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MILITARY SPECIFICATION

PLOTTING TABLE, ANTI-SUBMARINE AND DEAD RECKONING (NAVAL SHIPBOARD)

1. SCOPE

1.1 This specification covers the design of the anti-submarine and dead reckoning plotting table for use in combat information centers or similar spaces in Naval ships during anti-submarine or other similar tactical situations.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MILITARY

MIL-C-25 - Capacitors, Fixed, Paper-Dielectric, Direct Current (Hermetically Sealed in Metallic Cases),
MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-I-983 - Interior Communication Equipment, Naval Shipboard, Basic Design Requirements for.
MIL-D-1000/2 - Drawings, Engineering and Associated Lists.
MIL-G-2857 - Glass, Heat-Treated, Glazing, Rectangular (for Bridge Windows).
MIL-P-5425 - Plastic, Sheet, Acrylic, Heat Resistant.
MIL-P-15137 - Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-S-15291 - Switches, Rotary, Snap Action.
MIL-M-17185 - Mounts, Resilient; General Specification and Tests for (Shipboard Application).
MIL-E-17555 - Electronic and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of.
MIL-S-20708 - Synchros, 60 and 400 cycle, General Specification.
MIL-P-21549 - Product Quality Program Requirements for Fleet Ballistic Missile Weapon System Contractors.
MIL-S-21604 - Switches, Rotary, Multipole and Selector Type, 1 to 10 Amperes.
MIL-C-24145/12 - Cable, Electrical, Special Purpose, for Shipboard Use, Type 3SWA.
MIL-S-38130 - Safety Engineering of Systems and Associated Subsystems and Equipment, General Requirements for.
MIL-H-46855 - Human Engineering Requirement for Military Systems, Equipment and Facilities.

STANDARDS

MILITARY

MIL-STD-470 - Maintainability Program Requirements (for Systems and Equipments).
MIL-STD-471 - Maintainability Demonstration.
MIL-STD-701 - Lists of Standard Semiconductor Devices.
MIL-STD-721 - Definitions of Terms for Reliability Engineering.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-749 - Submission of Data for Approval of Nonstandard Electronic Parts.
MIL-STD-756 - Reliability Prediction.

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MILITARY (Cont'd)
MIL-STD-757 - Reliability Evaluation from Demonstration Data.
MIL-STD-781 - Reliability Tests, Exponential Distribution.
MIL-STD-785 - Requirements for Reliability Program (For System and Equipments).
MS15571 - Lamps, Incandescent, T-3-1/4, Miniature Bayonet: Single Contact.
MS17322 - Meter, Time Totalizing Miniature, 400 Cycle, Digital.

HANDBOOK

MILITARY
MIL-HDBK-217 - Reliability Stress and Failure Rate Data for Electronic Equipment.
MIL-HDBK-472 - Maintainability Prediction.

DRAWINGS

MILITARY
S2487-533730 - Drafting Machine (Parallel Motion Protractor Type) MK 3 MOD 3, Details.
2134438 - Motor, Step Receiver.

PUBLICATIONS

MILITARY
NAVSHIPS 94324 - Maintainability Design Criteria Handbook for Designers of Shipboard Electronic Equipment.
NAVSHIPS 94501 - Bureau of Ships Reliability Design Handbook.
NAVSHIPS 0900-002-3000 - Reliability and Maintainability Training Handbook.
NAVWEPS 00-65-502 - Handbook Reliability Engineering.
OPNAV 43P2 - Maintenance and Material Management (3M) Manual.

U. S. NAVAL OCEANOGRAPHIC OFFICE
H.O. No. 9 - America's Practical Navigator (1958 Edition).
H.O. No. 2665 - The Maneuvering Board Manual.

(Application for copies should be addressed to the U. S. Naval Oceanographic Office, Washington, D.C. 20390, or the Superintendent of Documents, Government Printing Office, Washington, D C. 20402.)

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

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

UNIFORM CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules

(Application for copies should be addressed to the Uniform Classification Committee, 202 Union Station, 516 West Jackson Boulevard, Chicago, Illinois 60606.)

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)
239.01 - Measuring Methods and Practices Manual for Control of Spur, Helical and Herringbone Gears.

(Application for copies should be addressed to the American Gear Manufacturers Association, Standard Department, 1330 Massachusetts Avenue, N.W., Washington, D.C. 20005.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)
TP4 - Reliability Control in Aerospace Equipment Development.

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(Application for copies should be addressed to the Society of Automotive Engineers, Department M3, 485 Lexington Avenue, New York, N.Y. 10017.)

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

3. REQUIREMENTS

3.1 Preproduction sample. - Prior to beginning production, a sample shall be tested as specified in 4.2. (see 6.4).

3.2 Description. -

3.2.1 Plotting table. - The table shall be provided with a heat-treated glass surface on which five images move in response to electrical signals from various sources. Two plastic sheets shall be provided, one of which shall be frosted to permit direct viewing of the display and the other shall be clear to permit use of tracing paper or map overlay instead of direct viewing. Provision shall be made for easily accessible stowage of both plexiglass sheets on the side of the table. The stowage fixture with both sheets in place shall meet the environmental testing requirements invoked herein. Each of these plastic sheets shall be in accordance with MIL-P-5425 and shall be designed such that the plastic sheet in use shall cover the glass surface so as to make the upper plastic surface flush with the top of the table. The plastic shall permit plotting with either china marking pencil or lead pencil or may be overlaid with a plain paper sheet or chart for plotting. One image, designated own ship, shall be represented as a polar diagram image on the plotting surface, the center of which represents the geographic position of own ship. The direction and the rate of movement of the polar diagram, scaled to selected values, shall follow the direction and the rate of own ship's actual movement as determined by the gyrocompass and log. The rate of travel of own ship while tracking shall be variable from zero to at least 10 inches per minute to enable the various scale factors to be used at maximum ship speeds. The origin of the polar diagram shall be capable of being positioned on the plotting surface as described in 3.6.2.1 and 3.6.2.2. In addition to own ship, the plotting table shall contain four target images which shall be referred to in this specification as TPA's. Each TPA shall appear as a spot of light onto the plotting surface which corresponds to the range at the correct scale and the true bearing of a given object measured from own ship. Each TPA shall receive target position signals properly scaled and convert these signals into mechanical motion which moves the projected image in the required direction and speed to the correct geographic position. The TPA's therefore provide four automatically positioned target images relative to own ship's position. All TPA's shall be provided with a cursor (see 3.7.2). An alternate mode of operation, "Relative", places and stops own ship at the center of the plotting surface for relative plotting, maneuvering board solutions, or initiation of man-overboard plotting. In the center of own ship's display there shall be an arrow, or similar Naval Ship Engineering Center (NAVSEC) (see 6.5) approved display, which will automatically provide a continuous indication of own ship's heading (OSH). The OSH device shall be part of own ship's image. Own ship's image (polar diagram (see 3.6.4.1) display described above) shall not rotate.

3.2.2 Data inputs. - The NC-2 plotting table shall accept input signals of the following form:

(a) Own ship's heading - 360 degrees per revolution and 10 degrees per revolution (1X and 36X), 115 volt, 400 cycle synchro information.
(b) Own ship's speed. - 100 knots per revolution and 10 knots per revolution (1X and 10X), 115 volt, 400 cycle synchro information.
(c) Target range and bearing (R, θ) signals. - 72000 yards per revolution and 2000 yards per revolution (1 and 36 speed) or 72000 yards per revolution (1 speed) 115 volt, 60 or 400 cycle synchro range information and 360 degrees per revolution and 10 degrees per revolution (1 and 36 speed) or 360 degrees per revolution (1 speed) 115 volt, 60 or 400 cycle synchro bearing information. Any numbered bearing inputs may be relative; however only true bearing with respect to own ship shall be displayed on the plotting surface.
(d) Target (X, Y.) scaled voltage. - Reference root mean square (rms) voltage of 20-CT-20 at 400 cycles per second (cps) where CT (center tap) is grounded at source at a scale factor of 2000 yards per volt in addition to the 115 volt reference voltage. The table shall accept two signals in this form.

3.2.2.1 TPA switching panel. - Four 16-position selector switches shall be provided, one for each TPA. Each TPA shall be able to select its input from any one of 15 different sources (see 3.7.5). Selection of the

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source shall automatically adapt the TPA circuitry to accept the information in the form used by that source (see 3.2.2). TPA's shall retain their correct relationship to each other and own ship's true geographic position at all times at any scale and range and be displayed even when own ship's position is not within the boundaries of the plotting surface. TPA's shall be capable of synchronizing automatically without the need for realignment when TPA switching from R, θ to X, Y data occurs. Maximum time for synchronizing to a new input signal (TPA switching) shall not exceed 5 seconds.

3.2.2.2 Step output. - The NC-2 shall transmit own ships distance N-S and E-W as 115 volt d.c. step motor signals, 6 pulse states per revolution, 750 revolutions per mile. These signals shall be continuously transmitted by the table and shall reflect the speed and heading mode of operation of the NC-2 (manual or automatic) (see 3.9.4 and 3.9.5). Each step transmitter circuit shall drive a step motor, GAP Instrument Co. Part No. 163-1 (size 18) or equivalent, as shown on Drawing 2134438. 1N647 diodes are connected across each leg of the step motor shown on the drawing and 1K ohm resistors are connected in series with each lead of the step motor.

3.3 General features. - The equipment shall be in accordance with the requirements of MIL-I-983, and as specified herein. Whenever a requirement of MIL-I-983 conflicts with a requirement of this specification, the requirement of this specification shall govern.

3.4 Design. - The plotting table shall be so designed that vibration, shock, or acceleration, which may be encountered in service onboard any of the types of ships for which the equipment is intended, will not adversely affect the accuracy of the equipment under normal conditions, nor under extreme conditions, derange any part of the equipment beyond normal adjustment at sea. Shock mounts, if used shall be in accordance with MIL-M-17185. The equipment shall be so designed that the operator will not receive an electrical shock when making any ordinary adjustment while the equipment is in operation. Operation in a hot, dusty, high humidity environment for at least 1000 hours without replacement of any part or subsystem shall be considered as normal operational environment.

3.4.1 Excessive play between moving parts, resulting in noise when the equipment is subjected to vibration, shall be eliminated insofar as practicable.

3.4.2 The equipment and its operation shall not be adversely affected by magnetic fields up to 5 gausses.

3.4.3 Adjusting devices, as well as the controls listed in 3.9, shall be free from excessive friction. Each adjusting device requiring a setting, shall be provided with a suitable indicator, which shall be so designed that it may read without difficulty. Handles of adjusting devices shall be so constructed or protected that accidental contacts will not change their setting, or shall be provided covers attached to the unit in such a manner as not to cause interference or affect ease of handling. All components or modules requiring adjustment after repair or for calibration of the equipment as a whole shall be capable of being adjusted in place from the front without removal of any components in the equipment.

3.4.4 Mechanical components shall be of a suitable material, properly and evenly hardened or treated to prevent wear. They shall be provided with a means of adequate lubrication (see MIL-I-983).

3.4.4.1 Mechanical resolvers, friction disks, rollers, or other similar mechanical components shall not be used in this equipment.

3.4.5 Bearings shall be double shielded, as specified in MIL-I-983, and shall be the prelubricated sealed-for-life type.

3.4.6 Windows, where required, shall be so mounted as to minimize danger of breakage or cracking due to stress at the edges.

3.4.7 All external wiring shall terminate at terminal boards and shall not be connected directly to internal switches, components, and so forth.

3.4.8 Parts of the equipment requiring accurate placing shall be marked or doweled, so that when disassembled for repairs or adjustments, the parts may be replaced in their proper position. Parts requiring occasional renewal due to unavoidable service wear shall be designed for maximum practicable ease of replacement and alignment.

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3.4.9 Interchangeability. - Except as specifically provided herein, similar parts and permanent assemblies, including repair parts or corresponding apparatus furnished on the same contract or order or built to the same drawings, shall be interchangeable without the necessity of further machining or hand fitting of any kind.

3.4.10 Proposed changes in design affecting interchangeability of parts or assemblies, including repair parts, shall not be effected unless specifically approved by NAVSEC.

3.4.11 Terminal boards shall be provided with protective covers to prevent accidental short circuits while working on the plotting system.

3.4.12 The effect of roll and pitch shall not adversely affect the operation of any unit of equipment when tested in accordance with 4.5.3.

3.4.13 Mercury and radium in any form, shall not be used in this equipment nor in the manufacture or test of this equipment.

3.4.14 Gears. - Gears used in critical backlash applications shall be precision 1C or better, as defined by AGMA 239.01, and of a material satisfactory to NAVSEC. Corrosion-resisting steel gears may be used where this material will provide superior performance. Low torque, high precision gears shall not be lubricated unless they are fully sealed in an enclosure. All gears shall be designed such that wear, to the extent that the tolerance of the gear trains taken alone exceeds the accuracy requirements of this specification (see 3.10), shall not occur during the expected lifetime and total accrued operating hours for this equipment (see 3.12).

3.4.15 Warm-up. - The equipment shall be capable of performing all required functions within the specified accuracy limits, 2 minutes after power application. The use of a preheater circuit to keep the equipment in a standby condition to meet this requirement will require specific written NAVSEC approval prior to its use in the table design. Before submitting such a request for approval, the following criteria must be met: under no circumstances shall the power requirement of this circuit exceed 150 watts, nor shall the time to be fully operational from a completely secured condition exceed 5 minutes. A separate switch and indicator light shall be provided for standby power. Any failure of the standby circuit shall not affect the operability of the projector devices or equipment. The standby circuit shall be separately fused. If a single source of illumination is used for all projected TPA images, a redundant source shall be used which will automatically be switched into position in the event of failure of the source in use.

