MG-402

Handbook for APOLLO INSTRUMENTATION SHIPS

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MG-402

HANDBOOK
FOR
APOLLO INSTRUMENTATION SHIPS

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Figure 1-1. Apollo Instrumentation Ships (Artist's Conception)

July 2008 Publication Note

The Handbook for Apollo Instrumentation Ships, MG-402, was prepared for shipboard Flight Controllers and technical personnel for their use. It describes the two different classes of Apollo ships to familiarize personnel with the ship's configuration. The original document was provided by Ed Fendell, Apollo Flight Controller.

This PDF version was produced by Bill Wood. The original pages were scanned with an Epson Expression 10000XL, using Silverfast AI Studio, to produce high quality 400 pixel per inch, 48-bit images, for further processing. Each page image was straightened and cleaned up in Photoshop CS3 prior to producing 300 pixel-per-inch EPS page images. Adobe Acrobat 9 Professional was used to prepare the final PDF edition. The document is made searchable by using Adobe ClearScan.

Bill Wood was a Unified S-Band Lead Engineer at the Goldstone Apollo MSFN station during the lunar missions. Ed Fendell was the Head, Apollo Communications Sections, Flight Control Operations Branch at JSC during most of the Apollo missions. Both are now retired in Barstow, California and Houston, Texas, USA.

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SECTION I
GENERAL DESCRIPTION

INTRODUCTION

The Manned Space Flight Network (MSFN), originally implemented to support Project Mercury, and subsequently, Project Gemini, is now equipped to support the requirements of Project Apollo.

The network consists primarily of stations in the United States and six foreign countries. These stations are geographically situated to provide the most efficient coverage between the latitudes of approximately 35° North and 35° South, where most of the spacecraft orbits are contained.

In support of Project Apollo, five instrumentation ships have been added to the network: three 19-Class, consisting of T-AGM-19, 20, 21 Apollo Instrumentation Ships (AIS) for earth orbital insertion and translunar injection; and two 6-Class, consisting of T-AGM-6, 7 AIS for the reentry phase of the Apollo mission.

PURPOSE OF THE HANDBOOK

This handbook has been prepared to acquaint the shipboard Flight Controllers and technical personnel with their mission, responsibilities, and the facilities available for their use. For some personnel, this may be the first experience aboard a ship. This handbook will help familiarize them with their surroundings, facilities, duties, and naval terminology. This handbook has been prepared for the National Aeronautics and Space Administration (NASA) (GSFC/ISO) by the Bendix Field Engineering Corporation, a subsidiary of The Bendix Corporation, under contract NAS5-9870, and reissued under contract NAS5-10750.

SHIPS' PURPOSE

The ships have been instrumented and deployed for optimum coverage of the Apollo mission in areas not supported by land stations. These mobile tracking and communication platforms provide the mission with the flexibility required to support all phases from launch to recovery. Figure 1-1 is an artist's conception of both classes of ships as they might appear at sea in support of a mission.

19-CLASS

The flight of the Apollo spacecraft from lift-off to insertion into an earth orbit is programed to a launch azimuth which varies as a function of launch delay from the start of the launch window. This fan of possible launch trajectories is monitored by the Bermuda station in the North and by the Antigua station in the South. Optimum data coverage of launch and insertion has a gap in the middle which is filled by an instrumentation ship.

The Apollo spacecraft is injected into its translunar trajectory after a brief period in earth orbit. Injection may take place over the Atlantic, Indian, or Pacific Oceans, so the Apollo network data coverage is supplemented by three instrumentation ships.

NASA requires as many as 30 days on-station time in support of Project Apollo. When not supporting Project Apollo, the ships are assigned to other space programs requiring data acquisition not supported by land-based stations.

6-CLASS

The declination of the moon determines whether a landing area in the Northern Hemisphere or Southern Hemisphere is affected. Once the landing area has been determined, the two reentry ships are assigned their positions in the landing area.

Another factor affecting the spacecraft landing area is the manner in which reentry into the earth's atmosphere is accomplished. The spacecraft may reenter directly in a minimum lift trajectory or it may reenter via a skipout trajectory. Downrange and crossrange travels from the initial point of entry into the atmosphere as a function of the spacecraft's reentry angle and bank angle are: downrange travel: 1,000 to 5,000 nautical miles, and crossrange travel: ± 250 to ± 500 nautical miles.

The ships assigned to the reentry area are concerned with the blackout areas occurring along the reentry track due to transfer of spacecraft kinetic energy into heat. These areas are of importance for proper choice of position for the reentry ship along the ground track of the spacecraft to permit data acquisition with the spacecraft during the early phase of possible skipout The selection of reentry ship position is not the most favorable one for a particular trajectory, but rather for a family of possible trajectories within the spacecraft's reentry capability.

SHIPS' PERSONNEL

The marine crews are Military Sea Transport Service personnel. The technical personnel are Department of Defense (DOD) contractor engineers and technicians. These personnel are assigned aboard ship for a cruise length determined by their agency. The Flight Controllers are assigned by NASA for the individual Apollo missions, and their assignments are determined by mission duration. They normally experience a 5-week tour aboard ship.

REPORTING ABOARD

Personnel reporting aboard are met at the quarterdeck by one of the ship's officers. He directs them to the Ships Operations Manager's (SOM's) office where they are assigned staterooms. In each stateroom are billet cards bearing each man's name, stateroom number, work area assignment, and various emergency station assignments.

19-CLASS

The three 19-Class ships are the USNS Vanguard, USNS Redstone, and USNS Mercury. Each ship carries a NASA station designation as follows: the Vanguard (VAN), the Redstone (RED), and the Mercury (MER). Each ship is manned by 17 officers, 71 crew members, and 122 technical personnel including the NASA Flight Controllers.

6-CLASS

The two 6-Class ships are the USNS Watertown (WTN) and the USNS Huntsville (HTV). Each ship has a complement of 14 officers, 56 crewmen, and 72 technical personnel including the NASA Flight Controllers.

SHIP'S SUPPORT PLANS

The ship's support plan is finalized 3 days before DOD missions or more than 30 days before Apollo missions. At this time, the ship starts instrumentation setup and calibration. Such operational details as meterology, equipment warmup and

checkout times, and recorder operating times are documented for each mission in countdown format. The SOM coordinates all subsystem activities and reports status to the Range. Final calibrations and checks are in mission configuration. Subsystems (telemetry, radar, etc.) are calibrated first and checked individually, then the complete instrumentation system is checked as an integrated data-gathering station.

Whenever possible, all checks are computer controlled and/or monitored to provide controllable conditions and to obtain quick confirmation of equipment status. Ship status is monitored through daily status reports required by Range or Apollo Network Control.

SYSTEM TESTS

Before scheduling operations, a series of shipboard electronic systems tests are performed. These tests include, but are not limited to, any or all of the following:

a. Subsystem Test (SST)—to verify station equipment on a module or subsystem level

b. System Test (ST)—to verify station equipment on a system level

c. Integrated System Test (IST)—to verify interfaced station equipments

d. Station Readiness Test (SRT)—to verify station's overall capability to support a mission

e. Dynamic Operations Test (DOT)—to test station equipment in conjunction with the NASA test aircraft

f. Computation and Data Flow Integrated Subsystem Test (CADFISS)—to determine the operational readiness of the MSFN to furnish tracking and data acquisition support for a mission

The ships also participate in network drills and simulations while functioning as part of the NASA MSFN. Flight Controller teams are normally placed aboard 2 or 3 weeks prior to a mission. This time is devoted to system testing and maintenance, telemetry and display system calibration and alignment, and Flight Controller local and network exercises. Network drills and tests are used to evaluate communications and data flow paths from operational areas.

This premission period also allows for completion of bathymetric bottom-mapping operations. A bottom area near the ship's desired location (or locations, if ships are required to move during the mission) is selected on the basis of depth profile. The area(s) is then mapped, and depth matrices computed. This data is used during tracking periods to provide precise information on the ship's position.

During premission and mission periods, the ships are in radio contact with the Network Control Center. At a specified time, the ships establish mission support communications with other Range stations and report "on-station, ready to support."

TARGET ACQUISITION

Telemetary systems are expected to acquire the target first. If the target is not acquired by this system, the Designate Controller uses the computer's inflight acquisition information to direct the antennas. All required systems are placed "on track" to collect and transmit tracking and telemetry data and to display and retransmit acquired data.

POST-MISSION OPERATIONS

After mission termination, the ships perform required post-mission calibrations. The SOM completes and sends to the

Range a "quick look" report, which includes general system performance and track times.

Copies of magnetic tape recordings are made. In the case of vehicle malfunctions, some telemetry data playback may be required to investigate specific channels. All original magnetic tape recordings, chart recordings, logs, charts, and other data are packed in special containers for security and protection. Data collected during the Apollo mission is processed and forwarded in accordance with Operations Directive 63-1 (as revised).

After completion of mission support, HF communications, timing, and navigation are maintained. When released, the ship reverts to control of the Range scheduling authority for sailing orders and operating instructions.

SHIPS' PERFORMANCE PARAMETERS

Both classes of ships have been modified from noncommissioned U.S. Navy ships. The 19-Class has undergone extensive structural modification, while the 6-Class structural modifications have been less severe. In both cases, the modifications have converted these ships from their previous tanker configuration and Victory ship configuration into fully instrumented, mobile, space-tracking platforms. Provisions have been made for officers' quarters, crew's quarters, and adequate, comfortable staterooms for the technical personnel and Flight Controllers.

The main deck area and above has been converted into several antenna platforms. Internally, space has been provided for all the various system equipment. Areas for storage of both marine spares and electronic spares are located throughout the ships. These ships have been equipped with both conventional and sophisticated navigation systems for pinpoint position accuracy.

The ships have provisions for emergency underway replenishment of fuel, foodstuffs, and other supplies. Both ships are air conditioned in all manned and instrumented spaces.

Distilling equipment to provide fresh water, a roll stabilization system to decrease motions, a recirculating distilled water cooling system for electronic equipment, an emergency generator set, an internal communication system, and related equipment are also on board.

19-CLASS

The 19-Class modification consists of joining a T-2 tanker bow and stern section to a new, larger midsection (figure 1-2) to permit adequate space for instrumentation systems, support equipment, storage, and personnel.

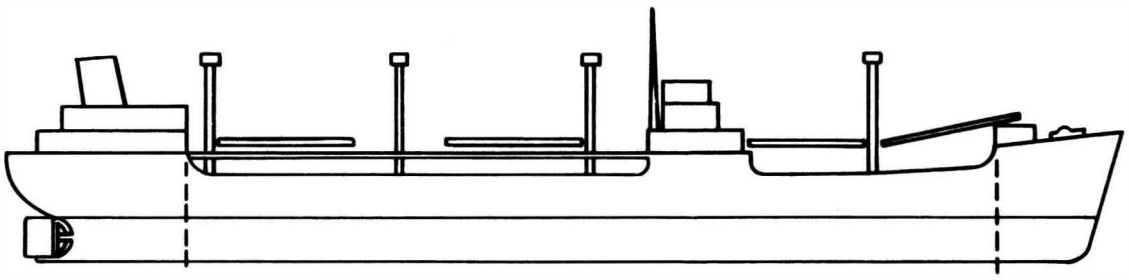
The 19-Class leading particulars are as follows:

- overall length .....595 feet, 5 inches
- extreme beam .....75 feet
- full load draft .....25 feet
- full load displacement .....23,310 tons
- tracking speed .....13 knots
- standard speed .....15 knots
- flank speed .....17 knots
- shaft horsepower 10,000
- shaft rpm 106
- potable water capacity .....360 tons
- fuel oil capacity .....3,724 tons
- maximum "on-station" endurance .....20,150 total nautical miles

6-CLASS

The 6-Class are former Victory ships that have undergone conversion to provide

Existing T-2 Tanker



Modified Instrumentation Ship

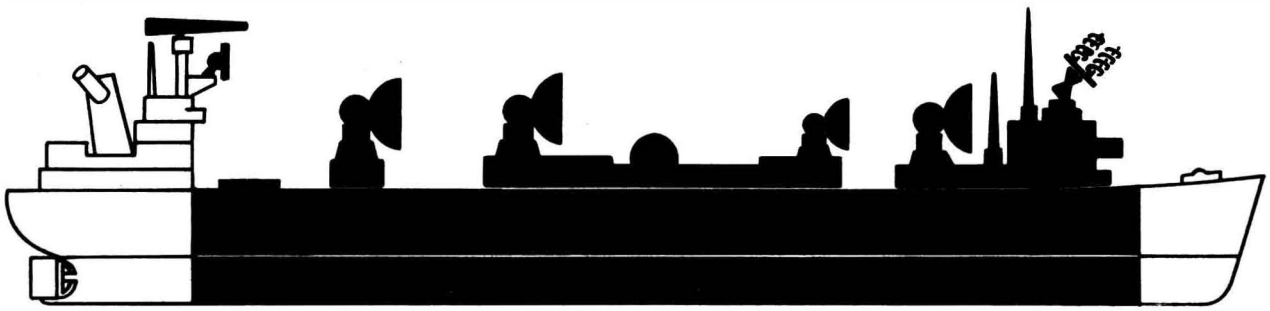


Figure 1-2. T-AGM-19 Class Hull Modification

support for the reentry phase of the Apollo moon flight.

The 6-Class leading particulars are as follows:

- overall length .....455 feet, 3 inches
- extreme beam .....62 feet
- full load draft .....23 feet, 7¼ inches
- full load displacement .....12,199 tons
- tracking speed .....13 knots
- standard speed .....15 knots
- flank speed .....16.5 knots
- shaft horsepower 6,000
- shaft rpm 92
- potable water capacity .....168 tons
- fuel oil capacity .....2,645 tons
- maximum "on-station" endurance .....10,000 total nautical miles

BRIDGE

A typical bridge configuration is shown in figure 1-3. The controls located on the bridge consist of the wheel, engine-order telegraph, compass, and hooded radar displays.

ENGINE ROOM

A typical engine room control panel is illustrated in figure 1-4. In addition to this control panel, the engine room contains the main propulsion plant and evaporators for fresh water treatment along with other equipment concerning prime functions aboard ship.

INSTRUMENTATION MACHINE SHOP

A typical instrumentation machine shop layout of equipment is shown in figure 1-5. The instrumentation machine shop performs a most important function underway. Each instrumentation machine shop is equipped to handle all at-sea instrumentation repairs and fabrication projects. This machine shop is for the use of technical personnel only. The ship has a separate machine shop for non-instrumentation use.

POWER GENERATION

The main electrical generating equipment consists of steam-turbine-driven, motor-driven, and diesel-driven generators to supply 60-Hz and 400-Hz power. The 19-class power generation requirements are as follows:

- motor-driven generator, 120 vdc, 50 kw—2
- steam-turbine-driven generator, 60 Hz, 1250 kw—4
- steam-turbine-driven generator, 60 Hz, 400 kw—2
- diesel-driven generator, emergency, 60 Hz, 100 kw—1
- motor-driven generator, 400 Hz, 10 kw —6
- motor-driven generator, 400 Hz, 5 kw —2
- motor-driven generator, 60 Hz, 5 kw —2
- steam-turbine-driven generator, 3610 v, 7650 kw (propulsion)—1

The 6-class power generation requirements are as follows:

- steam-turbine-driven generator, 60 Hz, 750 kw—3
- diesel-driven generator, emergency, 60 Hz, 100 kw—1
- motor-driven generator, 400 Hz, 10 kw—5
- motor-driven generator, 60 Hz, 5 kw —2
- motor-driven generator, 450, 30/230 vdc, 150 kw—1
- motor-driven generator, 400 Hz, 100 kw—1

