

MILITARY SPECIFICATION SHEET

ELECTRON TUBE, KLYSTRON

TYPE DOL-007 1/

The complete requirements for procuring the electron tube described herein shall consist of this document and the latest issue of Specification MIL-E-1.

**DESCRIPTION:** Pulsed amplifier, negative grid modulated, self-focused, tunable frequency range 960 to 1,215 MHz

**ABSOLUTE RATINGS:**

Parameter:	E <sub>f</sub>	E <sub>c</sub>	E <sub>b</sub>	eg <sub>y</sub>	ib	P <sub>i</sub>	P <sub>i</sub>	P <sub>i</sub> (rf)	P <sub>o</sub>
Unit:	V	V	kV	v	a	kw	W	w	kw
Maximum:	4.6	-400	30	600	8	240	4,800	500	50
Minimum:	3.8	-850	--	--	--	--	--	--	--
Notes:	12	13	6, 12, 13, 14	7, 14	--	--	6, 13, 14	8	3, 4, 9, 10, 11, 15, 22

**ABSOLUTE RATINGS:**

Parameter:	P <sub>o</sub>	F	prf	D <sub>u</sub>	tp at 10% amplitude	TE
Unit:	W	MHz	pairs/sec	%	μs	°C
Maximum:	1,200	1,215	3,783	2.5	10	150
Minimum:	--	960	--	--	--	--
Notes:	--	9	--	19	--	2. Fig 1 (ref A thru E)

**PHYSICAL CHARACTERISTICS:**

Dimensions:	Figure 1	Cooling:	Forced-air (Note 2)
Mounting:	Note 1	Weight:	45 pounds (max)
Temperature reference:	Figure 1	Marking:	Figure 1

**TEST CONDITIONS:**

Parameter:	E <sub>f</sub>	E <sub>c</sub>	E <sub>b</sub>	eg <sub>y</sub>	ib	P <sub>i</sub>	P <sub>i</sub> (rf)
Unit:	V	V	kV	v	a	W	w
	4.2	-500	24	400 to 475	--	4,600	75
Notes:	--	--	--	17	16, 17	--	--

**TEST CONDITIONS:**

Parameter:	P <sub>o</sub>	F	prf	tp at 10% amplitude
Unit:	kw	MHz	pairs/sec	μs
	37 (min)	1,215 and 960	3,783	3.5 ± 0.5
Notes:	--	--	--	16

**GENERAL:**

Qualification - Required

1/ Formerly Type SAL 219

DOL-007

METHOD	REQUIREMENT OR TEST	NOTES	CONDITIONS	SYMBOL	LIMITS		UNIT
					MINIMUM	MAXIMUM	
	<u>Qualification inspection</u>						
4257	Amplifier insertion loss (forward)	29	egy = 0 Ib = 0	po po	-- --	5 -5.7	$\mu$ w dBm
4250	Power level	24		po	--	60	dBm
4250	Power level	23		Po	--	-35	dB
4303	Warmup time	27	At 6 seconds At 24 seconds At 116 seconds Time to rated po	po po po t	-- -- -- --	9 15 25 6	kw kw kw minutes
1047	High- and low-temperature performance	18, 20	TA = 30° ± 20° C  TA = 30° ± 40° C	po spect po spect	-- -- -- --	37 -45 36 -44	kw dB kw dB
1042	Shock, specified pulse	26		--	--	--	--
1031	Nonoperation vibration	25		--	--	--	--
1105	Permanence of marking	-		--	--	--	--
	<u>Quality conformance inspection, part 1</u>	31					
1301	Heater current	5	Ef = 4.2 V	If	33	37	A
1256	Anode current	-	Eb = 24 kV; Ec = -500 V; Ef = 4.2 V; egy = 475 v	Ib	--	8	a
4250	Power output	-	Ef = 4.2 V; Eb = 24 kVdc; prf = 3,783 pairs/sec; F = 960 and 1,215 MHz; Ec = -500 Vdc; egy = 400 to 475 v; pd = 75 w (Pulse width shall be measured at 0.675 amplitude)	po	37	--	kw
---	Spectrum	16		Spect 1 Spect 2	-- --	-45 -55	dB dB
1261	Electrode voltage (cutoff)	-	Eb = 24 kV; Ef = 4.2 V; egy = 0; Ib = 1 mA	Ec	--	-475	V
4214	Cathode emission	28		$\Delta I_b/I_b$	--	10	%
1111	Base pin solder depth	-	Visually inspect rf output connector for complete solder fill	--	360	--	degrees
	<u>Quality conformance inspection, part 2</u>						
1331	Direct-interelectrode capacitance	-	Connect shell to cathode	Cgt	--	150	pF

