Attachment 001

SCOPE OF WORK FOR REPAIR OF THREE AZIMUTH TACHOMETERS BY KOLLMORGAN

Section C: The contractor shall supply the necessary labor, parts, material, equipment, services, and facilities needed to return the Azimuth Tachometers to condition code A (serviceable – to be issued without qualification). The repair will include as necessary, unpacking, disassembly, inspection, diagnosis, removal and replacement of subassemblies/component parts, reassembly, cosmetic work (when necessary to prevent further deterioration), calibration, final testing/inspection, and packing for shipment.

Section D: Each repaired Azimuth Tachometer shall be packaged IAW the requirements of Special Packaging Instruction (SPI) (AM)P12561691.

Section E: Acceptance testing shall be performed IAW the Conformance Tests listed as 100% in Table IV of MIL-DTL-12561691.

Attachment 002

SPECIAL PACKAGING INSTRUCTION

Form Approved
OMB No. 0704-0188

1. PART OR DRAWING NO. NOMENCLATURE			2. CODE IDENT	3. SPI NO.
12561691 AZIMUTH TACHOMETER ASSEMBLY			19200	(AM) P12561691
4. NATIONAL STOCK NO.			5.DATE OF DRAWING/SPI(YYMMDD)	6. REVISION / ERR NO.
6680-01-371-5877			00-12-06	-/H0K2016
7. QUP / UNIT OF ISSUE	8. ICQ	9. UNIT PACK WT. (LB) (0.0)	10. UNIT PACK CU (CU. FT.)(0 000)	11. UNIT PACK SIZE (INCHES)(00.0)
1/EA		1.3	0.125	6.0 X 6.0 X 6.0

12. MILITARY PRESERVATION	18. STEPS	19. REQD	20. DESCRIPTION
MIL-STD-2073-1, METHOD 41	1		BAG,MIL-B-117,TY-I,CL-E
13. CLEANING	2		CONTAINER,ASTM D5118,ST-RSC,GR-W5C
*	3		CLOSURE,ASTM D1974,SEALING METHOD B
14. DRYING			
*			
15. PACKING			
a. LEVEL A			
MIL-STD-2073-1			
b. LEVEL B			
MIL-STD-2073-1			
16. MARKING			
MIL-STD-129			

17. NOTES/DRAWING

* UNLESS OTHERWISE SPECIFIED, CLEANING AND DRYING SHALL BE IN ACCORDANCE WITH PARAGRAPH 5.2.1 OF MIL-STD-2073-1. WEIGHTS AND SIZES ARE ESTIMATED AND MAY VARY SLIGHTLY. INTERMEDIATE PACKAGING AND PACKING WILL BE IN ACCORDANCE WITH SPECIFICATION MIL-STD-2073-1 OR AS OTHERWISE SPECIFIED HEREIN.

WSC:KF ITEM SIZE:5.42 X 5.42 X 5.30 ITEM WEIGHT: 0.95 APPROVED: JAMES F. ZOLL

STATEMENT A, UNLIMITED

Attachment 003

TABLE IV Category of inspection.

Class.	Description	Requirements	Method 1/	First Article	Conformance
	Performance	3.2.1	4.5.2		
Major	Output impedance	3.2.1.2	4.5.2.1	X	100%
	Tachometer output	3.2.1.3	4.5.2.2		
Major	Phasing	3.2.1.3.1	4.5.2.2.1	X	100%
Major	Scale factor	3.2.1.3.2	4.5.2.2.2	X	100%
Major	Linearity	3.2.1.3.3	4.5.2.2.3	X	100%
Major	Hysteresis	3.2.1.3.4	4.5.2.2.4	X	100%
Major	Threshold	3.2.1.3.5	4.5.2.2.5	X	100%
Major	Brush test	3.2.1.3.6	4.5.2.2.6	X	100%
Major	Insulation resistance	3.2.1.4	4.5.2.3	X	100%
	Environmental tests	3.2.2	4.5.3		
	Operational environment	3.2.2.1	4.5.3.1		
	Ambient operating temp.	3.2.2.1.1	4.5.3.1.1		
Major	Cold	3.2.2.1.1	4.5.3.1.1.1	X	
Major	Hot	3.2.2.1.1	4.5.3.1.1.2	X	
Major	Humidity	3.2.2.1.2	4.5.3.1.2	X	
Major	Salt fog	3.2.2.1.3	4.5.3.1.3	X	
Major	Vibration	3.2.2.1.4	4.5.3.1.4	X	
	Shock	3.2.2.1.5	4.5.3.1.5		
Major	Basic shock	3.2.2.1.5.1	4.5.3.1.5.1	X	
Major	Gun firing shock	3.2.2.1.5.2	4.5.3.1.5.2	X	
Major	Altitude	3.2.2.1.6	4.5.3.1.6	X	
	Nonoperational environ.	3.2.2.2	4.5.3.2		
	Ambient storage temp.	3.2.2.2.1	4.5.3.2.1		
Major	Cold	3.2.2.2.1	4.5.3.2.1.1	X	
Major	Hot	3.2.2.2.1	4.5.3.2.1.2	X	
Major	Fungus	3.2.2.2.2	4.5.3.2.2	X	
Major	Altitude	3.2.2.2.3	4.5.3.2.3	X	
Major	Washdown	3.2.2.2.4	4.5.3.2.4	X	
Minor	First article sample inspection	3.4.1	4.5.3.3	X	
	Workmanship	3.5	4.5.5		
Minor	General	3.5.1	4.5.5.1	X	2/
Minor	Packaging	5	4.5.6		2/

