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LOCKHEED MARTIN

May 21, 1996

95-61

U.S. Nuclear Regulatory Commission
License Fee & Collection Department
P.O. Box 95414
St. Louis, MO. 63195-4514

RE: Registry numbers: NR-313-D-102-S
NR-313-D-101-S — ? Custom [illegible]

Dear Nuclear Regulatory Commission:

As a result of the recent merger of Loral Aerospace Corporation with Lockheed Martin Corporation, Loral Aeronutronic was renamed and is now Lockheed Martin Aeronutronic. This change was effective April 29, 1996. The legal entity remains unchanged. Lockheed Martin Aerontronic is a division of Lockheed Martin Tactical Systems, Inc., a wholly-owned subsidiary of Lockheed Martin Corporation.

Please accept this correspondence as official notification of the name change and amend your records to reflect these changes. All other pertinent information, i.e., facility address, mailing address, contact persons etc., remain the same.

If you have any questions or require additional information please call the undersigned at (714) 459-3561 or Rick Mounts at (714) 459-4207. Thank you for your continued support.

Sincerely,

Heidi Fowers

Heidi Fowers
Environmental Safety & Health

Lockheed Martin Aeronutronic
29947 Avenida De Las Banderas P.O. Box 7004
Rancho Santa Margarita, CA 92688-7004

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63195-4514

SECTION ONE SUMMARY DATA

1.1 Date: 8 September, 1988

1.2 Applicant:

Ford Aerospace Corporation Aeronutronic Division Ford Road Newport Beach California 92658	Contact: R. A. Macare F/A-18 FLIR LTD/R Deputy Technical Manager Phone (714) 720-5008

1.3 Device Type: Laser Transceiver Containing Two (2) Americium-241 Sealed Sources @ 4+/- 0.5 Microcuries Each

1.4 Model: Type 117 Laser Designator
Ferranti Drawing 3280/39000

1.5 Other Companies Involved:

a. Amersham International Limited White Lion Road Amersham Buckinghamshire HP7 9LL	Manufacturer of Sealed Source Housing
b. Ferranti Defence Systems Ltd Laser Systems Group Electro-Optics Department Robertson Avenue Edinburgh EH11 1PX U.K.	Subcontractor to McDonnell Douglas Corp. to provide Laser Target Designator/ Ranger
c. McDonnell Douglas Aircraft Corp Box 516 Saint Louis Missouri 63166	Prime Contractor to U.S. Navy
d. U.S. Navy	Customer

1.6 Radioactive sealed source model designation:

a. Americium-241 foil in a sealed source housing
b. Manufacturer: Amersham International Plc
Lincoln Place Green End
Aylesbury
Buckinghamshire HP202TP
U.K.

c. Model Number: AMM. 1001H
d. NRC Certificate of Registration: NR-136-S-174-U
e. Source Housing No. 3280-38214

1.7 Radionuclide and Maximum Activity:

Radionuclide: Americium-241
Maximum Activity: 4)Ci per sealed source

1.8 Leak-test Frequency: Periodic leak testing is not proposed following transfer to the U.S. Navy as each source contains less than 10)Ci of Americium-241. Leak testing is to be accomplished immediately prior to transfer to the U.S. Navy in accordance with requirements of 10 CFR PART 31.

1.9 Principal Use Code: Use Code 0 - The radioactive source is used as an ion-generating source within the device to eliminate static electricity on the laser Q-Switch crystal.

Type of license under which device will be used:

Ford Aerospace possesses a specific California Radioactive Materials License Number 0167-30, Amendments 50 and 51, to "receive, use, possess, transfer or dispose" of AM-241 foil sources, (Amersham Model AMM of less than 26) microCurie each and never totaling more than 2.6) milliCurie, to any other organization currently possessing either an Agreement State specific radioactive materials license that authorizes that organization to possess AM-241 foil sources less than 26 microCurie each.

The sources incorporated within the Laser Transceiver may be transferred to the U.S. Navy under its broad-scope license for radioactive sources. With the registration of the device as described herein, Ford Aerospace Corporation anticipates a Nuclear Radiation Materials Permit will be issued by the U.S. Navy Radiological Affairs Safety Officer (RASO) in response to a request by NAVAIR to allow receipt of the device for use within/aboard the U.S. Navy/Marine Corps F/A-18 fighter aircraft.

1.10 Custom device: Yes.

1.11 Custom User: United States Navy for use on board the F/A-18 aircraft, within the Laser Target Designator/Ranger FLIR Pod; AN/AAS-38A.

SECTION TWO SUMMARY DESCRIPTION

2.1 Written Description

a. Nature and Intended Purpose

The device is the Ferranti Laser Target Designator/Rangefinder (LTD/R) which is fitted into the Ford Aerospace F/A-18 FLIR Pod (See Figure One) to provide target range and designation capability. The laser consists of two Weapon Replaceable Assemblies (WRAs); the Laser Transceiver (LTR) henceforth called the device, Part Number 3280/39001 (See Figure Two) and the Laser Power Supply (LPS), Part Number 3280/39002. The LTD/R, in conjunction with the FLIR Pod, will provide the F/A-18 Hornet with a 24-hour adverse weather strike capability. This is in support of the United States Navy/Marine Corps requirement for carrier based attack aircraft to perform interdiction and close air support missions. The laser will provide weapon guidance in the form of target designation and range information.

In order to ensure proper operation of the laser, two Americium-241 sealed sources are used to provide a source of free positive and negative ions for application to the end surfaces of the Laser Q-Switch crystal. The crystal (lithium niobate) possesses the physical property of static charge generation upon the crystal surface when the crystal is subjected to temperature variations as experienced within pre-delivery testing as well as actual operational use of the laser within the Laser Target Designator/Range FLIR pod, AN/AAS-38A. The positive and negative ions neutralize the static charge buildup on the surfaces of the Q-Switch, permitting it to maintain its large characteristic discrimination ratio. This characteristic is fundamental to the proper operation of the laser.

b. Materials and Construction

The LTR is an electro-optic assembly which produces intense pulses of laser radiation. It comprises a stiff aluminum chassis which forms the compartment into which the laser optics and the sealed source housings are fitted. The chassis also houses high voltage and very sensitive electronic assemblies. The laser optics are precision parts and require special consideration for their reliable performance. The compartment (laser optical module) which houses them is clean, sealed against the ingress at moisture and is filled with very dry nitrogen.

