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

TES-3206

AUGUST 1986

REVISION 1

OCTOBER 1986

TELEDYNE
ENERGY SYSTEMS

110 WEST TIMONIUM ROAD
TIMONIUM, MARYLAND 21093

R1
10/86

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 were only two Sentinel (LCG) - 25A units constructed. The first, SN-001, was built in early 1966 for the Navy and was installed on Fairway Rock, Alaska. The unit is still at this location. The second, SN-004, was built in mid 1968 and is currently located at Burnt Mountain, Alaska. It is currently owned by the U.S. Air Force. For SN-004, the construction details of the thermoelectric (T/E) module were modified (as described below). In response to the NRC request, a summary of the information provided herein follows:

* 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) - 25A

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ORIGINAL UNIT SERIAL NO.	OWNER	CURRENT LOCATION	CONSTRUCTION DATE
001	U.S. Navy	Fairway Rock, Alaska	Early 1966
004	U.S. Air Force	Burnt Mountain, Alaska	Mid 1968

SN-001:

COMPONENT/ASSEMBLY	DRAWING NO.	REMARKS
Top Assembly	N0013100	Included w/August 1986 submittal
Shield Body	001-70024	Included w/Rev. 1
Shield Plug	001-70025, Detail 001	Included w/Rev. 1
Shielding 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.
Generator Housing Lid (Shield Vessel Lid)	N-13107-009	Not available - see text
Cast Generator Housing Specification	001-80005	Included w/Rev. 1, (Appendix D)

SENTINEL (LCG) -25A (Continued)

SN-004:

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COMPONENT/ASSEMBLY	DRAWING NO.	REMARKS
Top Assembly	001-10000	Included w/Rev. 1
Shield Body	001-70024	Included w/Rev. 1
Shield Plug	001-70025, Detail 001	Included w/Rev. 1
Shielding 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
Generator Housing Lid	001-40000	Not Available, see text
Cast Generator Housing Specification	001-80005	Included w/Rev. 1, (Appendix D)

Our current investigations indicate that SN-001 was constructed in accordance with Top Assembly Dwg. N00113100. This drawing was the one submitted with the original license application (circa 1965). A distinctive feature of this first unit is that the T/E elements were installed into the generator housing lid assembly (as shown on N0013100). For SN-004, the design was revised such that the T/E elements were installed in a separate assembly with a bellows seal. The lid assembly was then modified to accept the new module assembly (T/E elements within bellows). The module assembly fit within a recessed portion of the lid assembly - see Top Assembly Dwg. No. 001-10000.

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. Not all drawings were reissued; one example being the Top Assembly Dwg. for SN-001 (N0013100). However, our current investigations indicate that the tungsten alloy shield body and shield plug for both 25A units were constructed to (reissued) Dwgs. 001-70024 and 001-70025, Detail 001, respectively. The shield material is in accordance with shielding specification 001-80003 (included herein in Appendix D).

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With regard to the generator housing (shield vessel), the Top Assembly Dwg. for SN-001 cites Dwg. N-0013113 whereas the Top Assembly Dwg. for SN-004 cites Dwg. N0013213. Whether or not there were actually two drawings is unknown - the difference could have been a drawing error or a change in the part numbering system. Neither N0013113 nor N0013213 could be located. However, we believe that all cast iron housings were cast in accordance with Dwg. 001-70036 and were 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 - "remove this ear"). These lugs were retained for both the 25A and 25B units. All castings were in accordance with the shield body casting specification 001-80005 (included herein in Appendix D).

The generator housing (shield vessel) lid for SN-004 was constructed to Dwg. 001-40000. The lid assembly drawing for SN-001 cited as N-13107-009 (Module Assembly) on Top Assembly Dwg. N0013100 could not be located.

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10	Report from Supplier of Tungsten Alloy Shield - "Chemical and Metallurgical Laboratory Report No. A-401," M. Simon, Kennemetal, Inc., Latroke, Pa., October 22, 1965		
11	Calculation of Maximum Fuel Core Temperature, LCG-25A		

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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, Sheet 1	Liner, Capsule

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

N0013100	Generator Assembly, LCG-25
N0013108	Fuel Capsule Assembly

Teledyne Drawings:

001-10000	Generator Assembly - LCG 25A
001-70024	Shield Body
001-70025, Sheet 1	Shield Plug
001-70033	Shield Vessel Machined (Sheets 1, 2)
001-70036	Casting, Shield Vessel
001-40000	Lid Assembly

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Shipping Pallet - all Sentinel (LCG) -25 units

001-90039	Pallet Assembly (Sheets 1, 2, 3)

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APPENDIX D

SPECIFICATIONS FOR SHIELD AND SHIELD VESSEL MATERIALS

Included herein are the specifications for:

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

SECURITY REVIEW | (UNCL.) CONF. SECRET
DI RD GP: 1 2 3 4
CLASSIFIER George J Stevens 7/13/67

This specification is to be used for material control only.

