

**Table of TS-R-1 1996 (Revised) Requirements**

TS-R-1	TS-R-1 SUMMARY	Staff Evaluation
501	Before the first shipment of any package, the following requirements shall be fulfilled:	
501 (a)	If the design pressure of the containment system exceeds 35 kPa (gauge), it shall be ensured that the containment system of each package conforms to the approved design requirements relating to the capability of that system to maintain its integrity under that pressure.	Satisfied. The containment system for the ASPECT 12K consists of the special form radioactive source capsules. The actual containment for the radioactive material is the welded radioactive source capsule, certified as special form radioactive material under an IAEA Certificate of Competent Authority. See SAR Sections 3.5.3 and 3.5.4.
501 (b)	For each Type B(U), Type B(M), and Type C package and for each package containing fissile material, it shall be ensured that the effectiveness of its shielding and containment and, where necessary, the heat transfer characteristics and the effectiveness of the confinement system, are within the limits applicable to or specified for the approved design.	Satisfied. The application (see Section 8.1.6) describes acceptance tests that affect components relied upon for shielding, such as checks to assure that no defects, voids or streaming paths exist in the shielding. The staff finds these tests to be acceptable and adequate to ensure the shielding design of the fabricated package.
502	Before each shipment of any package, the following requirements shall be fulfilled:	
502(a)	For any package it shall be ensured that all the requirements specified in the relevant provisions of these regulations have been satisfied.	Satisfied. The competent authority's certificate lists the actions to be performed prior to each shipment. The application describes these actions in greater detail in the ASPECT 12K Operating Manual.
502(b)	It shall be ensured that lifting attachments which do not meet the requirements of para. 607 have been removed or otherwise rendered incapable of being used for lifting the package, in accordance with para. 608.	Satisfied. The lifting attachments meet the requirements of para. 607.
502(c)	For each Type B(U), Type B(M), and Type C package and for each package containing fissile material, it shall be ensured that all the requirements specified in the approval certificates have been satisfied.	Satisfied. The competent authority's certificate lists the actions to be performed prior to each shipment. The application describes these actions in greater detail in the ASPECT 12K Operating Manual.
502(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 requirements for temperature and pressure	Package at equilibrium temperatures begins to dissipate heat from the outside surface at the rate it generates heat.

	unless an exemption from these requirements has received unilateral approval.	
502(e)	For each Type B(U), Type B(M) and Type C package, it shall be ensured by inspection and/or appropriate tests that all closures, valve 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 paras. 656 and 669 were made.	Satisfied. There are no penetrations of the containment. There are no drains or fill ports, valves, seals, test ports, pressure relief devices, lids, cover plates or other closure devices. The source capsules are seal welded using a weld process that has been demonstrated to be acceptable for certification of the radioactive source capsule as special form radioactive material under an IAEA Certificate of Competent Authority.
502(f)	For each special form radioactive material, it shall be ensured that all the requirements specified in the special form approval certificate and the relevant provisions of these regulations have been satisfied.	Satisfied. The Special Form radioactive material is certified by an IAEA Certificate of Competent Authority and the relevant regulations have been considered in the application.
503	A package shall not contain any other items except such articles and documents as are necessary for the use of the radioactive material. This requirement shall not preclude the transport of low specific activity material or surface contaminated objects with other items. The transport of such articles and documents in a package, or of low specific activity material or surface contaminated objects with other items may be permitted provided that there is no interaction between them and the packaging or its radioactive contents that would reduce the safety of the package.	Satisfied. The package allows for other accessory equipment to be transported in the volume between the monolithic thermal ceramic insulation liner and the drum cover, provided that the maximum authorized mass limit is satisfied.
507	In addition to the radioactive and fissile properties, any other dangerous properties of the contents of the package, such as explosiveness, flammability, pyrophoricity, chemical toxicity and corrosiveness, shall be taken into account in the packing, labelling, marking, placarding, storage, and transport in order to be in compliance with the relevant transport regulations for dangerous goods of each of the countries through or into which the materials will be transported, and, where applicable, with the regulations of the cognizant transport organizations, as well as these regulations.	Satisfied. The package has considered the effects of any dangerous properties of the contents in package design and labeling. Additionally see SAR Sections 1.2.1 and 2.2.2. The materials from which the package is fabricated, along with the contents of the package, will not cause significant chemical, galvanic, or other reaction among the packaging components, among package contents, or between packaging components and package contents.
508	The non-fixed contamination on the external	Satisfied. The operating procedures

