Changes to IAEA Paragraphs to Add SCO-III to the Transport Regulations (SSR-6) and Guidance (SSG-26)

CHANGES TO SSR-6 REGULATIONS

SSR-6 Section 2

Para 244:

244. Transport index (TI) assigned to a package, overpack or freight container, or to unpackaged LSA-I or SCO-I or SCO-III, shall mean a number that is used to provide control over radiation exposure.

SSR-6 Section 4

Table 1

Surface contaminated objects

| UN 2913 | RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II or SCO-III), non fissile or fissile-excepted |

Para 413:

413. SCO shall be in one of two-three groups:

(a) SCO-I... (as is)
(b) SCO-II...(as is)
(c) SCO-III: A large solid object which because of its size cannot be transported in a type of package described in these Regulations and for which:

(i) All openings are sealed to prevent release of radioactive material during routine conditions of transport;
(ii) The inside of the object is as dry as practicable;
(iii) The non-fixed contamination on the external surfaces does not exceed the limits specified in para. 508;
(iv) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm$^2$ does not exceed $8 \times 10^5$ Bq/cm$^2$ for beta and gamma emitters and low toxicity alpha emitters, or $8 \times 10^4$ Bq/cm$^2$ for all other alpha emitters, unless it can be demonstrated that, following a transport accident, the activity intake by a person in the vicinity of the accident does not exceed $10^6 A_2$ or a corresponding inhalation dose of 50 mSv.
SSR-6 Section 5

Para 517:

517. The quantity of LSA material or SCO in a single Type IP-1, Type IP-2, Type IP-3 package, SCO-III, object or collection of objects, whichever is appropriate, shall be so restricted that the external radiation level at 3 m from the unshielded material or object or collection of objects does not exceed 10 mSv/h.

Para 520:

520. LSA material and SCO in groups LSA-I, and SCO-I and SCO-III may be transported, unpackaged, under the following conditions:

(a) through (d) as is; …

(e) For SCO-III;

(i) Transport shall be under exclusive use by road, rail or vessel;

(ii) Stacking shall not be permitted;

(iii) The requirements of para. 624 for a Type IP-2 package shall be satisfied, except that the maximum damage referred to in para. 722 may be determined based on provisions in the transport plan (para. 827 bis.(f)), and the requirements of para. 723 are not applicable.

(iv) The object and any shielding are secured to the conveyance in accordance with para. 607.

(v) The transport shall be subject to multilateral approval.

Para 522:

522. The total activity in a single hold or compartment of an inland waterway craft, or in another conveyance, for carriage of LSA material or SCO in a Type IP-1, Type IP-2, Type IP-3 package or unpackaged, shall not exceed the limits shown in Table 6. For SCO-III, the limits in Table 6 may be exceeded provided it can be demonstrated that, following a transport accident, the activity intake by a person in the vicinity of the accident does not exceed $10^{-6}$A$_2$ or a corresponding inhalation dose of 50 mSv.

Table 6:

<table>
<thead>
<tr>
<th>Nature of material</th>
<th>Activity limit for conveyances</th>
<th>Activity limit for a hold or compartment of an inland waterway craft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Other than inland waterway</td>
<td>Craft</td>
</tr>
<tr>
<td>LSA-I</td>
<td>No limit</td>
<td>No limit</td>
</tr>
<tr>
<td>LSA-II and LSA-III</td>
<td>No limit</td>
<td>No limit</td>
</tr>
<tr>
<td>Non-combustible solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSA-II and LSA-III</td>
<td>100A$_2$</td>
<td>10A$_2$</td>
</tr>
<tr>
<td>Combustible solids and All liquids and gases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCO$^1$</td>
<td>100A$_2$</td>
<td>10A$_2$</td>
</tr>
</tbody>
</table>

$^1$For SCO-III see para. 522
523. The TI for a package, overpack or freight container, or for unpackaged LSA-I, or SCO-I or SCO-III, shall be the number derived in accordance with the following procedure:

(a) Determine the maximum radiation level in units of millisieverts per hour (mSv/h) at a distance of 1 m from the external surfaces of the package, overpack, freight container or unpackaged LSA-I, and SCO-I and SCO-III. The value determined shall be multiplied by 100 and the resulting number is the TI.

(b) For tanks, freight containers and unpackaged LSA-I, and SCO-I and SCO-III, the value determined in step (a) shall be multiplied by the appropriate factor from Table 7.