ISOTOPES
NUCLEAR SYSTEMS DIVISION
A TELEDYNE COMPANY
Baltimore, Maryland

DRAWN BY	DATE
W. Miller Jr.	6-30-67
CHECKER	
H KELLY	7/13/67
APPROVED	
A.J. Stolb	m.H.
APPROVED SHIELDING	
A.M. SPARER	7/13/67

[redacted] INTERNATIONAL AIRPORT, [redacted]

SHIELDING SPECIFICATION

MATERIAL	SIZE	CODE IDENT NO.	
REV E	A	30856 [redacted]	001-80003
	SCALE		SHEET 1 OF 1

005-30/007-35 | 005-6 | 007-12 | 001-32 | 001-10 FORM MH-1112A (12-65)

REVISIONS

SYM	PAGE	DESCRIPTION	DATE	APPROVED
A	5	Revised Table I; WAS Property / Temperature 70°F / 1500°F 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 Paragraph 3.4 WAS Martin NOW Isotopes 6 Paragraph 4.3 WAS Martin Marietta Corporation NOW Isotopes 7 Paragraph 6.1.2 WAS Martin NOW Isotopes	11/4/68	P. Aller PFA W.A.M
B	5	Elongation at Fracture in Tensile Test (%) WAS 7 NOW 5 ADDED PLATING CALLOUT & THICKNESS IN PARA. 3.3	12/2/68	P. Aller PFA W.A.M
C	8	[illegible] Added Approved Sources IN SECTION 7.0	5-12-69	J.HIMES Hodges
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	625-011 J.HIMES
D	7	Added "Powder Alloys" as approved source.	1-20-81	J.HIMES 026-006

CHG. E

CODE IDENT NO. 30856 18597

SIZE A

001-80003

SCALE

PAGE 2

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SHEET	REV	SHEET	REV	SHEET	REV
1	A, B, D, E				
2	A, B, D, E				
3	A, B, D, E				
4					
5	A, B				
6	A, D				
7	A, C, E				

REV	SIZE	CODE IDENT NO.	
D	A	30856	001-80003

SCALE

SHEET 3

FORM MM-1112 (12-65)

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.

TABLE I (A)

Minimum Mechanical Properties

Property	Temperature 70°F	1300°F
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.

3.3 Oxidation Retarding Coating - The surfaces of the shield pieces (B) 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 (A) 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.

REV	SIZE	CODE IDENT NO.	
	A	30856	001-80003
	SCALE		SHEET 5

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_2, O_2, H_2, N_2.

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

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.

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

(C) 7.0 APPROVED SOURCES

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

2. Kennametal, Inc.
   Latrobe, Pennsylvania 15650

(E) 3. Powder Alloys
   Clifton, New Jersey 07013

REVISIONS: SEE SHEET 2	REV LEVEL	
	DWG	THIS SHEET

SECURITY CLASSIFICATION: UNCL. CONF. SECRET
REVIEW DI RD GR: 1 2 3 4
CLASSIFIER 5/29/68

ISOTOPES
NUCLEAR SYSTEMS DIVISION
A TELEDYNE COMPANY BALTIMORE, MD.

EFFECTIVE ON	CALC WT	DASH NUMBER	NEXT ASSEMBLY	USED ON	NEXT ASSY	FINAL ASSY	TEST
			APPLICATION		QTY REQ'D		

CONTRACT NO.

DRAWN BY KELLY DEPT 1534 DATE 5/29/68

CHECKER

APPROVED J. McDonald

CUST REP

MARTIN MARIETTA CORPORATION
BALTIMORE, MARYLAND 21203

SPECIFICATION
SHIELD VESSEL CASTING

SIZE A

CODE IDENT NO. [redacted] 50856

001-80005

SCALE

SHEET 1 OF 8

001-27

FORM MM-1110 (6/67)

REVISIONS

SYM	PAGE	DESCRIPTION	DATE	APPROVED

CHG.	CODE IDENT NO.	SIZE	
	38597	A	001-80005
	SCALE		PAGE 2

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PAGE	CHG.	PAGE	CHG.	PAGE	CHG.

CHG	CODE IDENT NO.	SIZE	
	38597	A	001-80005
	SCALE	SHEET	PAGE 3

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)

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.

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 [redacted] 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

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.

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.