METHOD	REQUIREMENT OR TEST	NOTES	CONDITIONS	SYMBOL	LIMITS		UNIT
					MINIMUM	MAXIMUM	
4250	<u>Quality conformance inspection, part 2</u> -Continued Power level (pulse droop)	21		--	--	0.5	%
----	<u>Quality conformance inspection, part 3</u> Life test	30	Group D; E <sub>I</sub> = 4.2 V; E <sub>c</sub> = -500 Vdc; E <sub>b</sub> = 24 kVdc; e <sub>g</sub> = 400 to 475 v; t <sub>p</sub> = 10 μs; P <sub>i</sub> = 4,320 W	t	1,000	--	hrs
4250	Life-test end points: Power output	-	E <sub>I</sub> = 4.2V; E <sub>b</sub> = 24 kVdc; prf = 3,783 pairs/sec; F = 960 and 1,215 MHz; E <sub>c</sub> = -500 Vdc; e <sub>g</sub> = 400 to 475 v; p <sub>d</sub> = 75 w	p <sub>o</sub>	37	--	kw
----	Spectrum	18		Spect 1 Spect 2	-- --	-45 -55	dB dB
4214	Cathode emission	28		ΔIb/Ib	--	10	%

NOTES:

- The tube is designed to be mounted by the "mounting step" (figure 1) in any position and supported by a suitable strap around the 5-3/8-inch (136.53 mm) diameter, as shown in figure 1.
- The cooling requirements of this tube will be met at sea level with 18 pounds of air per minute of 0.0730 pounds per cubic foot density at a pressure drop no more than 1.6 inches of water.
- The tube will not produce harmful X-radiation when operated as specified herein.
- This specification applies in all respects from sea level to 10,000 feet altitude.
- Within a 5-minute preheat period, the heater current shall stabilize within the limits specified.
- E<sub>b</sub> is a dc potential applied to the cathode negative with respect to the tube body. The output of the dc beam supply shall be followed by a series resistor of approximately 10 ohms to prevent serious surges of beam current through the tube. Overload circuits should be included in the HV power circuits to remove beam potential from the tube when the required average beam current value is exceeded.
- The control grid shall be driven with a pulse which has a peak amplitude as specified with reference to the negative bias potential. The grid shall never be driven more than 100 volts positive with respect to the cathode. A resistor of 1,000 to 2,500 ohms shall be used in series with the control grid.
- The rf drive is applied to the input resonator of the tube. The rf drive may be either pulsed or CW. When a rectangular pulse drive is used, synchronization shall be provided to allow the control grid pulse to appear in time phase with the rf pulse. The rf drive pulse shall be free from frequency modulation which would prevent testing the tube to the performance limits indicated.
- A tuning curve shall be supplied with each tube. The frequency of each resonator can be set approximately by adjusting the tuning ring spacing of each resonator according to the tuning charts. Tuning rings shall be parallel with one turn of the tuning nut after final adjustment.