Table 7: Change title to:

Multiplication Factors for Tanks, Freight Containers and Unpackaged LSA-I, and SCO-I and SCO-III

540. Each label conforming to the applicable models in Figs 2–4 shall be completed with the following information:

(a) Contents:

(i) Except for LSA-I material, the name(s) of the radionuclide(s) as taken from Table 2, using the symbols prescribed therein. For mixtures of radionuclides, the most restrictive nuclides must be listed to the extent the space on the line permits. The group of LSA or SCO shall be shown following the name(s) of the radionuclide(s). The terms “LSA-II”, “LSA-III”, “SCO-I”, and “SCO-II” and “SCO-III” shall be used for this purpose.

546. 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:

(n) For LSA-II, LSA-III, SCO-I, and SCO-II and SCO-III, the total activity of the consignment as a multiple of $A_2$. For radioactive material for which the $A_2$ value is unlimited, the multiple of $A_2$ shall be zero.

572. Where the consignment in or on the vehicle is unpackaged LSA-I material or SCO-I or SCO-III, or where a consignment is required to be shipped under exclusive use and is packaged radioactive material with a single UN number, the appropriate UN number (see Table 1) shall also be displayed, in black digits not less than 65 mm high, either:
SSR-6 Section 8

Para 802:

802. *Competent authority approval* shall be required for the following:…

(c) Certain *shipments* (see paras 825-8289)

Para 825:

825. *Multilateral approval* shall be required for:…

(e) The *shipment of SCO-III*.

Para 827 bis.:

827 bis. An application for *approval of SCO-III shipments* shall include:

(a) A statement of the respects in which, and of the reasons why, the consignment is considered a *SCO-III*.
(b) Justification for choosing *SCO-III* by demonstrating that:
   i. no suitable packaging currently exists;
   ii. designing and/or constructing a packaging or segmenting the object is not practically, technically or economically feasible;
   iii. no other viable alternative exists;
   iv. the advantages and level of overall level of safety and security to conducting the transport as *SCO-III* exceed any possible disadvantages or risks, respectively.
(c) A detailed description of the proposed *radioactive contents* with reference to their physical and chemical states and the nature of the radiation emitted;
(d) A detailed statement of the *design* of the *SCO-III*, including complete engineering drawings and schedules of materials and methods of manufacture;
(e) All information necessary to satisfy the *competent authority* that the requirements of para. 520(e) and the requirements of paras. 413(c)(iv) and 522, if applicable, are satisfied;
(f) A transport plan covering all activities associated with the shipment, including radiation protection, emergency response, and any special precautions or special administrative or operational controls which are to be employed during transit;
(g) A specification of the applicable *management system* as required in para. 306.
SSR-6 Annex I

Table Part 1:

<table>
<thead>
<tr>
<th>Key paragraphs in the Regulations</th>
<th>Class of package or material</th>
<th>Competent authority approval required</th>
<th>Consignor required to notify country of origin and countries en route of each shipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Country of origin</td>
<td>Countries en route</td>
</tr>
<tr>
<td>Excepted package&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>LSA material&lt;sup&gt;c,d,e&lt;/sup&gt; and SCO-I&lt;sup&gt;c,e&lt;/sup&gt; and SCO-II&lt;sup&gt;c,e&lt;/sup&gt;</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>— Type IP-1,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Type IP-2 or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Type IP-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>520, 825</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SCO-III</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>— Shipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type A&lt;sup&gt;c,d,e&lt;/sup&gt;</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

SSR-6 Annex III

SUMMARY OF CONSIGNMENTS REQUIRING EXCLUSIVE USE

The following consignments are required to be shipped under exclusive use:

(a) Unpackaged LSA-I material, and SCO-I and SCO-III (see para. 520);
CHANGES TO SSG-26 ADVISORY MATERIAL

SSG-26 Section 3

Para. 310.5: Applicable guidance moved to para 413.7 bis., removing any references to special arrangement

310.5. For large components generated from replacement or dismantlement of nuclear facility components, a hundred transports have been conducted under special arrangements in the Member States. On the basis of these experiences, the guidance included in Appendix VII was prepared to assist consignors and competent authorities in preparing and assessing applications for special arrangements for shipments of large components.