Attachment 004

DTL12561691
CAGE Code: 19200
21 June 2001

DETAIL SPECIFICATION

ITEM SPECIFICATION

FOR THE

TACHOMETER ASSEMBLY, AZIMUTH: 12561691

U.S. Army TACOM-ARDEC
Picatinny Arsenal, NJ 07806-5000

DTL12561691

Prepared by
TACOM-ARDEC Quality Engineering Directorate
Fire Control Group - AMSTA-AR-QAT-F

This specification was certified to be in compliance with the criteria of MIL-STD-961D by the TACOM ARDEC Standards Executive (TBD). Copies of the certification and signatures of the authorizing authorities are on file and are available upon request from the Preparing Activity.

FSC: 1290

This cover page must be part of the solicitation copy.

1. SCOPE

1.1 Scope. This specification establishes the requirements for manufacture and acceptance of the azimuth tachometer assembly used in the Automatic Fire Control System (AFCS) for the M109A6 self-propelled howitzer (SPH) (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are needed to meet the requirements specified in sections 3 and 4 of this specification. This section does not include documents 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 requirements 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

STANDARDS
DEPARTMENT OF DEFENSE

MIL-STD-202	–	Test Methods for Electronic and Electrical Component Parts
MIL-HDBK-454	-	General Guidelines for Electronic Equipment
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-1916	-	DOD Preferred Methods for Acceptance of Product

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from Standardization Documents Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings and publications. The following other Government documents, drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation (see 6.2).

DRAWINGS

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (ARDEC)

12561691 - Assembly, Azimuth Tachometer

(Copies of drawings, publications, and other Government documents required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of documents cited in the solicitation. (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Polymeric Matrials to Fungi.

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken PA19428-2959)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references 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 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.2), in accordance with 4.3.

3.1.1 First article sample inspection. After completion of first article test, the first article sample shall meet the requirements of 3.5.1.

3.2 Characteristics.

3.2.1 Performance.

3.2.1.1 External load. The azimuth tachometer assembly shall provide rated performance for external resistive loads whose impedance is 36k ohms minimum.

3.2.1.2 Output impedance. The output impedance of the azimuth tachometer assembly shall be 360 ohms maximum.

3.2.1.3 Tachometer output. Maximum output voltage shall be 4.3 Vdc ± 12 percent at a maximum operating speed of 10.0 Radians/Second (R/Sec).

3.2.1.3.1 Phasing. Clockwise rotation (as viewed into gear attachment end) will cause pin A to be positive with respect to pin B. Counterclockwise rotation (as viewed into gear attachment end) will cause pin A to be negative with respect to pin B.

3.2.1.3.2 Scale factor. The Scale Factor (SF) of the azimuth tachometer assembly, which is the output voltage at a rotational velocity divided by the rotational velocity, shall be 0.43 Volts/Radian/Second (V/R/Sec) ± 12 percent. The scale factor shall be met over the operating range from 0.05 to 10.0 rad/sec for both clockwise (CW) and counterclockwise (CCW) directions.

3.2.1.3.3 Linearity. The linearity of the azimuth tachometer assembly, defined in the equation below, shall be .5 percent maximum.

linearity (%) = {sqrt sum ([SF(avg) - SF(i)]^2)/SF(avg)} x 100

where: SF(avg) = (sum of all SF(i))/16

SF (i) = scale factor at i sample in Table V
x^2=x*x

3.2.1.3.4 Hysteresis. The hysteresis of the azimuth tachometer assembly, as defined in the equation below, shall be 2 percent maximum.

Hysteresis (%)={|(avg CW SF - avg CCW SF)|/(avg CW SF)} x 100

where: avg CW SF = (sum of all CW SFs)/8
avg CCW SF = (sum of all CCW SFs)/8

3.2.1.3.5 Threshold. The threshold output voltage shall be 0.0215 ± 12 percent at an operating speed of 0.050 R/Sec.

3.2.1.3.6 Brush test. The tachometer shall be driven at 10 rad/sec clockwise for thirty seconds and thereafter thirty seconds counter clockwise at 10 rad/sec. The running time shall be 500 hours. Rerun test specified in 3.2.1

3.2.1.4 Insulation resistance. The insulation resistance from the tachometer output pins to the case shall be 100 megohms minimum. The resistance between pins C and D shall be less than 1 ohm.

3.2.2 Environmental.

3.2.2.1 Operational environment.

3.2.2.1.1 Ambient operating temperature. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 while the operating temperature of the ambient air is within the range of -50°F to +140°F.