3.4.16 Special tools. - Any special tool required for assembly, disassembly, test, repair, alignment, calibration, or other maintenance of the equipment shall be submitted to NAVSEC for approval and shall be supplied as part of the equipment. Special tools are defined as those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the Defense Contract Administration Service (DCAS)).

3.4.17 Stepper motors. - Steppers motors, if used, shall be either of the variable reluctance or permanent magnet type and of low inertia design with grease sealed ball bearings of the type specified in 3.4.5. Excitation for the motor shall be generated within the plotting table.

3.4.18 All interconnection cables shall be type 3SWA in accordance with MIL-C24145/12. All cable shields shall be tied to a common point and grounded at that point within the equipment.

3.4.19 The plotting table shall be provided with a means for eliminating heat generated within the plotting table and maintain an operating temperature, even under extreme conditions, not higher than that considered in the reliability design assurance plan, failure mode analysis and the plan for maintenance. The ventilation system shall be interlocked with the main power supplied to the table such that loss of power to the cooling system will result in a shutdown of all power to the table. A red indicator light shall be provided to indicate loss of power to the coling system. A thermal sensitive device shall be provided near the heat critical parts closest to the heat sources within the table. Temperature rise above the design values shall cause a yellow warning light to glow on the front panel. If the temperature rises above a value which will cause damage to the equipment, the power to table shall be secured automatically and an indicator light shall glow on the front panel indicating the reason for loss of power. A manual override shall be provided to permit emergency operation of the table. This overide shall be a normally deactivated device and shall be deactivated whenever the table is secured.

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3.5 General design features. -

3.5.1 Enclosure. - The NC-2 plotting table shall consist of a single enclosure (degree of enclosure drip-proof). Dustproof covers shall be provided for all precision gears, ball screws and other dirt critical components and assemblies. Mounting and external wiring of the equipment shall be accomplished without removal of components from the enclosure, and without exposing the gears to dust. Internal subassemblies shall not be supported by a nonstructural part of the enclosure.

3.5.2 Accessibility. - All subassemblies and modules shall be easily accessible for adjustment and readily removal for repair. All modules and subassemblies shall be of plug-in configuration such that unsoldering of any wires shall not be required to remove any subassembly, module or part established by NAVSEC as replaceable onboard ship. Calibration shall not require removal of components or modules, or require the use of extension cables to accomplish calibration or adjustment. Whenever possible all plugs and connectors for all modules and subassemblies shall be identical. Protection of the internal subassemblies shall be provided in accordance with MIL-I-983. Suitable supports shall be furnished where necessary to allow repair work without the units resting on electrical components, electrical connections, or on component that may be disarranged or otherwise damaged. Knurled knob captive screws with a screwdriver slot shall be used on all covers that require removal or opening for maintenance and shall be used to hold all modules and subassemblies in place. All electronic circuits shall be mounted on printed circuit cards and located in a central card file. These printed circuit cards shall be of a plug-in configuration and shall contain test points at the protruding end to permit troubleshooting when the cards are installed in the card file. The circuitry contained on each card shall correspond to a functional block of the system or module of which it is a part, and shall be represented as such in the equipment technical manual. All printed circuit cards shall be keyed to insure proper installation.

3.5.2.1 Breakout requirement. - Breakout cables shall be provided with each equipment for observing the operation of any module removed from the equipment. These cables shall contain a test panel for measuring input and output signals or monitoring critical points within the modules during maintenance actions such as zeroing of synchros, etc. The breakout cables shall be at least 6 feet in length with the test panel 2 feet from the end connected to the module. Suitable supports for each module shall be furnished with each equipment to allow repair work on the module without the unit resting on electrical components, connectors, or on parts which may be disarranged or damaged. Printed circuit extender cards shall be provided for taking measurements on any printed circuit card in the equipment while the equipment is in operation. These extender cards shall plug into the slot occupied by the circuit card in question and shall have a connector on the opposite end into which the printed circuit card shall fit. There shall be an electrical connection between opposing terminals at each end of the extender card. Provisions shall be made for stowage of all breakout cables, module supports and extender cards within the equipment enclosure. Stowage shall be designed such that vibration shall not result in audible noise or vibration of these parts or damage to either the parts or the equipment when sustaining shock. All environmental tests to be performed on the preproduction unit shall be carried out with the breakout cables, extender cards and module supports within the equipment.

3.5.3 Weight and size. - The weight and size of the plotting table shall be kept to a minimum. Plotting table weight shall not exceed 800 pounds. Outside dimensions, including mounts, shall be equal to the following dimensions The foundation for the NC-2 plotting table shall consist of four shock mounts arranged in a rectangular pattern, 47.500 ± 0.010 inches by 32.500 ± 0.010 inches, measured from the geometric center of each shock mount mounting pad. Each pad shall have a four-bolt mounting arrangement, 4.35 ± 1/64 inches in a square pattern drilled to $0.468^{+0.002}_{-0.002}$ diameter.

Vertical 1/ (inches)	Depth (width) 2/ (inches)	Horizontal length (Inches)
39-1/2	36-1/8	51-1/8

1/ Surface of the table shall be not more than 40 inches from the deck.
2/ Does not include control knobs.

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3.5.4 Plotting scales.- The plotting table shall operate at the following scales independent of the range to the target:

		As marked on scale selector switch
0.10 NMI per in. = 200 yds per in.	= 7,200:1	200 yd per in.
0.25 NMI per in. = 1/500 yd per in.	= 18,000:1	500 yd per in.
0.348 NMI per in. = 694 yd per in.	= 25,000:1	$\frac{1}{25,000}$
0.50 NMI per in. = 1000 yd per in.	= 36,000 1	1000 yd per in.
0.694 NMI per in. = 1388 yd per in.	= 50,000 1	$\frac{1}{50,000}$
1:00 NMI per in. = 2000 yd per in.	= 72,000.1	1 MI per in
2.50 NMI per in. = 5000 yd per in.	= 180,000 1	2.5 MI per in.
5.00 NMI per in. = 10,000 yd per in.	= 360,000:1	5 MI per in.

1/ One nautical mile (NMI) shall be taken as 2,000 yards.

3.5.4.1 Plotting scale vernier.- Adjacent to the scale selector switch (see 3.9.3) a single vernier adjustment shall be provided which shall permit varying the plotting scale factor upward from each of the values selected (see 3.5.4) to at least the next larger plotting scale for all plotting scale factors except for the 10,000 yard per inch scale. The plotting scale factor shall be chosen by utilizing the range readout and length for the cursors. Selection of a plotting scale, other than those available at the discrete positions of the scale selector switch (see 3.5.4), shall be accomplished as follows The scale factor which comes closest to without exceeding the desired scale factor is set by the selector switch, one of the cursors is set for a measured length on the plotting surface, the vernier adjustment is then used to obtain the correct cursor range readout for the desired plotting scale and cursor length chosen. (As an example, if a plotting scale factor of 1675 yards per inch is desired, the selector switch is set to 1388 yards per inch one of the cursors is set to a length of 10 inches, the vernier is used to obtain a cursor range readout of 16750 yards, the plotting scale factor is then 16750/10 or 1675 yards per inch.) All displayed information, readouts, own ship's motion, target motion and position shall correspond to the scale factor in use. The vernier adjustment control shall have a positive "OFF" position which shall result in selection of the discrete scale factors by the scale selector switch. The plotting scale factor chosen using the vernier shall be stable to within 0.1 percent of the value set for a minimum of 10 hours of continuous operation in a shipboard environment (see MIL-I-983). During the 10 hours all table functions shall be used and all inputs varied. Stability of the variable plotting scale function shall be part of the acceptance test requirements and shall be demonstrated during the 100 hour burn-in test.

3.5.5 Provision shall be made for convenient initial setting of own ship at any point on the operating plotting surface and for correcting the position of the own ship. Repositioning of own ship shall also cause a corresponding change in the position of the TPA's.

3.5.6 Provision shall be made to protect the porjection devices against possible damage or excessive wear in case target tracks are allowed to run indefinitely beyond the limits of the projection device marking area.

3.5 7 Provision shall be made for starting and stopping all operating components of the system.

3.5.8 Servo amplifiers.- Servo amplifiers, if used, shall be capable of operating from the data sources listed in 3.2.2. Each data source, except the LAMINAR and WEAPON source shall supply at 11 volt reference voltage at the frequency of the data source The total reference power taken from any one data source shall not exceed 15 watts. The amplifier chassis shall be grounded to the case, and a B minus bus, isolated from the chassis shall be provided for the servo amplifiers and shall be positively connected (bonded) to the enclosure at one physical point only. Matching transformers shall be used between amplifier output and servo motor control field, if the servo motor is not directly matched to the amplifier during manufacture The servo motor shall not be modified to match the impedance of the amplifier. All servo trimming circuits shall be external to the amplifier package. The types of servo amplifiers used shall be kept to a minimum. These amplifiers shall be constructed as removable and serviceable units. The amplifier's wiring shall be flexible leads and suitable plugs or terminal blocks rather than by fixed plugs and sockets. The number of potentiometer adjustments of each amplifier shall be kept to a

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minimum; however, where these are required, they shall be mounted separately, from the potted components.

3.5.9 Synchro units. - Whenever used in this equipment, synchro control transformers, servo motor, and synchro signal generators shall be mounted on a plate so as to be removable in order to adjust the synchro units for electrical zero. The synchro generators and control transformers shall be contractor-furnished material and shall meet the requirements of MIL-S-20708. The synchro equipment shall have corrosion-resistant steel housings, terminal board type lead terminations, spline shafts and shall be high temperature approved (125° ± 2°C.). All control transformers used in the servo loops both for the main table and the target plot attachments shall be size 15 or size 18, except in the projectors if used, which may be size 11.

3.5.10 Servo motors. - The servo motors, if used, shall be a two-phase low-inertia design with double-shielded ball bearings. Varying types of servo motors shall be kept to a minimum. All motors shall be mounted so that they may be removed and replaced without disturbing the gear trains which they drive. Mo- shall be mounted so that rotating shafts are completely enclosed. Servo motors shall be contractor-furnished equipment.

3.5.11 Power supply. - The equipment shall operate from a power supply of single-phase, 400-cycle, 115-volt, a.c. Single-phase, 60-cycle, 115-volt, a.c. shall be provided for illumination.

3.5.12 Fuses and blown fuse indicators. - Fuses and blown fuse indicators shall be located on front of the control and indicator panel to protect and to indicate loss of power supply and loss of excitation to each of the following circuits, and to other circuits whenever necessary

(a) Range and bearing for each radar and sonar data input.
(b) Weapons and Laminar source data.
(c) Own ship's course reference.
(d) Synchro excitation (115 volts a.c., 400 c.p.s.).
(e) Power lines (115 volts a.c., 60 c.p.s., 15 volts a.c., 400 c.p.s.).
(f) All unlabeled TPA switch positions.
(g) Own ship's speed reference.

All spare input positions shall be wired to accept R, Θ, synchro information as described in 3.2.2(c).

3.5.13 Synchro capacitors. - The correct delta connected synchro capacitors shall be provided for all synchro control transformer and synchro control differential transmitters receiving synchro transmissions from external sources to maintain unity power factor. The capacitors shall be mounted as close to the control transformers and synchro control differential transmitters as possible. The capacitor section shall be rated for 600 volts d.c. or greater, and shall be in accordance with MIL-C-25. For 400 cycle application, capacitors shall be rated for 1000 working d.c. volts. Each synchro capacitor shall have the capacitance of its three capacitor sections balanced within 1 percent, as measured by the divergence of the capacitance of any one leg from the arithmetical means of the three.

3.5.14 Electron tubes. - No electron tubes, or thermionic devices of any type, shall be used in this equipment.

3.5.15 Semiconductor devices. - Semiconductor devices shall be of silicon type in accordance with MIL-STD-701. The contractor shall submit a tentative semiconductor complement report to NAVSEC as soon as the equipment design requirements have been determined. In the event a change in the semiconductor complement is found necessary, it shall be reported with 30 days. In order to assure sufficient quantity for maintenance of equipment in the Naval service, the contractor shall furnish NAVSEC with a final semiconductor complement report after the equipment design has been completed, and before production has begun. These reports shall be submitted on the same form as used for electron tubes, and shall be combined into a consolidated report.

3.5.16 Effect of synchro bus load on synchro control transformers. - In order to prevent excessive reflected errors on the synchro bus, the secondary load on the synchro control transformers used in this equipment shall be greater than 30,000 ohms for 60 cycle and 400 cycle units.

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3.5.17 Illumination control. - A selector switch shall be provided for a choice of either red or white background illumination. Red and white illumination intensities shall be controlled by rheostats or other control devices as specified in the applicable paragraphs of MIL-I-983. The selector switch and illumination intensity controls shall be approved by NAVSEC. All TPA's shall retain their respective colors at all times and one intensity control shall control all four TPA's.

3.5.17.1 Red illumination. - The illumination shall be red indirect light, free from glare and shadows and of uniform intensity throughout. No stray light shall be visible externally. Red illumination shall be arranged to utilize filters passing less than 1 percent of light of wavelength shorter than 5800 angstrom units but passing at least 90 percent of light of wavelength longer than 6800 angstrom units. Illumination of individual instruments shall be satisfactory to NAVSEC.