SSG-26 Section 4: Revised 413.1 and new paragraphs for guidance on SCO-III:

413.1. A differentiation is made between two categories of SCOs-I and SCO-II in terms of their contamination level…

413.8. For large objects generated from refurbishment or decommissioning of nuclear facilities, over a hundred transports have been conducted under special arrangements in the Member States [VII.1-VII.12]. These objects are quite large and massive, for example, measuring up to 6 m in diameter, up to 20 m in length and weighing over 400 000 kg, and are not readily amenable to transport under the Transport Regulations. While it was apparent that most of the objects transported contained only surface contamination, it was not certain that the SCO limits for inaccessible areas could be met, owing to non-uniform contamination deposition; nor could the interior areas be readily surveyed without on-site dismantlement of the object. These objects are generally substantial in design and construction, as necessitated by their use as pressure vessels under the applicable codes. If the objects are required to be transported in accordance with current Transport Regulations and in packages that meet tests such as stacking and free drop tests, then this would incur severe engineering challenges, prohibitive costs, or logistical difficulties during transport, owing to the size and weight of the components being transported. As experience with this type of transport has grown and is now more routine, specific regulatory requirements were needed to allow the movement of large objects without the need for special arrangement. On the basis of these experiences, a set of regulatory requirements for transport of large objects as surface contaminated objects (SCO-III category), based on the IAEA “performance package” concept, have been developed. Note that these requirements do not apply to components such as reactor vessels, due to the more limited experience and greater radioactivity levels.

413.9. For SCO-III, although typically welded, openings may be sealed (para. 413(c)(i)) by any method provided it is justified to prevent release of the radioactive material during routine conditions of transport. Openings should be sealed such that they may only be opened by destructive techniques such as machining, sawing, drilling or flame cutting.

413.10. Though a threshold value for dryness is not given (para. 413(c)(ii)), drain out of water, air blow and air ventilation are procedures employed to dry an object from the viewpoint of transport. More stringent dryness specifications may be required for disposal.
413.11 For SCO-III, there is no specific limits for the levels of fixed contamination on the external surfaces, since similar to packages, the external radiation resulting therefrom will combine with the penetrating radiation from the contents, and the net radiation levels are controlled by other specific requirements. The limit on the external non-fixed contamination is conservatively set to that for packages which, combined with the controls on radiation levels will ensure that the risk from fixed contamination is low. The major percentage of the component’s activity (A₂ quantity) should be due to surface contamination on interior surfaces, rather than on exterior surfaces or resulting from neutron activation of the component. Though a threshold value is not specified, this is not intended to allow transport of components with non-fixed external surface contamination exceeding the levels specified in para. 508 of the Transport Regulations or with overt activation of material. Transport of clearly activated components, such as reactor vessels, are outside the scope of SCO-III.

413.12 For SCO-III, contamination on the inaccessible surface may be determined by conservative estimates and/or analysis by methods other than direct contamination measurements. In the Q system (see Appendix I), five radiation exposure routes, i.e. external photon dose (Qₐ), external beta dose (Qₐ), inhalation dose (Qᵢ), skin and ingestion dose due to contamination transfer (Qₙ) and submersion dose (Qₑ) are considered. Among these, the inhalation dose (Qᵢ) can be taken as a major exposure route for SCO-III in the event of an accident, since most of the activity that is dispersed is from the surface contamination that comes from the surfaces of the object which may be scratched during an accident. If a SCO-III is involved in an accident, the maximum activity intake for a person in the vicinity of the accident should be approximately of the same level as that from Type A packages (see Appendix VII).

Para 520:

520.2 The basic concept of allowing transport of SCOs unpackaged is that, though unpackaged, the objects should comply with the applicable Type IP package requirements, when the outer envelope (shells, etc.) is considered as packaging. In addition to being allowed to be transported unpackaged, certain requirements for Type IP packages may be excluded, provided that compensatory safety measures in the form of more stringent operational controls are demonstrated in order to ensure the same level of safety.

520.3 For SCO-III, the free drop test requirement of para. 722 of the Transport Regulations should be applied to the component, without the benefit of any securing devices or systems, as prepared for transport and including attached covers and shielding.

520.4 As addressed in para. 722.6 in this publication, if the conditions in the transport plan effectively prevent the SCO-III from dropping or colliding in certain orientations, then these orientations could be ignored in assessing the maximum damage. Demonstration of compliance may be performed in accordance with any of the methods referred to in para. 701 of the Transport Regulations.

520.5 The SCO-III, including any unpackaged penetrations, openings and crevices, as well as additional shieldings, should meet the Type IP-2 requirements, with the noted exclusions. If a SCO-III is involved in an accident, the maximum activity intake for a person in the vicinity of the accident should be approximately of the same level as that from Type A packages (see Appendix VII).
520.6 The SCO-III, including any unpackaged penetrations, openings and crevices, as well as additional shieldings, should be capable of withstanding the effects of any acceleration, vibration or vibration resonance which may arise under routine conditions of transport. This is set to comply with para. 613 of the Transport Regulations under routine conditions of transport.

Para 522:

522.3 If a SCO-III is involved in an accident, the maximum activity intake for a person in the vicinity of the accident should be approximately of the same level as that from Type A packages (see Appendix VII).