The LTR is a Replaceable Weapon Assembly located during service conditions inside the FLIR Pod which itself is carried on the underside of a military aircraft. The aircraft is distributed world-wide and is supported at various locations both on land and at sea.

c. Methods of Assembly and Attachment

The laser optical module contains two static eliminating sources used to remove charge from a crystal surface. Figure Three shows the dimensions of the optical module with the sealed source with its protective grill and stud-like outer housing which provide for its permanent attachment on the inside of the optical compartment. The source is qualified to the performance specified on the drawing. The combination of the manufacturer's sealed source, the integral ruggedised housing, the substantial outer chassis and the application of the ALARA philosophy together, make the low-level radiation externally undetectable.

d. Chemical and Physical Form of Radioactive Material

The Americium-241 is in the form of an alpha emitting foil. The radioactive material is in a gold matrix. This is contained between a gold/palladium alloy front cover and a silver backing. The front face of the foil is thick enough to allow efficient emission of the alpha radiation. The foil emits alpha radiation from one side.

e. Materials of Construction

The foil is mounted in a metal holder made of Stainless Steel and, as such, is classified a sealed source. The sealed source is mounted in a housing made of stainless steel and covered by a stainless steel protective grill. Further details are supplied in the Engineering Drawing (See Figure Four).

f. Dimensions

Dimensions of foil: 5 millimetres in diameter
0.2 millimetres thick
Dimensions of a sealed source: shown in Engineering Drawing (See Figure Four).
Dimensions of sealed source housing: shown in Engineering Drawing (See Figure Four).

g. Methods of Fabricating and Sealing the Source

The foil is manufactured by Amersham International as follows:

The radionuclide, in the form of Americium Oxide, is uniformly mixed with gold, formed into a briquette and sintered a greater than 800°C. The briquette is then mounted between a backing of silver and a front cover of gold/palladium alloy and sealed by hot forging.

The composite briquette is cold rolled in several stages to yield the required active and overall areas. During this process the front cover is reduced in thickness to 0.002-0.003 mm and the metal layers are consolidated to produce a single strip of metal approximately 0.2mm thick (See Figure Five). The foils are normally in one metre lengths and are subdivided by punching into circular discs of 5 mm in diameter (See Figure Six). The discs are mounted in stainless steel holders having a metal rim which is rolled over to seal the cut edges of the foil completely. The source is then a sealed source.

h. <u>Radioactive Source Classification</u>

The ISO 2919 Classification is CXX4X4.

Full descriptions of this classification are contained within Section 3.4 of this application.

SECTION THREE DETAILS ON CONSTRUCTION AND USE

3.1 Conditions of Use

a. Planned Use of Device

The device is part of the Ford Aerospace Forward Looking Infrared (FLIR) pod. The LTD/R FLIR pod is an optional payload of the U.S. Navy Type F/18 aircraft which is deployed by the Navy worldwide on carriers and at fixed bases. The device is therefore subjected to a military aircraft environment and this is described in a traditional way by military specifications.

The high and low temperatures are +95°C and -62°C respectively. The vibration envelope is controlled by an antivibration mount into which the laser transceiver is secured. Appendix B identifies the acceleration versus frequency which the device must endure. Atmospheric conditions do not affect the device due to its sealed construction. The device is expected to have a service life of 15 years.

b. Extremes of Environment Which Device is Designed to Withstand

Temperature-Altitude in Accordance with MIL-T-5422

Cold Storage:	-62°C
High Temp Storage:	+95°C
Altitude:	70000 ft @ -54°C
	70000 ft @ +10°C
	to 50000 ft @ +61°C
	in 2 mins.

Vibration

Low Frequency Sinusoidal:	5-50-5 Hz cycle
	Performance Level - 3g max
	Endurance Level - 4g max
High Frequency Random:	50-2000 Hz
	Performance Level - 0.01 g^2/Hz max
	- 3.2 g R.M.S.
	Endurance Level - 0.02 g^2/Hz max
	- 6.0 g R.M.S.
Gunfire Vibration:	1.7 g max over the range 100-1000 Hz

Shock

Lateral/Vertical Axes:	11g peak 17 ms duration
	16g peak 30 ms duration
Longitudinal Axes:	22g peak 11 ms duration
	10g peak 30 ms duration

All 1/2 sine wave.
Three shocks in each direction, selected from those above.

Additional environments the device (Laser Transceiver) is designed to withstand, but not tested to, since the device is contained within an environmental controlled cavity of the AN/AAS-38A FLIR pod, are:

1. Humidity. Humidity conditions in accordance with paragraph 3.2.24.4 of MIL-E-5400 shall be applicable. The equipment shall be designed to withstand humidity tests in accordance with procedure 4.4 of MIL-T-5422 or method 106 of MIL-STD-202.

2. Salt Fog. Salt fog conditions in accordance with paragraph 3.2.24.9 of MIL-E-5400 shall be applicable. The equipment shall withstand salt fog tests in accordance with procedure 4.5 of MIL-T-5422 or method 101 of MIL-STD-202.

3. Explosion. Explosion conditions in accordance with paragraph 3.2.24.10 of MIL-E-5400 shall be applicable. The equipment shall withstand explosion tests in accordance with procedure 4.6 of MIL-T-5422 or method 109 of MIL-STD-202.

4. Sand and Dust. Sand and dust conditions in accordance with paragraph 3.2.24.7 of MIL-E-5400 or method 110 of MIL-STD-202 shall be applicable.

5. Fungus. Fungus conditions in accordance with paragraph 3.2.24.8 of MIL-E-5400 shall be applicable. The equipment shall withstand fungus tests in accordance with test procedure 4.8 of MIL-T-5422 or method 508 of MIL-STD-810 except that in lieu of such testing certification of the use of only non-nutrient material in accordance with requirement 4, paragraph 3.2 of MIL-STD-454 shall constitute compliance with the fungus environmental design requirements.

6. <u>Acoustic noise susceptibility</u>. When installed in the pod, the device shall meet the specified performance requirements when the pod is subjected to acoustic noise in accordance with MIL-STD-810, method 515.2, procedure II with the following modifications:

Frequency spectrum:	MDC A3376 Zone 7 including the entire octave band spectrum indicated therein	
Overall external Acoustic levels	Endurance	160 dB
	Performance	154 dB
Exposure times	Endurance	MDC A3376 Zone 6 45 min
	Performance	30 min

7. <u>Electromagnetic interference and compatibility (EMIC)</u>. The device shall comply with the requirements of MIL-STD-461A notice 3 to the extent specified herein.

CE03 Power Line Conducted 20 kHz to 50 MHz
Primary Power Leads

CE04 Control and Signal Leads

CS01 Conducted Susceptibility 30 Hz to 50 kHz
Primary Power Leads

CS02 Conducted Susceptibility 50 kHz to 400 MHz
Primary Power Leads

CS06 Spike Susceptibility 10)sec, 100v peak
Primary Power Leads

RE02 Radiated Emission 14 kHz to 10 GHz

RS03 Radiated Susceptibility:

14 kHz - 35 MHz 10 V/m
35 MHz - 10 GHz 5 V/m

RS02-2 Magnetic Induction Field

REOI The device shall not generate more than 20 mv into a 6 turn 5 inch diameter loop positioned plane parallel to and 1 inch away from any position from the external surface of the LPS, LTR and PFN cases.

Spike Emission: Spikes (transients of duration less than 500 microseconds) generated by the equipment shall not exceed the following values when measured from the base of the transient.

a. 115 VAC primary power lines plus or minus 60 volts

Notes:
1. Laser Arm/Fire circuits shall have a minimum of 6 dB safety factor for CS01, CS02, CS06, RS02 and RS03.
2. The limits of Method RS02(a) and (b) shall apply except that the voltage spike for part (b) shall be 400 volts across 5 ohms.
3. RS03 shall include CW and worst case modulation.