3.2.2.1.2 Humidity. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 at a relative humidity up to a maximum of 100 percent across the temperature range defined in 3.2.2.1.1.

3.2.2.1.3 Salt fog. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 during and after exposure to salt fog solution.

3.2.2.1.4 Vibration. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 during and after being subjected to vibration as shown in Table I using the axis configurations as shown in Figure 1.

TABLE I. Vibration

Test Phase	5-500 Hz Floor Level (g^2/Hz)	No. Sweeps	Narrowband 1 BW (Hz)	Narrowband 1 Ampl (g^2/Hz)	Narrowband 1 Sweep BW (Hz)	Narrowband 2 BW (Hz)	Narrowband 2 Ampl (g^2/Hz)	Narrowband 2 Sweep BW (Hz)	Narrowband 3 BW (Hz)	Narrowband 3 Ampl (g^2/Hz)	Narrowband 3 Sweep BW (Hz)	Narrowband 4 BW (Hz)	Narrowband 4 Ampl (g^2/Hz)	Narrowband 4 Sweep BW (Hz)	Narrowband 5 BW (Hz)	Narrowband 5 Ampl (g^2/Hz)	Narrowband 5 Sweep BW (Hz)
						VERTICAL AXIS (11 minutes per test phase)											
V01	0.0010	6	18-30	0.0882	6	36-60	0.0081	12	-------	------	--	-------	------	--	-------	------	--
V02	0.0024	6	36-42	0.4914	3	72-84	0.0391	6	108-126	0.0076	9	144-168	0.0275	12	-------	------	--
V03	0.0026	2	48-60	0.2467	6	96-120	0.0319	12	144-180	0.0062	18	192-240	0.0135	24	-------	------	--
V04	0.0034	2	66-96	0.1227	15	132-192	0.0249	30	198-288	0.0074	45	-------	------	--	-------	------	--
V05	0.0024	2	102-126	0.0307	12	204-252	0.0120	24	408-500	0.0079	48	-------	------	--	-------	------	--
						TRANSVERSE AXIS (11 minutes per test phase)											
T01	0.0022	4	18-36	0.0585	9	36-72	0.0064	18	-------	------	--	-------	------	--	-------	------	--
T02	0.0034	4	42-48	0.1639	3	84-96	0.0435	6	126-144	0.0128	9	168-192	0.0130	12	210-240	0.0239	15
T03	0.0032	2	54-66	0.0332	6	108-132	0.0223	12	162-198	0.0150	18	216-264	0.0179	24	270-330	0.0152	30
T04	0.0040	2	72-96	0.0457	12	144-192	0.0221	24	216-288	0.0660	36	288-384	0.0076	48	-------	------	--
T05	0.0030	2	102-126	0.0024	12	204-252	0.0647	24	306-378	0.0072	36	408-500	0.0074	48	-------	------	--
						LONGITUDINAL AXIS (11 minutes per test phase)											
L01	0.0012	4	18-36	0.0069	9	36-72	0.0046	18	-------	------	--	-------	------	--	-------	------	--
L02	0.0017	4	42-48	0.0305	3	84-96	0.0143	6	126-144	0.0040	9	168-192	0.0246	12	210-240	0.0037	15
L03	0.0022	2	54-66	0.0679	6	108-132	0.0034	12	162-198	0.0067	18	216-264	0.0032	24	-------	------	--
L04	0.0030	2	72-90	0.0369	9	144-180	0.0229	18	216-270	0.0040	27	288-360	0.0052	36	360-450	0.0069	45
L05	0.0022	2	96-126	0.0157	15	192-252	0.0091	30	288-378	0.0076	45	384-500	0.0072	60	-------	------	--