SSG-26 Section 8

827 bis.1 A written transport plan is used to govern the transport of SCO-III. The transport plan should contain lines of authority, responsibilities, requirements, precautions, prerequisites, instructions, personnel restrictions, emergency response actions, a radiation protection programme that includes any conveyance transfers, and the sequence of events regarding the transport.

827 bis.2 As part of the transport plan, special attention should be paid to the radiation protection programme since the transport of SCO-III would be conducted in a different manner from the routine transport of ordinary packages and may involve workers not familiar with transport operations. As such, it should take into account all steps and activities of transport and all relevant transport workers and members of the public. Radiation levels of the object, transport and handling methods, including durations and distances of workers from the object in each operation, should be carefully examined and doses to workers should be optimized with the proper dose constraint.

SSG-26 Appendix VII

INTRODUCTION

VII.1. Since the mid-1990s, organizations in some Member States with nuclear facilities began to find it increasingly necessary to transport large radioactive components for disposal or material reuse purposes. The transport needs arose owing to the retirement and dismantlement of some facilities, as well as component degradation requiring replacement to provide for continued operation at other facilities. The dismantling of retired nuclear facilities requires the transport of reactor vessels, reactor vessel heads, pressurizers, steam generators and other kinds of components. In the case of pressurized water reactors, the replacement of degraded components to permit operations to continue has generally been limited to steam generators, reactor heads and pressurizers. These components are quite large and massive, for example, measuring up to 6 m in diameter, up to 20 m in length and weighing over 400 000 kg.

Moved to 413 guidance.

VII.2. Several issues arose, owing to the implementation of the 1985 Edition of the IAEA Transport Regulations, on the practical matters of how to characterize these components and comply with the Transport Regulations. The large components were not readily amenable to transport under the Transport Regulations, and while it was apparent that most of the components contained only surface contamination, it was not certain that the SCO limits for inaccessible areas could be met, owing to non-uniform contamination deposition; nor could the interior areas be readily surveyed.
without on-site dismantlement of the large component. The components are generally substantial in design and construction, as necessitated by their use as pressure vessels under the applicable codes. If the objects are required to be transported in accordance with current Transport Regulations and in packages that meet tests such as stacking and free drop tests, then this would incur severe engineering challenges, prohibitive costs, or logistical difficulties during transport, owing to the size and weight of the components being transported. Moved to 413 guidance.

VII.3. Over the course of more than a decade, much experience has been gained in transporting nearly a hundred of these components in and between Member States [VII.1–VII.12]. Steam generators and pressurizers have typically been transported in an unpackaged manner; that is, the outermost shell of the component provides a boundary for the radioactive material. The transport of reactor heads with control rod drive mechanisms intact has typically involved the use of packagings. Moved to 413 guidance.

VII.4. This appendix is intended to be a standardized guidance for competent authorities to use as reference for large component special arrangement preparation and approval. It could also be used as reference for industries. No longer required with new SCO-III regulations.

LARGE COMPONENTS

VII.5. Owing to wide range in terms of size, shape, mass, radioactivity composition and distribution, origin of nuclear facilities, etc., a comprehensive definition of large components is hard to establish. On the other hand, with consideration of basic safety concepts, some boundaries on large component specifications can be set as guidelines in conjunction with limits specified, such as those for SCOs and/or LSAs in the Transport Regulations. No longer required with new SCO-III regulations – SCO-III is defined.

VII.6. On the basis of Member States’ experience, this guidance generally covers components which are generated from nuclear power stations and which are mainly SCOs with masses ranging from a few tens of tonnes to several hundred tonnes. In spite of this, it may be applicable to components from other types of nuclear facility with other radiological characteristics and masses, when the same level of safety of transport operation is ensured. Moved to 413 guidance.

VII.7. Owing to limited experience and higher radioactivity levels, the transport of reactor vessels is not included in this guidance. Moved to 413 guidance.

BASIC SAFETY CONCEPT

VII.8. The basic concept of allowing transport of SCOs unpackaged is that, though unpackaged, the objects (i.e. large components) should comply with the applicable Type IP package requirements, when the outer envelope (shells, etc.) is considered as packaging. In addition to being allowed to be transported unpackaged, certain requirements for Type IP packages may be excluded, provided that
compensatory safety measures in the form of more stringent operational controls are demonstrated in order to ensure the same level of safety.
Moved to 520 guidance.

VII.9. In the Q system, which was developed to establish a radiological basis for the Transport Regulations, five radiation exposure routes, i.e. external photon dose (QA), external beta dose (QB), inhalation dose (QC), skin and ingestion dose due to contamination transfer (QD) and submersion dose (QE) are considered. Among these, the inhalation dose (QC) can be taken as a major exposure route for large components under accident conditions, since most of the activity that is dispersed is from the surface contamination that comes from the surfaces of the component which may be scratched during the accident. Therefore, to assess the level of safety of transport of large components, evaluation of inhalation dose from surface contamination can be considered as being essential.
Moved to 413 guidance.

