MIL-D-2759D(SHIPS)
18 October 1963
SUPERSEDING
MIL-D-2759C(SHIPS)
2 August 1961
(See 6.5)

DEAD RECKONING TRACER

(DRT) (NAVAL SHIPBOARD)

1. SCOPE

1.1 This specification covers the design of Dead Reckoning Tracer (DRT) for use in Naval ships.

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-I-983 - Interior Communication Equipment; Naval Shipboard, Basic Design Requirements for.
MIL-Q-9858 - Quality Control System Requirements.
MIL-E-17555 - Electronic and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of.

DRAWINGS

BUREAU OF SHIPS
S2487-533730 - Drafting Machine, MK 3 Mod 3, Details.

PUBLICATIONS

NAVY HYDROGRAPHIC OFFICE
Publication No. 9 - American Practical Navigator (1958 edition).

(Application for copies should be submitted to the Navy Hydrographic Office, Washington 25, D. C. or the Superintendent of Documents, Government Printing Office, Washington 25, D. C.)

(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.

OFFICIAL CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York 16, N. Y.)

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)
236 - Inspection of Fine-Pitch Gears.

(Application for copies should be addressed to the American Gear Manufacturers Association, 1 Thomas Circle, NW, Washington 5, D. C.)

(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, one preproduction sample of the equipment shall be tested as specified in 4.3 (see 6.4).

3.2 Description.- The DRT is intended to indicate and record own ship's dead reckoning position graphically and to indicate latitude and longitude on dials or counters.

3.3 Operation.- The DRT shall operate as follows: North and east components of own ship's distance traveled in the form of step by step signals of 115 volt direct current at 750 revolutions per nautical mile from dead reckoning analyzer-indicators are supplied to the DRT. These signals position the DRT plotting head so that own ship's geographic position is continuously indicated on an overlayed chart of any scale specified in 3.6.4 as the center of a polar diagram and recorded as a pencil mark on plotting paper. Own ship's current position in latitude and longitude are also continuously displayed on dials.

3.4 General features.- The DRT shall be in accordance with the following paragraphs of MIL-I-983, in addition to the requirements specified herein. Whenever a requirement of MIL-I-983 conflicts with a requirement of this specification, the requirement of this specification shall govern:

General requirements
Definitions
Materials, general
Substitution of (equal or superior) materials or parts
Fungus-inert materials
Unacceptable materials
Acceptable materials
Flammable materials
Arc-resistant materials
Toxic materials
Wood
Metals
Plastics
Ceramics
Impregnating, embedding and encapsulating compounds
Glass
Lubricants and lubrication
Painting
Protection against corrosion
Bolts, machine screws, studs and nuts
Gaskets
Dials and pointers
Dial sizes
Locking devices
Washers
Ball bearings (precision grade required)
Parts - electrical - general
Requirements for semiconductor devices
Electron tube or capacitor sockets
Capacitors
Variable resistors
Transformers
Relays
Synchros
Electrical tapes
Batteries
Dial illumination lamps
Switches
Indicator lights and lampholders
Fuses

Fuseholders and fuse clips
Metallic rectifiers
Printed wiring and circuits
Enclosures - general
Enclosure - accessibility
Enclosure - degree of (dripproof) (see 3.6.1)
Enclosure - mounting (see 3.6.1)
Stiffening grooves
Minimum sheet metal thickness (watertight enclosures)
Through bolting
Cable entrance
Ventilation
Size (for submarines)
Threaded devices
Rounded corners and edges
Internal subassembly protection (see 3.6.2)
Drilled and tapped holes
Welding
Temperature and humidity (see 3.6.1)
Accelerated life
Shock, vibration, and inclination (vital vibration test required) (see 3.5)
Primary power supply circuits
Power supply tolerances
Personnel protection
Shielding and radio frequency noise reduction
Ground potential and grounding
Soldering
Electrical parts mounting
Internal subassembly connection
Terminal boards, connectors and terminals
Wiring
Dial illumination
Electrical insulation
Dielectric strength and insulation resistance clearances
Airborne noise
Structureborne noise
Drawings - general
Drawings - preliminary
Drawings - working
Schematic diagrams - Wiring diagram - Assembly drawings
Drawings - manufacturing
Bill of materials
Interchangeability and standardization
Manuals
Repair parts
Repair parts (electronic)
Designation and marking
Reports
Nomenclature
Workmanship and general examination

3.5 Design.- The DRT shall be so designed that vibration, shock, or acceleration, which may be encountered in service aboard 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. The equipment shall be so designed that the operator will not receive an electric shock when making any ordinary adjustment while the equipment is in operation.