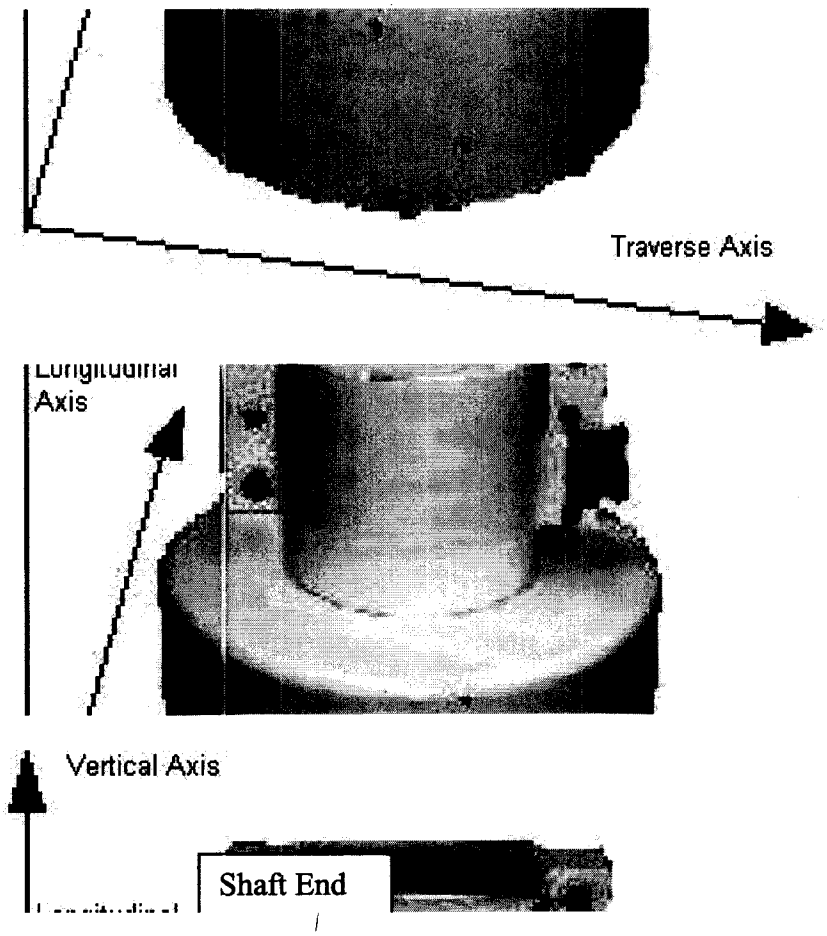

FIGURE 1. Azimuth tachometer assembly axes orientations.

3.2.2.1.5 Shock.

3.2.2.1.5.1 Basic shock. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 during and after being subjected to three half sine wave pulses applied along each of three mutually perpendicular axes with peak amplitudes of 30 ± 3 g for 18 ± 1.8 msec as shown in figure 1.

3.2.2.1.5.2 Gun firing shock. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 during and after being subjected to three half sine wave pulses applied along each of three mutually perpendicular axes with peak amplitudes of 200 ± 20 g for 0.5 ± 0.1 msec as shown in figure 1.

3.2.2.1.6 Altitude. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 during and after exposure to pressure encountered at altitudes up to 10,000 feet above sea level (10.1 psia).

3.2.2.2 Nonoperational environment.

3.2.2.2.1 Ambient storage temperature. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 after being subject to storage temperature of the ambient air within the range of -50°F to +160°F per the following restrictions:

a. Exposure at temperature extremes of 145°F to 160°F shall be limited to one hour duration per 24-hour period.

b. Temperature variation during any 8-hour period shall be sinusoidal with a maximum variation of 69°F.

3.2.2.2.2 Fungus. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 after exposure to spore suspension as defined in the "Specimen Inoculation" paragraph of ASTM G21, followed by exposure to ambient air temperatures between 81°F and 93°F at relative humidity between 96 and 100 percent non-condensing for a 28 day duration. All exterior connectors and mounting surfaces shall have a mating connector, cover, or equivalent installed during exposure.

3.2.2.2.3 Altitude. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 after exposure to pressures within the range of 1.68 to 2.14 psia.

3.2.2.2.4 Washdown. The azimuth tachometer assembly shall meet the performance requirements in 3.2.1 after being subjected to washdown using hot water at 140° ± 20°F with a shearing pressure between 9 and 11 psi and air drying at a temperature not to exceed 145°F. All exterior connectors and mounting surfaces shall have a mating connector, cover, or equivalent installed during exposure.

3.3 Fabrication. The azimuth tachometer assembly shall be manufactured in accordance with drawing 12561691.

3.4 Workmanship.

3.4.1.General workmanship. General workmanship shall be in accordance with MIL-HDBK-454 , Guideline 9.

