

RADIATION PROTECTION ACT
([CHAPTER 262, SECTION 28](#))

RADIATION PROTECTION (TRANSPORT OF RADIOACTIVE MATERIALS)
REGULATIONS

Rg 3

G.N. No. S 30/2000

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PART I

PRELIMINARY

Citation

1. These Regulations may be cited as the Radiation Protection (Transport of Radioactive Materials) Regulations.

Application

2. These Regulations shall not apply to —

- (a) establishments in which the radioactive material is produced, used or stored other than in the course of transport, and in respect of which the Radiation Protection (Ionising Radiation) Regulations (Rg 2) apply;
- (b) persons who have been implanted with radioisotopic cardiac pacemakers or other devices, or who have been treated with radiopharmaceuticals; and
- (c) the movement of radioactive materials forming an integral part of a vehicle, vessel or aircraft.

Operation of other laws

3. Nothing contained in these Regulations shall be so construed as to limit or in any way affect the provisions of the Radiation Protection (Ionising Radiation) Regulations or any written law relating to the transport of dangerous goods or hazardous substances.

Definitions

4.—(1) In these Regulations, unless the context otherwise requires —

“A₁” means the activity value of special form radioactive material which is listed in Table 1 or derived in Section B of [the Second Schedule](#) and is used to determine the

activity limits for the requirements of these Regulations;

“A₂” means the activity value of radioactive material, other than special form radioactive material, which is listed in Table 1 or derived in Section B of [the Second Schedule](#) and is used to determine the activity limits for the requirements of these Regulations;

“cargo aircraft” means any aircraft, other than a passenger aircraft, which is carrying goods or property;

“carrier” means any person who transports radioactive material, whether on his own behalf or on behalf of another person, but shall not include the driver of a vehicle or the master of a vessel or aircraft carrying radioactive material unless no other person is a carrier of that material;

“certificate of approval” means a certificate issued by the Chief Executive or any competent authority signifying his approval of the design for special form radioactive material, the transport of a consignment under special arrangement, the package design or the shipment;

“competent authority” means any national or international authority designated or otherwise recognised as such for any purpose in connection with the regulation and control of the transport of radioactive materials and includes the Chief Executive;

“compliance assurance” means a systematic programme of measures applied by the Chief Executive which is aimed at ensuring that the provisions of these Regulations are complied with;

“confinement system” means the assembly of fissile material and packaging components specified by the designer and agreed to by the competent authority of the country of origin as intended to preserve criticality safety;

“consignee” means any person who receives a consignment;

“consignment” means any package, overpack, freight container or tank of radioactive material presented by a consignor for transport;

“consignor” means any person who presents a consignment for transport, and is named as consignor in the transport documents;

“containment system” means the assembly of components of the packaging specified by the designer as intended to retain the radioactive material during transport;

“contamination” means the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters or 0.04 Bq/cm² for all other alpha emitters;

“conveyance” means —

(a) in the case of transport by road or rail, any vehicle;

(b) in the case of transport by water, any vessel, or any hold, compartment, or defined deck area of a vessel; and

(c) in the case of transport by air, any aircraft;

“criticality safety index” or “CSI” when assigned to a package, overpack or freight container containing fissile material, means a number, which is used to provide control over the accumulation of packages, overpacks or freight containers containing fissile material;

“defined deck area” means the area of the weather deck of a vessel, or of a vehicle deck of a roll-on/roll-off ship or a ferry, which is allocated for the stowage of radioactive material;

“depleted uranium” means uranium containing a lower mass percentage of uranium-235 than natural uranium;

“design” means the description of special form radioactive material, low dispersible radioactive material, package or packaging for the purpose of fully identifying the item, which may include specifications, engineering drawings, reports demonstrating compliance with regulatory requirements and other relevant documentation;

“enriched uranium” means uranium containing a greater mass percentage of uranium-235 than natural uranium;

“exclusive use” means the sole use, by a single consignor, of a conveyance or of a large freight container in respect of which all initial, intermediate, and final loading and unloading is carried out in accordance with the directions of the consignor or consignee;

“fissile material” means uranium-233, uranium-235, plutonium-239, plutonium-241, or any combination of these radionuclides but does not include unirradiated natural uranium, depleted uranium, and natural or depleted uranium which has been irradiated in thermal reactors only;

“fixed contamination” means contamination other than non- fixed contamination;

“freight container” means an article of transport equipment designed to facilitate the transport of goods, either packaged or unpackaged, by one or more modes of transport without intermediate reloading, and shall be divided into the following classes:

(a) small freight containers — containers which have an overall outer dimension of less than 1.5 m or an internal volume of not more than 3.0 m³; and

(b) large freight containers — containers other than small freight containers;

“intermediate bulk container” or “IBC” means a portable packaging that —

(a) has a capacity of not more than 3 m³;

(b) is designed for mechanical handling;

(c) is resistant to the stresses produced in handling and transport, as determined by performance tests; and

(d) is designed to conform to the standards in the chapter on Recommendations on

Intermediate Bulk Containers (IBC's) of the United Nations Recommendations on the Transport of Dangerous Goods;

- “licensed carrier” means a carrier who has in force a licence issued under the [Act](#) authorising him to transport radioactive materials;
- “low dispersible radioactive material” means either a solid radioactive material or a solid radioactive material in a sealed capsule, that has limited dispersibility and is not in powder form;
- “low specific activity material” or “LSA material” means radioactive material which by its nature has a limited specific activity or for which limits of estimated average specific activity apply, and shall be divided in accordance with Section A of [the First Schedule](#) into 3 groups, namely, LSA-I, LSA-II and LSA-III;
- “master”, in relation to a vessel, means any person (except a pilot or harbour master) having for the time being control or charge thereof and, in relation to an aircraft, the captain of the aircraft;
- “maximum normal operating pressure” means the maximum pressure above atmospheric pressure at mean sea level that would develop in the containment system in a period of one year under the conditions of temperature and solar radiation corresponding to environmental conditions of transport in the absence of venting, external cooling by an ancillary system, or operational controls during transport;
- “multilateral approval”, in relation to a consignment, means approval by the relevant competent authority both of the country of origin of the design or shipment and of each country through or to which the consignment is to be transported and includes any validation or endorsement of the original certificate by a competent authority of any country through or to which the consignment is transported;
- “natural uranium” means chemically separated uranium containing the naturally occurring distribution of uranium isotopes (approximately 99.28% uranium-238, and 0.72% uranium-235 by mass);
- “non-fixed contamination” means contamination that can be removed from a surface during normal handling;
- “overpack” means a receptacle (other than a freight container) which is used by a single consignor to consolidate into one handling unit a consignment of 2 or more packages for convenience of handling, stowage and carriage;
- “package” means the packaging with its radioactive contents as presented for transport and shall be classified into the following classes:
- (a) excepted packages;
 - (b) industrial packages Type 1 (Type IP-1), Type 2 (Type IP-2) and Type 3 (Type IP-3);
 - (c) Type A packages;
 - (d) Type B packages which are further classified into Type B(U) or Type B(M)

packages; and

(e) Type C packages;

“packaging” means the assembly of components necessary to enclose the radioactive contents completely and may, in particular, consist of one or more receptacles, absorbent materials, spacing structures, radiation shielding, service equipment for filling, emptying, venting and pressure relief, devices for cooling, for absorbing mechanical shocks, for providing handling and tie-down capability and for thermal insulation, and service devices integral to the package, and includes a box, drum or similar receptacle, freight container or tank;

“passenger aircraft” means an aircraft that carries any person other than a crew member, a carrier’s employee in an official capacity, an authorised representative of an appropriate national authority, or a person accompanying a consignment;

“quality assurance” means a systematic programme of controls and inspections applied by any organisation or body involved in the transport of radioactive material which is aimed at providing adequate confidence that the standard of safety prescribed in these Regulations is achieved in practice;

“radiation level” means the corresponding equivalent dose rate;

“radioactive contents” means the radioactive material together with any contaminated or activated solids, liquids and gases within the packaging;

“revoked Regulations” means the Radiation Protection (Transport of Radioactive Materials) Regulations 1974 (G.N. No. S 248/74) revoked by these Regulations;

“shipment” means the specific movement of a consignment from origin to destination;

“special arrangement” means those conditions approved by the Chief Executive under which a consignment which does not satisfy all the applicable requirements of these Regulations may be transported;

“special form radioactive material” means either an indispersible solid radioactive material or a sealed capsule containing radioactive material;

“specific activity” means —

(a) the activity of a radionuclide per unit mass of that nuclide; or

(b) where the radionuclide is essentially uniformly distributed in any material, the activity per unit mass of the material;

“surface contaminated object” or “SCO” means a solid object which is not itself radioactive but which has radioactive material distributed on its surfaces and shall be divided in accordance with Section B of [the First Schedule](#) into 2 groups namely, SCO-I and SCO-II;

“tank” means a tank container, portable tank, a road tank vehicle, a rail tank wagon or a receptacle having a capacity of 450 litres for liquids, powders, granules, slurries or solids which are loaded in gaseous or liquid form or not less than 1,000 litres for

gases;

“tank container” means a tank which —

- (a) is constructed to facilitate the carriage of goods by land or water without need for the removal of its structural equipment;
- (b) has stabilising members and tie-down attachments external to the shell; and
- (c) is capable of being lifted when full;

“transport” means to remove from any place, vehicle, vessel or aircraft to another place, vehicle, vessel or aircraft by road, rail, water or air, and includes transport which is incidental to the use of radioactive materials and all operations incidental to transport, such as loading, unloading and storage in transit;

“transport index” or “TI” means a single number assigned to a package, overpack, tank or freight container, or to unpackaged LSA-I or SCO-I, which is used to provide control over radiation exposure;

“uncompressed gas” means gas at a pressure not exceeding ambient atmospheric pressure at the time the containment system is closed;

“unilateral approval” means an approval of a design which is required to be given by the competent authority of the country of origin of the design only;

“unirradiated thorium” means thorium containing not more than 10^{-7} grams of uranium-233 per gram of thorium-232;

“unirradiated uranium” means uranium containing not more than 2×10^3 Bq of plutonium per gram of uranium-235, not more than 9×10^6 Bq of fission products per gram of uranium-235 and not more than 5×10^{-3} g of uranium-236 per gram of uranium-235;

“vehicle” includes a vehicle whether mechanically propelled or otherwise and also includes a trailer;

“vessel” means any seagoing vessel or inland waterway craft used for carrying cargo.

(2) For the purposes of determining the estimated average specific activity of any LSA material, any external shielding materials surrounding the LSA material shall be disregarded.

(3) References in these Regulations to transport through or to Singapore or any other country shall exclude references to an aircraft carrying any radioactive material flying over Singapore or that country without landing therein.

(4) For the purposes of these Regulations, low toxicity alpha emitters means natural uranium, depleted uranium, natural thorium, uranium-235 or uranium-238, thorium-232, thorium-228 and thorium-230 contained in ores or physical concentrates, or alpha emitters with a half-life of less than 10 days.

