

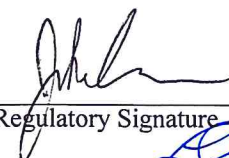




TYPE A Package Evaluation

1. Product Model/Description: Model Sentry Transport Packages (110, 330 and 867)		
2. Package Specifications/Limitations: Type B Co-60 Capacities: Sentry 110 Max Activity: 110 Ci Sentry 330 and 867 Max Activity: 330 Ci. Constructed in compliance with Drawing R86000.		
3. Source Assemblies Authorized for Transport		
Type A Approved Activity (Max.)	Isotope	Source Assembly Model Number
10.8 Ci (399.6 GBq)	Co-60, Special Form	A424-13, A424-14, 943, A424-15, or A424-18
4. References:		
<ul style="list-style-type: none"> • Drawings R86000 and R86060 • Test Plan Report 180 #1 01142010 • Test Plan Report 180 #2 04072010 • Test Plan Report 195 07212010 • Test Plan Report 178 • TP178A Profile Results 06021010 • Technical Report No 171 Sentry Transport Package Lifting Analysis 06302010 • Technical Report No 172 Sentry Transport Package Tie-Down Analysis 07212010 		
5. Maintenance and Operational Controls: MAN-038, MAN-039		
6. Max Weight of Package	605 lb. (274.4 kg) – Sentry 110 780 lb. (353.8 kg) – Sentry 330 or 867	

This is to certify that QSA Global Inc. has assessed the packaging and contents described above as complying with the relevant requirements of the International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Material, Safety Standards Series 1996 Edition (Revised) [No. TS-R-1], USDOT, 49 CFR Part 171, et al., effective 1 October 2004 and USNRC, 10 CFR Part 71, effective 1 October 2004.

It is the responsibility of the consignor to ensure that packaging conforms fully to the requirements of the design specification detailed in Section 2, that the contents are as specified in Section 3 and that the maintenance and operational control requirements specified in Sections 5 and 6 are met.

 _____ Regulatory Signature	<u>1/27/14</u> Date	 _____ Engineering Signature	<u>22 JAN 2014</u> Date
	 A.P.D. 1/28/14		



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7. General Requirements.

7-1. Handling:

The package must be easily handled and properly secured in or on a conveyance during transport.

* USDOT, 49 CFR 173.410 (a)

* IAEA TS-R-1, para. 606

Complies. The package can be easily handled using the Model 859 cart, lifted as evaluated in Technical Report 171, and properly secured during transport as evaluated in Technical Report 172.

7-2. Lifting Attachment:

Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three (3) against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting attachment under excessive load would not impair the ability of the package to meet other requirements. Any other structural part of the package which could be used to lift the package must be capable of being rendered inoperable for lifting during transport or must be designed with strength equivalent to that required for lifting attachments.

* USDOT, 49 CFR 173.410 (b)

* USNRC, 10 CFR 71.45 (a)

* IAEA TS-R-1, para. 607, 608

Complies. The package can be lifted without exceeding a safety factor of three (3) against yielding as evaluated in Technical Report 171.

7-3. Tie-down:

See the listed regulatory requirement for full details.

* USNRC, 10 CFR 71.45 (b) (1) (2) (3)

Complies. The package can be tied down as evaluated in Technical Report 172.

7-4. External Surface:

The external surface, as far as practicable, shall be free from protruding features and easily decontaminated.

* USDOT, 49 CFR 173.410 (c)

* IAEA TS-R-1, para. 609

Complies. The external surfaces are free from protruding features except for the handling rib assembly in the standard configuration. Since the rib assembly is used to facilitate handling, the design is free, as far as practicable, of protruding features. The metallic surface is easily decontaminated.

7-5. Outer Layer:

The outer layer, as far as practicable, shall be free pockets or crevices where water might collect.

* USDOT, 49 CFR 173.410 (d)

* IAEA TS-R-1, para. 610

Complies. In the standard and basic configurations there are no pockets or crevices on the outer layer where water might collect.



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7-6. Added Features:

Each feature that is added to the package will not reduce the safety of the package.

* USDOT, 49 CFR 173.410 (e)

* IAEA TS-R-1, para. 611

Complies. The rib/link assembly, which is optional, will not reduce the safety of the package during transport. In fact it provides protection and substantial impact energy absorption and will enhance the package's ability to meet the impact tests under normal and accident conditions of transport.

7-7. Vibration:

The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal 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 and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.

* USDOT, 49 CFR 173.410 (f)

* IAEA TS-R-1, para. 612

Complies. The test results in Test Plan Report 178 show the SENTRY package can safely withstand vibration that may arise under normal conditions of transport.