4. VERIFICATION.

TABLE II. Requirements/verification cross-reference matrix

REQUIREMENT/VERIFICATION CROSS-REFERENCE MATRIX

METHOD OF VERIFICATION

N/A	–	NOT APPLICABLE
1	–	ANALYSIS
2	–	DEMONSTRATION
3	–	EXAMINATION
4	–	TEST

CLASSES OF VERIFICATION

A	–	DESIGN VERIFICATION
B	–	FIRST ARTICLE TEST
C	–	CONFORMANCE 1/

SECTION 3 REQUIREMENT	DESCRIPTION	VERIFICATION METHOD					VERIFICATION CLASS			SECTION 4 VERIFICATION
		N/A	1	2	3	4	A	B	C	
3.2.1.1	External load					X		X	X	4.5.1.1
3.2.1.2	Output impedance.					X		X	X	4.5.1.2
3.2.1.3	Tachometer output.					X		X	X	4.5.1.3
3.2.1.3.1	Phasing.					X	X	X	X	4.5.1.3.1
3.2.1.3.	Scale Factor					X		X	X	4.5.1.3.
3.2.1.3.3	Linearity.					X		X	X	4.5.1.3.3
3.2.1.3.4	Hysteresis.					X		X	X	4.5.1.3.4
3.2.1.3.5	Threshold.					X		X	X	4.5.1.3.5
3.2.1.3.6	Brush test.					X		X		4.5.1.3.6
3.2.1.4	Insulation resistance					X		X	X	4.5.1.4
3.2.2.1.1	Ambient operating temperature					X		X	X	4.5.2.1.1
3.2.2.1.2	Humidity					X		X		4.5.2.1.2
3.2.2.1.3	Salt fog					X		X		4.5.2.1.3
3.2.2.1.4	Vibration.					X		X	X	4.5.2.1.4
3.2.2.1.5.1	Basic shock					X		X	X	4.5.2.1.5.1
3.2.2.1.5.2	Gun firing shock					X		X	X	4.5.2.1.5.2
3.2.2.1.6	Altitude					X		X	X	4.5.2.1.6
3.2.2.2.1	Ambient storage temperature					X		X	X	4.5.2.2.1
3.2.2.2.2	Fungus.		X					X		4.5.2.2.2
3.2.2.2.3	Altitude					X		X	X	4.5.2.2.3
3.2.2.2.4	Wash down.					X		X		4.5.2.2.4
3.3	Fabrication.				X		X	X	X	4.5.3.3
3.4.1	General workmanship				X		X	X	X	4.5.5.1

1/ Unless otherwise specified perform 100% inspection.
2/ Sample size is as defined by level II of Table IV

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

a. First Article Inspection (see 4.3).
b. Conformance (see 4.4).

4.2 Verification conditions. Unless otherwise specified, all verification shall be performed in accordance with the test conditions specified in Table II

-

4.3 First article. When specified in the contract, a sample shall be subjected to first article verification in accordance with Table III

4.3.1 First article quantity. First article verification shall be performed on three (3) items.

4.3.2 Inspections to be performed. The sequence of first article testing shall be in accordance with Table III . The first article sample shall have been subjected to, and pass, the conformance requirements as defined in Table II. Subassemblies and piece parts, at a minimum, shall be inspected for conformance to the characteristics defined in the assurance provisions of the applicable drawing.

4.3.3 First article rejection. If any item fails to comply with the first article requirements, the sample shall be rejected (see 6.2). Disposition of the item shall be as specified in the contract or purchase order (see 6.2)

1/ To ensure the First Article sample has been subjected to, and passed, the conformance tests as defined in Table II the contractors records may be reviewed to assess compliance.

2/ The first article performance tests, as defined in Table II, shall be performed only once. Performance testing, after the first article sample has been subjected to the various environments shall consist of the performance test defined in the conformance section of Table II

TABLE III First article test sequence.

Test Sequence 1/	Requirement Paragraph	Test Method	Sample 1	2	3
Performance 2/	3.2.1	4.5.2	X	X	X
Cold ambient storage temp.	3.2.2.2.1	4.5.3.2.1.1	X	X	X
Hot ambient storage temp.	3.2.2.2.1	4.5.3.2.1.2	X	X	X
Cold ambient operating temp.	3.2.2.1.1	4.5.3.1.1.1	X	X	X
Hot ambient operating temp.	3.2.2.1.1	4.5.3.1.1.2	X	X	X
Altitude non-operating	3.2.2.2.3	4.5.3.2.3	X	X	X
Altitude operating	3.2.2.1.6	4.5.3.1.6	X	X	X
Vibration	3.2.2.1.4	4.5.3.1.4	X	X	X
Basic shock	3.2.2.1.5.1	4.5.3.1.5.1	X	X	X
Gun firing shock	3.2.2.1.5.2	4.5.3.1.5.2	X	X	X
Wash down	3.2.2.2.4	4.5.3.2.4	X	X	X
Humidity	3.2.2.1.2	4.5.3.1.2	X		
Fungus	3.2.2.2.2	4.5.3.2.2		X	
Salt fog	3.2.2.1.3	4.5.3.1.3			X
First article sample inspection	3.4.1	4.5.3.3	X	X	X

4.4 Conformance inspection.

4.4.1 Lot formation. Lot formation shall be in accordance with the lot formation requirement of MIL-STD-1916, paragraph 4.5

4.4.2 Examinations and tests.

4.4.2.1 Classification of characteristics. Conformance examination and test shall be as specified in Table II. The contractor's program or detailed inspection plan shall provide assurance of compliance of all characteristics with the applicable drawing and specification requirements utilizing as a minimum the conformance criteria specified herein. Subassemblies and piece parts shall be inspected for conformance to the characteristics defined in the assurance provisions of the applicable drawing.

TABLE IV Attributes sampling inspection.

Inspection levels 1/		
Lot Size	I	II
2 to 8	*	*
9 to 15	*	13
16 to 25	*	13
26 to 50	*	13
51 to 90	*	13
91 to 150	125	13
151 to 280	125	32

1/ Numbers under inspection levels indicate sample size: asterisks (*) indicate one hundred percent inspection. If sample size exceeds lot size, perform one hundred percent inspection. Accept on zero and reject on one or more for all inspection levels.