(5) For the purposes of these Regulations, A_1 , A_2 , the activity concentration for exempt materials and the activity limits for exempt consignments shall be determined —

- (a) in accordance with Table 1 of [the Second Schedule](#); or
- (b) in the case of individual radionuclides whose identities are known but are not specified in Table 1 of [the Second Schedule](#), in accordance with Table 2 of [the Second Schedule](#) or in such other manner as may be approved by the Chief Executive or a competent authority.
- (6) The following abbreviations and symbols are used in these Regulations:

<i>Abbreviation or symbol</i>	<i>Definition</i>
Bq	becquerel
°C	Degree Celsius
cm	Centimetre
cm ²	Square centimetre
g	Gram
h	Hour
kBq	Kilobecquerel
Kg	Kilogram
kPa	Kilopascal
l	Litre
m	Metre
m ²	Square metre
m ³	Cubic metre
MBq	Megabecquerel
MPa	Megapascal
ml	Millilitre
mm	Millimetre
mS	Millisiemens
mSv	Millisievert
Pa	Pascal (= newton/m ²)
PBq	Petabecquerel
TBq	Terabecquerel
W	Watt

PART II

CATEGORIES OF PACKAGES AND OVERPACKS

Determination of transport index and criticality safety index

5.—(1) The transport index based on radiation exposure control for a package, overpack, tank, freight container, or for unpackaged LSA-I or SCO-I, shall be the number derived in accordance with the following procedure:

- (a) the maximum radiation level at a distance of 1 m from the external surfaces of the package, overpack, tank, freight container, or unpackaged LSA-I and SCO-I shall first be determined, and —
 - (i) where the radiation level is determined in units of millisievert per hour, the value determined shall be multiplied by 100; and
 - (ii) for uranium and thorium ores and concentrates, the maximum radiation level at any point 1 m from the external surface of the load may be taken as —

0.4 mSv/h	for ores and physical concentrates of uranium and thorium;
0.3 mSv/h	for chemical concentrates of thorium; and
0.02 mSv/h	for chemical concentrates of uranium, other than uranium hexafluoride;
- (b) for tanks, freight containers and unpackaged LSA-I and SCO-I of such size specified in the first column of Table 4 of [the Third Schedule](#), the value determined in [sub-paragraph \(a\)](#) shall be multiplied by the appropriate multiplication factor specified in relation thereto in the second column of that Table; and
- (c) the figure obtained in [sub-paragraphs \(a\)](#) and [\(b\)](#) shall be rounded up to the first decimal place, except that a value of 0.05 or less may be considered as zero.

(2) The transport index for each overpack, freight container or conveyance shall be determined as either the sum of the TIs of all the packages contained, or by direct measurement of radiation level, except in the case of non-rigid overpacks for which the transport index shall be determined only as the sum of the TIs of all the packages.

(3) The criticality safety index (CSI) for packages containing fissile material shall be obtained by dividing the number 50 by the value of N which shall be derived in accordance with regulations 53 and 54. The value of the criticality safety index may be zero, provided that an unlimited number of packages is subcritical, that is to say, N is effectively equal to infinity.

(4) The criticality safety index for each consignment shall be determined as the sum of the CSIs of all the packages contained in that consignment.

Limits on transport index and criticality safety index

6.—(1) Except for consignments under exclusive use, the transport index of any individual package or overpack shall not exceed 10, nor should the criticality safety index of any package or overpack exceed 50.

(2) Packages of fissile material for which the criticality safety index exceeds 0 shall not be carried in an overpack.

(3) Packages of fissile material for which the criticality safety index is 0 and packages of non-fissile radioactive material may be combined together in an overpack for transport, provided that each package contained therein meets the applicable requirements of these Regulations.

Categories of packages and overpacks

7. Packages and overpacks shall be assigned to either category I-WHITE, II-YELLOW or III-YELLOW in accordance with the conditions specified in Table 5 of [the Third Schedule](#) where applicable, and with the following requirements:

- (a) for a package, both the transport index and the surface radiation level conditions shall be taken into account in determining the appropriate category;
- (b) where the transport index satisfies the condition for one category but the surface radiation level satisfies the condition for a different category, the package shall be assigned to the higher category of the two; and for this purpose, category I-WHITE shall be regarded as the lowest category;
- (c) a package transported under special arrangement shall be assigned to category III-YELLOW; and
- (d) an overpack which contains packages transported under special arrangement shall be assigned to category III-YELLOW.

PART III

TRANSPORT REQUIREMENTS

Limitation of exposure of transport and storage personnel to radiation

8. A licensed carrier transporting radioactive materials shall —

- (a) make arrangements to keep the radiation exposure from the transport of such materials as low as practicable so that no person involved in such transport shall be likely to receive a radiation dose in excess of the appropriate dose limits specified in the Second Schedule to the Radiation Protection (Ionising Radiation) Regulations (Rg 2); and
- (b) ensure that all his transport and storage personnel receive such instructions as are necessary concerning the hazards involved in the transport of radioactive materials and the precautions to be observed.

Segregation of radioactive materials

9.—(1) A licensed carrier transporting radioactive materials shall ensure that such materials and packages, overpacks, freight containers and tanks containing such materials are in the

course of transport (including storage in transit) separated from —

- (a) transport workers and regularly occupied working areas such that a transport worker or person in such area shall not receive a radiation dose in excess of 5 mSv per year;
- (b) members of the public, regularly occupied public areas and areas where the public has regular access such that the critical group shall not receive a radiation dose in excess of 1 mSv per year; and
- (c) undeveloped photographic film such that the radiation exposure of undeveloped photographic film is not more than 0.1 mSv per consignment of such film.

(2) In determining the segregation distances for the purposes of paragraph (1)(a) and (b), hypothetical but realistic mathematical models and parameters shall be used together with the maximum radiation doses specified in [paragraph \(1\)\(a\)](#) and [\(b\)](#), respectively.

(3) A licensed carrier transporting radioactive materials shall ensure that —

- (a) consignments of such materials are in the course of transport (including storage in transit) separated from other dangerous goods in accordance with these Regulations and any other written law relating to the transport of dangerous goods or hazardous substances; and
- (b) categories II-YELLOW or III-YELLOW packages or overpacks shall not be carried in compartments occupied by passengers, except those exclusively reserved for couriers specially authorised to accompany such packages or overpacks.

Transport of other goods

10.—(1) Subject to [paragraph \(2\)](#), a package shall not contain any other items except such articles and documents as are necessary for the use of the radioactive material; and such articles and documents shall be separated from the packaging and the contents of the package.

(2) [Paragraph \(1\)](#) shall not preclude the transport of any LSA material or SCO with other items provided that there is no interaction between them and the packaging or its contents that would reduce the safety of the package.

(3) Tanks and intermediate bulk containers used for the transport of radioactive material shall not be used for the storage or transport of other goods unless decontaminated below the level of 0.4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters and 0.04 Bq/cm² for all other alpha emitters.

(4) The carriage of other goods with consignments being transported under exclusive use shall be permitted provided it is arranged for only by the consignor and such carriage is not prohibited by any other provision in these Regulations.

Dangerous properties of contents of package to be taken into account

11. In addition to the radioactive properties, any other dangerous properties of the contents of the package, such as of package explosiveness, flammability, pyrophoricity, chemical toxicity and corrosiveness, shall be taken into account in the packing, labelling, marking,

placarding, storage and transport in order to comply with other written laws relating to the transport of dangerous goods or hazardous substances.

Stowing for transport

12.—(1) A licensed carrier of any consignment of radioactive materials shall ensure that the consignment is stowed securely and in accordance with this regulation.

(2) If the average surface heat flux does not exceed 15 W/m^2 and the immediately surrounding cargo is not in sacks or bags, a package or overpack may be carried among packaged general cargo without any special stowage provisions except as may be specifically required by the competent authority of the country of origin or by the Chief Executive in a certificate of approval.

(3) Except in the case of shipment under special arrangement, mixing of packages of different kinds of radioactive material, including fissile material, and mixing of different kinds of packages with different transport indexes is permitted without specific approval by the Chief Executive.

(4) Subject to [regulation 21\(2\)](#), loading of tanks and freight containers and accumulation of packages, overpacks, tanks and freight containers shall be as follows:

(a) the total number of packages, overpacks, tanks and freight containers aboard a single conveyance shall be so limited that the total sum of the transport indexes aboard the conveyance does not exceed the values shown in Table 6 of [the Third Schedule](#);

(b) the radiation level under conditions likely to be encountered in routine transport shall not exceed 2 mSv per hour at any point on, and 0.1 mSv per hour at 2 m from, the external surface of the conveyance.

(5) [Paragraph \(4\)\(a\)](#) shall not apply to consignments of LSA-I material.

(6) The total sum of the criticality safety indexes in a freight container and aboard a conveyance shall not exceed the values shown in Table 7 of [the Third Schedule](#).

(7) Any package or overpack having either a transport index greater than 10, or any consignment having a criticality safety index greater than 50, shall be transported only under exclusive use.

Limits on non-fixed contamination on surface of package

13.—(1) The non-fixed contamination on the external surfaces of a package shall be kept as low as practicable and, under conditions likely to be encountered in routine transport, shall not exceed the limits specified in Section B of [the First Schedule](#).

(2) Except as provided in [regulation 15\(3\)](#), the level of non-fixed contamination on the external and the internal surfaces of overpacks, freight containers, tanks and intermediate bulk containers containing radioactive material or any SCO shall not exceed the limits specified in Section B of [the First Schedule](#).

Control of leaking packages

14.—(1) If there is any indication or reason to suspect that a package may have leaked or is leaking, the licensed carrier transporting the package shall restrict access to the package and a survey shall be made as soon as possible, by qualified personnel to assess the extent of contamination and the resultant radiation level of the package, the conveyance, the adjacent loading and unloading areas, and, if necessary, any individual and all other material which has been carried in the conveyance.

(2) Packages leaking radioactive contents in excess of allowable limits for normal conditions of transport may be removed under supervision but shall not be forwarded until repaired or reconditioned and decontaminated, so as to meet the requirements of these Regulations.

Contaminated conveyance

15.—(1) A licensed carrier shall ensure that every conveyance and equipment in his possession and used routinely for the carriage of radioactive material shall be periodically checked to determine the level of contamination. The frequency of such checks shall be related to the likelihood of contamination and the extent to which radioactive material is carried.

(2) Except as provided in [paragraph \(3\)](#), where any conveyance or equipment or part thereof which has in the course of the carriage of radioactive material become contaminated such that the level of contamination exceeds the limits specified in Section B of [the First Schedule](#) or which shows a radiation level in excess of 5 $\mu\text{Sv/h}$, the licensed carrier in possession of that conveyance or equipment —

- (a) shall take steps for the conveyance or equipment to be decontaminated as soon as possible by a qualified person; and
- (b) shall not allow the conveyance or equipment to be re-used unless the non-fixed radioactive contamination is below the limits specified in Section B of [the First Schedule](#) and the radiation level resulting from the fixed contamination on surfaces after decontamination is less than 5 $\mu\text{Sv/h}$.

(3) An overpack, freight container, tank, intermediate bulk container or conveyance used to transport any LSA material or SCO under exclusive use shall be excepted from the requirements of [paragraph \(2\)](#) and [regulation 13\(2\)](#) with regard to its internal surfaces.

Emergency response

16.—(1) In the event of a package of radioactive materials suffering breakage or leakage during transport, or becoming involved in a crash, wreck or fire, the relevant storage personnel in charge of or the driver of the vehicle or master of the vessel or aircraft carrying the package of radioactive materials at the time of accident or, if appropriate, the licensed carrier of the package of radioactive materials shall ensure that —

- (a) the affected place is isolated to prevent contact of any individual with any loose radioactive material and, when practicable, posting and fencing is provided;
- (b) no individual is allowed to enter or remain within the isolated place until qualified personnel are available to check radiation hazards and supervise the handling or salvage;

(c) the consignor, the Chief Executive and all appropriate authorities are notified immediately; and

(d) any conveyance, building, place, equipment, or part thereof, which has become contaminated as a result of the accident is decontaminated as soon as possible by qualified personnel.

