

RESUBMITTAL OF PRIOR APPLICATIONS  
AND SUPPLEMENTS FOR APPROVAL TO  
TRANSPORT THE SENTINEL - 25B  
RADIOISOTOPE THERMOELECTRIC GENERATOR  
AS A TYPE B( ) PACKAGE

TES-3209

AUGUST 1986

REVISION 1

OCTOBER 1986

 **TELEDYNE  
ENERGY SYSTEMS**

110 WEST TIMONIUM ROAD  
TIMONIUM, MARYLAND 21093

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PDR ADOCK 07104888  
PDR

PREFACE TO REVISION 1

Revision 1 is in response to a NRC request\* to supply component drawings for each of the Sentinel 25 series generators for the following components:

Shield Body  
Shield Plug  
Generator Housing (Shield Vessel)  
Generator Housing Lid (Shield Vessel Lid)

There was only one Sentinel (LCG) -25B unit constructed-unit SN-002 built in mid 1966. In response to the NRC request, a summary of the information provided for this unit follows:

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\* U.S. NRC Letter FCTC:CEW 71-4888, dated 23 September 1986 from Charles E. MacDonald to John W. McGrew (TES) with enclosure.

SENTINEL (LCG) -25B  
SN-002  
CONSTRUCTED MID 1966

<u>COMPONENT/ASSEMBLY</u>	<u>DRAWING NO.</u>	<u>REMARKS</u>
Top Assembly	N 00113200	Included w/August 1986 submittal
Shield Body	001-70024	Included w/Rev. 1
Shield Plug	001-70025, Detail 001	Included w/Rev. 1
Shield Specification (Tungsten Alloy)	001-80003	Included w/Rev. 1 (Appendix D)
Generator Housing (Shield Vessel)	001-70036 001-70033	Included w/Rev. 1, See text regarding removal of lifting lug
Cast Generator Housing Specification	001-80005	Included w/Rev 1 (Appendix D)
Generator Housing Lid (Shield Vessel Lid)	001-40012	Lid assembly drawing not available, this drawing shows cross section of cast head (to scale)

As cited above, the 25B unit was constructed in accordance with top assembly drawing N00113200. This drawing lists components of the unit in accordance with the Martin Marietta series N and PN numbering system. Specifically:

<u>COMPONENT</u>	<u>DWG. NO. (AS PER N 0013200)</u>
Shield Body	PN 1000005-003
Shield Plug	PN 1000005-001
Shield Vessel	N 0013213-001
Lid Assembly	N 0013208-009

In August 1968, the Martin Marietta Nuclear Division was acquired by Teledyne. Subsequently, many of the Martin-Marietta Series N and PN drawings for the Sentinel (LCG-25) units were reissued as Teledyne Series 001-drawings.

Our current investigations indicate that the tungsten alloy shield body and shield plug for the 25B unit were constructed to (reissued) drawings 001-70024 and 001-70025, Detail 001, respectively. The shield material is in accordance with shielding specification 001-80003 (included herein in Appendix D).

We believe that the cast iron housing (shield vessel) for the 25B unit was cast in accordance with Dwg. 001-70036 and was then machined to final dimensions to Dwg. 001-70033 with one exception. The lifting lug shown on 001-70033 to be removed applies for 25D units only (see note on drawing - "remove this ear"). This lug was retained for the 25B unit. All castings were in accordance with the shield body casting specification 001-80005 (included herein in Appendix D).

The lid assembly drawing (shield vessel lid), N0013208-009, is not available. We have included Dwg. 001-40012 (to scale) which shows a cross section and some other details of this assembly.

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	Appendix D: Specification for Shield and Shield Vessel Materials	D-1	R1 10/86

APPENDIX A  
DRAWING LIST  
(August 1986)

The following drawings are included with and form part of this report.

Fuel Capsule - All Sentinel (LCG) -25 units.  
Isotopes, Inc. Drawings:

001-20000	Fuel Capsule Assembly
001-20001	Housing
001-20002	End Cap
001-20003	Liner, Capsule

Sentinel (LCG) -25A  
Martin Co. Drawings:

N0013200	Generator Assembly, LCG-25B*
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Teledyne Drawings:

001-70024	Shield Body
001-70025, Sheet 1	Shield Plug
001-70033	Shield Vessel, Machined (sheets 1, 2)
000-70036	Casting, Shield Vessel
001-40012	Finned Radiator and Module Assembly, LCG-25B

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Shipping Pallet - All Sentinel (LCG) -25 units.

001-90039	Pallet Assembly (Sheets 1, 2, 3)
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\* Reduced size, not to scale.