3.5.17.2 White Illumination. - The illumination shall be white indirect light, free from glare and shadows and of uniform intensity throughout. No stray light shall be visible externally.

3.5.18 Terminal markings. - All terminals, terminal boards, plugs, jacks and connectors shall be marked in a clear and permanent manner so as to identify individual wires, terminals and other electrical connections. The identification designations shall appear on all applicable drawings and shall be approved by NAVSEC prior to its adoption by the contractor.

3.5.19 Calibration. - Calibration shall be accomplished without requiring any electrical circuit switching external to the table and with own ship operating on any course and at any speed. Calibration shall be accomplished without the removal of any module, subassembly or component from its normal operating position and without disconnecting or changing any of the table wiring. Detail calibration instruction shall be provided as pa part of the table and be so protected as to not become damaged through normal use. A means of recording the next calibration time shall be provided adjacent to the time totalizing meter. A simple means (example - screwdriver) shall be the only equipment necessary to accomplish the calibration adjustments. All calibration adjustments must be easily accessible and capable of being set without the removal of any module, subassembly or component from its normal operating position and without disconnecting or changing any of the table's or ship's wiring. Under no circumstances shall the total calibration time exceed 1 hour.

3.6 Plotting table. -

3.6.1 Table structure. - The table shall be a dripproof structure consisting of two major assembly sections, an upper and lower. The assemblies shall be so designed that during normal operation they are firmly attached to one another and when required, for repair and otherwise, the upper assembly can be easily detached and removed from the lower assembly. All electrical connections between the upper and lower assemblies shall be made via electrical connectors. Provisions shall be made to provide accessible stowage for the technical manual inside the table.

3.6.1.1 Lower assembly. - The lower assembly shall consist of a base mounting plate containing computing circuits and other modules required for the operation of the table. The base mounting plate is the primary structural member of the plotting table and is shock mounted in such a fashion to allow footroom between the plate and the deck. On the base are attached the vertical members which support the upper assembly. Provisions shall be made at the south side or the top (without disturbing the plotting surface) of the structure for removing any module for maintenance. The cable entry point for all electrical connections to the table shall be on the lower west side of the north panel of the table within 6 inches of the bottom of the base mounting plate.

3.6.1.2 Vertical members and side panels. - The vertical members shall locate and support the upper assembly at the proper distance from the lower assembly. The side panels shall be sheet metal structure fastened to the vertical members, the lower assembly and the upper assembly. The side panels shall be at right angles to the upper surface of the plotting table and the deck. The side panels shall not bulge out or support components or fixtures which extend beyond the horizontal dimensions specified in 3.5.3. All controls, indicators, and fuses located on the table shall be mounted on the upper portion of the south side panel. The control panel shall have a black matte finish with labeling and lettering in white. Machine screws or bolts shall be used to hold the vertical members and side panels (which do not require removal (see 3.5.2)) in place so that the table can be dismantled for passing through hatches in a ship or for shipping.

3.6.1.3 Upper assembly. - The upper assembly shall consist of the plotting surface and the supporting structure. It shall be constructed to provide a table top approximately 36 by 51 inches. The frame of the

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table shall support a glass surface of such a size that there is a clear area of glass 30 inches in length and 30 inches in width located equidistant from the North, East and South sides of the table structure. This glass plate shall be at least 3/8 of an inch thick. The table surface shall be fitted with a plastic sheet above the glass so that a flush surface will be presented from the plotting surface to the table edge. The surface of the table shall be a sheet of heat-treated plate glass in accordance with MIL-G-2857, of sufficient size to provide the clear area required and proper support along the edges for the plastic sheet. The glass surface shall be supported in such a manner as to pass all the environmental requirements specified in MIL-I-983. Glass supporting materials shall conform to the material requirements of MIL-I-983. When the glass surface is covered by the plastic sheet which shall be at least 1/8 inch thick, the plotting surface shall be flush with the top of the table. The plastic sheet shall be contractor-furnished, shall be etched to allow either china marking pencil or lead pencil plotting. The upper frame shall have provisions for installation of the mounting plate of the drafting machine MK 3 Mod 3 (see Drawing S2487-533730).

3.6.2 Mechanical features. -

3.6.2.1 Projection devices. - Devices used for projection of the own ship or TPA images shall be stationary and designed such that elliptical distortion shall not occur regardless of the position of the image on the plotting surface. Any projection devices which require maintenance shall be mounted in place using captive fasteners and dowled mounting to facilitate replacement without realignment. Projection lamps, if used shall be replaceable from the front or top of the table in less than 2 minutes.

3.6.2.2 Slewing. - Individual controls shall be provided for slewing the position of own ship in N-S and E-W directions at both fast and slow slew speeds. The slew speed shall be independent of the plotting scale selected and shall be designed such that slew motion occurs only when the control is activated and all slew motion stops the instant the slew control is released. The fast slew speed shall be not less than 10 inches per second. The slow slew speed shall be not greater than one inch per second.

3.6.3 Electrical features. -

3.6.3.1 Internal illumination. - Internal illumination to flood the plotting area with red or white light will be provided by lamps conforming to type T-3 1/4 part number MS15571-7 of MS15571. Provisions shall be made for selecting either a white or a red lighting system (see 3.5.17) without changing the light sources.

3.6.3.2 Plot illumination. - All projected images, all readouts and all indicator lights shall be clearly discernable in ambient lighting conditions consisting of 40 foot candles of white light incident at the plotting surface as well as in an environment consisting of 10 foot candles of red light only (see 3.5.17.1) incident at the plotting surface. Images shall be intelligible when viewing at angles of 30 degrees from the horizontal. Ambient light shall be determined by light meter readings made at the plotting surface. These requirements shall be part of the general examination of the equipment. All lamps in all projectors shall be of a type satisfactory to NAVSEC and shall be easily replaceable without adjustment and focusing.

3.6 3.2.1 The projector lamps, if used, shall have a 200-hour life expectancy. Lamps shall be of a standard readily available, unmodified design

3.6.3.3 Image resolutions. - All projected images, as displayed on the plotting surface, shall be clear, sharp and of good definition and shall be legible to observers located in normal operating positions and shall be uniform, irrespective of their position on the display surface. All elements of the own ship's polar diagram display and the TPA displays including the cursor shall not exceed a width of 1/32 of an inch. Compliance with this requirement shall be part of the general examination (see 4.4.).

3.6.3.4 Limit switches. - If considered necessary by NAVSEC, own ship drive limit switches, of a type satisfactory to NAVSEC shall be provided. Construction of the own ship drives and positioning of limit switches shall allow at least 27 inches of N-S and E-W motion of the own ship's image on the plotting surface. When actuated, the limit switches shall interrupt excitation of the appropriate servo but will permit the slewing controls to be used to drive own ship's projector drives away from the limit switches and stops (see 3.9.11).

3.6.3.5 Terminal arrangements. - The main terminals for connecting table wiring to that of the ship shall be located on a structural member with direct access to the cable entry point. The external wiring shall be terminated on blocks located for convehience during maintenance (see also 3.4.11). A minimum of 25 percent spare terminals shall be provided for possible future additions and modifications to the table. All cables shall be brought out via stuffing tubes. A plate opening shall be provided for mounting stuffing tubes. Stuffing tubes shall be provided by the installing activity. The cable entry point shall be on the bottom west corner of the north panel.

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3.6.3.6 Protective coatings. - NAVSEC approval shall be obtained for the use of any impregnating, embedding, incapsulating, conformal or protective coating of any kind prior to its application to any electrical component, subassembly or module.

3.6.3.7 Frequency variation protection. - The table shall not be damaged by excess frequency drifts up to 25 percent from normal conditions. Frequency drifts beyond 25 percent shall cause a protective device to disconnect the power from the table and actuate a suitable device for indicating the reason of power loss. A quick, easy to operate reset mechanism shall be provided.

3.6.4 Miscellaneous features. -

3.6.4.1 Plotting display. - Own ship's image shall be identical to the polar diagram portion of H.O. 2665, except that the radial lines of each 30 degrees of bearing (0 degrees, 30 degrees, 60 degrees, and so forth) shall be solid lines and an additional set of bearing indications shall be made on the "3" circle. The circles and radial lines shall extend to the corners of the image. The distance between circles of the image on the plotting surface shall be 4 inches (equal to one nautical mile when on the 500 yards per inch scale). The optical system shall be such that the dimensions of the image on the plotting surface shall be at least 40 inches. The figures indicating bearing and range on the image shall be clear, distinct and so located that ranges and bearings of all plotted targets can be read directly by display observers. The figures on the image shall appear twice the size they do on H.O. 2665. The dimensions of the image shall be accurate to 0.25 percent of the measured distance. The projector assembly shall be designed such that replacement of any part shall not require realignment of the optical system to ensure the accuracy of the polar display. None of the images or projected displays shall be white.

3.6.4.2 Time totalizing meter. - A time totalizing meter shall be mounted in clear view on the south panel to provide a means of telling when the table is to be calibrated A meter similar to that described in MS17322 shall be used

3.7 Target plotting. -

3.7.1 Target images (TPA's). - Each TPA shall represent the true geographic position of one target as a cross of light or other NAVSEC approved display, on the plotting surface. Each TPA shall be represented by a distinctive color or shape. If colors are used, each TPA shall be a distinctive color, one of which shall be red, one green, but none of which shall be white. The maximum length of the cross or symbol shall be 1/4 inch. The TPA's shall be capable of being positioned anywhere on the plotting surface, regardless of own ship position and to a range of at least 70,000 yards on any plotting scale. The range scale of the TPA shall be controlled by the scale selector switch on the south central panel so that the TPA range scale is always the same as own ship. The TPA shall plot targets whose speed is 600 knots in any cardinal heading. The TPA's or TPA projectors shall not obscure own ship or any portion of own ship's polar diagram. The maximum settling time for scale changes (time required for the TPA to correctly position itself) shall be not greater than 5 seconds.

3.7.2 Cursor. - Each of the four TPA's shall be provided with a cursor which can be pointed on any bearing and varied in length from the image spot to a length of 20 inches. Each cursor image shall be a continuous straight line of light (see 3.6.3.3). Each TPA shall have individual cursor controls located on the south panel (see 3.9). A cursor range counter shall be alongside each range control and shall present the cursor range to four significant figures plus the required number of zeros. Only numbers to left of decimal shall be shown. A cursor bearing counter shall be provided alongside each bearing control and shall present the cursor bearing in increments of 0.5 degrees. Both the range and bearing counter shall be easily and clearly readable from a distance of 3 feet. The cursor range counter shall be capable of indicating the full cursor range at all scales as well as being synchronized with plotting image so that the image always represents the range indicated. The cursor bearing indicator shall be synchronized with the cursor bearing image at all times. The cursor range control shall cause a constant, linear change in the cursor length, independent of the plotting scale. The cursor range control shall have fine and a coarse control, the scale factor of the coarse control being 20 inches per revolution and the fine control having a scale factor of 2 inches per revolution.

3.7.3 Ambiguities. - There shall be no ambiguity in the operation of the TPA positioning mechanism. The system shall be capable of synchronizing to a new signal automatically when shifting input signal sources. The position of TPA shall be unique for any value of target range and bearing input. If the target is out of range for the scale selected, the TPA shall appear on the periphery of the plotting surface.

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3.7.4 TPA automatic tracking unit. - Provision shall be made to operate any one of the four TPA's with dummy motion inputs. This unit shall accept

(a) Initial position of a target.
(b) Own ship's heading and speed.
(c) Manual target course and speed.

The TPA automatic tracking unit shall cause the assigned TPA to move continuously in response to the manual target course and speed ordered by the controls described in 3.9.8 from any initially set position. When the table is operating in a geographic mode, the automatic tracker shall provide a geographic track, and when the table is operating in a relative mode, the automatic tracker shall provide a relative track. A switch shall be provided for starting and stopping the TPA track.

3.7.5 TPA input data switching panel. - The TPA input data switching panel shall mount four selector switches, in accordance with MIL-S-21604. Each switch shall be labeled to indicate the TPA it is associated with. The switches shall allow for the selection of any one of fifteen input sources (including the TPA tracking unit) plus an off position which completely de-energizes the TPA drive circuitry. The MANUAL position shall cause the selected TPA to move in response to dummy course and speed signal (see 3.7.4). The OWN SHIP position shall cause the selected TPA go go to an remain superimposed on the own ship's position (center of the polar diagram). The selector switch wiring shall be done in such a way that it may be made variable as required for the TPAs to accept automatically any of the forms of data listed in 3.2.2. All circuit changes which may be required in order to accept these various types of data shall be accomplished by the TPA input data switches. The wiring of the TPA input data switching panel shall provide for incorporation of any of these data sources. The system shall operate properly without damage or loss of accuracy when operated indefinitely with all TPA input data selector switches placed in the same position (identical signal source) simultaneously.

3.7.5.1 HOLD switch. - Each TPA will be provided with a separate switch marked "HOLD". The HOLD switch, when activated shall stop the motion of the selected TPA which remains illuminated and cause the TPA to remain in that position on the plotting surface. Scale change shall not affect the relative position of any TPA in "HOLD" with respect to own ship.

3.8 Testing equipment. - Unless otherwise specified (see 6.2) all test equipment required for preproduction testing or any other testing requirements shall be contractor-furnished.

3.8.1 Integrators. - Pulsed stepper integrators shall be used wherever integration is performed.

3.9 Controls, indicators and fuses. - The following controls, indicators and fuses shall be located on the south control panel and the top panel of the table as listed below.