	<p>surfaces of any package shall be kept as low as practicable and, under routine conditions of transport, shall not exceed the following limits:</p> <p>(a) 4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters, and</p> <p>(b) 0.4 Bq/cm<sup>2</sup> for all other alpha emitters</p> <p>These limits are applicable when averaged over any area of 300 cm<sup>2</sup> of any part of the surface.</p>	<p>require a surface contamination check to be completed in preparation to transport in accordance with this paragraph.</p>
520	<p>An empty packaging which had previously contained radioactive material may be transported as an excepted package provided that:</p>	
520(a)	<p>It is in a well maintained condition and securely closed.</p>	<p>Satisfied. Operating procedures for preparation of an empty package requires securing the package and checking the condition of the package. The maintenance and acceptance procedures require that the package is in a well maintained condition.</p>
520(b)	<p>The outer surface of any uranium or thorium in its structure is covered with an inactive sheath made of metal or some other substantial material.</p>	<p>Satisfied. Copper and brass are used to separate the depleted uranium from the stainless steel to preclude the possibility of the formation of an iron-uranium eutectic alloy at temperatures below the melting temperatures of the individual metals. The depleted uranium components are covered with copper foil where contact with stainless steel is possible. The 10-Channel source tubes are plated with copper.</p>
520(c)	<p>The level of internal non-fixed contamination does not exceed one hundred times the levels specified in para. 508.</p>	<p>Satisfied. Operating procedures for preparation of an empty package requires checking the internal contamination of the package.</p>
520(d)	<p>Any labels which may have been displayed on it in conformity with para. 541 are no longer visible.</p>	<p>Satisfied. The operating procedures for preparation of an empty package references procedures which check the labeling.</p>
526	<p>Specifies that the TI for a package, overpack, or freight container, or for unpackaged LSA-I or SCO-I, shall be the number derived in accordance with the procedure in paras. 526 - 527.</p>	<p>Satisfied. The TI is determined by direct measurement of radiation level from the package.</p>

526(a)	Determine the maximum radiation level in units of mSv/h at a distance of 1 m from the external surfaces of the package, overpack, freight container, or unpackaged LSA-I and SCO-I. The value determined is multiplied by 100 and the resulting number is the transport index. For uranium and thorium ores and their concentrates, the maximum radiation level at any point 1 m from the external surface of the load may be taken as: .4 mSv/h for ores and physical concentrates of uranium and thorium; 0.3 mSv/h for chemical concentrates of thorium; 0.02 mSv/h for chemical concentrates of uranium, other than uranium hexafluoride.	Satisfied. The TI is determined by direct measurement of radiation level from the package.
526(c)	The value obtained in (a) and (b) shall be rounded up to the first decimal place (e.g., 1.13 becomes 1.2) except that a value of 0.05 or less may be considered as zero.	Satisfied. The TI is determined by direct measurement of radiation level from the package.
527	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.	Satisfied. The TI is determined by direct measurement of radiation level from the package.
530	Except for consignments under exclusive use, the transport index of any package or overpack shall not exceed 10, nor shall the criticality safety index of any package or overpack exceed 50.	Satisfied. The does not need to be shipped under exclusive use as the TI determined by direct measurement is 2.5.
531	Except for packages or overpacks transported under exclusive use by rail or by road under the conditions specified in subpara. 572(a), or under exclusive use and special arrangement by vessel or by air under the conditions specified in paras. 574 or 578 respectively, the maximum radiation level at any point on any external surface of a package or overpack shall not exceed 2 mSv/h.	Satisfied. The maximum radiation level at any point on any external surface of a package is 0.905 mSv/h, therefore, the staff finds the requirement of this paragraph is met for shielding for non-exclusive use.
533	Packages and overpacks shall be assigned to either category I-WHITE, II-YELLOW, or III-YELLOW in accordance with the conditions specified in Table VII and with the following requirements	Satisfied. It is a Category II.
534	Each package shall be legibly and durably marked on the outside of the packaging with an identification of either the consignor or	Satisfied. It is a requirement of the operating procedures.

	consignee, or both.	
535	For each package, other than excepted packages, the United Nations number (see Table VIII), 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 para. 580 shall apply.	Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.
536	Each package of gross mass exceeding 50 kg shall have its permissible gross mass legibly and durably marked on the outside of the packaging.	Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.
538	Sets marking requirements for packages which conform to an approved design under paras., 805-814 or 816-817.	Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.
538(a)	Each package shall be legibly and durably marked on the outside of the packaging with the identification mark allocated to that design by the competent authority.	Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.
538(b)	Each package shall be legibly and durably marked on the outside of the packaging with a serial number to uniquely identify each packaging which conforms to that design.	Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.
538(c)	Each package shall be legibly and durably marked on the outside of the packaging with "TYPE B(U)" or "TYPE B(M)" in the case of a Type B(U) or Type B(M) package design.	Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.
539	Each package which conforms to a Type B(U), Type B(M), or Type C package design 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 shown in Fig. 1.	Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.
541	Each package, overpack and freight container shall bear the labels which conform to the models in Fig. 2, Fig. 3, or Fig. 4, except as allowed under the alternative	Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and