APPENDIX D  
SPECIFICATIONS FOR SHIELD  
AND  
SHIELD VESSEL MATERIALS

Included herein are the specifications for:

	<u>Spec No., Title</u>
Tungsten Alloy, Shield Body and Shield Plug	001-80003, Shielding Specification
Generator Housing (Shield Vessel) Casting	001-80005, Specification, Shield Vessel Casting

SECURITY | UNCL. CONF. SECRET  
REVIEW | DI RD GP:1.2 3 4

CLASSIFIER *George J. Stivers 7/13/67*

This specification is to be used for material control only.



ISOTOPES  
NUCLEAR SYSTEMS DIVISION  
A TELEDYNE COMPANY

Beltsville, Maryland

DRAWN BY WILLIAMS JR. DATE 6-30-67  
CHECKER H. KELLY 7/13/67  
APPROVED A. J. Strob m. H.  
APPROVED SHIELDING A. M. SPANER 7/13/67

~~ISOTOPES CORPORATION~~  
~~A DIVISION OF TELEDYNE INTERNATIONAL CORPORATION~~  
~~TELEDYNE INTERNATIONAL AIRPORT, WASHINGTON, D.C.~~

# SHIELDING SPECIFICATION

MATERIAL	SIZE <b>A</b>	CODE IDENT NO. <b>30856</b> <del>12345</del>	<b>001-80003</b>
REV <b>E</b>	SCALE	SHEET <b>1</b> OF <b>7</b>	

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REVISIONS

SYM	PAGE	DESCRIPTION	DATE	APPROVED																		
A	5	Revised Table I; <u>WAS</u> <u>Temperature</u> <table border="1"> <thead> <tr> <th><u>Property</u></th> <th><u>70°F</u></th> <th><u>1500°F</u></th> </tr> </thead> <tbody> <tr> <td>0.2% Tensile Yield (PSI)</td> <td>75,000</td> <td>30,000</td> </tr> <tr> <td>0.2% Compressive Yield (PSI)</td> <td>75,000</td> <td>30,000</td> </tr> <tr> <td>Ultimate Tensile Strength (PSI)</td> <td>105,000</td> <td>45,000</td> </tr> <tr> <td>Ultimate Compressive Strength (PSI)</td> <td>105,000</td> <td>45,000</td> </tr> <tr> <td>Elongation at Fracture in Tensile Test (%)</td> <td>7</td> <td>5</td> </tr> </tbody> </table> Paragraph 3.4 <u>WAS</u> Martin <u>NOW</u> Isotopes Paragraph 4.3 <u>WAS</u> Martin Marietta Corporation <u>NOW</u> Isotopes Paragraph 6.1.2 <u>WAS</u> Martin <u>NOW</u> Isotopes	<u>Property</u>	<u>70°F</u>	<u>1500°F</u>	0.2% Tensile Yield (PSI)	75,000	30,000	0.2% Compressive Yield (PSI)	75,000	30,000	Ultimate Tensile Strength (PSI)	105,000	45,000	Ultimate Compressive Strength (PSI)	105,000	45,000	Elongation at Fracture in Tensile Test (%)	7	5	11/4/68	P. Aller PFA W.A.M
<u>Property</u>	<u>70°F</u>	<u>1500°F</u>																				
0.2% Tensile Yield (PSI)	75,000	30,000																				
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Elongation at Fracture in Tensile Test (%)	7	5																				
B	5	Elongation at Fracture in Tensile Test (%) <u>WAS</u> 7 <u>NOW</u> 5 ADDED PLATING CALLOUT & THICKNESS IN PARA. 9.3	12/2/68	P. Aller PFA W.A.M																		
C	8	Deleted 7.0 of 7, now 1.0 of 7. Added Approved Sources in SECTION 7.0	5-12-69	J. HINES Hines																		
D	6	Appropriate engineering drawing was para. 3.1 in para. 4.1 Add certification requirement in para. 4.3 3.2 was 3.1.1 in para. 4.4	2-20-71	025-011 J. HINES																		
D	7	Added "Powder Alloys" as approved source.	1-20-81	J. HINES 026-106																		

CODE IDENT NO.

30856

88597

SIZE

A

001-80003

CHG.

E

SCALE

PAGE

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1.0 SCOPE

1.1 Purpose - This specification establishes the requirement for the design and manufacture of the biological shield for a radioisotope fueled thermoelectric power generator. The shielding is required to limit the radiation from the generator assembly.

2.0 APPLICABLE DOCUMENTS

None

3.0 REQUIREMENTS

The design and construction of the shield shall be in accordance with the requirements of this specification and any referenced specifications or other documents specified herein.

