STANDARD NAVIGATION BRIEFING

1. CO/XO/OOD/Conning Officer/Bridge-CIC Ship Control Teams

a. Review of charts and track

(1) Planned fix intervals

(2) Anticipated NAVAIDS

b. Hazards to navigation

(1) Danger bearings/ranges

(2) Danger soundings

(3) Navigation warnings

c. Maximum allowable deviation from track

d. Maximum safe speed for each leg

e. Areas where ship can divert to or anchor in emergencies

f. Anticipated maritime traffic

g. Environmental considerations

(1) Tides

(2) Currents

(3) Weather predictions

h. Demarcation lines

(1) Inland/international rules of road

(2) Bridge-to-bridge RT

i. Buoyage system in effect (lateral or cardinal)

j. Port requirements/regulations

k. Navigation equipment status

l. Berthing/mooring configuration

m. Tug(s)/pilot assignments

NAVIGATION CHECKLIST

	YES	NO
1. Is there a navigation bill (doctrine) that prescribes uniform responsibilities and procedures for the safe navigation of the ship, including navigation in restricted waters under conditions of low visibility? Ref: OPNAVINST 3120.32B, Arts. 630.13 and 630.13.5	____	____
2. Is the watch, quarter and station bill current, complete and readily available to navigation personnel? Ref: OPNAVINST 3120.32B, Art. 602	____	____
a. Does the organization provide for and designate stations for personnel to pilot the ship	____	____
(1) During special sea and anchor detail?	____	____
(2) During general quarters?	____	____
(3) During low visibility?	____	____
3. a. Are appropriate steering casualty procedures available at all steering stations?	____	____
b. Do procedures cover individual responsibilities? Ref: OPNAVINST 3120.32B, Art. 640.3 and COMNAVSURFPACINST 3530.2B	____	____
4. Are speed and RPM tables posted at all conning stations?	____	____
5. Are extracts from the Oil Pollution Control Act of 1961 readily available to the OOD?	____	____
6. Is the Officer of the Deck Standing Orders Book readily available to the OOD? (OOD Notebook)	____	____
a. Does it contain OOD standing orders? Ref: OPNAVINST 3120.32B, Art. 1003	____	____
b. Does it contain tactical data and checkoff lists? Ref: OPNAVINST 3120.32B, Art 630.21.5	____	____
7. Is the Captain's Night Order Book maintained? Ref: OPNAVINST 3120.32B, Art. 1003	____	____
8. Are all foreign articles stowed away from all electric and electronic equipment?	____	____
9. Are operating instructions available for all electronic equipment?	____	____
10. Is all emergency lighting in operating condition?	____	____
11. Are effective editions of the following instructions on board and readily available to the navigator? Ref: COMNAVSURFPAC Notice 5215 (current)	____	____
a. COMNAVSURFPACINST 3180.2E (Subj: Pacific Fleet Replenishment Guide)	____	____
b. CINCPACFLTNOTE C5440 (current) (Subj: PACFLT Organization)	____	____

	YES	NO
c. FACSFACSDINST 3120.1M (Subj: Manual of Fleet Operating Areas)	____	____
d. OPNAVINST 3120.32B (Standard Organization and Regulations Manual of the U. S. Navy)	____	____
e. COMNAVSURFPACINST 3530.2B (Navigation Standards and Procedures)	____	____
12. Is a complete file of the following properly maintained?	____	____
a. Weekly Notice to Mariners?	____	____
b. Local Notice to Mariners? (Eleventh Coast Guard District)	____	____
c. HYDROPACS/NAVAREAS?	____	____
d. Broadcast Notice to Mariners?	____	____
e. Summary of Chart Corrections?	____	____
13. Is there an adequate system in force to ensure that the navigator receives all radio message traffic concerning navigational hazards?	____	____
14. Are the following on board and properly maintained?	____	____
a. Magnetic Compass Record Book? Ref: OPNAVINST 3120.32B, Art. 422	____	____
b. Navigation Work Book? Ref: OPNAVINST 3120.32B, Art. 323 and OPNAVINST 3530.3B	____	____
(1) Is a U. S. Navy Navigation Work Book used?	____	____
(2) If not, is a green record book used?	____	____
(3) Has the commanding officer specified in writing that the green record book is the command's official work book? Ref: OPNAVINST 3530.3B	____	____
c. Sounding Record Book? Ref: OPNAVINST 3120.32B, Art. 323 (Recommended)	____	____
d. U. S. Navy Standard Bearing Book? Ref: OPNAVINST 3530.3B and OPNAVINST 3120.32B, Art. 323	____	____
e. Ship's Deck Log? Ref: OPNAVINST 3100.7B	____	____
f. RADFO Log? Ref: NWIP 50-3, Appendix "E"	____	____
15. Has the commanding officer determined in writing which charts and publications are to be kept corrected up to date? Ref: OPNAVINST 3120.32B, Art. 323 and Art. 630.13.4	____	____
16. Are the following on board and properly corrected up to date if required by the commanding officer?	____	____
a. Nautical chart and Publication Allowance, CINCPACFLTINST 3140.3. List discrepancies:	____	____

_____ _____ _____

_____ _____ _____

_____ _____ _____

	YES	NO
b. Semiannual Bulletin Digest: DEC/JUN	____	____
c. Monthly bulletin - JAN/JUL	____	____
FEB/AUG	____	____
MAR/SEP	____	____
APR/OCT	____	____
MAY/NOV	____	____
d. Catalog to nautical charts (1 through 9)	____	____
List deficiencies:	____	
e. COMDTINST M16672.2A (Rules of the Road)	____	____
17. Are short corrections for sailing directions correctly applied?	____	____
18. a. Is the basic minimum oceanographic office chart and publication allowance on board? Ref: CINCPACFLTINST 3140.3	____	____
b. Are the latest editions of approach and harbor charts for designated home port on board?	____	____
19. Are chart and publication correction record cards prepared for the full allowance of charts and publications? Ref: CINCPACFLTINST 3140.3	____	____
20. Are the chart and publication correction record cards changed through the latest Notice to Mariners, Local Notice to Mariners if applicable?	____	____
21. Are those charts corrected through the latest Notice to Mariners, Local Notice to Mariners, Broadcast Notice to Mariners and HYDROPACS, if applicable?	____	____
22. Have all magnetic compasses been tested for sensitivity when first received on board and during each regular overhaul? Ref: S9086-HW-STM-000; Ch 252 (must be recorded in Magnetic Compass Record)	____	____
23. Have all magnetic compasses been adjusted within the past twelve months or since the last overhaul? Ref: S9086-HW-STM-000; Ch 252	____	____
24. Is the observed deviation within 3o degaussing off and 5o degaussing on?	____	____
25. a. Is a current copy of the deviation table posted at or near each magnetic compass? Ref: S9086-HW-STM-000; Ch 252	____	____
b. Is a copy available for use at Nav Plot and CIC?	____	____
26. Do the observed deviations recorded in the magnetic compass record book correspond to the table deviations?	____	____
27. Is the following navigational equipment in satisfactory operating condition?	____	____
a. Steering casualty alarm?	____	____

	YES	NO
b. Gyro repeaters? (error displayed and dated) (daily)	____	____
c. Gyro alarm?	____	____
d. Navigational lights?	____	____
e. Ship's whistle?	____	____
f. Bridge radar repeater? (Range and bearing error displayed and dated, daily)	____	____
g. Bell and gong for fog signals? Ref: NSTM 9240.121	____	____
h. Fathometer? (operating instructions posted)	____	____
i. Does ship have a lead line?	____	____
j. Speed log?	____	____
k. Dead reckoning analyzer?	____	____
l. Chronometers?	____	____
m. Sextants, 3-arm protractor?	____	____
n. Alidades?	____	____
o. Stadimeters?	____	____
p. Aneroid barometer? (Ht. correction and calibration date)	____	____
q. SATNAV (operating instructions posted?)	____	____
r. Degaussing system?	____	____
s. OMEGA (operating instructions posted?)	____	____
t. LORAN C (operating instructions posted?)	____	____
u. Gyro repeaters have relative bearings indicated/or dummy compass card?	____	____
28. Are the largest scale corrected charts available and used at navigation plot in CIC as well as the bridge?	____	____
29. Do CIC and the bridge Nav plot use the same charts and tracks?	____	____
30. Are all turning points based on advance and transfer, complete and accurately determined?	____	____
31. Had the gyro error and repeater errors been determined by a range and dated and posted at all conning stations?	____	____
32. Was radar range error determined, dated and posted on all radar repeaters?	____	____
33. Was the bridge-to-bridge radio telephone operational and used, and the R/T Log properly maintained? Ref: Public Law 92-63	____	____
34. Are the watches fully manned in accordance with the SORM and CIC Doctrine?	____	____

	YES	NO
35. Are the watch personnel PQS-qualified for their assigned positions?	____	____
36. Are experienced personnel, as opposed to the newest members onboard, designated to maintain the logs? (The purpose of the logs is not only for historical record but for reconstructing ship evolutions.)	____	____
37. Are senior and experienced petty officers on the watch bill as watch supervisors to lend maximum professionalism to the performance of the watch teams?	____	____
38. Is the bridge organized to swiftly transition to a LOWVIS piloting team? (The bridge should be augmented, not replaced, by CIC as the primary LOWVIS team.)	____	____
39. Are the ship's tactical data available at navigation plots?	____	____
40. Are communications on the navigation circuits checked prior to getting underway and the results logged in the appropriate logs?	____	____
41. Are clocks synchronized between CIC and the bridge prior to getting underway or before commencing a coordinated piloting evolution, e.g., coastal navigation or returning to port?	____	____
42. Are the LOWVIS watch bills published prior to getting underway to facilitate immediate implementation?	____	____
43. Does the navigator hold a formal letter of designation and instruction regarding maintenance and correction of nautical charts and publications?	____	____
44. Did the navigator conduct the briefing required by COMNAVSURFPACINST 3530.2B?	____	____
45. Have wind, tide, current and other weather conditions been determined and posted at all plotting stations?	____	____
46. Has the intended track been appropriately laid out on the chart?	____	____
47. Does the track include danger bearings, proposed turn bearings and labeled shoal waters?	____	____
48. Fix frequency will be as dictated by the circumstances and the judgment of the command. However, the general guidelines laid down by international agreement as outlined in DUTTONS 12th ED, Chap 14 Article 1408 serves as a useful reference. Were fixes taken at intervals of three minutes or less?	____	____
49. Were all fixes of the bridge and CIC team coordinated, compared and analyzed by the navigator? For minimum bridge noise level, the navigator should quietly receive CIC's fix/position information via a navigation S/P phone circuit, compare that information with his plot, and merely add in report to conn that CIC concurs/does not concur in his fix/position.	____	____
50. Do the navigator's fix reports to conn include the following information?	____	____

	YES	NO
a. Quality of fix;	____	____
b. Time;	____	____
c. Position;	____	____
d. Depth of water beneath keel and nearest shoal water or navigation hazard;	____	____
e. Course recommendation;	____	____
f. Turning point (visual aid);	____	____
g. Next track course;	____	____
h. Turn bearing;	____	____
i. Set and drift;	____	____
j. Length of present course;	____	____
k. Turn time;	____	____
l. Method of turn (upon navigator's recommendation); and,	____	____
m. CIC concurs/does not concur.	____	____
51. Is the bridge quiet, orderly, and free of non-essential noise?	____	____
52. Are the navigator's fix reports to the conning officer clear, concise and meaningful? An appropriate example is provided as follows: "Based on an excellent fix at time 0810 I hold the ship 50 yards to the right of track, depth of water under the keel is 7 fathoms, nearest shoal water is on the starboard beam 500 yards. Recommend coming left to 300°T to regain track at next turning point which is buoy #2. Next track course is 285°T after passing Buoy #2 on the port beam on turn bearing 290°T on the Coronado water tower. Set and drift is 140°T at 3 kts. Length of present course is 1500 yards, turn time on my recommendation is 0814, CIC concurs.	____	____
53. Does the conning officer hear, evaluate and formally acknowledge the navigator's recommendations?	____	____
54. Was there a continuous and healthy dialogue/exchange of information between the conning officer and navigator after each fix report? An example of a typical exchange follows: "Conn aye, concur, will remain on 315°T to avoid shipping for approximately 500 yards, then come left to 298°T to regain track." Navigator: "Navigator aye, 315°T is a safe course for 500 yards."	____	____
55. Are turn bearings effectively forewarned, used and adjusted as necessary?	____	____
56. Was there an effective turn bearing countdown? Was the turn bearing valid?	____	____
57. Is fathometer information directly available to the navigator and recorded with each fix?	____	____
58. Is SONAR and FC radar information available in the event of low visibility?	____	____

	YES	NO
59. Is a DR effectively used at all times and extended to the maximum length appropriate to the circumstances? (As a rule of thumb, the minimum DR should be twice the fix interval.)	____	____
60. Did the ship utilize the bridge-to-bridge communications on an initiative basis to advise ships astern of hazards to navigation or changes in weather conditions, if appropriate?	____	____
61. Were changes initiated only by the person required to sign the log? (OPNAVINST 3100.7B)	____	____
62. Did the OOD sign the log upon being relieved? (See para 2-13 and log example sheets in OPNAVINST 3100.7B)	____	____
63. Are set and drift accurately computed and considered in making recommendations?	____	____
64. Does the navigator inform the conn when to use international/inland navigation rules?	____	____
65. Is the navigation plot complete and legible?	____	____
66. The watch team principals should be intimately familiar with the collision regulations (COLREGS) published as Navigation Rules effective 23 Dec 1983. Is there a knowledge of COLREGS demonstrated by the command?	____	____
67. Does the ship's standing orders reflect the requirements of COLREGS?	____	____
68. Under conditions of low visibility, did the OOD/ JOOD order:		
a. Qualified fog lookouts to be posted? (No other duties, unimpaired by sound powered phones, and in addition to regular lookouts)	____	____
b. Chains to be manned and ready with equipment on station? (Qualified leadsman with lead line must be on station.)	____	____
c. Anchor(s) to be manned and ready for letting go?	____	____
d. Material Condition Zebra to be set main deck and below?	____	____
e. Running lights turned on?	____	____
f. Silence on the bridge, all hands in pilothouse (or at conning station) to listen for and report sound signals (horns, whistles, bells, etc.)?	____	____
g. Ship's whistle sounded to conform to inland/ international rules as appropriate?	____	____
69. Was safe speed used as prescribed by rules in COLREGS?	____	____
70. When a fog signal was heard forward of the beam, was speed reduced to that required?	____	____
71. Were all uncorrelated fog signals identified and all risk of collision determined not to exist before the ship proceeded on?	____	____

CIC SURFACE CONTACT MANAGEMENT AND LOWVIS PILOTING CHECKLIST

	YES	NO
1. Are watch standers properly qualified in accordance with PQS standards for each watch station they will occupy?	____	____
2. Are all the stations manned as required by the SORM and CIC Doctrine? (Watch stations should be manned and tasked with realistic work loads.)	____	____
3. Are phone stations manned by knowledgeable and qualified talkers?	____	____
4. Were communications on the NAV circuits checked prior to getting underway and results logged in appropriate logs?	____	____
5. Are the communications procedures adequate to ensure rapid exchange of vital information between CIC/Conn/navigator?	____	____
6. Are all contacts designated and logged in the Contact Log while underway?	____	____
7. As a minimum, is the following contact information determined/recorded:		
a. Time/date	____	____
b. Designation	____	____
c. Range/bearing	____	____
d. Course/speed (and changes thereto)	____	____
e. CPA (including time of CPA, bearing, range and changes thereto)	____	____
f. Remarks (e.g., identification, opening, closing, fading, scrubbed, lost)		
8. Are contacts tracked and reported, in accordance with the command policy directives?	____	____
9. Are contacts "scrubbed" and "watched" by the authority outlined in command directives?	____	____
10. Are lookouts relaying contact information to CIC/conn?	____	____
Are they coached onto new contacts?	____	____
11. Are lookout contacts correlated by CIC with radar contacts?	____	____
12. Is the DRT/NC-2 operator proficient in DRT mechanics of operation, symbology and plotting legibility?	____	____
13. When potentially dangerous situations become discernible, do all watch standers understand the responsibility to make the facts known to the conn, including means of communications alternative to the JL circuit such as the 21 MC and messenger to the bridge?	____	____

EXTRA COPY

COMMANDER NAVAL SURFACE FORCE
UNITED STATES PACIFIC FLEET
NAVAL AMPHIBIOUS BASE, CORONADO
SAN DIEGO, CALIFORNIA 92155-5035

