

MIL-I-28791  
10 January 1973

## MILITARY SPECIFICATION

### ISOLATORS, RADIO FREQUENCY

#### GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense

#### 1 SCOPE

1.1 Scope This specification covers the general requirements for isolators, coaxial, wave-guide and strip-line radio frequency for use in armed-service radar and radio application

#### 2 APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of the specification to the extent specified herein

#### SPECIFICATIONS

##### FEDERAL

NN P 71	- Pallets, Materials Handling, Wood (General Construction Requirements)
QQ-S 781	Strapping, Steel, Flat and Seals
TT-P-645	- Primer, Paint, Zinc-Chromate, Alkyd Type
ZZ R-765	Rubber, Silicone
PPP-B 566	- Boxes, Folding, Paperboard
PPP-B 585	- Boxes, Wood, Wirebound
PPP-B 601	Boxes, Wood, Cleated, Plywood
PPP-B 621	- Boxes, Wood, Nailed and Lock-corner
PPP-B 636	Boxes, Shipping, Fiberboard
PPP-B 676	- Boxes, Setup
PPP-T 60	Tape, Pressure-sensitive Adhesive, Waterproof, For Packaging
PPP-T 76	Tape, Pressure - Sensitive Adhesive Paper, (For Carton Sealing)

##### MILITARY

MIL-P 116	- Preservation Methods of
MIL-F-3922	- Flanges, Waveguide, General Purpose, General Specification For
MIL-F-14072	- Finishes for Ground Signal Equipment
MIL-E-15090	Enamel, Equipment, Light-Gray (Formula No. 111)
MIL-C-39012	Connectors, Coaxial, Radiofrequency, General Specification For
MIL-B-43014	Boxes, Water Resistant Paperboard, Folding, Set-up And Metal-Stayed
MIL-C-45662	Calibration System Requirements
MIL-I-28791/1	Isolator, Radio Frequency, Coaxial

#### STANDARDS

##### MILITARY

MIL STD 105	Sampling Procedures and Tables for Inspection By Attributes
MIL STD 129	Marking For Shipment and Storage
MIL STD 147	Palletized and Containerized Unit Loads, 40 Inch x 48 Inch Pallets, Skids, Runners, Or Pallet Type Base
MIL STD 202	Test Methods for Electronic and Electrical Component Parts
MIL STD-454	- Standard General Requirements for Electronic Equipment
MIL STD-1285	- Marking of Electrical and Electronic Parts

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## PUBLICATION

## ANA Bulletin No. 400 - Airborne Electronic and Associated Equipment, Applicable Documents

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

## AMERICAN NATIONAL STANDARDS INSTITUTE INC

H17.2-1943	Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars
H38.3-1969	- Aluminum-Alloy Drawn Seamless Tubes
H37.1-1970	- Seamless Copper and Copper-Alloy Rectangular Waveguide Tube
R1553-1971 (ISO Rec)	- Chemical Analysis of Copper and Copper Alloy-Electrolytic Determination of Copper in Unalloyed Copper Containing Not Less Than 99.90% of Copper

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.)

## NATIONAL BUREAU OF STANDARDS

Handbook H28 - Screw-Thread Standards for Federal Services

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.)

Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.

## 3. REQUIREMENTS

3.1 Specification sheets The individual part requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between this specification and the specification sheet, the latter shall govern.

3.2 First article inspection Products furnished under this specification shall be products which have passed the first article inspection in 4.4.

3.3 Materials Materials shall be as specified herein, however, when a definite material is not specified, a material shall be used which will enable the isolators to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.3.1 Copper alloy Copper alloy used in the fabrication of waveguide-type isolators shall conform to commercial bronze, 90 percent of ANSI H37.1. Copper alloy used in the fabrication of coaxial-type isolators shall conform to the material requirements of ANSI H17.2, 99.90 percent purity as determined by ISO Recommendation R1553.

3.3.2 Aluminum alloy. Aluminum alloy shall conform to the requirements for 6061 or 6063 of ANSI H38.3. The finished waveguide shall have an "F" temper and after heat treatment and aging, shall meet the mechanical properties of the T6 temper of ANSI H38.3.

3.3.3 Rubber. Rubber shall conform to the requirements in ZZ-R-765.

3.4 Design and construction. Isolators shall be designed and constructed to conform to the requirements specified (see 3.1), in a manner entirely suitable for their intended use. They shall be of the lightest practicable weight consistent with the strength required for sturdiness, safety, and reliability. Isolators shall be fully shielded to external magnetic fields.