4.4.1.2 Alternative conformance provisions. Alternative inspection procedures, methods, or equipment, such as statistical process control, tool control, other types of sampling procedures, etc., may be used by the contractor when they provide, as a minimum, the level of assurance required by the provisions specified herein. Prior to applying such alternative procedures, methods, or equipment, the contractor shall describe them in a written proposal submitted to the procuring contracting officer for evaluation and approval by the Government. When required, the contractor shall demonstrate that the effectiveness of the proposed alternative(s) is equal to or better than the specified assurance provisions herein. In cases of dispute as to whether the contractor's proposed alternative(s) provide equal assurance, the provisions of this specification shall apply. All approved alternative inspection provisions shall be specifically incorporated into the contractor's program plan or detailed inspection system, as applicable. (See 6.4)

4.4.2 Rejection. If any assembly, component, or test specimen fails to comply with any of the applicable requirements, the item shall be rejected. Disposition of the item shall be as specified in the contract or purchase order. (See 6.2.).

4.5 Methods of inspection.

4.5.1 Test conditions.

4.5.1.1 Environmental. Unless otherwise specified, all tests shall be performed at an atmospheric pressure between 28 and 32 inches of mercury, a temperature of 75 ± 25°F, and a relative humidity between 10 percent and 90 percent.

4.5.1.2 Test software. Test software includes supporting test software that resides in external test computer(s). Test software used for first article and conformance tests shall be submitted for approval (see 6.3) as part of the inspection test equipment.

4.5.1.3 External load. Unless otherwise specified, there shall be an externally connected load as specified in 3.2.1.1.

4.5.2 Performance test methods.

4.5.2.1 Output impedance. With the azimuth tachometer assembly speed set at 1.0 ± 0.1 rad/sec, measure the no load voltage across pins A and B. With 2610 ohm load resistor (1 percent tolerance) applied across pins A and B measure the output voltage across the load resistor. The ratio of loaded output voltage over no load output voltage shall be equal to or greater than 0.87.

4.5.2.2 Tachometer output. The azimuth tachometer assembly output shall meet the requirements of 3.2.1.3. The voltage shall be measured at pins A and B for the maximum CW and CCW operating speed defined in Table V. The output voltage shall be as specified in Table V.

4.5.2.2.1 Phasing. The azimuth tachometer assembly phasing shall meet the requirements of 3.2.1.3.1. The output voltage shall be measured at pins A and B when the tachometer shaft is rotated in the CW direction (as viewed into gear attachment end). The output voltage shall be positive on pin A with respect to pin B for CW rotation. The output voltage shall be negative on pin A with respect to pin B for CCW rotation.

4.5.2.2.2 Scale factor. The azimuth tachometer assembly scale factor shall meet the requirements of 3.2.1.3.2. The voltage shall be measured at pins A and B for the CW and CCW operating speeds defined in Table V. The scale factor shall be calculated using the following equation for both directions of rotation.

$$\text{Scale Factor} = \text{Vout}(W)/W$$

where: Vout = tachometer output voltage at W
W = rotational velocity

TABLE V Azimuth tachometer test data.

	Rotation ± 1% (CW is +)	Expected Output (Volts)		
	Rad/Sec	Min	Nominal	Max
1	0.05	0.0189	0.0215	0.0241
2	0.10	0.0378	0.0430	0.0482
3	0.20	0.0757	0.0860	0.0936
4	0.50	0.1892	0.2150	0.2408
5	1.00	0.3784	0.4300	0.4816
6	2.00	0.7568	0.8600	0.9632
7	5.00	1.892	2.150	2.408
8	10.00	3.784	4.300	4.816
9	-0.05	-0.0189	-0.0215	-0.0241
10	-0.10	-0.0378	-0.0430	-0.0482
11	-0.20	-0.0757	-0.0860	-0.0936
12	-0.50	-0.1892	-0.2150	-0.2408
13	-1.00	-0.3784	-0.4300	-0.4816
14	-2.00	-0.7568	-0.8600	-0.9632
15	-5.00	-1.892	-2.150	-2.408
16	-10.00	-3.784	-4.300	-4.816

4.5.2.2.3 Linearity. The azimuth tachometer assembly linearity shall meet the requirements of 3.2.1.3.3. Linearity shall be calculated, for both CW and CCW directions, using the equation defined in 3.2.1.3.3. This equation uses the scale factors determined in 4.5.2.2.2.

4.5.2.2.4 Hysteresis. The azimuth tachometer assembly hysteresis shall meet the requirements of 3.2.1.3.4. The scale factors for both directions of rotation shall be calculated using the equation defined in 4.5.2.2.2. Hysteresis shall be calculated using the equation defined in 3.2.1.3.4.

4.5.2.2.5 Threshold. The azimuth tachometer assembly threshold shall meet the requirements of 3.2.1.3.5. The voltage shall be measured at pins A and B for the minimum CW and CCW operating speed defined in Table V. The output voltage shall be as specified in Table V

4.5.2.2.5 Brush test. The azimuth tachometer brush assembly shall meet the requirements of 3.2.1.3.6.

4.5.2.3 Insulation resistance. The azimuth tachometer assembly insulation resistance shall meet the requirements of 3.2.1.4 when tested in accordance with MIL-STD-202, Method 302, Condition B. The measurement shall be made between pin A and the case.