COMMANDER NAVAL AIR FORCE
UNITED STATES PACIFIC FLEET
NAVAL AIR STATION, NORTH ISLAND
SAN DIEGO, CALIFORNIA 92135-5100

COMNAVSURFPAC/
COMNAVAIRPACINST 3530.3B
Code N52/WPC-127-88
05 JUN 1989

COMNAVSURFPAC INSTRUCTION 3530.3B/COMNAVAIRPAC INSTRUCTION 3530.3B

Subj: STANDARDIZED NAVIGATION PROGRAM

Encl: (1) Joint COMNAVSURFPAC/COMNAVAIRPAC Navigation Guidelines

1. Purpose. To promulgate joint navigation guidelines to be observed by COMNAVSURFPAC and COMNAVAIRPAC vessels.

2. Cancellation. COMNAVAIRPACINST 3530.3A/COMNAVSURFPACINST 3530.3A.

3. Action. Effective upon receipt, enclosure (1) shall be utilized as a guide in improving navigational accuracy.

L. R. Canepa
L. R. CANEPA
Chief of Staff

J. B. PERKINS III
Deputy and
Chief of Staff
COMNAVSURFPAC

Distribution:
SNDL Parts 1 and 2
26A2 Amphibious Group PAC
28A2 Carrier Group PAC
28B2 Cruiser-Destroyer Group PAC
28C2 Surface Group PAC
28D2 Destroyer Squadron PAC
28E2 Surface Squadron PAC
28G2 Mine Squadron and Division PAC
28I2 Craft Opportunity Mine Squadron and Unit PAC (COOPMINERON 11 only)
28J2 Combat Logistics Group and Combat Support Squadron PAC
28L2 Amphibious Squadron PAC
29A2 Guided Missile Cruiser PAC (CG)(CGN)
29B2 Aircraft Carrier PAC (CV) (CVN)
29E2 Destroyer PAC (DD) 963 Class
29F2 Guided Missile Destroyer PAC (DDG)
29H2 Frigate PAC (FF) less 1040/1097 Class
29J2 Frigate PAC (FF) 1040/1051 Class
29K2 Frigate PAC (FF) 1052/1077 Class
29L2 Frigate PAC (FF) 1078/1097 Class
29R2 Battleships PAC (BB)
29AA2 Guided Missile Frigate PAC (FFG) 7 Class
29BB2 Guided Missile Destroyer (DDG) 993 Class PAC
30A2 Minesweeper, Ocean (Nonmagnetic) PAC (MSO)
30C2 Mine Countermeasures PAC (MCM 1) Class and Fleet Introduction Team
31A2 Amphibious Command Ship PAC (LCC)
31B2 Amphibious Cargo Ship PAC (LKA)
31G2 Amphibious Transport Dock PAC (LPD)
31H2 Amphibious Assault Ship PAC (LHA)(LPH)
31I2 Dock Landing Ship PAC (LSD) 41 Class
31J2 Dock Landing Ship PAC (LSD)
31M2 Tank Landing Ship PAC (LST)
32A2 Destroyer Tender PAC (AD)
32C2 Ammunition Ship PAC (AE)
32G2 Combat Store Ship PAC (AFS)
32H2 Fast Combat Support Ship PAC (AOE)
32N2 Oiler PAC (AO)
32Q2 Replenishment Oiler PAC (AOR)
32S2 Repair Ship PAC (AR)

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SECTION 1

INTRODUCTION

1. Background. While a great deal of emphasis must always be placed on piloting and navigation in restricted water, the increasing use of tactics designed to exploit the capabilities of advanced surface, subsurface, and airborne weapons systems has caused a greater emphasis to be placed on open ocean navigation accuracy. Over-the-Horizon Targeting (OTH-T), Direct Support operations (DS), and the requirement for rendezvous under EMCON conditions demand highly accurate ship navigation. Complex operations which combine surface forces with submarines and long-range ASW aircraft require accurate navigation during tactical maneuvering to properly employ those systems which rely on geodetic positioning to obtain entry and egress point in the operating area. The use of Harpoon and Tomahawk missiles in battle group tactics extends the meaning of the hallowed phrase "safety of the vessel" far beyond the avoidance of collision, grounding, or storm damage. Only accurate navigation by each unit and an accurate plot of force elements by the officer in tactical command (OTC) will ensure that weapons destroy the intended target and not a member of the battle group or another friendly unit. Studies have shown that navigational accuracy can be adversely affected by a number of factors; included are:

a. Accumulation of errors in information flow.

b. Deteriorated expertise in conventional navigation techniques because of a heavy dependence on electronic navigation.

c. Lack of proper emphasis on navigation accuracy.

d. Improper determination of set and drift, and failure to properly apply set and drift to manual DR.

e. Improperly calibrated EM log, and inaccurate or improper azimuth reference.

Accurate open ocean navigation can be consistently achieved with proper emphasis, firm understanding of all navigation aids (both electronic and conventional), proper training of navigation team personnel, and strong management of the navigation problem on a continuous basis.

2. Purpose. This document can help ship's personnel attain the navigation accuracy needed by the tactics and weapons employed by their individual and battle group units. The document presents organizational relationships and operational procedures that will help the navigation team use all the resources at their disposal to obtain accurate fixes and estimated positions, while maintaining the DR plot within the required standard. It provides some management techniques which will contribute to improved navigation and operational effectiveness of the Force.

SECTION 2

THE NAVIGATION TEAM

1. Background. In addition to being thoroughly proficient in piloting and navigation in restricted waters, the navigation team must effectively combine sound navigation and seamanship skills with an understanding of ASW, AAW, STW, and ASUW tactics to navigate in a hostile environment. Tactical navigation demands the highest level of professionalism from those who direct or contribute to it. Great care must be taken in organizing and training the team which will perform this crucial function. The navigator, quartermasters, CO, OOD, TAO, CIC watch officer, and other supporting warfare coordinators are all producers and users of navigational data. They must all participate in the tactical navigation effort. These participants must establish, maintain, and use effective lines of communiation to disseminate the ship's current navigation data during battle group tactics.

2. Organization. The navigator must organize the navigation team so it is flexible enough to meet demands of the ship's missions. Section 3 provides a standard navigation bill with associated duties and responsibilities.

3. Non-Hostile Environment. The navigator shall advise the CO and OOD of the ship's movements, and of best courses to steer. He should operate and coordinate the maintenance of the ship's navigational equipment.

a. The navigator is supported by personnel whose duties and expertise support his responsibilities. Quartermasters support the navigator by maintaining the DR and deck log, and by helping fix and estimate the ship's position. The OOD supports the navigator by reporting radar and visual navigation landmark sightings, and indicating course and speed changes to be logged by the QMOW. It must be stressed that the QMOW is not the navigator on watch, in the absence of the ship's navigator. He is a vital assistant to the OOD, who must take an active role in ensuring the ship is properly and safely navigated at all times. The CIC/CDC navigation team provides radar bearings and ranges to known points, and tracks ships and other hazards which might endanger the ship. The CICWO maintains a separate DR and track plot to support the bridge navigation efforts.

b. The navigator draws navigation data from all available sources, including the quartermasters, CICWO, and OOD, to determine the ship's position and its relationship to hazards to navigation. He provides the CO and OOD with ship's position and recommends courses and speeds. The navigation team must strive to navigation data that is as accurate as possible.

c. The QMOW maintains the navigator's plot on the bridge as a record of the ship's track and intended movements. He updates this navigation plot with course and speed orders issued by the OOD, and fixes or estimates positions as directed by the navigator. This plot must be maintained on the largest scale chart available. The QMOW's performance is the foundation for maintaining the required standards of accuracy and precision of geodetic positioning. He maintains the watch-to-watch vigil on the navigator's plot and modifies it to reflect the ship's current and projected movement and intentions.

d. The checklist provided in Appendix E is a guide to properly turn over a watch and to maintain standards of accuracy. All oncoming and offgoing watch QMOW's should use this checklist.

e. During piloting, a radar navigation team in CIC/CDC plots the ship's track in order to help the bridge navigation team. The CIC/CDC track is compared with the ship's position as supplied by the navigator. When necessary, the CIC/CDC navigation team maintains a mechanical DR track on the DRT or NC2. In other than piloting situations, CIC/CDC provides radar range and bearing data for position comparison, error detection, and DRT track validation. Effective exchange of information between the bridge, CIC/CDC, and the navigation watch will reduce or preclude errors from occurring and will aid in resolving differences.

4. Hostile Environment. The navigation team is faced with additional duties when Condition III or I is set, to provide the CO and TAO with the timely geodetic positioning data that they may require to position the ship, acquire the target, and employ all required weapons and tactics while fighting the ship. The importance of smooth and continuous flow of information between the navigator and TAO cannot be overemphasized. In an

OTH-T situation, even a minor discrepancy between the plots held on the bridge, in CIC, and weapons plot can make target acquisition impossible. The navigator must assume an integral role in determining position data used in tactical data systems in order to ensure that the most accurate navigational/position data available is provided to these systems. It has been shown in numerous exercises that position data supplied automatically to NTDS from inertial and navigation inegrator devices results in the most geodetically accurate data links. However, the navigator must constantly compare automatically supplied data to fix information obtained from all sources and take action to override automatic data determined to be less accurate than his navigation team's position information. Ship's fighting doctrines should include procedures to ensure that the navigator's role in tactical situations is clearly prescribed.

a. In a tactical situation, the navigator becomes the TAO's primary source of geodetic positioning data for the tactical plot. He receives inputs from all available resources to aid in developing the ship's position. He delivers this data to the TAO for display and/or input into the NTDS. He communicates with the TAO to accommodate changes in the TAO's requirements for accuracy and precision, and provides for the detection and correction of errors.

b. A necessary ingredient in the maintenance of accurate navigation throughout the entire combat system is the detection and correction of errors. This can be accomplished by the following:

(1) The producers (i.e., navigation team) of navigation information should utilize all possible navigation aids in determining the fix.

(2) The users (i.e., CIC, weapons, etc.) of navigation information, in conjunction with the producers, should plot all fixes and compare data for accuracy.

5. Training. Maintaining the ship's position within the normally accepted accuracy standards found in Appendix C, Table C-1, demands an aggressive training program for all personnel involved in ship's navigation. Electronic navigation and data systems have provided precise fix accuracy that is frequently 0.25 NM or less. Thorough training in the understanding of principles of operation, as well as operational use of the various equipments, is mandatory. However, basic conventional navigation skills, including celestial navigation and plotting accuracy, must be maintained through training and practice. Remember that inherent inaccuracy of charts, dependent on scale, can be considerable.

SECTION 3

STANDARD NAVIGATION BILL

References: (a) OPNAVINST 3120.32B (SORM)
(b) U.S. Navy Regulations
(c) COMNAVSURFPACINST 3530.2B, Navigation Standards and Procedures
(d) COMNAVAIRPACINST 3530.2, Navigation and Surface Contact Management

1. General. This section contains a standard navigation bill that can be adapted for use by the navigation team. It will serve as the foundation for the development of ship's instructions.

2. Responsibility for the Bill. The navigator is responsible for maintaining this bill.

3. Duties and Responsibilities. With respect to navigation, the following duties and responsibilities exist as stated in references (a) and (b).

a. Commanding Officer. The commanding officer is responsible for the safe navigation of his ship. He shall:

(1) Ensure that the current authorized allowance of nautical and aeronautical charts and publications are on board and that such charts and publications are corrected to date prior to any use for navigational purposes.

(2) Make every effort to obtain from reliable sources (foreign or otherwise) all information that will aid him in any case of doubt about safe navigation over routes he proposes to take or ports he intends to visit.

(3) Keep himself informed of the error of all compasses and other devices available as aids to navigation.

(4) Immediately before leaving and as soon as practicable after entering port, require the navigating officer to ascertain the draft of the ship, forward and aft, and enter it in the log.

(5) Have the anchors ready for letting go when the proximity of land or the depth of water is such that there is danger of grounding.

(6) Ensure that lookouts are proficient in their duties and are stationed, as necessary, in accordance with the best practice of seamanship, having in mind any special conditions, the results to be accomplished, and the physical limitations of personnel. When underway during low visibility, or when approaching or traversing congested traffic lanes or areas, at least one lookout shall be stationed in the bow as far forward and as near the water as is feasible.

(7) Require that available electronic and other devices appropriate as aids to safe navigation be employed during periods of low visibility and at other times, when needed.

(8) Ensure that efficient devices for fixing the ship's position and for ascertaining the depth of water are employed when underway, or sounding; entering or leaving port; or upon approaching an anchorage, shoal, or rock, whether or not a pilot is on board. If circumstances warrant, he shall reduce speed to the extent necessary to permit these devices to be operated efficiently and accurately.

(9) Observe every precaution prescribed by law to prevent collisions and other accidents on the high seas and inland waters.

(10) When underway in restricted waters or close inshore, and unless unusual circumstances prevent, steam at a speed which will not endanger other ships or craft, or property close to the shore.

(11) Take special care that lights required by law to prevent collisions at sea, in port, or in the air are kept in order and burning in all weather from sunset to sunrise, or other times it is deemed necessary, and require that means for promptly relighting or replacing such lights are available.

(12) Keep a night order book, which shall be preserved as part of the ship's official records, in which shall be entered the commanding officer's orders with respect to courses and special precautions concerning the speed and navigation of the ship, and all other orders for the night for the officer of the deck.

(13) When under the tactical command of a senior, promptly give notice to such senior and to the ship or aircraft endangered if he finds that the directed course is leading his ship or aircraft, or any other ship or aircraft, into danger.

(14) When under the tactical command of a senior, perform no independent evolution without orders from such senior, except as necessary to avoid collision or imminent danger.

b. Navigator. The navigator is the head of the navigation department. He will normally be senior to all watch officers, except on small vessels. He is responsible, under the commanding officer, for the safe navigation and piloting of the ship. He will receive all orders relating to his navigational duties directly from the commanding officer and will make all reports in connection therewith directly to the commanding officer. Additional duties of the navigator include:

(1) Advising the commanding officer and officer of the deck as to the ship's movements, and if the ship is running into danger, a safe course to be steered. To this end, he shall:

(a) Maintain an accurate plot of the ship's position by celestial, visual, electronic, and other appropriate means. Establish a sound liaison between CIC/CDC and NAVPLOT when comparing navigation information.

(b) Prior to getting underway, navigation team will obtain ship's fixed position by all available means. Fixes from various sources will be compared to determine fix error. When error is considered excessive, the navigator will investigate and resolve problem. Conditions permitting, the same procedure will be employed prior to entering restricted waters.

(c) Give careful attention to the course, speed, and depth of water, when approaching land or shoals.

(d) Maintain record books of all observations and computations made for the purpose of navigating the ship, with results and dates involved. Such books shall form a part of the ship's official records.

(e) Report in writing to the commanding officer, when underway, the ship's position at 0800, 1200, and 2000 each day, and at such other times as the commanding officer may require.

(f) Procure and maintain all hydrographic and navigational charts, sailing directions, light lists, and other publications and devices for navigation, as may be required. Maintain records of corrections affecting such charts and publications. Correct navigational charts and publications as directed by the commanding officer and, in any event, prior to any use for navigational purposes. Corrections shall be made in accordance with directions published within DMA Catalog of Maps, Charts and Related Products, Part 2 Hydrographic Products, or the individual document or document change, using officially promulgated navigation data. Recommend to the commanding officer changes to the list of chart portfolios to be kept continuously up to date.

(g) Personally supervise the navigation of the ship when the ship is in restricted waters and when at battle stations, unless specifically designated to stand another watch, in which case another officer qualified to serve as navigator will be directed to perform these duties by the commanding officer.

(h) Prior to entering piloting waters, study all available sources of information concerning the navigation of the ship therein.

(i) Upon anchoring, ensure that the appropriate chart showing the ship's anchorage/position, and all navigation aids to be used with commonly used boat landings, are maintained and available to the officer of the deck. Ensure drag circles and swing circles are plotted properly and

fix times established.

(j) Prepare, for the commanding officer's night orders, a navigator's night steaming orders sheet in such a format as is prescribed by the commanding officer. As a minimum, operating areas, night steaming instructions, aids to navigation, and fix interval (if other than prescribed in the standing orders) should be included.

(k) For nuclear-powered ships, the navigator shall verify the ship will moor or anchor at an approved berth or anchorage in accordance with OPNAVINST C3000.8 series (authorized berths and anchorages for recurring use by nuclear powered ships) when entering port or shifting berths within a port.

(2) The operation, care, and maintenance of the ship's navigational equipment. To this end, he shall:

(a) Determine daily, when the ship is underway and weather permits, the error of the INS, master gyro, auxiliary gyro, and magnetic compasses (as installed), and report the results in writing to the commanding officer. He shall cause frequent comparisons of the INS, gyro, and magnetic compass to be made and recorded; adjust and compensate the magnetic compasses, when necessary, subject to the approval of the commanding officer; and prepare a table of deviations, keeping correct copies posted at the appropriate compass stations.

(b) Ensure that the ship's clocks are properly set in accordance with the standard zone time of the locality or in accordance with the orders of the senior officer present.

(c) Ensure that the electronic navigational equipment assigned to him is kept in proper adjustment and, if appropriate, that calibration curves or tables are maintained and checked at prescribed intervals.

(d) Due to weather conditions the sun is often obscured, which precludes compass error by azimuth or amplitude. However, the sky will often clear up at night. It is therefore important to train and practice alternative methods of determining compass error. Stars, planets and the moon can be used as well as the sun. Pub 9 "Bowdich" explains numerous methods of obtaining compass error.

(3) Advise the engineering officer and the commanding officer of any deficiencies observed in the steering systems, and monitor the progress of corrective action.

(4) Ensure the correct preparation and care of the deck log. He will daily, and more often when necessary, inspect the deck log and take such corrective actions as may be necessary and within his authority to ensure that it is properly maintained.

(5) Ensure the preparation of such reports and records as are required in connection with his navigational duties, including those pertaining to the compasses, hydrography, oceanography, and meteorology.

(6) Ensure the conduct of required navigational training of all personnel, such as junior officers, boat coxswains, and boat officers; the training of all quarter-deck personnel in the procedures for honors and ceremonies; and of all junior officers in Navy etiquette.

(7) Normally, be responsible for honors and ceremonies and other special occasions.

(8) Relieve the officer of the deck, as authorized or directed by the commanding officer (in writing).

(9) Organizational relationships. The navigator reports to the commanding officer in all matters pertaining to the navigation of the ship, and to the executive officer in matters pertaining to the administration of the navigation department and the training of deck and watch officers. On smaller ships he may report to the senior watch officer for the training of deck and watch officers in navigation.

c. The Assistant Navigator. The assistant navigator will assist the navigator in all aspects of navigation, piloting, and administration of the navigation department. He will ensure proper preparation of the various

reports required by higher authority.

4. Organization of the Navigation Team. In addition to the commanding officer and navigator, there are several other key member of the navigation team. These include the command duty officer, tactical action officer, officer of the deck, and CIC/CDC watch officer. Their duties and responsibilities are described in references (a) and (b).

5. Training. The ship's and departments' training instructions must provide for adequate training necessary to educate, qualify, evaluate, and periodically requalify assigned personnel.

a. Watch Qualification

(1) Initial watch qualification shall be accordance with the ship's personnel qualification standards (PQS).