South control panel

(a) Table power and own ship's projector illumination switch and indicator light (see 3.9.1).
(b) Geographic-relative mode selector switch (see 3.9.2)
(c) Scale selector switch (see 3.9.3).
(d) Own ship input selector switch (see 3.9.4).
(e) Own ship manual course order (see 3.9.5).
(f) Own ship manual speed order (see 3.9.5).
(g) N-S slew control and limit switch indicators (see 3.9.6 and 3.9.11).
(h) E-W slew control and limit switch indicator (see 3.9.6 and 3.9.11).
(i) Four TPA power and illumination switches, and indicator lights (one for each TPA) (see 3.9.7).
(j) Four TPA input data selector switches (one for each TPA) (see 3.7.5).
(k) TPA manual course order (see 3.9.8).
(l) TPA manual speed order (see 3.9.8).
(m) TPA initial N-S position control (see 3.9.6).
(n) TPA initial E-W position control (see 3.9.6).
(o) Four cursor bearing controls (one for each cursor) (see 3.7.2).
(p) Four cursor range controls (one for each cursor) (see 3.7.2).
(q) Own ship projector illumination intensity control (see 3.9.9).
(r) TPA illumination intensity control (see 3.9.9).
(s) Table internal illumination intensity control (see 3.9.9).

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(t) Table control panel illumination intensity control (see 3.9.9).
(u) Blown fuse indicators and fuse holders as required (see 3.5.12).
(v) Elapsed operation time indicator (see 3.6.4.2).
(w) Red-white illumination selector switch (see 3.5.17).
(x) Automatic tracker scale selector switch (see 3.9.8).
(y) Automatic tracker "on-off" switch (see 3.9.8).
(z) Plotting scale vernier (see 3.5.4.1).

Table top control panel:

(a) Own ship's heading readout (see 3.9.12).
(b) Own ship's speed readout (see 3.9.12).
(c) Time going selector switch (see 3.9.10).

Fuses shall be provided for both sides of the power and excitation circuit.

3.9.1 Power switch. - A rotary power switch of appropriate type in accordance with MIL-S-15291 shall provide OFF-ON control of all 115-volt, 400- and 60-cycle power supplier and the various excitation power in each unit. These switches shall break both sides of the circuit. A power on indicator light shall be provided for both the 400 and 60 cycles power inputs. All synchro excitation as well as signal leads (R_1, R_2, S_1, S_2, S_3,) shall be broken by the main power switch. Only exception to this shall be power required by standby circuit which shall be separately switched off.

3.9.2 Geographic-relative mode selector switch. - The geographic-relative mode selector switch shall provide for selection of either the geographic or relative mode of operation as described in 3.2.1. When this switch is placed in the RELATIVE position it shall cause the own ship projection to slew to the center of the plotting surface, remain fixed in that position and cause all TPA's to be positioned in correct true relative position with respect to own ship. When placed in the GEOGRAPHIC position, this switch shall cause own ship and all TPA's to move in true geographic motion across the surface of the earth represented by the plotting surface.

3.9.3 Scale selection. - Scale selection for both the table and TPAs shall be achieved by a rotary switch with eight usuable positions. These scale positions are listed in 3.5.4.

3.9.4 Own ship input selector switch. - A selector switch shall be provided for selection of various combinations of normal or manual inputs of course and speed to the table. The switch shall allow selection of:

(a) Automatic course and speed inputs.
(b) Manual course and automatic speed inputs.
(c) Automatic course and manual speed inputs.
(d) Manual course and speed inputs.

3.9.5 Own ship's manual course and speed orders knobs and indicators. - Two knobs and illuminated indicators shall be provided to allow selection of any speed from 0-60 knots and any course from 0 to 360 degrees when operating in any mode requiring manual inputs of either or both of these signals. Dials shall be at least 3 inches in diameter and arranged with increasing values in a clockwise direction.

3.9.6 North-South and East-West slew switches. - Two switches shall be provided to allow slewing of the own ship north-south and east-west. Each switch shall have a fast and slow speed (see 3.6.2.2). Identical controls shall be provided to initially position any TPA. The TPA initial position controls and the own ship slew switches shall override the signals while the controls are activated. Slew switches and TPA initial position controls shall be spring loaded or be provided with some other means by which they will automatically inactivate when released When the controls are released, the normal signals shall automatically continue to drive the projectors.

3.9.7 TPA power and illumination switches. - An individual power and illumination switch and indicator light shall be provided for each TPA. The switch will control power to the TPA intensity circuit and positioning signals. Each TPA indicator light shall be identifiable with its respective TPA.

3.9.8 TPA manual course and speed. - Controls shall be provided to allow for inserting manual course and speed inputs to any selected TPA. Course shall be from 0 to 360 degrees and speed from 0 to 600 knots.

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To aid in maintaining the desired accuracy (see 3.10), the TPA manual speed order switches may be divided into speed ranges from 0 to 100 knots and from 60 to 600 knots. If necessary, two separate TPA manual speed order switches may be used per TPA. Both indicators shall be of counter configuration and be capable of being read from a distance of 3 feet. The speed indicator shall be graduated in increments not greater than 1/2 knot on the 0 to 100 knot range and not greater than 1 knot on the 60 to 600 knot range The course indicator shall be graduated in 0.5 degree increments Generation of manual course and speed signals shall be independent of heading and speed input signal references

3.9 9 Illumination intensity controls - Four illumination intensity controls shall be located on the south control panel. These controls will be for

(a) Internal table illumination
(b) South control panel illumination.
(c) Own ship projector
(d) TPA projectors.

In all cases, clockwise rotation of the control shall increase illumination

3.9.10 Timer. - An electric timer shall be provided which shall cause an audible loud gong to sound at preselected intervals. The selection control shall be located on the upper panel adjacent to the relative position indicator unit and shall permit selection of intervals from 0 seconds to 5 minutes. A positive shut off shall be provided after the 5 minute position. The timing gong shall operate and sound indefinitely either the timer is shut off or the power to the table is secured.

3.9.11 Limit switch lights. - Four indicator lights shall be provided to show which limit switch (N, S, E or W) has been actuated. These indicator lights shall be located in the center of each side of the plotting surface frame and shall be flush with the frame (see 3 6 3.4).

3 9 12 Own ship heading and speed readouts - The own ship's heading and own ship's speed readouts shall not provide continuous information if digital type readouts are used For digital readouts, the speed and heading information shall be updated at 5-second intervals The heading and speed readouts shall indicate the value of heading and speed inputs as defined by the condition of the own ship input selector switch Both indicators shall be of a counter configuration and shall be easily read from a distance of 3 feet The speed indicator shall be graduated in 0.1 knot increments and the heading indicator shall be graduated in 0.5 degree increments.

3 10 Accuracies. - The plotting table error shall be measured as a percentage deviation of the plotted final position from the theoretical correct position The accuracy specified below relates to those instances where the test measurement would exceed a 3/16 inch diameter error circle. All accuracy tests will be considered verified if the plotted position falls within a 3/16 inch diameter error circle

(a) Plotting table position error	1.0 percent
(b) TPA plotting error	0.5 percent (except on 200 yards per inch which shall be 1.5 percent)
(c) TPA bearing line maximum non-linearity	0.5 percent
(d) TPA tracking unit tracking rate	(1) 1/2 knot or 1 percent, whichever is greater, 0-100 knot scale (2) 3 knots or 1 percent, whichever is greater, 60-600 knot scale
(e) Cursor range error	0.5 percent
(f) Cursor bearing error	0 5 degree
(g) Own ship heading display	0.5 degree
(h) Own ship speed readout	0.1 knot
(i) Own ship's distance, N-S, E-W (see 3.2.2.2)	0.5 percent
(j) Own ship heading readout	0 5 degree

NOTE Calculations for navigation errors and plotting shall be in accordance with procedures and tables found in H.O No. 9.

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3.10.1 Error calculations. - All errors shall be calculated using the signal or signals supplied to the equipment terminal boards by a calibrated dummy synchro dual speed signal generator and the actual position of the images on the plotting surface as measured by an accurate linear rule and accurate, precise protractor. Relative bearing as well as true bearing shall be applied to the equipment terminals. The distance component transmitted signals shall be measured at the terminal board outputs by driving a circuit as described (see 3.2.2 2)

3 10.2 Plotting table position error. - The plotting table position error is the error in final position of the center of polar diagram on the plotting surface measured from the correct final position indicated on a test pattern overlay, and expressed as a percent of the total theoretical distance input to the unit.

3.10 3 TPA plotting error. - The TPA plotting error is the error in final position of the center of the TPA on the plotting surface measured from the correct final position indicated on a test pattern overlay.

3.10.4 Cursor range error. - The cursor range error shall be measured as the deviation of the cursor range readout from the correct range as calculated from the input signals. The error shall be as specified in 3.10 except where the error of the cursor range corresponds to the range indicated by a 3/16 inch error circle. Minimum cursor range error is equal to 3/16 inches multiplied by the plotting scale factor.

3 10 5 Cursor bearing error. - The cursor bearing error shall be measured as the difference between the actual correct bearing and the cursor bearing readout. The allowable error shall be as specified in 3.10 except for those instances where 3/16 inches displacement from the target would result in an error exceeding 0.5 degrees The maximum cursor bearing error is arc ton (3/16)/range.

3.10 6 Maintenance philosophy. - The following definitions of equipment levels are set forth and shall be used for establishment of maintenance philosophy.

(a) Equipment. - Equipment shall refer to the entire NC-2, all input and output terminals, casting and shock mounts.
(b) Assembly/module. - The assembly/module shall be the highest level functional block beneath the equipment level. Examples shall be own ship's speed module, own ship's heading module, projector module, etc.
(c) Subassembly. - Subassembly shall refer to those portions of equipment functions which together comprise a module. Usually, electronic groupings such as printed circuit cards shall be referred to as subassemblies
(d) Components. - Components shall refer to devices which perform a well defined unique function and which usually may not be broken down into a lower level Synchros, resolvers, transformers, buffer amplifier, etc., shall be classified as components.
(e) Parts. - Parts shall be defined as the lowest equipment operational level Parts are devices which by themselves do not perform a defined function in the equipment but rely on their relation with other parts or subassemblies. Resistors, capacitors, gears, bearings, etc., are defined as parts.

Maintenance shall be planned for this equipment on the module/assembly level, that is, the module and assemblies shall not be replaced but shall be repaired onboard ship using necessary subassemblies and components to carry out necessary repairs. Shipboard maintenance shall include all calibration and alignment of components and subassemblies within the equipment. Subassemblies and components shall be replaced but not repaired onboard ship The use of nonstandard parts shall be kept to a minimum. Those nonstandard parts which must be used shall be submitted to NAVSEC for approval, and shall be of the format required by MIL-STD-749, and shall contain all the information required therein.

3.11 the supplier shall furnish accurate information on weight and vertical center-of-gravity (v c g.) of each unit or equipment, weighting 100 pounds or more, as well as items known to be stowed or group-located in quantity so as to constitute an aggregate weight of 100 pounds or more. This information shall be required as follows (see 6 3)

(a) By notation of calculated weight and location of v c.g. on the outline drawing initially submitted for approval.
(b) On all revisions of drawings which result from changes in the calculations, under (a).
(c) By notation of the actually measured weight and corrected location of v.c.g , made prior to shipment, on the final revision of drawings sent to NAVSEC

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3.12 Reliability/maintainability (R/M). - The equipment shall provide satisfactory performance and operation in accordance with this specification for a 20 year period during which time it shall operate 4000 hours per year while experiencing 400 on-off cycles per year, evenly distributed throughout the year. The equipment shall operate in 3 month deployment (mission) periods, during which time the equipment shall accumulate a total operating time of 1000 hours, shall experience 100 on-off cycles, and shall require minimum preventive or corrective maintenance. After each 3 month/1000 hour cycle, limited preventive or corrective maintenance may be performed to insure satisfactory operation during the next 3 month/1000 hour cycle. During each 3 month/1000 hour deployment, the equipment shall have an operational availability (Ao) of 99 2 percent defined as·

$$Ao = \frac{(1000 - \overline{Mt} \times 100)}{1000} \text{ percent}$$

where $\overline{Mt}$ is the mean total maintenance downtime for a 3 month/1000 hour mission defined as

$$\overline{Mt} = \overline{Nc} \times \overline{Mct} + \overline{Np} \times \overline{Mpt}$$

where $\overline{Nc}$ = mean number of corrective maintenance actions required during a 1000 hour period of operations ($\overline{Nc} = \frac{1000 \text{ hours}}{\text{Mean time between failure (mtbf)}}$).

$\overline{Mct}$ = mean corrective maintenance downtime for a corrective maintenance action The maintenance downtime for corrective maintenance shall be predicted and demonstrated assuming that maintenance personnel and any necessary test equipment and repair parts are immediately available. $\overline{Mct}$ is the time required to analyze the equipment malfunction, localize the defective part or parts, execute the required maintenance actions and restore the equipment to a satisfactory operating condition.

$\overline{Np}$ = mean number of preventive maintenance actions required during a 3 month/1000 hour mission. The value of $\overline{Np}$ shall be demonstrated by accuracy testing each equipment undergoing the MIL-STD-781 reliability demonstration after each 100 hours of operation The results of these tests shall be used to calculate a mean time between required calibration ($\overline{mp}$). $\overline{Np}$ shall be determined as $\frac{1000}{\overline{mp}}$

$\overline{Mpt}$ = mean preventive maintenance downtime. Replacement of parts or modules during the 3 month/1000 hour mission shall not be required as part of the preventive maintenance schedule.