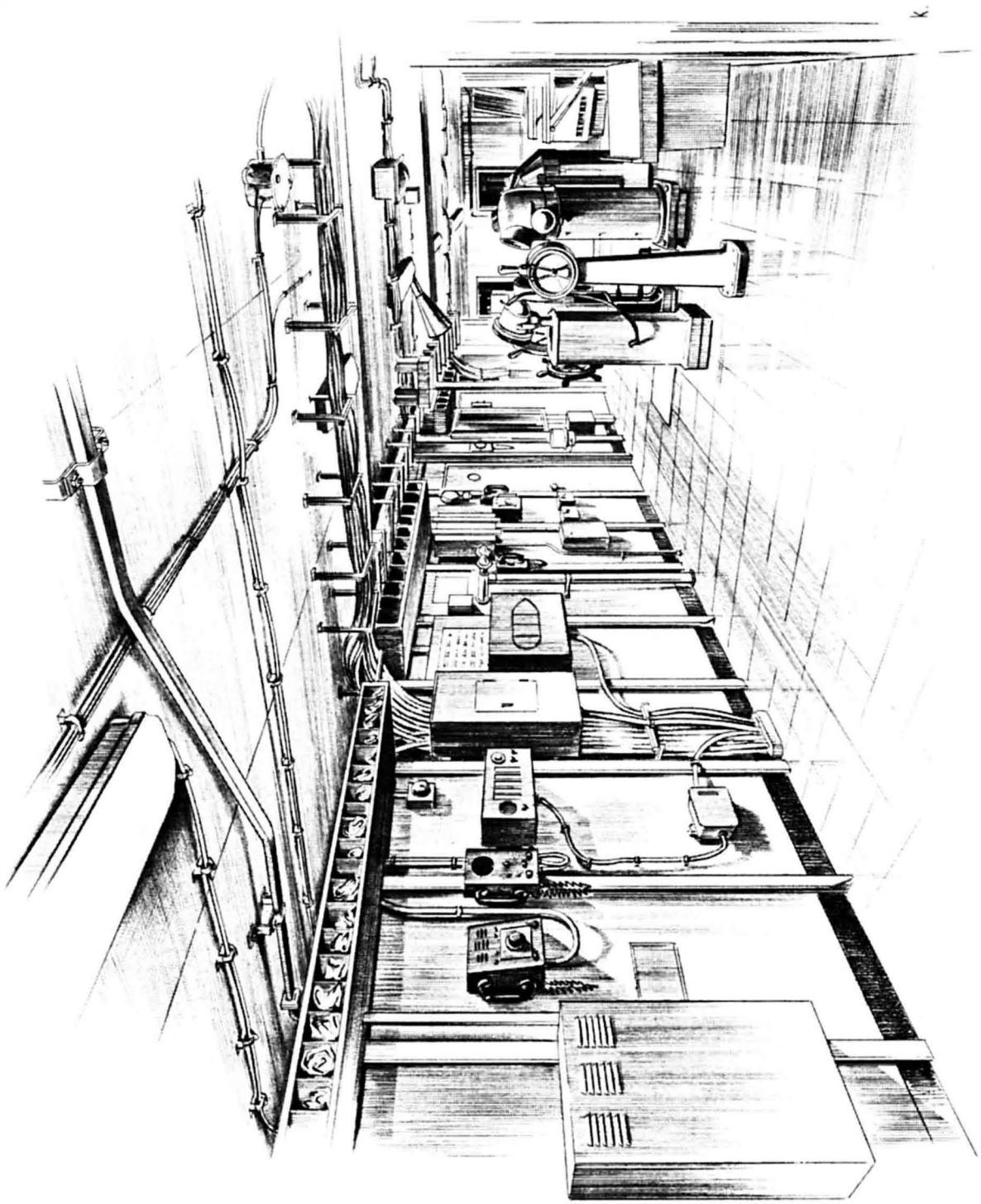


Figure 1-3. Typical Bridge

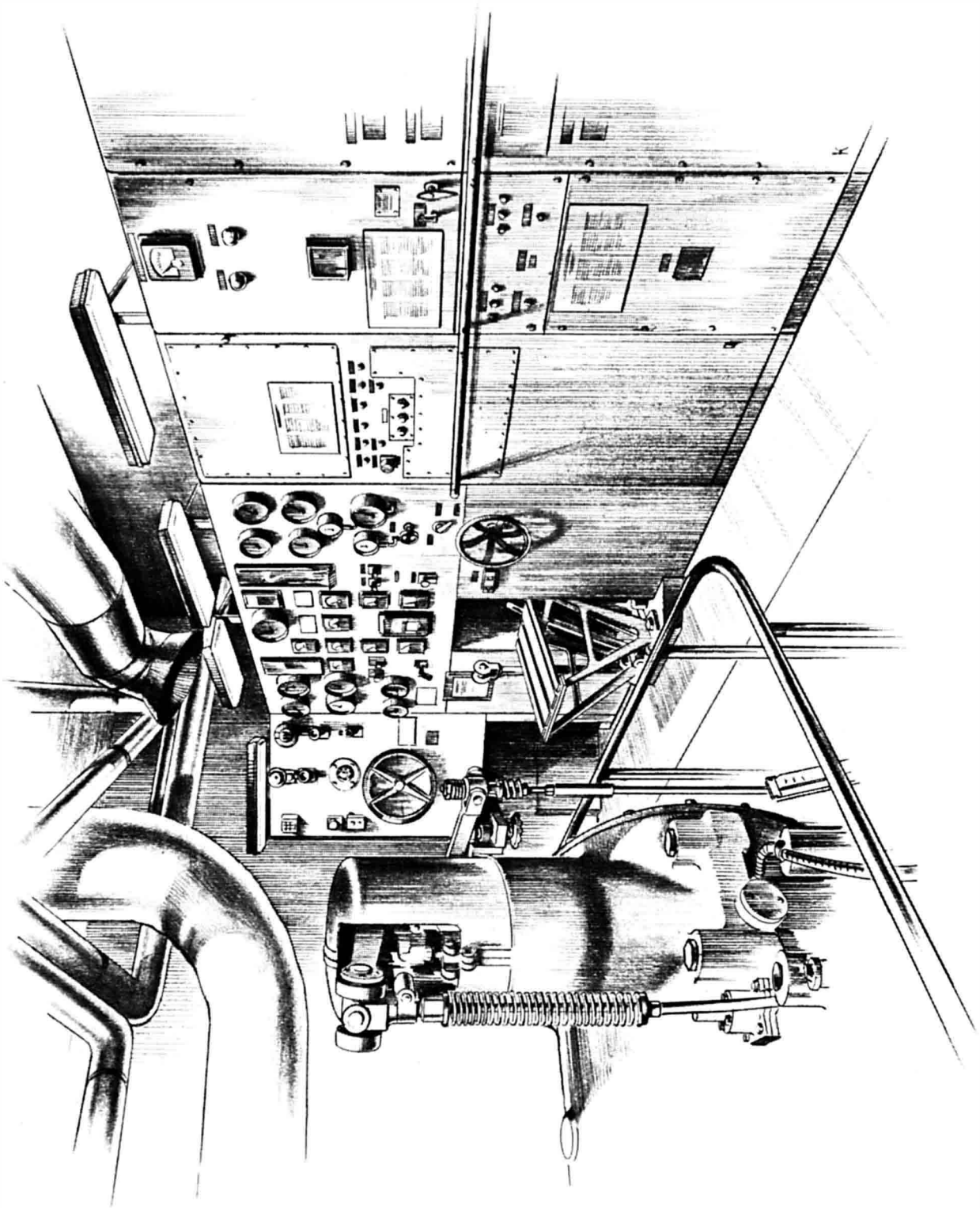


Figure 1-4. Engine Room Controls

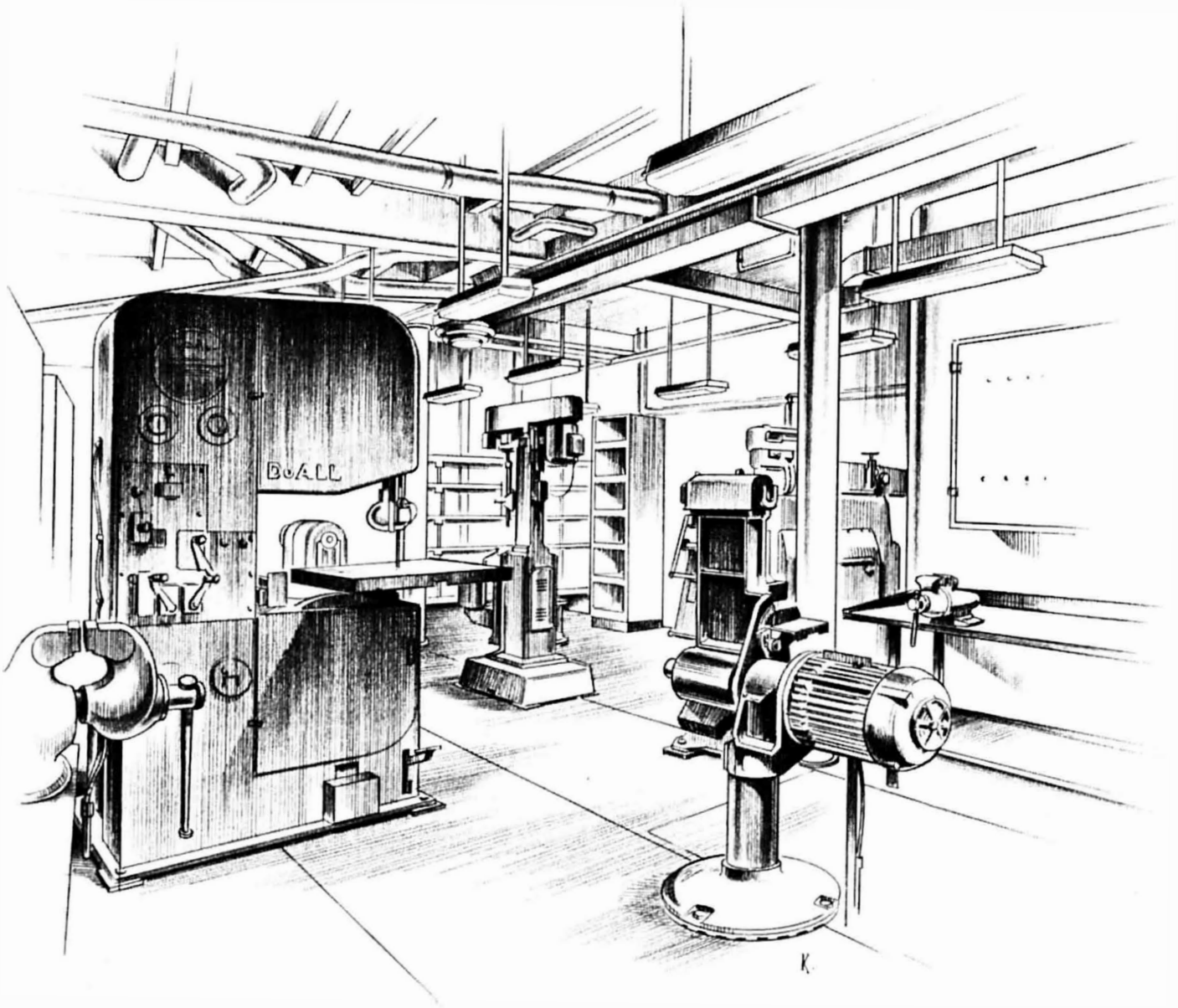


Figure 1-5. Typical Machine Shop

DURATION OF CRUISE

The 19-Class and the 6-Class are programed for sea duty periods up to 60 days. Port time for provisioning, refueling, and shore leave is short, but the ships do remain in port during periods between support assignments whenever possible.

A 24-hour-notice sailing condition is observed during these periods. The ports are selected to reduce sailing time from station to port, and return, to a minimum.

POSITIONING

The Ship's Position and Attitude Measurement System (SPAMS) furnishes the necessary ship position and attitude data to enable the Central Data Processor to convert C-band radar and unified S-band tracking data outputs from deck-referenced to earth-referenced coordinates. Additional details of the system are in section II of this handbook.

SHIP'S COMMUNICATIONS

The T-AGM-6 and T-AGM-19 Class AIS are equipped with an Instrumentation Communications System and a Ship's Radio System.

The primary function of the instrumentation system is communications support during missions. The system is also used to support the daily nonmission instrumentation operations, such as instrumentation system checkout, handling administrative traffic and range schedules, supply requisitions, emergency messages, etc.

The Ship's Radio System conforms with international maritime regulations for the safety of ships at sea and is used to support the ship's maritime operational requirements including ship-to-ship and ship-to-shore radiotelephone and CW (Morse code).

Interior communications aboardship link all instrumentation and operations managers with Systems Control. The ship's telephones are used for nonoperational communications. When in port, the ship uses a cable connecting the ship's telephone system with the shore telephone system.

SHIPS' LAYOUT

The Apollo Instrumentation Ships have the necessary facilities for creating a comfortable atmosphere while underway; it is imperative that every man lend his personal support to the ship's well-being. The Flight Controllers and technicians have semiprivate living quarters with flush and showering facilities; this area is their responsibility and must be treated as such. However, stewards are provided for making beds and cleaning the quarters.

19-CLASS

The ship's layout is illustrated in figure 1-6, which shows the general areas of interest and concern to the Flight Controllers. A self-service laundry is provided with washers, driers, and ironing facilities; other facilities include a commissary, hospital, library, machine shop, offices, etc. A more complete listing can be found in table 1-1.

Starting aft on the main deck and working forward, the ship's antenna systems are as illustrated in figure 1-6. The superstructure is aft of midship on the main deck and houses the following:

01 Level

a. Balloon Inflation Room . . 01-19-0
b. Clean Linen Locker 01-41-1
c. Fan Room No. 3 01-43-1
d. Embarkation Ladder . . . Starboard aft

02 Level

a. Chief Engineer's Office. .02-47-1
b. Fan Room No. 2.....02-43-3
c. Battery Room 02-43-5

03 Level

a. Master's Office 03-47-4
b. Gyro Room 03-45-0
c. Fan Room No. 1 03-47-1
d. Clean Linen Locker.....03-43-1

04 Level

a. Chart Room 04-45-4
b. Radio Room 04-45-1
c. Wheelhouse.....04-47-0

The second deck houses the crew's quarters, the technician's quarters, and most of the ship's domestic services. Figure 1-7 illustrates a typical stateroom.

The Technicians' Messroom is also on the second deck (2-104-0) and seats 56 men. Figure 1-8 illustrates a typical messroom arrangement.

The third deck houses most of the instrumentation and range equipment as illustrated in the deck cutaway, figure 1-6, and in the equipment location illustrations in section II.

Table 1-1. 19-Class Compartment Location Directory

COMPARTMENT	LOCATION
Aft Paint Mixing and Issue Room	1-25-2
Amplifier Room	3-107-3
Athletic Gear Locker	4-177-2
Auxiliary Engine Room	5-25-0
Auxiliary Steering Station	01-209-0
Balloon Inflation Room	01-19-0
Barber Shop	2-54-2
Battery Locker	1-121-2
Battery Room	02-43-5
Boiler Room	3-31-0
Boiler Water Test Room	3-19-3
Bosun's Storerooms	2-9-2
	2-209-4
	2-218-1
	2-222-1
Bridge Toilet	04-45-2
Briefing Room	3-152-1
C-Band Radar Room	3-173-0
Carpenter Shop	2-218-2
Carpenter Storeroom	2-222-2
Chain Locker	3-222-0
Chart Room	04-45-4
Chief Engineer's Office	02-47-1
Chief Steward's Office	1-39-2
Clean Linen Lockers	0-41-1
	0-45-1
	2-47-4
	2-50-1
	2-119-2
	2-173-3
	2-173-6
Communications and Timing Center	3-137-1
Command Control Room	3-193-0
Communications Transmitter Room	3-77-1
Crew's Baggage Room	3-54-0

Table 1-1. 19-Class Compartment Location Directory (Cont.)

COMPARTMENT	LOCATION
Crew's Laundry Room	2-32-1
Crew's Lounge	2-17-0
Crew's Mess	2-107-4
Crew's Pantry	2-86-2
Crypto Room	3-143-5
Damage Control Locker No. 1	2-203-1
Damage Control Locker No. 3	2-43-0
Darkroom	2-176-2
Data Processing Room	4-143-1
Deck Gear Lockers	01-38-2
	1-123-1
	1-209-0
Deck Stores	2-214-0
Dumbwaiter	5-120-1
Electrical Shop	2-17-2
Electronics Shop	4-119-2
Electronics Storeroom	5-143-0
Electronics Test and Calibration Lab	4-113-2
Electronic Test Equipment Storeroom	4-131-4
Emergency Generator Room	1-19-1
Engine Room	5-45-0
Engineering Workshop	3-19-1
Examining Room	1-45-1
Fathometer Trunk	5-149-2
Film Room	2-191-4
Filter Cleaning Shop	2-209-3
Finishing Room	2-185-6
Forward Paint Locker	2-203-2
Galley	2-89-0
Garbage Disposal Room	2-82-2
General Workshop (Technicians)	3-193-2
Generator Room	3-47-0
Gyro Room	03-45-0
Handtruck Stowage	1-123-2
Helium Bottle Storeroom	1-19-2
Hobby Shop	3-77-2
Hospital	1-47-3
Isolation Ward	1-37-1
Master's Office	03-47-4
Motion Picture Locker	2-146-2
Navigation Data Room	1-137-0
Navigation Room	1-137-0
Navigation Storeroom	04-41-2
Officers' Baggage Room	2-25-2
Officers' Laundry	1-35-2
Officers' Lounge	2-107-5
Officers' Mess Room	2-96-1
Officers' Pantry	2-85-1
Operation Control Center	3-143-2
Physical Training Room	4-193-0
Processing Room	2-181-2
Programmer's Office	4-113-1
Public Toilet No. 1	2-179-1
Public Toilet No. 2	2-170-2
Public Toilet No. 3	2-149-4
Public Toilet No. 4	2-114-3
Public Toilet No. 5	2-74-1

Table 1-1. 19-Class Compartment Location Directory (Cont.)