VII.10. To maintain the same level of safety as in the Type IP package transport means that a large component should satisfy design requirements for that particular Type IP package, without packaging, and comply with the requirements and controls for the Type IP package transport. In addition, in an accident, an activity intake for a person in the vicinity of the accident should be approximately of the same level as the intake from SCOs or Type A packages, which is considered as a value of $10^{-6}A_2$.
Moved to 520 guidance.

**GUIDANCE FOR CALCULATION OF ACTIVITY INTAKE FOR TRANSPORT OF SCO-III**

VII.1. In an accident, for SCO-III the maximum activity intake for a person in the vicinity of the accident should be approximately of the same level as the intake from Type A packages, which is considered as a value of $10^{-6}A_2$ or a corresponding inhalation dose of 50 mSv.

VII.11. An activity intake for a person in an accident is given by:

$$Q_{INT} = (Q_{INT, FIX} + Q_{INT, NF})$$  \hspace{1cm} (VII.1)

where

$Q_{INT}$ is the intake activity of radionuclides (Bq);

$Q_{INT, FIX}$ is the intake activity of radionuclides due to the fixed contamination (Bq);

$Q_{INT, NF}$ is the intake activity of radionuclides due to the non-fixed contamination (Bq).

The intake activity of radionuclides due to the fixed contamination, $Q_{INT, FIX}$, can be calculated from:

$$Q_{INT, FIX} = Q_{IV, FIX} \times F_{SCRAP} \times F_{REL, FIX} \times F_{RSUS} \times F_{INT}$$  \hspace{1cm} (VII.2)

where
QIV, FIX is the inventory attributed to fixed contamination in a package or an object (Bq);

FSCRAP is the fraction of surface area that is scraped in an accident;
FREL, FIX is the fraction of the activity which is freed from the scraped surfaces and released from
the package or the object in an accident;

FRSUS is the fraction of the released activity which is in a form of respirable aerosol;
FINT is the fraction of respirable released activity intake for a person in the vicinity of the accident.

In the formula above, for objects with an homogeneous surface contamination, QIV, FIX, can be
determined from:

\[
QIV, \text{ FIX} = \text{CFIX} \times \text{A} \times 10^4
\]

where

CFIX is a level of fixed surface contamination (Bq/cm^2);

A is the surface area of an object (m^2).

When calculating the intake activity of radionuclides due to the non-fixed contamination, QINT,NF, 100% of the non-fixed contamination present on the object should be assumed to be available for release without any scraping of the surfaces required. Therefore, the intake activity of radionuclides due to the non-fixed contamination, QINT, NF, can be calculated from:

\[
QINT, \text{ NF} = QIV, \text{ NF} \times \text{FREL, NF} \times \text{FRSUS} \times \text{FINT}
\]

where

QIV, NF is the inventory attributed to non-fixed contamination in a package or an object (Bq);

FREL, NF is the fraction of the activity which is free and released from the package or the object in
an accident^3;

FRSUS is the fraction of the released activity which is in respirable aerosol;
FINT is the fraction of respirable released activity intake for a person in the vicinity of the accident.

^3 FREL, NF should be taken as unity (100%) unless the use of a lower release fraction can be
justified.

For objects with an homogeneous surface contamination, the inventory, QIV, NF, is determined as:

\[
QIV = \text{CNF} \times \text{A} \times 10^4
\]

where

CNF is a level of non-fixed surface contamination (Bq/cm^2);
A is the surface area of an object (m²).

Example calculation: SCO-III

*Same figure as on p. 423 of SSG-26, but replace “Large component” with “SCO-III”.*

Since the internal surface of a large component SCO-III is considered as an inaccessible surface, the contamination limit can be $8 \times 10^5$ Bq/cm² for the fixed contamination, plus the non-fixed contamination. In the evaluation below, limits each for the fixed contamination and for the non-fixed contamination are taken, since it gives a slightly conservative result (by 1.25%).