NOTES: -Continued

10. The tube shall deliver the specified rated power into a load presenting a VSWR of 1.5 to 1, or less.
11. No damage to the tube or output connector shall occur if the tube is operated into a load presenting any VSWR between 1 and infinity after it has been tuned into a properly matched load. Insulation at the output fitting shall withstand failure 1.6 times rated output power of 37 kW.
12. No damage to the tube will occur from applied voltage variations of  $\pm 30$  percent for 1 second or  $\pm 20$  percent for 5 seconds. Filaments shall not be damaged with voltage variations of  $\pm 15$  percent.
13. Tubes stored over 3 months and new tubes require a special start-up procedure as follows:
  - (a) Operate the tube with only heater voltage and  $E_c = -500$  volts applied for 5 minutes.
  - (b) With  $e_{g1} = 0$  apply 10 kV  $E_b$ . Allow to operate for 7 minutes. Then apply rated  $E_b$  for 7 minutes.
  - (c) Raise  $e_{g1}$  until 50 mA of beam current is obtained. Operate for 15 minutes.
  - (d) Adjust  $e_{g1}$  for normal operation.
  - (e) Normal operation of the tube shall be obtained within 2 hours. RF drive may be applied at any time during the start-up procedure.
14. When a new tube is placed in equipment employing an output line spectrum filter, or when the operating frequency is changed after the tube is placed in such equipment, the tuning is performed at a low-power level. This is done by reducing the beam potential, reducing the grid drive, or reducing both. For this purpose, low-power level may be considered as that corresponding to 24 kV beam potential and 30 mA of average beam current.
15. The tube tuning procedure is as follows:
  - (a) Alternately tune the input cavity of the tube and the rf exciter final amplifier for maximum transfer of power from the exciter at the time in the rf pulse when the beam current pulse is at its peak as shown.



- (b) While viewing the output cavity of the tube, adjust the center cavity of the tube for maximum amplitude of the detected pulse. (If no change is observed, move the viewing circuit to the center cavity monitor connection on the tube and tune the center cavity until a maximum indication is secured. Replace the viewing circuit and tune for the maximum amplitude signal from the output cavity.)

## NOTES: -Continued

## 15. -Continued

- (c) Adjust the output cavity of the tube and transformer (if used) for maximum detected output signal. (If there is a filter in the output load line, it shall be tuned in accordance with the manufacturer's directions, to present a matched low-VSWR load to the tube.)
  - (d) Check all three cavities of the tube, and any transformer and or filter, to determine that each is set for the maximum output power from the tube.
  - (e) The tuning for the rated high-power operation is performed as described after the beam current is raised to correspond to the test conditions listed. It will be noted that as the beam potential is raised, the center resonator tuning will show the greatest effect upon power output. Thus, it may be adjusted first and then the adjustments of all resonator cavities and transformer made as described. When tuning is completed, all settings are locked by pulling the nuts tight against each side of the tuning flanges.
16. A beam current pulse of the shape shown in diagram A shall provide rf output voltages which conform to diagram B.

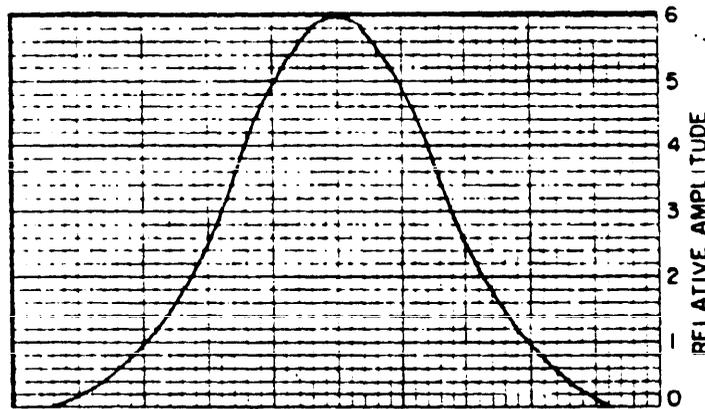


Diagram A.