7-8. Seals:

Incorporates a feature, such as a seal, that is not readily breakable and that, while intact, would be evidence that the package has not been opened by unauthorized persons.

* USDOT, 49 CFR 173.412 (a)

* USNRC, 10 CFR 71.71 (b)

* IAEA TS-R-1, para. 635

Complies. The front plate outlet port of the Sentry 110 and Sentry 330 devices incorporate a seal wire attached to the locked protective cover which, if broken during transport, serves as evidence of possible unauthorized access to the contents. For the Sentry 867 (or alternatively for the Sentry 110 and Sentry 330 devices) a tamper indicating seal is attached to the lock plate assemblies as shown on drawing R86080.

7-9 External Radiation Levels:

Each package must be designed so that, under conditions normally incident to transportation, the radiation level does not exceed 200 mR/hr (2 mSv/hr) at any point on the external surface of the package and the transport index does not exceed 10, unless shipped exclusive use.

* USNRC, 10 CFR 71.47 (a)

* USDOT, 49 CFR 173.441 (a)

* IAEA TS-R-1, para. 531, 532

Complies. The Sentry 110 was designed to hold a maximum of 110 Ci of Co-60 without exceeding the transport dose rate limits. The Sentry 330 and 867 were designed to hold a maximum of 330 Ci of Co-60 without exceeding these limits. The limited quantities for Type A result in measured radiation levels well below the allowable transport limits and package surveys prior to shipment will prevent shipment of any package which does not meet the transport requirements.



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8. Additional Requirements.

8-1. Overall Size:

Smallest overall dimension must be 4 inches (10 cm) or greater.

- * USDOT, 49 CFR 173.412 (b)
- * USNRC, 10 CFR 71.43 (a)
- * IAEA TS-R-1, para. 634

Complies. In their basic configuration, all versions are cylindrical in shape, 12 ½ inches tall and 18 ½ inches in diameter. In the standard configuration, handling rib and link plates are added, resulting in dimensions of 19 ½ inches wide, 19 ½ inches tall and 19 ½ inches deep.

8-2. Tie-down:

Tie-down attachment that is a structural part of the package, under both normal and accident conditions, shall not impair the ability of the package to meet other requirements of the governing regulations.

- * USDOT, 49 CFR 173.412 (i)
- * IAEA TS-R-1, para. 636

Complies. See Section 7-3.

8-3. Containment:

- a. Containment and shielding is maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F). Attention shall be given to freezing temperatures for liquids and to the potential degradation of packaging materials within the given temperature range. The design of the package will take into account ambient temperatures and pressures that are likely to be encountered in routine conditions of transport. For radioactive material having other dangerous properties, the package design shall take into account those properties.

- * USDOT, 49 CFR 173.412 (c)
- * IAEA TS-R-1, para. 637, 615, 616

Complies. All SENTRY containment and shielding materials have continuous operating temperature ranges equal to or extending beyond -40C to +70C. Except for the sealed capsule, the remainder of the package is open to and will balance with ambient pressures occurring during normal conditions of transport. The sealed capsule is pressure tested to exceed pressures occurring during normal conditions of transport. See Section 8-3e.

- b. Containment system securely closed by a positive fastening device that cannot be opened unintentionally or by a pressure that may arise within the package.

- * USDOT, 49 CFR 173.412 (d)
- * USNRC, 10 CFR 71.43 (c)
- * IAEA TS-R-1, para. 639

Complies. The source capsule is closed by an airtight welded seal and attached to a wire assembly. The wire assembly is secured to the package by a lock mechanism during transport. Further the lock plate assemblies are secured to the devices using torqued security screws that cannot be removed unintentionally or by any pressure generated within the package.



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- c. 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.
 - * USDOT, 49 CFR 173.412 (d)
 - * IAEA TS-R-1, para. 641

Complies. The source capsule is closed by an airtight welded seal and attached to a wire assembly. The wire assembly is secured to the package by a lock mechanism during transport.

- d. Components 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.
 - * USDOT, 49 CFR 173.412 (e)
 - * IAEA TS-R-1, para. 642

Not Applicable. Radiolytic decomposition of liquids, other vulnerable materials and the generation of gas by chemical reaction and radiolysis are not applicable since fluids are not used in the package design and there are no known radiolytic decomposition reactions between materials of construction.

- e. The containment system shall retain its radioactive contents under a reduction of ambient pressure to 60 kPa (8.6 psi) (25 kPa for USDOT), (5 kPa for IAEA).
 - * USDOT, 49 CFR 173.412 (f)
 - * IAEA TS-R-1, para. 643
 - * IAEA TS-R-1, para. 619

Complies. The authorized contents are source capsules that have met the ANSI N43.6 and ISO 2919 classification of Class 3 for pressure. This classification is more limiting than the external pressure requirement as it covers 25 kN/m² to 2 MN/m².

