

The documentation and process conversion measures necessary to comply with this document shall be completed by 27 September 2024.

INCH-POUND

MIL-PRF-19500/74F  
w/AMENDMENT 3  
27 April 2024  
SUPERSEDING  
MIL-PRF-19500/74F  
w/AMENDMENT 2  
14 April 2017

## PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, NPN, SILICON, MEDIUM-POWER,  
THROUGH-HOLE MOUNT PACKAGE, TYPES 2N497, 2N498, 2N656, AND 2N657,  
QUALITY LEVEL JAN

Inactive for new design after 7 June 1999.

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

The requirements for acquiring the product described herein shall consist of  
this specification sheet and [MIL-PRF-19500](#).

### 1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon, medium power transistors. One level of product assurance (JAN) is provided for encapsulated devices.

1.2 Package outlines. The device package outlines are as follows: TO-205AA (formerly modified TO-5) (without suffix S, see [1.5.3](#)) or a TO-205AD (formerly modified TO-39) (with suffix S, see [1.5.3](#)) in accordance with [figure 1](#) for all encapsulated device types.

1.3 Maximum ratings. Unless otherwise specified,  $T_A = +25^\circ\text{C}$ .

Type	$P_T$ (1) $T_A = +25^\circ\text{C}$	$P_T$ (2) $T_c = +25^\circ\text{C}$	$V_{CBO}$	$V_{CEO}$	$V_{EBO}$	$T_{STG}$
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>°C</u>
2N497	0.8	4	60	60	8	-65 to +200
2N498	0.8	4	100	100	8	-65 to +200
2N656	0.8	4	60	60	8	-65 to +200
2N657	0.8	4	100	100	8	-65 to +200

(1) Derate linearly 4.6 mW/°C for  $T_A > +25^\circ\text{C}$ .

(2) Derate linearly 23 mW/°C for  $T_c > +25^\circ\text{C}$ .

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to [Semiconductor@dla.mil](mailto:Semiconductor@dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

AMSC N/A

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FSC 5961



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1.4 Primary electrical characteristics. Unless otherwise specified,  $T_A = +25^\circ\text{C}$ .

Limits	h <sub>FE</sub> V <sub>CE</sub> = 10 V dc I <sub>C</sub> = 50 mA dc		h <sub>FE</sub> (1) V <sub>CE</sub> = 10 V dc I <sub>C</sub> = 200 mA dc		h <sub>FE</sub>   V <sub>CE</sub> = 30 V dc I <sub>C</sub> = 30 mA dc f = 10 MHz	V <sub>CE(SAT)</sub> (1) I <sub>C</sub> = 200 mA dc I <sub>B</sub> = 40 mA dc	V <sub>BE</sub> (1) I <sub>C</sub> = 200 mA dc V <sub>CE</sub> = 10 V dc
	2N497 2N498	2N656 2N657	2N497 2N498	2N656 2N657			
Minimum	10	20	12	30	1.5	V dc	V dc
Maximum	40	100	36	90	10.0	2.0	2.0

(1) Pulsed (see 4.5.1).

1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.4 for PIN construction example, 6.5 for a list of available PINs, and 6.6 for supersession information.

1.5.1 JAN certification mark and quality level. The only quality level designator for encapsulated devices that is applicable for this specification sheet is the base quality level "JAN" that uses no modifiers.

1.5.2 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

1.5.2.1 First number and first letter symbols. The transistors of this specification sheet use the first number and letter symbols "2N".

1.5.2.2 Second number symbols. The second number symbols for the transistors covered by this specification sheet are as follows: "497", "498", "656", and "657".

1.5.3 Suffix symbols. The suffix symbol "S" is used on devices that have a shortened lead length: 0.5 inch (12.7 mm) minimum to .75 inch (19.1 mm) maximum. Devices with standard length leads use no suffix. See figure 1.

1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on QPDSIS-19500.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

### 2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

#### DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-19500 – Semiconductor Devices, General Specification for.

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DEPARTMENT OF DEFENSE STANDARDS

**MIL-STD-750** – Test Methods for Semiconductor Devices.

(Copies of these documents are available online at <https://quicksearch.dla.mil>.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in **MIL-PRF-19500** and as specified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein shall be as specified in **MIL-PRF-19500**.

3.4 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in **MIL-PRF-19500** and herein. The device package style is either a modified TO-205AA (formerly TO-5) or a modified TO-205AD (formerly TO-39) in accordance with [figure 1](#) for all device types.