NOTES: -Continued

16. -Continued

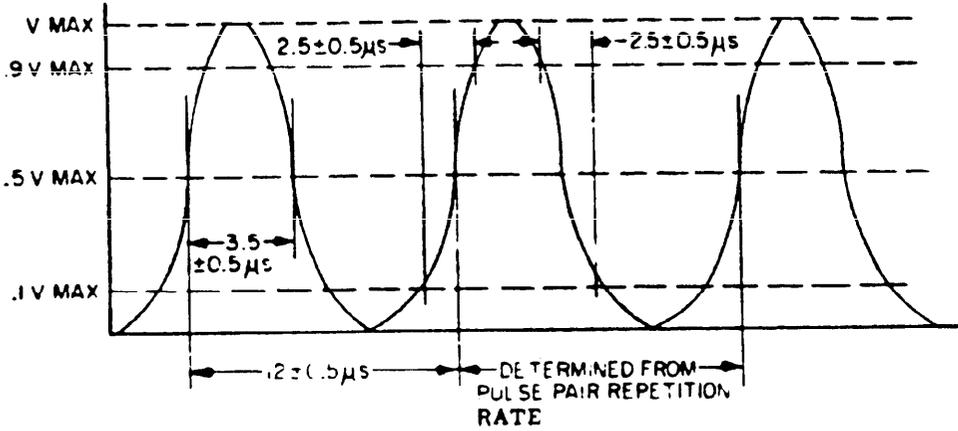
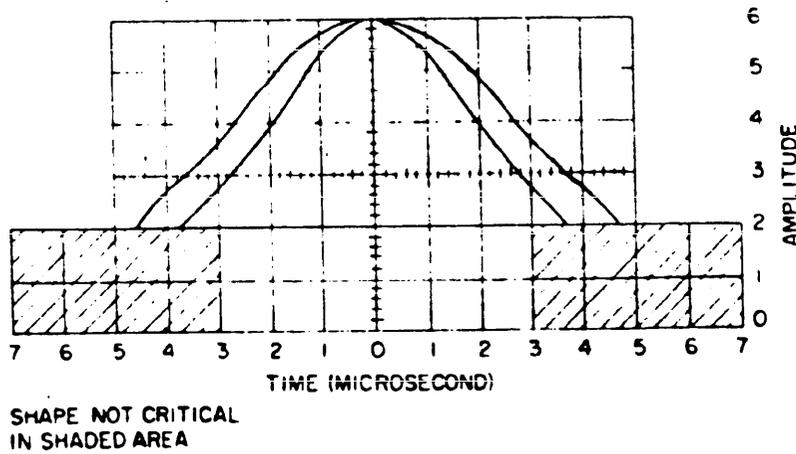


Diagram B.

17. The beam current pulse shape shown in diagram A (note 16) can be secured with a grid modulator capable of the operating range specified in the following diagram.



## NOTES: -Continued

18. With an rf voltage pulse width in the range 3.4 to 4.0  $\mu$ s inclusive, the following conditions shall be met:
  - (a) The frequency spectrum of the output rf pulses is defined in terms of the relative energy in each 500 kHz wide band, centered  $\pm$  800 kHz from the center frequency, to the energy in the 500 kHz band centered on the carrier frequency, and the relative energy in each 500 kHz wide band, centered  $\pm$  2.0 MHz from the center frequency, to the energy in the 500 kHz band centered on the carrier frequency. The limits given specify the maximum energy allowable in each sideband referred to that of the carrier centered band.
  - (b) Each normally 83.3 kHz spaced lobe of the spectrum shall be generally of less amplitude than the adjacent lobe nearer the center frequency. In no case will it exceed that adjacent lobe by more than 10 dB.
19. The duty cycle is computed from the rf output power pulse and is averaged over a period of 1 second.
20. The tube will meet specified power and spectrum specifications over a  $\pm$  20° C temperature range starting from an ambient temperature of 30° C without retuning. The tube will provide a minimum of 36 kw peak power output and provide a minimum spectrum of -44 dB throughout the temperature range of  $\pm$  40° C starting from an ambient temperature of 30° C without retuning.
21. After an account has been taken of existing differences in the amplitude of adjoining eg pulses, and correction made for the 5/4 power relationship between the output voltage pulse amplitude and droop in Eb, there shall be in addition no more than 0.5 percent difference between the maximum amplitude pulse and the minimum amplitude pulse in a group of 24 successive pulses. These 24 pulses may be evenly spaced in a total interval not exceeding 330 microseconds.
22. The power output from the tube may be lowered continuously to 4 kw by reducing the grid-drive voltage; with some retuning the tube will meet the requirements of the specification except for the lower power output.
23. The maximum allowable amplitude of the second harmonic of the fundamental drive frequency is specified with reference to the amplitude of the drive frequency. The test is made under specified test conditions at drive frequencies of 960, 1,100, and 1,215 MHz.
24. The tube shall not oscillate with the input line disconnected and the input and output resonators tuned to the same frequency provided that the middle resonator is detuned by one turn of one tuning nut from resonance.
25. This is a mechanical test only. The resonant frequency of each resonator shall be set at 1,100  $\pm$  2 MHz by "cold test" methods. After vibration, the cold resonant frequency of the respective resonators shall be within the limits specified of the original settings. The frequency of the vibrating table shall be 25  $\pm$  2 Hz. Acceleration shall not exceed 2.5 G.
26. The tube shall be shocked with a half-sine wave shock pulse, 30 G  $\pm$  10 percent, 6.5 milliseconds, 3 shock pulses shall be applied in each of the +X, +Y, and +Z planes of the tube. The tube shall then be tested against the requirements of the quality conformance inspection, part 1, power output test.
27. With the rated heater potential applied for not less than 5 minutes, the tube will meet minimum power output and spectrum requirements within the specified time after simultaneous application of the correct values of eg and Eb.