3.4.1 Waveguide isolators. The mating face of the isolators shall be so designed and manufactured as to provide the mating characteristics of the flange specified (see 3.1) in accordance with MIL-F-3922.

3.4.2 Coaxial isolators. Connectors shall be as specified (see 3.1). The material and gaging for receptacle connectors shall conform to the requirements of MIL-C-39012.

3.4.3 Dimensions. The dimensions shall be as specified (see 3.1).

3.4.4 External finish. External finish shall be applied to the isolators regardless of plating or chemical treatment, except that the mating surfaces shall not be coated. The primer coat shall be zinc chromate conforming to TT-P-645. Two finish coats of enamel, conforming to type III, class 2, of MIL-E-15090, shall be applied. External coatings shall be applied as continuous films.

3.4.5 Dissimilar metals. Dissimilar metals between which an electromotive couple may exist shall not be placed in contact with each other. Refer to MIL-F-14072 for the definition of dissimilar metals.

3.4.6 Screw threads. Screw threads shall be in accordance with Handbook H28. If used, helical inserts shall be selected from ANA Bulletin 400 and shall meet MIL-STD-454, Requirement 12.

3.4.7 Engineering parameters. The parameters of nominal impedance, voltage rating, frequency range, temperature range, and power rating shall be as specified (see 3.1).

3.5 Dielectric withstanding voltage (applicable to coaxial only). When isolators are tested as specified in 4.7.2, there shall be no evidence of breakdown.

3.6 Isolation. When isolators are tested as specified in 4.7.3, the isolation shall be as specified (see 3.1).

3.7 Insertion loss. When isolators are tested as specified in 4.7.4, the insertion loss shall not exceed the value specified (see 3.1).

3.8 Voltage standing wave ratio (VSWR). When isolators are tested as specified in 4.7.5, the VSWR shall not exceed the value specified (see 3.1).

3.9 Shock (specified pulse). When isolators are tested as specified in 4.7.6, there shall be no change in electrical or mechanical performance.

3.10 Temperature cycling. When isolators are tested as specified in 4.7.7, there shall be no evidence of damage or electrical degradation due to the test.

3.11 Moisture resistance. When isolators are tested as specified in 4.7.8, there shall be no change in electrical or mechanical performance or destructive corrosion. Destructive corrosion shall be construed as any type of corrosion which in any way interferes with electrical or mechanical performance.

3.12 Vibration, high frequency. When isolators are tested as specified in 4.7.9, there shall be no change in electrical or mechanical performance.

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**3.13 Marking.** Isolators shall be marked with the military part number, manufacturer's code and numbers identifying each part (see 3.1). Marking shall be applied directly on the isolators or on an attached name plate. Marking shall be in accordance with MIL-STD-1285.

**3.14 Workmanship.** Isolators shall be processed in such a manner as to be uniform in quality and shall be free from defects that affect life, serviceability, or appearance.

#### 4 QUALITY ASSURANCE PROVISIONS

**4.1 Responsibility for inspection.** Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

**4.1.1 Test equipment and inspection facilities.** Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the supplier. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-C-45662.

**4.2 Classification of inspections.** The inspections specified herein are classified as follows:

- (a) Materials inspection (see 4.3).
- (b) First article inspection (see 4.4).
- (c) Quality conformance inspection (see 4.6).

**4.3 Materials inspection.** Materials inspection shall consist of certification supported by verifying data that the materials listed in table I used in fabricating the isolator are in accordance with the applicable referenced specifications or requirements prior to such fabrication.

TABLE I Materials inspection

Material	Requirement paragraph	Applicable specification
Copper alloy.	3.3.1	ASTM A37.1 ASTM A17.2 JIS Re. P. 1553
Aluminum alloy	3.3.2	ASTM B30.3
Rubber	3.3.3	ZZ-R-765

#### 4.4 First article inspection

**4.4.1 Samples.** First article inspection shall be performed by the supplier, after award of the contract and prior to production, at a location acceptable to the Government. First article inspection shall be performed on sample units which have been produced with equipment and procedures normally used in production. First article approval is valid only on the contract or purchase order under which it is granted unless extended by the Government to other contracts or purchase orders.

**4.4.2 Sample size.** Two isolators shall be subjected to the first article inspection.

**4.4.3 Inspection routine.** The first article samples shall be subjected to the inspection specified in tables I and II.

TABLE II. First article inspection.

