

SPECIFICATION  
FOR  
28-TRACK WIDEBAND  
PORTABLE/LABORATORY REPRODUCER  
MODEL M-14G

Date:

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1.0 SCOPE

This Specification defines the general performance requirements for a modified version of the Astro-Science Corporation Model M-14G Wideband Reproducer System. The recorder will operate at tape speeds of 1-7/8, 3-3/4, 7-1/2, 15, 30 and 60 inches per second. The function of the M-14G is to reproduce up to 28 tracks of wideband data. Bandwidth is 400 Hz to 1 MHz at 60 ips and proportional at lower tape speeds.

Figure 1 illustrates the form factor and packaging of the reproducer. As shown, the reproducer is contained in two enclosures:

- a) The prime enclosure contains the transport, ac power supply, magnetic heads, operator controls, and 14-channels of reproduce amplifiers. This rack mount enclosure is 19" wide 26-1/4" high x 16" deep. The weight of this portable enclosure is approximately 135 lbs.
- b) The secondary enclosure contains the second set of 14 reproduce amplifiers, to complete the 28-track reproduce system. This rack mountable enclosure is 19" wide x 5-1/4" high x 14" deep and weighs approximately 25 lbs. Drawer slides are included, along with interconnecting cables.

Detail specifications are presented in the following paragraphs. Specifications are based upon reproducing tapes recorded on the Astro-Science GPAR or MARS-1428(LT)-3B