(2) Watch station qualification will provide for a formal method to ensure minimum standards of knowledge are demonstrated for each watch station. Qualification cards, which specify areas to be knowledgeable in and provide for signatures of appropriately designated persons who will certify that minimum standards have been met for that specific area, will be used. The final qualification should include a written examination and practical demonstration of skills which are certified by the navigator or his designated representative.

b. Watch station requalification will be required to ensure adequate level of knowledge is being maintained for all qualified watchstanders. Watch station requalification should be required, as follows:

(1) When more than six months have passed since the watchstander has stood the watch

(2) When changes in procedures or equipment require it in the judgment of the senior watch officer or commanding officer as recommended by the navigator

(3) When, through poor performance, the watchstander has been disqualified

c. Requalification shall be conducted in a manner similar to initial qualification and will consist of demonstrating a satisfactory proficiency level by completing the appropriate sections of the qualification card, as determined by the senior watch officer. The commanding officer shall certify completion of the requalification.

6. Logs and Records

a. Log Keeping

(1) The importance of keeping complete, concise, and accurate navigation logs and records cannot be overemphasized. Besides providing the recorded history of the ship, they become a basis for analysis, evaluation and correction of material, operational and personnel deficiencies in warfare, and should it ever become necessary, comprise the legal records examined by courts of inquiry and official investigation.

(2) The use of erasures is strictly forbidden in all navigation logs and records. Corrections may only be made by neatly lining out and initialing an entry. Black ball-point pen will be used throughout, except in the navigation workbook and the navigator's sight log, in which pencil is authorized for recording and computations.

b. Ship's Deck Log

(1) Purpose. The deck log shall be a complete daily record, by watches, in which shall be described every circumstances and occurrence of importance or interest which concerns the crew and the operation and safety of the ship, or which may be of historical value.

(2) Instructions for Maintenance. The deck log shall be maintained in accordance with the instructions promulgated by the Chief of Naval Operations (OPNAVINST 3100.7). A copy of these instructions shall be placed in the front of the log, if not provided by preprinted format. In addition, the following instructions apply:

(a) The deck log is the official record of the ship. No page shall be removed therefrom, nor shall any page be used for other than its intended purpose.

(b) The deck log shall be kept by the quartermaster of the watch at sea, and the duty quartermaster/petty officer of the watch in port. The officer of the deck/duty officer shall review the log, add any necessary comments, and sign it.

(c) The following entries, required by reference (a), will be included as appropriate:

1 Orders under which the ship is operating and the character of duty in which engaged

2 Significant changes in the state of the sea and weather, i.e., water spouts, discoloration of water, etc.

3 Courses and speeds of the ship

4 Bearing and distances of objects detected

5 Position of the ship

6 Tactical formation of the ships in company

7 Draft

8 Sounding

9 Time zone description

10 Particulars of anchoring and mooring

11 Changes in the status of ship's personnel or passengers, except for the recording of receipts and transfers of officers by reason of permanent changes of station, and except for the recording of receipts and transfers of enlisted personnel

12 Damage or accident to the ship, its equipage, or cargo

13 Death or injuries to personnel, passengers, visitors, longshoremen, harbor workers, or repairmen

14 Meeting and adjourning, recessing of courts-martial, and other formal boards

15 Arrests, suspensions, and restorations to duty

16 Such other matters as may be specified by competent authority

c. Ship's Position Log (OPNAV Form 3100/3 (6-76). A ship's position record shall be maintained during coastal and open ocean navigation. It shall be a record of positions and soundings from all sources used. In addition, DR positions, set and drift and resets of SINS, NTDS, DRAI, etc. shall be recorded. In light of different ship configurations and missions, the format for the record shall be decided upon by the navigator. The ship's position log (OPNAV Form 3100/3 (6-76)), bearing record book and locally prepared forms or logs may be used.

(1) Responsibility. The quartermaster of the watch is responsible for maintaining the log, and shall sign the log upon being relieved. The navigator will review daily.

(a) The ship's position log is a record of the ship's position, including fixes, dead reckoned, and estimated positions. It is also a record of resets. It shall be maintained by the QMOW in accordance with the instructions printed inside the front and back covers, with the following modifications:

1 As a minimum, the DRAI, corrected INS, dead reckoned position, and others as specified by the navigator, shall be recorded at half-hour intervals.

2 Whenever a fix is determined, a DRAI position, dead reckoned position, LORAN position (if applicable), SINS/WSN-5 position, NAVSAT position, and OMEGA position will be recorded. The navigator may limit this to once every 30 minutes if frequent fixes are obtained. Resets will be conducted as directed by the navigator or commanding officer. An "x" will be entered in column 27 to indicate that the DRAI, NAVSAT, LORAN (if applicable), or OMEGA were reset. If reset, the new position will also be recorded, unless this function is performed by automatic equipment. (NOTE: INS reset may also be computed; however, INS will only be reset on orders from the navigator.)

3 A sounding should be obtained and recorded in the remarks column, with each fix. (In cases where operating in restricted or piloting waters, soundings will be recorded in intervals not to exceed 30 minutes.)

4 The position log may be secured with the concurrence of the navigator or assistant navigator whenever the standard bearing book is utilized in piloting waters. When entering piloting waters from open sea, the initial piloting fix will be recorded in both the position log and standard bearing book. The same is true of the last piloting fix when leaving piloting waters.

(b) This log shall be retained for three years after the date of the final entry, unless it must be destroyed for reasons of security.

d. Navigation Workbook (OPNAV Form 3530/1). The navigation workbook is the record of all celestial observations and LORAN readings, and the resulting computations. The navigation work book shall be maintained in accordance with OPNAVINST 3530.3B. All computations used to navigate the ship shall be entered. Locally prepared strip forms shall be affixed to or recorded in the work book. If calculators or computers are used, enough data must be recorded in the work book to reconstruct the computation. For example, for a star sight, the following data must be recorded: GMT, date, DR position, body, IC and height of eye.

(1) Responsibility for Maintenance. The navigator is responsible for proper maintenance of this log.

(2) Responsibility for Review and Approval. The commanding officer will review the navigator's workbook quarterly.

(3) Disposition. This record will be retained three years from the last entry, as part of the ship's official records.

e. Standard Bearing Book (OPNAV Form 3520/2)

(1) Responsibility. Bearing recorder during special detail; otherwise the quartermaster of the watch.

(2) The bearing record book is a record of the data obtained to determine the ship's position by visual bearings, RDF bearings, radar bearings, and/or radar ranges. It shall be maintained in accordance with the instructions printed inside the cover, with the following modifications:

(a) The chart in use shall be recorded at the top of the initial page each day. Each shift of charts will be noted in the first available blank line of the log.

(b) The time zone and date will be indicated.

(c) Radar ranges will be labeled Yd (yards) or NM (nautical miles). Stadimeter ranges will additionally be labeled "STAD."

(d) Sounding will be in column 7 at the time each fix is obtained and labeled FT (feet) or FM (fathoms).

(e) All bearings are true, unless otherwise indicated by R (relative).

(f) All abbreviations must be in accordance with Chart No. 1, Nautical Chart Symbols and Abbreviations.

(g) The current gyro error shall be recorded at the top of the initial page each day. Any revised gyro error shall be noted in the first available blank line of the log. The radar bearing error and range error,

if determined, will be entered at the top of the initial page each day.

NOTE: WHEN ABBREVIATIONS ARE USED, THEY MUST BE READILY IDENTIFIABLE IN THE EVENT THIS RECORD IS EVER REQUIRED IN AN ADMIRALTY COURT OR FOR USE AT A BOARD OF INQUIRY. COMMON ABBREVIATIONS MAY BE FILED IN THE BOOK FOR READY REFERENCE.

(3) The bearing log will be signed on the next available line, by the bearing recorder, at the end of his watch.

(4) The bearing book will be retained on board for three years after the date of the last entry, as part of the ship's official records.

f. Chart/Publication Correction Files

(1) Purpose. A record of all corrections for the current allowance of DMA charts and publications established by the current edition of the Nautical Chart and Publication Allowance.

(2) Format. Chart/Publication Correction Cards (DMAHC 8660/9) will be used.

(3) Instructions for Maintenance. These cards will be on board and maintained in accordance with the instructions contained in CMS Catalog of Maps, Charts and Related Products - part 2 Hydrographic Products Requisitioning Procedures. In addition, at least three extra copies of appropriate OPAREA and harbor charts will be maintained.

(4) Responsibility for Maintenance. The chart custodian will enter corrections to the chart cards and the publication custodian will enter corrections to the publication cards; however, the duty quartermaster is responsible to enter all corrections to charts and publications required for current use, as received. Local area charts and those portfolios designated by the commanding officer will be maintained up to date at all times. The corrections for all other charts will be indexed and these changes entered prior to chart use. Those publications designated by the commanding officer will be maintained current at all times.

(5) Responsibility for Review and Approval. The department leading quartermaster is responsible for reviewing the ship's charts, publications, and correction files to ensure their proper maintenance. During audits, he will ensure that applicable allowance lists and lists of effective corrections are reviewed prior to inventory.

(6) Disposition. Correction cards will be kept in a file box, and maintained in an up to date status for all charts and publications on board. When a chart or publication is destroyed, its correction card will also be destroyed.

g. Weekly Notice to Mariners/Summary of Corrections

(1) Purpose. To establish a file of information that has not yet been entered on appropriate charts or in specific publications.

(2) Responsibility. Publications custodian.

(3) Instructions. A separate file for each will be maintained, as follows:

(a) Weekly Notice to Mariners File. The Weekly Notice to Mariners file will be maintained as set forth in DMA Catalog of Maps, Charts and Related Products - Part 2 Hydrographic Products by each work center maintaining charts.

(b) The summary of corrections is a series of catalogs that incorporates a historic record of corrections dating from the latest edition date for that particular D.M.A. product.

(4) Responsibility for Review and Approval. The leading quartermaster.

(5) Disposition. These bulletins will be retained on board until all pertinent information has been extracted from them. They will then be destroyed.

h. Classified Notice to Mariners.

(1) Purpose. To establish a file of information that has not yet been entered on the appropriate charts or publication.

(2) Responsibility. Assistant navigator.

(3) Instructions. Classified Notices to Mariners:

(a) Will be maintained in a file contained in publication 1-N-S until corrections have been entered on pertinent charts (and/or unclassified BC charts) by each work center maintaining charts.

(b) Will be returned to the appropriate classified material control officer upon completion of entering corrections for destruction.

i. HYDROPAC file

(1) Purpose. To maintain a file of the latest navigational aid discrepancies and hazards to navigation.

(2) Format. All HYDROPAC messages will be filed chronologically, by number, on a clip/wire message board or binder. A review signature sheet and HYDRO's in effect for the local OPAREA status sheet is attached to the front cover. Copies will be provided each work center maintaining charts.

(3) Instructions for Maintenance and Review

(a) At sea, HYDROPAC's are routed to the navigator and assistant navigator/leading quartermaster, with a copy to the QMOW for the HYDROPAC file. In port, HYDROPAC's will be routed to the duty quartermaster. When received, they will be reviewed to determine if there is any pertinent information that should be immediately brought to the attention of the OOD (at sea), and to the attention of the navigator or leading quartermaster, if in doubt at anytime.

(b) The assistant navigator/leading quartermaster will review the HYDROPAC file daily, at sea, and the day before getting underway from an inport period. The HYDROPAC file shall be routed to the commanding officer prior to getting underway.

(c) All navigation personnel will review the HYDROPAC file and status sheet prior to getting underway or returning to port and before relieving the watch at sea, in order to determine whether there are any HYDRO's in effect that may influence the navigation of the ship. Personnel reviewing the HYDROPAC file will initial the signature sheet.

(d) The assistant navigator will ensure effective HYDRO's are noted and corrections made to charts actually in use, as necessary.

(4) Disposition. Canceled HYDROPAC's will be destroyed; all others remain in effect until canceled.

j. NAVAREAS: Radio Navigational Warning System File

(1) Disposition. To be handled the same as HYDROPAC's. They must be filed separately, as they have a different set of sequential numbers than the HYDROPAC's.

k. Coast Guard Local Notice to Mariners File

(1) Purpose. To be handled the same as HYDROPAC's. Recommend these be held on board for six months from date of issue, since it may take from 6 to 18 weeks to incorporate a significant change to a Weekly Notice to Mariners.

l. Navigation Hazardous Message/Special Warnings File

(1) Purpose. To maintain a file of miscellaneous messages and any other information containing corrections to charts or publications used by this vessel.

m. The Magnetic Compass Record (NAVSEA 3120/3)

(1) The Magnetic Compass Record is a complete record of all magnetic compass readings and comparative true headings. It is also a record of computed gyro errors. While the ship is underway, gyro error shall be computed daily, if possible, for all gyros and recorded in the remarks column of each page. (A separate log for the computation of repeater error may be utilized which should also record the computed gyro error, but this log does not obviate the requirement to record computed gyro errors in the Magnetic Compass Record.) Compass comparisons between the magnetic compass and the helm repeater in use for steering shall be made and recorded every half hour and every time a new order course is steered. Helm repeater error shall be computed and recorded every four hours, comparing the SINS and forward gyro to the forward helm repeater and the aft gyro to the aft helm repeater. Compass checks shall be made anytime a gyro compass alarm is received.

(2) If the steering repeater and the heading source do not correspond within 1.0 degree at the time of obtaining a compass check, immediately repeat the check for possible error in reading. If, at this time, there is still an error, immediately inform the OOD, navigator, assistant navigator, and leading IC electrician. Additionally, if the SINS and MK19 gyros do not agree within 1.0 degree, inform the OOD and navigator immediately.

n. Ship's Position Reports

(1) Purpose. To provide a means of reporting the ship's position.

(2) Format. Ship's Position Report, NAVSHIPS Form 9240/1 or locally prepared forms may be used if containing, as a minimum, that information provided on the NAVSHIPS form.

(3) Instruction for Maintenance. Each day at sea, prior to 0800, 1200, and 2000, the assistant navigator will prepare or cause to have prepared a ship's position report. After the navigator has signed the position report, the original copy will be delivered to the commanding officer at the appropriate time. A copy will be placed in a file retained in the chart house, and CIC/CDC should receive a copy. Ensure that correct security classification of the report is indicated. (When a senior officer is embarked, a copy of each position report will be provided to him unless otherwise directed.)

(4) Responsibility for Maintenance. The assistant navigator is responsible for maintaining the file of duplicate position reports.

(5) Responsibility for Review and Approval. The navigator is responsible for reviewing the ship's position reports and approving them by signature, prior to their submission to the commanding officer.

(6) Disposition. The duplicate ship's position report will be retained as may be convenient, but will not normally be retained beyond the duration of the voyage unless directed otherwise by the navigator.

o. Captain's Night Order Book. Captain's night order book is maintained in loose-leaf or bound ledger form and contains the orders of the commanding officer for the operation and safe navigation of a ship during the night, while underway. The orders for each night are written on a separate sheet and signed by the commanding officer. They include such items as courses and speeds to be maintained throughout the night, expected sightings, engineering data, the tactical situation, and supplementary orders to the officer of the deck. This book is required by reference (b) and forms a permanent part of the records of the ship's operations.

7. Piloting Procedures. The following procedures should be followed when preparing to get underway or enter port:

a. Prepare a plan for safe and prudent passage, including piloting. This plan should be reviewed with the commanding officer. In preparing this plan, the following points should be considered.

(1) The sailing directions, coast pilots, and fleet guides are correct and contain the latest revision.

(2) Charts to be used are correct and all area charts are compared to ensure that hazards to navigation are properly displayed and highlighted on all charts in use. Navigation charts should normally be selected from the largest scale charts available.

(3) The ship's proposed track is laid down on all charts used for navigation, including those used on the bridge, navigator's and CIC/CDC navigation plots. On all tracks, the following items should be accurately plotted or indicated:

(a) The course and distance of each leg

(b) Danger bearings and ranges to navigation hazards

(c) Turning bearings/ranges and slide bars shall be properly plotted allowing for the ship's advance and transfer, and corrections, based on ship's tactical data.

(4) The track chart should be checked independently, by a second person, for accuracy and corrections.

(5) The day and/or night characteristics of all navigational landmarks intended for use have been determined.

(6) Track charts in use are annotated for shoal water, or points of hazards or danger including overload obstructions, with danger bearing/ ranges laid out for hazards. Primary and secondary plot charts should be signed after being prepared or updated.

Prepared by:
Submitted by: (NAV)
Approved by: (CO)
("CO shall approve NAV PLAN")
(Ref: COMTHIRDFLT TACMEMO)

(7) The navigator shall brief members of the navigation team, including the assigned OOD, before getting underway or entering port. This briefings will conform to the following guidelines: (See Appendix B)

(a) It should include a review of all track charts to be used while in restricted waters, with emphasis on navigation hazards, navigation aids anticipated to be used, the nomenclature to be used by all members of the team when referring to these navigation aids, assignment of personnel to team stations, and a review of team duties.

(b) The briefing may be modified by the navigator, for entry or departure from homeport and ports frequently visited, to require attendance only by key navigation team personnel. However, the entire team should be briefed on homeport sailings, at least quarterly.

(c) The navigator shall verify that all navigation equipment is on board operating properly and in calibration, and that navigation pre-underway or entering port checks are completed in accordance with the ship's standard operating procedures, navigation department check-off lists, and individual equipment operating procedures. He shall also review the status of equipment. Estimated time of repair (ETR) shall be provided by the EMO or electrical officer, as appropriate.

b. Underway Piloting Procedures and Checks. The following procedures should be employed while underway in a piloting situation:

(1) The navigator's plot is designated as the primary navigation plot. Navigation information maintained in CIC/CDC, designated as the secondary navigation plot, shall supplement the navigator's plot. The commanding officer may authorize a shift in the location of the primary plot to suit a particular situation. The navigation team should adhere, insofar as possible, to the following fundamental piloting principle that:

(a) An optimum balance between accuracy and speed must be achieved while piloting. When operating in close proximity to shoals or hazards, accurate present and projected ship position information is required. In addition, such fix information must be updated sufficiently often to provide timely warning if the ship is standing into danger. This is particularly true when in restricted waters. Prudent mariners will always utilize at least three LOP's.

(2) The navigator shall ensure that:

(a) Data for fixes are taken in such sequence that effects of ship's motion are minimized. In piloting situations, the first line of bearing taken on sightings should be those whose bearing is changing most rapidly (close to the beam). (The navigator shall use as a minimum three LOP's for each fix.)