Examination or test	Requirement paragraph	Test method paragraph
Visual and mechanical examination - -	3.1 thru 3.4, 3.13 and 3.14	4.7.1
Dielectric withstanding voltage <u>1/</u> - - -	3.5	4.7.2
Isolation - - - - -	3.6	4.7.3
Insertion loss - - - - -	3.7	4.7.4
VSWR - - - - -	3.8	4.7.5
Shock (specified pulse) - - - - -	3.9	4.7.6
Temperature cycling - - - - -	3.10	4.7.7
Moisture resistance - - - - -	3.11	4.7.8
Vibration, high frequency - - - - -	3.12	4.7.9

1/ Coaxial types only.

4.4.4 Failures. One or more failures shall be cause for refusal to grant first article approval.

4.5 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspections.

4.6.1.1 Inspection lot. An inspection lot shall consist of all isolators of one type produced under essentially the same conditions, and offered for inspection at one time.

4.6.1.2 Group A inspection. Group A inspection shall consist of the examinations and test specified in table III in the order shown.

TABLE III Group A inspection

Examination or test	Requirement paragraph	Test method paragraph	AQL (percent defective)	
			Major	Minor
Visual and mechanical examination - - - - -	3.1 thru 3.4, 3.13 and 3.14	4.7.1	1.0	4.0
Dielectric withstanding voltage <u>1/</u> - - - - -	3.5	4.7.2	1.0	---

1/ Applicable to coaxial only.

4.6.1.2.1 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for general inspection level II. The acceptable quality level (AQL) shall be as specified in table III. Major and minor defects shall be as defined in MIL-STD-105

4.6.1.2.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

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**4 6 1 3 Group B inspection** Group B inspection shall consist of the examinations and tests specified in table IV in the order shown and shall be made on sample units which have been subjected to and have passed the group A inspection

TABLE IV Group B inspection

Test	Requirement paragraph	Test paragraph
Isolation	3 6	4 7 3
Insertion loss	3 7	4 7 4
VSWR	3 8	4 7 5

**4 6 1 3.1 Sampling plan** The sampling plan shall be in accordance with MIL-STD-105 for special inspection level S-4 The AQL shall be 2.5 percent defective

**4 6.1.3.2 Rejected lots** If an inspection lot is rejected the supplier may rework it to correct the defects, or screen out the defective units and resubmit for reinspection Resubmitted lots shall be inspected using tightened inspection Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots

**4 6 1 3.3 Disposition of sample units** Sample units which have passed all the group B inspection may be delivered on the contract or purchase order if the lot is accepted and the sample units are still within specified electrical tolerances

**4 6.2 Inspection of preparation for delivery** The sampling and inspection of the preservation packaging and interior package marking shall be in accordance with the group A and B quality conformance inspection requirements of MIL-P-116 The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification and the marking requirements of MIL-STD-129

#### **4 7 Methods of examination and test**

**4 7.1 Visual and mechanical examination** Isolators shall be examined to verify that the materials, design construction physical dimensions, marking and workmanship are in accordance with the applicable requirements (see 3 1)

**4 7 2 Dielectric withstanding voltage (applicable to coaxial only) (see 3 1 and 3 5)** Isolators shall be tested in accordance with method 301 of MIL-STD-202 The following details apply

- (a) Special conditions
  - (1) The maximum relative humidity shall be 50 percent
  - (2) The voltage shall be metered on the high side of the transformer
- (b) Magnitude of test voltage (see 3 1)
 

The voltage shall be instantaneously applied
- (c) Nature of potential - Alternating current
- (d) Points of application of the test voltage - Between the center contact and the shell of the coaxial connector

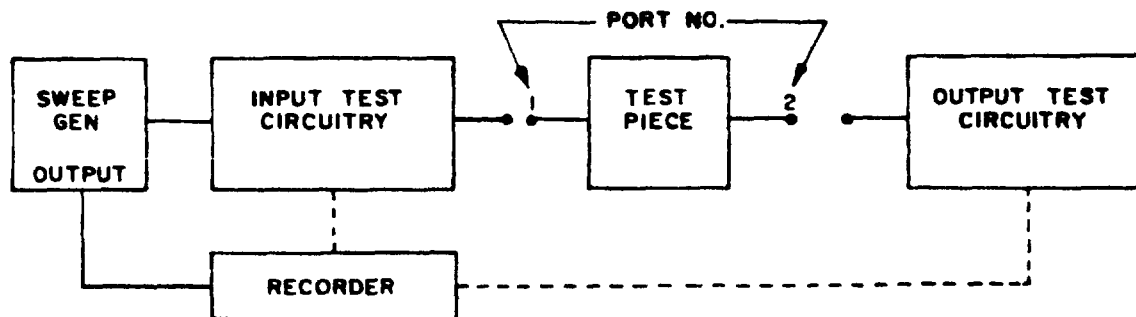
**4 7 3 Isolation (see 3 6)** With the output port 2 of the test isolator connected to the input circuitry and the input port 1 connected to the output circuitry (see figure 1), the frequency range shall be swept and the isolation measured