	<p>provisions of para. 546 for large freight containers and tanks, according to the appropriate category. In addition, each package, overpack and freight container containing fissile material, other than fissile material excepted under the provisions of para. 672, shall bear labels which conform to the model in Fig. 5. Any labels which do not relate to the contents shall be removed or covered. For radioactive material having other dangerous properties see para. 507.</p>	546 of TS-R-1.
542	<p>The labels conforming to the models in Fig. 2, Fig. 3, and Fig. 4, shall be affixed to two opposite sides of the outside of a package or overpack or on the outside of all four sides of a freight container or tank. The labels conforming to the model in Fig. 5, where applicable, shall be affixed adjacent to the labels conforming to the models in Fig. 2, Fig. 3, and Fig. 4. The labels shall not cover the markings specified in paras 534–539.</p>	<p>Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.</p>
543	<p>Each label conforming to the models in Fig. 2, Fig. 3, and Fig. 4, shall be completed with the following information:</p> <p>(a) Contents:</p> <p>(i) Except for LSA-I material, the name(s) of the radionuclide(s) as taken from Table I, using the symbols prescribed therein. For mixtures of radionuclides, the most restrictive nuclides must be listed to the extent the space on the line permits. The group of LSA or SCO shall be shown following the name(s) of the radionuclide(s). The terms “LSA-II”, “LSA-III”, “SCO-I”, and “SCO-II”, shall be used for this purpose.</p> <p>(b) Activity: The maximum activity of the radioactive contents during transport expressed in units of becquerels (Bq) with the appropriate SI prefix (see Annex II). For fissile material, the mass of fissile material in units of grams (g), or multiples thereof, may be used in place of activity.</p> <p>(c) For overpacks and freight containers the “contents” and “activity” entries on the label shall bear the information required in subparas. 543(a) and 543(b), respectively, totalled together for the entire contents of the overpack or freight container except that on</p>	<p>Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.</p>

	<p>labels for overpacks or freight containers containing mixed loads of packages containing different radionuclides, such entries may read "See Transport Documents."</p> <p>(d) Transport index: See paras. 526 and 527. (No transport index entry is required for category I-WHITE.)</p>	
546	<p>Large freight containers carrying packages other than excepted packages, and tanks shall bear four placards which conform with the model given in Fig. 6. The placards shall be affixed in a vertical orientation to each side wall and each end wall of the large freight container or tank. Any placards which do not relate to the contents shall be removed. Instead of using both labels and placards, it is permitted as an alternative to use enlarged labels only, as shown in Fig. 2, Fig. 3, Fig. 4, and Fig. 5 where appropriate, with dimensions of the minimum size shown in Fig. 6.</p>	<p>Satisfied. The operating procedures require proper labeling on the outside of the package in accordance with paragraphs 535-540, 542-543, and 546 of TS-R-1.</p>
554	<p>When an empty packaging is transported as an excepted package under the provisions of para. 520, the previously displayed labels shall not be visible</p>	<p>Satisfied. The operating procedures for preparation of an empty package for transport</p>
606	<p>The package shall be so designed in relation to its mass, volume, and shape that it can be easily and safely transported. In addition, the package shall be so designed that it can be properly secured in or on the conveyance during transport.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR that the package has been designed properly secured, and can be transported safely on a conveyance.</p>
607	<p>The design shall be such that any lifting attachments on the package will not fail when used in the intended manner and that, if failure of the attachments should occur, the ability of the package to meet other requirements of these regulations would not be impaired. The design shall take account of appropriate safety factors to cover snatch lifting.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR that the package is designed to be easily moved by hand using a mechanical lifting device, and straps or cables placed through the two folding handles attached to the outer container. The staff verified by reviewing the analysis and test results as presented in SAR Appendix 2.12.9, performed by Source Production &amp; Equipment Co., Inc. (SPEC) located in USA, and in accordance with SPEC's USNRC approved Quality Assurance Program. Based on the staff's review the safety factor is greater than 3.</p>

		Therefore, the staff determines that these lifting handles comply with the requirements of the 10 CFR 71.45(a) regulations. (A more stringent requirement than that required by IAEA para. 607).
608	Attachments and any other features on the outer surface of the package which could be used to lift it shall be designed either to support its mass in accordance with the requirements of para. 607 or shall be removable or otherwise rendered incapable of being used during transport.	Satisfied. The staff verified in the applicant supplied SAR, that there are no other attachments or other features that could reasonably be used to lift the package.
609	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.	Satisfied. The staff verified in the applicant supplied SAR, that there is no protruding feature, and the lifting handles can be easily decontaminated - if necessary.
610	As far as practicable, the outer layer of the package shall be so designed as to prevent the collection and the retention of water.	Satisfied. The staff verified in the applicant supplied SAR, that the outer layer of the package is designed to prevent collection and retention of water.
611	Any features added to the package at the time of transport which are not part of the package shall not reduce its safety.	Satisfied. There are no added features to the package which would reduce safety.
612	The package shall withstand the effects of any acceleration, vibration or vibration resonance which may arise under routine conditions of 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, even after repeated use.	Satisfied. Staff has independently verified that the transport packages similar in construction to the ASPECT 12K package including its inner packages have been in use in the radiography industry in USA. Furthermore, as the nuts, bolts, and other securing devices are designed to prevent from becoming loose, the staff concludes that the ASPECT 12K package, including the inner packages, will withstand the vibration normally incident to transport.
613	The materials of the packaging and any components or structures shall be physically and chemically compatible with each other and with the radioactive contents. Account shall be taken of their behavior under irradiation.	Satisfied. See SAR Sections 2.2.2 and 2.2.3.
614	All valves through which the radioactive contents could otherwise escape shall be protected against unauthorized operation.	Satisfied. Radioactive contents are in sealed sources and there are no valves.
615	The design of the package shall take into account ambient temperatures and pressures	The staff verified in the applicant supplied SAR Section 2.6.6.1, and