4.5.3 Environmental test methods.

4.5.3.1 Operational environment.

4.5.3.1.1 Ambient operating temperature.

4.5.3.1.1.1 Cold ambient operating temperature. This test shall be conducted in accordance with MIL-STD-810, Method 502.2, Procedure II after thermally stabilizing at a low temperature of -50° +5°/-0°F for a minimum of 4 hours. During the stabilization period the unit shall be unpowered. At the conclusion of this time, the azimuth tachometer assembly shall be tested per the conformance performance tests specified in Table II. If needed, the chamber door may be opened to take measurements directly or the unit may be removed from the chamber to perform the tests. These tests shall be completed within 15 minutes of opening the door, if not completed within 15 minutes; the temperature conditions shall be re-established prior to continuing.

4.5.3.1.1.2 Hot ambient operating temperature. This test shall be conducted in accordance with and MIL-STD-810, Method 501.2, Procedure II after thermally stabilizing at a high temperature of +140° +0°/-5°F for a minimum of 4 hours. During the stabilization period the unit shall be powered. At the conclusion of this time, the azimuth tachometer assembly shall be tested per the conformance performance tests specified in Table II. If needed, the chamber door may be opened to take measurements directly or the unit may be removed from the chamber to perform the tests. These tests shall be completed within 15 minutes of opening the door, if not completed within 15 minutes, the temperature conditions shall be re-established prior to continuing.

4.5.3.1.2 Humidity. This test shall be conducted in accordance with MIL-STD-810, Method 507.2, Procedure I, cycle 2, for 240 hours (10 cycles) except that the temperature shall be cycled from 85°F to 140°F for a minimum of 4 hours. During each 24 hour cycle the temperature shall be stabilized at 85°F for a minimum of 4 hours and at 140°F during each 24 hour cycle. The rate of temperature change during transition periods shall not exceed 8°F/hour. All exterior connectors and mating surfaces shall have a mating connector, cover, or equivalent installed prior to exposure. Operational checkouts shall be conducted using the conformance performance tests specified in Table II within 1 hour of removal of the unit from the chamber and shall be performed at the end of the tenth cycle as a minimum.

4.5.3.1.3 Salt fog. This test shall be conducted in accordance with MIL-STD-810, Method 509.2 except with fog density as specified by 3.2.2.1.3. The unit under test shall be unpowered while exposed to a salt fog solution of 5 percent ± 1 percent Sodium Chloride for 48 hours. The temperature in the exposure zone shall be maintained between 90°F and 95°F. All exterior connectors and mounting surfaces shall have a mating connector, cover, or equivalent installed prior to exposure. After exposure, the azimuth tachometer assembly shall be dried for 48 hours and then tested per the conformance performance tests specified in Table II

4.5.3.1.4 Vibration. This test shall be conducted in accordance with MIL-STD-810, Method 514.3, Procedure I, category 8. The vibration test levels and duration are specified in Table I in 3.2.2.1.4. After exposure, the azimuth tachometer assembly shall be tested per the conformance performance tests specified in Table II. Orientation of the vibration control accelerometers shall be with the axis shown in Figure 1. Test duration shall be as specified in Table I plus or minus 30 seconds.

4.5.3.1.5 Shock.

4.5.3.1.5.1 Basic shock. This test shall be conducted in accordance with MIL-STD-810D, Method 516.3, Procedure I and shall consist of 3 cycles of shock as specified in 3.2.2.1.5.1. The response spectra shall not deviate from the input condition by more than ± 3.5 dB. After exposure, the azimuth tachometer assembly shall be tested per the conformance performance tests specified in Table II.

4.5.3.1.5.2 Gunfire shock. This test shall be conducted in accordance with MIL-STD-810, Method 516.3, Procedure I and shall consist of 3 cycles of shock as specified in 3.2.2.1.5.2. The response spectra shall not deviate from the input condition by more than ± 3.5 dB. After exposure, the elevation tachometer assembly shall be tested per the conformance performance tests specified in Table II.

4.5.3.1.6 Altitude. This test shall be conducted in accordance with MIL-STD-810, Method 500.2, Procedure III. Pressure shall be maintained at 10.1 psi for a minimum of 30 minutes. During the stabilization period the unit shall be unpowered. At the conclusion of this time the azimuth tachometer assembly shall be tested per the conformance performance test specified in Table II.

4.5.3.2 Nonoperational environment.

4.5.3.2.1 Ambient storage temperature.

4.5.3.2.1.1 Cold ambient storage temperature. This test shall be conducted in accordance with MIL-STD-810, Method 502.2, Procedure I for 168 hours at a low temperature of -50° +5°/-0°F. After exposure, the azimuth tachometer assembly shall be tested per the conformance performance tests specified in Table II at -50° +0°/-5°F and again at room temperature (75° ± 25°F).