(b) The ship's position is fixed at an interval that ensures safe navigation. A two-minute interval is recommended when in a harbor, channel, or other severely restricted area. The standard for fix accuracy stated in Dutton's is 50 yards. The interval between fixes may be increased by the navigator as a function of water depth, current, bottom contour, ship's depth and track, assessed position accuracy, width of channel, and other factors. Two minutes may not be adequate to accurately determine set and drift (some legs in harbors are quite short). One recommendation is two-minute fixes on legs of 2000 yards or less, and three minutes on legs in excess of 2000 yards. The three-minute interval corresponds most easily with the three-minute rule for distance (5 knots = 500 yards in three minutes). There is a speed graph which can be made up for any chart which easily accommodates one, two, or three-minute fix intervals. A good rule of thumb is 'if shoal water falls within a circle of which whose radius is that of two DR intervals' then the time interval between fixes is too long.

(c) Gyro errors are determined frequently. Master gyro and repeater errors should be determined prior to getting underway or entering port, and should be checked against available navigational ranges when the opportunity exists. Changes to gyro error should be entered in bearing record books and applied to fix information by the plotter.

(d) Set and drift are accurately determined, logged, and kept updated.

The OOD and CIC/CDC should be periodically advised of the calculated set and drift. (Set and drift shall be determined on each leg when feasible and more often when required, and applied to the DR to obtain an EP.)

(e) Every fix must have a DR track projected far enough ahead to include positions for at least the next two fixed intervals.

(f) Every fix and projected DR track does not endanger the ship.

(g) Course changes are based on turn points and bearings plotted on the chart; consider advance and transfer; and conditions of wind, sea, visibility, and currents. Ensure that the track of the recommended course is clear of navigation hazards. A fix should be taken as soon as the ship is steady on the new course.

(h) Fixes are obtained from aids to navigation and fixed markers rather than buoys, whenever possible. Bearings to buoys may be used to help clarify the navigation picture when no other objects are available. However, the navigator must be circumspect in his use of such information.

(i) Positions and fixes are verified by all available means, including soundings, buoys, radar, INS, electronic aids, fog signals, and active sonar.

(j) The fathometer is energized and recording whenever in restricted waters or less than 100 fathoms. Under these conditions, soundings will be taken continuously. Soundings should be reported to the bearing recorder and the OOD, and immediately reported to the OOD whenever soundings are less than the minimum values designated. Soundings are reported to the navigator whenever the navigator desires such reports. Soundings are to be compared with charted depths on each fix and reported to the OOD. All soundings will be logged.

(k) A fix is not erased because it appears in error; another fix should be taken immediately to ascertain the ship's position. If a usable fix of the ship's position is not determined in three successive attempts, then the recommendation shall be made to slow down, turn away from danger, or stop the ship until an accurate fix of the ship's position is obtained.

(l) Accurate records and logs are maintained. Complete reconstruction of the ship's track should be possible at any time. Replotting of logged data at a later date provides a good evaluation of the

navigation team's proficiency and can be an excellent training aid.

(m) Checklists are used in routine navigation.

(n) Bridge and CIC/CDC shall coordinate chart shifts so that both are not shifted at the same time and so that they do not require shifting during or at the time of an impending turn.

(o) Every fix determined from the primary navigation plot is compared to the fix obtained at the secondary plot. In addition, the phrase 'CIC/CDC concurs/CIC/CDC does not concur/CIC/CDC has no fix,' with appropriate amplifying information, shall be included in every verbal position report made by the navigator to the commanding officer and OOD.

c. Navigation Team Communications

(1) The navigation team should use designated sound-powered phone circuits when operating in piloting or restricted waters. Additionally, primary and backup lines of communication should be established for each essential navigation team function. Alternate means of communications need not be sound-powered, but should be exercised periodically.

(2) Rudder and engine orders shall be given using standard phraseology. Orders should be paralleled on a sound-powered telephone circuit. If conflicts arise, the engine order telegraph (EOT) should take priority until the conflict is resolved.

d. Duties of the Navigation Team in piloting of restricted waters. In addition to the commanding officer, navigator, and officer of the deck, whose duties are covered elsewhere, duties of other members of the navigation team include:

(1) Bridge Team

(a) Navigation Plotter. Maintains the navigator's plot. He shall plot and label each fix on the chart in use. He shall extend the DR at least two fix intervals, compute set and drift since last fix, and evaluate ship's projected movements. He shall make recommendations to the navigator. He shall compute such items as time and distance to the next course change, revised turning bearings, and any other tasks directed by the navigator.

(b) Bearing Recorder. Acts as the navigator's talker on the designated sound-powered telephone circuit, relays information received to the navigator, maintains the bearing record book (U.S. Navy Standard Bearing Book OPNAV Form 3530/3) in accordance with current directives, and may give 'marks' to the bearing takers, as directed by the navigator.

(c) Bearing Takers. Obtain accurate bearings to navigation aids designated by the navigator. They advise the navigator regarding the navigation aids available for use, including the gaining and losing of navigation aids from sight. They shall keep the aids in sight between shots.

(d) Leadsman Talker. If required, his soundings will be sent over the maneuvering and docking circuit to the bridge. This information is usually desired by the captain and the officer of the deck, as well as by the navigator.

(e) Surface Search Radar Operator (Navigators). Is in close proximity of the navigator and plotter, and provides all radar data considered pertinent, when directed by the navigator.

(f) Fathometer Operator. Operates the fathometer on a scale designated by the navigator. The OOD should be advised whenever the scale is shifted. Sounding shall be reported to the bearing recorder. The minimum sounding expected should be known and reported, if reached. The navigator must be advised if difficulty is experienced obtaining a sounding.

(g) Quartermaster of the Watch. Maintains the deck log in accordance with guidance provided, in addition to those duties which are prescribed in other navigational department instructions.

(2) CIC/CDC Navigation Team

(a) CICWO. Supervises the performance of the CIC/CDC navigation team, ensuring smooth flow of information within CIC/CDC and between CIC/CDC and the bridge.

(b) Surface Search Radar Operator/Surface Tracker. Tracks surface contacts and provides information to the navigation team. The range scale used will be appropriate to manage the surface picture, as well as obtain accurate navigation information. The radar operator shall normally report all contacts to the OOD and the CICWO. He will track radar contacts designated by the OOD or CICWO.

(c) Watch Supervisor. Supervises the CIC/CDC team.

(d) Plotter. Shall maintain a plot on the appropriate chart, as directed by the CICWO.

(e) Lookouts shall be so stationed as to provide 360° coverage of the horizon. They shall have no other duties while acting as lookouts, and shall be rotated to ensure that they can efficiently and vigilantly perform their duties. During periods of low visibility, lookouts shall be provided phone talkers to allow lookouts to conduct their duties unimpaired (both listening and looking for potential hazards).

(f) Navigation Radar Operator. When called to "Mark," as rapidly and accurately as possible, call ranges in yards or 10ths of miles from own ship to designated navigation points. Maintain communications with the navigation plotter, keeping him informed of designated points available for use. Mark those points which are changing most rapidly first, to improve accuracy of the plot.

(g) Navigation Plotter. Swing range ARC's as rapidly and accurately as possible. Plot own ship DR's at least two fix intervals ahead, compute, and plot set and drift at least once each leg and compute correcting/compensating course, as necessary. Maintain communications with navigation scope, and navigation recorder for navigation point information.

(h) Navigation Recorder. Call mark at the same time as the bridge team, allowing for continuity, log reported point ranges from navigation scope, log fathometer reading: log fix time, be prepared to assume marking responsibility from bridge team in low visibility.

(i) Piloting Officer. Evaluate fix accuracy. Keep shipping officer advised of pending course/speed changes in order to determine which contacts should be tracked. Supervise action of the navigation radar operator, navigation plotter, and navigation recorder. Report the following information to OOD and navigator.

1 Fix time (reported each fix)

2 Fix accuracy (reported each fix)

3 Fix position in relation to proposed track (reported each fix)

4 Nearest danger to navigation (reported each fix)

5 Depth of water beneath the keel and comparison to charted depth (reported each fix)

6 Nearest AID to navigation (reported each leg or more often as required, i.e., when channel buoys are on the bow and on the beam)

7 Time to next turn (reported each leg or more often as changes occur)

8 Course on next turn, ensuring BRG clear with shipping (reported each leg and updated as changes occur)

9 Any recommendation to regain/maintain proposed track (reported each leg and as changes occur, or as required)

10 Report computed set and drift (reported each leg and updated as changes occur)

NOTE: Set and drift shall be calculated each for report once each leg, update as changes occur.

11 CIC/CDC concurs/does not concur (reported each leg or more often as required)

(j) Shipping Officer. Evaluates surface picture. Designates contacts to be watched or tracked in accordance with ship's directives as directed by the OOD. The shipping officer shall:

1 Keep the OOD/CICWO/piloting officer advised of the surface picture.

2 Keep the piloting officer informed of the location and movement of all surface contacts in order that the piloting officer may make timely and intelligent recommendations to the bridge.

3 Direct optimum range scale for surface search radar operator/surface tracker, based upon the density of surface contacts and the piloting situation.

4 Pass bearing, range, course, speed, and CPA of significant contacts to the OOD in a timely manner.

5 Supervise the actions and performance of the surface search radar operator/surface tracker DRT operator.

6 Correlate visual reports/fog signals from lookouts with surface contacts and report evaluated information.
(Note: When the whipping officer is unable to correlate fog signals forward of the beam or abaft of the beam and getting louder, he shall immediately make recommendations to avoid in accordance with applicable rules of the road).

SECTION 4

STANDARD NAVIGATIONAL PRACTICES

1. General. This section contains and provides guidance on the standard navigational practices which serve as a foundation for the development of a type ship routine.

2. Policy. When at sea, the officer of the deck shall keep himself informed of the position of the ship and all other particulars which may be used to keep the ship out of danger. He shall employ all means available for detecting and avoiding danger. The ODD, the QMOW, and other watchstanders responsible to the OOD should never hesitate to station or recommend stationing the full navigation team, or to request additional navigational personnel assistance. The OOD is totally responsible to the commanding officer for the safety of the ship.

3. Voyage Preparations. This guide provides the basic steps to ensure proper preparation. They are as follows:

a. Establish the overall track to comply with operation orders and sail orders.

b. Prepare, in detail, the navigational and operational plans for those portions of the voyage outside of restricted waters.

c. Prepare, in detail, the navigational track and supporting information required for maneuvering in restricted waters while departing from port, operating within restricted waters during the operation, if applicable, and arriving in the next port.

d. Thoroughly brief the appropriate members of the ship's navigation and operational teams on each of the phases.

e. Verify the proper operation and calibration of navigational equipment including radars and completion of the appropriate preparations prior to their use or need.

f. Record the status of electronic aids and the inoperative operational status of electronic NAVAID's, and post them in a prominent location.

4. Navigational Practices While in the Open Sea. The QMOW is the principal navigation assistant to the OOD in each watch section. As such, he must continually strive to accurately fix the ship's position by all available means. The QMOW must be alert to navigational hazards and anticipate indications which can identify possible problems. The QMOW should never allow himself to become distracted or occupied to the point that it interferes with his primary responsibility, which is the safe navigation of the ship. The QMOW has numerous duties, including the keeping of the deck log, weather, and obtaining fix information. The OOD must recognize this and, if fix taking becomes so involved to the point of sacrificing his other duties, then the navigator/assistant navigator should be informed so as to provide additional assistance to the QMOW.

5. Ship's Position. In the open sea, the following guidelines should be utilized for obtaining an accurate fix by both primary and secondary plots.

a. Fix the ship's position at least half-hourly, when possible, assuring that fix data is available from NAVAID's.

b. Compare navigation data from multiple sources, such as electronic NAVAID's, radar, and celestial sources.

c. If comparisons indicate excessive deviation, determine the source of excessive deviation from resultant best fixes and analyze them to determine the cause for the deviation.

d. Report the ship's position, half-hourly, to navigation information users, such as the CICWO/TAO, OOD, embarked commander, and OTC, as directed.

e. Set and drift should be computed each time the ship's position is fixed. The ship's course will be compensated as directed by the navigator.

f. Except when directed by the commanding officer, a sounding will be taken with every fix and at least every 30 minutes. Soundings shall be recorded and compared to the ship's position.

g. If weather permits, an azimuth/amplitude of the sun or other celestial body will be taken daily to compute gyro error.

h. The INS shall be reset only when directed by the navigator or commanding officer. The error and magnitude of the reset should be checked before the reset is entered. DRAI and other equipment that indicates a DR position shall be reset on "good" fixes, when directed by the navigator. When resetting, record the resets in accordance with the instructions for maintaining the ship's position log. A DR track should be extended from the fix through the next three fix intervals.

6. Compass Checks

a. A check of the SINS (if installed), ship's gyros, steering repeater, and standard compass will be made and recorded at least every 30 minutes, and with major course changes. It is emphasized that the gyros (i.e. source of input to gyro repeaters) be checked regularly.

b. Comparisons of greater than one degree difference between the ship's gyros and SINS will be reported to the OOD and navigator immediately.

c. Comparison of the gyrocompass and magnetic compass headings shall be made and recorded half-hourly and when steady on a new heading of each course change.

7. Routine Reports. Unless otherwise directed, the officer of the deck/quartermaster of the watch will ensure that the following reports are made to the navigator:

a. Changes in course and speed, as specified in standing orders

b. Soundings that do not correlate with the DR/fix position. In open ocean, the deviation should be specified by the navigator.

c. Any departure from an assigned track or operating area

d. Any sudden or large change in set or drift, two kts or greater

e. The sighting of all navigational markers, such as lights, buoys, etc.

f. When an expected aid to navigation is or is not sighted at the time or bearing at which it was anticipated

g. When a marked change in the weather is observed or the visibility decreases to less than the distance specified in the commanding officer's standing orders

h. Any SINS/master gyrocompass/auxiliary gyro comparison reading that is greater than one degree

i. Any observed malfunction to navigational support equipment (i.e., DRAI, SINS, DRT, ship's gyro, etc.)

j. Any time the ship's position is in doubt or the projected track's prudence is questionable

8. Quartermaster's Duties. While performing open ocean navigation, the QMOW or designated member of the navigation team shall:

a. Maintain a projected track, corrected for anticipated set and drift, of the intended ship's courses and speeds, as established by the navigator.

b. At least every 30 minutes, plot and compare both SINS and combat systems (NTDS or DRAI) positions on the chart in use, informing the officer of the deck and navigator of developing errors.

c. Pay particularly close attention to the compass comparison checks every 30 minutes, immediately notifying the officer of the deck and navigator if errors are noted.

d. Examine the charts in use and make recommendations to the officer of the deck for times when the fathometer could be used to gain useful navigation information.

e. During the watch, the quartermaster of the watch is responsible for the following additional specific items:

(1) Carrying out watch routine

(2) Keeping the logs and records, as applicable

(3) Assisting the OOD, navigator, and assistant navigator in piloting the ship

(4) Assisting in the resetting of the DRAI, as appropriate

(5) Operating the fathometer with permission of the OOD/TAO if acoustic EMCON is set

(6) Being alert to preventing any changes in the status of equipment supplying inputs to the SINS and DRAI's such as the log, dummy log, or compass. He will immediately inform the navigator of any change in the status of such equipment and will log in the deck log of the time and nature of such occurrence, noting the DRAI and SINS readings at the time.

(7) Making reports to the navigator and assistant navigator

(8) Being careful to double check all position plotting calculations and procedures

(9) Monitoring the helmsmen for ordered ship's course and speed

(10) When operations permit taking an azimuth on each watch, recording the results in the navigation workbook (OPNAV Form 3530/1) and reporting results to the officer of the deck and the navigator

(11) Estimating set and drift, comparing to SINS set and drift data as obtained from raw speed vectors, when directed by navigator

(12) Correcting the DR plot. If the new fix varies more than one NM from EP, ensuring that OS and IC personnel are informed that the dead reckoning analyzer and tracking equipments require investigation.

(13) Preparing the ship's 2000 position report for distribution to the CO, CICWO (TAO if on watch), any embarked commander, and the OTC

(14) Preparing notes for the night orders notebook

(15) Computing the time of the beginning of the next morning's civil twilight and preparing a list of celestial observations. Assignment of personnel to accomplish specific elements of the day's routine shall be made by the navigator, based on an assessment of experience and expertise demonstrated by the QMOW.

f. Times for accomplishing these elements are not defined, due to variations in the times of celestial observations. Assignment of personnel to accomplish specific elements of the day's routine shall be made by the navigator, based on an assessment of experience and expertise demonstrated by the QMOW.

g. Ensure proper watch turnover is executed by QMOW, utilizing a checklist such as that detailed in Appendix E.

SECTION 5

INTEGRATED NAVIGATION

1. Background. The accuracy of navigation depends on a knowledgeable assessment of all position data. Each source and fix technique is subject to some error. The prudent navigator, therefore, must assess each position determination and evaluate it with respect to others.

2. Use of Available Resources. Evaluating from all electronic aids, celestial, visual, and DR/EP computations provides the basis for knowledgeable evaluation of the ship's position. Each source of fix is subject to some degree of error and accuracy. The navigation team must understand the sources of error that each fix source is subject to, and apply that knowledge combining multiple sources to the best position. This type of application will also be useful in identifying a fix source that has a significant error. By integrating as many sources of fix information as is reasonably possible, mutually supportive fixes will improve position accuracy and raise the confidence in data produced. The integration of several NAVAID's to derive a composite fix requires:

a. Understanding those factors influencing their day-to-day or seasonal variation and effectiveness.

b. Precise data collection, plotting, and analysis at the precise time set for fixing the ship's position.

This effort requires that the sum of the navigator's experience, judgment, and confidence in this work will be employed. This decision to select a single source of positioning data or an averaging approach is based on his analysis of the factors which influence NAVAID accuracy, and the time available to gather and analyze the data.