The contractor shall predict, prior to formal demonstration, the values of each parameter affecting the specified availability. This prediction shall become binding and the contractor shall be committed to achieving each of the parameters listed. Should formal demonstration indicate that any parameter has not measured up to the prediction, the contractor shall conduct a design review and failure analysis to determine design deficiencies and shall make any necessary design changes to the equipment. The demonstration shall be repeated to verify that the prediction has been achieved. Upon successful completion of the demonstrations, all equipment which may have been previously delivered shall be retrofitted at contractor's expense.

Table I indicates the reference which shall be used in predicting each of the parameters, the reference which shall be used to demonstrate the parameters, and the minimum acceptable values of each parameter. The minimum acceptable values listed are for use in performing R/M tradeoff studies and are not to be interpreted as compliance with operational availability requirement. The minimum acceptable mtbf requires a specified mtbf (predicted) not lower than 750 hours (see MIL-STD-781).

Table I - Minimum acceptable values of each parameter.

Parameter	Prediction	Demon.	Min. acceptable
mtbf	MIL-STD-756 MIL-HDBK-217	MIL-STD-781, test level A, test plan II	≥ 500 hours
$\overline{Mct}$	MIL-HDBK-472, procedures 2, part B	MIL-STD-471, method 2	≤ 4 hours

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Table I - Minimum acceptable values of each parameter—Continued.

Parameter	Prediction	Demon.	Min. acceptable
Np		MIL-STD-781, method B test plan II	4
Mpt	MIL-HDBK-472, procedure 2, part B	MIL-STD-471, method 2	1.5 hours

Reliability demonstration shall be conducted according to test level B, test plan II of MIL-STD-781. The specified mtbf for this demonstration shall be that predicted by the contractor, however, the minimum acceptable mtbf shall be not less than 500 hours. During each accuracy test after each 100 hours of operation, should the equipment fail to comply with the accuracy requirements of this specification the number of operating hours since the last calibration shall be noted and logged. The equipment shall be recalibrated and the test continued. Calibration of equipments during this period shall be part of the MIL-STD-471 demonstration. For demonstration of mtbf, a failure (as defined in MIL-STD-721) shall not be considered if correction can be accomplished by recalibration. Any failure which cannot be corrected by calibration shall be considered corrective maintenance and the failure logged as specified in MIL-STD-781.

3.12.1 The supplier shall provide and maintain a detailed written reliability and maintainability assurance program plan in accordance with the general requirements of MIL-STD-785 and MIL-STD-470. The plan shall be acceptable to NAVSEC and shall be submitted as a separate and complete entity within the supplier's proposal for designing and developing this equipment. The plan shall be an integrated effort within the total program plan and shall comply with the reliability program plan of MIL-STD-785 and MIL-STD-470 as a minimum.

3.12.2 The reliability (R) design assurance plan shall include the following in accordance with MIL-STD-785

(a) Reliability organization.
(b) R Management and control.
(c) R Program review.
(d) Manner of demonstrating R.
(e) R design guides.
(f) Operation modes determination.
(g) Equipment apportionment prediction and math models.
(h) Failure mode and effects analysis (materials).
(i) Human error analysis (man-machine interface).
(j) Integrated R/M test planning of MIL-P-21549 and MIL-STD-785.
(k) Integrated R/M design review.
(l) Quality assurance planning during design.
(m) Supplier and subcontractor R/M programs.
(n) Failure data collection, and analysis and corrective action.

3.12.3 The maintainability (M) design assurance plan shall include the following, in accordance with MIL-STD-470·

(a) M organization.
(b) M management control.
(c) M program review.
(d) Manner of demonstrating M.
(e) M design guidelines.
(f) M engineering apportionment and R/M design trade of math models.
(g) M engineering prediction.
(h) M task and skill analysis.
(i) Integrated R/M test planning.
(j) Integrated R/M design reviews.
(k) Supplier and subcontractor M program control.
(l) M data collection, analysis and corrective action system.

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(m) M retention (quality assurance plans) during production, installation, and so forth.
(n) Logistic support data, including maintenance manuals and repair parts.

3.12.4 The R design assurance program shall incorporate the following specific features

(a) Operation modes determination - NAVWEPS 00-65-502, chapter 2 shall be used as a guide.
(b) R design guidelines - NAVSHIPS 94501, MIL-HDBK-217, shall be a basis for design guidelines criteria, as well as supplier internal design guidance documents.
(c) Apportionment and math models - NAVSHIPS 0900-002-3000, chapter 3 and chapter 6 shall be used respectively as guides.
(d) Failure mode and effect analysis - NAVSHIPS 0900-002-3000, chapter 12 and chapter 6 of SAE TP4.
(e) Human error analysis - NAVSHIPS 0900-002-3000, chapter 14 shall be used as a guide.
(f) Supplier and subcontractor control - NAVSHIPS 0900-002-3000, chapter 19 shall be used as the basic guide.
(g) Failure data collection, analysis, and corrective action - NAVSHIPS 0900-002-3000, chapter 16 and MIL-P-21549, shall establish the basic minimum criteria for inclusion in the R program.

3.12.5 The M design assurance program shall incorporate the following specific features

(a) Maintenance concept - NAVSHIPS 0900-002-3000, chapter 8 shall be used as a guide. Definition shall comply with MIL-STD-721
(b) Manner of demonstrating M - NAVSHIPS 0900-002-3000, chapter 8 and chapter 11 shall be used as guides.
(c) M design guidelines - NAVSHIPS 94324 shall be used, as well as contractor internal guides and check lists.
(d) R/M design trade offs apportionment and math models - NAVSHIPS 0900-002-3000, chapter 8 shall be used as a guide.
(e) M prediction - MIL-HDBK-472 shall be used.
(f) M task and skill analysis - NAVSHIPS 0900-002-300, chapter 8, figures 8-37 and 8-38 shall be used as a guide.
(g) Supplier and subcontractor M control - NAVSHIPS 0900-002-3000, chapter 19 shall be used as a guide.
(h) M data collection, analysis and corrective action - NAVSHIPS 0900-002-3000, chapter 16 shall be used as a guide.
(i) Integrated R/M design reviews - NAVSHIPS 0900-002-3000, chapter 15 shall be used as a guide.
(j) M retention during production, installation, and so forth - The contractor shall integrate with quality assurance plan and identify problem areas and interfaces.
(k) Logistic support data, including maintenance manuals and spare/repairs - NAVSHIPS 0900-002-3000, chapter 14 and chapter 20 shall be used as guides. Correlation between R program and maintenance support information and hardware shall be included by the contractor.

3.12.6 Reliability/Maintainability program plan -This plan prescribes the reliability tasks which the contractor shall implement throughout the design, construction and test of the NC-2 plotting system. The purpose of this program plan is to facilitate the design and production of equipment in minimum time and in a manner which gives maximum confidence that specified reliability and maintainability (R/M) parameters are being attained.

3.12.6.1 Redundance considerations. - In the event the contractor chooses to use redundancy as a means of achieving the required reliability the following shall apply

(a) Standby. - Switching redundancy is preferred (that is, no power applied to the redundant element until failure of the primary element).
(b) If active (power applied to redundant element continuously) redundancy is employed, it shall be the switching type only. No load sharing will be permitted.
(c) The switch-over from the failed element to the redundant element may be accomplished by either manual switching from the control panel or by automatic means. In either case, indicators shall be provided to indicate which element is in use.

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3.12.6.2 Maintenance considerations. - It is the intention to provide a system that will require minimum maintenance and calibration during a 3 month ship's deployment during which time the system will be operated approximately 1000 hours with 100 on-off cycles. At the end of the 3 month deployment period, the system will undergo a detailed maintenance/calibration schedule which assures a continuing operational availability for the next 3 months usage. It is desirable that the maintenance/calibration time be kept to an absolute minimum by providing self-contained test features and readily accessible and repairable modules.

3.12.6.3 Philosophy. - There are five fundamental concepts which shall be employed in achieving the R/M objectives of this specification. The policies and procedures which result from these concepts will facilitate the timely and orderly accomplishment of R/M tasks.

3.12.6.3.1 Inherent equipment reliability and maintainability shall be achieved through concerted design effort early in the program.

3.12.6.3.2 Design reliabilities shall be translated into equipment reliabilities by carefully controlled parts procurement and production programs.

3.12.6.3.3 The objectives of developmental tests and formal reliability demonstrations are distinctly different and mutually exclusive. Developmental tests are a check of design effectiveness and parts adequacy which assure the contractor of a quality product. Formal reliability/maintainability demonstrations are statistically valid tests of hypothesis which give NAVSEC a known confidence that specified reliability parameters have been achieved.

3.12.6.3.4 A single contractor R/M manager shall be responsible and accountable for planning, implementing, controlling, and reporting all R/M tasks required.

3.12.6.3.5 The contractor shall require NAVSEC approvals at specified program points, and he shall be constrained from commencing tasks which follow sequentially whenever approvals are withheld for failure to comply with specification requirements.

3.12.6.4 The tasks to be performed by the contractor are divided into four categories. (a) design related tasks, which are performed prior to equipment construction, (b) development tasks, which occur as the completed design is translated into equipment, (c) formal demonstrations, which verify that the equipments meet specified parameters; and (d) report submissions, which occur throughout the program. The tasks are described in 3.12.6.4.1 through 3.12.6.4.4 in the order in which they will occur.

3.12.6.4.1 Design tasks. - During the design phase of the program great emphasis shall be placed on controlling the efforts of individual equipment design engineers. The R/M manager shall establish formal, detailed departmental procedures for accomplishing these tasks, and shall supervise the implementation of the procedures.

3.12.6.4.1.1 Design engineer indoctrination. - The R/M manager shall thoroughly instruct each equipment design engineer in the techniques for achieving circuit reliability. Engineers shall understand the effects of environmental stresses on component life. They shall be made familiar with techniques of component derating and the use of failure-rate prediction documents such as the MIL-HDBK-217. The necessity for employing standard circuits shall be emphasized, and the design engineers shall be made aware of sources of standard parts data and parts performance and reliability data. Design engineers shall be indoctrinated in the use of design review worksheets and they shall be briefed on the need for fully satisfying all circuit/component reliability design requirements. Emphasis shall be placed on the considerations which determine optimal module configurations. The importance of ready module accessibility, adequate provisions for fault isolations, and effective circuit and personnel safety devices shall be stressed. The responsibilities of the design engineers to the R/M manager shall be clearly established.

3.12.6.4.1.2 Initial apportionment of reliability requirements. - The R/M manager shall prepare a model which will show the logical divisions of the system into assemblies, subassemblies, and modules, and he shall assign to each a quantitative reliability requirement based upon parts complexity and overall system reliability requirements. The assigned values shall be based upon state-of-the-art technology and shall reflect a liberal margin of design safety.

3.12.6.4.1.3 Design engineer requirements. - The R/M manager shall provide each design engineer with the apportioned failure rate for each system element he is to design. Each design engineer shall be

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given the parts derating policies for components, and he shall be furnished design review worksheets for each element he is to design. As each element design is finalized, the design review worksheets shall be completed and turned in to the R/M manager for review.

3.12.6.4.1.4 Informal design reviews. - The R/M manager shall conduct an informal design review with each design engineer at least weekly. During these reviews, circuit features should be discussed, the derating of components scrutinized, unique maintainability features discussed, and the design review worksheets examined. The design engineer should discuss any problems he is encountering in meeting the apportioned failure rates, and if necessary the manager shall reapportion these rates among the circuits on modules.

3 12 6.4.1.5 Preliminary design review (PDR) - As part of the PDR, the R/M manager shall review the progress of the reliability design to date. The following items, as a minimum, shall be included in a technical report to NAVSEC 1 week prior to the PDR meeting·

(a) A block diagram showing the apportioned failure rates to the module level
(b) A summary of informal design review activities
(c) A summary of any problem areas uncovered to date.
(d) A summary of unique or significant reliability and maintainability features developed.

PDR shall be the first program point where NAVSEC approval is required of the contractor's R/M progress.

3 12 6 4.1.6 Reliability math model. - The R/M manager shall prepare a reliability prediction model which reflects data taken from the design review worksheets The prediction shall show a block diagram of elements in serial or redundant configuration as applicable The model shall be prepared using a parts complexity model and MIL-HDBK-217 failure rates Each block shall show the elements name and identification number, and the predicted element failure rate Failure rates used other than those contained in MIL-HDBK-217 should be noted and their source listed NAVSEC approval of non MIL-HDBK-217 failure rates is required

3 12.6 4.1.7 Failure mode and effect analysis. - As an integral part of the early design phase, the R/M manager shall develop projected analyses for the system to determine possible modes of failure and their effect on mission success. The primary objective of these analyses shall be to discover critical failure areas and remove susceptibility to such failures from the system The analysis shall be made starting at the system level and expanding downward to the component level In the analysis, each potential failure should be considered in light of probability of occurrence and should be categorized as to probable effect on mission success

3 12 6 4 1.8 Parts procurement - The R/M manager shall review all lists of parts to be purchased, before purchase requests and released to procurement He shall insure that nonstandard or tested and nonapproval parts are not ordered unless acceptable parts are unavailable from any source

3 12 6.4 1 9 Design approvals - As each design is completed, and when the resulting parts list and drawings have been reviewed by the R/M manager, the manager shall sign-off the design Design sign-off for a module certifies that the apportioned failure rate has been met, and the specified parts list satisfies requirements

3 12.6 4 1 10 Critical design review (CDR). - During the overall system CDR, the R/M manager shall summarize the status of the reliability/maintainability design He shall include in a technical report to NAVSEC, 1 week prior to the CDR, the following items as a minimum

(a) A summary of the informal design reviews to date.
(b) A discussion of any reliability or maintainability problem areas
(c) A list of signed-off designs, with dates
(d) An updated reliability block diagram and math model
(e) A list of all nonstandard untested parts for which approval has been received or approval is pending NAVSEC action
(f) Results of failure mode and effect analysis

CDR is the second program point where NAVSEC approval of the contractor's reliability progress is required.