A full description of environmental test conditions which the device is required to meet is given in Appendix B.

c. <u>Type of User and Locations of Use</u>

The laser device is one of twelve Weapon Replaceable Assemblies (WRA) comprising the Laser Target Designator/Ranger FLIR pod (AN/AAS-38A). The Laser WRA is contained within a cavity of the Pod Forward Section WRA and when assembled with all pod WRAs comprise a targeting pod which, in operational use, is attached to the F/A-18 aircraft on the outer surface of the left engine inlet. The F/A-18 aircraft is deployed at sea and ashore throughout the world at U.S. Navy and Marine Corps Air Stations. The governments of Canada, Australia and Spain have also procured the F/A-18 aircraft and have expressed interest in procurement of the AN/AAS-38A to supplement their fleet capabilities . As the F/A-18 program matures it is anticipated that additional sales will be made to other foreign governments friendly to the United States.

3.2 Details of Construction

3.2.1 Device

Figure Three shows an isometric view of the laser transceiver with the cover plate which contains the sources clearly marked. The essential part of the laser transceiver is the Optical Module, which contains the optical elements of the laser. The Optical Module has a closure plate which compresses an "o" ring to hermetically seal the compartment. A dessiccator keeps the internal dew point to less than -30°C. The orthographic assembly drawing of the Optical Module cover shows two static eliminating sources fixed in position. A second orthographic drawing (See Figure Four) shows the detail of the source housing.

The construction employs an aluminium chassis which is machined from a billet of controlled material and which is described as an "Aircraft Standard Part". Mechanical strength is provided to the trunion mountings by substantial chassis sections. However, elsewhere the Optical Module wall thickness is reduced locally to a minimum of 0.060". Outside dimensions of the Optical Module are shown on the drawing.

The primary active source is a foil. The foil is mechanically constrained by crimping the edge of the holder over the foil edge. A protective stainless mesh prevents the inadvertent puncture of the foil and this is contained as part of a ruggedised outer housing. The outer housing has surfaces inscribed with the sealed source characteristics. Attachment of the source to the Optical Module cover is achieved by its integral threaded stud. Positive locking of the two items together is provided by a fillet of adhesive.

There is no access to the sources when the device is complete.

3.2.2 SOURCE HOUSING

a) Engineering Drawing

Attached Drawing No. D3280/38214. (See Figure Four)

b) Materials of Construction

Foil:	Americium Oxide Gold Silver backing Gold/palladium alloy front cover
Foil Capsule:	Stainless steel type 304S15
Housing:	Stainless steel type 304S15 Stainless steel wire cloth 16 strands/inch x 28AWG (Type 204S15 mesh 58% open)

c) Dimensions:

Foil:	0.2mm thick, 5mm in diameter
Foil Capsule:	Shown on engineering drawing.
Housing:	Shown on engineering drawing.

d) Methods of Fabrication

Foil:	The radionuclide in the form of Americium Oxide is uniformly mixed with gold, formed into briquette and sintered at greater than 800 C. The briquette is then mounted between a backing of silver and a front cover of gold/palladium alloy and sealed by hot forging.

The composite briquette is cold rolled in several stages to give the required active and overall areas. During this process the front cover is reduced in thickness to 0.002-0.003 millimetres and the metal layers are consolidated to produce a single strip of metal approximately 0.2mm thick (see figure 1). The foils are normally in one metre lengths and are subdivided by punching into circular discs of 5 millimetres in diameter (see Figure Two).

Foil Capsule: The foil is mounted in a capsule. The capsule is fabricated from stainless steel. The edges of the capsule are crimped over the edges of the foil. (see Figure Three).

Housing: The foil capsule is then bonded in a stainless steel housing using an adhesive. A stainless steel mesh is placed over the front of the capsule and the edges of the housing are crimped to hold it in position. (see Figure three).

Laser Device: Each housing is mounted in a threaded boss and pinned in the lid of the optical module. There are a total of 2 sealed sources in each laser device. The locations are shown in Figure 5. The walls and lid of the optical module are machined from cast Aluminum and have a minimum thickness of 0.06 inches. In many regions the walls of the optical module are significantly thicker.

e) Special Design Features

(i) The sealed source capsule is mounted in a stainless steel housing with a protective grill.

(ii) Only 4 +/- 0.5 microCurie is present in each source.

(iii) Materials surrounding the radioactive foil have been chosen to minimize the possibility of corrosion or damage to the foil.

3.3 LABELLING

a) Technique used for Labelling Sealed Source

1. The labelling is engraved on the sealed source housing as shown in Figure Four.

2. The information supplied on the label is as follows:

Americium-241
Model Number
Ferranti Trademark
Radiation Symbol
Activity Level

b) A similar label will be used for the device as shown in Figure Two

3.4 Testing of Prototypes

3.4.1 DEVICE

A test program is conducted on the prototype laser device to demonstrate the suitability of the design in meeting the performance requirements. Environmental conditions of test which reflect the conditions of use are shown in Appendix B. The test schedule is an exhaustive and lengthy issue which subjects the equipment to severe vibration, temperature extremes and low pressure. After each stage is complete an assessment of performance is made.

The LTD/R comprises an hermetically sealed laser module inside which are secured two sources. It is impracticable to routinely break the seals and carry out a leak check on the inside of the containment vessel as this would affect the continuity of assessment of the laser device.

3.4.2 SEALED SOURCE

An additional test program is therefore conducted on the sealed source. This program assesses the performance of the source as a suitable component by subjecting it to the same environmental conditions. An assessment is also carried out at the time of the ability of the component to withstand accidental damage or humid environmental conditions.

The source testing gives rise to a capability which can be described by an alpha-numeric code according to the ANSI-N542 scheme. The attached drawing of the source (See Figure Four) details the environmental conditions which the source is subjected to and calls out a CXX4X4 rating. Leak testing to ANSI 454 App 4.2.1.1 is required after each test.

Results from the source testing program will be available by November 1988.

The above approach establishes the integrity of the device by demonstrating the integrity of the source in the device environment, an acceptable procedure for low potential hazard devices having limited distribution.

3.5 Quality Control

The correspondence of each delivered device to the design specification controlling the activity and integrity of the devices is established by the quality control program implemented by Ferranti International.

Ferranti Defence Systems Limited is a major United Kingdom defence contractor with certification of established quality assurance to the requirements of NATO AQAP-1. This approval, together with declared quality control cost accounting provides an overall capability which is acknowledged as the equivalent of MIL-Q-9858A.

The Quality requirements governing the supply of sources are laid down in the Ferranti Supplier Control Procedure QC/90/017 a copy of which is shown in Appendix C.

The supplier in turn is contractually required to implement an inspection procedure to MIL-I-45208A together with a complimentary calibration system to MIL-STD-45662. The approved source vendor is Amersham International and they have an established quality assurance program which is certified to ISO9001, this being the equivalent of MIL-Q-9858A.