3. Procedures for Data Collection and Reduction. For integrating any navigation data:

a. Draw positioning data from visual sightings, celestial observations (sun line LOP), and the ship's NAVAID's. Note the precise time of data collection for each aid. Enter the LOP's obtained in the Standard Bearing Book (OPNAV form 3530/1) as appropriate.

b. Reduce the raw data obtained and record the fixes developed in the appropriate logs and as specified by the CO.

c. Plot LORAN C and OMEGA fixes on the special charts available for use with these systems. Some LORAN C and OMEGA systems produce fix data in latitude/longitude format and do not require special charts.

d. Plot GPS/SATNAV fixes (if available).

e. Advance/retard all fix data to common time reference.

f. Translate all fix data acquired to latitude and longitude values for transfer to the navigator's plot.

g. A convenient method of handling data collection is provided through the use of the ship's position log (OPNAV 3100/3). The log is a chronological record of the ship's position in latitude and longitude, as developed by NAVAID's, the precise time the fix was taken, and the initial of the person acquiring the data. Space is allocated for the navigator's evaluation of the composite estimate of position, an indication of verification against the DR, radar (when possible), and remarks related to the status of specific NAVAID's or conditions which prevented fixing through any given technique. This log is used for reconstructing the track and forms a data base for estimating the accuracy of the ship's NAVAID's. When resetting the DRAI, the old and new reset positions must be logged.

4. Procedures for Data Analysis and Display. One method of plotting the fix data recorded in the ship's position log would be to:

a. Plot the fixes on the navigator's working plot, indicating the precise time of initial data collection and the NAVAID used to derive the fix (Figure 5-1).

b. Advance or retard the fixes to common time reference as estimated positions (Figure 5-1) in this case 0645 the time of the NAVSAT fix.

c. Insert an estimated error of each NAVAID utilized (Figure 5-2), based on data derived from previous NAVAID performance and accuracy of data obtained or representative accuracies found in Appendix D.

d. As an example from previous performance and system capabilities NAVSAT has been selected as the most accurate fix of current position. Comparison of the NAVSAT fix with all other NAVAID fixes indicates the NAVSAT fix falls within each of the other NAVAIDS CEP, thus verifying the validity of the NAVAID fix.

e. Record the latitude and longitude of the NAVSAT fix on the work sheet, evaluate its quality, and verify it against the DR and, if possible, with radar.

All data must be plotted on the largest scale chart available. All too often, the navigation team plots the ship's track and DR positions on a scale which permits them to maintain the "big picture." While this is convenient and reassuring for the CO and members of the bridge team conning the ship, it severely limits the ability of the navigation team to maintain their plotting accuracy when one NM can be lost in the width of pencil lead. More importantly, changing from small to large-scale charts at the onset of potential hostilities multiplies the odds of inducing a plotting error during the transition to the new chart. Any big picture representation of the track for the conning officer should be maintained separately from the working plot used by the navigation team. The OOD, and others, must not mark on nor alter the navigator's working charts. Inserting the estimated accuracy values for the NAVAID's plotted is a significant step in deriving an approximate geodetic position, and visually displays the interrelationship of the various NAVAID accuracies. The accuracy of a NAVAID varies, dependent upon equipment operating condition, geographic location, data collection reliability, and other factors such as seasonal variation. The conscientious navigator can use test data to develop a reliable estimate of accuracy for his equipment.

5. Error Detection and Correction. The critical issue in tactical navigation is when to recognize that the DR or other fixes contain significant errors, and to pinpoint the cause of the error. The degree of confidence also depends on an awareness of the differences between fix source data and the degree of error involved, and the identification and resolution of the source of errors. A properly maintained DR is the foundation in determining ship's position between fixes, comparing fixes when obtained, catching errors, and resolving conflicts among other sources. Hence, a vital factor in the determination position is the DR. Each fix from any source should be compared with the DR fix at every opportunity. This comparison will validate the consistency of that method or indicate a degradation trend over a period of time, allowing the navigation team to locate the source of error and correct it. For ships with INS the system presents an accurate "ground truth" between fixes that can be extremely accurate if error corrections are applied to the raw INS data and the INS has been updated by a satellite fix inside its 30-hour operating window.

a. All members of the navigation team must be alert to detect possible errors. The practice of navigation must not become routine. Proper attention to the details and proper internal communication is essential to prevent accuracy degradation. It cannot be over stressed that an accurately maintained DR plot is essential to accurate navigation.

b. Procedures. The navigator and quartermaster must:

(1) Properly maintain the ship's DR, including a running E.P. plot.

(2) Use the DR and all available fixes to determine a composite fix.

(3) Note variations in fix clusters in successive plots, and remain alert to the first indication of accuracy degradation in their data.

(4) Flag all geodetic positioning data provided to the users of navigation information, with an assessment of fix quality.

c. The TAO must:

(1) Ensure that the NTDS DR position is frequently updated to

reflect the fix or EP on the navigator's plot.

(2) Be alert to the quality of the fix in his tactical evaluation to reduce errors in tactical warfare situations.

(3) Ensure that any positioning data he receives from the navigator is compared with the current display. Any that do not constitute a logical extension of previous fixes, and estimated position in relation to time, are brought to the attention of the navigator and CIC/CDC watch supervisor to coordinate a resolution of the error. (The navigator will provide final verification and correction, if required.)

(4) When requesting own ship's position or providing another unit's position, the navigator must ensure that the data includes:

(a) Latitude, longitude, time of report, time of fix on which position report is based.

(b) Quality of fix.

(c) Course/speed.

(d) Flagship's bearing and range if appropriate.

(e) Source of fix information.

(5) The ship's position report provided to the OTC for force position plotting shall contain the same data.

d. Figure 5-2 presents two examples of error detection by the navigation team. In this figure, it can be seen that the ship's position is drifting north of the position and intended movement (PIM). At 0645, when a celestial observation was made, additional fixes acquired from the satellite navigation and OMEGA devices combined with the DR position. Through succeeding fix plots, the relationship of the fixes developed by satellite navigation and OMEGA remained relatively constant with the DR position. Detecting such shifting across succeeding fix intervals is generally indicative of previously unknown or uncompensated sailing factors such as set and drift. (Uncompensated velocity errors such as set and drift could result in a large error for the satellite navigation fix.) When, at 0745, the navigator's plot indicates deviation from the PIM exceeding two NM, changes in course and speed are ordered by the OOD to regain the PIM. By 0900, the ship is well on its way to resolving the error.

e. At the time of the 0645 fix, the estimated positions developed by the DRAI and NTDS DR are noted to be in error, and these units are reset after the fix is developed. In succeeding plots, both begin to accumulate error, with the NTDS DR pulling away from the manual DR much faster than the DRAI. This is significant since both systems accept inputs from common data sources (log and gyro) and should track closely together. Large variations in the data developed by a single resource usually indicate equipment malfunction and should be thoroughly investigated and resolved.

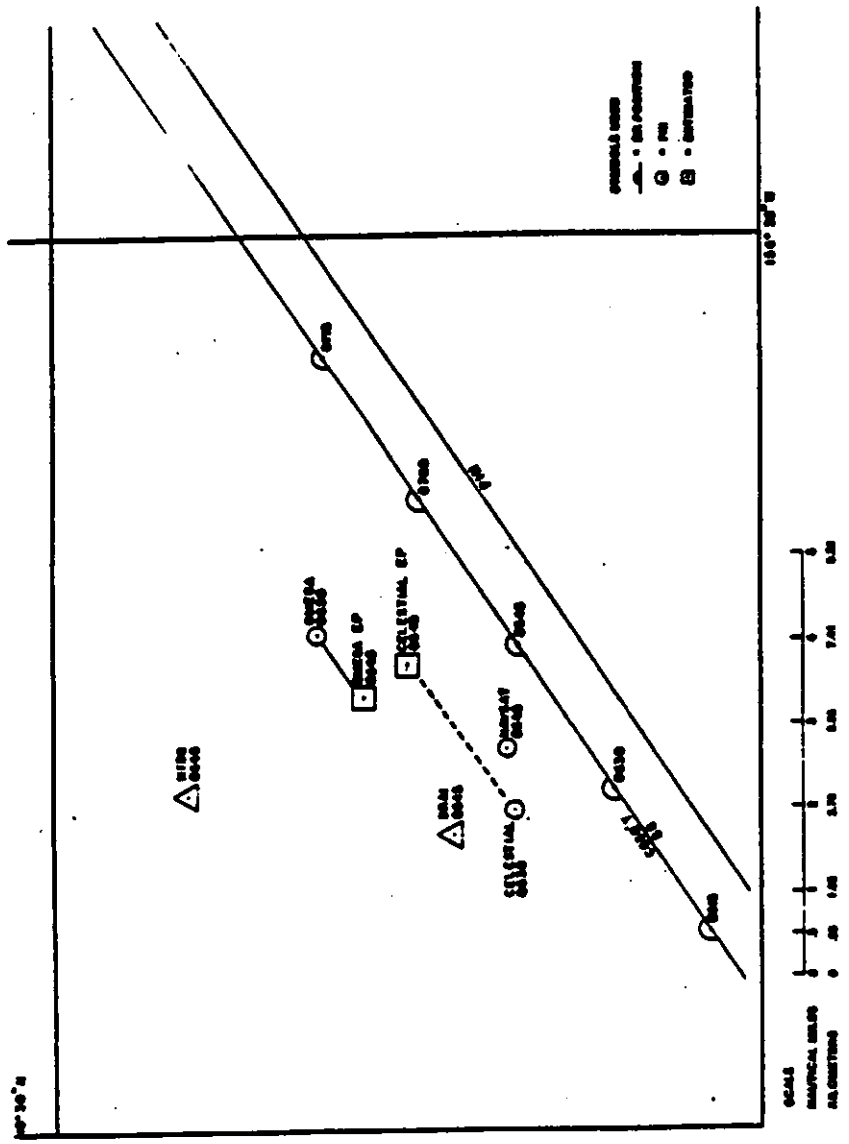

FIGURE 5-1 PLOTTING FIXES ON THE NAVIGATOR'S PLOT

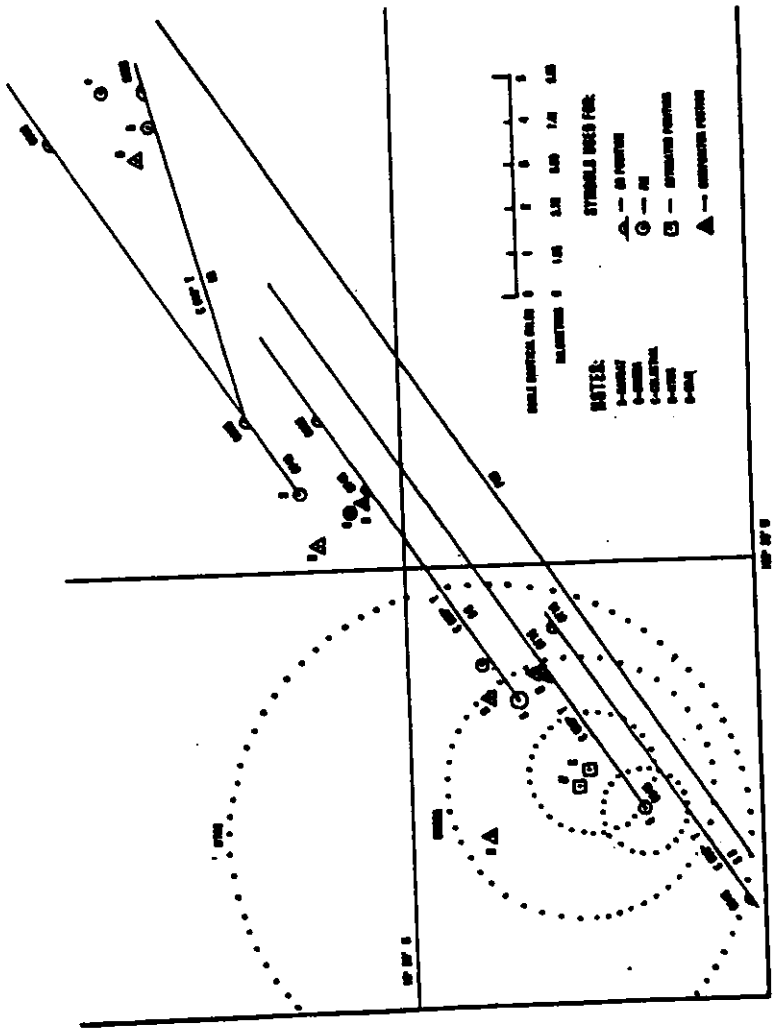

FIGURE 5-2 ERROR DETECTION AND SOLUTION

APPENDIX A

LIST OF ACRONYMS, TERMS, AND DEFINITIONS

Acronyms

AAW	Anti-Air Warfare
AMW	Amphibious Warfare
ASU	Anti-Surface Ship Warfare
ASW	Anti-Submarine Warfare
CASREP	Casualty Report
CEP	Circular Error Probability
CIC	Combat Information Center
CDC	Combat Direction Center
CICWO/CDCWO	CIC/CDC Watch Officer
CNO	Chief of Naval Operations
CO	Commanding Officer
CWC	Composite Warfare Commander
DR	Dead Reckoning
DRAI	Dead Reckoning Analyzer Indicator
DRT	Dead Reckoning Tracer
DS	Direct Support
EM	Electromagnetic
EMCON	Emission Control
EMO	Electronics Material Officer
EP	Estimated Position
ESM	Electronic Support Measures
ESO	Educational Services officer
ET	Electronic Technician
ETR	Estimated Time of Repair
FCS	Fire Control System
FORACS	Fleet Operation Readiness Accuracy Check Site
FTC	Fleet Training Center
FTG	Fleet Training Group
IC	Interior Communication Electrician
IFF	Identification Friend or Foe
INS	Inertial Navigation System
LAMPS	Light Airborne Multipurpose System
LOP	Line of Position
MOTU	Mobile Ordnance Technical Unit
MOVREP	Movement Report
NAVAID	Electronic Aid to Navigation
NESEC	Naval Electronic Systems Engineering Center
NM	Nautical Mile
NTOS	Naval Tactical Data System
OJT	On-the-Job Training
OOD	Officer of the Deck
OPNAV	Office of the Chief of Naval Operations
OPNAVINST	OPNAV Instruction
OS	Operations Specialist
OTC	Officer in Tactical Command
OTH-T	Over-the-Horizon Targeting
PCA	Polar Cap Absorption
PDL	Pass Down Log
PIM	Position and Intended Movement
PMS	Planned Maintenance System
PPC	Predicted Propagation Correction
QM	Quartermaster
QMOW	Quartermaster of the Watch
RDF	Radio Direction Finding
SID	Sudden Ionospheric Disturbance
SINS	Ship's Inertial Navigation System
SOA	Speed of Advance
SOP	Standard Operating Procedure
ST	Sonar Technician
STW	Strike Warfare
TAO	Tactical Action Officer
TDS	Tactical Data System
WLO	Weapons Liaison officer

ESTIMATE OF POSITION--The more probable position of a vessel determined from incomplete data or data of questionable accuracy. In practical usage, it is often the DR position modified by the best additional information available.

CONNING OFFICER--The officer actually in control of the ship's movement through the water.

FIX INTERVAL--The time between fixes. It will be determined depending on the type of conditions encountered, i.e. open ocean, coastal waters, or piloting. (See Appendix C, table C-1.)

GEODETIC POSITION--The unit's location on the earth's surface, expressed in latitude and longitude coordinates.

INTEGRATED NAVIGATION--Navigation based on integrating data from all available resources and techniques which is subjected to rigorous review and analysis to detect and resolve potential sources of error.

NAVIGATION RESOURCES--Those practices, procedures, techniques, aids, personnel, and experiences that can be brought to bear on the requirement for accurate navigation.

NAVIGATION TEAM--Those members of the ship's force who develop and/or utilize navigation data.

REEF-- An off-shore consolidated rock hazard to navigation with a least depth of 20 meters (or 10 fathoms) or less.

SHIP'S POSITION--The ship's location expressed in geodetic coordinates of latitude and longitude.

SHOAL-- An off-shore hazard to navigation with a least depth of 20 meters (or 10 fathoms) or less, composed of unconsolidated material.

TACTICAL NAVIGATION-- Navigation services provided by the navigation team in support of tactical operations.

APPENDIX B

NAVIGATION BRIEF

Attended by:

Commanding Officer
Executive Officer
Operations Officer
Navigator
Chief Engineer
First Lieutenant
CIC/CDC Officer
Assistant Navigator
CIC/CDC Surface Watch Team
(Piloting and Shipping Officers)
Bridge Sea and Anchor Team
(OOD, JOOD, JOOW, Conning Officer, OOD(U/I))
Geophysics Officer/AG
QMC
Leading OSC
Staff Surface Operations Officer
Other personnel as directed

SEQUENCE

I. ARRIVAL/DEPARTURE TIME - Navigator

Consideration of options

Tides
Operational requirements
Speed required

II. WEATHER - Geophysics Officer/AG/Navigator

III. TIDES - Navigator

Ebb/flood - range in feet for line tending
Sine curve of tide for entry/departure

IV. CURRENT - Navigator

Direction (degrees T)
Sine curve of current for CO, NAV, CONN, OOD, CIC/CDC

V. CHARTS - Navigator

Currency
Changes (Notice to Mariners, hydropacs, etc.)
Track
Major courses
Head, turn and danger bearings
Shoal water and danger arcs
CDC and NAV track compared
Depth of water
Channel
Turning basin
Recent survey
Visual and radar landmarks
Description of anchorage or mooring
Head and drop bearings
Pier heading
Holding ground
Depth of water
Vessel traffic separation schedules/check in points

VI. GROUND TACKLE - First Lieutenant

Ready anchor - port/starboard
Scope of chain
Recommended evolution (i.e., let go or walk out to certain scope)
Status of windlass/winches
Special mooring buoy procedures

Mooring plan

VII. TUGS AND PILOT - Navigator

VIII. SIGNIFICANT TRAFFIC - Expected movements - Operations Officer

Monday morning sortie
Ferry movements

IX. STATUS OF NAV EQUIPMENT - Navigator

Gyro and repeater error comparison
Fathometer
Pit log
SINS
Radars and repeater error calibration

X. STATUS OF ENGINEERING PLANT - Chief Engineer

Limiting casualties

XI. SPECIAL CONSIDERATIONS/EVENTS - Navigator

Coordination with the pilot for embark/debark
Fleet Guide, Port Guide, SOPAINST
Honors
Flag officer movements
Visitors
Bridges
Helo operations (VOD/VERTREP)
Debrief schedule
Flight deck/water washdown system
Boats in the water
Accommodation ladder up/down

XII. SEA AND ANCHOR DETAIL - Navigator

Time/Uniform

XIII. EMERGENCIES

Steering Casualty
Engineering Casualties
Man Overboard
Rapid Weather Deterioration
Loss of Gyro
Loss of Radars
Plan for Lost Communications

APPENDIX C

BASIC SKILLS

1. Introduction. In modern naval tactics navigation is not safety alone; it includes targeting and protection against engagement by friendly forces. In battle group applications, the OTC's knowledge of other ships' positions is often based on the last reported position received, coordinated with the OTC's own DR and the PIM's of units not in company. Identification of friendly units can be difficult unless all units are able to maintain accurate plots of their positions and movements. Under these conditions, DR's and EP's must be maintained and utilized with the greatest skill. Basic skills must be stressed and adequate training provided for, because it is the foundation upon which accurate navigation is to be maintained.