ASTRO-SCIENCE CORPORATION

A TRACOR COMPANY

PRIMARY ENCLOSURE

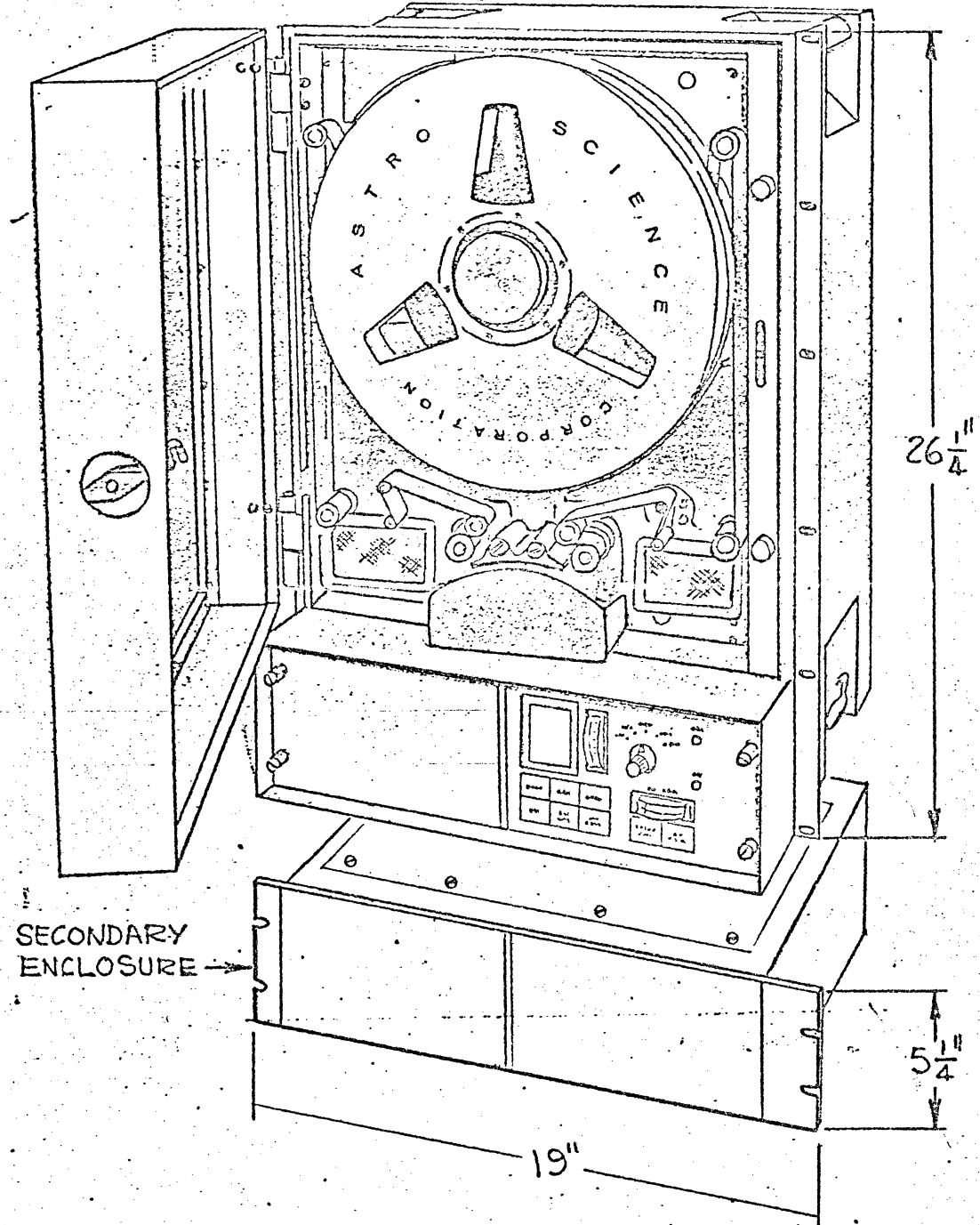


FIGURE 1  
FORM FACTOR, 28 TRACK REPRODUCER

Modular Airborne Recorder System, unless otherwise specified.

## 2.0 APPLICABLE DOCUMENTS

The following documents of the issue shown shall form a part of this specification to the extent specified herein. In the event of conflict between the referenced documents and the detailed requirement of this specification, the latter shall take precedence.

### 2.1 MILITARY STANDARDS

MIL-STD-129D (Notice 12)	Marking for Shipment and Storage
MIL-STD-130C	Identification Marking of U.S. Military Property
MIL-STD-454B (Notice 1)	Standard General Requirements for Electronic Equipment

### 2.2 SPECIFICATIONS

#### Federal

W-T-0070 (Navy Ships)	Tapes, Recording, Sound and Instrumentation - Magnetic Oxide Coated
W-R-00175b	Reels and Hubs for Magnetic Recording Tape

#### Military

MIL-E-15090	Painting Requirement
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MIL-C-5541A	Chemical Film Finishes
MIL-E-16400F (Amendment 4)	Electronic Equipment, Naval Ship and Shore
MIL-I-6181D	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-Q-9858A	Quality Assurance Requirements

2.3 OTHER DOCUMENTS

IRIG Document 106-71	Telemetry Standards, Telemetry Working Group, Inter-Range Instrumentation Group, Range Commanders Council
IRIG Document 118-71	Test Methods for Telemetry Systems and Subsystems, Telemetry Working Group, Inter-Range Instrumentation Group, Range Commanders Council
ASC Document 98000911	Technical Specification, Astro- Science GAPR/MARS-1400 Series Modular Airborne Recorder System

3.0 DESIGN REQUIREMENTS

3.1 GENERAL

This specification defines the requirements for a portable wideband magnetic tape reproducer of modular construction.

### 3.2 DESIGN OBJECTIVES

The basic design objectives for the 28-track reproducer are that the equipment reproduce with high quality tapes recorded on the ASC GPAR/MARS-1428(LT)-3B Recorder. The final product shall reflect the utmost in simplicity, have maximum reliability and minimum weight consistent with the state-of-the art, and be easy to install and maintain.

### 3.3 RELIABILITY

#### 3.3.1 GENERAL

Reliability of operation shall be considered of prime importance in the design and manufacture of the equipment. The manufacturer shall employ all methods possible in the manufacture of the equipment which will assure quality with maximum reliability consistent with the state-of-the art.

#### 3.3.2 FUNCTIONAL APPLICATION OF PARTS

In the functional application of parts to the recorder/reproducer circuits, the manufacturer shall:

- a) Take the necessary precautions to assure the part is being applied within its thermal, mechanical, and electrical rating.
- b) Provide the necessary deratings in order to assure equipment reliability under the specified operating conditions.