4.5.3.2.1.2 Hot ambient storage temperature. This test shall be conducted in accordance with MIL-STD-810, Method 501.2, Procedure I for 168 hours (7 cycles) at a high temperature of +145° +0°/-5°F, with 1 hour +0/-5 minutes of each 24 hour cycle at 160° +0°/-5°F per figure 3. After exposure, the azimuth tachometer assembly shall be tested per the conformance performance tests specified in Table II at 140° +0°/-5°F and again at room temperature (75° ± 25°F).

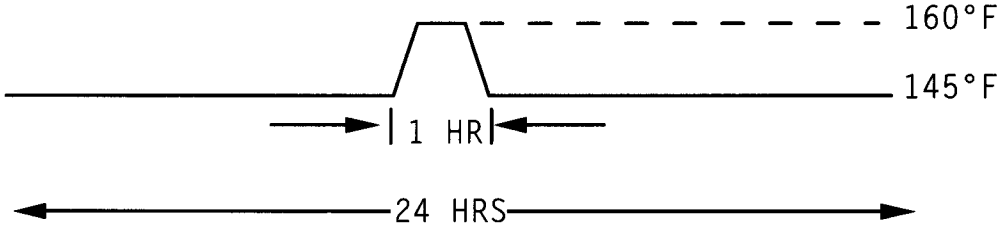

FIGURE 3. Hot storage temperature profile.

4.5.3.2.2 Fungus. This test shall be conducted in accordance with ASTM-G21, Class 2, Method B except temperature and duration shall be as specified in 3.2.2.2.2. All exterior connectors and mounting surfaces shall have a mating connector, cover, or equivalent installed prior to exposure. After exposure, the azimuth tachometer assembly shall be tested per conformance performance tests specified in Table II at room temperature (75° ± 25°F).

4.5.3.2.3 Altitude. This test shall be conducted in accordance with MIL-STD-810, Method 500.2, Procedure I and 3.2.2.2.3. Pressure shall be maintained at specified value for 4 hours - 0/+5 minutes. All exterior connectors and mounting surfaces shall have a mating connector, cover, or equivalent installed prior to exposure. After exposure, the azimuth tachometer assembly shall be tested per the conformance performance tests specified in Table II.

4.5.3.2.4 Washdown. The azimuth tachometer assembly shall be subjected to a washdown in accordance with 3.2.2.2.4 for 5 minutes ± 1 minute uniformly applied over external surfaces and air dried for 2 hours ± 5 minutes at a temperature not to exceed 145°F. All exterior connectors and mounting surfaces shall have a mating connector, cover, or equivalent installed prior to exposure. After exposure and during, the azimuth tachometer assembly shall be tested per the conformance performance tests specified in Table II.

4.5.3.3 First article sample inspection. The item shall be visually inspected (externally) for damage resulting in workmanship defects in accordance with 3.5.1. The cover shall be removed and the item interior shall be visually inspected for damage resulting in workmanship defects in accordance with MIL-HDBK-454, Guideline 9.

4.5.5 Workmanship.

4.5.5.1 General workmanship. General workmanship shall be in accordance with MIL-HDBK-454, Guideline 9. The azimuth tachometer assembly shall be visually inspected for legible identification markings specified in accordance with the applicable drawing.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DOD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. 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.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 General description. The azimuth tachometer assembly is a precision, permanent magnetic unit. The azimuth tachometer assembly measures angular velocity about its axis. It provides a direct current (dc) voltage that is proportional to the angular velocity of the input shaft.

6.1.1 Intended use. The azimuth tachometer assembly is intended for use as a component of the M109A6 Howitzer automatic fire control system.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Packaging requirements

c. Requirements for first article (see 4.3)

d. Special test equipment approval requirements (see 6.3).

e. Disposition instructions for nonconforming material (see 4.3.3 and 4.4.2).

6.3 Submission of inspection equipment designs for approval. Contractor designs for the final acceptance inspection equipment should be approved by the Government prior to fabrication or procuring the equipment. Submit designs as required to: Commander, U.S. Army Armament Research, Development and Engineering Center, AMSTA-AR-QAT-F, Picatinny Arsenal, NJ 07806-5000. This address will be specified on the Contract Data Requirements List DD Form 1423 in the contract.

6.4 Submission of alternative conformance provisions. All contractor proposed alternative conformance provisions will be submitted to the Government for evaluation/approval as directed by the contracting activity.

6.5 Precautions.

6.5.1 Mounting precaution. Since the azimuth tachometer is a sensitive magnetic device, precaution must be taken to assure that the assembly is not mounted in the vicinity of permanent magnets or coils with strong magnetic fields. Items within one inch of the azimuth tachometer, such as mounting screws, shall be of non-magnetic material.

6.5.2 Assembly precaution. The unhoused tachometer consists of a permanent magnetic field with keeper, armature, brush assembly, and brush hardware. The keeper should be kept within the magnetic field to maintain magnetization.

6.5.3 Subject term (key word) listing.
AFCS
Fire Control System, Automatic

Custodian
Army - AR

Preparing Activity
Army –AR