2. Fixing the Ship's Position. A fix is the closest possible approximation of the geodetic position of the vessel. The resources used may include celestial observations, visual bearings, lines of position (LOP's) developed by electronic aids to navigation and NAVSAT/GPS data. At the time the fix is taken, the position of the ship is established in latitude and longitude. This position will vary from the actual geodetic position to the extent that errors have been introduced in the fix through inaccuracies in procedures, technique, and the accuracy of the NAVAID's utilized.

3. Standards. Minimum accuracy standards for fixing the ship's position and the interval between these fixes are, to some extent, situation dependent. Table C-1 summarizes the orders of accuracies and fix intervals described. Generally, the ship's position should be known within two NM when outside coastal waters and not engaged in battle group evolutions which may require a higher standard of accuracy.

TABLE C-1

SUMMARY OF FIX ACCURACIES AND INTERVALS

Area	Distance from Nearest Danger	Water Depth (Fathoms)	Accuracy	Recommended Interval
Pilot Waters (Harbors)	Less than 2 NM	Less than 20	50 yds	2 min or less
Coastal Waters	3 - 50 NM	20 - 100	0.25 NM	3-15 minutes
En route Navigation	Over 50 NM	Over 100	Goal of .75NM or better is established for B6 operations. 2NM is reasonable for transits using celestial navigation.	As conditions warrant (typically not greater than 30 minutes)

The position of the ship must be determined by all available means at every opportunity. Navigation personnel must always strive for the highest degree of accuracy possible.

4. Procedures. To ensure that the required standards of accuracy are met:

a. Fix the ship's geodetic position by all available means and resources available. Celestial, NAVSAT/GPS, OMEGA and LORAN-C fixes should all be compared with the DR track and INS position (if available).

b. Plot OMEGA and LORAN C fixes. If direct lat/long read-out is not available, then plot on appropriate charts prior to transferring the fix to the navigator's plot. Ensure accurate transfer of data.

c. When developing or plotting fixes away from the navigator's plot, record the precise time the fix data was acquired and transfer this time with the fix to the navigator's plot.

d. Plot all fixes and label the time of fix on the largest scale chart available to allow the greatest accuracy. Construct DR from each fix, extending at least two fix intervals.

e. When recording fix data in the position log, indicate the source of fix and assign an assessment of fix quality (E-excellent, G-good, F-fair, P-poor, N-no fix).

f. Report fixes to the OOD, CICWO and/or TAO with an assessment of fix quality.

g. After obtaining a fix which is evaluated as good or better, with the concurrence of the navigator, reset the DRA or DRAI. Inform CIC/CDC to enable the update of tactical plot information.

h. With concurrence of TAO/CICWO, update NTDS, as appropriate, and resolve errors, using gridlock procedures.

i. On ships which have a SINS update to NTDS, compare the position information between SINS and a good or better fix. If the error exceeds two NM, an evaluation by the navigator and CICWO and/or TAO should be made whether to shift out of SINS update mode.

j. INS resets should be made only after careful evaluation of the proposed reset and with the concurrence of the navigator. Navigation inputs to aircraft systems is usually raw SINS data. SINS resets should be carefully coordinated so as not to interrupt aircraft alignment procedures. After the reset has been completed, aircraft navigation systems should be stabilized with the new data.

k. Assessments of fix accuracies must include the design specifications of the equipment, as well as the environmental conditions existing when the fix was obtained, which could reduce the accuracy of the fix. In addition, the skill, training, and other human factors involved in the personnel who produce the navigation data must also be considered in assessing fix accuracy.

l. Detailed description of the techniques employed to acquire fixes may be found in DUTTON's, DOWDITCH, and quartermaster training manuals. The details of shipboard electronic navigation systems are found in component technical manuals. Some important considerations associated with electronic systems are also described in Appendix D.

5. Dead Reckoning. The DR plot is the most under-utilized source of navigation information. It is a projection of the ship's intended movement from the last fix. DR position accuracy is directly related to the attention given to the precision of the maintenance of the DR plot between fixes. Factors which affect the accuracy of the DR include currents, wind, sea state, advance and transfer, human factors, charts, scale selection, condition of the ship's propulsion and steering systems, and performance of the EM log. The navigation team must rely on DR as the foundation for maintaining an acceptable estimate of the ship's position between fixes. A properly maintained DR is the foundation for the navigation plot and is the basis for the estimated positions until the next fix, sighting land, or arrival at the destination. The DR plot provides a data source to compare with the estimated positions derived from the electronic NAVAID's (i.e., DRAI, INS, NTDS) and detect potential errors. It also aids in resolving data source conflicts.

6. Standards. The accuracy and degree of precision required in constructing and maintaining any DR plot is dependent upon the mission of the vessel. A properly maintained DR, supported by a day's work in navigation and frequent fixing by electronic aids, should be sufficient to maintain accuracy approaching or better than one NM. Under circumstances which require a higher standard of precision and accuracy, attention to the DR becomes crucial to approximate the geodetic position, advance the ship's position, and avoid hazards. All standards of accuracy which apply to fixing the ship's position apply to maintaining the DR between fixes. A properly constructed DR does not allow for any internal or external influences acting on the ship. It is a good basis for establishing an EP from known influences affecting the ship's progress. A DR is simply projecting ordered speed and course steered. Allowances for known set and drift must be considered in establishing an EP in the absence of external information.

7. Procedures. The procedures specified in Dutton's, which should be applied to dead reckoning on the navigator's plot, are:

a. Plot a DR position at least every hour on the hour.

b. Plot a DR position at every course change.

c. Plot a DR position at every speed change.

d. Plot a DR position when obtaining a fix or running fix.

e. Plot a DR position when obtaining a single line of position.

f. Plot a new course line from each fix or running fix, as soon as it has been determined and plotted on the chart.

g. Plot the DR on the largest scale chart commensurate with tactics employed.

h. When using a DRAI, DRT, or NC2 plotter, ensure that latitude and longitude values drawn from an accurate fix are entered whenever the track error between this device and the manual DR exceeds one NM, to reduce accuracy degradation induced by EM log and gyrocompass errors, and those factors affecting set and drift.

i. When accepting speed data from dummy log, ensure that all speed changes are entered as they are ordered. Attention by EOOW is required.

j. When DRT or NC2 is utilized for plotting, ensure that this unit remains energized during the course of the voyage, including those periods when the unit is not in use. This will protect the electrical/electronic components and improve reliability.

k. Retain the navigator's plot as a record for evaluating performance and for use in reconstructing the mission.

l. Updating DR.

8. Estimating Position. When insufficient data is present to accurately fix the position of the vessel, an estimated position may be generated by combining incomplete data at hand from a variety of sources. The estimated position may combine the DR position with a single line of bearing, account for set and drift, compensate for advance and transfer, or represent a combination of these and other factors, depending upon the situation. Since DR positions are plotted on lines derived from ordered courses and speed and do not compensate for current sailing factors or tactical characteristics of the ship, their relationship to the geodetic position may not always be accurate. To reduce the magnitude of error between the ship's DR position and the geodetic position, the DR plot must be refined during the interval between fixes with a plot of estimated positions.

9. Standards. While no rigid standards can be applied to techniques aimed at estimating position, the navigation team must minimize the accuracy degradation provided by the last fix acquired.

10. Procedures. To produce an estimated position:

a. Use the largest scale chart practicable to enhance the plotting accuracy. Navigation accuracy depends on this. Tactical plots may be more usefully maintained on smaller scale charts.

b. Include the last DR position in any calculation leading to an estimate of the ship's position.

c. Combine all available lines of position of questionable quality with DR position data in the absence of a fix.

d. Estimate set and drift, and apply this data to current work on the navigator's plot. For ships with SINS, set and drift should be derived from velocity vectors.

e. During high-speed maneuvering, compensate for advance and transfer, using knowledge of the ship's turning circle at speeds and rudder angles other than standard, and values for determining acceleration/deceleration distances.

f. Use bottom contour charts and the fathometer, when appropriate, as described in Dutton's to fix ship's position, to establish an estimated position or to increase confidence in an estimated position.

APPENDIX D

ELECTRONIC AIDS TO NAVIGATIONS

1. Background. Electronic aids to navigation (NAVAID's) are installed aboard naval vessels to provide a broad base of positioning data when these resources are combined with visual and celestial techniques. When data provided by NAVAID's are combined, the navigator has position reference capabilities that will support global all-weather navigation. Characteristics of position systems are summarized in tables D-1 through D-5.

a. Proper selection and use of aids require a thorough knowledge of their concepts, capabilities, and limitations. Knowledge is best attained through formal school training supplemented by on-the-job training.

b. One of the major problems encountered in employing any NAVAID is determining the accuracy of the aid and the level of accuracy of fixes developed by it. The navigator must determine the accuracy of those NAVAIDS installed in his ship because of differences in equipment installation and material condition, geographic area of the ship's operations, training procedures, and skills of the navigation team. Specific procedures for assessing the accuracy developed by selected NAVAID's are presented in this section.

2. Own Ship Data Systems. These include the gyrocompass, magnetic compass, EM log, and those units which provide DR data, such as synchro amplifiers, compass repeaters, DRAI's, DRT's, and NC2 plotters. These systems play a role in all phases of the navigation process. Any problems associated with these systems must be brought to the attention of the navigator.

a. Gyrocompass. The gyrocompass is a spin-stabilized device which provides true north data for navigation and steering purposes, and roll and pitch data for sensor and weapons systems stabilization. Typified by the Mark 9 Mod 4 units installed in most surface ships, it is extremely reliable and accurate to within 8.5 arc-minutes in the shipboard environment. This accuracy is degraded somewhat by ship and latitude corrections, and synchro data transmission systems employed to bring the bearing data to the remote compass indicators. When operating within PMS specifications, course findings at the compass repeater may be presumed accurate plus/minus one degree.

b. The Electromagnetic (EM) Log. The EM log is a water-flow sensing device which detects changes in electrical voltages. It converts and displays the ship's speed in knots and the distance traveled in nautical miles. This device measures speed through the water and not speed over the ground. No compensation is made by the EM log for current sailing factors such as set and drift, advance and transfer, or sea state. Since the EM log provides one of the prime inputs to mechanical or electronic, these sources of errors must be understood and compensated for, and are discussed below.

(1) The EM log's specified accuracy for velocity is 0.4 kt, non-maneuvering; 0.7 kt, maneuvering. Velocity errors may be induced through the synchro/servo loops transferring log data to its display device.

(2) Velocity errors from the EM log cause errors in the navigation and calculations using devices which accept EM log inputs. Position fixing or DR computations from NTDS, DRAI, NC2, or DRT will be in error to the extent that the EM log speed output to these devices varies from the true speed over ground.

(3) On ships with INS, procedures exist to check log accuracy. The EM log can also be checked by running a measured range. The accuracy of the EM log will directly affect SINS error, since EM log input damps SINS platform.

c. Dead Reckoning Analyzer Indicator. Both the DRA and DRAI are electromechanical computers which utilize heading information from the ship's gyro-compass and speed information from the EM log. The speed input, resolved into east and north velocities through use of heading data provided by the gyrocompass, is integrated with time to read distance. The DRA displays miles steamed north or south, east or west, and the total number of miles steamed. The DRAI provides the three read-outs of the DRA and read-outs of latitude and longitude. The accuracy is primarily dependent on the accuracy of the gyrocompass and EM log inputs. It is extremely

important that the navigation team check the latitude and longitude readings of the DRAI and compare them with the ship's position developed by the most recent fix, to ensure this device continues marking accurately if other systems fail. Errors exceeding one NM must be resolved.

d. DRT and NC2 Plotter. The DRT and NC2 plotter provide a graphic trace of ship's DR through the water. The DRT receives input from a DRA or DRAI. The NC2 plotter receives input from a DRAI and traces the tracks of multiple targets. This permits a constant display of target range and bearing. Target data may be manually inserted or supplied by radar or sonar sensor inputs. Different scales are available for use, depending on the tactical situation. DRT/NC2 equipment should be energized when underway with frequent checks made by the navigation team to ensure that the latitude and longitude displayed by these devices track the current estimated position. Latitude and longitude errors exceeding one NM, induced by the EM log, gyrocompass, DRA/DRAI, and the signal distribution system must be corrected. DRT/NC2 "bugs" need not be energized to maintain the latitude and longitude reading when the plotter is not in use, and may be de-energized so long as DRT/NC2 itself remains energized.

3. OMEGA. OMEGA provides continuous world-wide, all-weather navigation. It consists of eight transmitting stations, designated by letters A through H located around the globe at points selected for optimum coverage. It transmits on VLF frequencies between 10 and 14 kHz. Accuracies are specified at +1 to +2 NM CEP, but are dependent upon geographic position and environmental factors.

a. Concept. OMEGA is essentially a guided wave system. The radio wave is channeled between the earth and ionosphere. The eight stations each transmit a basic signal of 10.2 kHz for a definite duration between 0.9 and 1.2 seconds, but not all at once. They transmit in prearranged sequence, which repeats every 10 seconds to allow for a unique identification of each station. Sufficient redundancy is provided by the eight stations to permit station maintenance without the loss of global coverage. In most shipboard OMEGA equipment, the OMEGA phase difference between two stations is measured. The phase difference is proportional to the distance of receiver from the stations, yielding a hyberbolic LOP. (As with any other navigation system, a minimum of two crossing LOP's is required for a fix, and, as in visual, radar, and celestial navigation with more independent LOP's, obtained intersecting at optimum crossing angles result in more accurate fixes.) In theory, the ship should be capable of receiving a sufficient number of OMEGA stations whose LOP's present crossing angles suitable for accurate navigation.

(1) Since the wavelength for the basic frequency of 10.2 kHz is approximately 16 NM when two signals met, a phase difference is formed which will repeat twice in 16 NM on the baseline between two stations. From this phase difference, two lanes are formed, each one 8 NM wide or the baseline between transmitting stations. The OMEGA receiver counts the lanes as they are crossed and indicates a measured fraction of a lane. The receiving equipment is incapable of measuring the complete lane count. The boundaries of OMEGA's guided wave component are the Earth's surface and the ionosphere. Due to changes in the properties of the boundaries from the propagation corrections (PPC's) must be applied to the receiver readings.

b. Operation and Anomalies. Standard OMEGA receivers can receive four stations simultaneously, and will provide continuous lane counts for three station pairs. Once synchronized, the OMEGA receiver will automatically count lanes as they are crossed. Numerous factors will affect the accuracy of the OMEGA fix. A thorough understanding of these factors is essential to obtain the best navigation data. Use of the most current OMEGA user's bulletin will provide guidance for proper set-up and selection of stations. Use of the user's bulletin is mandatory if accuracy is to be achieved. Verify equipment performance by conducting the test described in figure D-1 or utilizing the OMEGA strip form as provided in the navigator's workbook (OPNAV 3530/1).

c. When fixing the ship's position with OMEGA, the navigator must:

(1) From the OMEGA charts serving the ship's intended track, select LOP's with optimum crossing angles and pre-work the PPC's for these LOP computations on a daily basis, or more often, if appropriate.

(2) Consult appropriate HYDROPAC's and the OMEGA Weekly Status Report disseminated by the U.S. Coast Guard in AIG 8980, to determine OMEGA

station status and propagation advisories in effect.

(3) Utilize the strip chart at all times, marking the lane numbers on the chart as they are crossed. Cross-check the strip chart with the lane count read-out and resolve all discrepancies between these indications to avoid undetected lane jump. A determination should be made of the cause of lane jumps. If propagation anomalies are the cause (i.e., PCA's and SID's), see item b. The OMEGA user's bulletin should be consulted if self interference is the suspected cause. In either case, the information from the station undergoing the problems should be seriously questioned or deselected.

(4) If lane jump occurs, reset the lanes.

(5) Read LOP differences from the digital read-out and evaluate these readings with strip chart data, particularly if noise or poor signals are encountered.

(6) Apply the pre-worked PPC's and plot-corrected position on the OMEGA chart.

(7) Determine latitude and longitude of the OMEGA fix and transfer this data to the navigator's plot.

d. To avoid problems with OMEGA:

(1) Be aware of the geometry or geographic relationship between the OMEGA stations in use, and the ship which determines whether the LOP's generated by the OMEGA stations intersect at right angles or are more nearly parallel.

(2) Ensure that correct LOP's are assigned at the day/night LOP changeover. Consult receiver technical manual and current OMEGA user's bulletin.

(3) Check the strip chart periodically to ensure continuity of tracking.

(4) Ensure correct geoidal height is set.

4. Navy Navigation Satellite System. NAVSAT provides accurate, all-weather, world-wide navigation information. The accuracy of this system is exceptional.

a. Concept. The navigation fix computed from data obtained by the NAVSAT receivers is based on a shift in frequency (Doppler shift) that occurs whenever the relative distance between a transmitter and receiver changes. The Doppler shift is proportional to the relative velocity between the satellite and the user.