3.4.1 Lead finish. Unless otherwise specified, lead finish shall be solderable in accordance with **MIL-STD-750**, **MIL-PRF-19500**, and herein. Unless otherwise specified (see 6.2), the lead finish shall be gold-plated. Where a choice of lead finish or lead formation is desired, it shall be specified in the acquisition document (see 6.2).

3.4.2 Pin-out. The pin-out of the device shall be as shown on [figure 1](#). Terminal 1 is the emitter, terminal 2 is the base, and terminal 3 is the collector. The collector shall be electrically connected to the case.

3.4.3 Terminal-lead length. Terminal-lead length(s) other than that specified on [figure 1](#) may be furnished under contract or order (see 6.2) where the devices covered herein are required directly for particular equipment-circuit installation or for automatic-assembly-technique programs. Where other lead lengths are required and provided, it shall not be construed as adversely affecting the Qualified-product status of the device, or applicable JAN marking (see 6.2).

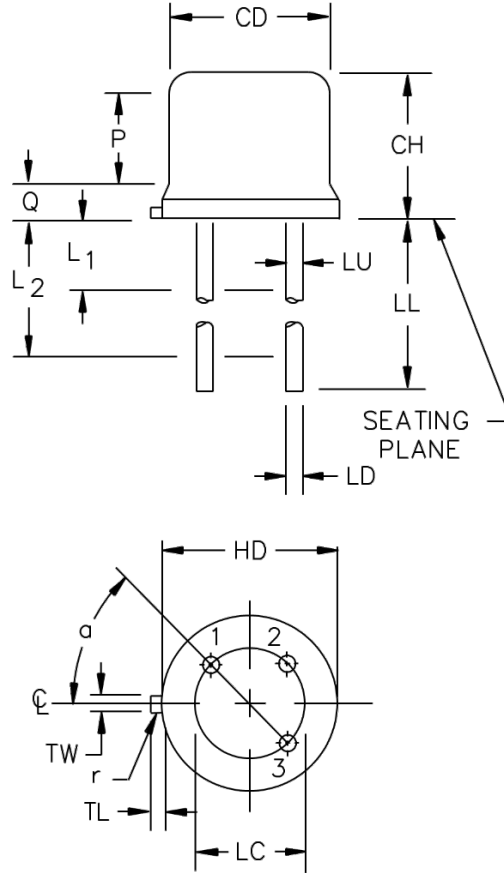
3.5 Marking. Marking shall be in accordance with **MIL-PRF-19500**.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics shall be as specified in 1.3, 1.4, and [table I](#) herein.

3.7 Workmanship. The devices covered by this specification sheet shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

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Symbol	Dimensions				Note
	Inch	Inch	mm	mm	
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	3
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.1414 TP		3.592 TP		4
LD	.016	.021	0.41	0.53	5, 6
LL	See notes 6, 7, and 8				
LU	.016	.019	0.41	0.48	5, 6
L <sub>1</sub>		.050		1.27	5, 6
L <sub>2</sub>	.250		6.35		5, 6
P	.100		2.54		9
Q		.030		0.76	3
TL	.029	.045	0.74	1.14	10, 11
TW	.028	.034	0.71	0.86	10
r		.010		0.25	12
$\alpha$	45° TP		45° TP		4



NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Lead 1 = emitter, lead 2 = base, lead 3 = collector. The collector shall be internally connected to the case.
3. CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
4. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods or by gauging procedure.
5. Dimension LU applies between L<sub>1</sub> and L<sub>2</sub>. Dimension LD applies between L<sub>2</sub> and LL minimum. Diameter is uncontrolled in and beyond LL minimum.
6. All three leads. Lead diameter dimension accounts for all lead finishes that can be applied.
7. For the TO-205AA (formerly a modified TO-5) package (PINs without the S suffix), dimension LL is 1.500 inch (38.10 mm) minimum and 1.750 inch (44.45 mm) maximum.
8. For the TO-205AD (formerly a modified TO-39) package (PINs with the S suffix), dimension LL is .500 inch (12.70 mm) minimum and .750 inch (19.05 mm) maximum.
9. Body contour optional within zone defined by HD, CD, and Q.
10. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 (0.28 mm).
11. Dimension TL measured from maximum HD.
12. Dimension r (radius) applies to both inside corners of tab.

FIGURE 1. Physical dimensions and configurations of TO-205AA and TO-205AD package.