#### 3.3.3 HEAD LIFE

The Minimum Unconditional Warranty on Reproduce Head Life shall be 1000 hours minimum.

### 3.4 MODULAR CONSTRUCTION AND MAINTAINABILITY

Design for modular construction or maintainability shall be a prime consideration. When installed in its normal rack installation, the design shall permit any major module or subassembly to be removed, replaced or serviced without removing the recorder from its rack installation or enclosure, with access from the front of the rack installation only. A hinged dust/RFI cover and hinged transport door shall be provided for quick and easy access to the following sub-assemblies at a minimum:

- ① Record Amplifier Subassembly (When Applicable)
- ② Magnetic Head Subassembly
- ③ Tape Guides
- ④ Capstan Motor Subassembly
- ⑤ Reel Motor Drive Subassembly
- ⑥ Reel Servo Module and its associated plug-in printed circuit boards
- ⑦ Transport Electronic Housing Assembly and its associated plug-in printed circuit boards
- ⑧ Capstan Servo Driver Subassembly
- ⑨ Power Supply Assembly
- ⑩ Cooling Fan Assembly
- ⑪ Air Filter Assembly
- ⑫ Power/Control Accessory Box Assembly
- ⑬ Reproduce Amplifier PC Boards

All fastening and hold down hardware shall be kept to an absolute minimum. Captive screws and bolts shall be used to the greatest extent practical.

### 3.5 PARTS AND MATERIAL SELECTION

For equipment of existing design, selection of parts and material shall follow Requirement 18 of MIL-STD-454, as guides. Where required to meet the primary design objectives and to provide optimum functional performance, parts and materials of the same or improved grade shall be acceptable. Non-standard parts approval shall not be required for equipment existing.

### 3.6 PAINTING AND FINISH

The external surfaces of the enclosure for the recorder/reproducer shall be painted per MIL-E-15090, Class I, Type 3, Formula 111, Light Grey in color. Other internal surfaces shall be chemical film finished per MIL-C-5541A.

### 3.7 SAFETY

Safety design shall be in accordance with Requirement 1 of MIL-STD-454.

### 3.8 ENVIRONMENTAL CONDITIONS

The Recorder/Reproducer shall be designed to meet the following environmental requirements.

#### 3.8.1 TEMPERATURE CONDITIONS

The recorder/reproducer shall be capable of continuous reliable operation under temperature ranges from 0°C to +54 C.

#### 3.8.2 HUMIDITY

The equipment shall operate satisfactorily at relative humidities of up to 95% for both continuous



and intermittent periods. Under conditions wherein condensation takes place in and on the equipment in the form of both water or frost, it shall be permissible to clean or dry the equipment to restore normal operation.

### 3.8.3 SHOCK

The recorder/reproducer shall be designed to withstand and subsequently operate to specifications, with shock impacts of up to 15 g's for 11 ms.

### 3.8.4 VIBRATION

The reproducer shall continue to operate when exposed to vibration as follows when mounted in its normal rack installation:

4-15 Hz  $\pm 0.030''$   $\pm 0.006''$  Table Amplitude  
16-25 Hz  $\pm 0.020''$   $\pm 0.004''$  Table Amplitude  
26-33 Hz  $\pm 0.010''$   $\pm 0.002''$  Table Amplitude

## 3.9 ELECTRICAL DESIGN

### 3.9.1 PRIMARY POWER

Primary operating power for the reproducer shall be as follows:

115 VAC  $\pm 10\%$ , 50/60 Hz  $\pm 5\%$ , Single-Phase

Power consumption shall not exceed 400 watts average.

### 3.9.2 OVERLOAD PROTECTION

Overload Protection shall be in accordance with

Requirement 8 of MIL-STD-454. Spare fuses as required shall be made available in the Service Kit furnished with the reproducer.

### 3.9.3 ELECTROMAGNETIC INTERFERENCE REQUIREMENTS

The reproducer shall meet the broadband conducted (with LSN) and radiated interference requirements of MIL-I-6181D under test conditions specified in the Electromagnetic Test Plan for the unit. In addition, the reproducer will meet the power line susceptibility limits of MIL-I-6181D.