(1) Only one satellite at a time can be used to establish position. Each satellite continuously transmits data which provides a series of hyperbolic LOP data giving the fixed and variable parameters which describe its own orbit, together with a time reference. These data are repeated every two minutes during the 10 to 17-minute pass. Four satellite tracking stations monitor the Doppler signal of the satellites as a function of time. The Naval Observatory monitors the satellite time transmission and comparison information is passed to the computing center for satellite update.

(2) The satellite used with the NAVSAT system transmits variable orbital parameters affecting the two-minute data set and fixed orbital parameters provided by the computing center. To establish a fix with NAVSAT, the shipboard receiver/processor must receive and compare data from at least three two-minute transmissions and a minimum of three Doppler points. While data comparison can begin immediately after the satellite rises above the horizon, Doppler points cannot be accepted before a minimum elevation angle of 7.5° is attained to reduce the atmospheric errors, which are largest at low elevation angles. The fix is developed and displayed and data collection continues. If the satellite elevation angle exceeds 75° during the pass, all data for that pass is rejected and no fix will be developed, since the ambiguity of the hyperbolic lines of position create large errors in the position fix.

(3) A satellite pass may occur approximately every 107 minutes, with

the frequency increasing at the higher latitudes. Due to restrictions imposed by the elevation angle limits, progressive changes in the satellite orbits, and the potential for those satellites which rise at nearly the same time to interfere with each other, usable passes may occur as much as four to six hours apart.

b. Operation and Anomalies. Shipboard equipment for satellite navigation consists of a receiver, a computer, and a display unit. Only the ship's estimated position, geoidal height, and speed are required as local inputs to the shipboard equipment. The NAVSAT navigation receivers currently deployed on surface ships differ primarily in their capability for single or dual-channel operations and the level of automation in their interface with other ship systems such as NTDS or SINS.

(1) Fix errors which can be avoided or reduced include the entry of inaccurate geoidal height and ship's speed data. Geoidal height may be drawn from the current Geoid Height Chart WOBZC7500, available from the Defense Mapping Agency. This chart provides the current reference for determining variations in the height of mean sea level.

(2) At the time a fix is developed by NAVSAT, computations are made using the ship's course and speed inputs. Accuracy of the ship's speed over the ground is critical to these calculations, since NAVSAT fix errors can typically be 0.2 NM for each knot of speed error. The effects of this error increase with satellite elevation angle and the extent to which the error is in a northerly direction. With automated log input, the amount of error in speed estimation will be a function of the effect of those error sources previously described for the EM log. When comparison of the navigator's plot data for speed made good and EM log readings indicates a significant error in log speed, manual entry of the ship's estimated speed is recommended.

(3) Some satellite navigation systems maintain a continuous display of the ship's position in latitude and longitude, based on an internal DR between fix capability. As with any other electronic or mechanical DR device, position errors from the EM log and gyro inputs accumulate with time.

(4) Since the satellite is only effective between the elevation angles of 7.5° and 75° from the receiving unit, and the number of available satellites does not permit full continuous period coverage, the navigation team must be able to predict the availability and rise times for NAVSAT satellites. These predictions can be made from data provided by the Navy Astronautics Group at Point Mugu, CA. For ships equipped with satellite navigation systems interfaced with the Model 4 NTDS program, six-hour rise time forecasts are calculated as a function of the NTDS program. This system can predict the rise times for up to six satellites, based on estimated position and data on orbital parameters acquired during the satellite pass. Six-hour forecast data can only be developed for a satellite from which a fix was derived. Other NAVSAT, such as the AN/WRN-5 or AN/SRN-9, provide satellite prediction capabilities.

(5) To fix the ship's position using NAVSAT:

(a) Consult the appropriate operating instructions manual for the equipment installed.

(b) Determine satellite rise time, ensuring that the pass elevation angle will exceed 7.5°, but not 75° (in practice 10° to 70°).

(c) Estimate and input the ship's position within 30 NM.

(d) Input geoidal height and antenna height (SRN-19 requires heights in meters), using DMA chart WOBZC7500.

(e) Periodically verify NAVSAT system performance by using the available, built-in test features of these systems.

(f) Determine the source of a discrepancy when gross differences exist between NAVSAT fixes and those developed by other means, through a rapid and comprehensive evaluation of equipment performance, system constraints, and the operational environment.

c. Prudent navigation practices consider such factors as time since last valid pass, variations between ship's true speed, the speed input to NAVSAT, etc., to avoid dependence upon potential faulty positioning data.

5. Navstar Global Positioning System (GPS). The system provides extremely accurate, instantaneous three-dimensional (position, velocity, and time) information. The GPS will comprise 18 satellites distributed on three planes of six satellites each. A ground network of stations are used to track the satellites and update the satellite data. Currently the SRN-25 integrated receiver OMEGA/transit/GPS obtains GPS satellite data and provides position, velocity, altitude, and time information. GPS is extremely accurate and will provide continuous passive world-wide navigation data coverage once all satellites are in place.

6. LORAN C. LORAN C is a method of radio navigation with typical ranges of 800 to 1200 NM. It enables a navigator to determine his ship's position from radio signals which are broadcast from stations of known position. The LORAN C system completely covers the U.S. inland waters, a large part of the northern hemisphere, and limited parts of certain overseas areas. During the day, LORAN C ground waves have a maximum range of about 1200 NM. Accuracy from the master station should be within 50 to 330 ft. The sky waves, usually obtained at night, have a maximum range of 2300 NM. Accuracy, using the sky wave, is generally within two to three NM, with corrections applied.

a. Concept. LORAN C transmitters use a base frequency of 100 kHz (in the LF band), with its stations grouped together into chains. Each chain consists of one master and up to four secondary stations (designated W' X, Y' and Z). A LORAN C chain is designated by rate, which is the repetition interval between pulse groups (e.g., a chain with rate 9930 repeats its pulse groups every 99,300 microseconds). A pair of transmitters in this system is designated by the rate and the letter of the secondary station used with the master (e.g., 9930-X would be the master and secondary station X of rate 9930).

(1) A LORAN C LOP is determined by obtaining the time difference of the arrival of signals from two stations. A LORAN fix is determined by the intersection of LOP's from two or more pairs of transmitting stations. The range of LORAN stations, the type of signal received, and the accuracy of the resulting time difference measurement are affected by the path over which the radio waves travel. The portion of the transmitted radio energy which travels from the transmitters parallel to the surface of the earth is known as the ground wave. Another portion of the transmitted radio energy travels upward and outward, encounters electrified layers of the atmosphere and is reflected, forming sky waves. LORAN C depends upon the ground wave component of its transmitted signal with corrections applied to the sky wave component for accuracy in position fixing. Sky waves, because they must travel greater distances, must be corrected to the ground wave. These special corrections to be applied to the sky wave are indicated in the LORAN C tables. Consult the equipment technical manual for further information.

b. Operation Anomalies. The most significant LORAN C anomalies are ground conductivity and station geometry which can produce nearly parallel LOP's as described for OMEGA. Because the LORAN C operates at higher frequencies and utilizes the ground wave components of its transmission, the effect of other propagation anomalies are negligible. The greatest limitation on LORAN C usage is its relatively short-range and limited coverage.

(1) Tailoring the system to the area in which it will be used is of secondary concern. The amount of communications interference in the frequency spectrum used by LORAN C varies from area to area and requires the use of special filters to minimize the effect of this interference. Additional data concerning LORAN C area coverage and transmission characteristics can be obtained from:

Commandant (G-WAN-2/73)
U.S. Coast Guard
Washington, DC 20590

7. Ship's Inertial Navigation (SINS). Inertial navigation is an improved form of dead reckoning in which velocity and position are determined through very accurate sensing of acceleration and direction. Inertial systems, used for long-range navigation, are completely self-contained, require no shore support, and are independent of weather.

a. Concept. Inertial navigators measure the total acceleration vector in a gyroscope-stabilized coordinate system. Integrating acceleration with time and applying the computed components to the initial velocities make it

possible to determine actual velocity component and distance traveled. The sensors used in inertial navigation are gyroscopes and accelerometers. These components make up the sensitive element. The gyroscopes in an inertial navigator are normally mounted on a platform, as follows:

(1) Gyro 'X' with its spin axis aligned in a north-south direction

(2) Gyro 'Z' with its spin axis perpendicular to the 'X' and 'Y' gyros.

(3) The 'X' and 'Y' gyros sense the roll and pitch of the ship, and through the use of torquing motors, keep the platform perpendicular to a line passing from the center of the platform to the center of the earth. The purpose of the 'Z' gyro is to supply heading reference data. Thus, the gyroscopes provide a stable platform and a directional reference.

(4) Two accelerometers are used to measure acceleration in the north-south and the east-west directions. The accelerations sensed by these components are integrated over time to yield velocity readings which are stored in the computer, thereby continually updating the ship's speed. Inputs in N-S and E-W components are resolved by computer to give ground speed. Ground speed and heading are continually used to update the ship's position, giving read-outs in latitude and longitude. The comparison of E-W, N-S speed vectors can provide data to compute set and drift.

b. Application and Anomalies. SINS provides continuous read-outs of latitude, longitude, and ship's heading. It provides data on roll, pitch, and velocity for weapons stabilization. It can provide information on the ship's motion, to satellite navigation equipment, and the NTDS system. Without SINS, inputs for course and speed to these systems must be drawn from the gyrocompass and EM log.

(1) The INS requires periodic reference to an external FIX source to define the inherent propagation of the machine, calculate the predicated propagation curves, and provide proper reference for INS reset. Although fix sources such as radar, LORAN, visual and OMEGA can be entered into the monitoring program, the most accurate and most desirable is SRN-25 Integrated Receiver Fixes fixes. These SRN-25 fixes, when properly entered, define the INS propagation characteristics which are then used to evaluate past and present performance, as well as predict future raw position errors.

(2) As in any other form of dead reckoning, any velocity error, however small, accumulates and, with time, contributes to positioning error. In the SINS system, a cyclical error occurring at 24-hour intervals has the greatest impact. Accordingly, SINS positioning data is subjected to internal monitoring and is periodically reset upon navigational information drawn from external sources. Once the INS errors curves have been defined using the SKOR program, the operators monitor/review the INS parameters and determine when the system should be given a reset. Resets are accomplished at a time which will maintain system performance and remain compatible with ship's operations and maintenance. When a reset is inserted into the system, several electronics adjustments are made to make the platform gyroscopes more closely reflect ship's movement, hence provide a better dead reckoning product.

(3) The overall accuracy of the carrier's SINS will vary, depending on external FIX accuracy, material and calibration status, and operator proficiency. The accuracy specifications for the system require the maintenance of several criteria in support of the aircraft maintenance, flight operations, and navigation accuracy. The overall system navigation accuracy specification is less than one NM position error in 30 hours of underway time. This accuracy is sufficient to provide 'ground truth' to the battle group during routine operations. Although it should be more accurate than a DR obtained by other means, an INS position is not a fix and prudent navigators refrain from placing confidence in the INS position to the exclusion of other aids.

8. RADAR. Radar is an electronic mean of establishing the range and bearing of land masses, surface vessels, and aircraft. While its primary purpose is detecting and tracking contacts, equally important applications are its use as an electronic aid to navigation in coastal piloting and determining the ship's relative position to other vessels of known geodetic position. Radar is a useful tool, when near land masses, to fix the ship's position and confirm fixes derived from other techniques and resources. The value of radar as a navigational aid is greatest during periods of low

visibility in hazardous or restricted waters, or where other NAVAID's are not available.

a. Operation and Anomalies. Accuracy limitations in radar navigation arise from range and bearing errors inherent in the system as a whole, and inconsistent practices on the part of personnel operating these devices. Radar accuracies usually reflect the unavoidable and uncorrectable system errors. Other correctable errors exist in radar systems. To eliminate these, the navigator should ensure that:

(1) Radar and radar repeaters are calibrated in accordance with PMS scheduling, and errors are logged and known.

(2) The bridge and CIC/CDC surface master repeaters are periodically compared with a target of known range and bearing, and that range and bearing errors are posted by each repeater.

b. To reduce errors induced in operating the radar repeaters, the navigator should ensure that members of the navigation team:

(1) Can adjust the presentation of the repeater to attain the required balance between video, sweep, cursor, strobe, and range rings for precise target identification and tracking.

(2) Are aware of the bearing and range error readings posted at the appropriate radar repeater.

(3) Are aware of the optimum portion of the presentation in which to position the targets used for navigation, to maintain them as usable piloting points.

(4) Are aware that, when taking ranges and bearings, to always approach the target from the same direction, clockwise with the bearing cursor and from the ship toward the target with the range strobe. This technique ensures errors from the repeater's mechanical counters remain constant.

(5) Are aware of the possible misinterpretation of shore line presentations. The shore line may appear some distance inland as bluffs or cliffs back of a low, flat, or sloping beach. False shore lines also make inaccurate ranges and bearings from points along the shore. Be aware of the characteristics of the area in which operating.

9. RDF. Radio direction finding techniques can be applied to navigation utilizing appropriate radio beacon stations, airport/air station transmissions, or commercial VHF broadcast transmitters of known location. The navigation team should establish the LOP's from these sources cautiously, using transmitting stations separated by more than 30°. The LOP is subject to various errors, which are a function of antenna aspect, and interference.

OMEGA NAVIGATIONAL POSITIONING TEST

1. FIX THE SHIP'S POSITION, UTILIZING A RESOURCE OTHER THAN OMEGA. PLOT THIS FIX ON THE OMEGA CHART AND DETERMINE THE SHIP'S POSITION IN THE OMEGA LANES PLOTTED ON THE CHART.

2. ENTER THE LANE COUNTS FOR THREE LOP POSITIONS INTO THE RECEIVER. AFTER THE RECEIVER HAS STABILIZED, RECORD EACH LOP READING AND, WITH THE USE OF PPC TABLES, CORRECT THE PERCENT OF LANE AND LANE COUNT, AS REQUIRED. PLOT THE DISPLAYED OMEGA POSITION AND COMPARE WITH PLOTTED DR POSITION.

LOP	#1	#2	#3
DATE			
TIME			
LANE			
% OF LANE			
CORRECTION			
CORRECTED LANE/% LANE			
OMEGA POSITION			

3. CALCULATE THE AVERAGE DIFFERENCE FROM OVER 10 PLOTS (TAKEN AT DIFFERENT TIMES DURING THE DAY).

NUMBER OF PLOTS TAKEN _____

AVERAGE DIFFERENCE (OMEGA-DR.) _____

FIGURE D-1

CHARACTERISTICS OF NAVIGATION SYSTEMS

SYSTEM	NOMENCLATURE	TYPE	OUTPUT	ACCURACIES	COVERAGE OPERATING AREA	SYSTEM CONFIGURATION	REMARKS
GPS (Global Positioning System) NAVSTAR	Under development	3-dimensional satellite ranging system; 4 satellites required for position fix and time	Position Velocity Time	+15M (SEP) +0.1 ft/sec per axis 20 nano sec between satellites	World-wide continuous All weather	3 Rings of 6 Satellites each at 11,000 NM orbits	IOC 1988
JTIDS (Joint Tactical Information Distribution System)	Hughes-AN/URQ-31 Hughes-AN/ARC-181 Singer-AN URQ-28 ITT-AN/USQ-72 AN/USQ-75	Integrated communications; 3-dimensional navigation; both relative and geo-navigational	Relative position range accuracy	100 ft rms 30 ft rms	Local area, 500NM continuous form net	Passive and active users Tri-Service.	In development. Operational Late-1980's
LORAN-C	AN/SPN-38 AN/WPN-5	L.F. pulsed, phase comparison, hyperbolic 2-dimension	Position 180 m(CEP)	¼ 1 NM	Northern hemisphere continuous 16-20 stations world-wide	3-5 stations/chain interference	No velocity data Limited by skywave
OMEGA	AN/ARN-99 AN/BRN-7 AN/SRN-12 LTN-211	VLF, phase comparison, hyperbolic 2-dimension	Position absolute differential	1-2 NM ¼ 1 NM	World-wide, continuous (90% global)	8 stations	No velocity data Subject to multipath errors
NNSS (Naval Navigation Satellite Systems)	AN/BRN-6 AN/SRN-9 AN/SRN-18	Satellite, Doppler Systems, 1 satellite required for position fix, 2-dimensions	Position	0.1 NM 200 m (CEP)	World-wide intermittent, 35-110 minutes (varies with latitude)	5 satellites	No velocity data Interval between fixes is about 90 minutes. For use in slow moving vehicles
SATNAV	AN/SRN-19		Position	0.25 NM			
TRANSIT	AN/WRN-5		Position Dual Channel	0.25 NM			
			Single channel Day 400 Hz + 150 Hz Night 400 Hz +150 Hz	0.1 NM 1.0 NM 0.05 NM 0.5 NM			

TABLE D-1, SUMMARY OF CHARACTERISTICS OF NAVIGATION SYSTEMS

CHARACTERISTICS OF NAVIGATION SYSTEMS

SYSTEM	NOMENCLATURE	TYPE	OUTPUT	ACCURACIES	COVERAGE OPERATING AREA	SYSTEM CONFIGURATION	REMARKS
TACAN (Tactical Aid to Navigation)	AN/ARN-84	L-Band phase comparison beacon transponder set	Bearing distance	+5°-3.0 +0.1-+0.25NM	Range 300 NM Line-of-sight	Receivers require signal from beacon station	No velocity data Position accuracy degraded mainly because of azimuth uncertainty. 400m (CEP)
	AN/SRN-15		Azimuth distance	+5° 125 ft	Range 35 NM Line-of-sight		
Gryo-compass	Mk-19 MOD 3A	Compass, shipboard	Heading roll pitch	5.8 min 2.9 min 2.9 min	World-wide, continuous	Self-contained	
	Mk-27	Compass, shipboard	Heading	2°			
	AN/WSN-2	Compass, shipboard	Heading roll pitch	4 min X Sec L 1.75 min 1.75 min			
INS (Inertial Navigation System	AN/WSN-5	3 Axis gyro stabilized platform recognized as a local level inertial navigator	Heading roll pitch VE, VN Vertical velocity	2 min X Sec L 1.75 min 1.75 min 0.4 kt 0.6 kt	World-wide, continuous all-weather	Self-contained Needs external inputs of present location, speed, direction	Degraded performance in polar areas.
	Mk-3 MOD 7 Mk-3 MOD 6	Inertial System, carrier	Heading pitch, roll VE, VN VT latitude longitude	60 sec 10 sec 0.2 kt 0.3 kt 0.65 NM 0.65 NM			
	AN/WSN-1	Redundant inertial system (dual mini SINS) shipboard	Position VE, VN pitch, roll Heading	1.0 NM 0.4 kt 0.3 min 2 X Sec L			

TABLE D-2, SUMMARY OF CHARACTERISTICS OF NAVIGATION SYSTEMS

CHARACTERISTICS OF NAVIGATION SYSTEMS

SYSTEM	.NOMENCLATURE	TYPE	OUTPUT	ACCURACIES	COVERAGE OPERATING AREA	SYSTEM CONFIGURATION	REMARKS
ESGN (Electrically Suspended Gyro Navigator	AN/WSN-3	Electrical suspended gyro (ESG)	Position VE, VN roll, pitch Heading	1.0 nm 0.4 kt 2 min 2 x Sec L	World-wide, continuous all-weather	Self-contained	Degraded performance in polar areas.
EM underwater log		Electro-magnetic	Speed	0.4-0.7 kt	World-wide, continuous	Self-contained	Less accurate during maneuvers.