3.12 6.4.2 Development tasks - Release of the contractor's design to production shall follow receipt of NAVSEC approval of the CDR during the production phase parts ordering is completed, production is initiated, equipment developmental tests are completed, and any required hardware or design changes are made

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3.12.6.4.2.1 Stress verification measurements. - During the module factory test phase of the first production unit, actual measurements of component stress levels shall be made as a verification of stress level calculations. The purpose of these measurements is to insure that the design engineer's intended stresses have not been exceeded in each module. These measurements shall be made on 20 percent of all electrical components in each module of which 50 percent are active components (that is, transistors, motors, etc.). The environmental temperature of each selected part, and its operating stress level shall be measured in the first module which is fabricated. The dates and results of all measurements shall be retained in a file.

3.12.6.4.2.2 Failure analysis and corrective action. - During the developmental tests, formal failure reporting to NAVSEC will be performed for every failure that occurs. The R/M manager will review each failure report and ascertain that the cause of failure has been correctly determined. Additionally, he shall insure that adequate corrective action is taken and the fault is corrected.

3.12.6.4.2.3 Reliability/maintainability design review (RMDR). - A formal review of the R/M program shall be conducted by the R/M manager following completion of developmental testing, and immediately prior to the start of formal reliability demonstrations. During this review the following information shall be reviewed·

(a) An updated reliability math model reflecting results of the stress verification measurements.
(b) A summary of completed corrective actions.
(c) A summary of failure reports.
(d) A list of all critical life items.
(e) A list of any outstanding untested or non standard parts awaiting approval.
(f) The results of all parts approval tests.
(g) The approved reliability demonstration test procedure.

The RMDR is the third program point where NAVSEC approval of the contractor's R/M progress is required.

3.12.6.4.3 Formal reliability demonstration test - The predicted mtbf of the system shall be demonstrated by subjecting production equipment to an environmental life test under test level B of MIL-STD-781 and testing until an accept or reject decision is reached in accordance with test plan II of MIL-STD-781. Test plan II is designed for 20 percent decision risks and a 1.5 to 1 discrimination ratio: that is, for demonstration of minimum acceptable mtbf it is designed such that there is a 20 percent chance that an equipment having a specified mtbf of 750 hours will be rejected (manufacturing risk) and a 20 percent risk chance that an equipment having a minimum acceptable mtbf of 500 hours will be accepted (consumer's risk).

3 12.6.4.3.1 Formal maintainability demonstration. - The contractor shall demonstrate the achieved degree of maintainability by testing the systems according to method 2 MIL-STD-471. When possible, maintainability samples shall include equipments which failed during burn-in or during the reliability demonstration. Maintenance tasks shall be so varied that at least 50 different tasks shall be sampled. Tasks shall be selected according to predicted usage rates from the reliability prediction.

3 12.6.4.4 Data submissions. - The R/M manager shall prepare and submit the following data.

(a) R/M periodic progress reports (monthly).
(b) PDR and CDR technical reports (1 week prior to formal meeting)
(c) Failure mode and effect analysis report (30 days after completion of analysis).
(d) Failure reports (10 days after a failure).
(e) Reliability test and evaluation report. (60 days after completion of test).

3.12.6.5 Subcontractor reliability programs. - The R/M manager shall review each subcontractor R/M specification to insure that quantitative requirements are passed on correctly.

3.12.7 Maintenance studies and plans. - The contractor shall conduct a maintenance engineering analysis utilizing the efforts of his reliability and maintenance design assurance plans to explore the possibility of tradoffs between reliability and maintainability to develop the optimum system configuration.

3.12 7.1 The design shall be based on the fundamental precepts of simplicity, reliability, ruggedness and maintainability. The human element must be considered as early as possible and continually in system design in order to incorporate systems and equipments requiring a minimum of logistic and maintenance effort, and to provide a ship system that can be operated and maintained efficiently and economically with minimal personnel requirements. Greatest dependability will result it the tasks

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required are straightforward thus minimizing the margin of error. The first level supervisor for shipboard and yard work shall be considered to be a high school graduate with special training Human engineering design shall comply with the requirements of MIL-H-46855 and MIL-S-38130.

3.12.7.1.1 The adequacy of logistic support is a matter equal in importance to the adequacy of the item itself and shall be so considered in design and production. The reliability and the maintenance and equipment overhaul program of the item throughout its 20 year life shall be tuned to assuring that the unit will operate satisfactorily under fire, during and after a mechanical shock similar to that prescribed in MIL-S-901. Any item subject to degradation through age, operation and environmental forces and which, therefore, could fail at time of the additional stress resulting from mechanical shock shall be considered in the reliability design assurance plans.

3.12.7.1.2 Under combat conditions, the only assured supply to the Fleet may be limited to the material covered by individual ships, the mobile logistic support forces and stocks positioned at overseas bases. The range and depth of Fleet support spare and repair parts and equipment related consumables to be carried by the forces afloat shall provide a 90 day endurance. The items to be carried by the mobile logistic support forces, and the resupply material positioned at designated bases in support of actual and planned fleet deployments without augmentation, shall satisfy the 90 day corrective and preventive maintenance requirements.

3.12.7.2 The contractor shall submit to NAVSEC, for approval, a maintenance engineering analysis reports (MEAR) which will document and substantiate the maintenance engineering analysis As a minimum requirement, the MEAR shall include the requirements specified in 3 12.7.2 1 through 3 12 7 2.3

3.12.7.2.1 A R/M design evaluation which, as a result of the maintenance engineering analysis, shall establish the following

(a) Military essentiality or criticality of each part and subsystem
(b) Mean time between failure and reliability for each part and subsystem
(c) Availability for a 4 day continuous mission.
(d) Modes of failure from analysis of physics of failure.
(e) Mean time to restore.

3.12.7.2.2 A discussion of possible tradeoffs indicating alternatives which will increase system reliability or reduce system down time.

3.12.7.2.3 Justification for tradeoffs which were or were not made

3.12.7.3 Upon approval of the MEAR, the contractor shall submit to NAVSEC, for approval, a plan for maintenance. The plan for maintenance shall be the framework around which all aspects of integrated logistic support shall be constructed. This "plan" shall provide the technical data base for all logistic requirements. As a minimum requirement, the information specified in 3 12 7.3 1 through 3.12 7 3 7 1 shall be included in the plan for maintenance

3.12.7.3.1 Periodic maintenance and logistic requirement. - A program shall be established for all maintenance actions To be identified are maintenance actions to be performed at 3 month intervals onboard ship by ship's force, and other actions and scheduling for these actions which shall require other facilities or personnel. This program shall include all actions required during the assumed 20 year equipment lifetime

3.12.7.3.1.1 The plan for maintenance shall summarize on a time schedule all parts which are to be replaced as defined by the preventive maintenance requirements, to provide reasonable confidence that the item will perform in accordance with the design operating life requirement until the next preventive maintenance action. Each part should be coded to indicate possible sources of supply for repeat buys or whether unrestricted-competition is possible Provisioning documentation, submitted in accordance with MIL-P-15137, shall reflect the plan for maintenance as approved. The plan shall indicate whether an item of work should be conducted onboard the ship the equipment is installed or at another facility.

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3.12 7.3.1.2 The following criteria shall be used in determining onboard spare and repair part and equipment related consumables detailed in the plan for maintenance.

(a) Backup items (items which do not have a predicted usage)
  (1) Only those backup items vital to the support of the primary mission of a ship or unit, or vital to the safety and welfare of personnel onboard ship shall be provided.
  (2) Backup items shall be included in minimum depth (either unity or minimum replacement unit to meet potential 90 day combat requirements) in those cases where they are vital to ship primary missions.
(b) Whenever usage of a part during combat will increase from peace-time requirements, the combat requirements shall be noted as a technical over-ride. Further, when an extended period between expected replacements of an onboard part will exist (exceeds approximately 1 year), its required continuation in the system shall be noted as a technical over-ride in the plan for maintenance and provisioning data, as submitted. (This notation is necessary to eliminate the possibility of removal of the item from the allowance list because of no replenishment usage within the supply system for 2 years.)
(c) The plan for maintenance shall reflect the military essentiality of each item.

3.12.7.3 2 Maintenance tasks. - Maintenance tasks are hereby defined as procedural steps required to accomplish a preventive (including visual examination) or corrective maintenance or calibration action. Contained in this section shall be a set of maintenance tasks for every maintenance action described in the plan for maintenance. All necessary steps, unless self-evident to the person carrying out the task, shall be completely described. The frequency of occurrence of each task shall be clearly designated.

3.12 7 3 3 Installation and checkout procedures - Exact and complete procedures for installing, connecting and verifying all required inputs to the table to be carried out by the installing activity to insure operational integrity of the equipment. Each task shall contemplate all necessary steps, unless self-evident to the person making the installation. Special precautions such as possible erroneous connections, which could result in physical harm to workmen or damage to the equipment shall be provided in this section.

3.12.7.3.4 Personnel planning data. - The plan for maintenance shall identify the personnel rating and skill levels required at each maintenance level. The data provided shall be complete and in sufficient detail to permit identification of acceptable personnel training programs and operational scheduling of personnel resources for both preventive and corrective maintenance.

3.12 7.3.5 Logistic documentation. - Identification of all required documents (publications, engineering drawings, maintenance aids, etc.) necessary to accomplish each maintenance requirement and task

3.12 7.3.6 Support equipment. - All necessary special test equipment or special tools required to accomplish preventive or corrective maintenance or calibration of the equipment shall be detailed. The test equipment in this section shall be identified with the specific maintenance tasks for which it is required, and shall indicate a possible alternate type of equipment which may be used. Specific NAVSEC approval of the plan for maintenance shall be obtained before final equipment design may be considered approved At any time that production tests indicate that the plan for maintenance requires revision, two copies of the proposed modification shall be forwarded to NAVSEC for approval. Portions of the plan for maintenance, as approved, shall be incorporated as required in the equipment manuals by the contractor as required by NAVSEC

3.12.7.3.7 Statement of work - maintenance requirement data. -

3 12.7.3 7 1 The contractor shall provide data for the preparation of maintenance requirement cards (MRC) The submission of data shall be in a format which will be readily transferable to the standard MRC format as prescribed in OPNAV 43P2. The data shall include·

(a) List of all maintainable items.
(b) Recommended planned inspection procedures and frequency at which the inspections are to be accomplished.
(d) List special safety precautions to be observed during and after the maintenance schedule (shipboard scheduled maintenance by calendar and time).
(c) List of special tools and test equipments required to perform maintenance actions recommended.

3.13 Drawings - In addition to the information required on drawings (see MIL-D-1000/2), the assembly drawings shall contain a warning to the effect that great care should be taken to maintain the specified

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tolerances during overhaul procedure and point out the specially critical features required to be maintained for quietness. The location of all attachment points for pickups used in measuring structureborne noise shall be shown on the drawings, and suitable means shall be indicated for the protection and preservation of these attachment points. Types and quantity of drawings shall be as specified (see 6.2).

3.14 Identification. - The plotting table shall be prominently identified by affixing a label plate bearing the following inscription "Quiet Equipment - Use Great Care in Maintenance". Serial numbers are required on identification plates.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 The supplier shall submit to NAVSEC for approval, the testing procedures to be followed during the preproduction inspection (see 4.2) and quality conformance inspection (see 4.3).

4.2 Preproduction inspection. - Preproduction inspection shall consist of the examination and tests specified in table II, which shall be performed, in general, in the order listed·

Table II - Preproduction inspection

Examination and tests	Requirement reference	Examination and test reference
General examination	MIL-I-983	4.4
Accuracy1/	3.10	4 5.1
Supply line voltage and frequency variation	MIL-I-983	MIL-I-983
Shielding and radio frequency noise reduction	MIL-I-983	MIL-I-983
Effect of magnetic fields	3.4.2	4.5 4.
Airborne noise (Grade A)	MIL-I-983	4 5.2
Structureborne noise (Type 3)	MIL-I-983	4 5.2
Temperature and humidity	MIL-I-983	MIL-I-983
Effect of roll and pitch	3.4.12	4 5 3
Transients	MIL-I-983	MIL-I-983
Accelerated life	MIL-I-983	4.5.5
Dielectric strength2/	MIL-I-983	MIL-I-983
Insulation resistance2/	MIL-I-983	MIL-I-983
Enclosure	3.5 1 and MIL-I-983	MIL-I-983
Vibration	MIL-I-983	4 5 6
Shock	MIL-I-983	4.5 6

1/See 4.5.1 7
2/For all but rotating components of the equipment

4.3 Quality conformance inspection. -

4.3.1 Group A. - All equipment offered for delivery on the contract or order shall be subjected to the group A examination and tests specified in table III. Any equipment failing to meet the requirements of this specification shall not be offered for delivery.