**4 7 4 Insertion loss (see 3 7)** With the input port 1 of the test isolator connected to the input circuitry and the output port 2 connected to the output circuitry (see figure 1), the frequency range shall be swept and the insertion loss measured

4 7 5 Voltage standing wave ratio (VSWR) (see 3 8) With the input port 1 of the test isolator connected to the input circuitry and the output port 2 connected to the output circuitry (see figure 1), the frequency range shall be swept and the input VSWR measured. Ports 1 and 2 shall be interchanged and the output VSWR measured.

4.7.6 Shock (specified pulse) (see 3.9). Isolators shall be subjected to method 213 of MIL-STD-202 The following details shall apply

- (a) Mounting - Isolators shall be clamped to the test fixture.
- (b) Test condition - I
- (c) Measurements after test - Insertion loss and VSWR shall be measured as specified in 4 7.4 and 4.7.5



NOTE

The input and output circuitry shall be such that the error in the measurement quantities are small. The values given in the specification sheets include worst case test circuitry errors.

FIGURE 1 Test set-up for isolation, insertion loss and VSWR.

4 7 7 Temperature cycling (see 3 10) Isolators shall be tested in accordance with method 102 of MIL-STD-202 The following details and exception shall apply

- (a) Test condition - D except that the low temperature shall be  $-65^{\circ}\text{C}$  and the high temperature shall be  $+105^{\circ}\text{C}$
- (b) Measurements after test - Insertion loss and VSWR shall be measured as specified in 4 7 4 and 4 7 5

4 7 8 Moisture resistance (see 3 11) Isolators shall be tested in accordance with method 106 of MIL-STD-202 The following details shall apply

- (a) Loading voltage - Not applicable
- (b) Measurements after test - Insertion loss and VSWR shall be measured as specified in 4 7 4 and 4 7 5

4 7 9 Vibration, high frequency (see 3 12). Isolators shall be tested in accordance with method 204 of MIL-STD-202 The following details shall apply

- (a) Mounting - Isolators shall be attached to the vibration table by clamps. A clamp shall be placed around the center of each isolator and no part of the isolator shall touch any object other than the clamp
- (b) Test condition - B
- (c) Measurements after test - Insertion loss and VSWR shall be measured as specified in 4 7 4 and 4 7 5

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## 5 PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. Preparation for delivery requirements of referenced documents listed in section 2 do not apply unless specifically stated in the contract or order. Preparation for delivery requirements for products procured by contractors shall be specified in the individual orders.)

5.1 Preservation-packaging Preservation-packaging shall be level A or C, as specified (see 6.2)

### 5.1.1 Level A.

5.1.1.1 Cleaning Isolators shall be cleaned in accordance with MIL-P-116 process C-1

5.1.1.2 Drying Isolators shall be dried in accordance with MIL-P-116

5.1.1.3 Preservative application Preservatives shall not be used

5.1.1.4 Unit packaging. Isolators shall be individually packaged in accordance with MIL-P-116, submethod IIc insuring compliance with the general requirements paragraph under methods of preservation (unit protection) and the physical protection requirements paragraph therein

5.1.1.5 Intermediate packaging Isolators, packaged as specified in 5.1.1.4 shall be placed in intermediate containers conforming to PPP-B-566 or PPP-B-676. Intermediate containers shall be uniform in size, shape and quantities shall be of minimum tare and cube and shall contain multiples of five unit packages not to exceed 50 unit packages. No intermediate packaging is required when the total quantity shipped to a single destination is less than 50 unit packages.

5.1.2 Level C Isolators shall be clean, dry and packaged in a manner that will afford adequate protection against corrosion, deterioration and physical damage during shipment from supply source to the first receiving activity.

5.2 Packing Packing shall be level A, B or C, as specified (see 6.2)

5.2.1 Level A The packaged isolators shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirements. In lieu of the closure and waterproofing requirement in the appendix of PPP-B-636, closure and waterproofing shall be accomplished by sealing all seams, corners and manufacturer's joint with tape, two inches minimum width, conforming to PPP-T-60, class 1 or PPP-T-76. Banding (reinforcement requirements) shall be applied in accordance with the appendix to PPP-B-636 using nonmetallic or tape banding only.

5.2.2 Level B The packaged isolators shall be packed in fiberboard containers conforming to PPP-B-636, class domestic, style optional, special requirements. Closures shall be in accordance with the appendix thereto.

