Proposed SSG-26 text on the concept of shipment after storage

106.1bis “Shipment after storage” is a specific shipment operation which requires consideration of ageing phenomena of package components, change of transport regulations and change of technical knowledge. Storage, which may be over time span of several years or decades, as defined in the IAEA Safety Glossary, means the holding of radioactive material in a package that provides for its containment, with the intention of retrieval (for spent fuel see also SSG-15, for radioactive waste see also WS-G-6.1). In-transit storage is a part of shipment regulated by the transport regulations, while storage in the context for “shipment after storage” is regulated by international and/or national storage regulations and out of the scope of the transport regulations.

Proposed SSG-26 text on the concept of Ageing Management Programme and Gap Analysis Programme

809.3 As the package used for shipment after storage will be put into service for a long duration with the radioactive contents loaded, effects of degradation mechanisms and ageing process should be demonstrated to comply with the safety justifications throughout the storage period in order to maintain transportability after storage. It will be demonstrated by the periodical safety assessment together with inspection, monitoring and surveillance of the package and its operational and environmental conditions as well as maintenance during storage. Such manner will be documented by the applicant in an Ageing Management Programme, which will be maintained under the management system (see para. 306.4). Examples for consideration on ageing mechanism of the package used for shipment after storage can be found in Refs [1bis1] to [1bis6].

809.4 Detailed information relative to objectives of the A gap analysis programme can be found in [1bis7]. A gap analysis is an assessment of the package design compliance with the current regulations, considering changes of regulations, changes in technical knowledge and changes of the state of package design during storage, and identifying existing gaps. A gap analysis can support the package design approval certificate renewal process or the validity of existing certificates. Further references on gap analysis for the package used for shipment after storage can be found in Refs [1bis8] and [1bis11].
Proposed SSG-26 text on the graded approach of ageing mechanism considerations

[Proposal from Japan]

613bis.1 Package components are subjected to degradation mechanisms and ageing processes which depend on the component itself and its operational conditions. Thus the design of package should take into account ageing mechanisms commensurate to the operational conditions. A large number of packages are designed for once-through use, and after transport the packagings (e.g., a cardboard box) will be disposed. In such package design, any ageing effect needs not to be considered. For the design of package where repeated use is intended, ageing mechanisms have been well considered historically, sometimes in conjunction with the inspection and maintenance programme. A designer of package for repeated use may define the design life of the package in order to evaluate the potential degradation phenomena over time, such as corrosion, fatigue, crack propagation, changes of material compositions or mechanical properties due to thermal loadings or radiation, generation of decomposition gas, and their impact on the functions important to safety. During the design life those effects may be measured directly or indirectly in periodical inspections on empty packaging during, and when some effects are detected to exceed the limits set by the designer, countermeasures such as replacement or repair of components will be taken within the maintenance programme to recover their safety functions.

613bis.2 In the design of packages intended to be used for shipment after storage, consideration of ageing mechanism is of importance, due to long continuous operating period and difficulties in inspection to detect ageing effects and maintenance on the radioactive contents loaded packages. Furthermore, a knowledge on new ageing mechanism not considered in the original design or new technology to inspect ageing effects may be recognized during such operating period. For such design an ageing management programme (see para. 306.4bis, and for details see Ref. [10bis]) to justify the design considerations on ageing mechanism and a gap analysis program (see para. 809.3) to cope with changes in technical knowledge should be provided. These programmes are required in the application of the design approval for packages for shipment after storage as prescribed in para. 809 of the Regulations.

[Proposal from WNTI]

613bis.1 Package components are subjected to degradation mechanisms and ageing processes which depend on the component itself and its operational conditions. Thus the design of package should take into account ageing mechanisms commensurate to the operational conditions with graded approach manner. A designer of package should evaluate the potential degradation phenomena over time, such as corrosion, abrasion, fatigue, crack propagation, changes of material compositions or mechanical properties due to thermal loadings or radiation, generation of decomposition gas, and their impact on the functions important to safety. How to apply graded approach to ageing
consideration depends on the intended use of the package and its operating conditions.

613bis.2 For single use packagings, that are packagings used for one transport in their life such as excepted packages, Type IP-1, Type IP-2, Type IP-3 and Type A packages (for example fiberboard boxes, drums), that are not intended for storage before shipment, therefore no ageing phenomena has to be considered. For such packages, inspection prior to use is sufficient. If such packagings involve storage before shipment, 613bis.4 should be considered.

613bis.3 For packages intended for the repeated use, during the design phase, ageing mechanism should be evaluated in the safety demonstration. Based on this evaluation, inspection and maintenance programme should be developed. The condition of the package that can be assured by this programme should be consistent with the assumptions of the demonstration of compliance.