(2) Nothing contained in paragraph (1)(a) and (b) shall be construed to prevent rescue or fire fighting operations from being carried out by qualified personnel.

(3) Any individual who may have become contaminated with radioactive materials shall be subject to appropriate control and examination measures.

Excepted packages

17.—(1) The provisions of [Parts III, IV, V, VI, VII](#) and [VIII](#) shall not apply to the transport of a package (referred to in these Regulations as an excepted package) if —

(a) the general transport requirements specified in regulations 8, 9, 11, [13\(1\)](#) and [16](#) are complied with;

(b) the excepted package complies with the general package and packaging requirements in [regulation 42](#);

(c) in the case of an excepted package with a gross mass exceeding 50 kg, the permissible gross mass is legibly and durably marked on the outside of the packaging;

(d) the excepted package is described in the transport document relating thereto as “RADIOACTIVE MATERIAL, EXCEPTED PACKAGE”;

(e) the transport document relating thereto states, in accordance with the Sixth Schedule, the proper shipping name of the substance or article being transported as an excepted package and the United Nations Number assigned to the material;

(f) the radiation level at any point on the external surface of the excepted package does not exceed 5 $\mu\text{Sv/h}$; and

(g) the specific requirements in [paragraphs \(2\) to \(7\)](#) applicable thereto are complied with.

(2) An excepted package comprising radioactive material which is enclosed in or forms a component part of an instrument or other manufactured article, and which has activity not exceeding the item and package limits specified in columns 2 and 3 of Table 1 of [the Third Schedule](#) shall comply with the following additional requirements:

(a) the radiation level at 10 cm from any point on the external surface of any unpackaged instrument or article shall be not greater than 0.1 mSv/h; and

(b) each such instrument or article (except radioluminescent time-pieces or devices) shall bear the marking “Radioactive”.

(3) An excepted package comprising radioactive material in forms other than as specified in

[paragraph \(2\)](#) and which has activity not exceeding the limit specified in column 4 of Table 1 of [the Third Schedule](#) shall comply with the following additional requirements:

- (a) the package shall retain its contents under conditions likely to be encountered in routine transport; and
- (b) the package shall bear the marking “Radioactive” on an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.

(4) A package comprising any manufactured article in which the sole radioactive material is unirradiated natural uranium, unirradiated depleted uranium or unirradiated natural thorium may be transported as an excepted package provided that the outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or some other substantial material.

(5) An empty packaging which previously contained radioactive material shall comply with the following additional requirements:

- (a) it shall be in a well maintained condition and securely closed;
- (b) the outer surface of any uranium or thorium in its structure shall be covered with an inactive sheath made of metal or some other substantial material;
- (c) the level of internal non-fixed contamination shall not exceed 1,000 times the levels specified in Section B of [the First Schedule](#) for excepted packages; and
- (d) any labels which may have been displayed on it in conformity with [regulation 27\(7\)](#) shall be no longer visible.

(6) An excepted package containing fissile material shall comply with the following additional requirements:

- (a) each package shall contain not more than 15 g of fissile material, the smallest external dimension of which is not less than 10 cm or, in the case of unpackaged material, each consignment carried in or on a conveyance shall contain not more than 15 g of fissile material;
- (b) a package containing homogeneous hydrogenous solutions or mixtures shall satisfy the conditions listed in Table 9 of [the Third Schedule](#) or, in the case of unpackaged material, a consignment carried in or on a conveyance shall not exceed the limits specified in Table 9 of [the Third Schedule](#);
- (c) in the case of a 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, the fissile material shall be distributed essentially homogeneously throughout the material and in addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement within the package;
- (d) in the case of a package containing not more than 5 g of fissile material in any 10 litre volume, the radioactive material shall be contained in a package which will maintain the limitations on fissile material distribution under conditions likely to be

encountered during routine transport;

- (e) each package shall contain 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;
- (f) where a package contains liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, the total plutonium and uranium-233 content shall not exceed 0.002% of the mass of uranium-235, and the minimum nitrogen to uranium atomic ratio (N/U) shall be 2.

(7) The transmission of an excepted package by post shall in addition be in accordance with [regulation 23](#).

Transport of LSA material and SCO in industrial packages, etc.

18.—(1) The quantity of LSA material or SCO in a single industrial package Type 1 (Type IP-1), industrial package Type 2 (Type IP-2), industrial package Type 3 (Type IP-3), or 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.

(2) LSA material and SCO which is or contains fissile material shall meet the applicable requirements of regulations 25 and [51\(1\)](#).

(3) LSA material and SCO in groups LSA-I and SCO-I may be transported unpackaged in or on any conveyance under the following conditions:

- (a) all unpackaged material other than ores containing only naturally occurring radionuclides shall be transported in such a manner that under conditions likely to be encountered in routine transport there will be no escape of the contents from the conveyance nor will there be any loss of shielding;
- (b) each conveyance shall be under exclusive use, except when only transporting SCO-I on which the contamination on the accessible and the inaccessible surfaces is not greater than 10 times the applicable level of contamination; and
- (c) in the case of SCO-I, where it is suspected that non-fixed contamination exists on inaccessible surfaces in excess of the values specified in paragraph (a)(i) of Section B of [the First Schedule](#), measures shall be taken to ensure the radioactive material is not released into the conveyance.

(4) Except as otherwise specified in [paragraph \(3\)](#), LSA material and SCO shall be packaged in accordance with the package integrity levels specified in Table 2 of [the Third Schedule](#) in such a manner that, under conditions likely to be encountered in routine transport, there will be no escape of contents from packages, nor will there be any loss of shielding afforded by the packaging.

(5) LSA material and SCO in groups LSA-II, LSA-III and SCO-II shall not be transported unpackaged.

(6) The total activity in a single hold or compartment of an inland water craft or other

conveyance for the carriage of LSA material or SCO in industrial packages or unpackaged shall not exceed the limits shown in Table 3 of [the Third Schedule](#).

Limits on radiation level for packages and overpacks

19.—(1) Except as otherwise provided in [regulation 20\(1\)\(a\)](#), [21\(1\)](#) or [22\(3\)](#), the radiation level at any point on any external surface of a package or overpack shall not exceed 2 mSv/h.

(2) The radiation level at any point on any external surface of a package transported under exclusive use shall not exceed 10 mSv/h.

Additional requirements relating to transport by rail and road

20.—(1) For consignments to be transported by rail or road and under exclusive use, the radiation level shall not exceed —

(a) 10 mSv/h at any point on the external surface of any package or overpack, provided that —

(i) the vehicle is equipped with an enclosure which, during routine transport, prevents the access of unauthorised persons to the interior of the enclosure;

(ii) provisions are made to secure the package or overpack so that its position within the vehicle remains fixed during routine transport; and

(iii) there are no loading or unloading operations between the beginning and end of the shipment;

(b) 2 mSv/h at any point on the outer surfaces of the vehicle, including the upper and lower surfaces, or in the case of an open vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load, and on the lower external surface of the vehicle; and

(c) 0.1 mSv/h at any point 2 m from the vertical planes represented by the outer lateral surfaces of the vehicle, or, if the load is transported in an open vehicle, at any point 2 m from the vertical planes projected from the outer edges of the vehicle.

(2) A licensed carrier of radioactive material in a road vehicle shall not permit —

(a) any person other than the driver and such other assistants authorised by the carrier to travel in the vehicle if the material is contained in packages, overpacks, tanks or freight containers assigned to category II-YELLOW or III-YELLOW; and

(b) any person who is below 18 years of age to travel in the vehicle.

(3) The radiation level at any normally occupied position in a vehicle transporting radioactive material by rail or road shall not exceed 0.02 mSv/h unless the persons occupying such positions are provided with personal monitoring devices.

Additional requirements relating to transport by vessels

21.—(1) No package having a surface radiation level greater than 2 mSv/h shall be

transported by vessel except under special arrangement or in or on a vehicle on board a vessel and such vehicle is under exclusive use and complies with the requirements of [regulation 20\(1\)](#).

(2) The transport of consignments by means of a vessel under special use which, by virtue of its construction, or by reason of its being chartered, is dedicated to the purpose of carrying radioactive material, shall be excepted from the requirements in [regulation 12\(4\)](#) provided that —

- (a) a radiation protection programme for the shipment shall be prepared and shall be approved by the competent authority of the flag state of the vessel and, when requested, by the Chief Executive;
- (b) stowage arrangements shall be predetermined for the whole voyage, including any consignments to be loaded at ports of call en route; and
- (c) the loading, handling and stowage and the unloading of the consignments shall be supervised by persons qualified in the transport of radioactive material.

Additional requirements relating to transport by air

22.—(1) No Type B(M) package and no consignment under exclusive use shall be transported on passenger aircraft.

(2) Vented Type B(M) packages, packages which require external cooling by an ancillary cooling system, packages subject to operational controls during transport and packages containing liquid pyrophoric materials shall not be transported by air.

(3) No package having a surface radiation level greater than 2 mSv/h shall be transported by air except by special arrangement.

Additional requirements relating to transport by post

23. A consignment which may be transported as an excepted package under [regulation 17\(1\)](#) and in which the activity of the contents does not exceed one tenth of the limits prescribed in Table 1 of [the Third Schedule](#), may be accepted —

- (a) for domestic movement by the postal authorities subject to such additional requirements as those authorities may prescribe; or
- (b) for international movement by post, subject in particular to the following additional requirements as prescribed by the Acts of the Universal Postal Union:
 - (i) the consignment shall be deposited with the postal authorities only by consignors authorised by the Chief Executive;
 - (ii) the consignment shall be dispatched by the quickest route, normally by air;
 - (iii) the consignment shall be plainly and durably marked on the outside with the words “RADIOACTIVE MATERIAL — Quantities permitted for Movement by Post”, and these words shall be crossed out if the packaging is returned empty;
 - (iv) the consignment shall carry on the outside the name and address of the

consignor with the request that the consignment be returned in the case of non-delivery; and

- (v) the name and address of the consignor and the contents of the consignment shall be indicated on the internal packaging.

Requirements relating to transport of sealed source to or from field site

24. The following requirements shall be complied with when any sealed source is transported to or from a field site —

- (a) the source container shall meet the relevant requirements specified in [Parts II, III, IV, VI, VII](#) and [VIII](#) for a package containing the same radioactive material in the same quantity and form;
- (b) the source container shall be provided with a locking device, and the container and any radiation shield shall be kept locked in the closed position at all times during transport;
- (c) the source container shall be secured to the conveyance to prevent any accidental shift under conditions normally incident to transport;
- (d) at any time during transport —
 - (i) the average radiation level at 5 cm from the surface of the container shall not exceed 0.2 mSv/h and the maximum radiation level shall not exceed 1 mSv/h;
 - (ii) the average radiation level at one metre from the centre of the source shall not exceed 0.02 mSv/h and the maximum radiation level shall not exceed 0.1 mSv/h; and
 - (iii) the radiation level shall not exceed 0.02 mSv/h at any place occupied by any individual in the conveyance unless such individual is provided with a personal monitoring device;
- (e) the conveyance carrying the source shall —
 - (i) have a placard in the form and of the colour and size shown in Figure 6 of [the Fifth Schedule](#) securely attached to each of the 2 external lateral walls, and such placards shall be removed or covered when the source is no longer carried in the conveyance while the conveyance is in a public place;
 - (ii) carry no individual less than 18 years of age; and
 - (iii) carry no individual unconnected with the transport or use of the source without the prior approval of the Chief Executive;
- (f) a competent and responsible individual shall continuously accompany the sealed source at all times during transport; and
- (g) the outer container of the sealed source shall have firmly attached a metal plate which shall be as large as practicable and durably and clearly marked with the following

information:

- (i) the name, address and telephone number of the licensee concerned; and
- (ii) the nature and activity of the radioactive contents at a specified date.