3.1 Material - The shield pieces shall be fabricated from a tungsten alloy consisting primarily of tungsten with small additions of copper and nickel, or other metals as binding agents. The material shall be formed by powder metallurgy techniques.

3.1.1 Density - The shield pieces shall have a density at room temperature of not less than 16.9 grams per cubic centimeters (.611 pound per cubic inch).

3.1.2 Mechanical Properties - The material in the shield shall have the mechanical properties presented in Table I as a minimum.

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TABLE I (A)

Minimum Mechanical Properties

<u>Property</u>	<u>Temperature</u>	
	<u>70°F</u>	<u>1300°F</u>
0.2% Tensile Yield (psi)	75,000	25,500
0.2% Compressive Yield (psi)	75,000	25,500
Ultimate Tensile Strength (psi)	94,000	31,000
Ultimate Compressive Strength (psi)	94,000	31,000
Elongation at Fracture in Tensile Test (%) (B)	5	4

3.2 Tolerances - Tolerances not specified herein shall be held and limited to good commercial standards.

(B) 3.3 Oxidation Retarding Coating - The surfaces of the shield pieces shall be plated with chrome plate to a thickness of 4 to 6 mils. per standard plating processes.

(A) 3.4 Method of Assembly - Isotopes will provide Fe base super-alloy bolts to hold the shield plug onto the shield body and will assemble the shield in a hot cell following insertion of a radioisotope filled fuel capsule (Ni base super-alloy) into the shield body.

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3.5 Environment - The normal operating environment of the shield pieces will be as follows:

Temperature - 1200°F to 1600°F

Atmosphere - Argon - 99%

Balance - CO<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub>, N<sub>2</sub>.

The shield pieces will be operated in a sealed chamber. Under emergency conditions the environment of paragraph 3.3 may be experienced.

#### 4.0 QUALITY ASSURANCE PROVISIONS

4.1 Dimensions - The dimensions of the shield pieces will be checked for compliance with the appropriate engineering drawing.

4.2 Integrity of Oxidation Retarding Coating - The shield pieces will be inspected to determine the freedom of the oxidation resistance coating from disfiguration. Any disfiguration, and in particular nicks, scratches and blisters, discernible with unaided eye, shall be cause for rejection.

4.3 The average density of both shield pieces shall be measured by water displacement and weighing and recorded. The average density of the pieces, individually, shall be not less than 16.9 grams per cubic centimeter. If the average density of the piece is less than 16.9 grams per cubic centimeter, the part shall be rejected. Certification of density shall be transmitted with the shield pieces.

4.4 Material Strength Verification - Test data verifying the conformance of the material used in the shield pieces to the mechanical properties requirements at 70°F of paragraph 3.1.2 shall be transmitted with

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the shield pieces. Material property tests shall be run on test pieces that are fabricated from the same raw material lots and processed at the same time as the shield pieces.

4.4.1 Vendor shall submit the test procedures along with the test results.

4.5 Vendor shall submit certification of material composition with the pieces.

5.0 PREPARATION FOR DELIVERY - Preparation for delivery shall be in accordance with best commercial practices with particular care taken to insure that the oxidation retarding coating is not nicked or marred during transportation.

6.0 NOTES

6.1 Definitions

6.1.1 Manufacturer or Vendor - The manufacturer or vendor shall be the industrial organization awarded the procurement agreement of which this specification becomes a part.

Ⓐ 6.1.2 Isotopes - Isotopes shall be Teledyne Isotopes, Nuclear Systems Division, 110 W. Timonium Rd., Timonium, Md. 21093.

Ⓒ 7.0 APPROVED SOURCES

1. Sylvania Electric Products, Inc.  
Chemical and Metallurgical Division  
Towanda, Pennsylvania 18848

2. Kennametal, Inc.  
Latrobe, Pennsylvania 15650

Ⓔ 3. Powder Alloys  
Clifton, New Jersey 07013

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REVISIONS: SEE SHEET 2

REV LEVEL

DWG	THIS SHEET

*George J. Thomas*  
 5/29/68  
 CLASSIFIER  
 SECURITY | UNCL CONF. SECRET  
 REVIEW DI RD GP: 1 2 3 4



ISOTOPES  
 NUCLEAR SYSTEMS DIVISION  
 ATELEDYNE COMPANY BALTIMORE, MD.