The source activity is determined early in the manufacturing procedure by assay of a foil from which the source is made. Discs are cut from the foil and mounted into a metal source holder which provides an effective sealed assembly by compressing the disc perimeter.

A leak check to the requirements of ANSI-N542 App A 2.1.1, according to the procedure in Amersham International document QCP130 verifies the source to be sealed. Further processing adds a protective grill to the source and final integrity is established by Amersham's procedure QCP131 which is an immersion test to the requirements of ISO TR 4826 para 2.1.3.

A final verification of activity is performed by comparison of the individual source radiation characteristics to a special reference source which has been calibrated. Reports are provided with each serialized source by the vendor to record its activity and integrity.

Hardware Configuration Management as required by the contract in conjunction with the sequence of tests, culminating in wipe tests, which are defined in and performed according to the Acceptance Test Procedure (SDRL E59.05) and certified in Acceptance Test Records (SDRL E59.06) shall ensure that each complete LTD/R meets the required specification.

The Acceptance Test Station used shall be calibrated in accordance with the requirements of MIL-STD-45662.

Compliance with the above is certified at the time of delivery of each complete LTD/R by the submission of a certificate of conformity (SDRL A015) signed by a responsible quality representative.

3.6 Radiation Profiles

Measurements have been made of the radiation profile from two prototype sources by the source manufacturer and by an independent consultant. Both measures found the isodistances normally employed to be too large to allow effective assay. The measured levels were so low that it would not be appropriate to take measurements of the device as any additional alternating effects presented to the source by the device would render the sources unobservable.

Amersham International, the manufacturers of the source used a Thermo Luminescent Dosimeter (TLD) over a period of 24 hours at the 5cm specified distance. This resulted in a count rate which was only 5-10 counts above the background.

Edinburgh radiation consultants employed an Isotope Development Alpha probe type 1027C. This is a photomultiplier tube coated with zinc sulfide phosphor. The probe head had an effective measuring area of $56cm^2$.

Beta and gamma fluxes were also measured with a thin window Geiger Muller tube type MX123. This probe had an effective measuring area of $3.14cm^2$.

The tables display the count rates versus distance for probes aligned along the principle axis of the source.

ALPHA PARTICLE MEASUREMENTS

	Distance from probe surface	Mean cps
Source 1	0.5	425 +/- 21
	1.0	123 +/- 11
	2.0	0.75 +/- 0.87
	2.5	0
	5.0	0
Source 2	0.5	525 +/- 23
	1.0	125 +/- 11
	2.0	0.75 +/- 0.87
	2.5	0
	5.0	0

TYPICAL ENERGY OF 4.5MeV

BETA AND GAMMA RAY MEASUREMENTS

	Distance from probe window	Net* cps
Source 1	0.5	700 +/- 26
	1.0	175 +/- 13
	2.0	11.5 +/- 3.4
	2.5	8.0 +/- 2.8
	5.0	2.5 +/- 1.6
	30	0
Source 2	0.5	700 +/- 26
	1.0	210 +/- 14
	2.0	11 +/- 3.3
	2.5	6.5 +/- 2.5
	5.0	2.5 +/- 1.9
	30	0

* After subtraction of background.

TYPICAL GAMMA ENERGY OF 59.5KeV

The basic energy of an alpha particle at the moment of release is 5.48MeV with an uncertainty of 10keV, however, passage of the particle through the foil matrix causes some moderation. The moderation reduces the energy of the most intense flux by about 1MeV and increases the uncertainty approximately tenfold.

The graph (See Figure Seven) from manufacturers data illustrates the spacial distribution of the alpha-particle energy.

3.7 Installation

The Laser Transmitter Designator/Rangefinder (LTD/R) forms part of the Ford Aerospace Forward Looking Infrared Receiver (FLIR) pod. Figure Eight is an outline drawing of the pod showing the location of the LTD/R as two assemblies. The laser device is fixed into the optical stablizer part of the pod by its attachments. When installed, the laser device is further shielded from the environment by two cylindrical metal envelopes. The inner envelope is an antivibration mount/chassis and the outer envelope is a smooth aerodynamic skin.

Installation will be carried out by qualified Navy technicians who have been trained in the maintenance of the FLIR pod. Before despatch to the Navy, Ford Aerospace technicians will assemble equipments as part of a production process.

3.8 Radiological Safety Instructions

The device does not present any radiological hazard to the user either when in normal operation or when being maintained. Should damage or improper use occur however, there is a minimal risk if active material is ingested.

Recommendations are made to the procuring authority in SDRL A044, the subsystem safety hazard analysis. This document addresses the necessary precautions and instructions to be used in the maintenance manuals. Recommendations are also made regarding the correct routes for disposal of active material whether damaged or intact.

3.9 Documentation Accompanying the Device

Each device will be supported by three certificates. A certificate of approval of the design of special form radioactive material covering the foil will account for the transporting of the material. The 34 page test certificate document establishing correct performance including a final leak check (F59.06), and an accompanying certificate of conformity (SDRL A015) will account for the activity and integrity of the device.

3.10 Servicing

Repair - Repair of the device will only be done by trained Navy personnel at Depot level or by Ferranti.

Leak Test - A leak test will be performed by Ford Aerospace before the device is shipped to the customer.

Source Replacement - Source replacement, when required, will only be accomplished by trained Navy personnel at Depot level or by Ferranti.

3.11 Periodic Leak Testing

The total activity per Laser device is controlled at 9 microCurie or less. Accordingly, Ford Aerospace recommends that periodic wipe testing not be required for this device. Ford Aerospace will perform wipe testing prior to transfer of the device from its plant in Newport Beach, CA. in accordance with the requirements of 10 CFR Part 31. No devices will be transferred if they exceed the prescribed allowable leakage activity level per 10 CFR Part 31.

3.12 Safety Analysis

The table outlines the considerations used to assess the risk associated with the device.

Potential hazard Am 241

How controlled - Hazard minimised by use of ALARA principle (see analysis of dose).

Condition	Hazard	Provision	Recommendations
Normal operation	None	None	None
Normal Maintenance	None	None	None
Improper Maintenance Improper Operation	Minimum Risk of internal exposure due to ingestion.	Caution Label on chassis & radioactive the foil on source.	Maintenance procedures adress precautions associated with damaged device or source together with notice that source should not be ingested.
Disposal	Ingestion	Negotiable contract with supplier.	Maintenance procedure identifies proper route.

Calculation of alpha dose to one hand from observed alpha count rates.

Assumptions

1. The range of 4 MeV alpha particles in soft tissue is 40×10^{-6} cm. So we can safely assume all the alpha particles reaching the hand ar absorbed.

2. Take the worst case where all the Am-241 alpha particles reaching the hand have an energy of 5.5 MeV i.e. we ignore the energy loss to air across the source to hand distance.