- f. Packages containing liquids will be capable of withstanding, without leakage, an internal pressure that produces a differential of not less than 95 kPa (13.8 lb/in²).
 - * USDOT, 49 CFR 173.410 (i)(3)

Not Applicable. This package does not contain liquids.

- g. Packages containing liquids will either provide sufficient absorbent material to absorb twice the volume of the liquid contents or 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 containment even if the primary containment leaks.
 - * IAEA TS-R-1, para. 648(b)

Not Applicable. This package does not contain liquids.



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- h. Packages containing liquids will provide for ullage (the amount of liquid within a container that is lost, as by leakage, during shipment or storage) to accommodate variations in the temperature of the contents, dynamic effects and filling dynamics.
* IAEA TS-R-1, para. 647

Not Applicable. This package does not contain liquids.

- i. Packages containing gases (excluding tritium or noble gases) shall prevent loss or dispersal of the radioactive contents when subjected to the tests specified in para 725.
* IAEA TS-R-1, para. 649

Not Applicable. This package does not contain gases.

- j. Any radiation shield that encloses a component of the packaging specified as part of the containment system 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.
* USDOT, 49 CFR 173.412 (h)
* IAEA TS-R-1, para. 645

Complies. The source capsule containment vessel is closed by an airtight welded seal and attached to a wire assembly. The wire assembly is secured in the shield of the package by a lock mechanism positively fastened to the package. The locking mechanisms are independent of any other packaging structure.

8-4. Chemical Reaction:

Materials and construction assures no significant chemical, galvanic, or other reaction among contents and components of package, including possible reaction resulting from in leakage of water. Also consider behavior of materials under irradiation.

- * USDOT, 49 CFR 173.410 (g)
- * USNRC, 10 CFR 71.43 (d)
- * IAEA TS-R-1, para. 613

Complies. The safety related components of the package are constructed with stainless steel, titanium, depleted uranium, copper, and tungsten material. These materials have been used extensively in package designs with negligible chemical, galvanic, or irradiation reaction.

Copper separators are used between all depleted uranium and steel interfaces. The stainless steel capsule containment vessel contacts and does not react with titanium and other stainless steel components.

The non-safety related materials are brass, elastomer, and polyurethane foam. These materials are more susceptible to corrosion, chemical, and irradiation reaction than the safety materials but pose no threat to safety or containment. Lubricants, sealants, and other chemical ingredients used in the SENTRY transport package are reviewed to ensure they do not contain halides which could cause unexpected corrosion in normal transport and hypothetical accident conditions.



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8-5. Valves:

All valves, other than pressure relief valves, shall be provided with an enclosure to retain any leakage from the valve. If valve failure allows release of radioactive contents, then valve shall have protection from unauthorized operation.

- * USDOT, 49 CFR 173.412 (g), 173.410 (h)
- * USNRC, 10 CFR 71.43 (e)
- * IAEA TS-R-1, para. 614, 644

Not Applicable. There are no valves on or in the package.

8-6. Integrity:

Package must be designed, constructed, and prepared to ensure; no loss or dispersal of the radioactive contents, no more than a 20% increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging, when evaluated against the performance and test requirements.

- * USDOT, 49 CFR 173.412 (j) (1) (2)
- * USNRC, 10 CFR 71.43 (f)
- * IAEA TS-R-1, para. 646

Complies. The Model package designs were successfully tested/assessed to the physical testing Type A transport requirements (Test Plan 180 Report #1). Based on profile results performed after completion of testing, the Sentry style packages will meet the requirements of this section.

8-7. No Venting:

A package may not incorporate a feature intended to allow continuous venting during transport.

- * USNRC, 10 CFR 71.43 (h)

Complies. The SENTRY package does not require venting.

8-8. Air Transport

a. Package must be designed, constructed, and prepared for transport so that in still air at 38°C (100°F) and in the shade, no accessible surface of a package would have a temperature exceeding 50°C (122°F) in a nonexclusive use shipment, or 85°C (185°F) in an exclusive use shipment.

- * USDOT, 49 CFR 173.410 (i) (1)
- * USNRC, 10 CFR 71.43 (g), 71.71 (c)(1)
- * IAEA TS-R-1, para. 617

Complies. The maximum surface temperature in the shade under normal conditions of transport has been determined to be 41°C (106°F) for the SENTRY Models 110, 330, and 867 devices when loaded to 330 Ci of Co-60.