1.1. Inventory of fixed contamination on an internal surface of a large component SCO-III:

$$Q_{IV,\text{ FIX}} = C_{\text{FIX}} \times A = 8 \times 10^5 \text{ Bq/cm}^2 \times 10 \text{ m}^2 = 8 \times 10^{10} \text{ Bq} = 80 \text{ GBq}$$

1.2. Inventory of fixed contamination scraped from an internal surface:

$$Q_{\text{SCRAP, FIX}} = Q_{IV,\text{ FIX}} \times F_{\text{SCRAP, FIX}} = 80 \text{ GBq} \times 20\% = 16 \text{ GBq}$$

1.3. Inventory released from scraped fixed contamination:

$$Q_{\text{REL, FIX}} = Q_{\text{SCRAP, FIX}} \times F_{\text{REL, FIX}} = 16 \text{ GBq} \times 0.01 = 0.16 \text{ GBq} = 160 \text{ MBq}$$

1.4. Inventory of the released activity from fixed contamination which is in respirable aerosol:

$$Q_{\text{RSUS, FIX}} = Q_{\text{REL, FIX}} \times F_{\text{RSUS}} = 160 \text{ MBq} \times 100\% = 160 \text{ MBq}$$

1.5. Intake activity from fixed contamination:

$$Q_{\text{INT, FIX}} = Q_{\text{RSUS, FIX}} \times F_{\text{INT}} = 160 \text{ MBq} \times (1 \times 10^{-4}) = 16 \text{ kBq}$$

2.1. Inventory of non-fixed contamination on an internal surface of a large component SCO-III:

$$Q_{IV,\text{ NF}} = C_{\text{NF}} \times A = 400 \text{ Bq/cm}^2 \times 10 \text{ m}^2 = 4 \times 10^7 \text{ Bq} = 40 \text{ MBq}$$

2.2. Inventory of non-fixed contamination released from an internal surface:

$$Q_{\text{SCRAP, NF}} = Q_{IV,\text{ NF}} \times F_{\text{SCRAP, NF}} = 40 \text{ MBq} \times 100\% = 40 \text{ MBq}$$

2.3. Inventory of the released activity from non-fixed contamination which is in respirable aerosol:

$$Q_{\text{RSUS, NF}} = Q_{\text{REL, NF}} \times F_{\text{RSUS}} = 40 \text{ MBq} \times 1 = 40 \text{ MBq}$$

2.4. Intake activity from non-fixed contamination:

$$Q_{\text{INT, NF}} = Q_{\text{RSUS, NF}} \times F_{\text{INT}} = 40 \text{ MBq} \times (1 \times 10^{-4}) = 4 \text{ kBq}$$

3. Total intake activity of radionuclides from an object:
QINT = QINT, FIX + QINT, NF = 16 kBq + 4 kBq = 20 kBq

4. Assuming A2 = 0.02 TBq (2 × 10^{10} Bq), then the activity intake is:

\[
\text{QINT} = 20\text{kBq} \times \frac{A2}{0.02\text{TBq}} = 1 \times 10^{-6} A2
\]

VII.42. In an approval of a SCO-III shipment special arrangement transport of large components, every parameter in para. VII.14 should be examined and justified. Parameter \( A \) can be calculated from the design drawings of the components. Distributions and radionuclide compositions of parameters CFIX, CNF and QIV throughout the component can be measured, or properly modelled, for a series of components, together with a verification measurement for representative points on each component. Parameters FSCRAP, FRSUS and FREL are sensitive and should be demonstrated as being appropriate through the literature [VII.11, VII.12], tests or reasoned argument. Parameter FINT may have a value of 10^{-4} to 10^{-3}, which is used in para. I.37, relative to the Q system.

VII.13. In a case where values used in the SCO-II model would be justified for parameters FSCRAP, FRSUS, FREL and FINT, inventories up to 10A_2 for fixed surface contamination plus the non-fixed contamination on the inaccessible surface can be allowed to maintain the same safety level. A simple scenario such as “10% of internal activity will be released from the component, and 1% of particles will be in the respirable size range” may be adopted, when justified; then inventory limits will be 10A_2 for fixed and non-fixed surface contamination. On the basis of more specific assessments, even higher levels of the total activity content could be justified. No longer required as covered by limits set in regulations and calculation method defined here in Appendix VII.

VII.443. Care should be taken about the radionuclide composition of the inventory. For example, in the case of \( \beta \) and \( \gamma \) emitting unknown radionuclides, an inventory limit of 10A_2 corresponds to 0.2 TBq, then to 4 × 10^3 Bq/cm^2, when a surface area of 5000 m^2 (a typical internal surface area for a steam generator) is assumed. This is two orders of magnitude lower than the contamination level limit on the inaccessible surface of a SCO-III, that is, 8 × 10^5 Bq/cm^2. In contrast, when Co-60 is the only radionuclide present in the inventory, the allowable level of inaccessible surface contamination increases up to 4 TBq and 8 × 10^4 Bq/cm^2.