COMPARTMENT	LOCATION
Purser's Office	01-45-2
Radio Room	04-45-1
Registered Publications Strongroom	3-180-1
Scullery	2-89-2
Ship's Laundry	2-17-1
Ship's Store	2-82-1
Soiled Linen Lockers	2-47-3
	2-139-1
	2-119-4
	2-149-1
Star Tracker FDN	1-127-0
Tech Baggage Room	2-209-0
Tech Laundry	2-191-2
Tech Library	3-180-3
Tech Lounge	2-198-1
Tech Mess Room	2-104-0
Tech Offices	3-126-1
	3-165-3
	3-173-3
	3-173-5
Tech Pantry	2-90-1
Telemetry Room	3-107-1
Tool Issue Room	3-177-2
Unified S-Band System Room	3-103-1
Washdown Equipment Room	1-105-1
Welding Shop	3-177-4
Wheelhouse	04-47-0
Workshop	1-127-1

6-CLASS

Starting aft on the main deck and working forward, the ship's antenna systems are as illustrated in figure 1-9.

The superstructure is at midship on the main deck, and houses the following:

01 Level

a. Emergency Generator Room 0198-0
b. Officers' Lounge 01-81-1
c. Officers' Laundry 01-88-1
d. Fan Room 01-97-1
e. Balloon Inflation Room ..01-131-0
f. Balloon Launching Platform .....aft

02 Level

a. Radio Room 02-93-2
b. Gyro Room 02-92-0
c. Battery Locker 02-92-1
d. Fan Room 02-91-1

03 Level

a. Master's Office 03-76-2

04 Level

a. Wheelhouse 04-76-2
b. Chart Room 04-79-1
c. Navigation Storeroom 04-81-1

The second deck houses most of the instrumentation and range equipment as illustrated in the deck cutaway, figure 1-9, and in the equipment location illustration in section II.

The Technicians' Messroom is on the first deck (1-103-01); it seats 44 men. Figure 1-8 illustrates a typical messroom arrangement.

Table 1-2 is a compartment location directory listing each major area in alphabetical order.

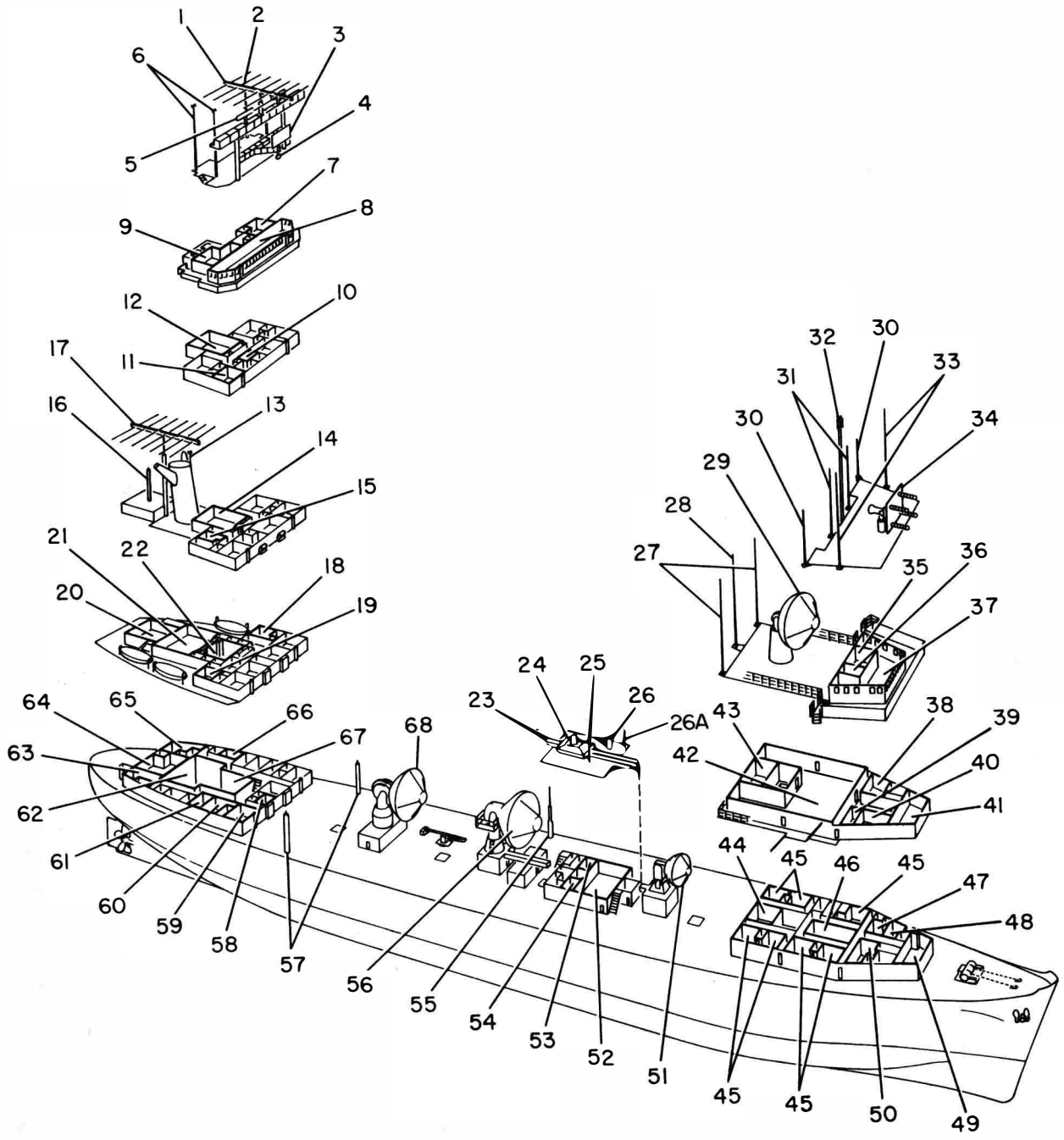


Figure 1-6. T-AGM-19 Class AIS, Facilities Illustration (Sheet 1 of 2)

LEGEND FOR T-AGM-19 CLASS AIS (FIGURE 1-6, SHEET 1)

1. HF LOG PERIODIC ANTENNA (KING POST)
2. LORAN WHIP ANTENNA
3. LOW-GAIN TELEMETRY ANTENNA
4. DIRECTION FINDER ANTENNA
5. NAVIGATION RADAR
6. SHIP'S COMMUNICATIONS WHIP ANTENNAS
7. CHART ROOM
8. WHEELHOUSE
9. RADIO ROOM
10. GYRO ROOM
11. FAN ROOM
12. GENERATOR ROOM HATCH
13. TELEVISION ANTENNA
14. GENERATOR ROOM HATCH
15. FAN ROOM
16. HF FOLDED MONOPOLE (HAIRPIN) ANTENNA (BALLOON DECK)
17. HF LOG PERIODIC ANTENNA (BALLOON DECK)
18. PURSER'S OFFICE
19. FAN ROOM
20. BALLOON INFLATION ROOM
21. BOILER CASING
22. GENERATOR ROOM HATCH
23. OPTICAL TUNNEL
24. STAR TRACKER ENCLOSURE
25. WHIP ANTENNA
26. OPTICAL DIRECTOR

26A. SRN 9 ANTENNA

27. COMMUNICATIONS WHIP ANTENNA
28. LORAN WHIP ANTENNA
29. SATCOM ANTENNA
30. HF COMMUNICATIONS RECEIVING WHIP ANTENNA (20 FT)
31. HF COMMUNICATIONS RECEIVING WHIP ANTENNA (25 FT)
32. DIRECTION FINDER ANTENNA
33. HF COMMUNICATIONS RECEIVING WHIP ANTENNA (35 FT)
34. RF COMMAND QUAD HELIX ANTENNA
35. CHART ROOM
36. NAVIGATION STOREROOM
37. BRIDGE
38. FIRST OFFICER'S STATEROOM
39. FAN ROOM
40. MASTER'S OFFICE
41. MASTER'S STATEROOM
42. SATCOM EQUIPMENT ROOM
43. AMPLIDYNE ROOM
44. FAN ROOM
45. TECHNICIANS' STATEROOMS
46. FAN ROOM
47. THIRD OFFICER'S STATEROOM
48. FOURTH OFFICER'S STATEROOM
49. ELECTRONICS SPARE PARTS STOREROOM
50. SECOND OFFICER'S STATEROOM
51. C-BAND RADAR ANTENNA
52. NAVIGATION ROOM
53. NAVIGATION DATA ROOM
54. WORKSHOP
55. TELEMETRY TRANSMITTER ANTENNA BEACON
56. UNIFIED S-BAND SYSTEM ANTENNA
57. HF FOLDED MONOPOLE (HAIRPIN) ANTENNA (PORT AND STARBOARD)
58. MEDICAL STOREROOM
59. SICKBAY
60. EXAMINING ROOM
61. ISOLATION WARD
62. BOILER CASING
63. EMERGENCY GENERATOR ROOM
64. METEOROLOGICAL ROOM
65. HELIUM BOTTLE STOREROOM
66. FAN ROOM
67. GENERATOR ROOM HATCH
68. MEDIUM GAIN TELEMETRY ANTENNA

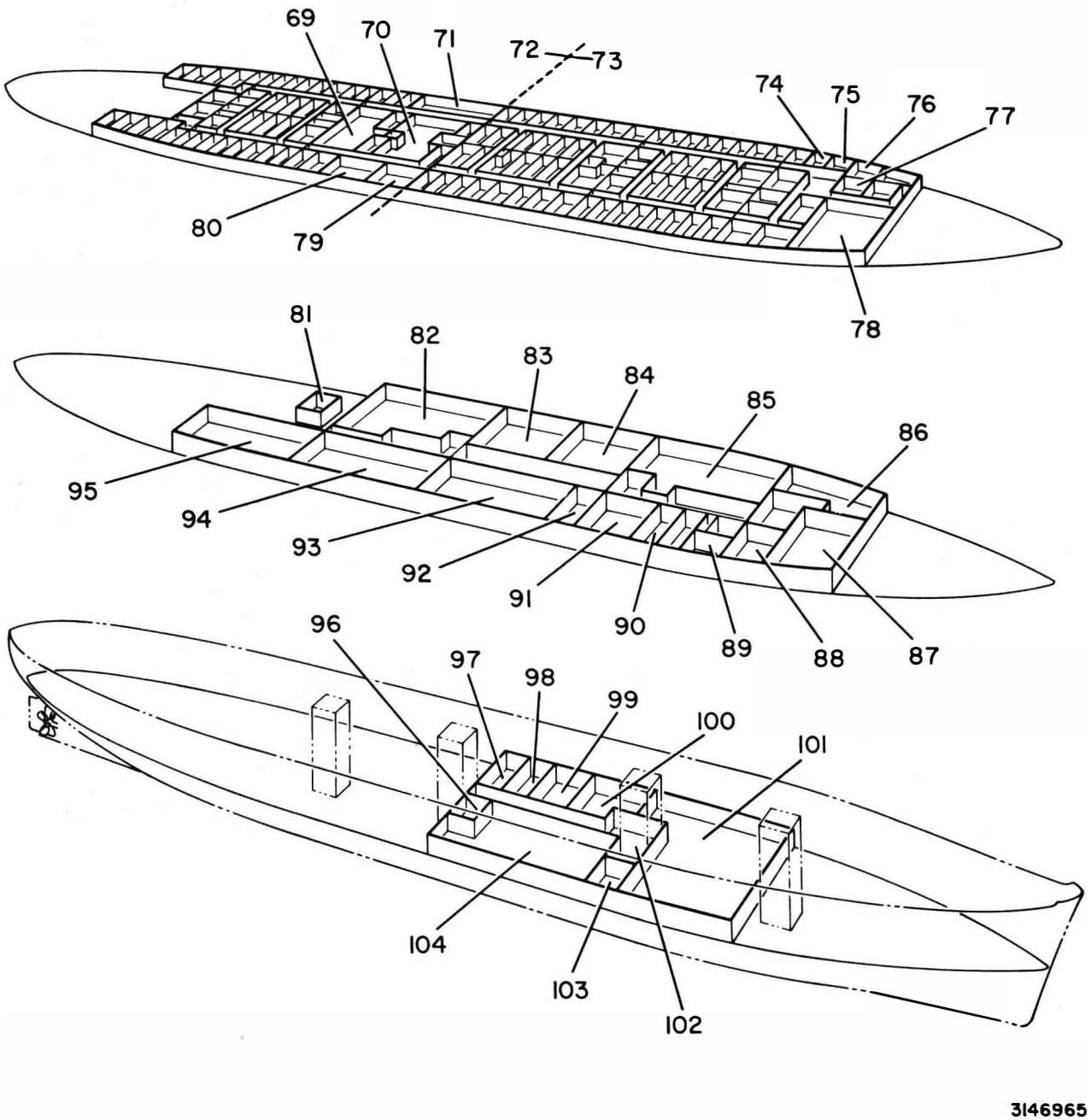


Figure 1-6. T-AGM-19 Class AIS, Facilities Illustration (Sheet 2 of 2)

LEGEND FOR T-AGM-19 CLASS AIS (FIGURE 1-6, SHEET 2)

69. GALLEY
70. TECHNICIANS' MESSROOM
71. CREW'S MESSROOM
72. CREW'S QUARTERS
73. TECHNICIAN'S QUARTERS
74. PROCESSING ROOM
75. FINISHING ROOM
76. FILM VIEWING AND EDITING ROOM
77. TECHNICIANS' LAUNDRY
78. TECHNICIANS' LOUNGE
79. OFFICERS' LOUNGE
80. OFFICERS' MESSROOM
81. AIR DATA PICKUP KIT STOREROOM
82. TELEMETRY ROOM
83. MISSION CONTROL CENTER
84. OPERATION CONTROL CENTER
85. C-BAND RADAR ROOM
86. TECHNICIANS' WORKSHOP
87. COMMAND CONTROL ROOM
88. TECHNICAL LIBRARY
89. TECHNICAL OFFICE
90. INSTRUMENTATION (RESERVED)
91. BRIEFING ROOM
92. CRYPTOGRAPHY ROOM
93. COMMUNICATIONS AND TIMING CENTER
94. UNIFIED S-BAND ROOM
95. COMMUNICATIONS TRANSMITTER ROOM
96. TECHNICAL OFFICE
97. ELECTRONIC TEST AND CALIBRATION LABORATORY
98. ELECTRONICS SHOP
99. TEST EQUIPMENT STOREROOM
100. ELECTRONICS STOREROOM
101. INSTRUMENTATION (RESERVED)
102. SYNCHRO EQUIPMENT ROOM
103. MOTOR GENERATOR AND AMPLIDYNE ROOM
104. DATA PROCESSING ROOM

Figure 1-7. Typical Stateroom

Figure 1-8. Typical Messroom

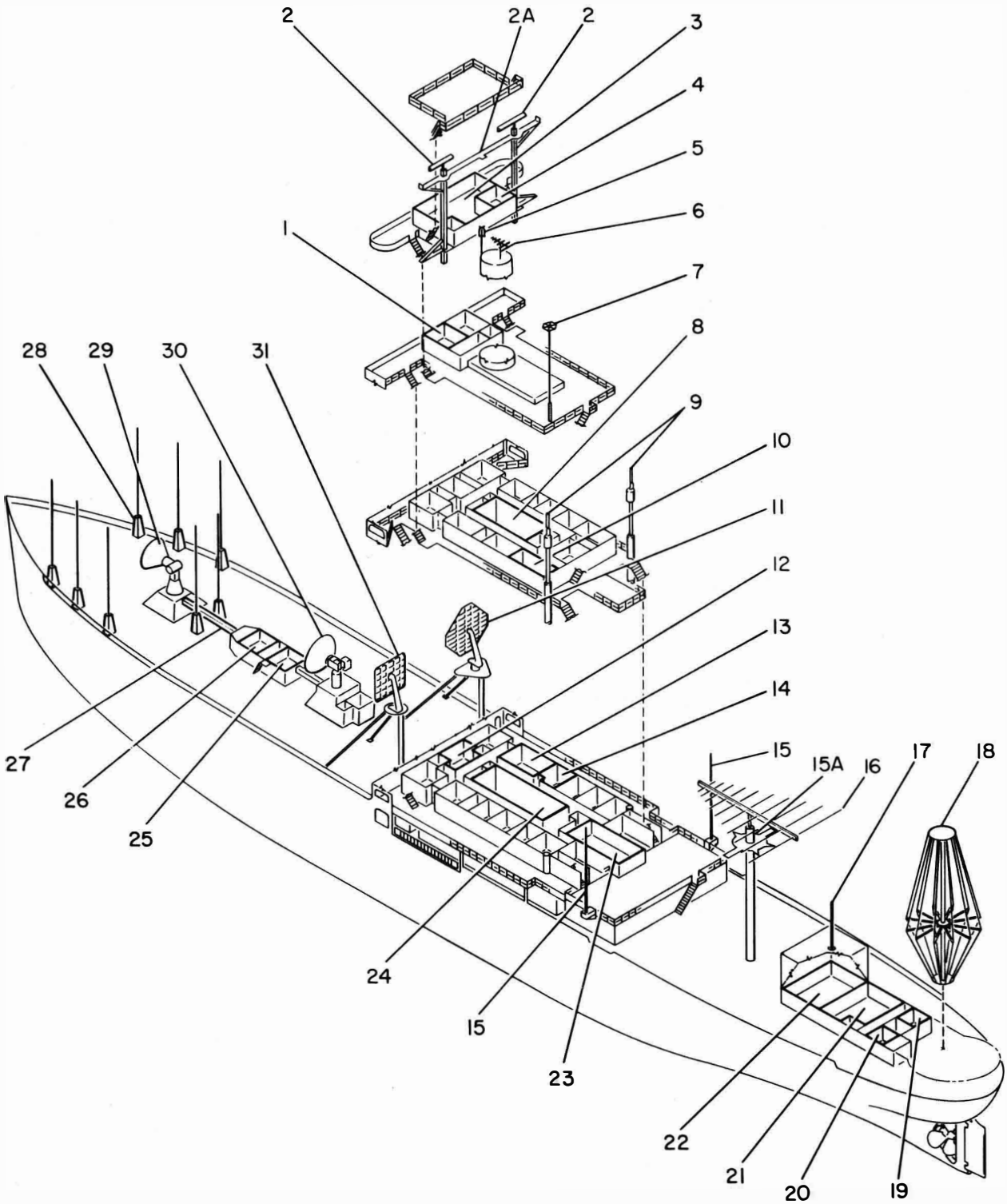


 Figure 1-9. T-AGM-6 Class AIS, Facilities Illustration (Sheet 1 of 2)