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

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

3.5.3 Adjusting devices shall be free from excessive friction. Each adjusting device requiring a setting shall be provided with a suitable graduated dial, scale, or indicator, which shall be so designed that it may be read without difficulty. Handles of adjusting devices shall be so constructed or protected that accidental contacts will not disturb them or change their setting, or shall be provided with protective covers attached to the unit in such a manner as not to cause interference or affect ease of handling.

3.5.4 Resolvers, friction disks, rollers, and other mechanical components shall be of a suitable material, properly and evenly hardened or treated to prevent wear. They shall, wherever practicable, be provided with oil-saturated felt wipers for lubrication.

3.5.5 Bearings shall be double-shielded, shall be at least class ABEC3, and shall be the prelubricated sealed-for-life type.

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

3.5.7 Electrical connections from each unit to external circuits shall be brought out to common termination connectors.

3.5.8 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.

3.5.9 Interchangeability.- Except as specifically provided herein, similar parts and permanent assemblies, including repair parts of 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.

3.5.10 Proposed changes in design affecting interchangeability of parts or assemblies, including repair parts, shall be satisfactory to the bureau or agency concerned before being made effective.

3.5.11 Terminal boards shall be provided with protective covers to prevent accidental short circuits while working on the tracer.

3.5.12 The effect of roll and pitch shall not adversely affect the operation of any unit of equipment when tested in accordance with 4.6.2.

3.5.13 Provision shall be made to protect the DRT against possible damage in case the equipment is allowed to run to or beyond its operating limits.

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

3.5.15 All cable shields shall be tied to a common point and grounded at that point within the equipment.

3.5.16 Gears.- Gears used in critical backlash applications shall be at least sixty-four pitch and precision 1C as defined by Publication AGMA 236 and of a material satisfactory to the bureau or agency concerned. 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.

3.6 Mechanical features.-

3.6.1 Enclosure.- All parts required for the proper operation of the DRT shall be mounted in an enclosing case (degree of enclosure dripproof or better) designed for horizontal mounting. Provision shall be made for the protection of gears from dust. 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 the enclosure. Adequate natural ventilation shall be provided to permit proper operation at any ambient temperature within the limits specified in MIL-I-983.

3.6.2 Accessibility.- All units and subassemblies of the equipment shall be easily accessible for replacing plotting paper, adjustment plotting section and the control section access doors shall be equipped with

hinges and brackets so that they lock in the open position. Protection of the internal subassemblies shall be provided in accordance with MIL-I-983.

3.6.3 Weight and size.- The effective plotting area shall be not less than 30 by 30 inches. The vertical thickness of the DRT shall not exceed six inches. The overall weight and size of the DRT shall be kept to a minimum.

3.6.4 The scale of the track shall be adjustable and through a gear shift arrangement shall provide for the following ranges: 200 yards per inch; 1/4 to 1 nautical mile per inch; 1 to 4 nautical miles per inch; 4 to 16 nautical miles per inch. The adjustment shall be indicated on a scale reading to hundredths of a nautical mile per inch over the lower variable range.

3.6.5 The track shall indicate intervals of time by interruption of the track for approximately 15 seconds each minute and additional interruption for 1 minute every 10 minutes. The timing shall be controlled by an 8-day clock which shall be accurate within 3 minutes at all times during a period of 96 hours when wound every 24 hours, irrespective of whether the track timing contacts are in operation. The contacts shall have ample clearance in the open position, and shall not impose an unduly heavy or variable load on the clock mechanism.

3.6.6 The track shall be clearly defined and shall be uniform irrespective of the position in which the tracer is operated.

3.6.7 Provision shall be made for conveniently starting the track at any point in the tracking area, correcting the position of the tracking mechanism, changing the scale of the track, and making all other normal operating adjustments and observations without moving the auxiliary plotting board.

3.6.8 The tracking device shall not cut, tear, nor unduly abrade the chart paper when run back and forth repeatedly over the same course. The tracking device shall be satisfactorily protected against breakage of pencil lead when the tracer is subjected to shock in any position.

3.6.9 Provision shall be made for starting and stopping the mechanism of the tracer.

3.6.10 Provision shall be made for electrically interchanging the course components to permit shifting the reference axes of the tracking mechanism at right angles. Label plates shall be provided, suitably marked, to indicate the directions of north, south, east, and west.

3.6.11 The tracking board shall be smooth and free from surface irregularities and shall be flat within 1/16 inch from highest to lowest point.