3. Assume that the hand in question encompasses the entire beam of alpha particles.

4. Assume in the worst case that the hand in question weighs 250g.

The absorbed dose in Grays, $\left(\frac{\text{Rad}}{100}\right)$, is the energy deposited in Joules per Kg of hand.

If the measured count rate of the alpha is C cps then energy deposited by beam per second

$= C \times 5.5$ MeV

$= C \times 5.5 \times 10^{6} \times 1.6 \times 10^{-19}$ Joules per second.

The energy deposited per Kg of tissue

$$= \frac{C \times 8.8 \times 10^{-13}}{.25} \text{ J per second}$$

$$= 35.2\ C \times 10^{-13} \text{ J per second}$$

i.e. the absorbed dose to hand from a count rate of C cps is 35.2×10^{-13} Grays per second.

The maximum observed count rate from the Am-241 source at 0.5cm is about 500 cps so taking a worst case assumption of 1000 cps to the hand over a period of 1725 hrs in one year*. The absorbed dose becomes

$$= 32.2 \times 10^{3} \times 10^{-13} \times 3600 \times 1725 \text{ Gy/yr}$$

$$= 2.2 \times 10^{11} \times 10^{-13} \text{ Gy/yr}$$

Taking into account the Radiobiological Effectiveness of the alpha radiation and assuming in the worst case the RBE = 30 the dose equivalent in Sieverts (=Rem) becomes
(100)

$= 2.2 \times 10^{-2} \times 30$ Sv

$= 6.6 \times 10^{-1}$ Sv

= .66 sV

= 66 Rem per year

Calculation of Gamma dose to one hand from observed Gamma count rates

Using the same worst case assumptions and, in addition, assuming that all the gammas are absorbed by the hand (in fact most gammas will only deposit a small fraction of their energy in the hand).

Then the energy absorbed at 0.5cm is

700 X 59.5 (KeV) per sec (Am-241 gamma energy = 59.5 KeV)

$= 700 \times 59.5 \times 10^{3} \times 1.6 \times 10^{-19}$ J per sec.

The absorbed does $= \frac{6.66 \times 10^{-12}}{0.25}$ J/Kg per sec.

$= 27 \times 10^{-12}$ Grays/sec

RBE = 1 so the dose equivalent $= 27 \times 10^{-12}$ Sv/sec.

In one working year of 1725 hrs* the dose equivalent
= 0.0165 Rem/year.

* 1725 hours represents a worst case assumption whereby an individual would be exposed for 7.34 hours every day for a 47 week working year. This is an impossible arrangement and would be reduced to a probable figure of 1 hour per year for a maintenance technician carrying out routine repair. This would drop the alpha dose to 0.038 Rem/year and make the gamma dose negligible.

The current NRC regulations prescribe a limit of 75Rem (750mSv) as the maximum premissible annual dose to the hands. The calculated maximum dose which is based on absolute worst case conditions gives rise to a figure for the combined radiations which is less than the limit.