LEGEND FOR T-AGM-6 CLASS AIS (FIGURE 1-9, SHEET 1)

1. MASTER'S OFFICE
2. S-BAND SURFACE SEARCH ANTENNAS
2A. SRN 9 ANTENNA
3. WHEELHOUSE
4. CHART ROOM
5. DIRECTION FINDER ANTENNA
6. LOG PERIODIC VHF TV ANTENNA
7. HF VERTICAL ANTENNA (SHIP'S RADIO)
8. MACHINERY ROOM
9. OMNIDIRECTIONAL UHF COMMUNICATIONS T/R ANTENNA
10. RADIO ROOM
11. TELEMETRY ANTENNA
12. ENGINEERING OFFICE
13. OFFICER'S LOUNGE
14. OFFICER'S LAUNDRY
15. HF RECEIVE AND TRANSMIT (SHIP'S RADIO)
15A. 3 UHF AND 2 VHF DIPOLE ANTENNAS
16. HF COMMUNICATIONS LOG PERIODIC ANTENNA
17. HF HELICAL ANTENNA
18. HF COMMUNICATIONS CONICAL-MONOPULSE ANTENNA
19. HOBBY SHOP
20. FILTER CLEANING SHOP
21. METEOROLOGICAL ROOM
22. BOTTLE STOREROOM
23. EMERGENCY GENERATOR ROOM
24. MACHINERY ROOM
25. FAN ROOM
26. NAVIGATION CENTER
27. OPTICAL TUNNEL
28. HF RECEIVING WHIP ANTENNAS (INSTRUMENTATION)
29. UNIFIED S-BAND ANTENNA
30. C-BAND TRACKER ANTENNA
31. UHF STEERABLE ANTENNA

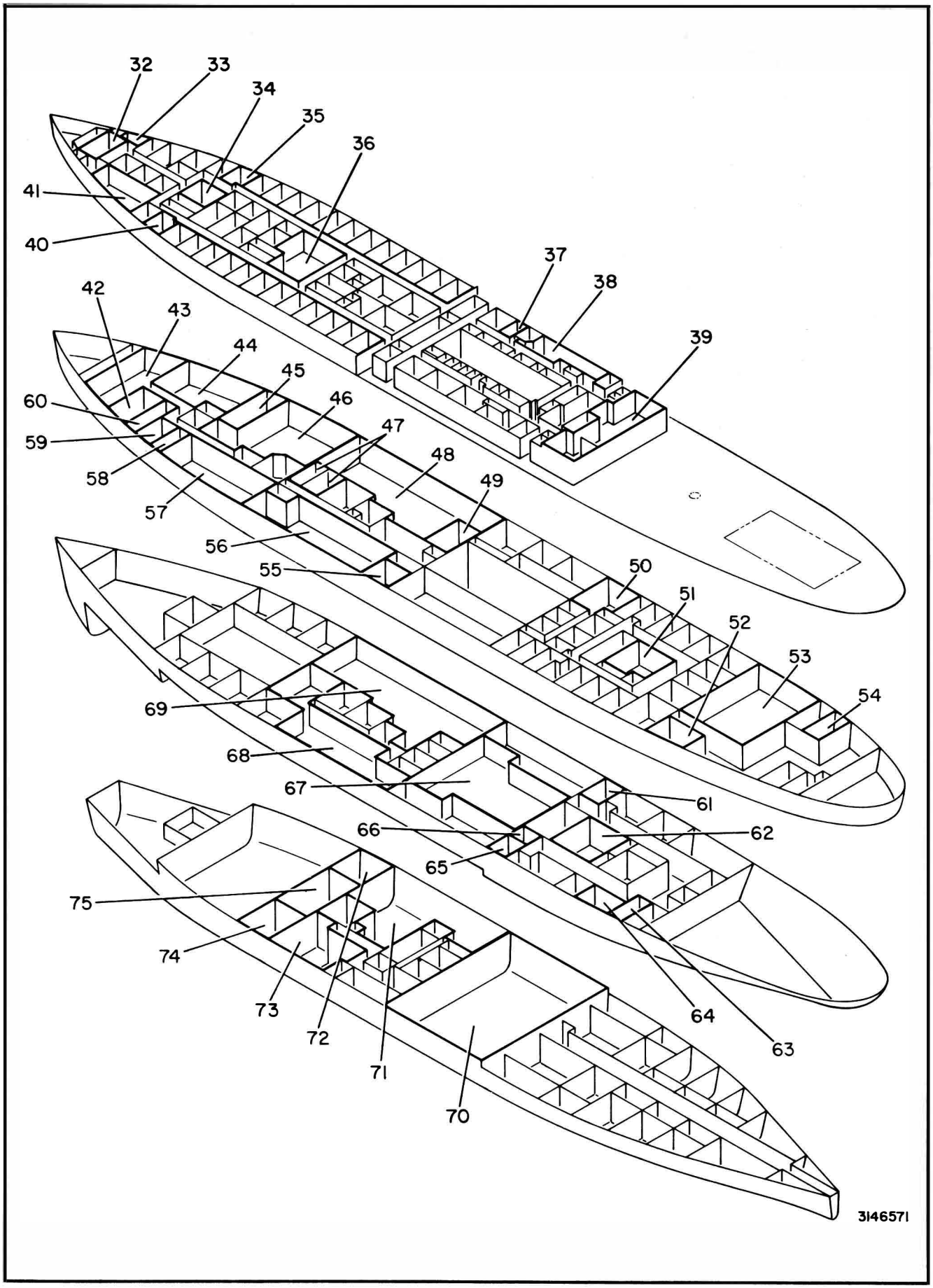


Figure 1-9. T-AGM-6 Class AIS, Facilities Illustration (Sheet 2 of 2)

LEGEND FOR T-AGM-6 CLASS AIS (FIGURE 1-9, SHEET 2)

32. M.G. ROOM (S-BAND)
33. TECHNICAL BAGGAGE ROOM
34. TECHNICIANS' LAUNDRY
35. TECHNICIANS' STATEROOMS
36. NAVIGATION CENTER
37. PURSER'S OFFICE
38. CREW'S MESSROOM
39. TECHNICIANS' MESSROOM
40. TECHNICIANS' STATEROOMS
41. TECHNICIANS' LOUNGE
42. FILM EDITING AND VIEWING ROOM
43. ELECTRONIC STOREROOM
44. TECHNICIANS' LIBRARY AND BRIEFING ROOM
45. UNIFIED S-BAND SYSTEM AMP ROOM
46. UNIFIED S-BAND SYSTEM ROOM
47. TECHNICAL OFFICE
48. TELEMETRY ROOM
49. SYNCHRO ROOM
50. CREW'S LOUNGE
51. HOSPITAL (SICKBAY)
52. CREW'S LAUNDRY
53. COMMUNICATIONS TRANSMITTER ROOM
54. BARBER SHOP
55. CRYPTO ROOM
56. COMMUNICATIONS AND TIMING CENTER
57. OPERATIONS CONTROL CENTER
58. DARKROOM
59. PROCESSING ROOM
60. FINISHING ROOM
61. CREW'S BAGGAGE ROOM
62. MACHINE SHOP
63. WELDING SHOP
64. ELECTRICAL SHOP
65. TECHNICIANS' BAGGAGE ROOM
66. OFFICERS' BAGGAGE ROOM
67. MACHINERY SPACE
68. C-BAND RADAR ROOM
69. DATA PROCESSING ROOM
70. MACHINERY SPACE
71. ELECTRONICS STOREROOM
72. ELECTRONICS STOREROOM
73. GENERAL WORKSHOP
74. ELECTRONICS SHOP
75. ELECTRONICS TEST AND CALIBRATION SHOP

Table 1-2. 6-Class Compartment Location Directory

COMPARTMENT	LOCATION
Aft Peak Tank	5-147-0
Balloon Inflation Room	01-131-0
Barber Shop	2-136-1
Bosun's Storerooms	1-8-0
	1-121-1
	1-121-2
	2-8-0
Butcher Shop	2-84-1
C-Band Radar Room	3-52-0
Capstan Machinery Room	2-150-2
Carpenter Shop	2-155-2
Chain Locker	2-11-0
Chart Room	04-79-1
Chief Steward's Office	1-101-1
Clean Linen Lockers	2-119-2
	2-141-2
CO_2 Stowage Room	2-95-0
Communications and Timing Center	2-52-6
Communications Transmitter Room	2-122-0
CPO Baggage Room	3-119-0
Crew's Baggage Room	3-95-1
Crew's Messroom	1-84-3
Crew's Laundry	2-122-4
Crew's Lounge	2-95-3
Crew's Pantry	1-97-1
Crew's Showers	2-102-1
	2-118-1
Crypto Room	2-73-4
Dairy	2-87-1
Damage Control Locker	1-81-1
Darkroom	2-34-2
Data Processing Room	3-52-1
Dry Provisions Storerooms	3-104-1
	3-110-1
Dumbwaiter	4-63-2
Electrical Locker	2-147-4
Electrical Shop	3-110-2
Electrical Storeroom	3-106-2
Electronics Shop	4-52-2
Electronics Storerooms (Ship's)	3-119-2
	4-58-1
Electronics Storeroom Office	4-52-1
Electronics T/E Stowage	4-73-1
Electronics Test and Calibration	4-52-0
Engineering Office	01-76-0
Engineer's Stores	2-78-3
	3-119-1
Film Viewing and Editing Room	2-21-4
Filter Cleaning Shop	1-143-2

Table 1-2. 6-Class Compartment Location Directory (Cont.)

COMPARTMENT	LOCATION
Finishing Room	2-27-2
Fish Locker	2-84-5
Forward Ballast	3-122-0
Fruit and Vegetable Locker	2-78-3
Galley	1-97-0
General Workshop (Technicians')	4-58-2
Generator Room (Emergency)	01-98-0
Gyro Room	02-92-0
Handling Room	2-84-1
Helium Bottle Storeroom	1-131-0
Hobby Shop	1-143-1
Hospital	2-109-0
Linen Locker	1-92-1
Machinery Casing	4-78-0
Meat Locker	2-89-1
Medical Locker	2-109-2
Meteorological Room	1-137-0
Motor Generator (S-Band)	1-14-0
Motor Generator Room	4-70-2
Navigation Center	1-46-01
Officers' and Technicians' Pantry	1-103-0
Officers' Baggage Room	3-95-2
Officers' Messroom	1-103-1
Officers' Laundry	01-88-1
Officers' Lounge	01-18-1
Operations Control Center	2-37-4
Paint Stores	2-147-1
Paint Lockers	2-147-5
	2-155-1
Processing Room	2-30-2
Public Toilets	2-73-0
	1-143-2
	1-58-1
Purser's Office	1-82-1
Radio Room (Ship)	02-93-2
Registered Publications Strongroom	2-33-1
Rodmeter Enclosure	5-52-1
Rope Locker	2-158-1
Scullery	1-96-1
Ship's Store Storeroom	3-106-0
Ship's Laundry	2-141-1
Ship's Store	2-95-2
Soiled Linen Lockers	2-117-2
	2-144-2
Star Track FND	1-46-0
Steering Gear Room	2-147-0
Stewards' Locker	1-92-2
Stewards' Storeroom	3-99-1
Synchro Room	2-74-1

Table 1-2. 6-Class Compartment Location Directory (Cont.)

COMPARTMENT	LOCATION
Technical Library and Briefing Room	2-21-1
Technicians' Baggage Rooms	1-16-1 3-95-4
Technicians' Laundry	1-31-0
Technicians' Lounge	1-20-2
Technicians' Messroom	1-103-1
Technicians' Office	2-55-0
Telemetry Room	2-52-1
Unified S-Band System Amp Room	2-37-1
Unified S-Band System Room	2-37-0
Ward	2-106-1
Welding Shop	3-116-2
Wheelhouse	04-76-0

INTERNAL TELEPHONE SYSTEM

The following instructions are for operating the internal communications equipment on board the AIS.

PABX INSTRUCTIONS

- Dial Tone: continuous, high-pitched tone
- Busy Tone: high-pitched tone, twice every second
- Ring Tone: high-pitched tone, 1 second on, 4 seconds off
- To Dial Shipboard Station:
  Dial 3-digit number assigned to required station.
- To Call Shipboard Operator (when turret is manned):
  Dial 'O'.
- To Call Ashore (when ship-shore cable is connected):
  Dial '9' to access shore exchange. Check directory for local operating instruction.
- Incoming Calls from Shore Exchange:
  All calls of this type will be routed via attendant or special night station.
- Transfer of Incoming Calls:
  To transfer an incoming call either from regular or night connection station, proceed as follows:
  a. Ask incoming party to wait.
  b. Dial digit '1' and wait for dial tone.
  c. Dial required station number.
  d. When station answers, announce the call and hang up.
- Consultation on Incoming Call:
  a. Proceed through items a, b, and c of transfer procedure.
  b. After consultation with station, request other station to hang up; outside call will be reconnected.

Note

During transfer or consultation, outside party is held and is not able to hear any conversation. Outgoing calls cannot be transferred.

- Special Instructions:

Emergency	Dial 299
Medical	(Hospital)
Fire at Sea	Dial 200 (Wheelhouse)
Fire in Port	Dial 288 (Quarterdeck)

LIVING QUARTERS

All the normal hotel facilities are included on board for personnel comfort and convenience. Included in the following paragraphs are descriptions of the individual facilities which provide hotel-type comfort.

STATEROOMS

A typical stateroom (figure 1-7) contains two berths, two secretary bureaus with chairs, and two wardrobes. Bookracks and complete semiprivate lavatory facilities are included on the 19-Class.

TECHNICIANS' LOUNGE

The technicians' lounge is large and comfortable. It is equipped with tables and chairs for card games, lounge chairs for reading, magazine racks, bulletin board, and bookcases (figure 1-10). Movie and television facilities are also available.

TECHNICIANS' MESSROOM

The technicians' messroom seats approximately 56 men at the tables. It has two double serving tables and a drinking fountain (figure 1-8). The galley is between the technicians' messroom and the crew's messroom.

SHIP'S STORE

The ship's store has sales counters, display cases, and stock shelves. Most personal at-sea needs may be purchased in the ship's store. For example, cigarettes, pipe tobacco, razor blades, shirts, underwear, and khaki and denim trousers are all stocked by the store.

PHYSICAL TRAINING ROOM

The physical training room is well equipped with card tables and chairs, exercise mats, ping pong tables, a horse and horse mat, punching bag, and weights. Additional miscellaneous equipment is planned for the physical training room.

TECHNICIANS' LAUNDRY

The laundry facilities have three washers, three dryers, and ironing equipment.

BARBER SHOP

The barber shop is modern and well equipped. There is a chair, sterilizer, and the necessary cabinets and mirrors mounted on the bulkhead. Figure 1-11 shows the barber shop.

MEDICAL FACILITIES

Above average seagoing medical facilities are found on board. A hospital with bunks and clothes lockers; an examining room with excellent supplies and capabilities; an isolation ward with bunks, clothing stowage and secretary bureau; and an isolation bath along with a ward bath are provided. The medical facility is staffed by a U. S. Navy medical corpsman. Figure 1-12 illustrates a typical hospital.

Note

No dental facilities are assigned to these ships.

TECHNICAL LIBRARY

The technical library contains tables, chairs, various files, a microfilm reader and printer, and the technical library unit. Figure 1-13 illustrates a typical library. Aboard the 6-Class, the library also serves as a briefing room; the 19-Class has a separate briefing room.

ENTERTAINMENT

Movies are shown at certain times in the lounge. Television is available when the ship is near enough to land. Entertainment antennas are on board, and radios may be used in the staterooms.