## 3.10 MECHANICAL DESIGN

Mechanical design of the reproducer shall comply with the requirements specified below.

### 3.10.1 ENCLOSURE

The reproducer shall be contained within two portable enclosures which can be installed in a standard 19-inch equipment rack. The prime enclosure shall contain the transport, ac power supply, magnetic heads, operator controls and 14-channels of reproduce amplifiers. The secondary enclosure shall contain 14 reproduce amplifiers to complete the 28 channel reproduce system.

The prime enclosure shall be ventilated. An internal cooling fan shall be provided. The air intake shall be located on the back of the enclosure, near the bottom edge.

The air intake shall be protected with a reusable air filter. Two lifting handles shall be provided on the top of the recorder and two lifting handles shall be provided on the bottom of the prime enclosure.

### 3.10.2 CONNECTORS

All signal input, signal output, power and remote control connectors shall be conveniently located on a panel located on the back of the enclosures. Signal output connectors shall be BNC type. The power and remote control connectors shall be MS type.

### 3.10.3 SIZE

The size of the enclosure shall not exceed the following:

- a) Prime Enclosure: 19" wide x 26-1/4" high x 16" deep.
- b) Secondary Enclosure: 19" wide x 5-1/4" high x 16" deep.

### 3.10.4 WEIGHT

The weight of the reproducer shall be kept to an absolute minimum consistent with good engineering design. Weight shall be approximately 135 pounds (excluding the magnetic tape reels) for the prime enclosure and 25 pounds for the secondary enclosure.

## 3.11 WORKMANSHIP

The equipment shall be manufactured in a thoroughly workmanship manner in accordance with Requirement 9 of MIL-STD-454, or the manufacturer's workmanship standards that are equal to or better than that specified by MIL-STD-454.

## 4.0 DETAILED DESIGN AND PERFORMANCE REQUIREMENTS

The Reproducer design and performance shall be in accordance

with the requirements functional and physical characteristics specified herein.

#### 4.1 TAPE TRANSPORT FUNCTIONAL DESIGN

The design requirements of the Tape Transport and the control thereof shall be in accordance with the requirements specified hereinafter.

##### 4.1.1 DATA TRACKS

28 channel direct reproduce capability shall be provided. Track spacing shall be in accordance with IRIG Document 106-71.

##### 4.1.2 REEL TYPE

The design of the tape transport shall be such as to accept, without modification or re-adjustment, standard or precision magnetic tape reels as defined herein, and as qualified in accordance with the applicable portions of Federal Specification W-R-00175b. The Reproducer shall conform to the requirements of this specification with the Standard or Precision Reels installed and using the nominal 1" wide tape specified in Paragraph 4.1.3.

- a) Standard Reels, metallic, 3-inch center, 4.5 inch hub with 10.5 or 14 inch flanges conforming to Types I or II and Classes PC or SC as specified in W-R-00175/3b, or the equivalent in Electronic Industry Association (EIA) standard.
- b) Precision Reels, metallic, 3-inch center, 4.5 inch hub with 10.5 or 14 inch flanges conforming to Types I, II or III, and Classes PCP or SCP as specified in W-R-00175/4b, or the equivalent in EIA Standards.

#### 4.1.3 TAPE TYPE

The minimum requirements of Federal Standard W-T-0070/5 high resolution-longitudinally oriented magnetic tape on a polyester film base material shall be used to define the appropriate design of the Reproducer. The tape shall have oxide characteristic E on a nominal 0.001 inch ( $H_T$ ) thickness backing. (3M Company Scotch Brand 888 Magnetic Tape is qualified to the requirements of Federal Standard W-T-0070/5).

#### 4.1.4 TENSION CONTROL

Tape tensions shall be controlled in all modes of operation, including start and stop interval, in such a manner that tape damage is precluded. A servo controlled tape holdback tension in the record and reproduce mode shall be provided.

#### 4.1.5 AUTOMATIC TRANSPORT SHUTOFF

The transport shall be equipped with an end-of-tape sensing mechanism such that transport motion shall stop automatically when end-of-tape is reached prior to tape run-off, or in the event tape breaks.