Storage in transit

25.—(1) The master of every vessel or aircraft —

- (a) bringing any radioactive material into Singapore in transit; or
- (b) carrying any radioactive material as part of the stores or equipment of that vessel or aircraft,

shall before the vessel enters into or the aircraft lands in Singapore, notify the Chief Executive as to the nature and quantity of radioactive material on board such vessel or aircraft.

(2) Where any radioactive material brought into Singapore in transit is landed or transhipped in Singapore, it shall be stored and dealt with as the Chief Executive may direct and shall be moved only under and in accordance with the prior consent in writing of the Chief Executive.

(3) Any consent given by the Chief Executive under this regulation may be expressed to be subject to such conditions as the Chief Executive may see fit to impose.

(4) The number of category II-YELLOW and category III-YELLOW packages, overpacks, tanks and freight containers stored in any one storage area, such as a transit area, terminal building, store-room or assembly yard, shall be so limited that the total sum of the transport indexes in any individual group of such packages, overpacks, tanks or freight containers does not exceed 50.

(5) Groups of category II-YELLOW and category III-YELLOW packages, overpacks, tanks and freight containers shall be stored so as to maintain a spacing of at least 6 m from other groups of such packages, overpacks, tanks or freight containers.

(6) Where the transport index of a single package, overpack, tank or freight container exceeds 50 or the total transport index on board a conveyance exceeds 50, as permitted in Table 6 of [the Third Schedule](#), storage shall be such as to maintain a spacing of at least 6 m from the other groups of packages, overpacks, tanks or freight containers or other conveyance carrying radioactive material.

(7) [Paragraphs \(4\)](#) to [\(6\)](#) shall not apply to consignments in which the radioactive contents are LSA-I materials.

(8) Nothing in this regulation shall apply to any radioactive material in transit by air if the aircraft passes over Singapore without landing.

Mixing of packages

26. Except in the case of shipment under special arrangement, mixing of packages of different kinds of radioactive material, including fissile material, and mixing of different kinds of packages with different transport indexes is permitted without specific approval of the Chief

Executive.

PART IV

LABELLING AND MARKING

Marking, labelling and placarding of packages and freight containers

27.—(1) The permissible gross mass of each package of gross mass exceeding 50 kg shall be legibly and durably marked on the outside of the packaging.

(2) For each package, other than excepted packages, the United Nations number (as specified in the Sixth Schedule), preceded by the letters “UN”, and the proper shipping name shall be legibly and durably marked on the outside of the packaging. In the case of excepted packages other than those accepted for international movement by post, only the United Nations Number preceded by the letters “UN”, shall be required. For packages accepted for international movement by post, the requirement of [regulation 23](#) shall apply.

(3) The outside of the packaging of each industrial package Type 1, industrial package Type 2, industrial package Type 3 or Type A package design shall be legibly and durably marked with the words “TYPE IP-1”, “TYPE IP-2”, “TYPE IP-3” or “Type A” as appropriate.

(4) An industrial package Type 2, an industrial package Type 3 or a Type A package design shall be legibly and durably marked on the outside of the packaging with the international vehicle registration code (VRI Code) of the country of origin of design and the name of the manufacturers, or other identification of the packaging specified by the competent authority of the country of origin.

(5) The outside of the packaging of each package which conforms to a design approved under [regulation 57](#), [58](#) or [59](#) or the revoked Regulations shall be legibly and durably marked with the following:

- (a) the identification mark allocated to that design by the Chief Executive;
- (b) a serial number to uniquely identify each packaging which conforms to that design; and
- (c) in the case of a Type B(U), Type B(M) or Type C package, with the words “TYPE B(U)”, “TYPE B(M)” or “TYPE C”, as the case may be.

(6) Each Type B(U), Type B(M) or Type C package shall have the outside of the outermost receptacle which is resistant to the effects of fire and water plainly marked by embossing, stamping or other means resistant to the effects of fire and water with the trefoil symbol in Figure 1 of [the Fifth Schedule](#).

(7) Where LSA-1 or SCO-1 material is contained in receptacles or wrapping materials and is transported under exclusive use as permitted by [regulation 18\(3\)](#), the outer surface of these receptacles or wrapping materials may bear the marking “RADIOACTIVE LSA-I” or “RADIOACTIVE SCO-I” as appropriate.

(8) Subject to [paragraph \(12\)](#), each package, overpack, tank and freight container shall bear

the labels which shall be in the form and of the colour and size specified in Figures 2, 3 or 4 of [the Fifth Schedule](#) according to the appropriate category of that package, overpack, tank or freight container. In addition, each package, overpack and freight container containing fissile material, other than fissile material excepted under the provisions of [regulation 17\(6\)](#), shall bear labels which conform to that specified in Figure 5 of [the Fifth Schedule](#). Any labels which do not relate to the contents shall be removed or covered.

(9) The labels shall be affixed to 2 opposite sides of the outside of a package or overpack, or on the outside of all 4 sides of a freight container or tank.

(10) Each label shall be completed with the following information:

(a) contents:

- (i) except for LSA-I material, the name(s) of the radionuclide(s) in accordance with Table 1 of [the Second Schedule](#) and the symbols prescribed therein;
 - (ii) for mixtures of radionuclides, the most restrictive nuclides must be listed to the extent the space on the line permits;
 - (iii) the group LSA or SCO shall be shown following the name(s) of the radionuclide(s);
 - (iv) the terms “LSA-II”, “LSA-III”, “SCO-I” and “SCO-II” shall be used for this purpose; and
 - (v) for LSA-I materials, the term “LSA-I”;
- (b) the maximum activity of the radioactive contents during transport expressed in units of becquerels with the appropriate SI prefix, except that for fissile material, the total mass in units of grams, or multiples thereof, may be used in place of activity;
- (c) for overpacks, tanks and freight containers, the entire contents of the overpack, tank or freight container and the sum of the activity of each package comprised in the overpack, tank or freight container, except that labels for overpacks or freight containers containing mixed loads of packages with different radionuclides may bear the words “See Transport Documents”; and
- (d) the transport index for all packages and overpacks not within category I-WHITE.

(11) Tanks and large freight containers carrying packages other than excepted packages shall bear 4 main placards which shall be in the form and of the colour and size specified in Figure 6 of [the Fifth Schedule](#) and affixed in a vertical orientation to each side wall and each end wall of the freight container or tank. Any placards which do not relate to the contents shall be removed.

(12) Tanks and large freight containers carrying packages other than excepted packages may, instead of bearing labels and placards in accordance with [paragraphs \(8\) and \(11\)](#), bear enlarged labels in the form and of the colour shown in Figures 2, 3 and 4 of [the Fifth Schedule](#) and of the size specified in Figure 6 of [the Fifth Schedule](#).

(13) Where the consignment in the tank or freight container is unpackaged LSA-I or SCO-I, or where an exclusive use consignment in a freight container is packaged radioactive material

comprised of a single United Nations Number commodity, the appropriate United Nations Number for the consignment specified in the Sixth Schedule shall also be displayed, in black digits not less than 65 mm high —

- (a) in the lower half of the main placard in Figure 6 of [the Fifth Schedule](#) preceded by the letters “UN” and against the white background; or
- (b) on the placard for separate display of the United Nations Number specified in Figure 7 of [the Fifth Schedule](#).

(14) The placard referred to in paragraph (13)(b) shall be in the form and of the colour and size specified in Figure 7 of [the Fifth Schedule](#) and be affixed immediately adjacent to the main placard on all 4 sides of the tank or freight container.

(15) Each label conforming to that specified in Figure 5 of [the Fifth Schedule](#), shall be completed with the criticality safety index (CSI) as stated in the certificate of approval for special arrangement or the certificate of approval for the package design issued by the competent authority of the country of origin.

(16) For overpacks and freight containers, the criticality safety index (CSI) on the label shall bear the information required in [paragraph \(15\)](#) totalled together for the fissile contents of the overpack or freight container.

Additional requirements relating to transport by rail and road

28.—(1) Rail and road vehicles carrying packages, overpacks, tanks or freight containers labelled with any of the labels in Figure 2, 3, 4 or 5 of [the Fifth Schedule](#) or carrying consignments under exclusive use shall display a placard in the form and of the colour and size specified in Figure 6 of [the Fifth Schedule](#) on each of —

- (a) the 2 external lateral walls in the case of a rail vehicle; and
- (b) the 2 external lateral walls and the external rear wall in the case of a road vehicle,

except that in the case of a vehicle without sides, the placards may be affixed directly on the cargo-carrying unit where they are readily visible, and in the case of physically large tanks or freight containers, the placards may be affixed to the tanks or freight containers.

(2) In the case of vehicles which have insufficient area to allow the fixing of larger placards, the dimensions of the placard as described in Figure 6 of [the Fifth Schedule](#) may be reduced to 100 mm.

(3) Any placards which do not relate to the contents shall be removed.

(4) Where the consignment in or on the vehicle is unpackaged LSA-I or SCO-I or where an exclusive use consignment is packaged radioactive material comprised of a single United Nations Number commodity, the appropriate United Nations Number specified in the Sixth Schedule shall also be displayed, in black digits not less than 65 mm high —

- (a) in the lower half of the main placard in Figure 6 of [the Fifth Schedule](#) preceded by the letters “UN” and against the white background; or
- (b) on the placard for separate display of the United Nations Number in Figure 7 of [the](#)

Fifth Schedule.

(5) The placard referred to in paragraph (4)(b) shall be affixed immediately adjacent to the main placard on the 2 lateral walls of a rail vehicle or the 2 lateral walls and the end wall of a road vehicle.

Removal of labels

29. No person shall —

- (a) in the course of transport, without reasonable cause, remove from any package or overpack, or any tank or freight container containing radioactive materials, any label or placard attached thereto or any sign or mark displayed on or within the package, overpack, tank or freight container in accordance with these Regulations;
- (b) without reasonable cause remove from a vehicle transporting radioactive materials any placard or label carried by that vehicle in accordance with these Regulations; or
- (c) wilfully deface any such label, placard, sign or mark referred to in paragraphs (a) and (b).

Display of placards

30. A carrier of radioactive material in a vehicle shall ensure that the vehicle is placarded in accordance with these Regulations with placards in the form and of the colour and size specified in [the Fifth Schedule](#) while the material is transported.

PART V

RESPONSIBILITIES OF CONSIGNOR

Labelling

31. The consignor of any consignment of radioactive material or SCO shall ensure that the consignment is packaged, labelled, marked and placarded in accordance with these Regulations when he presents the consignment for transport.