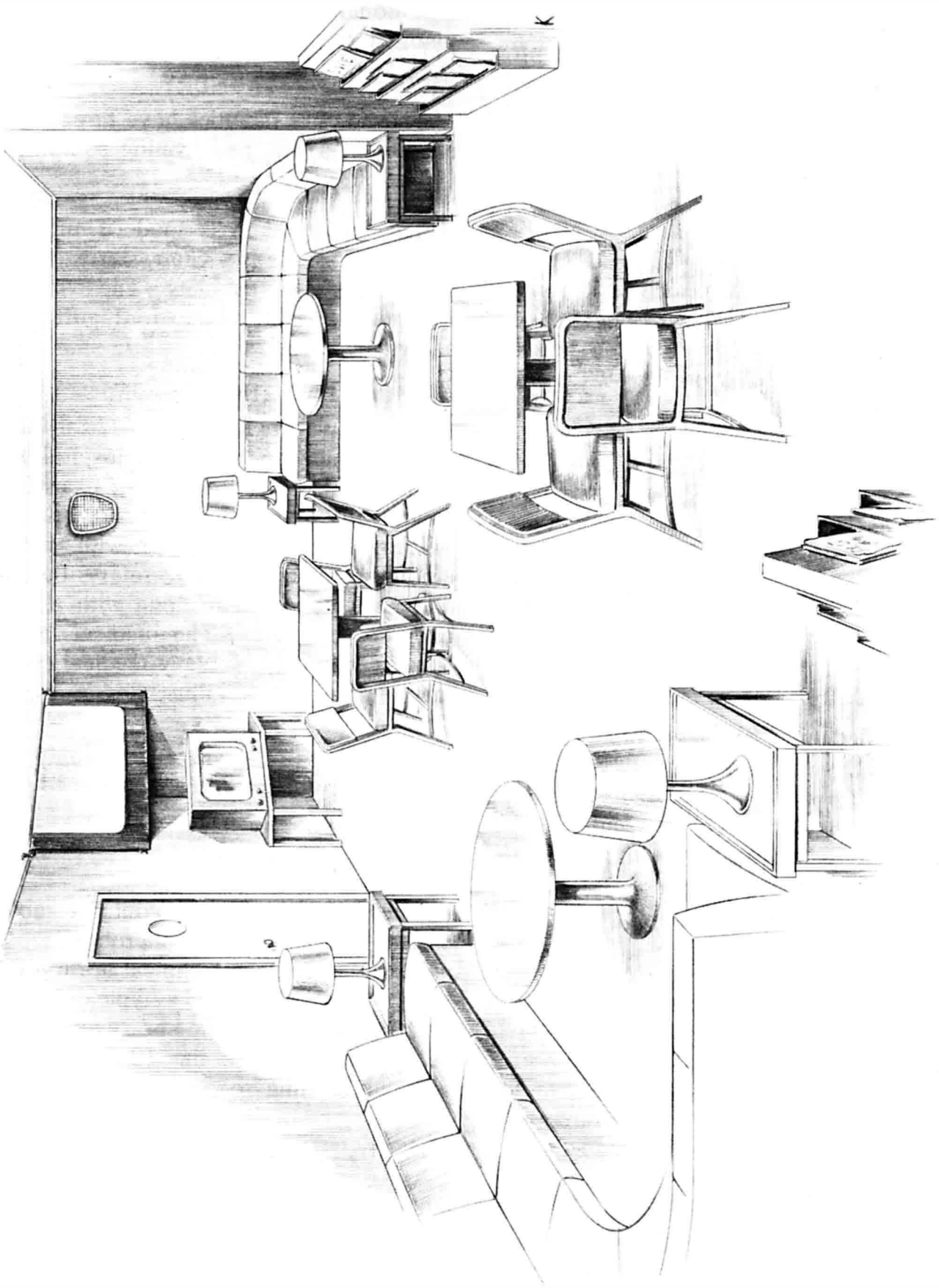


Figure 1-10. Typical Technicians' Lounge

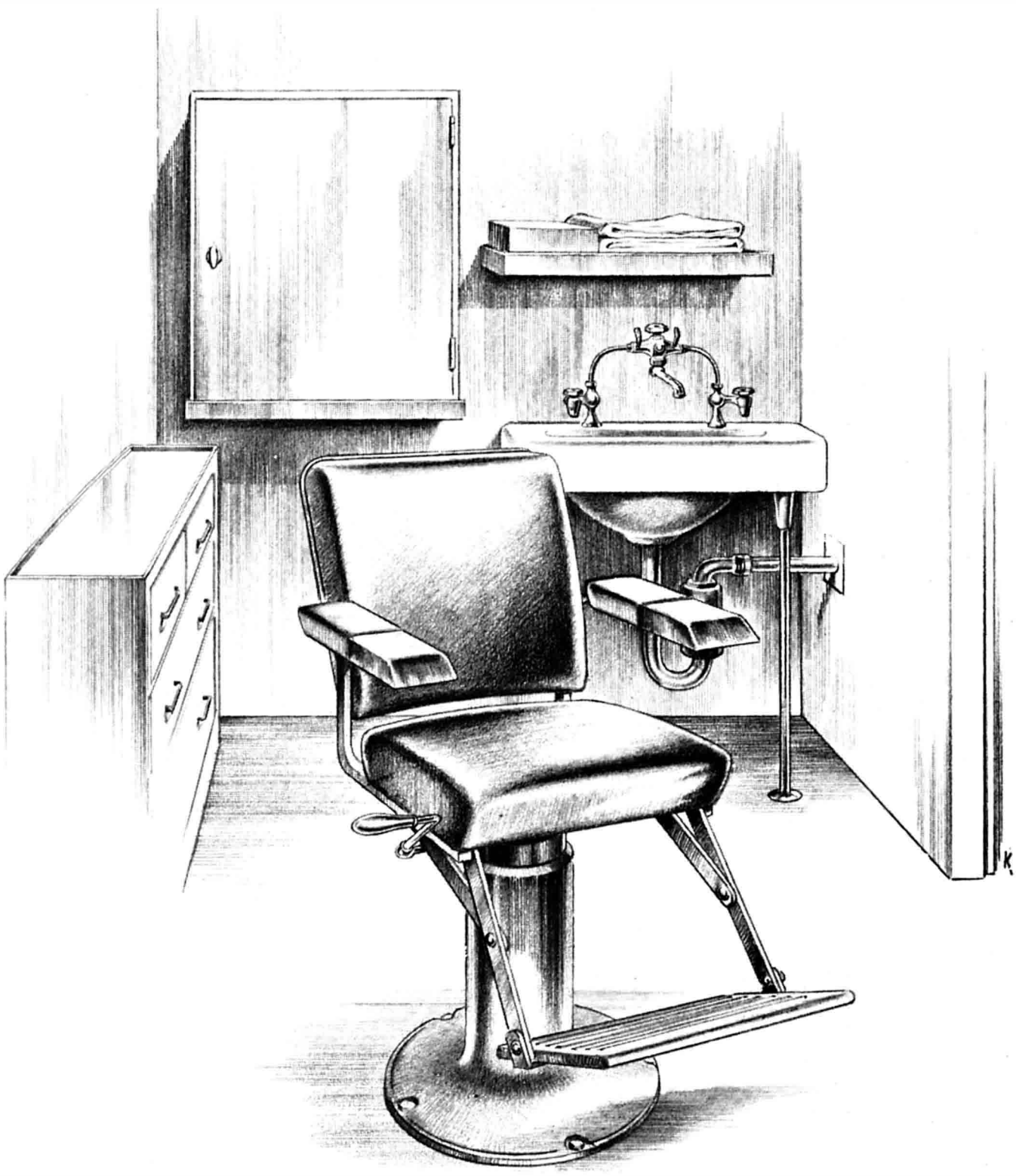


Figure 1-11. Typical Barber Shop

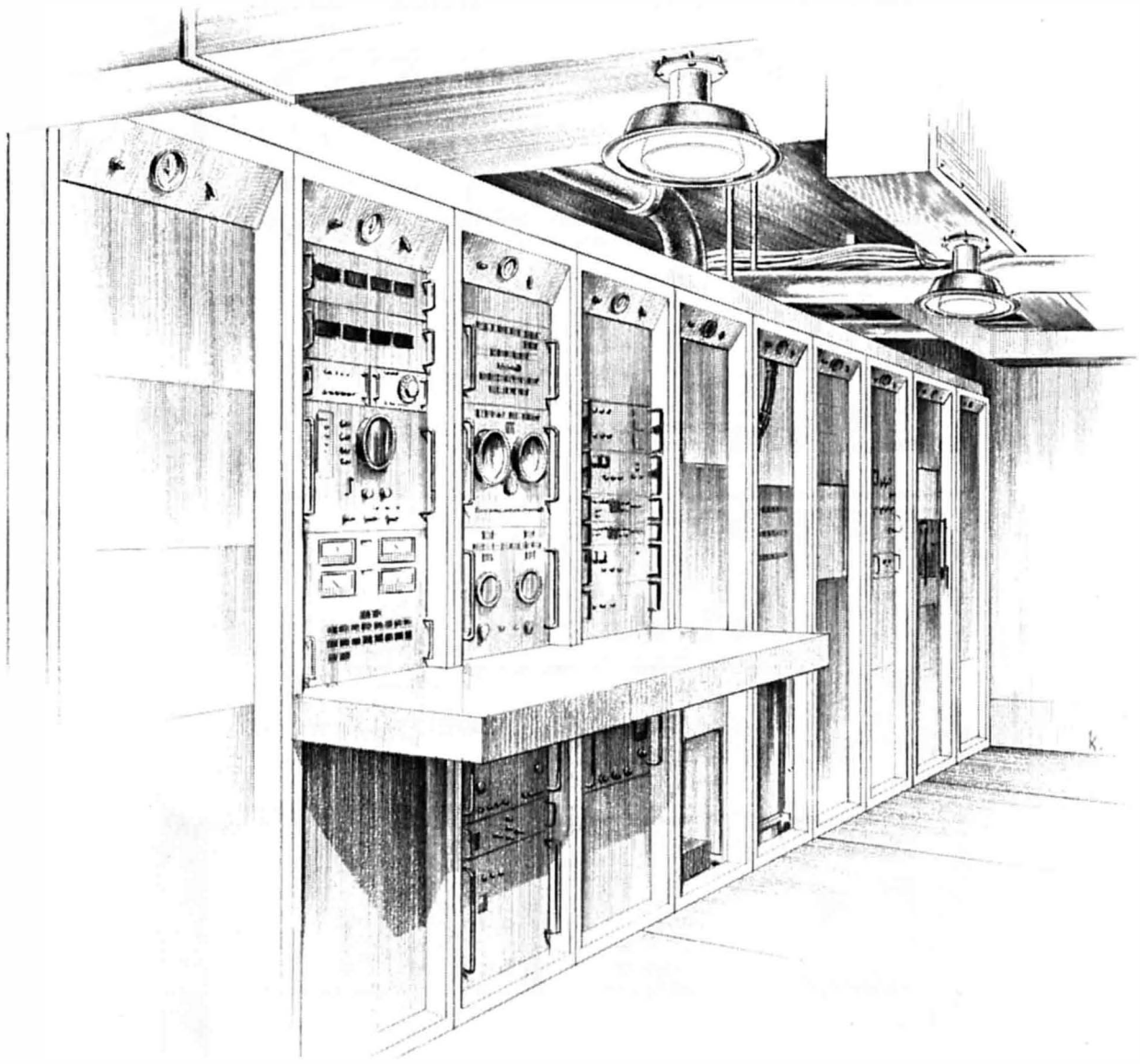


Figure 2-12. 6-Class Telemetry Room

SAFETY

SAFETY

SHIPS' SAFETY PRECAUTIONS

The purpose of this special section of the handbook is to present to the Flight Controllers the basic general regulations to be followed during an emergency at sea. During any emergency at sea, it is imperative that each individual remain calm and be at his emergency station in the least possible amount of time.

As soon as the ship is underway, emergency drills are held. These short drills give you an opportunity to locate each emergency station. These drills are for your benefit and should be participated in with the understanding that they are held for your own personal safety.

STATION BILL

The STATION BILL is a large chart that is posted on the bulletin board in the technicians' lounge. It depicts each man's location in the ship's organization and gives his station for various shipboard drills. In addition to the STATION BILL, each man is given a billet slip explaining his place and assignment aboard ship.

Each man is assigned a watch section, and these sections are numbered. Therefore, when the word is passed that the first section (or second, or third, etc.) has the watch, each man in that watch section immediately reports to his watch station. Watches must be relieved on time; it is customary to relieve the watch 15 minutes before the word is passed, to enable the man being relieved to convey adequate information and instructions relating to the proper standing of the watch.

ABANDON SHIP

The order to abandon ship can only be given by the commanding officer or his relief, and then no further general orders will be given. When the life-saving equipment is launched, leave the ship without delay. The word is passed by all available means, and "all hands" don life jackets (figure 1-14) and abandon ship by the most accessible route. Every effort must be made to save the greatest number of lives. You are expected to use your own initiative when not under the direction of ship's officers or ship's company.

Should it ever become necessary to abandon ship, the following procedure should be carefully observed:

a. Wear a full set of clothing, shoes, and soft hat or similar head covering to avoid exposure.

b. Make sure all ties and crotch straps of your life jacket are tight and secure. Failure to do so may result in injury and cause needless suffering in the water.

c. If possible, go over the side by ladder, net, or line.

d. If necessary to jump, make sure that the water is clear of personnel or wreckage.

e. JUMP FEET FIRST; DO NOT DIVE.

f. Abandon ship as far from damaged area of the ship as possible.

g. Know the direction of the wind and go to the windward side of ship if possible; avoid flames, oil, and drift of ship.

h. In the water, concentrate on staying calm and avoiding panic.

j. Obey the following rules:

(1) Conserve energy.

(2) Keep clear of oil slick if possible; if not, keep head well above water or swim under water.

(3) If danger of underwater explosion is present, float or swim on back as near surface of water as possible.

(4) *Stay in groups for safety and to facilitate rescue.*

(5) *If ship is sinking rapidly, swim clear promptly and tow injured men clear to avoid suction effect.*

Figure 1-14 contains instructions for donning life jackets and the care and stowage of your life jacket.

FIRE

Fire must be reported at once. Too often, fires have gone out of control because the first man to discover the fire tried to put it out by himself. Use any means to spread the alarm. Pass the word clearly and distinctly, giving the frame numbers, the side of the ship, and the compartment number or name; for example: "FIRE! FIRE, FIRE second deck, frame 82, starboard side, ship's store." If you are not qualified to fight fires, leave the area when help arrives.

EMERGENCY TRAFFIC FLOW

Shipboard emergency traffic flow is as follows:

- *Forward and up on the starboard side*
- *Down and aft on the port side*

This prevents men from running into each other or jamming narrow passages.

REFUELING

Refueling is carried out by the ship's company, and everyone aboard must abide by the following regulations:

No naked lights, lighted cigarettes, or electrical apparatus that is liable to spark are permitted within 50 feet of a fuel line, tank, compartment containing the tank, or the vent from the tank. No person is allowed to enter a fuel tank until the tank has been freed of vapor and the required precautions have been taken.

These regulations apply to all hands when refueling both at dockside and underway.

RESTRICTED AREAS

Restricted areas are clearly marked, and only authorized personnel are allowed to enter. Retricted areas are so designated for both the safety of the individual and the safety of the ship.

WATER CONSERVATION

Water conservation while underway is the responsibility of all hands. The most important area in which to conserve water is in personal hygiene. When showering, the following procedure is to be adhered to:

- *Turn on shower; wet entire body*
- *Turn off shower; soap entire body*
- *Turn on shower; rinse body*

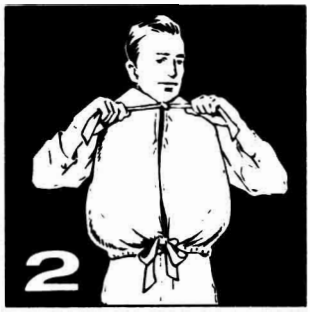
The conversion of salt water to fresh water (drinking, bathing, etc.) is a slow process, and once a ship uses more water than it can process, everyone is affected. WATER RESTRICTIONS MAY RESULT. Under certain conditions, a shortage of fresh water may affect the safety of the personnel and the ship.

RF-RADIATION HAZARD WARNING

The purpose of the Radiation Hazard Warning System is to ensure the safety of ship's personnel and personnel operating Instrumentation Complexes against RF radiation.

There are two warning systems. The primary system provides an audio warning tone at the beginning and end of any USBS, C-band, or command control antenna RF radiation period. The tone is 5 seconds continuous (beginning) and 1 second on, 1 second off for a period of 5 seconds (end), and is broadcast over the general announcing system (1 Mc). In addition, red lights located at each personnel access to the main decks forward of frame 46 blink on and off for the duration of the RF radiation period.