613bis.4 In the design of packages intended to be used for shipment after storage, consideration of ageing mechanism is of importance, due to long time period between loading and end of transport, conditions of storage (even though the transport regulations did not apply to the storage of the package), and difficulties in inspection to detect ageing effects and maintenance on the packages with radioactive contents loaded. Furthermore, a new technical knowledge or new requirements in the Regulations applicable to the design not considered in the original design or new technology to inspect ageing effects should be recognized during such operating period. For such design an ageing management programme (see para. 306.4bis, and for details see Ref. [10bis]) to justify the design considerations on ageing mechanism and a gap analysis program (see para. 809.3) to cope with changes in technical knowledge should be provided. These programmes are required in the application of the design approval for packages for shipment after storage as prescribed in para. 809 of the Regulations. The evaluation of ageing management programme and gap analysis programme should be implemented into an inspection plan prior to transport.

613bis.5 For UF6 Cylinders maintained and inspected in accordance to the ISO 7195 and ANSI N14.1 standards, no further evaluation of the potential degradation or ageing mechanism is required.
Comment from Japan on the Additional Justification by Switzerland (CH/2015/02 and CH/2015/03)

Japan requests TRANSSC to handle CH/2015/02 and CH/2015/03 carefully with considerations to their consequences.

1. Evaluation on the Multiplication Factors in TABLE 7

Proposals CH/2015/02 and CH/2015/03 make good point which has been discussed occasionally in previous review/revision cycles of the Regulations.

As stated in para. 523.2 of the Advisory Material SSG-26, the multiplication factors in TABLE 7 were introduced to compensate segregation distances corresponding to the sizes of radiation source. The segregation distances are calculated on the basis of a point source, where the decrease of radiation levels (dose equivalent rate) with distance follows the inverse square law. In the case of a large load, which can be considered as a surface (plane) source or a volume source, the decrease of radiation level with distance does not follow the inverse square law but indicates greater radiation level at the same distance compared with the case of point source. To compensate this, the multiplication factors depend to the size of load were introduced.

The problem identified by Switzerland will be clearly answered by comparison of the manners of decrease of radiation level with distance are calculated using models illustrated in Figure 1.

![Figure 1. Example of models to compare decrease of radiation level with distance](image)

Even before calculation, one can see the external radiation levels of the container will be similar to those of the large package at the points with the same distance. Hence, from the view point of radiation protection, or to calculate the segregation distances, some compensation due to its size should be applied to large packages. In that case, should the same factors as those for freight container or new factors specifically for the large packages be applied?
Para. 523(b) of SSR-6 may contain a logical question. It says "tanks, freight containers and unpackaged LSA-1 and SCO-I ..., then why specifically “tanks?” or “why not packages?", though tanks are always used as packagings.

From the viewpoint of radiation protection, TI is also used as the parameter for the loading limits on or in conveyance, hold, compartment or defined deck area as specified in para. 566 or TABLE 10. Impacts of the introduction of the multiplication factors to packages on the loading limits should be investigated, and appropriateness of the introduction of such factors should be evaluated.

2. Possible consequences of introduction of multiplication factors to packages

For consignors, TI of package is an important element to provide the transport plan. In accordance with para. 526 of SSR-6, consignors shall arrange exclusive use when the TI of package to be shipped exceeds 10. Consignors shall also decide the number of packages to be loaded per single conveyance, hold or compartment in order to comply with TABLE 10.

If the multiplication factors are introduced to packages, TIs of large packages may be doubled or tripled (or even 10 times greater when they are very large). Then, most of large packages have to be transported under exclusive use. Under the current Regulations consignors can load 5 packages per single non-exclusive use conveyance, hold or compartment. If the multiplication factor is introduced, 2 packages can be loaded when the TI is doubled, or single package when tripled. In case of air transport, consignors have to charter whole airplane when exclusive use is required.

Increased number of exclusive use shipments may cause burden to consignors. Decreased payload per conveyance leads to increased number of shipments and consequently the burden to consignors. Hence, aspect of large package transport might change considerably.

For large package designers, following two options seem to be available to determine shielding performance of package:

(a) To maintain external radiation levels less than 100 μSv/h at 1 m from the package external surface to avoid exclusive use (see para. 526), or
(b) To maintain external radiation levels less than 100 μSv/h at 2 m from the package external surface to be transported under exclusive use (see para. 573(c)).

In option (a), however, the radiation level criterion will be reduced to 50 μSv/h when TI is doubled, or to 33μSv/h when tripled commensurate to the size of package. Consequently the radioactive contents to be able to accommodate reduces, then number of transport and burden to consignor will increase.

3. Conclusions

From the viewpoint of radiation protection, the introduction of multiplication factors to packages seems feasible for the calculation of segregation distances, but its
appropriateness for the loading limits is unknown. Meanwhile, from the viewpoint of transport operation practices, its consequences may not be negligible. Having no idea how to balance these issues, Japan just requests TRANSSC careful considerations on the proposals CH/2015/02 and CH/2015/03.