	that are likely to be encountered in routine conditions of transport.	SAR Section 3.6.1, that the ambient temperatures and pressures were accounted for during the normal conditions of transport. Additionally, see SAR Section 3.1.3 (Table 3.2) and Section 3.1.4 (Table 3.3).
617	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.	Satisfied. The staff verified in the applicant supplied SAR and concludes that this requirement is met. See SAR Sections 3.3.1 and 3.6.2.1.
618	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.	Satisfied. The minimum service temperature for all package components is less than or equal to -40°C. The maximum service temperatures of the package components are based on the component's functional requirements for the service conditions. The maximum service temperature for metallic structural components is limited to the melting temperature of the material, all of which far exceeds the ambient upper temperature limit of +55°C. The staff concludes that the integrity of the containment is not impaired when the package is exposed to these temperature ranges. Additionally, see SAR Sections 3.6.4 and 3.6.5.
619	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.	Satisfied. The staff verified in the applicant supplied SAR Appendix 2.12.6, that for reduced pressure condition when this package is transported by air, the external pressure used in the analysis was only 5 kPa at 800° C. Additionally, see SAR Sections 3.6.4 and 3.6.5.
620	An excepted package shall be designed to meet the requirements specified in paras. 606–616 and in addition, the requirements of paras. 617–619 if carried by air.	Satisfied.
634	The smallest overall external dimension of the package shall not be less than 10 cm.	Satisfied. The staff verified in the applicant supplied SAR Section 1.2.1, that the minimum dimension is 15.5 inches (34 cm) which is greater than the 10 cm minimum requirement.
635	The outside of the package shall incorporate a feature such as a seal, which is not readily breakable and which, while intact, will be	Satisfied. The staff verified in the applicant supplied SAR Section 1.2.1, that a tamper seal is attached to the

	evidence that it has not been opened.	clamp ring to assure this requirement.
636	Any tie-down attachments on the package shall be so designed that, under normal and accident conditions of transport, the forces in those attachments shall not impair the ability of the package to meet the requirements of these Regulations.	Satisfied. The lifting handles described in para. 607, also serve as tie down devices. The staff reviewed the analysis and test results presented in SAR Appendix 2.12.5. The tie-down devices (lifting handles) have been shown by the applicant's analysis to withstand the force combination described in 10 CFR 71.45.b (more stringent requirements than para. 636) without generating stress in any material of the package in excess of its yield strength.
637	The design of the package shall take into account temperatures ranging from -40°C to +70°C for the components of the packaging. Attention shall be given to freezing temperatures for liquids and to the potential degradation of packaging materials within the given temperature range.	Satisfied. The staff verified in the applicant supplied SAR that the design of the package considered this range of temperatures. The minimum service temperature for all package components is less than or equal to -40°C. The maximum service temperatures of the package components are based on the component's functional requirements for the service conditions. The maximum service temperature for metallic structural components is limited to the melting temperature of the material, all of which far exceeds the ambient upper temperature limit of +70°C.
638	The design and manufacturing techniques shall be in accordance with national or international standards, or other requirements, acceptable to the competent authority.	Satisfied. The staff verified in the applicant supplied SAR that the design and manufacturing is in compliance with the IAEA TS-R-1. See section 2.3.1. The packages will be fabricated in accordance with engineering drawings, and welding will be performed in accordance with the standards identified in Section 2.1.4.
639	The design shall include a containment system securely closed by a positive fastening device which cannot be opened unintentionally or by a pressure which may arise within the package.	Satisfied. The staff verified in the applicant supplied SAR, that containment is seal welded and it cannot be opened unintentionally or by any internal design pressure of the package.
640	Special form radioactive material may be considered as a component of the containment system.	Satisfied. The staff verified in the applicant supplied SAR, that special form has been considered as the

		containment system.
641	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.	Satisfied. Special form sources are seal welded.
642	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.	Satisfied. The staff verified in the applicant supplied SAR that the design of the package has considered these possibilities and containment system is seal welded. There is no generation of gas. See SAR Section 2.2.3.
643	The containment system shall retain its radioactive contents under a reduction of ambient pressure to 60 kPa.	Satisfied. The staff verified in the applicant supplied SAR Appendix 2.12.6 that the package design assumed the reduced external pressure of 5kPa ( $\ll$ 60kPa). Under the worst case scenario the stress generated in the containment system is only 11% of the yield strength of the stainless steel material.
644	All valves, other than pressure relief valves, shall be provided with an enclosure to retain any leakage from the valve.	Satisfied. There are no pressure relief valves.
645	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.	Satisfied. The depleted uranium shielding is completely encased in stainless steel. A plug securely closes depleted uranium shield and secures the shield thereby preventing any unintentional release.
646	A package shall be so designed that if it were subjected to the tests specified in paras. 719–724, it would prevent:	Satisfied.
646(a)	Loss or dispersal of the radioactive content; and	Satisfied. The only effects of the tests on the packaging and its contents under normal conditions of transport and hypothetical accident conditions were denting and crushing of the outer container. The shielding did not sustain any damage, and remained intact during normal and hypothetical accident conditions testing.