3.6.12 The upper frame of the plotting section shall be capable of allowing installation of the mounting plate of the drafting machine MK3 Mod 3 (see Drawing S2487-533730).

3.6.13 The tracer shall be equipped with an auxiliary plotting board in accordance with the design that is satisfactory to the bureau or agency concerned. The plotting surface shall be a tempered glass plate sufficiently strong to serve the purpose, spaced above the tracking area for use in connection with a screen dial assembly. The screen dial assembly shall be designed for attachment to the pencil carrier, and shall include a light source, a screen dial, and a suitable light shield, so arranged as to project a shadow image of the screen dial to a chart placed on the plotting surface. The screen dial and the size of the projected image shall be in accordance with designs satisfactory to the bureau or agency concerned. Means shall be provided for adjusting the size and position of the projected image. Suitable switches shall be provided for optional use of this method of tracking, or pencil tracking, or both methods together. When both methods are used simultaneously, the time element in the pencil track (see 3.6.5) will not be required.

3.6.14 The tracer MK6 shall contain a latitude and longitude computer element which will compute and indicate latitudes up to 85 degrees north or south and compute and indicate longitude from 0 degrees to 180 degrees east and west. Provisions shall be made for manual resetting of the dials. Dials shall read to an accuracy of 1 minute of arc.

3.7 Power supply.- The equipment shall be designed to operate on ship's supply, 115-volt, 60-cycle, single phase, alternating current (a.c.) and 115-volt direct current (d.c.).

3.8 Accuracies.- The error of the plotting system shall not exceed the values shown below under all conditions specified in 4.6.1.

(a)	Resultant error	0.5 percent
(b)	Position error	2.0 percent

3.9 Error calculations.- The distance input to the equipment is defined as the theoretical length of run in nautical miles, and is represented by D. The distance input to a tracer is determined by the output of the distance transmitter. The distance output is determined by actual measurement on the plotting surface.

3.9.1 Resultant error.- The resultant error is the error in the resultant of the north-south, east-west component miles of the DRT output, and is expressed by the following formula:

$$Er = \frac{100 \times \sqrt{E^2 + N^2}}{D}$$

where:

Er = Resultant error, in percent.
D = Length of run in nautical miles, determined from the distance input to the unit.
E = The difference in the measurement of the east component of plotting head position and the E-W component of the distance input.
N = The difference in the measurement of the north component of plotting head position and the N-S component of the distance input.

3.9.2 Position error.- The position error is the error in final position indicated by the latitude and longitude dials, measured from the calculated final position as computed by the Mercator sailing method (Bowditch, "American Practical Navigator" H. O. Publication 9, 1958 edition) and expressed in percent of the total theoretical distance input to the unit. (The method of computing the position error is shown in the appendix to this specification).

3.10 The supplier shall furnish accurate information on weight and vertical center-of-gravity (v.c.g.) of each unit of equipment, weighing 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) above.
(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 the Government.

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, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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 Quality control system.- The contractor shall provide and maintain a quality control system acceptable to the Government for equipment covered by this specification. The system for quality control shall be in accordance with MIL-Q-9858.

4.2 General inspection.- The procedures for the various tests to be performed on the equipment shall be as specified hereinafter. (The attention of the manufacturer is invited to the applicable paragraphs of MIL-I-983 for information concerning these tests such as where conducted, failures, and test conditions).

4.3 Preproduction inspection.- One sample of the DRT equipment shall be subjected to the examination and tests shown in table I. Tests shall be performed in general in the order listed.

Table I - Preproduction inspection.

Examination and tests	Requirement paragraph	Test reference
General examination	3.4	4.5
Shielding and radio frequency noise reduction	3.4	MIL-I-983
Airborne noise	3.4	MIL-I-983
Structureborne noise	3.4	MIL-I-983
Effect of pitch and roll	3.5.12	4.6.2
Enclosure	3.4 and 3.6.1	MIL-I-983
Effect of magnetic fields	3.5.2	4.6.3
Accuracy	3.8	4.6.1
Accelerated life (Includes tests for supply line voltage, accuracy, temperature and humidity, dielectric strength, insulation resistance, shock, vibration and inclination)	3.4	4.6.4 and MIL-I-983

4.4 Quality conformance inspection.-

4.4.1 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 II. Any equipment failing to meet the requirements of this specification shall not be offered for delivery.

Table II - Group A examination and tests.

	Requirement paragraph	Test reference
General examination	3.4	4.5
Dielectric strength 1/	3.4	MIL-I-983
Insulation resistance 1/	3.4	MIL-I-983
Accuracy 2/	3.8	4.6.1
Supply line voltage	3.4	MIL-I-983

1/ For all but rotating components of equipment.
2/ See 4.6.1.3.