Particulars of consignment

32. The consignor shall include in the transport documents with each consignment the following information relating to the consignment, as applicable, in the order given:

- (a) the proper shipping name, as specified in the Sixth Schedule;
- (b) the United Nations Class Number “7”;
- (c) the United Nations Number assigned to the material as specified in the Sixth Schedule, preceded by the letters “UN”;
- (d) the name or symbol for each radionuclide or, for mixtures of radionuclides, an appropriate general description or a list of the most restrictive nuclides;

- (e) a description of the physical and chemical form of the material, or a notation that the material is special form radioactive material or low dispersible radioactive material, and for this purpose generic chemical description is acceptable for chemical form;
- (f) the maximum activity of the radioactive contents during transport expressed in units of becquerels with an appropriate SI prefix, except that for fissile material, the total mass of fissile material in units of grams, or appropriate multiples thereof, may be used instead;
- (g) the category of the package;
- (h) the transport index;
- (i) the criticality safety index, for consignments including fissile material;
- (j) the identification mark for each certificate of approval issued by a competent authority in respect of the consignment;
- (k) for consignments of packages in an overpack or freight container, a detailed statement of the contents of each package within the overpack or freight container and, where appropriate, of each overpack or freight container in the consignment, and if packages are to be removed from the overpack or freight container at a point of intermediate unloading, appropriate transport documentation;
- (l) where a consignment is required to be shipped under exclusive use, the statement “EXCLUSIVE USE SHIPMENT”; and
- (m) for LSA-II, LSA-III, SCO-I and SCO-II, the total activity of the consignment as a multiple of A_2 .

Certification by consignor

33.—(1) The consignor shall include in the transport documents a declaration certifying that the contents of the consignment are described by the proper shipping name, are properly classified, packaged, marked and labelled in accordance with these Regulations, and are in proper condition for transport.

(2) The declaration made under [paragraph \(1\)](#) shall —

- (a) contain the original or stamped facsimile signature of the consignor or his duly authorised agents together with the date; and
- (b) be made on the documents referred to in [regulation 32](#).

Information for carriers

34.—(1) The consignor shall provide in the transport documents a statement, in such languages as the carrier deems necessary, regarding safety and the actions, if any, that are required to be taken by the carrier including the following:

- (a) supplementary operational requirements for loading, stowage, transport, handling and unloading of the package, overpack or freight container including any special stowage provisions for the safe dissipation of heat, or a statement that no such

requirements are necessary;

- (b) restrictions on the mode of transport or conveyance and any necessary routing instructions; and
- (c) emergency arrangements setting out the plan of action to be taken in the event of an emergency involving the consignment.

(2) The consignor shall, at the request of the carrier, furnish all certificates of approval issued in respect of the consignment to the carrier before loading, unloading and any transshipment.

Notification of competent authorities

35.—(1) The consignor shall, at least 7 days prior to the commencement of the shipment, notify the Chief Executive, when any of the following packages is to be transported through or to Singapore:

- (a) a Type B(U) or Type C package containing radioactive materials with an activity greater than 3000 A₁, or 3000 A₂, as appropriate, or 1000 TBq, whichever is the lower;
- (b) a Type B(M) package; or
- (c) a package transported by special arrangement.

(2) The consignment notification referred to in [paragraph \(1\)](#) shall include —

- (a) sufficient information to enable the identification of the package or packages including all applicable certificate numbers and identification marks;
- (b) information on the date of shipment, the expected date of arrival and proposed routing;
- (c) the names of the radioactive materials or nuclides;
- (d) descriptions of the physical and chemical forms of the radioactive material, or whether it is special form radioactive material or low dispersible radioactive material; and
- (e) the maximum activity of the radioactive contents during transport expressed in units of becquerels with an appropriate SI prefix, except that for fissile material, the mass of fissile material in units of grams (*g*), or multiples thereof, may be used instead.

(3) The consignor shall not be required to send a separate notification to the Chief Executive if the required information has been included in the application under [regulation 60\(3\)](#) for a certificate of approval regarding shipment.

Possession of certificates and operating instructions

36. The consignor shall have in his possession a copy of each certificate of approval required under [Part VIII](#) and a copy of the instructions with regard to the proper closing of the package and other preparations for shipment, before making any shipment under the terms of

the certificates.

Requirements for shipment of any package

37.—(1) Before the first shipment of any package, the consignor shall ensure that —

- (a) if the design pressure of the containment system exceeds 35 kPa, the containment system of each package conforms to the approved design requirements relating to the capability of that system to maintain its integrity under pressure;
- (b) for each Type B(U), Type B(M) and Type C package and for each package of fissile material, the effectiveness of its shielding and containment and, where necessary, the heat transfer characteristics, shall be within the limits applicable to or specified for the approved design;
- (c) for each package of fissile material, where, in order to comply with the requirements of [regulation 51\(1\)](#), neutron poisons are specifically included as components of the package, tests are performed to confirm the presence and distribution of those neutron poisons; and
- (d) if the package requires the approval of the Chief Executive and is to be transported through or to Singapore, a copy of every certificate of approval by a competent authority relating to that package is submitted to the Chief Executive.

(2) Before each shipment of any package, the consignor shall ensure that —

- (a) for any package, all the requirements specified in the relevant provisions of these Regulations have been satisfied;
- (b) lifting attachments which do not meet the requirements of [regulation 42\(2\)](#) have been removed or otherwise rendered incapable of being used for lifting the package;
- (c) for each Type B(U), Type B(M) and Type C package and for each package of fissile material, all the requirements specified in the certificates of approval issued in respect thereof and the relevant provisions of these Regulations have been satisfied;
- (d) each Type B(U), Type B(M) and Type C package shall be held until equilibrium conditions have been approached closely enough to demonstrate compliance with the shipment requirements for temperature and pressure unless an exemption from these requirements has received unilateral approval;
- (e) for each Type B(U), Type B(M) and Type C package, by examination or appropriate tests or both, that all closures, valves, and other openings of the containment system through which the radioactive contents might escape are properly closed and, where appropriate, sealed in the manner for which the demonstrations of compliance with the requirements of [regulation 48\(8\)](#) were made;
- (f) for each special form radioactive material, all the requirements specified in the special form approval certificate and the relevant provisions of these Regulations have been satisfied;
- (g) for packages containing fissile material the measurement specified in [regulation 51\(4\)](#)

[\(b\)](#) and the tests to demonstrate closure of each package as specified in [regulation 52](#) shall be performed where applicable; and

- (h) for each low dispersible radioactive material, all the requirements specified in the approval certificate and the relevant provisions of these Regulations have been satisfied.

PART VI

ACTIVITY AND FISSILE MATERIAL LIMITS

Contents limits for packages

38.—(1) The quantity of radioactive material in a package shall not exceed the relevant limits specified in [paragraphs \(2\)](#) to (14).

(2) An excepted package of radioactive material other than articles manufactured of natural uranium, depleted uranium, or natural thorium shall not contain activities greater than —

- (a) where the radioactive material is enclosed in or forms a component part of an instrument or other manufactured article, such as a clock or electronic apparatus, the limits specified in [regulation 17\(2\)](#) for each individual instrument or article and each package, respectively; or
- (b) where the radioactive material is not so enclosed or not such a component, the limits specified in [regulation 17\(3\)](#).

(3) An excepted package of articles manufactured of natural uranium, depleted uranium, or natural thorium may contain any quantity of such material provided that the outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or some other substantial substance.

(4) For transport by post, the total activity in each package shall not exceed one tenth of the relevant limit specified in Table 1 of [the Third Schedule](#).

(5) The total activity in a single package of LSA material or in a single package of SCO shall be so restricted that the radiation level shall not exceed the level specified in [regulation 18\(1\)](#), and the activity in a single package shall also be restricted that the activity limits for a conveyance shall not exceed the level specified in [regulation 18\(6\)](#).

(6) A single package of non-combustible solid LSA-II or LSA-III material, if carried by air, shall not carry an activity greater than 3000 A_2 .

(7) Type A packages shall not contain activities greater than —

- (a) A_1 for special form radioactive material; or
- (b) A_2 for all other radioactive material.

(8) For mixtures of radionuclides whose identities and respective activities are known, the following condition shall apply to the radioactive contents of a Type A package:

$$\sum_i \frac{B(i)}{A_1(i)} + \sum_i \frac{C(j)}{A_2(j)} \leq 1$$

where

B(i) is the activity of radionuclide i as special form radioactive material;

A₁(i) is the A₁ value for radionuclide i

C(j) is the activity of radionuclide j as other than special form radioactive material; and

A₂(j) is the A₂ value for radionuclide j.

(9) Type B(U), Type B(M) and Type C packages shall not contain —

- (a) activities greater than those authorised for the design of the package;
- (b) radionuclides different from those authorised for the design of the package; or
- (c) contents in form, or a physical or chemical state different from those authorised for the design of the package,

as specified in the certificates of approval relating thereto.

(10) Type B(U) and Type B(M) packages, if transported by air shall meet the requirements of [paragraph \(9\)](#) and shall not contain activities greater than the following:

- (a) for low dispersible radioactive material — as authorised for the package design as specified in the certificate of approval;
- (b) for special form radioactive material — 3000 A₁ or 100,000 A₂, whichever is the lower; or
- (c) for all other radioactive material — 3000 A₂.

(11) All packages containing fissile material shall comply with the applicable activity limits for packages specified in [paragraphs \(2\)](#) to (7).

(12) All packages containing fissile material, other than excepted packages in [regulation 17\(6\)](#), shall not contain —

- (a) a mass of fissile material greater than that authorised for the design of the package;
- (b) any radionuclide or fissile material different from those authorised for the design of the package; or
- (c) contents in a form or physical or chemical state, or in a spatial arrangement, different from those authorised for the design of the package,

as specified in the certificates of approval relating thereto.

(13) The mass of uranium hexafluoride in a package shall not exceed a value that would lead to an ullage smaller than 5% at the maximum temperature of the package as specified for the plant systems where the package shall be used.

(14) The uranium hexafluoride shall be in solid form and the internal pressure of the

package shall be below atmospheric pressure when presented for transport.

PART VII

REQUIREMENTS FOR RADIOACTIVE MATERIALS AND FOR PACKAGINGS AND PACKAGES

Requirement for LSA-III material

39. LSA-III material shall be a solid of such a nature that if the entire contents of a package were subjected to the test specified in section B of [the Fourth Schedule](#) the activity in the water would not exceed $0.1 A_2$.

Requirements for special form radioactive material

40.—(1) Special form radioactive material shall have at least one dimension not less than 5 mm.

(2) Special form radioactive material shall be of such a nature or shall be so designed that if it is subjected to the tests specified in section C of [the Fourth Schedule](#), it shall meet the following requirements:

- (a) it would not break or shatter under the impact, percussion and bending tests in paragraph 2(1)(a), (1)(b), (1)(c) and (2)(a) of Section C of [the Fourth Schedule](#), as applicable;
- (b) it would not melt or disperse in the heat test in regulation 2(1)(d) and (2)(b) of section C of [the Fourth Schedule](#), as applicable; and
- (c) the activity in the water from the leaching tests specified in paragraph 3 of section C of [the Fourth Schedule](#) would not exceed 2 kBq, or, in the case of sealed sources, the leakage rate for the volumetric leakage assessment test specified in the provisions on “Radiation Protection — Sealed Radioactive Sources — Leak Test Methods” in the International Organisation for Standardisation Document ISO 9978 or, where there is any latest revision, that revision would not exceed the applicable acceptance threshold acceptable to the Chief Executive.

(3) When a sealed capsule constitutes part of any special form radioactive material, the capsule shall be so constructed that it can be opened only by destroying it.

Requirements for low dispersible radioactive material

41. Low dispersible radioactive material shall be such that the total amount of this radioactive material in a package shall meet the following requirements:

- (a) the radiation level at 3 m from the unshielded radioactive material does not exceed 10 mSv/h;
- (b) if subjected to the tests specified in paragraphs 10(3) and [10\(4\)](#) of Section E of [the Fourth Schedule](#) (for which purpose a separate specimen may be used for each test) the airborne release in gaseous and particulate forms of up to 100µmm aerodynamic

equivalent diameter would not exceed 100 A₂; and

- (c) if subjected to the test specified in Section B of [the Fourth Schedule](#), the activity in the water would not exceed 100 A₂. In the application of this test, the damaging effects of the tests specified in paragraph (b) shall be taken into account.