#### 4.1.6 BRAKING SYSTEM

The transport shall be equipped with a fail-safe emergency braking system which is automatically actuated in the event of power failure or tape breakage. Batteries or other emergency power supplies shall not be used.

#### 4.1.7 TAPE DRIVE

The tape drive shall be of the closed loop dual capstan configuration.

#### 4.1.8 CAPSTAN DRIVE

The capstan drive shall be of a low inertia type.

#### 4.1.9 REEL DRIVE

The drive system for the supply and take-up reels shall use separate servo-controlled motors to achieve tape control.

#### 4.1.10 SERVO CONTROL

- a) **Tape Velocity:** In the record mode, the tape velocity shall be controlled, as it passes the heads, by a fast response servo-controlled capstan. The input to the servo shall be from the encoder disc tachometer on the capstan motor shaft in the reproduce mode. This reference input shall be compared to an internal reference frequency from a crystal controlled oscillator. All items necessary for the complete servo shall be an integral part of the transport assembly.
- b) **Tape Lock Servo (Optional):** As an option, the recorder shall have the capability to provide tape lock servo control for low time base error and optimum speed accuracy. When this option is included, the time base error shall be less than  $\pm 2.0$  microsecond at a tape speed of 60 ips and the reproduce speed accuracy shall be within  $\pm 0.01\%$  of the recording speed. The option shall be included only when specified in the contract.

#### 4.1.11 HEADS AND TAPE GUIDES

Heads shall be inter-leaved reproduce assemblies consisting of 28 data tracks for use with one-inch wide magnetic tape. The Analog head and headstack configuration, dimensions spacing and head polarity shall be in accordance with IRIG 106-71, unless otherwise specified herein. The head assembly shall be of the modular plug-in type and shall be field installable without the need for special tools, shims, gauges or special adjustments and still meet requirements specified herein. Tape guides and record and reproduce heads shall be rigidly and individually mounted on a flat base plate. The tape guides shall be located so that the tape is accurately guided past the heads parallel to the base plate without damaging the tape.

#### 4.1.12 TAPE PATH

The transport shall be designed to facilitate simple threading of the tape. There shall be no sharp corners or edges on/or about the surface of the tape transport on which the tape might catch and tear or result in an operational hazard for the operator. The tape threading operation shall be accomplished in a simple straightforward manner, with a minimum of opportunities for the unskilled operator to misinterpret the threading procedure. An outline of the threading path shall be provided and clearly visible to the operator under normal threading operation.

#### 4.2 TAPE TRANSPORT PERFORMANCE

The functional performance of the Tape Transport and the control thereof shall be in accordance with the requirements specified hereinafter.

#### 4.2.1 TAPE SPEEDS

The Tape Transport shall operate either with tach lock or optional tape lock servo control at tape speeds of 60, 30, 15, 7-1/2, 3-3/4 and 1-7/8 inches per second, locally or remotely selectable.

#### 4.2.2 TAPE SPEED ACCURACY

Tape speed accuracy shall be within  $\pm 0.20\%$  of nominal tape speed.

#### 4.2.3 FAST FORWARD/REVERSE

The fast forward and rewind operation shall be at an average speed of 240 inches per second (7.5 minutes for 9200 feet of tape).

#### 4.2.4 REELS

The tape transport shall accept either precision or nonprecision reels of either 10.5, 12.5 or 14.0 inch diameter conforming to NAB standards without modification or readjustment to reel drive electronics or transport mechanics and meet all applicable specifications stated herein.

#### 4.2.5 TAPE WIDTH AND THICKNESS

The tape transport shall be capable of handling Scotch No. 888 or equivalent polyester-backed magnetic tape 1 inch in width. Further, it shall be capable of operation with any of the following tapes:



<u>TAPE BASE THICKNESS</u>	<u>FEET OF TAPE</u>	<u>REEL SIZE</u>
1.0 Mil (3M888/988/900)	9,200	14"