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#### 4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4 and tables I and II).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table II tests, the tests specified in table II herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.3 Screening. Screening is not applicable for devices compliant to this specification sheet.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500 and table I herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table E-VIB of MIL-PRF-19500 and herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B1	2026	Omit preconditioning.
B6	1031	$T_{stg} = + 200^{\circ}\text{C}$ ; $t = 340$ hours.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C2	2036	Test condition E.
C3	2046	Nonoperating.
C4	3005	Pre-pulse condition: $T_C = 25^{\circ}\text{C}$ , $V_{CE} = 0$ , $I_C = 0$ . Pulse condition: $V_{CE} = 40$ V dc, $I_C = 0.1$ A dc, $t_p = 60$ second, 1 cycle; $t_r \leq 8$ seconds; $t_f \leq 6$ seconds.
C6	1026	$T_A = 25^{\circ}\text{C}$ ; $P_T = 0.8$ W; $V_{CE} = 40$ V dc.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table II herein.

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4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse response measurements. The conditions for pulse response measurement shall be as specified in section 4 of [MIL-STD-750](#).

4.5.2 Transient thermal impedance. The transient thermal impedance measurements shall be performed in accordance with test method 3131 of [MIL-STD-750](#) using the guidelines in that test method for determining  $I_M$ ,  $I_H$ ,  $t_H$ ,  $t_{sw}$ , (and  $V_H$  where appropriate). See [table II](#), subgroup 4 herein.

TABLE I. Group A inspection.

Inspection <a href="#">1/</a>	<a href="#">MIL-STD-750</a>		Symbol	Limit	Limit	Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Collector to emitter breakdown voltage	3011	Bias condition D, $I_C = 250 \mu A$ dc	$V_{(BR)CEO}$	60 100		V dc V dc
2N497, 2N656 2N498, 2N657						
Collector to emitter breakdown voltage	3011	Bias condition D, $I_C = 80$ mA dc, pulsed (see <a href="#">4.5.1</a> )	$V_{(BR)CEO}$	60 100		V dc V dc
2N497, 2N656 2N498, 2N657						
Collector to base, breakdown voltage	3001	Bias condition D, $I_C = 100 \mu A$ dc	$V_{(BR)CBO}$	60 100		V dc V dc
2N497, 2N656 2N498, 2N657						
Emitter to base, breakdown to voltage	3026	Bias condition D, $I_E = 250 \mu A$ dc	$V_{(BR)EBO}$	8.0		V dc
Collector to base, cutoff current	3036	Bias condition D	$I_{CBO}$		1.0 1.0	$\mu A$ dc $\mu A$ dc
2N497, 2N656 2N498, 2N657		$V_{CB} = 50$ V dc $V_{CB} = 80$ V dc				
Forward-current transfer ratio	3076	$V_{CE} = 10$ V dc, $I_C = 50$ mA dc	$h_{FE1}$	10 20	40 100	
2N497, 2N498 2N656, 2N657						

See footnotes at end of table.

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TABLE I. Group A inspection – Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit	Limit	Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2 – continued</u>						
Forward-current transfer ratio  2N497, 2N498 2N656, 2N657	3076	V <sub>CE</sub> = 10 V dc, I <sub>C</sub> = 200 mA dc; pulsed (see 4.5.1)	h <sub>FE2</sub>	12 30	36 90	
Collector to emitter voltage (saturated)	3071	I <sub>C</sub> = 200 mA dc; I <sub>B</sub> = 40 mA dc; pulsed (see 4.5.1)	V <sub>CE(sat)</sub>	—	2.0	V dc
Base to emitter voltage (non-saturated)	3066	Test condition B; V <sub>CE</sub> = 10 V dc I <sub>C</sub> = 200 mA dc; pulsed (see 4.5.1)	V <sub>BE</sub>		2.0	V dc
<u>Subgroup 3</u>						
High temperature operation		T <sub>A</sub> = +150°C				
Collector to emitter cutoff current  2N497, 2N656 2N498, 2N657	3041	Bias condition A; V <sub>BE</sub> = -1.5 V dc  V <sub>CE</sub> = 60 V dc V <sub>CE</sub> = 100 V dc	I <sub>CEx</sub>		300 300	μA dc μA dc
Low temperature operation	3076	T <sub>A</sub> = -55°C				
Forward-current transfer ratio  2N497, 2N498 2N656, 2N657	3076	V <sub>CE</sub> = 10 V dc, I <sub>C</sub> = 200 mA dc	h <sub>FE3</sub>	6 15		
<u>Subgroup 4</u>						
Magnitude of common emitter small-signal, short-circuit forward-current transfer ratio	3306	V <sub>CE</sub> = 30 V dc, I <sub>C</sub> = 30 mA dc, f = 10 MHz	h <sub>FE</sub>	1.5	10	
<u>Subgroups 5 and 6</u>						
Not applicable						

1/ For sampling plan, see MIL-PRF-19500.