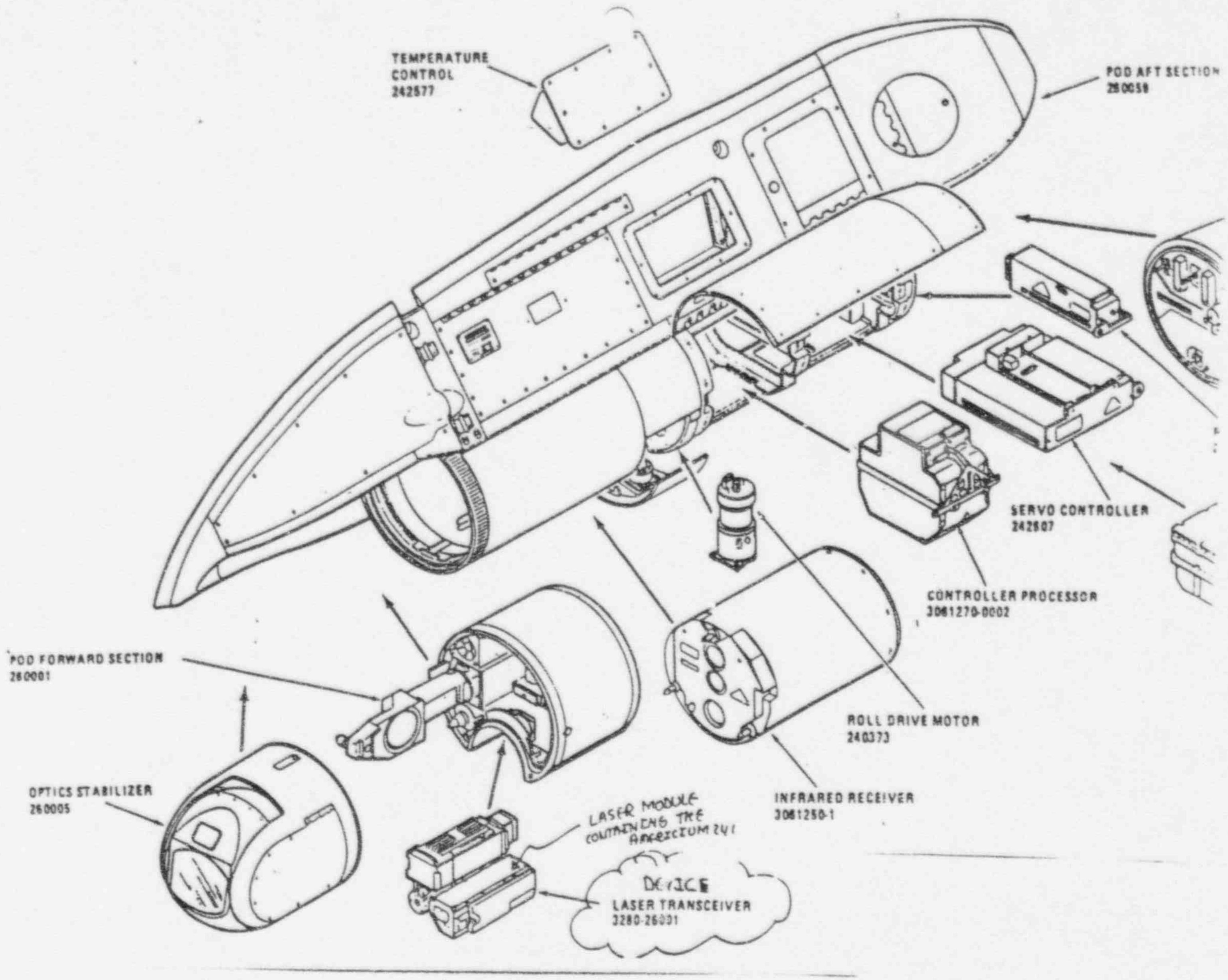


FIGURE 1. EXPLODED VIEW OF SUBSYSTEMS IN THE POD

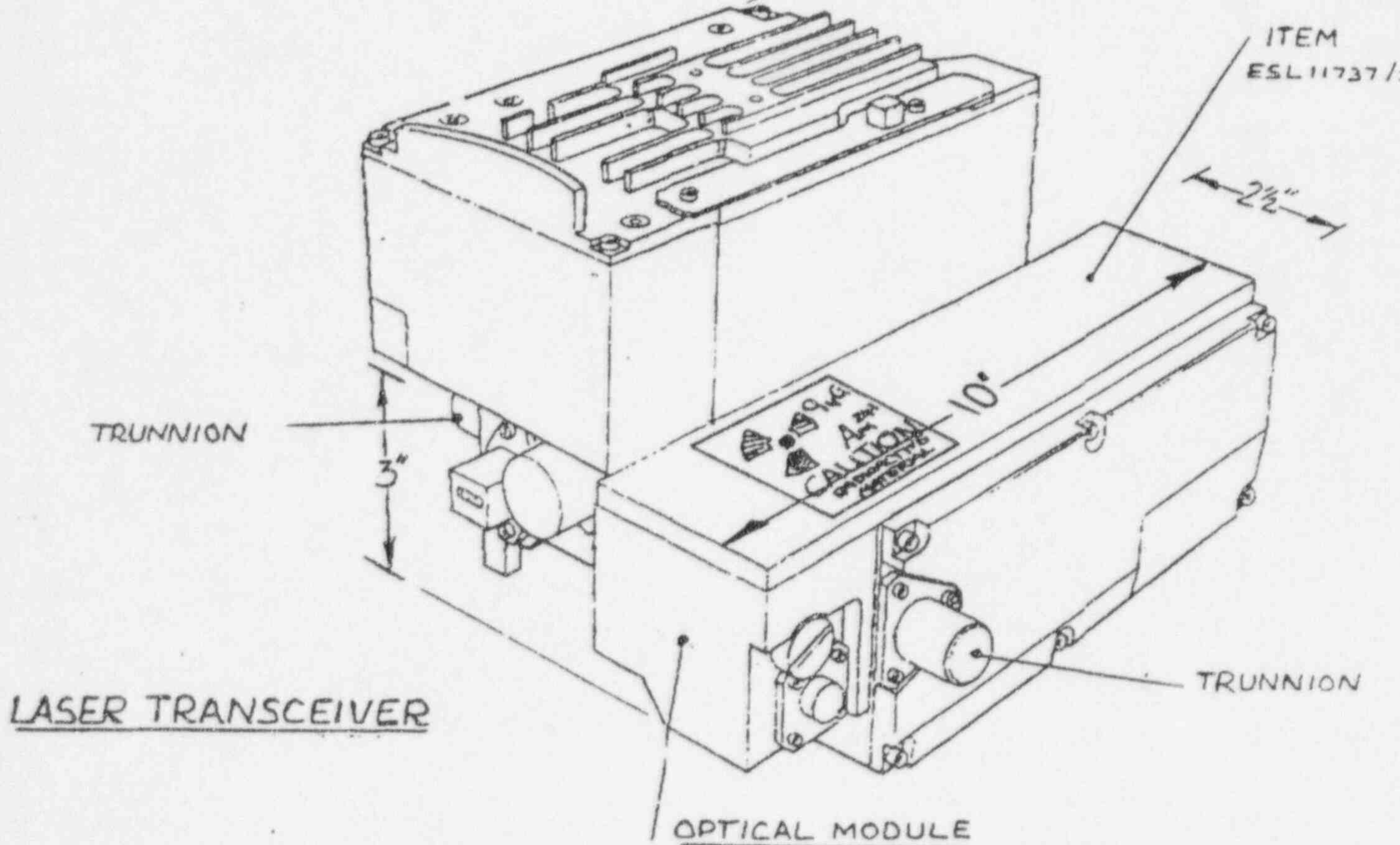


FIGURE 2. LASER TRANSCEIVER (DEVICE)