VII.15. The inventory of the component may also be restricted by the limitation of external doses to comply with applicable provisions of the Transport Regulations, and by the conveyance activity limit according to para. 522 of the Transport Regulations (see paras VII.24, VII.25 and VII.33). In the event that the inventory of the component or of the consignment exceeds the conveyance activity limits, adequate compensatory measures must be proposed by the consignor and approved by the competent authority. Covered by revised para 522 of the Regulations.
VII.16. There are clearly many aspects to be considered when shipping large components and each situation needs its own approach, based on the particular characteristics of the large components to be transported. A specific example from Germany, with a summary of the safety requirements for the barge transport of steam generators from light water reactors as large components, can be found at the end of this section [VII.7].

Removed as an example of a special arrangement is no longer applicable with the new regulations.

RECOMMENDED CRITERIA TO APPROVE SPECIAL ARRANGEMENT TRANSPORT OF LARGE COMPONENTS

VII.17. For large component transport, the following guidelines in paras VII.18–VII.37 should be met.

VII.18. The large component should be classified as transported under special arrangement, UN 2919 RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, non-fissile or fissile excepted. As specified in para. 310 of the Transport Regulations, the transport of large components should be subject to multilateral shipment approval.

Moved to Regulations (Table 1, 802 and 825).

VII.19. The major percentage of the component’s activity (A₂ quantity) should be due to surface contamination on interior surfaces, rather than on exterior surfaces or resulting from neutron activation of the component. Though a threshold value is not specified, this guideline is not intended to allow transport of components with non-fixed external surface contamination exceeding the levels specified in para. 508 of the Transport Regulations or with overt activation of material. Transport of clearly activated components, such as reactor vessels, are outside the scope of these guidelines.

Moved to 413 guidance.

VII.20. The quantity and distribution of activity in the large component should be such that, under accident conditions of transport, the activity intake by a person in the vicinity of the accident should not exceed an order of magnitude of 10⁻⁶ A₂ or a corresponding inhalation dose of 50 mSv (see paras VII.11–VII.14).

Moved to Regulations (413 and 522).

VII.21. The component and its contents should meet the fissile material exception requirements of para. 417 or para. 674 or para. 675 and subject to CSI accumulation control of the Transport Regulations. Material of the component and its contents should be fissile excepted to meet the requirements of para. 417, or the component, including its contents, should be fissile excepted to meet the requirements of either para. 674 or para. 675.

Covered by current Regulations.

VII.22. No unnecessary extraneous material should be placed in the interior void spaces of the component.

Not required as such details of the SCO-III will be reviewed in the application. It is unlikely that this would be permitted by the Competent Authority, but should not be forbidden.
VII.23. Liquid content should be negligible. Though a threshold value for dryness is not given, drain out of water, air blow and air ventilation are procedures employed to dry a component from the viewpoint of transport. More stringent dryness specifications may be required for disposal. Moved to Regulations and guidance (413).

VII.24. The maximum radiation level at any point on the outside shell of the component and at the plane formed by any opening or penetration on the component should be less than 2 mSv/h. This guideline is set to meet the external radiation level for the component itself, as prescribed in para. 573(a) of the Transport Regulations. As an exceptional case, the limitation of 10 mSv/h may be allowed, subject to measures prescribed in para. 573(a)(i)–(iii). Even in this case, paras VII.25 and VII.32 should be complied with. Covered by current Regulations.

VII.25. The external radiation level at 3 m from the unshielded radioactive contents of a large component should not exceed 10 mSv/h. This is set to comply with para. 517 of the Transport Regulations. Moved to Regulations (517).

VII.26. The component, including any unpackaged penetrations, openings and crevices, as well as additional shieldings, should be capable of withstanding the effects of any acceleration, vibration or vibration resonance which may arise under routine conditions of transport on the effectiveness of the closing devices on the component or in the integrity of the component, including additional shieldings. This is set to comply with para. 613 of the Transport Regulations under routine conditions of transport. Moved to 520 guidance.

VII.27. The component, including any unpackaged penetrations, openings and crevices, as well as additional shieldings, should meet the Type IP-2 requirements of para. 624 of the Transport Regulations. The stacking test and the free drop test for Type IP-2 packages are specified for the component (see para. VII.36). Moved to 520 guidance.

VII.28. The component, as offered for transport, should meet the non-fixed contamination requirements of para. 508 of the Transport Regulations. Moved to 413 Regulations.

VII.29. The component should be consigned as exclusive use. Moved to 520 Regulations.

VII.30. From its size and mass, air transport of the component can be excluded. Moved to 520 Regulations.