Put on as a vest



Tie tapes tightly to hold jacket against body

INSTRUCTIONS

for Donning and Adjusting Life Preservers

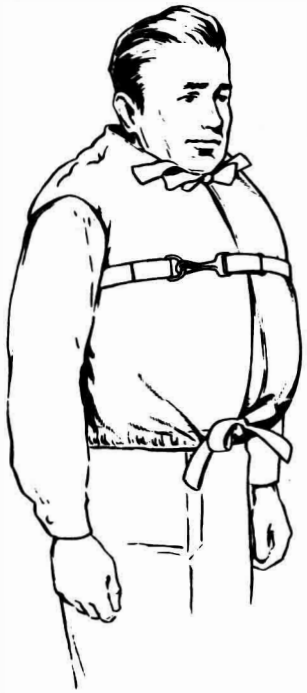
If lifting strap is inside, pull thru the armholes

NOTE:

After use, hang up to dry before stowing. Keep away from steam pipes.

Clip snap hook into ring

Pull strap tight to hold jacket close to body to prevent riding up



Jacket properly adjusted and ready for use

Figure 1-14. Life Preserver Instructions

CCS

COMMAND CONTROL SYSTEM (19-Class Only)

The purpose of the Command Control System (CCS) is to transmit UHF or S-band command signals to a spacecraft, satellite, missile, or other airborne vehicle under remote control of the AIS. Command signals originated by shipboard sources can be updated from remote sources via teletype, high-speed data links, or by relay from a remote mission control center.

The CCS operates in conjunction with receivers, decoders, and memory units aboard a spacecraft. In the spacecraft, received messages are interpreted as commands to trigger predetermined sequences of operation or as information to be stored for later use. Message format and significance can be changed to suit mission requirements. Usually, the spacecraft acknowledges receipt of valid commands.

Command data is generated and transmitted as explained in these paragraphs and illustrated in figure 2-13, a data flow block diagram. Figure 2-14 illustrates a typical command control center.

Command Control System leading particulars are as follows:

- UHF antenna capability ..... Simultaneous UHF communications in the 290- to 300-MHz band on the low-power antenna (spacecraft voice link)
- UHF antenna ... High power (15 kw), circularly polarized, steerable quad-helix array, 406 to 500 MHz low power (200 w), circularly polarized and mounted on the high-power antenna mount (225 to 300 MHz)
- Transmitters ... Frequency-Modulated transmitters, redundant 10-kw or redundant 500-w output, modulation rates 300-Hz to 100-kHz deviation ±30 kHz to ±300 kHz and frequency 406 to 500 MHz
- Coders ..... 20 audio tone channels (IRIG channels) range 7.5 kHz to 75 kHz
- Computer ..... Digital Command System (DCS) uses a Univac CP642B (Mod) to process and encode digital data into audio modulation signals for UHF, CCS, and USBS.

The DCS Data Processor is part of the DCS system. This digital computer is similar to the telemetry digital computer. The primary function is to provide information flow between the remote control consoles within the Mission Control Center (MCC), the master DCS within the MCC, and the CCS.

The DCS processes and encodes command data for transmission to a spacecraft. The processed data is digitally encoded information converted into audio signals to modulate the UHF-CCS. The converted audio signals are digitally coded modulation information in serial form as 1-kHz and 2-kHz phase-shift-keyed (PSK) audio tone signals. The 2-kHz signal contains the data information, and the 1-kHz signal is transmitted as the reference signal.

The DCS can also receive (via telemetry PCM link), monitor, and validate the command data transmitted by the CCS.

The same processed audio signals which modulate the UHF Command Control System are also used to modulate the USBS command control section.

Audio tone coders have also been included in the CCS for general Range use. These coders generate 20 standard IRIG (Inter-Range Instrumentation Group) audio tone frequencies between 7500 and 75,000 Hz. The coders can generate and mix as many as six audio tone channels concurrently.

The Modulation Status and Control Panel provides the ability to select outputs from any of the available coders for application to either of the transmitter/exciters.

The 500-watt transmitter/exciters generate Command Control carrier frequencies at 0.5-MHz intervals from 406 to 500 MHz. There is a modulator in the transmitter/exciter which modulates the generated carrier with the command data received from the Modulation Status and Control Panel. When used as a transmitter, the system can directly transmit the command signal through the antenna at a power level up to 500 watts. Through the use of a power dividing network and heat exchanger system, the system can be used as an exciter to supply 10 to 35 watts of power to the power amplifiers for amplification to 10 kw.

This switching network permits selection of the transmitter/exciter to be used with either of the power amplifiers, transmission of the transmitter/exciter output directly to the antenna, or termination of the transmitter/exciter output into a dummy load. This network also permits automatic switchover between the transmitter/exciters in the event of failure of the system which had been selected as the master system.

The 10-kw power amplifiers provide amplification of the 10- to 35-watt command signal received from the transmitter/exciter to a power level up to 10 kw.

This portion of the switching network provides selection of the power amplifier to be used as the master system and power amplifier used as the standby system. Automatic switchover capability from the master system to the standby system is provided if the master system fails.

The antenna array is a quad-helix array with a gain of 18 db and a beamwidth of 20 degrees.

Antenna elements are also provided to transmit UHF voice communications (290 to 300 MHz) to and from the spacecraft.

The array is mounted on a steerable pedestal. Synchro slaving signals are received from the Acquisition and Stabilization Network, or the pedestal can be steered manually from the console in the Command Control Room.

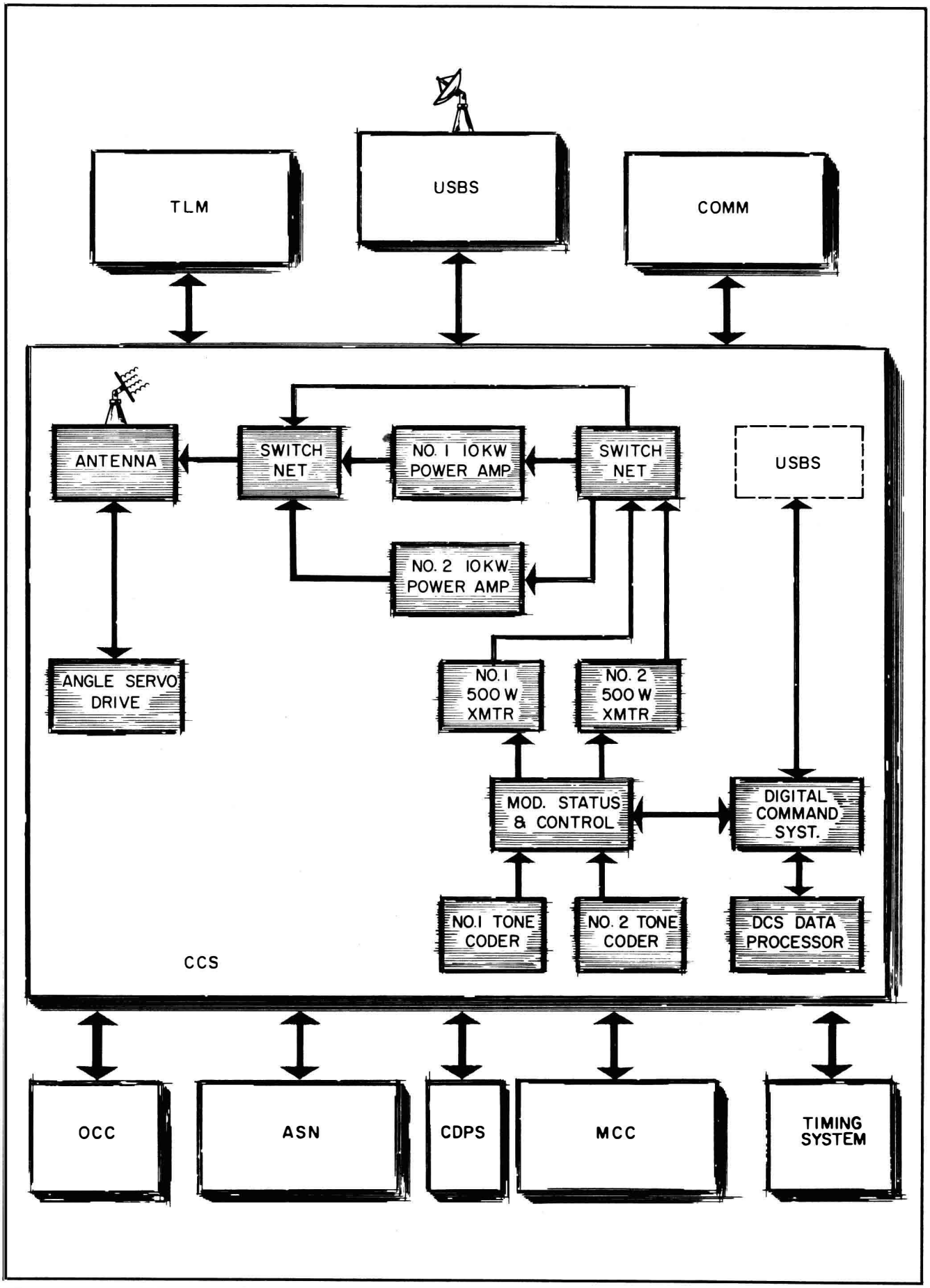


Figure 2-13. Command Control System Simplified Data Flow and Block Diagram

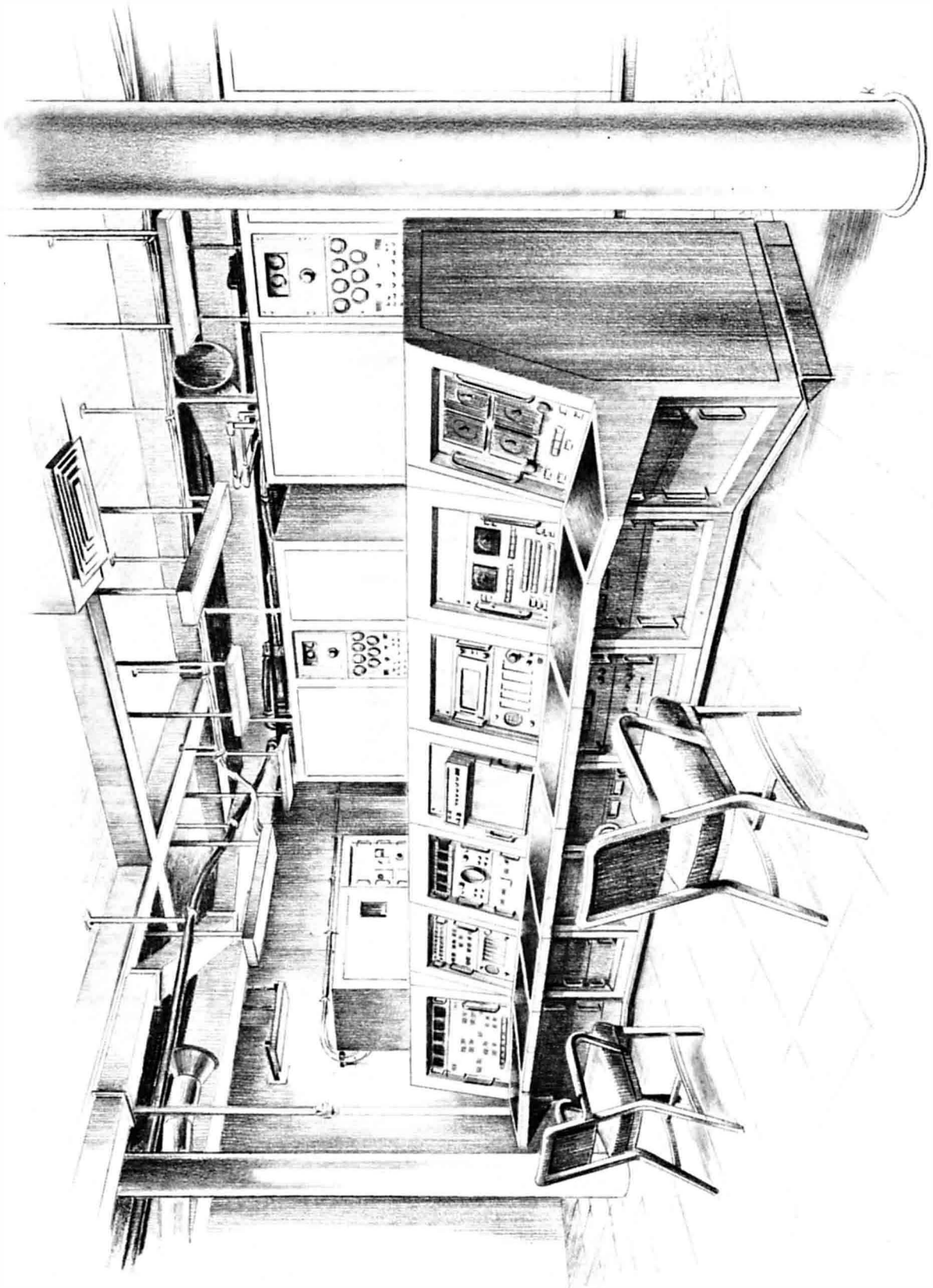


Figure 2-14. Typical Command Control Center Configuration

TIMING SYSTEM

The timing system generates and distributes standard frequencies, time codes, and repetition rates for use by shipborne instrumentation. How this is accomplished is illustrated by the timing system data flow and block diagram, figure 2-15. Figure 2-16 illustrates the communications and timing center room.

Timing System leading particulars are as follows:

- Standard reference frequencies . . 5 MHz, 1 MHz, and 100 kHz; pulses—2 pps, 20 pps, 400 pps, 2 ppm, and 10 ppm; and time signals —BCD time-of-year to 0.1 sec, serial binary time-of-year to 0.1 sec time codes IRIG A-E, NASA 1/sec, 1/min, 1/hr and serial decimal; all based on rubidium standard.
  Synchronization with WWV standard-time broadcasts.
  Standard frequencies, pulses, and time signals distributed to instrumentation centers.
- Rubidium frequency standard . . . . long term stability, 5 parts in 10^{11} per year
  short term stability, 1 part in 10^{11} per second
- Crystal oscillator . . . . long term stability 1 part in 10^{10} per day
  short term stability 1 part in 10^{10} per second

The WWV receiver receives standard time broadcasts on HF from the National Bureau of Standards at Boulder, Colorado. Outputs from this receiver are time-of-day in voice and synchronization pulses from which the master time-of-year clock is synchronized.

The VLF receiver receives standard frequency broadcasts in the 10- to 30-kHz frequency range. Outputs from this receiver show the phase relationship between the received signal and the reference frequencies from the local frequency source.

The Ship's Velocity Compensator eliminates doppler effect on the VLF received-signal when the ship is underway. Inputs are VLF standard receiver outputs, ship's velocity, heading, and position. The output from this unit indicates the true phase relationships between the VLF signal and system reference source with the doppler effect removed.

Frequency Source—Standard reference frequencies are generated with a rubidium standard and a crystal oscillator. The primary rubidium standard has a long-term stability of 5 parts in 10^{11} per year, and the secondary crystal oscillator has a long-term stability of 1 part in 10^{10} per day. The Frequency Source generates and distributes 5-MHz, 1-MHz, and 100 kHz frequencies.

Master Time-of-Year Clocks contain six-decade frequency dividers and a digital clock. These generate repetition rates and derive time-of-year information in seconds, minutes, hours, and days. Input is a 1-MHz frequency from the frequency source. Outputs are the generated signals explained previously. This unit contains the necessary output drivers for signal distribution.

The Time Signal Generator accepts the outputs of the Master Time-of-Year Clock and generates standard time codes and frequencies not available as standard outputs

from the Master Time-of-Year Clock. Outputs from this unit include the following time code formats: IRIG A, IRIG B, IRIG C, IRIG D, IRIG E, NASA 1/sec, NASA 1/min, NASA 1/hr, NASA Serial Decimal, Serial Binary Time-of-Year (seconds), Serial Binary Time-of-Year (tenths of seconds), Serial Binary Time-of-Day (seconds), 40 pps, 20 pps, 2 pps, 2 ppm, and 10 ppm repetition rates.

Shaper Modulator Unit / Transfer Switch—The Transfer Switch allows timing signals from either of the time signal generators and Master Time-of-Year Clocks to be distributed. The shaper modulator unit contains shapers (filters) to convert shifting logic levels to sinusoids, modulators to modulate carrier frequencies with NASA and IRIG time codes, and pulse shapers to generate pulses from transitions of the shifting logic levels. Outputs of this unit go to the patch panel.

The Line Driver Distribution Unit provides isolation, amplification, and impedance matching for the timing system output signals. All inputs and outputs associated with this unit are patched from and returned to the patch panel.

The patch panel is a removable programable board. Three boards are provided to satisfy different support requirements. Outputs from the patch panel are directed to instrumentation centers.

The Time-of-Year Distribution Unit accepts BCD parallel time-of-year from the Master Time-of-Year Clocks via the transfer switch. This unit consists of terminal blocks, indicator drivers, and the timing distribution frame. The BCD signals, once amplified, drive the Time-of-Year Indicators.

Elapsed Time Generator, Distribution and Display—the Master Elapsed Time Clock accepts the parallel BCD time-of-year, 100,000 pps, and 1 pps from the Master Time-of-Year Clock via the transfer switch. Elapsed time is derived from these inputs and is distributed to elapsed time indicators in the instrumentation rooms.