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Table III - Group A examination and tests.

Examination and test	Requirement reference	Examination and test reference
General examination	MIL-I-983	4.4
Accuracy1/	3.10	4.5.1
Dielectric strength2/	MIL-I-983	MIL-I-983
Insulation resistance2/	MIL-I-983	MIL-I-983

1/ See 4.5.1.7.
2/ For all but rotating components of the equipment.

4.3.2 Group C. - Group C tests, specified in table IV, shall be conducted on one complete equipment when the basic design of the equipment or the material of a vital part has been changed.

Table IV - Group C tests.

Test	Requirement reference	Test reference
Supply line voltage and frequency variation	MIL-I-983	MIL-I-983
Shielding and radio frequency noise reduction	MIL-I-983	MIL-I-983
Effect of magnetic fields	3.4.2	4.5.4
Temperature and humidity	MIL-I-983	MIL-I-983
Effect of roll and pitch	3.4.12	4.5.3
Transients	MIL-I-983	MIL-I-983
Accelerated life	MIL-I-983	4.5.5
Enclosure	3.5.1 and MIL-I-983	MIL-I-983
Vibration	MIL-I-983	4.5.6
Shock	MIL-I-983	4.5.6

4.3.3 Burn-in. - All equipment to be offered for delivery under this specification shall undergo a 100 hour burn-in period during which time all failures shall be repaired and defective parts replaced by the contractor. This burn-in shall be applied to all equipments subsequent to the group A examination and tests of 4.3.1 and any other quality conformance test.

4.3 4 Reliability maintainability demonstration. - As required by 3.12 and 3.12.6.4.3, the reliability shall be demonstrated by subjecting a quantity of equipment to test plan II, test line A, of MIL-STD-781. The quantity of equipments to be tested shall be determined by using table 5 of MIL-STD-781 and considering the entire production quantity as one lot. Maintainability requirement of 3.12 shall be made using procedure 2, part B of MIL-HDBK-472 to verify the maintainability prediction. Equipment availability shall be evaluated from the demonstrations using the procedures of MIL-STD-757.

4.4 General examination. - The general examination shall be conducted in accordance with MIL-I-983. The examination shall include, but shall not be limited to, the following:

(a) Cursor maximum length check (see 3.7.2).
(b) Image resolutions check (see 3.6.3.3).
(c) Plot illumination check (see 3.6.3.2).
(d) Geographic plot check.
(e) Own ship's mode selector switch check.
(f) TPA selector switch check.
(g) Own ship heading display.
(h) Master slew check.
(i) TPA manual slew check.
(j) Timing gong check.
(k) Illumination controls check.

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(l) Correct fuse value check.
(m) Own ship heading and speed readouts.

4.5 Test procedures. -

4.5.1 Accuracy. - Prior to the beginning of accuracy testing, the equipment shall be fully calibrated. Once the accuracy testing is begun, calibration in any form shall not be permitted. Accuracy testing is defined as any testing conducted in accordance with the requirements of 4.5.1.1 through 4.5.1 8. Should the equipment require calibration or similar adjustment, or the replacement of any parts in order to satisfactorily complete a test, the entire accuracy testing shall be repeated from the start. Only those test runs marked with an asterisk (*) shall be applied as acceptance tests to all production equipments offered for delivery. All tests shall be applied to the preproduction equipment. Those test runs marked with a double asterisk (**) shall be considered accuracy checks only.

4.5.1.1 Plotting table position error. - The test for position error shall be conducted in accordance with table V. All TPAs shall be positioned to track own ship which shall be initially positioned in the center of the plotting surface This test shall be performed using first synchro heading and speed inputs and then repeated using manual heading and speed inputs. During both runs the own ship heading display and own ship heading and speed readouts shall be monitored and the readouts recorded

Table V - Plotting table position error test.

Heading (degrees)	Speed (knots X a)	Time (minutes X b)	Scale (yards/inch)	a	b
005.0	3.5	8	*200	1	1
050.0	7.0	8	355	1.5	1 5
095.0	7.0	8	***500	2.5	1
140 0	8 75	7	575	3.0	1
185.0	5.25	12	694	3 0	1
230.0	7.0	8	835	2.5	2
275.0	7.0	8	*1000	2 5	2
320.0	3.5	16	1150	2.5	2.5
005.0	1.75	16	*1388	3.0	2.5
005.0	3 5	8	*1675	4.0	2 0
320.0	3.5	16	*2000	4.0	2 5
275.0	7.0	8	3550	6.0	3 5
230.0	7.0	8	*5000	6.0	4 0
185.0	5.25	12	7250	5 0	10.0
140.0	8.75	7	10000	5.0	10.0
095.0	7.0	8			
050.0	7.0	8			
005.0	3.5	8			

4.5.1.2 TPA cursor nonlinearity and symmetry. - Nonlinearity of the cursor is measured by determining the maximum offset of the cursor on the display surface from a straight edge connecting the ends of this line. The line shown on the display surface shall have no apparent fluctuations along its length and any deviation shall be curvature in one direction only with only one deviation from a straight line. The excursion shall not exceed 0.5 percent of the length of the cursor. The cursor shall be extended to a maximum length in nine directions (0, 45, 90, 135, 180, 225, 270, 315 and 360 degrees) and linearity measured in each direction to determine compliance with this requirement. The origin of the cursor shall be first at the center of the plotting surface, then at the nine points defined by the intersection of a 10-inch circle with center at the center of the plotting surface and the nine heading lines specified. The cursor shall be varied in length in 1-inch increments from 1 to 15 inches and measured for length variation along the nine headings of 3 10.4. The length of the cursor shall be varied up to 20 inches along the headings of 45, 135, 225 and 315 degrees. The length of the cursor shall not vary by more than ± 0.25 percent of the original setting of the cursor length prior to rotation. The cursor shall also be centered at four points 10 inches from the center of the plotting surface at each cardinal heading (0, 90, 180, and 270 degrees) and then repeated at a point 15 inches from the center of the plotting surface at four intercardinal headings (45, 135, 225, 315 degrees) and the test repeated.

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4.5.1.3 TPA plotting error. The TPA plotting error shall be measured by applying range and bearing signals to all TPA's simultaneously with own ship in relative mode. Five range (R) and bearing (B) inputs shall be applied at each scale factor as listed in table VI.

Table VI - TPA plotting error test

Scale	Pos A		Pos B		Pos C		Pos D		Pos E	
	R	B	R	B	R	B	R	B	R	B
yards/inch	yards	degrees	yards	degrees	yards	degrees	yards	degrees	yards	degrees
*200	625	335.5	1225	263.5	2025	191.5	2825	119.5	3625	047.5
354	1105	064.3	2170	352 3	3585	280.3	4690	208.3	6415	136.3
*500**	1565	151 8	3065	078.9	5065	007.8	6565	295 8	9065	223.8
575	1795	241.2	3570	169.2	5820	097.2	7545	025.2	10420	313.2
*694	2170	153.5	4240	081.5	7025	009.5	9110	297.5	12580	225 5
835	2610	248 2	5115	176.2	8455	104 2	10960	032.2	15130	320.2
*1000	3125	331.2	6125	259.2	10130	187 2	13130	115 2	18130	043.2
*1150	3595	061.9	7045	349.9	11640	277.9	15090	205.9	20840	133.9
*1388	4340	153.0	8500	081.0	14050	009.0	18220	297.0	25160	225.0
*1675	5235	333.0	10260	261.0	16960	189.0	22980	117.0	30360	045 0
*2000**	6250	063.0	12250	351.0	20250	279.0	26250	207.0	36250	135 0
3550	11090	243.0	21745	171.0	35943	099 0	46590	027 0	64340	315.0
*5000	15630	065.0	30630	353.0	50630	281.0	65630	209.0	72000	137.0
7250	22660	018 0	44400	306.0	70000	234 0	70000	162 0	70000	090.0
*10000	31250	108.0	61250	036.0	61250	324.0	61250	252 0	61250	180.0

4.5.1.4 Tracking rate error. - The TPA autotracking function shall be tested by performing the test runs of table VII.

Table VII - Tracking rate error test.

Heading (degrees)	Speed (knots)	Time (minutes)	Scale (yards/inch)
045.0	4.0	60	* 200
135.0	8.0	60	*** 500
315.0	7.5	60	694
045.0	10.0	60	* 835
225.0	75.0	10	*1000
315.0	101.0	8	*1388
135.0	304 0	5	1850
045.0	256.0	10	*2000
225.0	503.0	15	10000

4.5.1.5 Cursor range and bearing error. - The cursor range and bearing error shall be tested by setting up each of the situations listed in table VIII, for the scales as indicated Range and bearing shall be measured from each TPA to each other TPA and to own ship. Each TPA shall in turn be superimposed upon own ship and range and bearing measured to the remaining three TPA's In addition to the problems described in table VIII, the following problem will be set up on the 500 yard/inch scale. Own ship will be driven off scale until all TPA's are displayed and range and bearing measured from each TPA to each other TPA.

TPA #1		TPA #2		TPA #3		TPA #4	
R(yards)	B(deg)	R(yards)	B(deg)	R(yards)	B(deg)	R(yards)	B(deg)
45,000	045	51,000	030	48,000	035	49,900	044

Table VIII - Cursor range and bearing error test

Own ship		TPA #1		TPA #2		TPA #3		TPA #4			
Dist. from center of plot (inches)	B (degrees)	R X a (yards)	B (degrees)	R X a (yards)	B (degrees)	R X a (yards)	B (degrees)	R X a (yards)	B (degrees)	Scale (yards/inch)	a
0	-	1010	010.5	2510	030.5	625	325.0	1525	216.0	* 200	1
5.5	005.5	2050	185.0	3750	175.0	3100	236 5	505	340.0	356	1.5
7.25	137.5	655	140.5	3750	270.0	2520	315.0	505	091.0	* 500	2.5
13.5	315.5	3610	180.5	2520	136.5	1610	095.0	625	315.0	694	3.0
1.5	217.5	1410	325.0	2510	030.5	625	325.0	1525	216.0	***1000	5.0
										1388	6.0
										*1456	7.5
										*2000	8.0
										2560	8.5
										*5000	10 0
										10000	10.0

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4.5.1.6 Relative plot mode verification. - The situation as tabulated in table IX shall be set up and the problem run for 2 hours on the 500 yard per inch scale. Own ship heading shall be 210 degrees with a speed of 5 knots. Initial positions are with respect to the center of the plotting surface.

Table IX - Relative plot mode verification.

Image	Initial position	
	Distance (inches)	bearing (degrees)
Own ship	10.0	030
TPA #1	8.6	000
TPA #2	8.6	000
TPA #3	5.0	090
TPA #4	5.0	090

4.5.1.7 When conducting preproduction tests complete testing required by this specification shall be conducted prior to beginning all other testing and repeated after all environmental and accelerated life tests are completed. Accuracy checks shall be performed as required, during or after specific environmental tests, by performing those test runs marked with a double asterisk(**). Accuracy check shall be performed during the following tests supply line voltage and frequency variation; temperature and humidity; the effect of roll and pitch; and the vibration test, and as otherwise required. Accuracy check will not be required after the following tests general examination, shielding and radio frequency noise reduction, airborne and structureborne noise and insulation resistance.

4.5.1 8 Accuracy verification - The results of all the foregoing tests shall be within the limits of accuracy of 3 10. The contractor shall calculate the allowable error for each test and submit the allowable error as part of the test procedures.

4.5.2 Airborne and structureborne noise. -

4.5.2.1 Airborne noise.- Unless otherwise specified (see 6.2), airborne noise levels shall not exceed in 1/3 octave band sound power level limits for this equipment as shown in table X.

Table X - One-third octave band limits for airborne noise (sound power level re 10^{-13} watts).

Band center frequency (cps)	Noise level db.	Band center frequency (cps)	Noise level db.
25	1/	630	72
31.5	1/	800	70
40	92	1000	68.5
50	90	1250	67
63	88.5	1600	65
80	87	2000	63.5
100	85	2500	62
125	83.5	3150	60
160	82	4000	58.5
200	80	5000	57
250	78.5	6300	55
315	77	8000	53.5
400	75	10000	52
500	73.5		

1/ No limits established.

4.5.2.2 Structureborne noise. - Structureborne noise levels shall not exceed the values shown on figure 1 for equipment in any 1/3 octave band for the frequencies specified in 4.5.2.4. If 1/3 octave band levels exceed the specified limits in any band, the equipment may be accepted on the basis of narrow band analysis

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showing no peaks over the limits specified for the 1/3 octave band or bands in question. Except as specified in 4.5.2.5, no unnecessary weight shall be added to the equipment under test.

4.5.2.3 One-third octave analysis. - The levels of each 1/3 octave band for the selected pickup shall be recorded on a graphic level recorder. The complete frequency range shall be scanned twice. If any 1/3 octave band indicates a difference in recorded levels of more than 3 db. between the two scans, the level in this 1/3 octave band shall be recorded for 1 minute. The highest level recorded during this period shall be reported as the level for that band.

4.5.2.4 Frequency range. - Unless other frequency ranges are specified (see 6.2), the frequency range shall be as specified in MIL-STD-740, except that if the lowest exciting frequency of the equipment under test is below the range specified in MIL-STD-740 the lower limit of frequency shall be the lowest exciting frequency of the equipment. Frequencies referred to herein are the band center frequencies.