General requirements for all packagings and packages

42.—(1) Every package shall be so designed in relation to its mass, volume and shape that it can be easily and safely handled and transported and can be properly secured in or on the conveyance during transport.

(2) The design shall be such that any lifting attachments on the package will not fail when used in the intended manner and that, if the attachments should fail, the ability of the package to meet other requirements of these Regulations would not be impaired. Assessment shall take account of appropriate safety factors to cover snatch lifting.

(3) Attachments and any other features on the outer surface of the package which could be used to lift it shall be designed to support its mass in accordance with the requirements of [paragraph \(2\)](#) or shall be removable or otherwise rendered incapable of being used during transport.

(4) As far as practicable, the packaging shall be so designed and finished that the external surfaces are free from protruding features and can be easily decontaminated.

(5) As far as practicable, the outer layer of the package shall be so designed as to prevent the collection and the retention of water.

(6) Any features added to the package at the time of transport which are not part of the package shall not reduce its safety.

(7) The package shall be capable of withstanding the effects of any acceleration, vibration or vibration resonance which may arise under conditions likely to be encountered in routine transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole. In particular, nuts, bolts and other securing devices shall be so designed as to prevent them from becoming loose or being released unintentionally after repeated use.

(8) The materials of the packaging and any components or structures shall be physically and chemically compatible with each other and with the radioactive contents, having regard to their behaviour under irradiation.

(9) All valves through which the radioactive contents could otherwise escape shall be protected against unauthorised operation.

(10) The design of the package shall take into account ambient temperatures and pressures that are likely to be encountered in routine conditions of transport.

(11) For radioactive material having other dangerous properties, the package design shall take into account those properties.

Additional requirements for packages transported by air

43.—(1) For packages to be transported by air, the temperature of the accessible surfaces shall not exceed 50°C at an ambient temperature of 38°C with no account taken for insolation.

(2) All packages to be transported by air shall be so designed that, if they were exposed to ambient temperatures ranging from -40°C to +55°C, the integrity of containment would not be impaired.

(3) All packages containing radioactive material transported by air shall have a containment system able to withstand without leakage a reduction in ambient pressure to 5 kPa.

Requirements for industrial packages

44.—(1) An industrial package Type 1 (Type IP-1) shall be designed to meet the general requirements for all packagings and packages as specified in [regulation 42](#) and in addition, the requirements of [regulation 43](#) if carried by air, and its smallest external dimension shall not be less than 10 cm.

(2) An industrial package Type 2 (Type IP-2), shall be designed to meet the requirements for an industrial package Type 1 (Type IP-1) as specified in [paragraph \(1\)](#) and, in addition, if it were subjected to the tests specified in [paragraph 5\(4\)](#) and (5) of Section E of [the Fourth Schedule](#), it would prevent —

- (a) the loss or dispersal of the radioactive contents; and
- (b) the loss of shielding integrity which would result in more than 20% increase in the radiation level at any external surface of the package.

(3) An industrial package Type 3 (Type IP-3), shall be designed to meet the requirements for an industrial package Type 1 (Type IP-1) as specified in [paragraph \(1\)](#) and, in addition, the requirements specified in [regulation 47\(2\)](#) to [\(15\)](#).

(4) Packages may be used as industrial package Type 2 (Type IP-2) provided that —

- (a) they satisfy the requirements for Type IP-1 specified in [paragraph \(1\)](#);
- (b) they are designed to conform to the standards prescribed in the chapter on General Recommendations on Packing of the United Nations Recommendations on the Transport of Dangerous Goods, or other requirements at least equivalent to those standards; and
- (c) when subjected to the tests required for UN Packing Group I or II, they would prevent —
 - (i) loss or dispersal of the radioactive contents; and
 - (ii) loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the package.

Requirements for tanks and freight containers to qualify as industrial packages Types 2 and 3

45.—(1) Tank containers may also be used as industrial package Type 2 (Type IP-2) or Type 3 (Type IP-3) if —

- (a) they satisfy the requirements for an industrial package Type 1 (Type IP-1) specified in [regulation 44\(1\)](#);
- (b) they are designed to conform to the standards prescribed in the chapter on Recommendations on Multimodal Tank Transport of the United Nations Recommendations on the Transport of Dangerous Goods, or other requirements at least equivalent to those standards, and are capable of withstanding a test pressure of 265 kPa; and
- (c) they are designed so that any additional shielding which is provided shall be capable of withstanding the static and dynamic stresses resulting from normal handling and routine conditions of transport and of preventing a loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the tank containers.

(2) Tanks, other than tank containers, may also be used as industrial package Type 2 (Type IP-2) or Type 3 (Type IP-3), for transporting LSA-I and LSA-II liquids and gases as prescribed in Table 2 of [the Third Schedule](#) if they conform to standards at least equivalent to those prescribed in [paragraph \(1\)](#).

(3) Freight containers may also be used as industrial package Type 2 (Type IP-2) or Type 3 (Type IP-3), if —

- (a) the radioactive contents are restricted to solid materials;
- (b) they satisfy the requirements for an industrial package Type 1 (Type IP-1) specified in [regulation 44\(1\)](#); and
- (c) they are designed to conform to the requirements prescribed in the provisions on “Series 1 Freight Containers — Specifications and Testing — Part 1: General Cargo Containers” in the International Organisation for Standardisation document ISO 1496/1 or where there is any latest revision, that revision, and if they were subjected to the tests prescribed in that document and the accelerations occurring during routine conditions of transport, they would prevent —
 - (i) loss or dispersal of the radioactive contents; and
 - (ii) loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the freight containers.

(4) Metal intermediate bulk containers may also be used as industrial package Type 2 (Type IP-2) or Type 3 (Type IP-3), if —

- (a) they satisfy the requirements for an industrial package Type 1 (Type IP-1) specified in [regulation 44\(1\)](#); and
- (b) they are designed to conform to the standards prescribed in the chapter on Recommendations on Intermediate Bulk Containers (IBC’s) of the United Nations Recommendations on the Transport of Dangerous Goods, for Packing Group I or II,

and if they were subjected to the tests prescribed in that document, but with the drop test conducted in the most damaging orientation, they will prevent —

- (i) loss or dispersal of the radioactive contents; and
- (ii) loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the intermediate bulk container.

Requirements for packages containing uranium hexafluoride

46.—(1) Except as allowed in [paragraph \(4\)](#), uranium hexafluoride shall be packaged and transported in accordance with the provisions of the International Organisation for Standardisation document ISO 7195: “Packaging of Uranium Hexafluoride (UF₆) for Transport” and the requirements of [paragraphs \(2\)](#) and [\(3\)](#). The package shall also meet the requirements prescribed elsewhere in these Regulations which pertain to the radioactive and fissile properties of the material.

(2) Each package designed to contain 0.1 kg or more of uranium hexafluoride shall be designed so that it would meet the following requirements:

- (a) withstand without leakage and without unacceptable stress, as specified in the International Organisation for Standardisation document ISO 7195, the structural test as specified in paragraph 4 of Section E of [the Fourth Schedule](#);
- (b) withstand without loss or dispersal of the uranium hexafluoride the test specified in [paragraph 5\(4\)](#) of Section E of [the Fourth Schedule](#); and
- (c) withstand without rupture of the containment system the test specified in paragraph 7(3) of Section E of [the Fourth Schedule](#).

(3) Packages designed to contain 0.1 kg or more of uranium hexafluoride shall not be provided with pressure relief devices.

(4) Subject to the approval of the Chief Executive, packages designed to contain 0.1 kg or more of uranium hexafluoride may be transported if —

- (a) the packages are designed to requirements other than those given in ISO 7195 and [paragraphs \(2\)](#) and [\(3\)](#) but, notwithstanding, the requirements of [paragraphs \(2\)](#) and [\(3\)](#) are met as far as practicable;
- (b) the packages are designed to withstand without leakage and without unacceptable stress a test pressure less than 2.8 MPa as specified in paragraph 4 of section E of [the Fourth Schedule](#); or
- (c) for packages designed to contain 9000 kg or more of uranium hexafluoride, the packages do not meet the requirement of paragraph (2)(c).

Requirements for Type A packages

47.—(1) The design of Type A packages shall, in addition to meeting the requirements of [regulation 42](#) and, where applicable, [regulation 43](#), meet the requirements of [paragraphs \(2\)](#) to [\(18\)](#).

- (2) The smallest overall external dimension of the package shall not be less than 10 cm.
- (3) The outside of the package shall incorporate a feature such as a seal, which is not readily breakable and which, while intact, will be evidence that it has not been opened.
- (4) Any tie-down attachments on the package shall be so designed that, under both normal and accident conditions, the forces in those attachments shall not impair the ability of the package to meet the requirements of these Regulations.
- (5) The design of the package shall take into account temperatures ranging from -40°C to $+70^{\circ}\text{C}$ for the components of the packaging. Special attention shall be given to freezing temperatures for liquid contents and to the potential degradation of packaging materials within the given temperature range.
- (6) The design and manufacturing techniques shall be in accordance with these Regulations or other requirements, acceptable to the Chief Executive.
- (7) The design shall include a containment system securely closed by a positive fastening device which cannot be opened unintentionally or by pressure which may arise within the package.
- (8) Special form radioactive material may be considered as a component of the containment system.
- (9) If the containment system forms a separate unit of the package, it shall be capable of being securely closed by a positive fastening device which is independent of any other part of the packaging.
- (10) The design of any component of the containment system shall take into account, where applicable, the radiolytic decomposition of liquids and other vulnerable materials and the generation of gas by chemical reaction and radiolysis.
- (11) The containment system shall retain its radioactive contents under a reduction of ambient pressure to 60 kPa.
- (12) All valves, other than pressure relief valves, shall be provided with an enclosure to retain any leakage from the valve.
- (13) A radiation shield which encloses a component of the package specified as a part of the containment system shall be so designed as to prevent the unintentional release of that component from the shield. Where the radiation shield and such component within it form a separate unit, the radiation shield shall be capable of being securely closed by a positive fastening device which is independent of any other packaging structure.
- (14) A Type A package shall be so designed that if it were subjected to the tests specified in paragraph 5 of Section E of [the Fourth Schedule](#), it would prevent —
 - (a) loss or dispersal of the radioactive contents; and
 - (b) loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the package.
- (15) The design of a Type A package intended for liquid radioactive material shall make

provision for ullage to accommodate variations in the temperature of the contents, dynamic effects and filling dynamics.

(16) A Type A package designed to contain liquids shall, in addition —

- (a) be adequate to meet the conditions specified in [paragraph \(14\)](#) if the package is subjected to the tests specified in paragraph 6 of Section E of [the Fourth Schedule](#); and
- (b) either —
 - (i) be provided with sufficient absorbent material (which must be suitably positioned so as to contact the liquid in the event of leakage) to absorb twice the volume of the liquid contents; or
 - (ii) be provided with a containment system composed of primary inner and secondary outer containment components designed to ensure retention of the liquid contents, within the secondary outer containment components, even if the primary inner components leak.

(17) A Type A package designed for gases shall prevent loss or dispersal of the radioactive contents if the package were subjected to the tests specified in paragraph 6 of Section E of [the Fourth Schedule](#).

(18) [Paragraph \(17\)](#) shall not apply to a package designed for noble gases.

Requirements for Type B(U) packages

48.—(1) The design of Type B(U) packages shall, in addition to meeting the requirements of [regulation 42](#) and, where applicable, [regulation 43](#), meet the requirements of [paragraphs \(2\) to \(8\), \(11\) to \(18\)](#) and regulations 47 (2) to (15).