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- b. The integrity of containment will not be impaired if the package is exposed to ambient temperatures ranging from -40°C (-40°F) to 55°C (131°F).
 - * USDOT, 49 CFR 173.410 (i)(2)
 - * USNRC, 10 CFR 71.71 (c)(2)
 - * IAEA TS-R-1, para. 618

Complies. The materials used in the capsule, source wire, shield, rear plate, and welded body are capable of maintaining satisfactory performance during transport and storage from -40° C (-40° F) to 70° C (158° F).

8.9 Increased External Pressure

Evaluate the effects of an external pressure of an external pressure of 140 kPa (20 psia) on a package at an initial internal pressure at the minimum normal operating pressure and at a temperature between -20°F and 100°F most unfavorable to the package.

- * USNRC, 10 CFR 71.71 (c)(4)

Complies. The authorized contents are special form source capsules and have met the ANSI N43.6 and ISO 2919 classification of Class 3 for pressure. This classification is more limiting than the external pressure requirement as it covers 25 kN/m² to 2 MN/m². The remainder of the package is open to the atmosphere to allow pressure balance with varying external pressure at any temperature between -20°F and 100°F.

9. Test Requirements.

9-1. Water Spray Test:

Subject test specimen to a water spray that simulates exposure to rainfall of approximately 5 cm per hour for at least an hour. The free drop, stacking, and penetration test below are to be preceded in each case by the water spray test. Do not allow test specimen to dry before each test.

- * USDOT, 49 CFR 173.465 (b)
- * USNRC, 10 CFR 71.71 (c) (6)
- * IAEA TS-R-1, para. 721

Complies. All materials used in the construction of the SENTRY Models 110, 330 and 867 packages are water-resistant, thus the water spray test would not reduce the shielding effectiveness or structural integrity of the package.

9-2. Free Drop Test:

Subject the test specimen to drop onto a hard, flat, horizontal surface so as to suffer maximum damage in respect of the safety features to be tested. The height of the drop measured from the lowest point of the specimen to the upper surface of the target shall not be less than 1.2m (4 ft) for packages less than 5000 kg (11,000 lbs). See additional regulations for fissile and wood materials. Corner drops of 1 ft onto each corner of the package for cardboard packages.

- * USDOT, 49 CFR 173.465 (c)
- * USNRC, 10 CFR 71.71 (c) (7)
- * IAEA TS-R-1, para. 722

Complies. The test results in Test Plan 180 Report #1 show the SENTRY package can safely withstand the free drop test requirements described in Section 9-2.



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9-3. Stacking/Compression Test:

Subject the test specimen to a compressive load equal to 5 times the mass of the actual package for a period of 24 hours.

- * USDOT, 49 CFR 173.465 (d)
- * USNRC, 10 CFR 71.71 (c) (9)
- * IAEA TS-R-1, para. 723

Complies. The test results in Test Plan 180 Report #1 show the SENTRY package can safely withstand the stacking/compression test requirements described in Section 9-3.

9-4. Penetration Test:

Place the test specimen on a rigid, flat, horizontal surface which will not move significantly while the test is being carried out. Drop a bar, 6 kg (13.25 lb), 3.2 cm (1.26) diameter with hemispherical end, with its longitudinal axis vertical, onto the center of the weakest part of the specimen, so that, if it penetrates sufficiently far, it will hit the containment system. The height of drop measured from the bars lower end to the intended point of impact on the upper surface of the test specimen shall be 1 m (39.37 in).

- * USDOT, 49 CFR 173.465 (e)
- * USNRC, 10 CFR 71.71 (c) (10)
- * IAEA TS-R-1, para. 724

Complies. The test results in Test Plan 180 Report #1 show the SENTRY package can safely withstand the penetration test requirements described in Section 9-4.

9-5. Tests for Packages Containing Liquids and Gases:

- a. Subject the test specimen to drop onto a hard, flat, horizontal surface so as to suffer maximum damage in respect of the safety features to be tested. The height of the drop measured from the lowest point of the specimen to the upper surface of the target shall not be less than 9 m (30 ft).
 - * USDOT, 49 CFR 173.466 (a)(1)
 - * IAEA TS-R-1, para. 725(a)

Not Applicable. This package does not contain liquid or gases.

- b. Place the test specimen on a rigid, flat, horizontal surface which will not move significantly while the test is being carried out. Drop a bar, 6 kg (13.25 lb), 3.2 cm (1.26) diameter with hemispherical end, with its longitudinal axis vertical, onto the center of the weakest part of the specimen, so that, if it penetrates sufficiently far, it will hit the containment system. The height of drop measured from the bars lower end to the intended point of impact on the upper surface of the test specimen shall be 1.7 m (66.93 in).

- * USDOT, 49 CFR 173.466 (a)(2)
- * IAEA TS-R-1, para. 725(b)

Not Applicable. This package does not contain liquid or gases.