NOTES: -Continued

28. With the tube operating with specified test conditions, except no rf drive is required, when the heater potential is reduced to 3.8 volts for 3 minutes the change in beam current shall not exceed the limit specified.
29. With the tube operating with specified test conditions, removal of the grid pulse potential shall reduce the radiated rf and the transmitted output to the maximum specified. In the absence of beam current and for any condition of tuning, the maximum level of radiated rf or the transmitted output is specified with respect to the rf drive power.
30. Power output will be measured at the following specified periods during life test: At the end of 168, 336, 672, and 1,008 hours.
31. The AQL for all tests performed under quality conformance inspection, part 1, shall be 0.65, inspection level II.

Review activities:  
Navy - AS, OS, MC, CG, SH

Preparing activity: Navy - EC

Agent: DSA - ES

(Project 5960-N935)

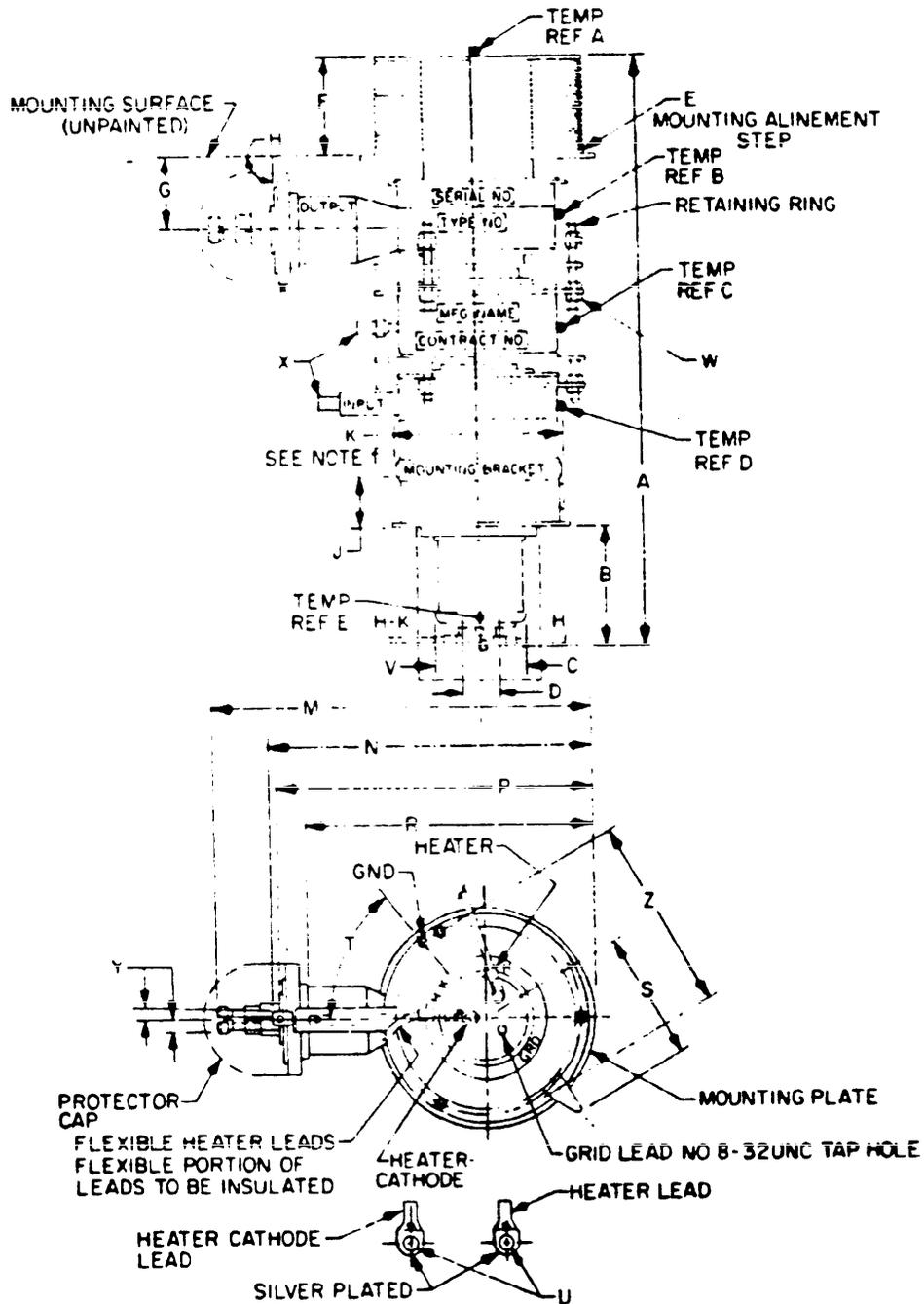


FIGURE 1. Outline drawing of electron tube type SAL-219.

Ltr	Dimensions in inches with metric equivalents (mm) in parentheses	
	Minimum	Maximum
Qualification inspection		
A	19.438 (493.73)	21.125 (536.58)
B		4.565 (115.95)
C	2.969 (75.41)	3.031 (76.99)
D	.547 (13.99)	.671 (17.04)
E	6.859 (174.22)	6.891 (175.03)
F	3.985 (101.22)	4.109 (104.37)
G	1.876 (47.65)	2.000 (50.80)
H	89°	91°
J	1.563 (39.70)	1.687 (42.85)