(2) A Type B(U) package shall be so designed that, if it were subjected to the tests in paragraph 7 of Section E of [the Fourth Schedule](#), it would retain sufficient shielding to ensure that the radiation level at 1 m from the surface of the package would not exceed 10 mSv/h with the maximum radioactive contents which the package is designed to carry.

(3) A Type B(U) package shall be so designed that, under the ambient conditions specified in [paragraphs \(5\) and \(6\)](#), heat generated within the package by the radioactive contents shall not, under normal conditions of transport, as demonstrated by the tests in paragraph 5 of Section E of [the Fourth Schedule](#), adversely affect the package in such a way that it would fail to meet the applicable requirements for containment and shielding if left unattended for a period of one week. Particular attention shall be paid to the effects of heat which may —

- (a) alter the arrangement, the geometrical form or the physical state of the radioactive contents or, if the radioactive material is enclosed in a can or receptacle, such as clad fuel elements, cause the can, receptacle or radioactive material to deform or melt;
- (b) lessen the efficiency of the packaging through differential thermal expansion or cracking or melting of the radiation shielding material; or
- (c) in combination with moisture, accelerate corrosion.

(4) Except as required in [regulation 43\(1\)](#) a Type B(U) package shall be so designed that, under the ambient condition specified in [paragraph \(5\)](#), the temperature of the accessible surfaces of the package shall not exceed 50°C, unless the package is transported under exclusive use.

(5) In applying [paragraphs \(3\)](#) and [\(4\)](#), the ambient temperature shall be assumed to be 38°C.

(6) In applying [paragraph \(3\)](#), the solar insolation conditions shall be assumed to be as specified in Table 8 of [the Third Schedule](#).

(7) A Type B(U) package which includes thermal protection for the purpose of satisfying the requirements of the thermal test specified in paragraph 7(3) of Section E of [the Fourth Schedule](#) shall be so designed that such protection will remain effective if the package is subjected to the tests specified in paragraphs 5 and 7(2)(a) and (b) or 7(2)(b) and (c) of Section E of [the Fourth Schedule](#), as appropriate. Any such protection on the exterior of the package shall not be rendered ineffective by conditions likely to be encountered in routine handling or transport, or in accidents, and which are not simulated in the tests referred to above, such as by ripping, cutting, skidding, abrasion or rough handling.

(8) A Type B(U) package shall be so designed that, if it were subjected to —

(a) the tests specified in paragraph 5 of Section E of [the Fourth Schedule](#), it would restrict the loss of radioactive contents to not more than $10^{-6}A_2$ per hour; and

(b) the tests specified in paragraph 7(1), (2)(b), (3) and (4) of Section E of [the Fourth Schedule](#) and the test in —

(i) paragraph 7(2)(c) of Section E of [the Fourth Schedule](#), where the package has a mass not greater than 500 kg, an overall density not greater than 1000 kg/m³ based on the external dimensions, and radioactive contents greater than 1000 A₂, not being special form radioactive material; or

(ii) paragraph 7(2)(a) of Section E of [the Fourth Schedule](#), for all other packages, it would restrict the accumulated loss of radioactive contents in a period of one week to not more than 10 A₂ for krypton-85 and not more than A₂ for all other radionuclides.

(9) Where mixtures of different radionuclides are present, the provisions of paragraphs 2 to 4 of Section B of [the Second Schedule](#) shall apply except that for krypton-85, an effective A₂ value equal to 10 A₂ may be used.

(10) For the purposes of paragraph (8)(a), the limits of non-fixed contamination on external surfaces shall be taken into account.

(11) A Type B(U) package for radioactive contents with activity greater than 10⁵ A₂ shall be so designed that, if it were subjected to the enhanced water immersion test specified in paragraph 8 of Section E of [the Fourth Schedule](#), there would be no rupture of the containment system.

(12) Compliance with the permitted activity release limits shall depend neither upon filters nor upon a mechanical cooling system.

(13) A Type B(U) package shall not include a pressure relief system from the containment system which would allow the release of radioactive material to the environment under the conditions of the tests specified in paragraphs 5 and 7 of Section E of [the Fourth Schedule](#).

(14) A Type B(U) package shall be so designed that if it were at the maximum normal operating pressure and it were subjected to the tests specified in paragraphs 5 and 7 of Section E of [the Fourth Schedule](#), the level of strains in the containment system would not attain values which would adversely affect the package in such a way that it would fail to meet the applicable requirements.

(15) A Type B(U) package shall not have a maximum normal operating pressure in excess of a gauge pressure of 700 kPa.

(16) The temperature of any accessible surface during transport of a Type B(U) package shall not exceed 85°C in the absence of insolation under the ambient temperature of 38°C unless the package is carried under exclusive use or by air. Account may be taken of barriers or screens to give protection to transport workers without barriers or screens being subject to any test.

(17) A Type B(U) package containing low dispersible radioactive material shall be so designed that any features added to the low dispersible radioactive material that are not part of it, or any internal components of the packaging shall not adversely affect the performance of the low dispersible radioactive material.

(18) A Type B(U) package shall be designed for an ambient temperature range from -40°C to +38°C.

Requirements for Type B(M) packages

49.—(1) Except as otherwise provided in [paragraph \(2\)](#), a Type B(M) package shall meet the requirements for Type B(U) packages specified in [regulation 48](#) as far as practicable, except that for packages to be transported solely within Singapore or solely between Singapore and other specified countries, conditions other than those given in regulation 48(5), (6) and (18) may be assumed with the approval of the Chief Executive.

(2) Intermittent venting of Type B(M) packages may be permitted during transport if the operational controls for venting are acceptable to the Chief Executive.

Requirements for Type C packages

50.—(1) The design of Type C package shall, in addition to meeting the requirements of regulations 42, 43 and [47\(2\)](#) to [\(15\)](#) except as specified in regulation 47(14)(a), meet the requirements of [paragraphs \(2\)](#) to [\(6\)](#) and regulation 48(3) to (6) and (12) to (18).

(2) A Type C package shall be capable of meeting the assessment criteria prescribed for tests in [regulation 48\(2\)](#), (8) and (14) after burial in an environment defined by a thermal conductivity of 0.33 W/(m.K) and a temperature of 38°C in the steady state. Initial conditions for the assessment shall assume that any thermal insulation of the package remains intact, the

package is at the maximum normal operating pressure and the ambient temperature is 38°C.

(3) A type C package shall be so designed that, if it were at the maximum normal operating pressure and subjected to —

- (a) the tests specified in paragraph 5 of Section E of [the Fourth Schedule](#), it would restrict the loss of radioactive contents to not more than $10^{-6}A_2$ per hour; and
- (b) the test sequences in [regulation 10\(1\)](#) of Section E of [the Fourth Schedule](#) it would meet the following requirements:
 - (i) retain sufficient shielding to ensure that the radiation level at 1 m from the surface of the package would not exceed 10 mSv/h with the maximum radioactive contents which the package is designed to contain; and
 - (ii) restrict the accumulated loss of radioactive contents in a period of one week to not more than $10A_2$ for krypton-85 and not more than A_2 for all other radionuclides.

(4) Where mixtures of different radionuclides are present, the provisions of paragraphs 2, [3](#) and [4](#) of Section B of [the Second Schedule](#) shall apply except that for krypton-85 an effective A_2 value equal to $10A_2$ may be used.

(5) For the purposes of paragraph (3)(a), the limits of non-fixed contamination on external surfaces shall be taken into account.

(6) A Type C package shall be so designed that there will be no rupture of the containment system following performance of the enhanced water immersion test specified in paragraph 8 of Section E of [the Fourth Schedule](#).

Requirements for packages containing fissile material

51.—(1) Packages containing fissile material shall meet the requirements prescribed elsewhere in these Regulations which pertain to the radioactive properties of the material and the requirements specified in [paragraphs \(3\)](#) to [\(6\)](#) and regulations 52, 53 and 54 unless excepted by [regulation 17\(6\)](#).

(2) Fissile material shall be packaged and shipped in such a manner that subcriticality is maintained under conditions likely to be encountered during normal conditions of transport and in accidents. The following contingencies shall be considered:

- (a) water leaking into or out of packages;
- (b) the loss of efficiency of built-in neutron absorbers or moderators;
- (c) possible rearrangement of the radioactive contents either within the package or as a result of loss from the package;
- (d) reduction of spaces between packages or radioactive contents;
- (e) packages becoming immersed in water or buried in snow; and
- (f) possible effects of temperature changes.

(3) Where the chemical or physical form, isotopic composition, mass or concentration, moderation ratio or density, or geometric configuration is not known, the assessments of regulations 52, 53 and 54 shall be performed assuming that each parameter that is not known has the value which gives the maximum multiplication consistent with the known conditions and parameters in these assessments.

(4) For irradiated nuclear fuel, the assessments of regulations 52, 53 and 54 shall be based on an isotopic composition demonstrated to provide —

- (a) the maximum neutron multiplication during the irradiation history; or
- (b) a conservative estimate of the neutron multiplication for the package assessments. After irradiation but prior to shipment, a measurement shall be performed to confirm the conservatism of the isotopic composition.

(5) The packaging, after being subjected to the tests specified in paragraph 5 of Section E of [the Fourth Schedule](#), must prevent the entry of a 10 cm cube.

(6) The package shall be designed for an ambient temperature range of -40°C to $+38^{\circ}\text{C}$ unless the Chief Executive specifies otherwise in the certificate of approval for the package design.

Assessment of individual package in isolation

52.—(1) For a package in isolation, it shall 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 error, absence of leakage may be assumed in respect of those void spaces.

(2) For the purposes of [paragraph \(1\)](#), “special features” includes the following:

- (a) multiple high standard water barriers, each of which would remain watertight if the package were subject to the tests prescribed in regulation 54(b), a high degree of quality control in the manufacture, maintenance and repair of packagings, and tests to demonstrate the closure of each package before each shipment; or
- (b) for packages containing uranium hexafluoride only —
 - (i) packages where, following the tests prescribed in regulation 54(b), there is no physical contact between the valve and any other component of the packaging other than at its original point of attachment and where, in addition, following the test prescribed in paragraph 7(3) of Section E of [the Fourth Schedule](#) the valves remain leaktight; and
 - (ii) a high degree of quality control in the manufacture, maintenance and repair of packagings coupled with tests to demonstrate closure of each package before each shipment.

(3) It shall be assumed that the confinement system shall be 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 regulation 54(b), close reflection of the package by at least 20 cm of water may be assumed in [paragraph \(4\)\(c\)](#).

(4) The package shall be subcritical under the conditions of [paragraphs \(1\), \(2\) and \(3\)](#) with the package conditions that result in the maximum neutron multiplication consistent with —

- (a) routine conditions of transport (incident free);
- (b) the tests specified in [regulation 53\(b\)](#); and
- (c) the tests specified in regulation 54(b).

(5) For packages to be transported by air —

- (a) the package shall be subcritical under conditions consistent with the tests prescribed in [regulation 10\(1\)](#) of Section E of [the Fourth Schedule](#), assuming reflection by at least 20 cm of water but no water in-leakage; and
- (b) allowance shall not be made for special features of [paragraphs \(1\) and \(2\)](#) unless, following the tests specified in paragraph 10(1) of Section 5 of [the Fourth Schedule](#), and subsequently, [paragraph 9\(3\)](#) of Section E of [the Fourth Schedule](#), leakage of water into or out of the void spaces is prevented.