VII.31. The TI of the component should be determined as per para. 523 of the Transport Regulations, with use of the multiplication factors for tanks, freight containers and unpackaged LSA-I and SCO-I. Moved to 523 Regulations.
VII.32. Other requirements and controls for transport specified in the Transport Regulations, such as categories, marking, labelling, placarding and consignor’s responsibilities should be complied with. Covered by current Regulations.

VII.33. The radiation levels of the means of transport should not exceed the levels specified in para. 573(b) and (c) of the Transport Regulations. Similar considerations may be taken for a vessel transport. Covered by current Regulations.

VII.34. The component and any conveyance shielding are secured to the conveyance in accordance with para. 607 of the Transport Regulations and applicable national transport standards. Covered by 520 Regulations.

VII.35. A written transport and emergency response plan is used to govern the transport and is approved with a management system in accordance with para. 306 of the Transport Regulations. The radiation protection programme should take into account all steps and activities of transport and all relevant transport workers and members of the public. The transport and emergency response plan must contain lines of authority, responsibilities, requirements, precautions, prerequisites, instructions, personnel restrictions, emergency response actions, a radiation protection programme that includes any conveyance transfers, and the sequence of events regarding the transport. Special attention should be paid to the radiation protection programme, since the transport of large components would be conducted in a different manner from the routine transport of ordinary packages and may involve workers not familiar with transport operations. Radiation levels of the component, transport and handling methods, including durations and distances of workers from the component in each operation, should be carefully examined and doses to workers should be optimized with the proper dose constraint. Moved to Regulations and guidance (827 bis.).

VII.36. If the transport conditions and emergency response plan specify a stacking prohibition and a component transport orientation restriction, then:

(a) The stacking test required in para. 723 of the Transport Regulations is not required:

—— As specified in para. 723 of the Transport Regulations, if the shape of the component or the transport and emergency response plan effectively prevents stacking, then the test can be excluded.

(b) The transport orientation restriction, administratively controlled by the transport and emergency response plan, may be considered when applying the free drop test requirement of para. 722 of the Transport Regulations that the specimen must drop on to the target so as to suffer maximum damage (e.g. Ref. [VII.8]). The free drop test requirement of para. 722 of the Transport Regulations should be applied to the component, without the benefit of any securing devices or systems, as prepared for transport and including attached covers and shieldings:

—— As addressed in para. 722.6 in this publication, if the transport conditions and emergency response plan effectively prevents the components from dropping or colliding in certain orientations, then these orientations could be ignored in assessing the worst damage.
Demonstration of compliance may be performed in accordance with any of the methods referred to in para. 701 of the Transport Regulations.
Moved to Regulations and guidance (520).

VII.37. On approval of the shipment, the competent authority should issue an approval certificate which includes information specified in para. 836 of the Transport Regulations.
Moved to Regulations (802, 825).

SPECIFIC EXAMPLE OF SAFETY REQUIREMENTS FOR LARGE COMPONENTS
Removed as an example of a special arrangement is no longer applicable with the new regulations.

What follows is a specific example, from Germany, of the safety requirements recently applied to the transport, by barge, of steam generators from light water reactors as large components [VII.7–VII.9].

The safety requirements can be summarized as follows:

(a) The large component itself must meet the SCO-II and Type IP-2 package requirements as far as possible. If additional shielding is needed, it must be considered as part of the Type IP-2 package. The most important criteria to be demonstrated are the required package integrity level under 0.3 m drop test conditions and the limitation of radiation level increase after the drop test to not more than 20%.

(b) If the requested package integrity level under drop test conditions cannot be fully demonstrated for certain drop orientations, technical measures must be applied to avoid occurrence of such drop orientations during transport.

(c) The dose rate at 3 m distance from the unshielded contents of the large component must not exceed 10 mSv/h and the conveyance limits of 10A2 for inland waterway transport and 100A2 for all other modes of transport must be complied with.

(d) The limitation on the total radioactive contents inside the large component must be such that, under accident conditions of transport, an equivalent level of safety will be achieved as that for Type IP-2 or Type A packages (radiation dose to a person in the vicinity of an accident should not exceed 50 mSv).

Regarding item (d), an assessment in Ref. [VII.7] leads to the conclusion that for a total radioactive content of the steam generator in the range of 5–10A2, an adequate level of safety, also under accident conditions of transport, is provided if both exposure routes due to external gamma radiation and due to inhalation are taken into account. On the basis of more specific assessments, even higher levels of the total activity content could be justified.


[VII.9] SCHIFFER, W., HILBERT, F., ibid.


Note that the above references were mistakenly numbered VI.1 to VI.12 instead of VII.1 to VII.12 in the current revision of SSG-26. There are a couple of typographical errors in these references that should be corrected, as noted in blue.