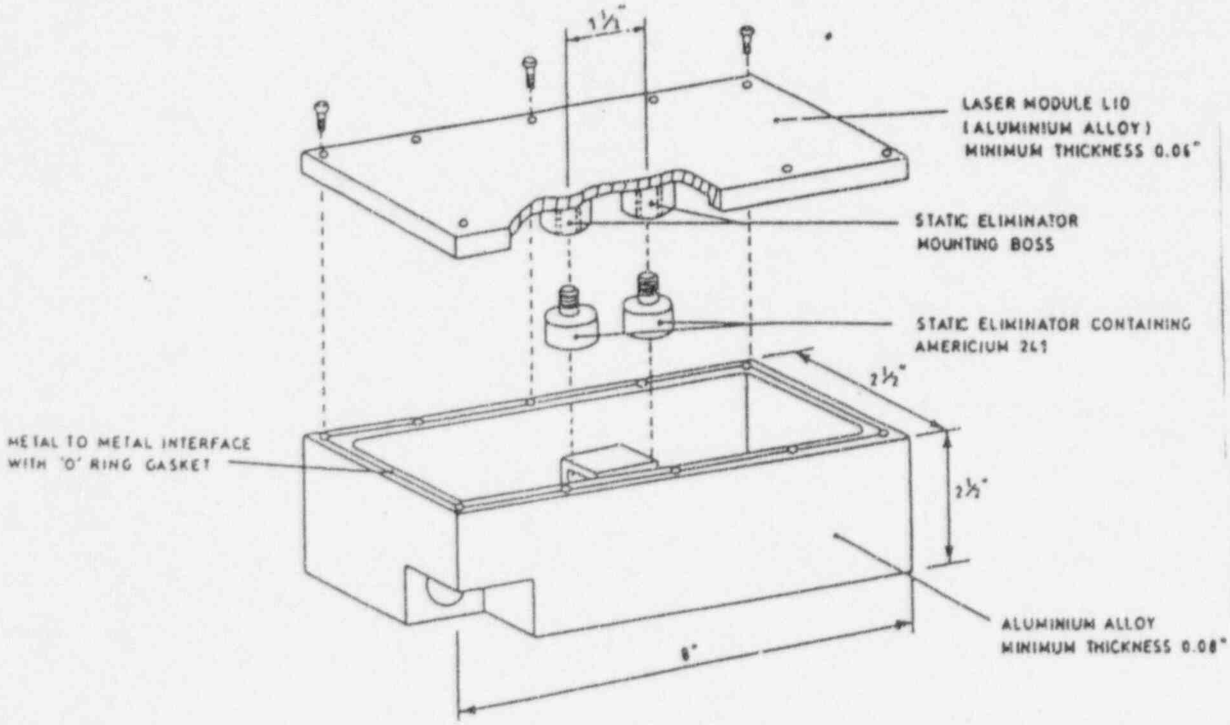


FIGURE 3. OPTICAL MODULE WITH STATIC ELIMINATORS

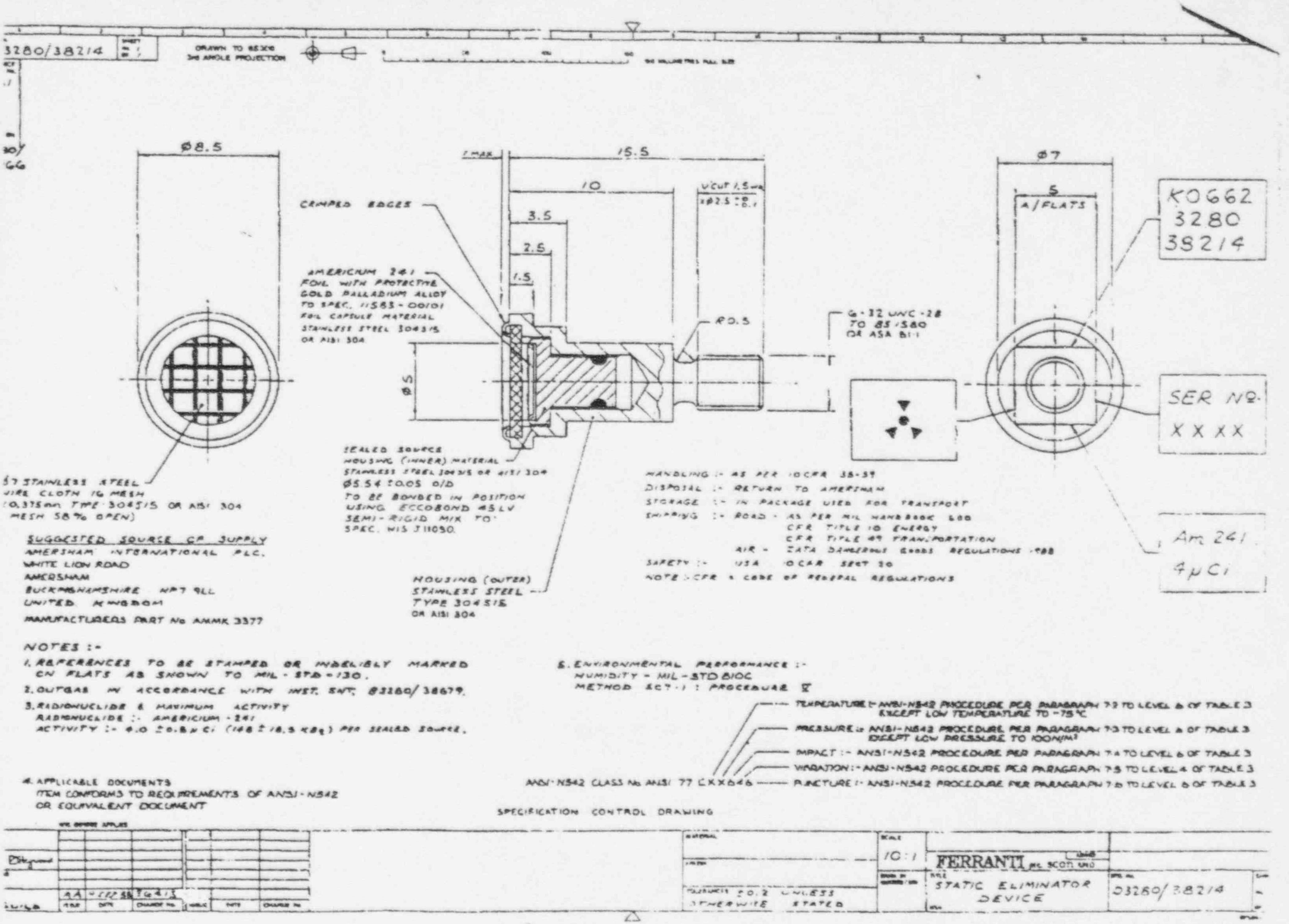
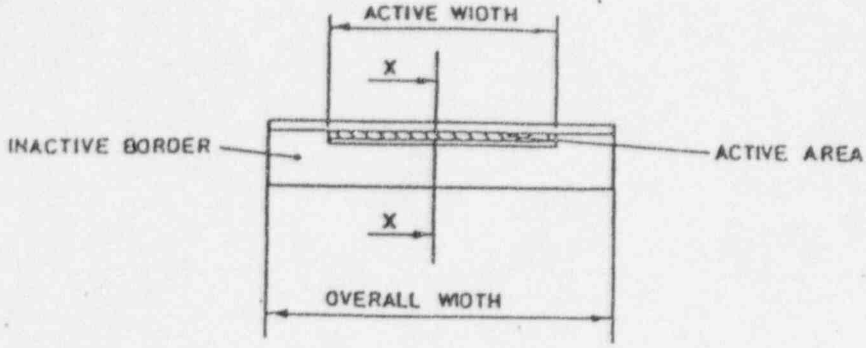
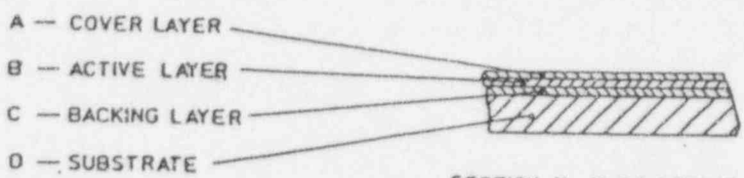


FIGURE 4 DRAWING OF SEALED SOURCE HOUSING



ROLLED FOIL LENGTHS UP TO 1 METRE



SECTION X–X OF ACTIVE AREA

A — GOLD-PALLADIUM ALLOY ~ 0,002 mm.

B — AMERICIUM OXIDE PLUS GOLD ~ 0,002 mm.

C — GOLD ~ 0,001 mm.

D — 0,20 mm.–0,25 mm.