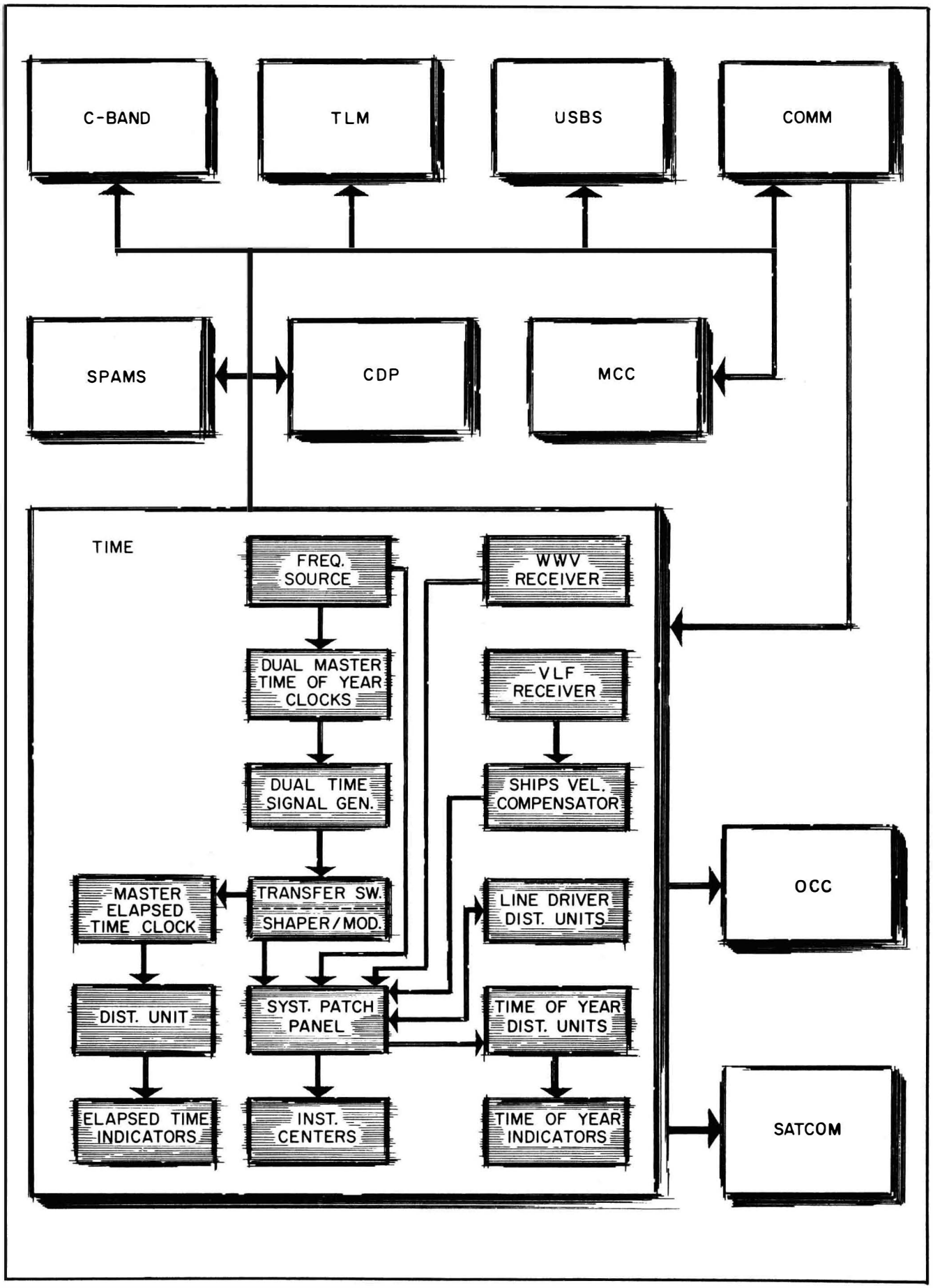


Figure 2-15. Timing System Simplified Data Flow and Block Diagram

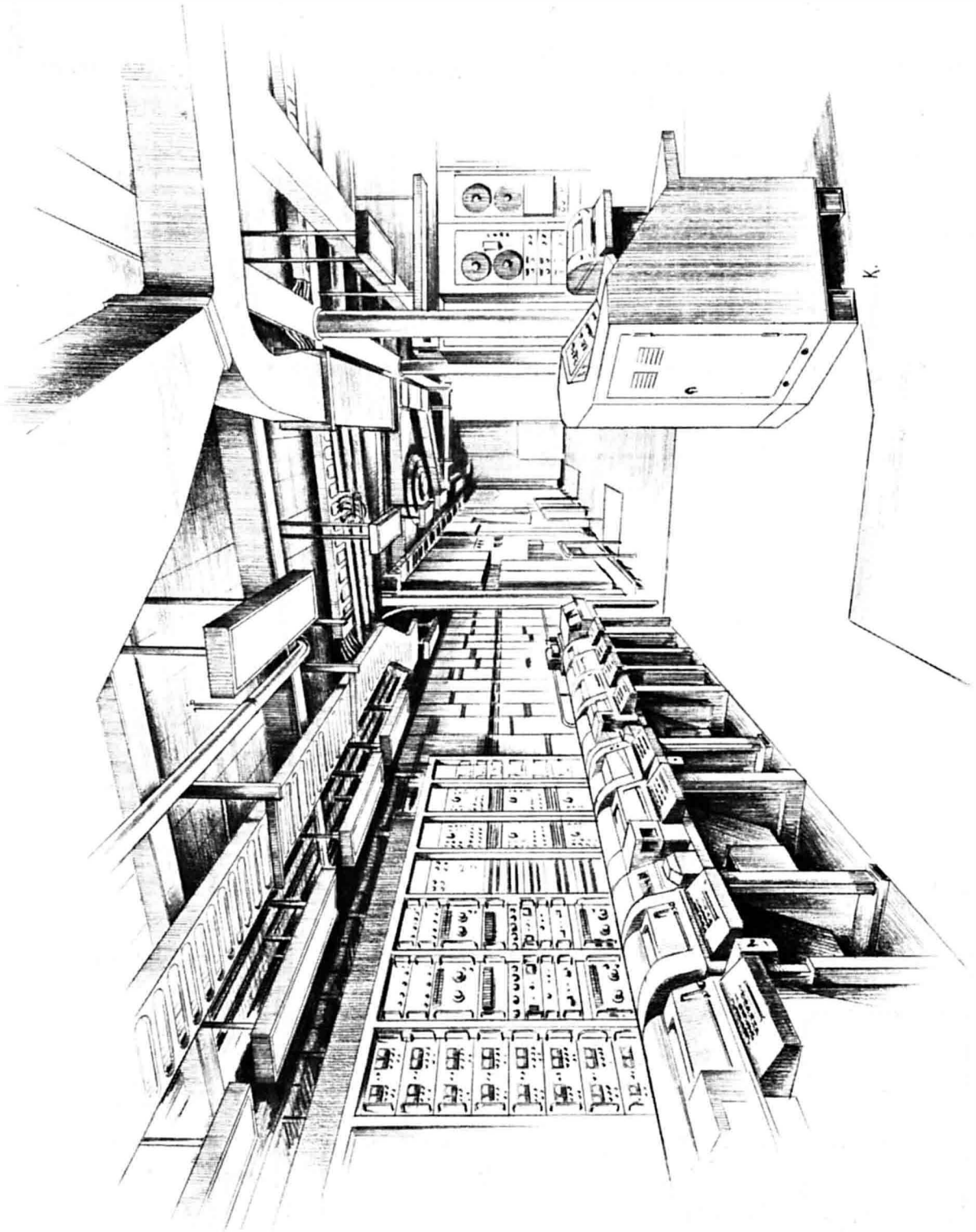


Figure 2-16. Communications and Timing System Room


SPAMS

SHIP'S POSITION AND ATTITUDE MEASUREMENT SYSTEM

The Ship's Position and Attitude Measurement System (SPAMS) is one of the principal systems of the instrumentation complex. This system is comprised of a number of individual subsystems and equipments integrated to provide data for stabilization of the shipboard antenna systems and for conversion of angle information from deck-referenced coordinates to earth-referenced coordinates. The system also provides for measurement of ship's velocity and for monitoring antenna mount flexure. The flow of data and system block diagram is shown in figure 2-17. Figure 2-18 shows a typical SPAMS arrangement. The principal subsystems included in SPAMS are:

- Integrated Navigation System
- MK 19 Gyro Compass
- Electromagnetic Underwater (EM Log)
- Bathymetric Navigation System (BNS)
- Loran C
- Flexure Monitor
- Navigation Satellite Receiver

The key subsystem in the SPAMS is the Integrated Navigation System (INS). The INS supplies extremely precise information concerning the ship's latitude and longitude; velocity north, east, and vertical components of velocity; roll, pitch, and heading.

The nucleus of INS is the Sperry MK3 Mod 5 Inertial Navigation System (SINS) supported by an automatic day/night Marine Star Tracker. Inertial components, gyros, and accelerometers incorporated into this system are not error free; thus, their outputs will degrade with time. These errors are unacceptable in shipboard application and must be reduced by a reset. System reset is possible when accurate position or heading information is available from one of several sources, BNS, Loran C, Navigation Satellite, and the Marine Star Tracker.

In the INS, the SINS and Marine Star Tracker are integral units; thus, the SINS can be reset by Star Tracker position and heading fixes whose errors are independent of time. The only required inputs from other equipments are velocity from the EM Log, time for star tracking, and heading information from the MK19 Gyroscope (for initial start).

The principal components of the INS are: Marine Star Tracker, consisting of two separate units; the Optical Tracking Unit, containing the abovedeck tracking head and the belowdeck tracker electronics cabinet; SINS binnacle, which houses eight inertial components (gyros and accelerometers) in a thermally stable environment isolated from the ship's motion by a conventional three-gimbal arrangement, a Miniaturized Data Assimilation Computer (MINDAC) and a set of Multispeed Repeaters, designed to very accurately repeat the SINS gimbal angles and transmit roll, pitch and heading in both analog and digital form.

Three mutually orthogonal axes are required as a reference for measurement of all shipboard equipment tracking angles and are established by the SINS. For this reason, it is very important that the ship's structural foundation meet certain requirements. To meet these requirements, a specially designed bedplate, supported by rigid ship's structure, is provided.

The flexure monitor system is provided to measure ship's flexure, continually and automatically, between the Optical Reference Cube mounted on the SINS bedplate, the C-band, and USBS antenna mounts.

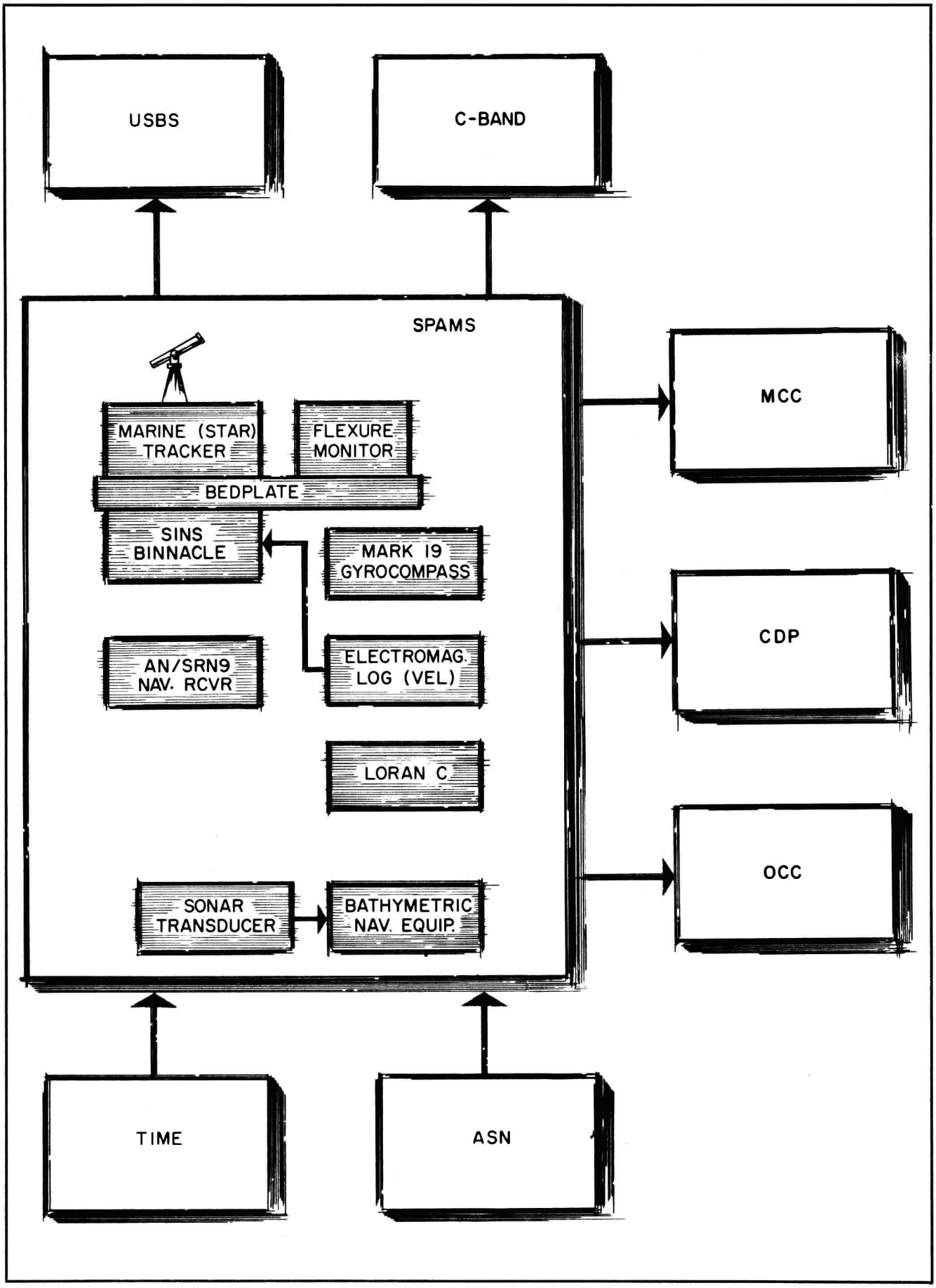


Figure 2-17. Ship's Position and Attitude Measurement System, Simplified Diagram

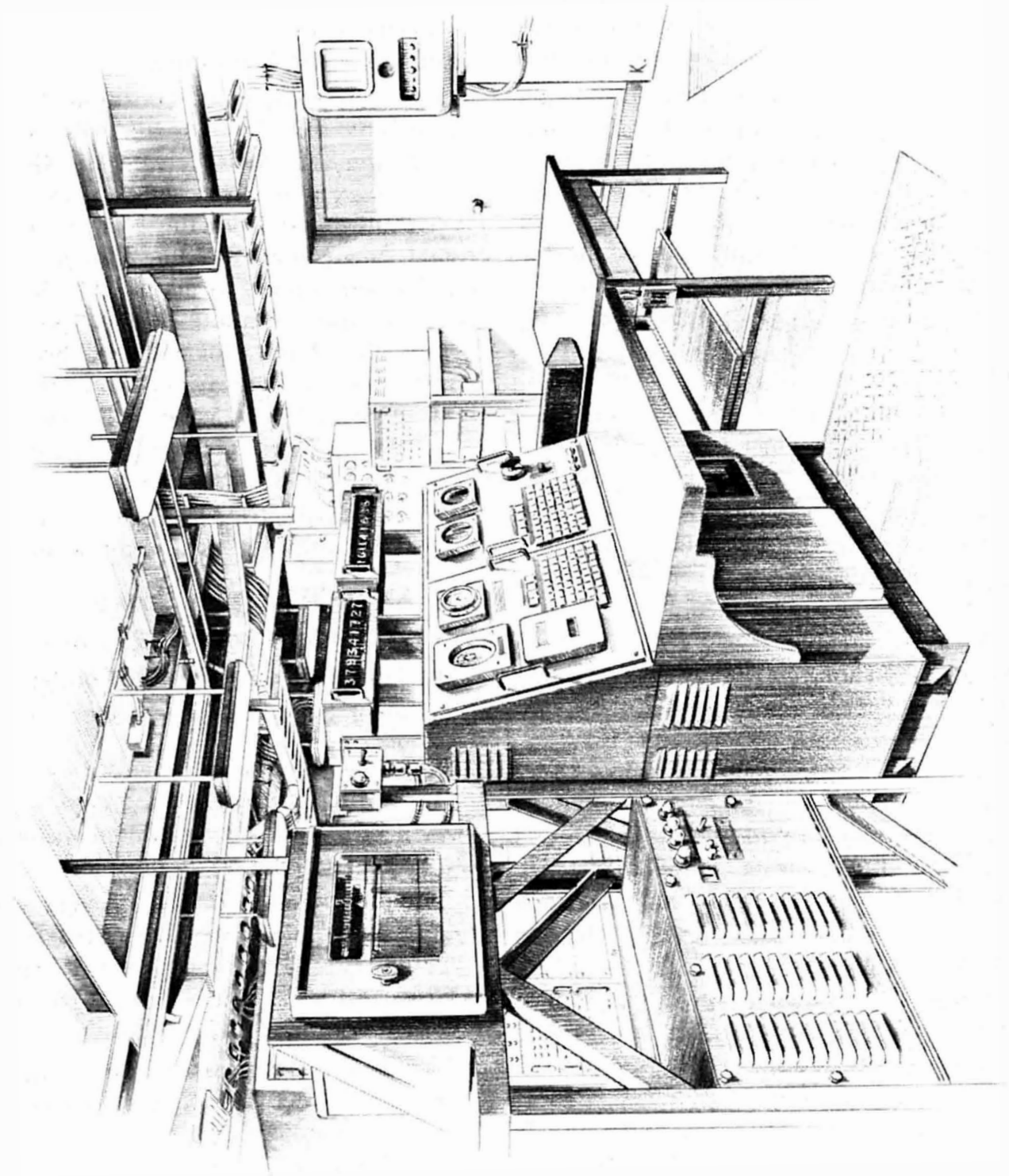


Figure 2-18. Typical SPAMS Arrangement

The Optical Reference Cube is aligned to the SINS axis and becomes the reference axis for monitoring and aligning the entire instrumentation complex. Flexure information, in digital form, is continually fed to the CDP where it is used to correct C-band and USBS tracking information.