Assessment of package arrays under normal conditions of transport

53. A number “N” shall be derived such that 5 times “N” shall be subcritical for the arrangement and package conditions that provide the maximum neutron multiplication consistent with the following:

- (a) there shall not be anything between the packages, and the package arrangement shall be reflected on all sides by at least 20 cm of water; and
- (b) the state of the packages shall be their assessed or demonstrated condition if they had been subjected to the tests specified in paragraph 5 of Section E of [the Fourth Schedule](#).

Assessment of package arrays under accident conditions of transport

54. A number “N” shall be derived, such that 2 times “N” shall be subcritical for the arrangement and package conditions that provide the maximum neutron multiplication consistent with the following:

- (a) hydrogenous moderation between packages, and the package arrangement reflected on all sides by at least 20 cm of water;
- (b) the tests specified in paragraph 5 of Section E of [the Fourth Schedule](#) followed by whichever of the following is the more limiting:
 - (i) the tests specified in paragraph 6(2)(b) of Section E of [the Fourth Schedule](#) and either paragraph 6(2)(c) of Section E of [the Fourth Schedule](#) for having a mass not greater than 500 kg and an overall density not greater than 1000 kg/m³ based on the external dimensions, or paragraph 6(2)(a) of Section E of [the Fourth Schedule](#) for all other packages; followed by the test specified in

[paragraph 6\(3\)](#) of Section E of [the Fourth Schedule](#) and completed by the tests specified in paragraph 9 of Section E of [the Fourth Schedule](#); or

- (ii) the test specified in paragraph 7(4) of Section E of [the Fourth Schedule](#); and
- (c) where any part of the fissile material escapes from the containment system following the tests specified in paragraph (b), it shall be assumed that fissile material escapes from each package in the array and all of the fissile material shall be arranged in the configuration and moderation that results in the maximum neutron multiplication with close reflection by at least 20 cm of water.

PART VIII

APPROVALS

Approval of special form radioactive material and low dispersible radioactive material

55.—(1) The design for special form radioactive material shall require unilateral approval. The design for low dispersible radioactive material shall require multilateral approval.

(2) An application to the Chief Executive for a certificate of approval in respect of a design for special form radioactive material or low dispersible radioactive material shall include —

- (a) a detailed description of the radioactive material or, if contained in a capsule, the contents thereof, with particular reference to both the physical and chemical states;
- (b) a detailed statement of the design of any capsule to be used;
- (c) a statement of the tests which have been done and their results, or evidence based on calculative methods to show that the radioactive material is capable of meeting the performance standards, or other evidence that the special form radioactive material or low dispersible radioactive material meets the relevant requirements of these Regulations;
- (d) a specification of the applicable quality assurance programme; and
- (e) any proposed pre-shipment actions for use in the consignment of special form radioactive material or low dispersible radioactive material.

Approval of package designs to contain uranium hexafluoride

56. The approval of designs for packages containing 0.1kg or more of uranium hexafluoride shall be subject to the following conditions:

- (a) after 31st December 2000, each design that meets the requirements of [regulation 46\(4\)](#) shall require multilateral approval. After 31st December 2003, each design that meets the requirements of regulations 44 (3) to [46\(3\)](#) shall require unilateral approval by the competent authority of the country of origin of the design; and
- (b) the application for approval shall include all information necessary to satisfy the Chief Executive that the design meets the requirements of [regulation 46\(1\)](#) and a

specification of the applicable quality assurance programme.

Approval of Type B(U) and Type C package designs

57.—(1) The design of each Type B(U) or Type C package shall require unilateral approval except that —

- (a) a package design for fissile material, which is also subject to [regulation 59](#) shall require multilateral approval; and
- (b) a Type B(U) package design for low dispersible radioactive material shall require multilateral approval.

(2) An application to the Chief Executive for a certificate of approval of a Type B(U) or Type C package design shall include —

- (a) a detailed description of the proposed radioactive contents with particular reference to their physical and chemical states and the nature of the radiation emitted;
- (b) a detailed statement of the design, including complete engineering drawings and schedules of materials and methods of manufacture;
- (c) a statement of the tests which have been done and their results, or evidence based on calculative methods or other evidence that the design is adequate to meet the applicable requirements;
- (d) the proposed operating and maintenance instructions for the use of the packaging;
- (e) if the package is designed to have a maximum normal operating pressure in excess of 100 kPa, a specification of the materials of manufacture of the containment system, the samples to be taken, and the tests to be made;
- (f) where the proposed radioactive contents are irradiated fuel, a statement of any assumption in the safety analysis relating to the characteristics of the fuel and any justification for such assumption and a description of any pre-shipment measurement required by [regulation 51\(4\)\(b\)](#);
- (g) any special stowage provisions necessary to ensure the safe dissipation of heat from the package, consideration being given to the various modes of transport to be used and type of conveyance or freight container;
- (h) an illustration, which may be reproduced, showing the make-up of the package and not longer than 21 cm and broader than 30 cm; and
- (i) a specification of the applicable quality assurance programme.

Approval of Type B(M) package designs

58.—(1) The design of each Type B(M) package shall require multilateral approval.

(2) An application to the Chief Executive for a certificate of approval of a Type B(M) package design shall, in addition to the information required in [regulation 57\(2\)](#) for Type B(U) and Type C packages, include the following:

- (a) a list of the requirements specified in regulations 47(5) and 48(5), (6), (11) to (18) with which the package does not conform;
- (b) any proposed supplementary operational controls to be applied during transport not routinely provided for in these Regulations, but which are necessary to ensure the safety of the package or to compensate for the deficiencies listed in [sub-paragraph \(a\)](#);
- (c) a statement relating to any restrictions on the mode of transport and to any special loading, carriage, unloading or handling procedures; and
- (d) the maximum and minimum ambient conditions of temperature and solar radiation expected to be encountered during transport and which have been taken into account in the design.

Approval of package designs for fissile material

59.—(1) The design of each package of fissile material which is not an excepted package shall require multilateral approval.

(2) An application to the Chief Executive for a certificate of approval in respect of the design of a package of fissile material shall include all information necessary to satisfy the Chief Executive that the design meets the requirements of [regulation 51\(1\)](#) and a specification of the applicable quality assurance programme.

Approval of shipments

60.—(1) Except as otherwise provided in [paragraph \(2\)](#), multilateral approval shall be required for —

- (a) the shipment of Type B(M) packages not conforming with the requirements of [regulation 47\(5\)](#) or designed to allow controlled intermittent venting;
- (b) the shipment of Type B(M) packages containing radioactive material with an activity greater than 3000 A₁ or 3000 A₂, as appropriate, or 1000 TBq, whichever is the lower;
- (c) the shipment of packages containing fissile materials if the sum of the criticality safety indexes of the individual packages exceeds 50; and
- (d) radiation protection programmes for shipments by special use vessels according to [regulation 21\(2\)\(a\)](#).

(2) The Chief Executive may authorise transport of any package through or to Singapore without a certificate of approval in respect of its shipment if there is specific provision therefor in a certificate of approval issued in respect of its design.

(3) An application to the Chief Executive for a certificate of approval of a shipment shall include —

- (a) the period of time, related to the shipment, for which the approval is sought;
- (b) the actual radioactive contents, the expected modes of transport, the type of

conveyance, and the probable or proposed route; and

- (c) details of how the precautions and administrative or operational controls, referred to in the certificate of approval issued in respect of package design are to be put into effect.

Special arrangement

61.—(1) A consignment which does not satisfy all the applicable requirements of these Regulations shall not be transported except under special arrangement.

(2) Each consignment shipped under special arrangement shall require multilateral approval.

(3) An application to the Chief Executive for a certificate of approval in respect of a shipment under special arrangement shall include all the information necessary to satisfy the Chief Executive that the overall level of safety in transport is at least equivalent to that which would be provided if all the applicable requirements of these Regulations had been met.

(4) Without prejudice to the generality of [paragraph \(3\)](#), an application under that paragraph shall include —

- (a) a statement of the respects in which, and of the reasons why, the consignment cannot be shipped, transported or made in accordance with these Regulations; and
- (b) a statement of any special precautions or special administrative or operational controls which are to be employed during transport to compensate for the failure to meet these Regulations.

Notification and registration of serial numbers

62. The Chief Executive shall be informed of the serial number of each packaging manufactured to a design approved under regulations 57(1), [58\(1\)](#), [59\(1\)](#) and 67.

Competent authority identification marks

63. Each certificate of approval issued by the Chief Executive in respect of design or shipment shall be assigned an identification mark in the form specified in the Seventh Schedule.

PART IX

MISCELLANEOUS

Customs operations

64.—(1) Customs operations involving examination of the radioactive contents of a package shall be carried out only in a place where adequate means of controlling radiation exposure are provided and in the presence of qualified persons.

(2) Any package opened on customs instructions shall, before being forwarded to the consignee, be restored to its original condition.

Undeliverable consignments

65. Where a consignment is undeliverable, the consignment shall be placed in a safe location and the Chief Executive shall be informed as soon as possible and a request made for instructions on further action.

Penalty

66. Any person who contravenes any provision of these Regulations shall be guilty of an offence and shall be liable on conviction to a fine not exceeding \$2,000 or to imprisonment for a term not exceeding 6 months or to both.

Transitional provision

67.—(1) Notwithstanding any provision in these Regulations, any packaging manufactured to a design approved by the Chief Executive under the provisions of the revoked Regulations may continue to be used, subject to the following conditions:

- (a) the necessary multilateral approval of the package design is obtained;
- (b) a specification of the quality assurance programme is provided to the Chief Executive;
- (c) the activity limits and material restrictions of [the Second Schedule](#) are complied with;
- (d) for a package containing fissile material and transported by air, the requirement of regulation 52(5) is complied with; and
- (e) a serial number, according to the provisions of [regulation 27\(5\)](#), is assigned to and marked on the outside of each packaging.

(2) Changes in the design of the packaging or in the nature or quantity of the authorised radioactive contents which, as determined by the Chief Executive, would significantly affect safety shall be required to meet these Regulations.

(3) All packagings for which manufacture begins after 31st December 2006 shall comply with these Regulations.

FIRST SCHEDULE

Regulations 4 (1), 13, [15\(2\)](#), [17\(5\)](#) and [18\(3\)](#)

TYPES OF LSA MATERIAL AND SURFACE CONTAMINATED OBJECTS

SECTION A — GROUPS OF LSA MATERIAL

LSA material shall be in one of 3 groups:

- (a) LSA-I
 - (i) Uranium and thorium ores and concentrates of such ores, and other ores containing naturally occurring radionuclides which are intended to be processed for the use of these radionuclides;

- (ii) solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures;
 - (iii) radioactive material, other than fissile material, for which the A_2 value is unlimited; or
 - (iv) other radioactive material, excluding fissile material, in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the values for activity concentration specified in [the Second Schedule](#).
- (b) LSA-II
- (i) water with tritium concentration up to 0.8 TBq/ l; or
 - (ii) other material in which the activity is distributed throughout and the estimated average specific activity does not exceed $10^{-4} A_2/g$ for solids and gases, and $10^{-5} A_2/g$ for liquids.

(c) LSA-III

Solids (including consolidated wastes and activated materials), excluding powders in which —

- (i) the radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.);
- (ii) the radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble matrix, so that, even under loss of packaging, the loss of radioactive material per package by leaching when placed in water for 7 days would not exceed $0.1 A_2$; and
- (iii) the estimated average specific activity of the solid, excluding any shielding material, does not exceed $2 \times 10^{-3} A_2/g$.