646(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.	Satisfied. The only effects of the tests on the packaging and its contents under normal conditions of transport and hypothetical accident conditions were denting and crushing of the outer container. The shielding did not sustain any damage, and remained intact during normal and hypothetical accident conditions testing.
650	Type B(U) packages shall be designed to meet the requirements specified in paras. 606–616, the requirements of paras. 617–619 if carried by air, and of paras. 634–647, except as specified in para. 646(a), and, in addition, the requirements specified in paras. 651–664.	Satisfied. The staff verified in the applicant supplied SAR and concludes that the ASPECT package will meet para. 650 requirements.
651	A package shall be so designed that, under the ambient conditions specified in paras. 653 and 654, heat generated within the package by the radioactive contents shall not, under normal conditions of transport, as demonstrated by the tests in paras. 719-724, 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 period of one week. Particular attention shall be paid to the effects of heat, which may:	Satisfied. See SAR Sections 3.4 and 3.6.1.
651(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 (for example, clad fuel elements), cause the can, receptacle or radioactive material to deform or melt; or	Satisfied. The thermal evaluations demonstrate that the maximum temperatures of all components of the package remain below their respective temperature limits under both normal conditions of transport and hypothetical accident conditions.
651(b)	Lessen the efficiency of the packaging through differential thermal expansion or cracking or melting of the radiation shielding material; or	Satisfied. The shielding consisting of depleted uranium is not temperature sensitive, nor will it experience changes in material densities at normal or accident conditions. SAR Section 2.6.1.2 indicates that there will be no thermal stress as a result of differential thermal expansion of the materials of the inner container. Additionally, see SAR Section 3.4.2.
651(c)	In combination with moisture, accelerate corrosion.	Satisfied. See SAR Section 2.2.2.
652	Except as required in para. 617 for a package	Satisfied. See SAR Sections 3.3.1

	transported by air, a package shall be so designed that, under the ambient condition specified in para. 653, the temperature of the accessible surfaces of a package shall not exceed 50°C, unless the package is transported under exclusive use.	and 3.6.2.1.
653	The ambient temperature shall be assumed to be 38°C.	Satisfied. The staff verified in the applicant supplied SAR Appendix 3.6.1, and concludes that this requirement is met.
654	The solar insulation conditions shall be assumed to be as specified in Table XI.	Satisfied.
655	Requires that for a package which includes thermal protection in order to satisfy the 30 minute thermal test, the protection on the exterior of the package shall not be rendered ineffective by ripping, cutting, skidding, abrasion, or rough handling.	Satisfied. SAR Section 3.6.5 performs a thermal analysis on the Special Form Capsules without the exterior packaging under hypothetical accident conditions.
656	Sets requirements indicating that a package shall be so designed that if it were subjected to certain tests (a and b below) it could meet given requirements.	
656(a)	The tests specified in paras. 719–724, it would restrict the loss of radioactive contents to not more than $10^{-6}$ per hour; and	Satisfied. The contents do not exceed the limits.
656(b)	<p>The tests specified in paras. 726, 727 (b), 728, and 729 and the tests in paras.:</p> <p>(i) 727(c), when the package has a mass not greater than 500 kg, an overall density not greater than 1000 kg/m<sup>3</sup> based on the external dimensions, and radioactive contents greater than 1000 A<sub>2</sub> not as special form radioactive material, or</p> <p>(ii) 727(a), for all other packages, it would meet the following requirements:</p> <p>(a) 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</p> <p>(b) restrict the accumulated loss of radioactive contents in a period of one week to not more than 10 A<sub>2</sub> for krypton-85 and not more than A<sub>2</sub> for all other radionuclides. Where mixtures of different radionuclides are present, the provisions of paras. 404–406</p>	Satisfied. The only effects of the tests on the packaging and its contents under normal conditions of transport and hypothetical accident conditions were denting and crushing of the outer container. The shielding did not sustain any damage, and remained intact during normal and hypothetical accident conditions testing.