K	5.344 (135.74)	5.406 (137.31)
M	10.250 (260.35)	10.500 (266.70)
N		9.250 (234.95)
P	8.750 (222.25)	9.000 (228.60)
R		8.000 (203.20)
S		8.500 (215.90)
T	32°	38°
U	.331 (8.41) NOM DIA	
V	See note a	
Quality conformance inspection part 2		
W	See note b	
X	See note c	
Y	See note d	
Z	See note e	

## Notes:

- a. Axis of tube shall be perpendicular to mounting surface within .015(.38) for every inch (this assumes parallel tuning).
- b. 5/16-24UNF-2 HEX NUT .500(12.70) across flats.
- c. Bayonet jacks to accommodate plugs UG-88/U.
- d. Antenna shall be aligned with center line within  $\pm 2^\circ$ .
- e. All tuning screws and nuts located on  $6.062 \pm .016$  (153.97  $\pm$  .41) B. C.  $120^\circ 5'$  apart as shown.
- f. Allow for 1.250 (31.75) inches travel for tuning.

FIGURE 1. Outline drawing of electron tube type SAL-219-Continued.

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**SPECIFICATION ANALYSIS SHEET**

Form Approved  
Budget Bureau No. 22-R255

**INSTRUCTIONS:** This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

DIRECT GOVERNMENT CONTRACT       SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

YES       NO (If "yes", in what way?)

4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)

SUBMITTED BY (Printed or typed name and activity - Optional)

DATE

**DD FORM 1426**  
1 JAN 66

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.

S/N-0102-014-1801 C-28394