TABLE D-3 SUMMARY OF CHARACTERISTICS OF NAVIGATION SYSTEMS

CHARACTERISTICS OF NAVIGATION SYSTEMS

SYSTEM	NOMENCLATURE	TYPE	OUTPUT	ACCURACIES	COVERAGE OPERATING AREA	SYSTEM CONFIGURATION	REMARKS
SONAR Sounding Set	AN/BQN-17	Acoustic system	Depths shallow deep	+.5-6 ft +10 fathoms or 1% of depth	World-wide, continuous	Self-contained	
	AN/UQN-1	Acoustic system	Depth fathom reading on CRT				
	AN/UQN-4	Acoustic system	Depth	10% of depth			Intended to replace AN/UQN-1
DRAI (Dead Reckoning Analyzer Indicator)	Mk-9 MOD 0	Electromechanical computer	Own ships lat, long Own ships distance (N.E.) Own ships velocity (N.E.)	1% of inputed DLONG or DLAT .5% of inputed OSDN,E .1kt+0<V<5 2% of V for 5<V<40	World-wide, continuous	Self-contained needs, input own ship's speed, own ship's course	
Set	AN/SRS-3	Passive angle measuring system	AME	4.2° 0.5 NM for AME	Line-of-sight		

TABLE D-4 SUMMARY OF CHARACTERISTICS OF NAVIGATION SYSTEMS

CHARACTERISTICS OF NAVIGATION SYSTEMS

SYSTEM	NOMENCLATURE	TYPE	OUTPUT	ACCURACIES	COVERAGE OPERATING AREA	SYSTEM CONFIGURATION	REMARKS
RADARS (Cont'd)	LN 66 HP	X-Band marine	Range Bearing	+1% of 40 yd +1%			
	AN/SPS-10/67	Medium range, high definitions, surface & air search radar bearing	Range short pulse long pulse	50 yds 275 yds <1 degree			
	AN/SPS-40	Early warning air search	Range resolution	100 yds for 1 sq meter target at 200 NM	Line-of-sight Range 200 NM	Self-contained	
	AN/SPN-43A	Air Surveillance	Range azimuth	2% + or - 2°	Line-of-sight range 50 NM		For RADNAV, set antenna elevation for minimum SEA return (1/2° to 1°)
	AN/SPS-48	Three coordinate, multiple beam, pulse S-Band radar	Range azimuth +250 yd elevation range resolution azimuth resolution elevation resolution	+250 yd 1/6° or 1/6° or +250 yd 500 yd 2° rms 2° rms	Line-of-sight range 220 NM		
	AN/SPS-49	Two dimensional air surveillance, long range	Range	+0.25 miles	Line-of-sight range 550 miles		
	AN/SPS-55	Surface search and navigation	Range short pulse long pulse Range resolution short pulse long pulse	50 yds 200 yds 75 ft 550 ft	Line-of-sight range 750 miles		

TABLE D-5 SUMMARY OF CHARACTERISTICS OF NAVIGATION SYSTEMS

APPENDIX E

QMOW WATCH TURNOVER CHECK-OFF LIST

WATCH _____
DATE _____
TIME ZONE _____

Prior to relieving the watch:

_____1. Read Night Order notebook and sign.

_____2. Review evolutions in progress and ship's intentions with OOD and QMOW.

a. Course _____

b. Speed _____

c. Time of next course/speed change _____

_____3. Note celestial bodies available and times of observation.

a. _____ d. _____

b. _____ e. _____

c. _____ f. _____

_____4. Determine status of electronic aids to navigation.

a. SATNAV up/down ETR _____

(1) Local time of next pass _____ (rise time)

(2) Satellite down

b. GPS avail _____

c. OMEGA up/down ETR _____

(1) Stations to be used for fix

---

a. Norway
b. Liberia
c. Hawaii
d. North Dakota
e. La Reunion
f. Argentina
g. Australia
h. Japan

(2) Stations down for maintenance or degraded performance

_____ETR_____ _____ETR _____

(3) Stations to be deselected

(4) Correct geoidal height _____
(for NAVSAT units)

d. LORAN C up/down ETR _____

(1) Station Rates to be used for fix

Rate

4990 Central Pacific
West Coast
7960 Gulf of Alaska
9440 U.S. West Coast
5990 Canadian
9970 Northwest Pacific
9990 North Pacific

(2) Stations down for maintenance or degraded performance

_____ETR_____ _____ETR_____

e. Mechanical Plotters

(1) DRAI up/down ETR _____

(a) Deviation from navigator's plot ___ NMI

(b) Time of last update ___

(2) DRT/NC2 up/down ETR ____

(a) Deviation from navigator's plot ____ NMI

(b) Time of last update ____

f. Other NAVAIDS

(1) NTDS DR up/down ETR ____

(a) Deviation from navigator's plot ____ NMI

(b) Time of last update ____

(2) INS up/down ETR ____

(a) Deviation from Navigator's plot _____ NMI

(b) Time of last update ____

_____5. Identify other units in company for fix comparison.

_____6. Determine wind speed _____ and direction _____.

_____7. Read barometer.

_____8. Check compass error (make sunline observations, as available).

a. Gyro _____

b. Gyro Repeater _____

c. Magnetic _____

_____9. Determine ship's position.

____10. Compare position with ship's track and DR.

____11. Determine set _____ and drift _____.

____12. Fathometer reading

____13. Call the navigator in accordance with his instructions.

____14. Relieve the watch.

_____ _____
Oncoming Signature Offgoing Signature

_____
Reviewed

File for_____ months.

Destroy on _____.

APPENDIX F

LIST OF NAVIGATION-RELATED SOURCE DOCUMENTS

1. OPNAVINST 3120.32B - Standard Organization Regulations Manual and Regulations of the U. S. Navy

a. General/Specific duties

b. Deck log

c. Magnetic compass record

d. Navigation watches

(1) QMOW

(2) Helmsman

(3) Lee Helmsman

(4) AFT Steering

2. SP-35 Glossary of Oceanographic Terms

a. Definitions of technical terms used in oceanography and allied marine sciences

b. Listing of abbreviations and acronyms

c. Listing of oceanographic institutions, agencies, activities and groups

3. Navigation Information Network Users Manual. Instructions for remote access to the Automated Notice to Mariners Systems (ANMS).

4. DMA Catalog of Maps, Charts, and Related Products

a. General information

b. Hydrographic products information

(1) Chart numbering system

(2) Portfolio designations

(3) Chart/publication correction record card system

(4) Chart correction techniques

c. Ordering procedures

d. Crisis support information and products

5. The Nautical Almanac. Used for celestial navigation

6. OPNAVINST 3100.7 (Series) - Preparing, Maintaining and Submitting the Ship's Deck Log

a. Forms preparation, assembly and disposition

b. Required ship's deck log entries

c. Sample ship's deck log entries

7. CINCPACFLTINST 3140.3 (Series) - Nautical Chart and Publication Allowances for Pacific Fleet Commands

a. Establishes minimum nautical chart and publication allowances for PACFLT naval commands (classified and unclassified).

b. Portfolio designations

8. Pub 217 - Maneuvering Board Manual

a. Glossary of terms

b. Radar and the navigation rules

c. Abbreviations

d. Fundamentals of relative motion

e. Examples of all types of maneuvering board problems

9. Notice to Mariners

a. Presents corrective information affecting:

(1) Charts

(2) Coast pilots

(3) Sailing directions

(4) Fleet guides

(5) Catalogs of charts

(6) Light lists (USCG and DMAHTL)

(7) Radio navigation aids

b. Contains examples explaining individual elements of a typical correction.

10. Pub 941 - Fleet Guide. Contains information on ports with major naval installations frequently visited by navy ships. The information includes:

a. Mission of the installation

b. Tasking of the station such as:

(1) Provide transportation services

(2) Provide communications support and services

(3) Provide port and harbor services

(4) Provide navigation aids support

(5) Provide naval control of shipping functions

(6) Provide general port services

c. Detailed navigation information such as:

(1) Approaches

(2) Geographical and topographical description

(3) Related navigational factors, including:

(a) Tides and currents

(b) Winds and weather

(c) Navigational regulations for anchorage

(d) Restricted and danger areas

(e) Electronic navigation aids available

(f) General information

11. CHART NO. 1 - Nautical Chart Symbols and Abbreviations

a. The coastline (nature of the coast)

b. Coast features

c. The land (natural features)

d. Control points

e. Units

f. Adjectives, adverbs, nouns, and other words

g. Ports and harbors

h. Topography (artificial features)

i. Buildings and structures

j. Miscellaneous stations

k. Lights

l. Buoys and beacons

m. Radio and radar stations

n. Fog signals

o. Dangers

p. Various limits, etcetera.

q. Soundings

r. Depth contours and tints

s. Quality of the bottom

t. Tides and currents

u. Compass

v. Abbreviations of principal foreign terms

Index to abbreviations

Aids to navigation in United States waters

IALA Maritime Buoyage System

12. COMDTINS M16672.2 (Series) - Navigation Rules, International and Inland. Contains information on the following:

a. Navigation rules and regulations

b. Steering and sailing rules

c. Lights and day shapes

d. Sound and light signals

13. Pub 1310 - Radar Navigation Manual. Contains information on radar navigation.

14. Pub 150 - World Port Index. Gives the location, characteristics, known facilities, and available services of ports, shipping facilities, and oil terminals throughout the world. The information includes the following:

a. Latitude and longitude of each port

b. Sailing direction number

c. Chart number

d. Size of the port

e. Type of harbor

f. Entrance restrictions

g. Overhead limitations if bridge or overhead cables exist

h. Depth information

i. Tide information

j. Pilotage information

k. Maximum size vessel that the port can accommodate

l. Whether or not a turning basin is available

15. COMDINST M16502.6 - Light List

a. Contains information on lights such as:

(1) Light list number

(2) Name and location

(3) Geographic position in latitude and longitude

(4) Light characteristics of lighted aids

(5) Height above water

(6) Nominal range of lighted aids in nautical miles

(7) Structural characteristics

b. Abbreviations

c. Glossary of aids to navigation terms

d. Radio beacon system, including:

(1) Frequency

(2) Station

(3) Characteristic

(4) Range in N.M.

(5) Latitude and longitude

16. Pub 117B - Radio Navigational Aids. Contains information on the following:

a. Radio beacons

b. Radio direction finder and radar stations

c. Radio time signals

d. Radio navigational warnings

e. Distress, emergency and safety traffic

f. Long range navigational aids (LORAN)

g. Automated Mutual - Assistance Vessel Rescue System (AMVER)

17. United States Coast Pilot. A series of nine nautical books that cover a wide variety of information important to navigators of U. S. coastal and intracoastal water and waters of the Great Lakes, such as:

a. Aids to navigation

b. Pier information

c. Hazards to navigation

d. Weather information

e. Pilotage information

f. Tides/currents

g. Anchorages

h. Navigation regulations

i. Conversion tables and distance tables

18. Pub No. 226 - Handbook of Magnetic Compass Adjustment. Presents all pertinent information regarding the practical procedures of magnetic compass adjustment.

19. Pub No. 229 - Sight Reduction Tables. A six-volume series designed to facilitate celestial navigation.

20. Dutton's Navigation and Piloting. Contains information that includes:

a. Introduction to navigation

b. The Earth and geographic coordinates

c. Compasses

d. Aids to navigation

e. Nautical charts

f. Navigational publications

g. Instruments for piloting

h. Dead reckoning

i. Tides and tide predictions

j. Currents and current predication

k. Visual piloting

l. Current sailing

m. Ship characteristics in piloting

n. Relative motion

o. The piloting team

p. Radar piloting

q. The practice of piloting

r. Navigational astronomy

s. Introduction to celestial navigation

t. Identification of celestial bodies

u. The Marine Sextant: Its use, adjustment and corrections

v. Time

w. Almanacs; celestial phenomena

x. Sight reduction methods

y. Celestial lines of position

z. The complete celestial solution

aa. Latitude and longitude observations

bb. Compass checks at sea

cc. The practice of celestial navigation

dd. The sailings

ee. Fundamentals of radio-navigation

ff. Basic radio-navigation systems

gg. Omega navigation system

hh. Satellite navigation

ii. Inertial navigation

jj. Bathymetric navigation

kk. Doppler navigation

ll. Navigational computers

mm. Lifeboat navigation

nn. Polar navigation

oo. Ship weather routing

pp. Abbreviations

qq. Symbols

Standards of precision and accuracy; mathematical rules

rr. The metric system

ss. Conversion table for feet, fathoms, and meters

tt. The use of electronic calculators and computers in navigation

21. The American Practical Navigator (BOWDITCH)

a. Volume I contains information that includes:

(1) History of navigation

(2) Basic definitions

(3) Chart projections

(4) Visual and audible aids to navigation

(5) The nautical chart

(6) Instruments for piloting and dead reckoning

(7) Compass error

(8) Dead reckoning

(9) The sailings

(10) Piloting

(11) Use of sextant in piloting

(12) Tide and current predictions

(13) Sailing directions and light lists

(14) Navigational astronomy

(15) Instruments for celestial navigation

(16) Sextant altitude corrections

(17) Lines of position from celestial observations

(18) Time

(19) The almanac

(20) Sight reduction

(21) Comparison of various methods of sight reduction

(22) Identification of celestial bodies

(23) The practice of marine navigation

(24) Ship weather routing

(25) Polar navigation

(26) Lifeboat navigation

(27) Navigational safety

(28) Oceanic soundings and hydrographic reports

(29) Position reporting systems

(30) The oceans

(31) Tides and tidal currents

(32) Ocean currents

(33) Ocean waves

(34) Breakers and surf

(35) Sound in the sea

(36) Ice in the sea

(37) Weather observation

(38) Weather elements

(39) Tropical cyclones

(40) Radio waves

(41) Radio direction finding

(42) Radar navigation

(43) Radio-navigation systems

(44) Satellite navigation

(45) Doppler sonar navigation

(46) Introduction to inertial navigation

(47) Abbreviations

(48) Greek alphabet

(49) Symbols

(50) Miscellaneous data

(51) Navigation coordinates

(52) Extracts from nautical almanac

(53) Extracts from air almanac

(54) Long-term almanac

(55) Identification of navigational stars

(56) Navigational stars and planets

(57) Constellations

(58) Extracts from tide tables

(59) Extracts from tidal current tables

(60) Extracts from Pub No. 214

(61) Extracts from Pub No. 229

(62) Extracts from Pub No. 249

(63) Navigational errors

(64) Loran-A

(65) Charts and publications of other agencies

(66) Hand-held digital calculators

(67) Underwater log calibration guidelines

(68) Beaufort wind scale

(69) Sea state

(70) Geodesy for the navigator

(71) Buoyage systems

(72) Extracts from Chart No. 1

b. Volume II contains information that includes:

(1) Conversion angle

(2) Conversion of compass points to degrees

(3) Traverse table

(4) Table of offsets

(5) Meridional parts

(6) Length of a degree of latitude and longitude

(7) Distance of an object by two bearings

(8) Distance of the horizon

(9) Distanced by vertical angle measured between sea horizon and top of object beyond sea horizon

(10) Direction and speed of true wind in units of ship's speed

(11) Correction of barometer reading for height above sea level

(12) Correction of barometer reading for gravity

(13) Correction of barometer reading for temperature

(14) Conversion table for millibars, inches of mercury, and millimeters of mercury

(15) Conversion table for thermometer scales

(16) Relative humidity

(17) Dew point

(18) Speed table for measured mile

(19) Speed, time and distance

(20) Conversion table for nautical and statute miles

(21) Conversion table for meters, feet, and fathoms

(22) Dip of the sea short of the horizon

(23) Altitude correction for air temperature

(24) Altitude correction for atmospheric pressure

(25) Meridian angle and altitude of a body on the prime vertical circle

(26) Latitude and longitude factors

(27) Amplitudes

(28) Correction of amplitude as observed on the visible horizon

(29) Altitude factor

(30) Change of altitude in given time from meridian transit

(31) Natural trigonometric functions

(32) Logarithms of numbers

(33) Logarithms of trigonometric functions

(34) Haversines

(35) The ageton method

(36) Time zones, zone descriptions, and suffixes

(37) Natural and numerical chart scales

(38) Compact traverse table

(39) Distance by vertical angle measured between waterline at object and sea horizon beyond object

(40) Geographic range

(41) Distance by vertical angle measured between waterline and object and top of object

(42) Mathematics

(43) Interpolation

(44) Compass conversions

(45) Conversion angle

(46) Distance calculations

(47) Time measurements and conversions

(48) Calculations of celestial navigation

(49) Sextant altitude corrections

(50) Sight reduction

(51) The sailings

(52) Tide and current predictions

(53) Predicted visual ranges of lights