EFFECTIVE ON	CALC WT	DASH NUMBER	NEXT ASSEMBLY	USED ON	NEXT ASSY	FINAL ASSY	TEST	
APPLICATION						QTY REQD		

CONTRACT NO.  
 DRAWN BY: *KELLY* DEPT: *1534* DATE: *5/29/68*  
 CHECKER  
 APPROVED: *W. McDonald*  
 CUST REP

**MARTIN MARIETTA CORPORATION**  
 BALTIMORE, MARYLAND 21203  
**SPECIFICATION**  
**SHIELD VESSEL CASTING**  
 SIZE: **A** CODE IDENT NO.: **001-80005**  
 SCALE: SHEET 1 OF 8

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1.0 Scope

This specification covers the casting and inspection of an iron biological shield for either a surface or an underwater radioisotope thermoelectric generator pressure vessel.

2.0 Applicable Documents

2.1 The following documents form a part of this specification to the extent specified herein.

- a.) Federal Specification QQ-I-652b, "Iron Castings, Gray".
- b.) ASTM Specification A48-64, "Standard Specification for Gray Iron Castings".

3.0 Requirements

3.1 General Casting Requirements

3.1.1 The cast parts shall meet the requirements of Federal Specification QQ-I-652b, Class 40 and ASTM Specification A48-64, Gray Iron Castings, ASTM Designation A48, Class 40B, and shall be fabricated and controlled to the Meehanite process or equivalent and Meehanite recommendations for pressure tight castings. This casting is the equivalent of Meehanite GC type. (Equivalency of process and control shall be determined by Isotopes Engineering Department)

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3.1.2 No chaplets are permitted.

3.1.3 The castings shall be cleaned by sand blasting or an equivalent method.

3.1.4 All burns, fins, sharp edges, etc., are to be ground off flush with the contour.

3.1.5 The castings shall be uniform in quality and condition, free from foreign material and from internal and/or external defects detrimental to performance. Defects revealed by machining which adversely affect the performance of the casting shall be cause for rejection. Minor voids, not exceeding 0.15 (5/32) inch in depth on as cast surfaces, or exposed by machining in non-critical areas shall be blended in.

### 3.1.6 Critical Areas

3.1.6.1 The tops of the side walls (Surface A) in which "O" ring seal grooves will be machined, must be free from all visible voids, blemishes, and inclusions.

3.1.6.2 All areas within two (2) inches of all lifting lugs and attachment holes (9 places) shall be free of cracks as proven by dry powder or die check method.

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3.1.7 The vessel shall be cast in such a manner as to permit the use of the casting in either of the environments of paragraph 3.3.

3.1.8 The casting shall be stress relieved by the vendor according to a schedule approved by Isotopes.

### 3.2 Description

See Drawing 001-70036

### 3.3 Environment and Use

The castings are to be used to form an undersea pressure vessel which shall be fabricated so as to operate successfully in the following environments:

3.3.1 Temperature: 0°F to 200°F.

3.3.2 Pressure: 1.5 atmosphere on the inside, and either ambient etc. up to 1500 psi hydrostatic pressure on the outside.

3.3.3 Atmosphere: Argon inside, seawater or ambient air outside.

### 4.0 Quality Control Provisions

4.1 General - Certification shall be furnished by the Vendor stating that the material has been sampled, tested and inspected in accordance with the provisions of ASTM-A48-64 and this specification. In addition, the Vendor shall furnish with this certification the results

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4.1 General (cont'd)

of the tests required by paragraph 4.3 of this specification.

4.2 Test Bars - The Vendor shall furnish with each casting, or each melt, two cast test bars. Test bars shall be processed in accordance with ASTM-A48-64.

4.3 Vendor Tests - The Vendor shall perform the following tests and shall furnish copies of test results to Isotopes with each casting.

4.3.1 The casting shall be checked for dimensional conformance to drawing. Deviation shall be cause for rejection.

4.3.2 A general visual inspection of the casting shall be made for conformance with the requirements of paragraph 3.1 of this specification.

4.3.3 All areas in vicinity of surfaces designated critical by paragraph 3.1.6 shall be inspected by the dry powder or dye check method for conformance to paragraph 3.1.5. Deviation shall be cause for rejection.

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4.4 Defects revealed by machining at Isotopes that are detrimental to the performance of the casting shall be cause for rejection.

4.5 If the casting shall leak or exhibit "weeping" when subjected to the hydrostatic tests required to meet requirements of paragraph 3.3.2, the casting shall be rejected if the leak is attributable to a casting defect.

Isotopes will perform this test.

#### 5.0 Notes

##### 5.1 Definitions

5.1.1 Vendor - The Vendor shall be the industrial organization awarded the procurement agreement of which this specification becomes a part.

5.1.2 Isotopes shall be Isotopes, Nuclear Systems Division, P.O. Box 4937, Middle River, Maryland 21220.

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