	shall apply except that for krypton-85 an effective $A_2$ value equal to $10 A_2$ may be used. For case (a) above, the assessment shall take into account the external contamination limits of para. 508.	
658	Compliance with the permitted activity release limits shall depend neither upon filters nor upon a mechanical cooling system.	Satisfied. The package is a completely passive thermal device and has no mechanical cooling system or relief valves. All cooling of the package is through free convection and radiation.
659	A 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 paras. 719–724 and 726–729.	Satisfied. The package is a completely passive thermal device and has no mechanical cooling system or relief valves. All cooling of the package is through free convection and radiation.
660	A package shall be so designed that if it were at the maximum normal operating pressure and it were subjected to the tests specified in paras. 719–724 and 726–729, 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.	Satisfied. The staff verified in the applicant supplied SAR Appendix 2.12.8 and concludes that the ASPECT 12K package design meets the requirements of para. 660. The permissible collapsing pressure is 2.15MPa, which is much greater than the maximum external pressure of 150kPa.
661	A package shall not have a maximum normal operating pressure in excess of a gauge pressure of 700 kPa.	Satisfied. The staff verified in the applicant supplied SAR Appendix 3.6.5, that the maximum normal operating pressure within the capsule is 370kPa which is much less than the 700 kPa requirement.
662	Except as required in para. 617 for a package transported by air, the maximum temperature of any surface readily accessible during transport of a package shall not exceed 85°C in the absence of insolation under the ambient conditions specified in para. 653. The package shall be carried under exclusive use, as specified in para. 652, if this maximum temperature exceeds 50°C. Account may be taken of barriers or screens intended to give protection to persons without the need for the barriers or screens being subject to any test.	Satisfied. See SAR Sections 3.3.1 and 3.6.2.1.
664	A package shall be designed for an ambient temperature range from -40°C to +38°C.	Satisfied. The minimum service temperature for all package components is less than or equal to -40°C. The maximum service temperatures of the package

		<p>components are based on the component's functional requirements for the service conditions. The maximum service temperature for metallic structural components is limited to the melting temperature of the material, all of which far exceeds the ambient upper temperature limit of +38°C.</p>
701	<p>Demonstration of compliance with the performance standards required in Section VI shall be accomplished by any of the methods listed below or by a combination thereof.</p> <p>(a) Performance of tests with specimens representing LSA-III material, or special form radioactive material, or low dispersible radioactive material or with prototypes or samples of the packaging, where the contents of the specimen or the packaging for the tests shall simulate as closely as practicable the expected range of radioactive contents and the specimen or packaging to be tested shall be prepared as presented for transport.</p> <p>(b) Reference to previous satisfactory demonstrations of a sufficiently similar nature.</p> <p>(c) Performance of tests with models of appropriate scale incorporating those features which are significant with respect to the item under investigation when engineering experience has shown results of such tests to be suitable for design purposes. When a scale model is used, the need for adjusting certain test parameters, such as penetrator diameter or compressive load, shall be taken into account.</p> <p>(d) Calculation, or reasoned argument, when the calculation procedures and parameters are generally agreed to be reliable or conservative.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR Appendix 2, that tests were performed on the prototype of ASPECT 12K package, and the compliance with the applicable performance standards as required were accomplished.</p>
702	<p>After the specimen, prototype, or sample has been subjected to the tests, appropriate methods of assessment shall be used to ensure that the requirements of this section have been fulfilled in compliance with the performance and acceptance standards prescribed in Section VI.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR Appendix 2, and concludes that this requirement is met.</p>

713	All specimens shall be inspected before testing in order to identify and record faults or damage including the following: (a) divergence from the design; (b) defects in manufacture; (c) corrosion or other deterioration; and (d) distortion of features.	Satisfied. The staff verified in the applicant supplied SAR Appendix 2, and concludes that this requirement is met.
714	The containment system of the package shall be clearly specified.	Satisfied. The staff verified in the applicant supplied SAR Section 1.2, that the containment system for the package has been clearly specified.
715	The external features of the specimen shall be clearly identified so that reference may be made simply and clearly to any part of such specimen.	Satisfied. The staff verified in the applicant supplied SAR Section 1.2 and concludes that this requirement is met.
716	After each of the applicable tests specified in paras. 718–737: (a) Faults and damage shall be identified and recorded; (b) It shall be determined whether the integrity of the containment system and shielding has been retained to the extent required in Section VI for the package under test;	Satisfied. The staff verified in the applicant supplied SAR Appendix 2.12.2.1, 2.12.2.2, and 2.12.2.3, and as the faults and damages were identified and recorded to ensure the integrity of the containment, concludes that this requirement is met.
717	The target for the drop test specified in paras. 705, 722, 725(a), 727, and 735 shall be a flat, horizontal surface of such a character that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase damage to the specimen.	Satisfied. The staff verified in the applicant supplied SAR Appendix 2.12.4, as well as on SPEC Drawing 50890-1, Rev. C, and as the carbon steel target plate was flat horizontal surface mounted on a 3,000 psi concrete pedestal; the target essentially an unyielding surface; and the mass of the target was over 4,763 kg. This mass exceeds 10 times the mass of the package - 149kg. Staff concludes that this requirement is met.
719	The tests are: the water spray test, the free drop test, the stacking test and the penetration test. Specimens of the package shall be subjected to the free drop test, the stacking test and the penetration test, preceded in each case by the water spray test. One specimen may be used for all the tests, provided that the requirements of para. 720 are fulfilled.	Satisfied. The staff verified in the applicant supplied SAR Section 2.6.6, that except for the water spray test which was not done, all other requirements are met. The applicant asserted that as the package is constructed entirely of metallic components exposure to water will not reduce the structural integrity of the package. The staff concurs with this explanation. Moreover, the outer package cover is securely fastened with a bolt ring to prevent any ingress of water.

