR-6 by a small margin. The applicant was aware of this and checked if one of the other exceptions in SSR-6 could be applied here.

The volume of the foreseen transport is several tons of metallic uranium fuel in form of several hundred rods with aluminum cladding. The applicant plans to ship the material in a Type A 20-feet ISO container with an inner container. Due to the high total mass to be transported none of the exceptions in para. 417 (c) to (e) would be of practical use in the present case. The material composition meets the requirements in para. 417 (a), but once the rods are placed in a package the lattice arrangement explicitly excluded in this subparagraph would be formed. Seeking competent authority approval for an exception per para. 417 (f) was therefore the logical step for the applicant.

The application comprises a statement why the other fissile exceptions in para. 417 (a) to (e) are not applicable for the material to be transported and why only the provisions in para. 417 (f) can be met. In principle, the absolute mass of the fuel to be transported and even the absolute activities are irrelevant for the exception per para. 417 (f) as only the material-specific properties determine if para. 606 is met. Nevertheless, such information still is well-received by a competent authority, as it helps to understand the scope and the intended use of the application and approval, respectively.

As per para. 805 an application for multilateral approval has to comprise *i. a*. the following information:

- A description of the material including its physical and chemical state
- A demonstration of criticality safety without accumulation control
- Statements regarding the required tests, their results, and their impact on criticality safety

The applications received by the CAs of Switzerland and Germany contained a sufficiently detailed description of the material including radiochemical analysis results, see above, and a detailed description of the foreseen packaging concept. The application documents stated that the materials criticality safety properties correspond to those of unirradiated natural uranium and that therefore the number *N* of packages subcritical under normal and accident conditions of transport is infinite.

Although we did not disagree with the latter statement, the declaration of *N*, which corresponds to the declaration of a criticality safety index, makes no sense for material on a very basic level as *N* is related to packages and para. 417 (f) talks about material, not packages. The intention of subparagraph 606 (b) is rather to apply the test procedures naturally specified for packages also to fissile-excepted materials in order to demand the same level of tolerance to transport conditions. However, the Transport Regulations are not very intuitive in this regard, because it is unusual in their framework that reference to another paragraph is made with the indication to meet its provisions in a certain context. Although the Advisory Material SSG-26 [2] gives valuable advice on this matter, the intention of subparagraph 606 (b) can still be misunderstood. Further clarification in future revisions may be needed here. Nevertheless, we were able to resolve the different understandings in a discussion with the applicant.

Furthermore, the usage of polyethylene sheets between layers of stacked rods was specified in the first revision of the application documents. From an assessors point of view this implies an irritating constellation: On the one hand the applicant does not have to specify the foreseen packaging (if no credit is taken for its properties, that is, see para. 606.2 in [2]), but has to demonstrate criticality safety for light water moderation. On the other hand, with the knowledge that polyethylene will certainly be present during the actual transport, demonstration und subsequent assessment of the criticality safety without this moderator is inconsistent. For the current application the material is natural uranium, and criticality safety would also be ensured with arbitrary amounts of polyethylene, but the question is raised how to deal with such situations in principle. We decided that the right solution is to ask the applicant for a criticality safety demonstration with polyethylene in the system. However, in a later state of the application the polyethylene sheets were removed from the packaging concept as they were not deemed necessary to prevent damage of the cladding.

CERTIFICATE OF APPROVAL

In the certificate of approval as per para. 835 (f) limiting specifications for the excepted material have to be included. This implies that the demonstration of criticality safety has to be based on this limiting specification. Since, as stated above, the inherent properties of the material are the matter of the approval process and not the extensive quantities such as the total mass or activity, it is clear that only mass-specific specification may be included in the certificate. The isotopic analysis provided by the applicant contains best-estimate values for the specific activities of all nuclides as well as the errors of the analysis results. Based on these data the applicant specifies the maximum U-235 content per unit uranium mass and the maximum specific content of Pu-239 and Pu-241 per unit of U-235.

Discussions between the two authorities and the applicant showed agreement to additionally include in the certificate a list of dominant nuclides, even if they are not accounted for in the criticality safety demonstration, and a limit for the specific activity of the material. Although technically this counts towards fixing limiting specification, from our point of view it rather adds to the qualitative description of the material as "irradiated natural uranium". For the same reason, we decided to include a reference to the radiochemical analysis report provided by the applicant in the certificate.

ORGANIZATION

Overall, we tried to deal with this application very similar as we do with applications for package designs, but since paras 417 (f) and especially 606 leave some room for interpretation by the CA, more direct communication with the applicant appeared expedient to us.

In contrast to other approval processes BfE started to draft the certificate in a comparably early stage of the process. This turned out to be the right approach, since ENSI already had a solid draft prepared. We decided to have a meeting of the two authorities to discuss and harmonize details of the certificate drafts, which was followed up by a conference call including the applicant. We got the impression that the cooperation between the authorities and how it worked out so far is well-received by the applicant. We, representing the authorities, benefit from the discussions in any case.

In Germany the Bundesanstalt für Materialforschung und –prüfung (BAM) is responsible for the assessment of the management system and the assessment of the demonstration of the tests for all transport conditions. Since the applicant decided to demonstrate criticality safety without any assumptions that take credit from the mechanical and thermal behavior of the material, BfE did not ask BAM to confirm any conditions. In that regard this assessment process is different from both, package design approval processes and validation processes for foreign package design approvals, where some basic conditions practically always have to be met by the package designs. Under these circumstances BAM was not involved in the discussions and the meeting described above. For many other applications for approval, however, the opposite should be the case. For the current application, BfE asked BAM to assess the management system of the applicant which is necessary to ensure that the fissile material meets the properties specified.

CONCLUSIONS

The first application for a fissile exception per para. 417 (f) of SSR-6 received by ENSI and BfE turned out to be a prime example for what kind of material should be excepted from the FISSILE classification. The Transport Regulations have to draw line from where a material should not automatically count as non-fissile and the irradiated natural uranium metal discussed in this paper is only slightly above the defined limits. For a competent authority who has to treat every applicant equally it is very comfortable to gain experience with such an undisputable case where basic formal questions are in the focus rather than more debatable decisions such as the question when the provision that subcriticality is ensured "without the need for accumulation control" is practically met.

REFERENCES

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

[2] International Atomic Energy Agency, *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition),* Specific Safety Guide No. SSG-26, IAEA Safety Standards, Vienna (2014).