4.5.2.5 Mounting for test. - The equipment shall be mounted on a fixture by the designed points of attachment of the equipment. This fixture shall be stiff between points of attachment and damped to eliminate resonances within itself. If the equipment being evaluated contains internal sound-isolating mounts, the mass of the fixture shall be great enough to permit these internal mounts to function properly. (In order to do this, the mass of the nonisolated structure, including the added fixture, should be approximately ten times the mass of the internal structure which is supported on sound-isolation mounts.) The combined assembly of equipment and test fixture shall be resiliently mounted and oriented in its normal operating position. The resilient mounting may consist of mounts as specified in MIL-STD-740 or a suspension system using flexible cord (shock cord). Preference shall be given to the use of resilient mounts. The total weight on the resilient mounting system (including the added fixture) shall be used to determine the allowable limits from figure 1. Equipment resilient mounting shall not be used during this test.

4.5.2.6 Attachment of pickups. - Pickups shall be attached directly to the equipment being tested without the use of mounting blocks, except in those instances where there is insufficient space to accommodate the tri-axial array of pickups. Where mounting blocks are necessary in order to accommodate the tri-axial array of pickups, the blocks shall be welded or brazed to the equipment, and the block surfaces shall be accurately machined. The pickups may be attached to the added fixture, if necessary, but they should be close to the equipment's own attachment points.

4.5.2.7 Operating conditions. - All external design loads shall be connected to the table during airborne and structureborne noise testing. Speed and course shall be continuously provided to own ship's reticule and the TPA's as follows

Course - 0 to 359 degrees cyclically at a rate of 10 degrees ± 2 degrees per second.
Speed - Own ship's reticule shall be provided with speeds of 5 to 35 knots cylically at a rate of 1 knot per second. All TPA's shall be provided with speeds of 5 to 500 knots cyclically at a rate of 15 knots per second.

4.5.2.7.1 This test shall be conducted on both the 200 yard per inch scale and on the 5 mile per inch scale. All TPA's and the own ship's projection shall remain on the plotting surface during the test.

4.5 3 Effect of roll and pitch. -

4.5.3.1 The purpose of this test shall be to determine whether the table will operate satisfactorily under condition of roll and pitch.

4.5.3.2 The unit under test shall be mounted on a Scorsby test stand which shall be operated during the runs with an amplitude of roll of 40 degrees on each side of the vertical with a period between 8 and 10 seconds, and an amplitude of pitch of 10 degrees on each side of the vertical with a period between 6 and 8 seconds. The unit may be mounted in any one or more positions in which it may be required to operate onboard ship and the roll and pitch axes of the Scorsby test stand may be interchanged, if necessary, to provide clearance for the motion of the unit.

4.5.3.3 The roll and pitch test shall be conducted for three 30-minute periods. During each 30-minute period inputs of OSS and OSC are programmed into the table. At the end of each period the test stand shall be stopped at its approximate maximum roll or pitch position and the own ship's position compared with its theoretical position as shown on an overlay. The own ship's position shall be within .5 percent of its theoretical image on the overlay (see 3.10.3).

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4.5.4 Effect of magnetic fields. - The accuracy tests of 4.5.1 shall be made to ensure that a magnetic field will not affect the accuracy of the table as specified in 3.4.2. The production accuracy test of 4.5.1 shall be used for this test.

4.5.5 Accelerated life. - The accelerated life test shall be conducted under conditions specified in MIL-I-983. Accuracy tests may be conducted simultaneously with the accelerated life tests when feasible to do so. When no conducting accuracy tests the operating conditions specified in 4.5.5.1 and 4.5.5.2 shall be in effect.

4.5.5.1 Plotting table accelerated life. - Plotting table accelerated life test shall be measured as follows· With scale set at 0.25 nautical mile per inch, initial position of main projector 4 inches in from north side and 6 inches in from west side of the plotting surface, course input at 180 degrees, speed input at 25 knots, start input signals. Reverse course (180-degree turn) to the east every 12 minutes so that parallel N-S tracks are produced which are about 1 inch apart and approach to about 4 inches of the north and south sides of the plotting surface. When a southbound track is within 6 inches of the east side of the plotting surface and about 4 inches from the south side, change course to 270 degrees (west) and start producing E-W tracks. Reverse course to the north every 20 minutes until a westbound tract is within 4 inches of the north side of the plotting surface. When this westbound track is within 6 inches of the west edge, repeat sequence. (Total time for each sequence about 13 hours.)

4.5.5.2 TPA accelerated life. - The TPA accelerated life test shall be conducted simultaneously with the plotting table accelerated life test. The TPA accelerated life test shall consist of two tests (tests A and B) which shall be run alternately for 100 hours each until completion of the 500-hour plotting table accelerated life test. The TPA accelerated life tests shall be as follows:

(a) Test A. - All TPA shall be driven at constant range and with continuously changing bearing. Bearing rate shall be at least 20 degrees per second. Range shall be varied every 15 minutes in 500-yard increments from 500 yards to 5,000 yards.

(b) Test B. - All TPA shall be driven at constant bearing and continuously changing range. Range shall be varied from zero to 5,000 yards and back to zero. Range rate shall be at least 1/2 inch per second, reversing direction of movement approximately every 8 seconds. Bearings shall be changed 5 degrees clockwise every 15 minutes.

4.5.6 Shock and vibration. - The plotting table shall conform to the grade A, class II shock requirements of MIL-S-901. Equipment shall meet the vibration test for vital equipment of MIL-I-983.

4.5.7 Inspection of preparation for delivery. - The packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

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

5.1 Domestic shipment and early equipment installation and for storage of onboard repair parts (see 5.3). -

5.1.1 Anti-submarine and dead reckoning plotting table. -

5.1.1.1 Preservation and packaging. - Preservation and packaging which may be the supplier's commercial practice shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation.

5.1.1.2 Packing. - Packing shall be accomplished in a manner which will insure acceptance by common carrier at the lowest rate and will afford protection against physical or mechanical damage during direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Rules or other carrier regulations as applicable to the mode of transportation, and may conform to the supplier's commercial practice.

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5.1.1.3 Marking. - Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the contractor's commercial practice. The information shall include nomenclature, Federal stock number or manufacturer's part number, contract or order number, manufacturer's name and destination.

5.1.2 Onboard repair parts. - Onboard repair parts shall be preserved and packaged by level A; packed by level C, and marked by levels A and C respectively in accordance with MIL-E-17555.

5.2 Domestic shipment and storage or overseas shipment. - The requirements, and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.2).

(5.2.1 The following provides various levels of protection during domestic ship and storage or overseas shipment, which may be required when procurement is made (see 5.3).

5.2.1.1 Preservation and packaging, packing and marking. - The equipment and accessories, repair parts and publications shall be preserved and packaged by levels A or C, packed by levels A or B as specified, and marked in accordance with MIL-E-17555.)

5.3 Use of polystyrene (loose-fill) material. -

5.3.1 For domestic shipment and early equipment installation and level C packaging and packing. - Unless otherwise approved by the procuring activity (see 6.2), use of polystyrene (loose-fill) material for domestic shipment and early equipment installation and level C packaging and packing applications such as cushioning, filler and dunnage is prohibited. When approved, unit packages and containers (interior and exterior) shall be marked and labelled as follows:

"CAUTION

Contents cushioned etc. with polystyrene (loose-fill) material.
Not to be taken aboard ship.
Remove and discard loose-fill material before shipboard storage.
If required, recushion with cellulosic material bound fiber, fiberboard or transparent flexible cellular material."

5.3.2 For level A packaging and level A and B packing. - Use of polystyrene (loose-fill) material is prohibited for level A packaging and level A and B packing applications such as cushioning, filler and dunnage.

6. NOTES

6.1 Intended use. - The equipment covered by this specification is intended for Naval service where it is expected to withstand continuous use for long periods, under Military service conditions without benefit of overhaul. The equipment is in each case a vital instrument intended for important use by the forces concerned. Failure at a critical moment invariably results in serious reduction in the battle efficiency of the ship. Functional use is specified in 3.2.

6.2 Ordering data. - Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) If testing equipment is to be other than contractor-furnished (see 3.8).
(c) Types and quantities of drawings required (see 3.13).
(d) Airborne noise levels if other than as specified in 4.5.2.1.
(e) Frequency range if other than as specified in 4.5.2.4.
(f) Preparation for delivery requirements if other than as specified in 5.1 (see 5.2).
(g) If use of polystyrene is approved for domestic shipment and early equipment installation and level C packaging and packing applications (see 5.3.1).

6.3 Bid data. Bidders shall be requested to furnish the following (see 3.11).

(a) Information on weight and v.c.g. of each unit of equipment weighing 100 pounds or more.
(b) Items known to be stowed or group-located in quantity so as to constitute an aggregate weight of 100 pounds or more.

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6.4 Preproduction. - Invitations for bids should provide that the Government reserves the right to waive the requirement for preproduction samples as to those bidders offering a product which has been previously procured or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending procurement.

6.5 For purposes of this specification, the approving office within the Naval Ship Engineering Center will be the Interior Communication, Navigation, Control and Computer Systems Branch.

6.6 CHANGES FROM PREVIOUS ISSUE. THE OUTSIDE MARGINS OF THIS DOCUMENT HAVE BEEN MARKED "#" TO INDICATE WHERE CHANGES (DELETIONS, ADDITIONS, ETC.) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS HAS BEEN 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 AS WRITTEN IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

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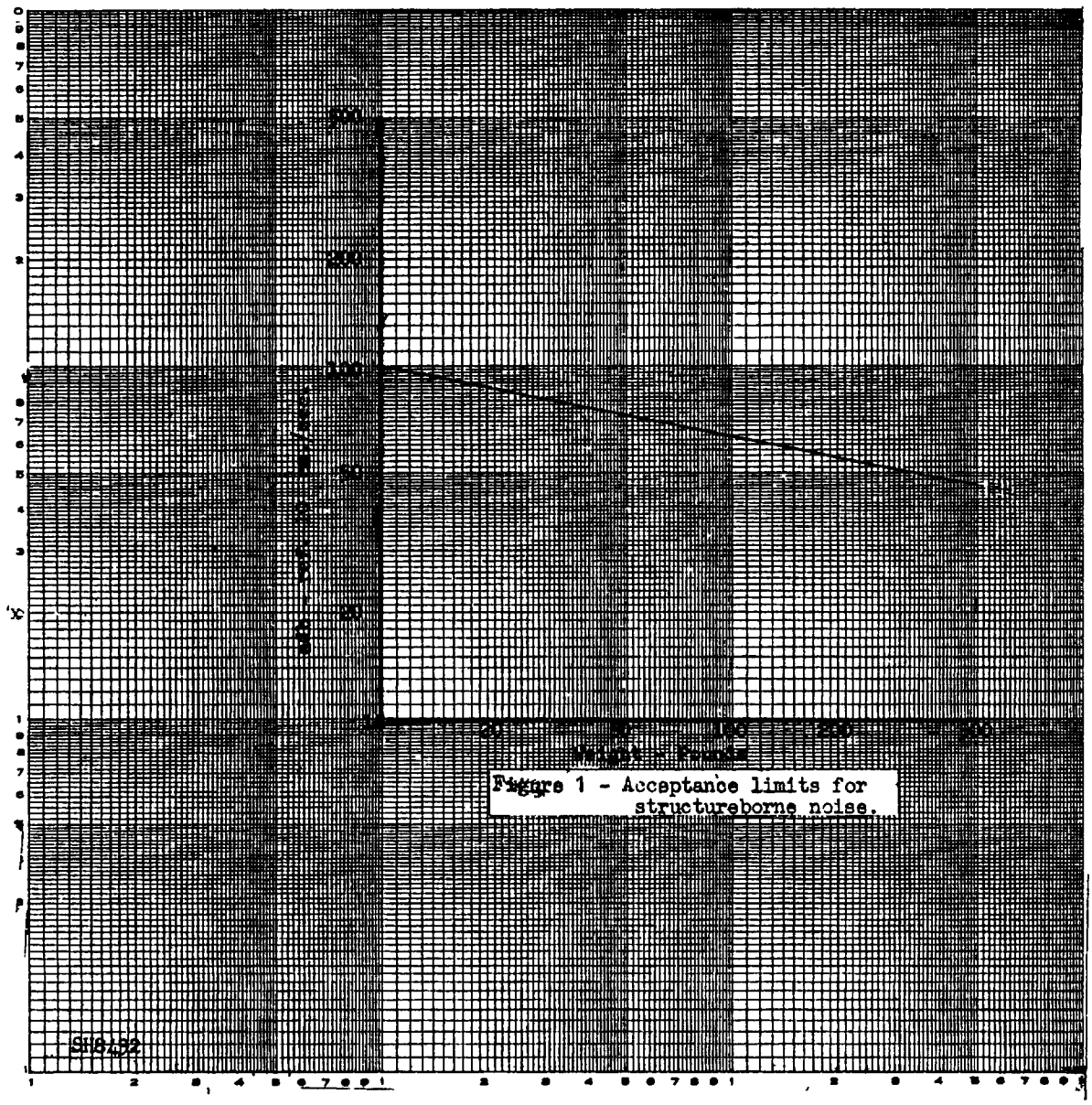

Figure 1 - Acceptance limits for structureborne noise.

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SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

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 *(as indicated on reverse hereof)*.

SPECIFICATION

ORGANIZATION *(Of submitter)* | CITY AND STATE

CONTRACT NO. | QUANTITY OF ITEMS PROCURED | DOLLAR AMOUNT $

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)* | DATE

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