720	<p>The time interval between the conclusion of the water spray test and the succeeding test shall be such that the water has soaked in to the maximum extent, without appreciable drying of the exterior of the specimen. In the absence of any evidence to the contrary, this interval shall be taken to be two hours if the water spray is applied from four directions simultaneously. No time interval shall elapse, however, if the water spray is applied from each of the four directions consecutively.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR that as the water spray test was not done this requirement is not applicable.</p>
721	<p>Water spray test: The specimen shall be subjected to a water spray test that simulates exposure to rainfall of approximately 5 cm per hour for at least one hour.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR that as the water spray test was not done this requirement is not applicable.</p>
722	<p>Free drop test: The specimen shall drop onto the target so as to suffer maximum damage in respect of the safety features to be tested.</p> <p>(a) The height of drop measured from the lowest point of the specimen to the upper surface of the target shall be not less than the distance specified in Table XIII for the applicable mass. The target shall be as defined in para. 717.</p> <p>(b) For rectangular fibreboard or wood packages not exceeding a mass of 50 kg, a separate specimen shall be subjected to a free drop onto each corner from a height of 0.3 m.</p> <p>(c) For cylindrical fibreboard packages not exceeding a mass of 100 kg, a separate specimen shall be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 m.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR Section 2.6.7, that the requirements of 722(a) are met. A full-scale physical testing of the ASPECT 12K package, (with maxiBulk inner container) with mass of 149 kg was conducted by the applicant. The height and the nature of the target complied with the applicable requirements. Para. 722 (b) and para. 722 (c) are not applicable, as package is not constructed with fiber board.</p>
723	<p>Stacking test: Unless the shape of the packaging effectively prevents stacking, the specimen shall be subjected, for a period of 24 h, to a compressive load equal to the greater of the following:</p> <p>(a) The equivalent of 5 times the mass of the actual package; and</p> <p>(b) The equivalent of 13 kPa multiplied by the vertically projected area of the package.</p> <p>The load shall be applied uniformly to two opposite sides of the specimen, one of which</p>	<p>Satisfied. The staff verified in the applicant supplied SAR Appendix 2.12.2, that a compressive load of 869 kg, the equivalent of five times the weight of the package (149 kg), for a period of 24 hours was applied during the full-scale test. Therefore, para. 723 (a) requirement is met. The para. 723 (b) is not applicable as para. 723 (a) governs.</p>

	shall be the base on which the package would typically rest.	
724	<p>Penetration test: The specimen shall be placed on a rigid, flat, horizontal surface which will not move significantly while the test is being carried out.</p> <p>(a) A bar of 3.2 cm in diameter with a hemispherical end and a mass of 6 kg shall be dropped and directed to fall, with its longitudinal axis vertical, onto the centre of the weakest part of the specimen, so that, if it penetrates sufficiently far, it will hit the containment system. The bar shall not be significantly deformed by the test performance.</p> <p>(b) The height of drop of the bar measured from its lower end to the intended point of impact on the upper surface of the specimen shall be 1 m.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR Section 2.6.10, that same full-scale of the prototype package used for the normal condition free drop test was used for the penetration test. A steel billet, with a diameter of 32 mm and a mass of 6 kg and hemispherical end was dropped from a height of 1 m three times as follows:</p> <ol style="list-style-type: none"> <li>1) Impact on the top of the package,</li> <li>2) Impact on the bottom of the package, and</li> <li>3) Impact on the center of the side of the package.</li> </ol> <p>After these three penetration tests, the applicant documented, and as reviewed by the staff in SAR Appendix 2.12.2.1, that the inner container remained fully secured. As the penetration test did not reduce the overall effectiveness of the package, the staff concludes that requirements of paras. 724(a) and 724 (b) are met.</p>
726	<p>The specimen shall be subjected to the cumulative effects of the tests specified in para. 727 and para. 728, in that order. Following these tests, either this specimen or a separate specimen shall be subjected to the effect(s) of the water immersion test(s) as specified in para. 729 and, if applicable, para. 730.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR Section 2.7, Appendix 2.12.2.3, and Appendix 2.12.8 that the package was subjected to the cumulative effects of the tests specified in para. 727 and para. 728 in that order, and subsequently the same prototype was subjected to the water immersion test described in para. 729. Therefore the staff concludes that requirements of para. 726 are met.</p>
727	<p>Mechanical test: The mechanical test consists of three different drop tests. Each specimen shall be subjected to the applicable drops as specified in para. 656 or para. 682. For details of Drop I, II, and III see TS-R-1.</p>	<p>Satisfied. The staff verified in the applicant supplied SAR Section 2.7, that the mechanical tests described as Drop I and Drop II, as specified in IAEA para. 727 were conducted as required. The staff concurs with the applicant that the Drop III test; dynamic crush test required per para. 727 is not applicable, since the package density is 1,884 kg/m<sup>3</sup></p>