4.4.2 Group C.- Group C tests, specified in table III, 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 III - Group C tests.

	Requirement paragraph	Test paragraph
Accelerated life	3.4	4.6.4
Enclosure	3.4 and 3.6.1	MIL-I-983
Vibration	3.4	MIL-I-983
Shock	3.4	MIL-I-983
Airborne noise	3.4	MIL-I-983
Effect of magnetic fields	3.5.2	4.6.3
Effect of pitch and roll	3.5.12	4.6.2

4.5 General examination.- The general examination shall be conducted in accordance with MIL-I-983.

4.6 Test procedures.-

4.6.1 Accuracy.-

4.6.1.1 Resultant error.- The resultant error test shall be conducted concurrently with the test for accuracy of position. Both tests shall be conducted using the runs described in table IV. Resultant errors shall be determined as indicated in 3.9.1 for each run.

4.6.1.2 Position error.- The test for accuracy of position shall include the seven runs of 100 nautical miles each and one run of 1000 nautical miles shown in table IV (see appendix for definition of abbreviations and method of computation). Accuracy check tests required by MIL-I-983 shall consist of run "e" only of table IV. This accuracy check test shall be conducted four times on courses 045, 135, 225, and 315 to determine equal accuracy in all quadrants of ships' motion.

Table IV - Accuracy test runs.

Run	D	L_1	Course	Resultant error test			Accuracy of position test				K
				D_N	D_E	R	DL		DL_o		
		Degrees	True azimuth	Miles	Miles	Miles	Degrees	Minutes	Degrees	Minutes	
a	100	0	030	86.603	50.000	100	1	27.04	0	49.88	1.001
b	100	15S	150	86.603	50.000	100	1	26.97	0	51.90	.961
c	100	25N	240	50.000	86.603	100	0	50.16	1	34.09	.915
d	100	40S	300	50.000	86.603	100	0	50.04	1	52.06	.778
e	100	55N	045	70.711	70.711	100	1	10.57 2/	2	04.6 2/	.539
f	100	65S	270	0.0	100.000	100	0	0.0	3	55.53	.425
g	100	85N	090	0.0	100.000	100	0	0.0	19	01.34	.088
h 1/	500	40N	045	353.56	353.56	500	5	53.65	8	02.0	.700
j	1000	40N	045	707.11	707.11	1000	11	46.92	16	58.0	.621

1/ Data for run "h" shall be obtained when practicable by making a stop for readings at 500 nautical miles during run "j".

2/ Values of DL and DL_o for accuracy check runs on alternate courses 135 and 225 degrees are: DL 1 degree, 10.59 minutes, DL_o 2 degrees, 01.0 minutes (see 4.6.1.2).

4.6.1.3 Accuracy (group A inspection).- When conducting quality conformance inspection, group A (see table II), the accuracy tests required may be reduced to runs "a", "b" and "g" only, if the results of the reduced tests meet the requirements of 3.8.

4.6.2 Effect of roll and pitch.-

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

4.6.2.2 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 abroad 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.

4.6.3 Effect of magnetic fields.- Tests shall be made to ensure that a magnetic field will not affect the accuracy of the DRT as specified in 3.5.2.

4.6.4 Accelerated life.- The accelerated life test shall be conducted as specified in MIL-I-983 with a constantly varying course input synchro signal of 360 degrees per minute in each direction, and a constantly varying speed input synchro speed of single harmonic motion of from 5 to 35 knots with a 60-second period for 250 hours. The heat dissipated from the sides and back of the equipment shall be restricted by means of low heat conducting bulkheads placed adjacent to the sides and back of the equipment.

5. PREPARATION FOR DELIVERY

5.1 Domestic shipment and early equipment installation and for storage of onboard repair parts.-

5.1.1 Dead reckoning tracer.-

5.1.1.1 Preservation and packaging.- Preservation of packaging 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, and may conform to the supplier's commercial practice when such meets these requirements.

5.1.1.2 Packing.- Packing shall be accomplished in a manner which will insure acceptance by common carrier 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 and Regulations or other carrier regulations as applicable to the mode of transportation, and may conform to the supplier's commercial practice when such meets these requirements.

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 and 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 shipment and storage or overseas shipment, which may be required when procurement is made:

5.2.1.1 Preservation and packaging, packing and marking.- The equipment and accessories, repair parts and technical 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.)