#### 4.2.6 TRANSPORT SPECIFICATION MEASURED PER IRIG-118-71

##### 4.2.6.1 Reproducing Tapes From ASC GPAR/MARS-1428(LT)-3B

<u>TAPE SPEED (IPS)</u>	<u>FLUTTER P-P (2-SIGMA) TACH SERVO</u>	<u>DYNAMIC SKEW MICROSECONDS (1)</u>	<u>RECORD TIME</u>
60	0.45%	<u>+0.4</u>	30 Min
30	0.60%	<u>+0.8</u>	1 Hr
15	0.70%	<u>+1.6</u>	2 Hrs
7-1/2	0.85%	<u>+3.2</u>	4 Hrs
3-3/4	1.50%	<u>+6.4</u>	8 Hrs
1-7/8	2.50%	<u>+12.8</u>	16 Hrs

NOTE: When delivered as a Reproduce Only System, the above specifications will be used as acceptance criteria.

##### 4.2.6.2 Recording and Reproducing on Itself

<u>TAPE SPEED (IPS)</u>	<u>FLUTTER P-P (2-SIGMA) TACH SERVO</u>	<u>DYNAMIC SKEW MICROSECONDS</u>		<u>RECORD TIME</u>
		<u>(1)</u>	<u>(2)</u>	
60	0.30%	<u>+0.30</u>	<u>+1.0</u>	30 Min
30	0.35%	<u>+0.60</u>	<u>+2.0</u>	1 Hr
15	0.40%	<u>+1.20</u>	<u>+4.0</u>	2 Hrs
7-1/2	0.50%	<u>+2.40</u>	<u>+8.0</u>	4 Hrs
3-3/4	0.65%	<u>+4.80</u>	<u>+16.0</u>	8 Hrs
1-7/8	1.30%	<u>+9.60</u>	<u>+32.0</u>	16 Hrs

(1) Adjacent tracks on same headstack. (2) Outside tracks on same headstack.

4.2.7 START TIME

The transport shall meet all flutter and speed specifications within five (5) seconds after start command at 60 ips.

4.2.8 STOP TIME

The transport shall stop within three (3) seconds after stop command at 60 ips.

4.2.9 PULSE TO PULSE JITTER

Pulse to pulse jitter shall be no more than  $\pm 0.5$  microsecond in a 200 microsecond interval at 60 ips measured on any given track without tape servo.

4.2.10 BI-DIRECTIONAL OPERATION

The tape transport shall operate in forward and reverse.

4.2.11 OPERATING MODE

The tape transport shall be capable of simultaneous recording and reproducing.

4.2.12 MAGNETIC HEADS

The tape transport shall be equipped with 28-track interlaced reproduce heads per IRIG 106-71 Standards.

Type of Recording: Direct Analog, FM or Digital

Track Geometry: Width 0.025"

Spacing 0.035"

Interlace 1.500"  $\pm 0.001$ "

Distance

Recording Density: 16,667 cycles per inch  
(1 MHz @ 60 ips)

4.3 RECORD/REPRODUCE SYSTEM

4.3.1 COMPLEMENT OF ELECTRONICS

The basic unit shall include up to 28 tracks of Direct, reproduce electronics. Equalized six-speed reproduce electronics shall be provided.

4.3.2 DIRECT REPRODUCE SPECIFICATION

- a) Normal Record Level: 2% third harmonic distortion.
- b) Frequency Response and Signal-to-Noise Ratio:

<u>TAPE SPEED (IPS)</u>	<u>BANDWIDTH ±3 db</u>	<u>S/N RATIO</u>
60	800 Hz to 1 MHz	20 db
30	800 Hz to 500 KHz	20 db
15	800 Hz to 250 KHz	20 db
7-1/2	800 Hz to 125 KHz	20 db
3-3/4	800 Hz to 62.5 KHz	20 db
1-7/8	800 Hz to 31.25 KHz	20 db

<u>TAPE SPEED (IPS)</u>	<u>BANDWIDTH ±3 db</u>	<u>S/N RATIO</u>
60	400 Hz to 1.0 MHz	18 db
30	400 Hz to 0.5 MHz	18 db
15	400 Hz to 0.25 MHz	18 db
7-1/2	400 Hz to 125 KHz	18 db
3-3/4	400 Hz to 62.5 KHz	18 db
1-7/8	400 Hz to 31.0 KHz	18 db

- c) Output Level: 1.0 VRMS at normal record level, adjustable, into 75 ohms.
- d) Output Impedance: Less than 100 ohms nominal, unbalanced to ground.
- e) Phase Response: Linearly increasing phase with increasing frequency for optimum pulse response. Phase response adjustable.

