SCHEDULE 8

REQUIREMENTS FOR RADIOACTIVE MATERIALS
AND FOR PACKAGINGS AND PACKAGES

PART XIV

REQUIREMENTS FOR PACKAGES CONTAINING FISSILE MATERIAL

1. Fissile material must be packaged and shipped in such a manner that subcriticality is maintained under conditions likely to be encountered during normal and accident conditions of transport. The following contingencies must be considered—

(a) water leaking into or out of packages;

(b) the loss of efficiency of built-in neutron absorbers or moderators;

(c) rearrangement of the radioactive contents either within the package or as a result of loss from the package;

(d) reduction of spaces within or between packages;

(e) packages becoming immersed in water or buried in snow; and

(f) temperature changes.

2. A package containing fissile material must meet the requirements of paragraph 2 of Part X and those requirements prescribed elsewhere in these Regulations which pertain to the radioactive properties of the material.

3. Packages are excepted from meeting the requirements of paragraphs 4- 10 where they are transported in a consignment meeting one of the exception criteria (a), (b), (c) or (d)—

(a) the mass of fissile material in the consignment is controlled such that—

$$\frac{\text{mass of uranium 235 (g)}}{X} - \frac{\text{mass of other fissile material (g)}}{Y} < 1$$

where X and Y are the mass limits defined in Table X of Schedule 1, and the mass of beryllium and deuterium is controlled such that it does not exceed 0.1% of the fissile material mass allowed and provided that either—

(i) for packaged material each package contains individually not more than 15g of fissile material, or

(ii) for unpackaged material the vehicle contains not more than 15g of fissile material, or

(iii) the fissile material is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or

(iv) there is not more than 5g of fissile material in any 10 litre volume of material.

b) each package containing uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the fissile material is distributed essentially homogeneously throughout the material; provided also that if uranium-235 is present in metallic, oxide, or carbide forms, it does not form a lattice arrangement.

c) each package containing liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium-235, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.

d) each package containing individually not more than 1 kg of total plutonium, of which not more than 20% by mass may consist of plutonium-239, plutonium-241, or any combination of those radionuclides.

4. A packaging for fissile material must be so designed that, if it were subjected to the tests specified in paragraphs 7 -12 of Part IV of Schedule 9 the construction of the packaging would prevent the entry of a 10 cm cube.

5. For the purposes of this Part:

"undamaged", in relation to a package means the evaluated or demonstrated condition of the package if it had been subjected to the tests specified in paragraphs 7 – 12 of Part IV of Schedule 9;

"damaged", in relation to a package, means the evaluated or demonstrated condition of the package if it had been subjected to whichever of the following combination of tests is the more limiting—

(a) the tests specified in paragraphs 7 – 12 of Part IV of Schedule 9 followed by the tests specified in paragraphs 15 and 16 of that Part of that Schedule and completed by the tests specified in paragraphs 19 – 21 of that Part of that Schedule (the mechanical test of paragraph 15 of that Part of that Schedule must be the tests specified in paragraphs 15(b)) and the test in paragraph—

(i) 15(c) of that Part of that Schedule, when the package has a mass not greater than 500 kg and an overall density not greater than 1000 kg/m^3 based on the external dimensions, or

(ii) 15(a) of that Part of that Schedule for all other packages, or

b) the tests specified in paragraphs 7 – 12 of Part IV of Schedule 9 followed by the test in paragraph 17 of Part IV of Schedule 9.

6. In determining the subcriticality of individual packages in isolation for the purposes of this Schedule, it must be assumed that water can leak into or out of all void spaces of the package, including those within the containment system. However, if the design incorporates special features to prevent such leakage of water into or out of certain void spaces, even as a result of human error, absence of leakage may be assumed in respect of those void spaces. Special features shall include the following—

(a) multiple high standard water barriers, each of which would remain watertight if the package were damaged; a high degree of quality control in the production and maintenance of packagings; and special tests to demonstrate the closure of each package before shipment; or

(b) for packages containing uranium hexafluoride only—

(i) where for damaged packages there is no physical contact between the valve and any other component of the packaging other than its original point of attachment and where, in addition, following the test specified in paragraph 16 of Part IV of Schedule 9 the valves remain leaktight; and

(ii) a high degree of quality control in the production and maintenance and repair of packagings; and special tests to demonstrate the closure of each package before each shipment

7. The individual package damaged or undamaged must be subcritical under the conditions specified in paragraphs 5 and 6 taking into account the physical and chemical characteristics including any change in those characteristics which could occur when the package is damaged and with the conditions of moderation and reflection as specified below.

For all material within the confinement system: the material arranged in the confinement system—

(a) in the configuration and moderation that results in maximum neutron multiplication; and

(b) with close reflection of the containment system by water 20 cm thick (or equivalent), or such greater reflection of the containment system as may additionally be provided by the surrounding material of the packaging unless it can be demonstrated that the confinement system remains within the damaged packaging;

8. An array of packages must be subcritical. A number, "N" must be derived assuming that if packages were stacked together in any arrangement with the stack closely reflected on all sides by water 20 cm thick (or its equivalent) both of the following conditions would be satisfied—

(a) five times "N" undamaged packages without anything between the packages would be subcritical; and

(b) two times "N" damaged packages with hydrogenous moderation between packages to the extent which results in the greatest neutron multiplication would be subcritical and, in addition if any part of the fissile material escapes from the containment system: that material, from two times "N" damaged packages must be subcritical when arranged in—

(i) the configuration and moderation that results in maximum neutron multiplication; and

(ii) with close reflection of that material by water 20 cm thick (or equivalent).

9. In evaluating the subcriticality of fissile material in its transport configuration, the following must apply—

(a) the determination of subcriticality for irradiated fissile material must be based on an isotopic composition demonstrated to provide—

(i) the maximum neutron multiplication during the irradiation history, or

(ii) a conservative estimate of the neutron multiplication for the package assessments. After irradiation but prior to shipment, a measurement must be performed to confirm the conservatism of the isotopic composition; and

(b) for fissile material whose chemical or physical form, isotopic composition, mass or concentration, moderation ratio or density, or geometric configuration is not known, each parameter that is not known must have the value which gives the maximum neutron multiplication consistent with the known conditions and parameters in paragraphs 5 to 8.

10. The package must be designed for an ambient temperature range of −40°C to +38°C unless the Secretary of State specifies otherwise in the certificate of approval for the package design.