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TABLE II. Group E inspection (all quality levels) – for qualification and requalification only.

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices, c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles.	
Hermetic seal	1071	Fine and gross leak.	
End-point electrical measurements		See <a href="#">table I</a> , subgroup 2 herein.	
<u>Subgroup 2</u>			45 devices, c = 0
Steady-state operating life	1026	T <sub>A</sub> = 25°C, P <sub>T</sub> = 0.8 W, V <sub>CE</sub> = 40 V dc, t = 1000 hours.	
End-point electrical measurements		See <a href="#">table I</a> , subgroup 2 herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See <a href="#">MIL-PRF-19500</a> .	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices, c = 0
Reverse stability	1033	Condition B.	

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.



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## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in [MIL-PRF-19500](#) are applicable to this specification.)

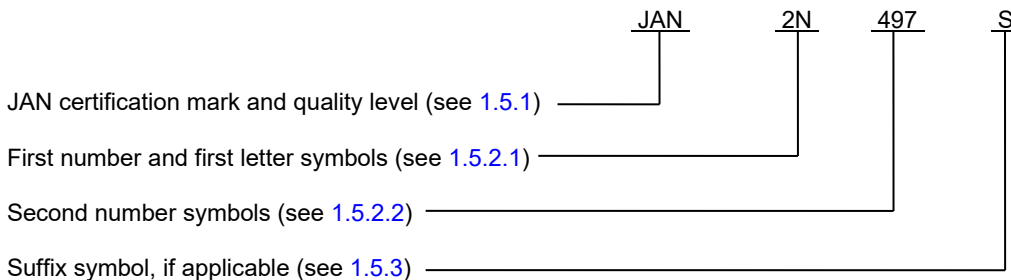
6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see [5.1](#)).
- c. Lead finish (see [3.4.1](#)).
- d. The complete PIN, see [1.5](#) and 6.4.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail [vqe.chief@dla.mil](mailto:vqe.chief@dla.mil). An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.dla.mil>.

6.4 PIN construction example. The PINs for encapsulated devices are constructed using the following form.



6.5 List of PINs. The following is a list of possible PINs available for devices covered by this specification sheet.

PINs for devices in a TO-205AA (formerly a modified TO-5) (standard lead lengths)	PINs for devices in a TO-205AD (formerly a modified TO-39) (short lead lengths)
JAN2N497	JAN2N497S
JAN2N498	JAN2N498S
JAN2N656	JAN2N656S
JAN 2N657	JAN2N657S

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6.6 Supersession information and superseded PINs.

6.6.1 Lead finish. The original issue of this specification through MIL-S-19500/74D with Amendment 1 (24 August 1964) did not specify a lead finish. Since the release of MIL-S-19500/74E (17 October 1967), the lead finish has been specified as gold-plate.

6.6.2 Lead length. The original issue of this specification through MIL-S-19500/74 with amendment 3 (26 June 1978) did not contain a suffix to designate lead length. MIL-S-19500/74E with amendment 4 (11 August 1986) introduced the "S" suffix option with the associated TO-205AD package. When applicable, PINs covering devices with a shortened lead length now shall include a suffix "S" to designate this package configuration (see 1.2, 1.5, and figure 1.)

6.6.3 Lead material. The original issue of this specification through MIL-S-19500/74D with Amendment 1 (24 August 1964) did not specify a lead material. MIL-S-19500/74E (17 October 1967) specified that the lead material as Kovar. MIL-S-19500/74E with Amendment 2 (20 August 1970) modified the lead material to Kovar or Alloy 52. Because of the performance format of this document, lead material is no longer specified.

6.7 Request for new types and configurations. Requests for new device types or configurations for inclusions in this specification sheet should be submitted to: DLA Land and Maritime, ATTN: VAC, Post Office Box 3990, Columbus, OH 43218-3990 or by electronic mail at "[Semiconductor@dla.mil](mailto:Semiconductor@dla.mil)".

6.8 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

Custodians:

Army – CR  
Navy – SH  
Air Force – 85  
DLA – CC

Preparing activity:  
DLA – CC

(Project 5961-2024-035)

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