		(which is in excess of 1,000 kg/m <sup>3</sup> ), and the radioactive contents are 1,000 A <sub>2</sub> , and are limited to special form only.
728(a)	Exposure of a specimen for a period of 30 minutes to a thermal environment which provides a heat flux at least equivalent to that of a hydrocarbon fuel/air fire in sufficiently quiescent ambient conditions to give a minimum average flame emissivity coefficient of 0.9 and an average temperature of at least 800 °C, fully engulfing the specimen, with a surface absorptivity coefficient of 0.8 or that value which the package may be demonstrated to possess if exposed to the fire specified, followed by:	<p>Satisfied. The staff verified in the applicant supplied SAR Sections 2.7.4 and 2.7.1, that the hypothetical accident thermal test was not conducted on the package, as required by para. 728(a). Instead, a detailed thermal evaluation has been presented in SAR Sections 3.5, 3.6.3, and 3.6.4.</p> <p>For the purpose of the structural evaluation it was assumed that the outer container was slightly deformed but the thermal ceramic insulator material was undamaged. The maximum stress of 7.05 MPa generated within the stainless steel at 800°C was still less than 11% of the yield strength of stainless steel at that temperature. Therefore, the staff concurs that structural requirements are met.</p>
728(b)	Exposure of the specimen to an ambient temperature of 38°C, subject to the solar insolation conditions specified in Table XI and subject to the design maximum rate of internal heat generation within the package by the radioactive contents for a sufficient period to ensure that temperatures in the specimen are everywhere decreasing and/or are approaching initial steady state conditions.	Satisfied. See SAR Section 3.6.3.
729	Water immersion test: The specimen shall be immersed under a head of water of at least 15 m for a period of not less than eight hours in the attitude which will lead to maximum damage. For demonstration purposes, an external gauge pressure of at least 150 kPa shall be considered to meet these conditions.	Satisfied. The actual test was not performed. However, the staff verified in the applicant supplied SAR Section 2.7.6 and SAR Appendix 2.12.8 that an evaluation was performed of the immersion test for the package under 15 meters of water (equivalent of 150 kPa). As the increased pressure resulting from this condition is merely 7% of the allowable collapsible pressure of the stainless steel housing, the staff concludes that the structural integrity of the inner container body will not be

		compromised, and the requirements of para. 729 are met.
806	<p>Each Type B(U) and Type C package design shall require unilateral approval, except that:</p> <p>(a) a package design for fissile material, which is also subject to paras. 812–814, shall require multilateral approval; and</p> <p>(b) a Type B(U) package design for low dispersible radioactive material shall require multilateral approval.</p>	Satisfied. Package does not require multilateral approval.
807	An application for approval shall include:	
807 (a)	a detailed description of the proposed radioactive contents with reference to their physical and chemical states and the nature of the radiation emitted;	Satisfied. See Section 1.0 of the SER and the ASPECT 12K Operating Manual.
807 (b)	a detailed statement of the design, including complete engineering drawings and schedules of materials and methods of manufacture;	Satisfied. See Section 1.0 of the SER. Complete engineering drawings are included in the SAR.
807 (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;	Satisfied. See SAR Section 2.0.
807 (d)	the proposed operating and maintenance instructions for the use of the packaging;	Satisfied. See Section 7.0 and 8.0 of the SER and the ASPECT 12K operating manual.
807 (e)	if the package is designed to have a maximum normal operating pressure in excess of 100 kPa gauge, a specification of the materials of manufacture of the containment system, the samples to be taken, and the tests to be made;	Satisfied. The package does not have a maximum normal operating pressure in excess of 100 kPa.
807 (g)	any special stowage provisions necessary to ensure the safe dissipation of heat from the package considering the various modes of transport to be used and type of conveyance or freight container;	Satisfied. The package does not need any special stowage provisions to ensure the safe dissipation of heat.
807 (h)	a reproducible illustration, not larger than 21 cm by 30 cm, showing the make-up of the package; and	Satisfied. See Section 1.0.
807 (i)	a specification of the applicable quality assurance program as required in para. 310.	Satisfied. Aspect Technologies Ltd. maintains a Quality Assurance (QA) program that meets the requirements of paragraph 310 of TS-R-1 as referenced in paragraph 13(a) of the

		PTNS regulations. IAEA Safety Series 113 was followed in the establishment of the program. All elements applicable to designers of transport packages have been included in the QA program per IAEA Safety Series 113 Table I.
808	The competent authority shall establish an approval certificate stating that the design meets requirements for Type B(U) or Type C packages and shall attribute an identification mark to the design.	Satisfied. Provided with CDN/2091/B(U)-96, Rev. 0.