5.2.3 Level C The packaged isolators shall be packed in shipping containers in a manner that will afford adequate protection against damage during direct shipment from the supply source to the first receiving activity. These packs shall conform to the applicable carrier rules and regulations.

5.2.4 Unitized loads Unitized loads, commensurate with the level of packing specified in the contract or order shall be used whenever total quantities for shipment to one destination equal 40 cubic feet or more. Quantities less than 40 cubic feet need not be unitized. Unitized loads shall be uniform in size and quantities to the greatest extent practicable.

5.2.4.1 Level A Isolators packed as specified in 5.2.1, shall be unitized on pallets in conformance with MIL-STD-147 load type 1, with a fiberboard cap (storage aid 4) positioned over the load.



5 2 4 2 Level B Isolators, packed as specified in 5 2 2, shall be unitized as specified in 5 2 4 1 except that the fiberboard caps shall be class domestic

5 2 4 3 Level C Isolators, packed as specified in 5 2 3 shall be unitized with pallets and caps of the type, size and kind commonly used for the purpose and shall conform to the applicable carrier rules and regulations

5 3 Marking In addition to any special marking required by the contract or purchase order (see 6 2) each unit package, intermediate and exterior container and unitized load shall be marked in accordance with MIL-STD-129

5 4 General Special requirements for Army and Navy procurements are specified in 5 4 2 and 5 4 3 respectively

5 4 1 Exterior containers Exterior containers (see 5 2 1, 5 2 2 and 5 2 3) shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent practicable

#### 5 4 2 Army procurements

5 4 2 1 Level A intermediate packaging All intermediate containers shall either be weather (or water) resistant or overwrapped with waterproof barrier materials. Containers conforming to PPP-B-566 or PPP-B-676 shall be overwrapped with waterproof barrier materials or shall conform to MIL-B-43014 (see 5 1 1 5)

5 4 2 2 Level A and B packing For level A packing, when quantities per destination are less than a unitized load, the fiberboard containers shall not be banded but shall be placed in a close fitting box conforming to PPP-B-601 overseas type PPP-B-621 class 2 style 4 or PPP-B-585 class 3 style 2 or 3. Closure and strapping shall be in accordance with applicable container specification except that metal strapping shall conform to QQ-S-781 type I class B. When the gross weight exceeds 200 pounds or the container length and width is 48 x 24 inches or more and the weight exceeds 100 pounds, 3 x 4 inch skids (laid flat) shall be applied in accordance with the requirements of the container specification. If not described in the container specification, the skids shall be applied in a manner which will adequately support the item and facilitate the use of material handling equipment. For level B packing, fiberboard boxes shall be weather resistant as specified in level A and the containers shall be banded (see 5 2 1 and 5 2 2)

5 4 2 3 Level A and B unitization For level A and B unitization, the fiberboard caps shall be weather resistant and softwood pallets conforming to NN-P-71, type IV size 2 shall be used (see 5 2 4 1 and 5 2 4 2)

5 4 3 Navy requirements For Navy requirements, the use of polystyrene loose fill material (such as strips, strands and beads) is prohibited for packaging and packing applications

## 6 NOTES

6 1 Intended use Isolators are intended for use in military equipment in the frequency range specified

6 2 Ordering data Procurement documents should specify the following:

- (a) Title, number, and date of the specification
- (b) Title, number, and date of the applicable specification sheet and complete part number (see 3.1).
- (c) Levels of preservation-packaging and packing required (see 5 1 and 5 2)
- (d) Special marking, if required (see 5 3).

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6.3 Definition For the purpose of the specification, the following definition shall apply.

6.3.1 Isolator. A ferrite device which allows RF energy to pass in one direction with little attenuation while radio frequency energy flowing in the opposite direction is attenuated. A circulator with one port terminated in a matched impedance will function as an isolator

**Custodians:**

Army - EL  
Navy - EC  
Air Force - 80

**Review activities:**

Army -  
Navy -  
Air Force - 11  
DSA - ES

**User activities:**

Army - MU  
Navy - OS, SH, MC  
Air Force -

**Preparing activity:**

Navy - EC

**Agent:**

DSA - ES

(Project 5985-T151)

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		<input type="checkbox"/> USER	
		<input type="checkbox"/> MANUFACTURER	
		<input type="checkbox"/> OTHER (Specify) _____	
5. PROBLEM AREAS			
a. Paragraph Number and Wording			
b. Recommended Wording			
c. Reason/Rationale for Recommendation			
6. REMARKS			
7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional		8. DATE OF SUBMISSION (YYMMDD)	

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