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) Inventory control point for repair parts (see 3.4).
(c) Whether unit FSN is to be entered on the identification plate (see 3.4).
(d) Quantity of manuals required (see 3.4).
(e) Preservation, packaging, packing, and marking required if other than as specified in 5.1 (see 5.2).

6.3 Bid data.- Bidders shall be required to furnish the following (see 3.10):

(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.

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 CHANGES FROM PREVIOUS ISSUE.- THE EXTENT OF CHANGES (DELETIONS, ADDITIONS, ETC.) PRECLUDE THE ANNOTATION OF THE INDIVIDUAL CHANGES FROM THE PREVIOUS ISSUE OF THIS DOCUMENT.

Preparing activity:
Navy - Ships
(Project 6605-N070Sh)

APPENDIX

COMPUTATIONS

10. Definition of abbreviations.- The abbreviations used in describing the methods of computing positions are defined as follows:

D - Distance of run in nautical miles.
L_1 - Initial latitude setting.
L_2 - Calculated final latitude.
L_M - Estimated middle latitude.
Course angle - Direction of movement measured in degrees in direction from true north and south.
C - Course setting - Direction of movement measured in degrees clockwise from true north.
DL - Difference in latitude between initial setting and final counter reading.
DL_o - Difference in longitude between initial setting and final counter reading.
K - The value of nautical miles per minute of longitude at the final latitude.

20. Method of computing.-

20.1 The Mercator method of computing the calculated final position for all runs except when the course is 90 degrees or 270 degrees is shown in the following example (calculations for run "d"):

(a) Given initial latitude = 40° 00.0'S = L_1
initial longitude = 0° 00.0'E
course = 300° = C
distance = 100 miles = D

(b) D_E = 100 sin 60° = 86.603 miles
D_N = 100 cos 60° = 50.000 miles
$L_M = L_1 + 1/2\ D_N$ (1 mile = 1 minute of latitude)
= 40° 00.0'S + 25.0' = 40° 25.0'S

(c) The difference in latitude is:

$$DL = 100 \cos 60° \times \frac{60.000}{59.949} = 50.043 \text{ minutes}$$

in which 59.949 is the value of miles per degree of latitude at the estimated middle latitude (L_M), from table 6 in Bowditch (H.O. Publication 9).

(d) The final latitude is:
$L_2 = L_1 + DL$ = 40° 00.0' - 50.043' = 39° 09.557'S

(e) From explanation of table 5 in Bowditch, the meridional parts for the initial latitude is:
m_1 - 2607.7

(f) Similarly the meridional parts for the final latitude is:
m_2 - 2542.5

(g) The difference in longitude is:
$DL_o = (m_2 - m_1) \tan C$
= 65.2 tan 60°
= 112.92' = 1° 52.92'

20.2 When the course is 90 degrees or 270 degrees, the final position is computed by the Middle Latitude sailing method, as shown in the following example:

(a) Given L_1 = 65° 00.0'S
C = 270°
D = 100 miles

(b) The difference in latitude is zero.

(c) The difference in longitude is:

$$DL_o = 100 \sin 270° \times \frac{60.000}{25.474} = 3° 55.53'$$

in which 25.474 is the value of miles per degree of longitude corresponding to 60° latitude (the mean latitude during the run) (from table 6 in Bowditch).

20.3 The position error is computed as shown in the following example (calculated for run "d"):

(a) Given: Observed values:

DL 0° 50.7'
DL_o 1° 50.5'

From Table IV

DL 0° 50.04'
DLO 1° 52.06'
K .778

(b) The latitude error is:

0° 50.7' - 0° 50.0' = 0.7'

Since the errors are small as compared with the total distance, 1 minute of latitude may be considered as equal to 1 nautical mile. Then

North component error = 0.7 mile.

(c) The longitude error is:

1° 50.5' - 1° 52.1' = 1.6'

The value K of miles per minute of longitude may be found by dividing the value of miles per degree at the final latitude (from table 6 in Bowditch) by 60.

$$K = \frac{46.7}{60.0} = 0.778$$

The east component error is K times the longitude error in minutes, or 1.24 miles.

(d) The position error is the vector sum of the north and east component errors, expressed in percent of the distance, or

$$Ep = \sqrt{(1.24)^2 + (0.7)^2} \times \frac{100}{100}$$

$$= \sqrt{2.03} \times \frac{100}{100} = 1.42 \text{ percent}$$

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

INSTRUCTIONS: The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/vendors who are prospective suppliers of the product are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

DOCUMENT IDENTIFIER AND TITLE

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

3. IS THE DOCUMENT RESTRICTIVE?

   ☐ YES ☐ NO *(If "Yes", in what way?)*

4. REMARKS

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