#### 4.4 CONTROLS AND INDICATORS

Controls and Indicators shall be provided as described in the following paragraphs.

##### 4.4.1 LOCAL

- a) MAIN POWER ON/OFF: Back-lighted Pushbutton
- b) TRANSPORT POWER ON/OFF: Back-lighted Pushbutton
- c) STOP: Back-lighted Pushbutton
- d) RECORD (Interlocked with Forward): Back-lighted Pushbutton
- e) FORWARD: Back-lighted Pushbutton
- f) REVERSE: Back-lighted Pushbutton
- g) FAST FORWARD: Back-lighted Pushbutton
- h) FAST REVERSE: Back-lighted Pushbutton
- i) END-OF-TAPE: Visual Display Light  
BROKEN TAPE: Visual Display Light
- j) TAPE SPEED: Visual Display Light

- k) TAPE REMAINING: Meter Movement
- l) VOLTAGE TEST: Meter Movement with Adjacent Test Point
- m) SPEED SELECT: Rotary Switch
- n) VOLTAGE SELECT: Rotary Switch
- o) TAPE-TACH SERVO SELECT: Rotary Switch (Optional per paragraph 4.1.10.b)
- p) TAPE-TACH PHASELOCK: Visual Display Light (Optional per paragraph 4.1.10.b)

#### 4.4.2 REMOTE CONTROLS

Functions c) through h) in paragraph 4.4.1, above, shall be available at a REMOTE connector located on the back panel for remote control by means of momentary contact closures. Tape Speed Select shall also be provided for Remote Control by permanent contact closure. In addition, the EOT indicator output and tape break shall be available for remote indication.

### 5.0 QUALITY ASSURANCE PROVISIONS

#### 5.1 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, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government may reserve 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.

## 5.2 CONTRACTOR'S QUALITY ASSURANCE SYSTEM

The contractor shall provide and maintain an effective inspection and quality assurance system acceptable to the Government covering the supplies under the contract. The quality assurance system shall be in accordance with MIL-Q-9858A.

## 5.3 GOVERNMENT VERIFICATION

All quality assurance operations performed by contractor will be subject to Government verification at any time. Verification will consist of (a) surveillance of the operations to determine that practices, methods and procedures of the written system description are being properly applied, and (b) Government product inspection to measure quality of product to be offered for acceptance. Failure of the contractor to promptly correct deficiencies discovered by him or of which he is notified shall be cause for suspension of acceptance until corrective action has been made or until conformance of product to prescribed criteria has been demonstrated.

## 5.4 TESTS, TEST EQUIPMENT AND TEST PROCEDURES

A list of proposed tests, test equipment, and test procedures shall be furnished by the contractor to the Government for approval prior to setting up test equipment for quality conformance inspection and acceptance test.

## 5.5 ACCEPTANCE TESTING

Acceptance Testing shall consist of all examination and testing necessary to determine compliance with the requirements of the individual equipment specification and unless otherwise specified shall include the examination and test specified hereinafter. Acceptance testing shall include the following:

### 5.5.1 SURFACE EXAMINATION

Equipment shall be examined for the following:

- a) Workmanship, assembly and fit, mechanical safety and marking.
- b) Conformance of materials, parts and finish to drawings.

### 5.5.2 OPERATING TEST

The equipment shall be energized and subjected to an operating test to insure qualitatively the proper functioning of the equipment, including all operating controls. The parameters specified in Section 4.0 of this specification shall be tested as applicable to verify performance.

### 5.6 ACCEPTANCE TEST DATA

Test data which shows the results of the acceptance tests performed in accordance with Paragraph 5.5, above, shall be provided with each deliverable equipment.

### 5.7 PREPARATION FOR DELIVERY

Marking for shipment and storage shall be in accordance with MIL-STD-129D.