FIGURE 5. CONSTRUCTION OF ALPHA-FOILS

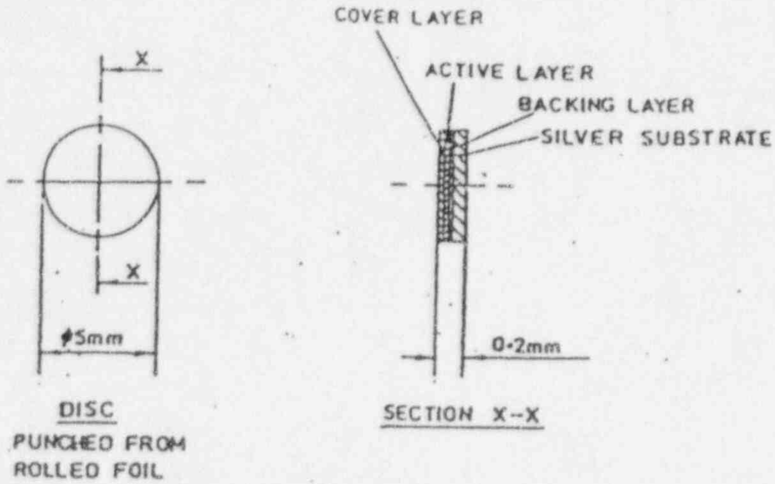


FIGURE 6 FOIL DISCS

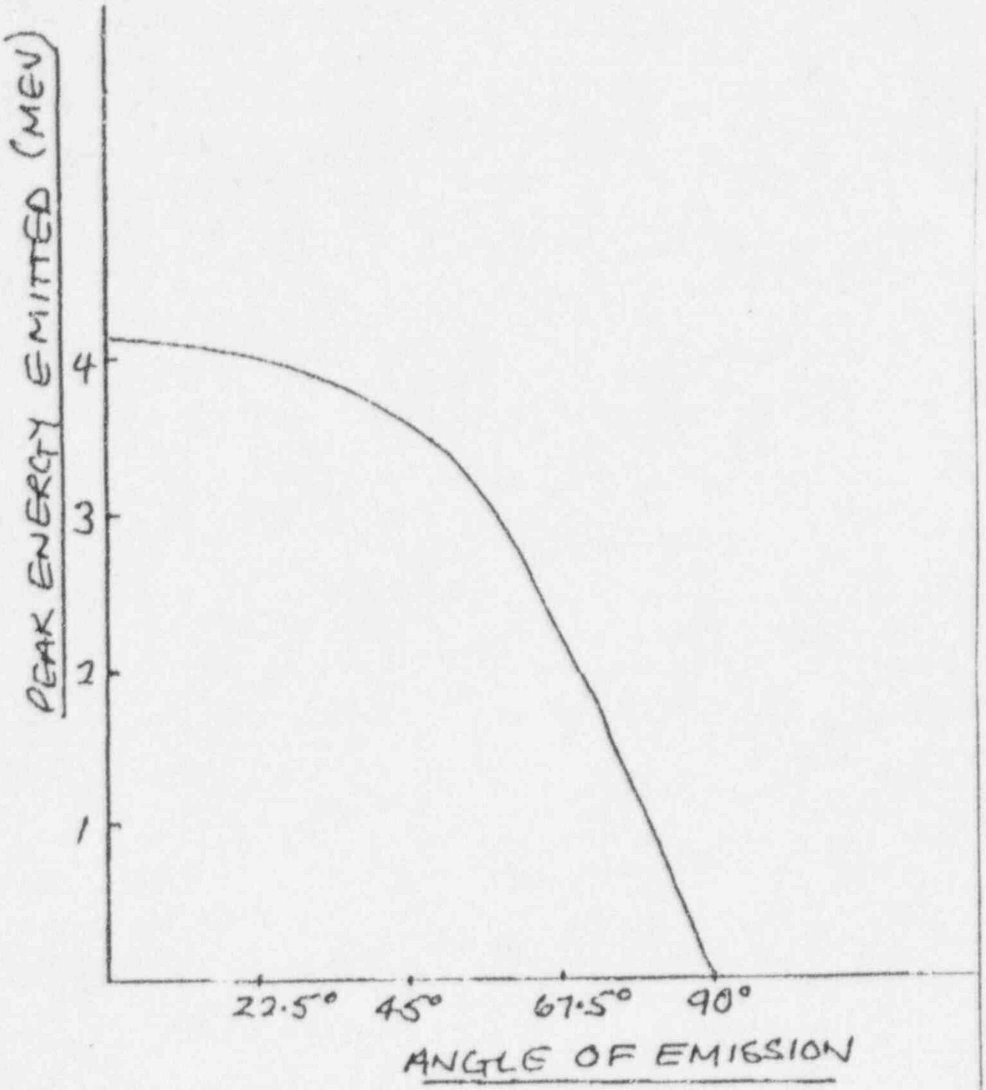


FIGURE 7

SPACIAL DISTRIBUTION OF ALPHA PARTICLES

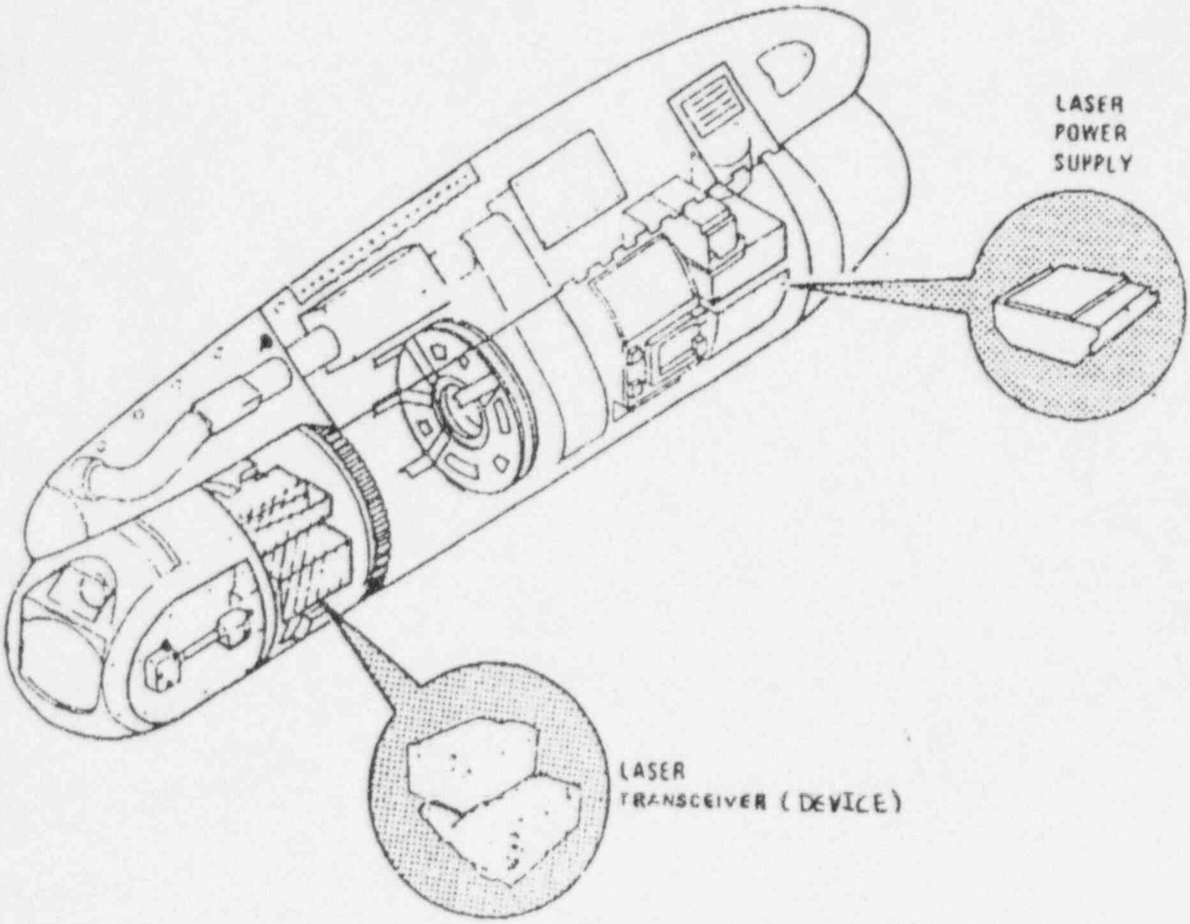


FIGURE 8. DEVICE INSTALLATION IN FLIR-LTD/R POD