Shipboard alignment of the instrumentation complex presents problems. Once the ship is at sea, measurements of alignment shift are a continuing requirement. The Apollo missions require that the instrumentation complex alignment be checked before and after each mission.

Another equipment in SPAMS is the MK 19 Gyro Compass. The outputs from this equipment are ship's roll, pitch, and heading. The MK19 Gyro Compass together with the EM Log serves as a backup for INS and for position and velocity information. In the event of INS failure, the MK19's outputs are supplied to the CDP System for use in stabilization of the instrumentation complex.

Measurement of ship's speed through the water is required for velocity damping of both the INS and MK19 Gyro Compass. The EM Log supplies this information. The EM Log measures ship's speed through the water, along a fore-and-aft axis of the ship. In addition to indicating ship's speed in knots, it computes distance traveled in nautical miles and transmits this information to various stations throughout the ship.

Loran C is also a part of SPAMS. This equipment is installed to provide position fix information for the reset of INS. Like most radio frequency, hyperbolic systems, Loran C accuracy is affected by atmospheric conditions and ship location relative to the transmitting stations. Accuracy in the order of 1500 feet is possible under favorable Loran C operating conditions. However, Loran C coverage will not be available for all geographical areas selected for stationing the Apollo Instrumentation Ships during Apollo missions. Loran C time difference information is fed into the CDP, where the necessary computations are made to determine the ship's position.

Another navigation (position fixing) equipment included in SPAMS is the Navigation Satellite Receiver, AN/SRN-9. This receiver receives doppler information transmitted from the Navy's Operational Navigation Satellite System. The CDP is programed to accept AN/SRN-9 outputs and compute ship's position. Where the ship is located and how accurate ship's velocity is known determines how often and with what accuracy position fixes can be obtained. Again, the fixes are used to reset SINS.

The Bathymetric Navigation System (BNS) is comprised of the following:

- AN/UQN-1 Depth Sounder
- Precision Fathometer Recorder
- Bathymetric Navigation Equipment
- Sonar Beacon (Transponder) Reference System

These equipments are integrated to produce a navigation fixing system using information from the ocean bottom.

The purpose of the BNS is to enable the ship to determine its position (latitude and longitude) very precisely in relation to bottom "bench marks" which locations have been established by previous surveys.

The BNS operations involve a survey phase and a recovery phase. The survey phase is accomplished during off-mission hours, during which time the ship selects one or more suitable bottom "bench marks" in an area that the ship is stationed when actually supporting an Apollo mission.

Selection of a site is based on two qualifications: water depth must be in the 200- to 4000-fathom range, and bottom topography across the site must display an rms depth variation of at least 12 fathoms, with a normalized spectral density having an effective bandwidth of one cycle/mile minimum. Site adequacy is determined by taking depth profiles across the two diagonals of the area being examined.

After site selection, three transponders are launched and moored to the ocean bottom for use in obtaining precise knowledge of the ship's ground track during the survey operation. This enables a surface ship to determine its relative position to an accuracy of better than 100 feet.

A&SN

ACQUISITION AND STABILIZATION NETWORK

The Acquisition and Stabilization Network (ASN) provides target acquisition and antenna stabilization signals required to interconnect, position, and stabilize the tracking and remotely controlled directional antennas on the ship. The system may be controlled centrally from the Operations Control Center or locally at the individual antenna consoles. The prime designation source may be either the CDP Computer, C-band Antenna, Optical Director, TM-1 Antenna, or the USB Antenna. Any or all of the remaining antennas, including the TM-2 Telemetry Antenna and the Command Control Antenna, may then be slaved to the prime designation source for acquisition purposes. The Star Tracker may also be slaved to the prime designation source.

In general, initial acquisition is accomplished in either of two ways. Designation data are stabilized deck coordinates generated in the CDP and transmitted via the Acquisition Subnetwork to the selected antennas. The alternate mode of operation is to manually order antenna position from handwheels at one of the individual antenna control areas. These data are transmitted to the computer, stabilized, then transmitted back to selected antennas via the Stabilization Subnetwork. When lock-on is accomplished and automatic tracking begins, on-track signals are transmitted to the pertinent consoles via the On-Track Subnetwork. The designate controller in the OCC receives the on-track data from the designate sources and assigns the master antenna for the acquisition and tracking bus.

The system has an optical acquisition aid and four principal subnetworks: Ship's Heading, On-Track, Stabilization, and Acquisition Subnetworks. These functions are described in the following paragraphs. Figure 2-19 is a composite data flow and block diagram of the system. Figure 2-20 illustrates a typical ASN room.

Acquisition-Stabilization leading particulars are as follows:

- Antenna designation control and distribution
- Manually ordered antenna position stabilization
- Distribution of on-track signals of active trackers to all tracking elements
- Distribution of ship's heading
- Optical director designation
- Acquisition and Stabilization Network ..... 0.5 degree overall accuracy under maximum dynamic loads
- Optical Director .. acquisition aid for balloon and aircraft
- Antenna Control Panels ..... tracking operator selection of designation
- Designate Control Console ..... central selection of master designation source

The Ship's Heading Subnetwork serves as a central distribution source for ship's heading indication. Ship's heading is obtained by selection in the Navigation Room of either INS or MK-19 heading data and is distributed via the action cutout switchboard and synchro amplifiers to the following display units: antenna control panels, master acquisition and stabilization control panel, wheelhouse, Mission Control Center, Operations Control Center, and the Communication Transmitter Room.

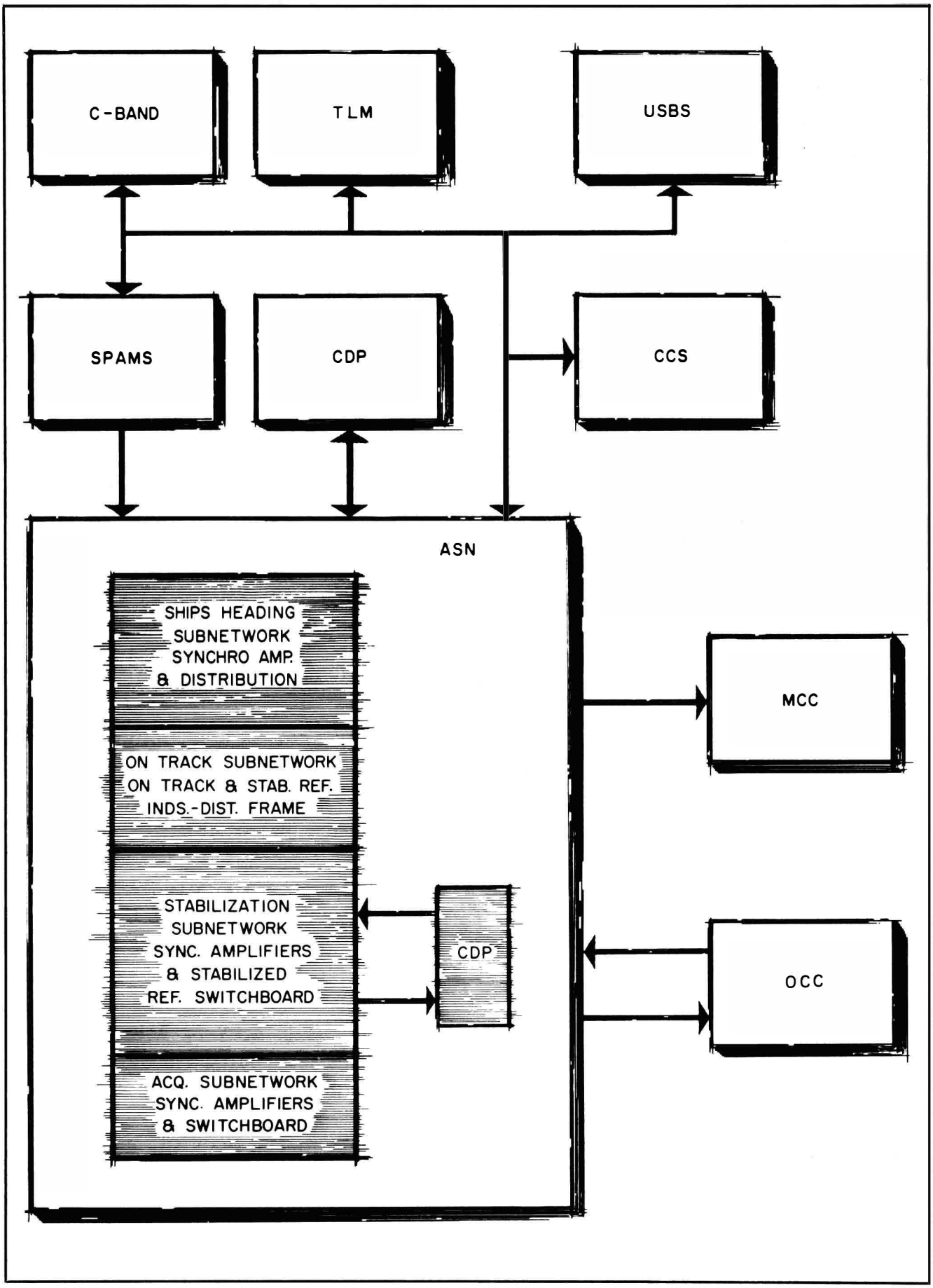


Figure 2-19. Acquisition and Stabilization Network Simplified Data Flow and Block Diagram

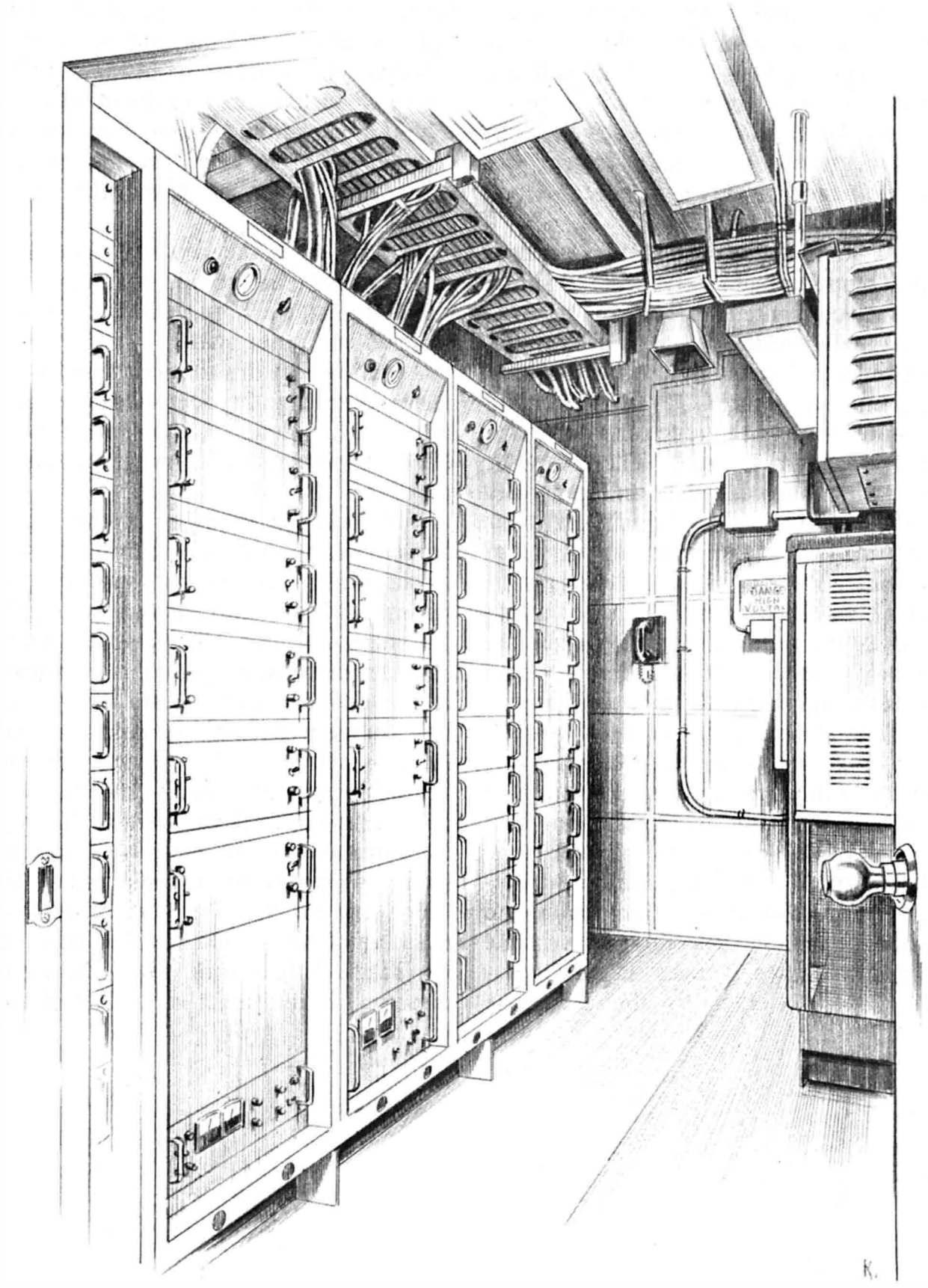


Figure 2-20. Typical ASN Room

The On-Track Subnetwork receives the on-track signals from systems in automatic track and distributes these signals to all other tracking systems to indicate tracking status. Two on-track signals, bearing and elevation, are received from all active tracking elements except the optical director, from which only one on-track signal is received.

The Stabilization Subnetwork provides computer-stabilized ordered position to selected antennas from any particular manually ordered antenna console. The handwheel manually ordered position is transmitted to the CDP Computer via the stabilization reference switchboard from the antenna console. The computer accepts ship's attitude data and generates the stabilization signals which are converted to synchro form and represent the difference between true and deck coordinates. The stabilization signals are transmitted to the antenna control panels selected via the synchro amplifiers, where they are compared with the ordered position. The difference is in deck coordinates, and positions the antennas as ordered. Ordered position is received from one source only, but may be attributed to any or all of the antennas as selected.

The purpose of the Acquisition Subnetwork is to provide designation data to the selected antennas. Selection of a prime designation source is made at the Operations Control Center by the Designate Controller or at the individual system antenna consoles by the operators. Selection is made by pushbutton switches through the synchro-acquisition switchboard which accepts and distributes bearing and elevation synchro-data in deck coordinates from any tracking antenna, from the CDP, or from the optical director.

In addition, a data quality signal is received from the computer and is distributed to all tracking element consoles to indicate computer status.

A handwheel designation signal is also received to signify operation in manual mode. This signal is transmitted to the CDP Computer for program control purposes.

The primary purpose of the Optical Director is to aid in acquiring balloon-borne target sources and aircraft. The optical director thus serves as a prime designation source. Single-speed bearing and elevation synchro-data is transmitted to the slaved system(s) via the Acquisition Subnetwork. These data are stabilized by virtue of the operator's manual compensation for ship's motion while maintaining optical contact with the target. The optical director serves as designation source primarily for C-band radar, USB radar, and the Star Tracker. A single on-track validation signal is provided on the On-Track Subnetwork when the optical director has the target in its field of view.


OCC

OPERATIONS CONTROL CENTER

The Operations Control Center (OCC) provides centralized control and coordination of all onboard instrumentation systems. It also provides single-point control reporting into and coordinating with the National Range Network. This control center is used by the SOM, assisted by the Ship's Instrumentation Manager (SIM) and the Designate Controller, to direct and control the ship's instrumentation. Figure 2-21 illustrates the data flow and block diagram. Figures 2-22 and 2-23 illustrate the OCC aboard both classes of ships.

Operations Control Center leading particulars are as follows:

- Single-point contact with the National Range Network
- Centralized control and coordination of all shipboard instrumentation systems for National Range programs
- Trajectory data display — plotting boards and height recorders
- The SOM has communication and display capabilities to monitor and control the ship and to deport and coordinate with the National Range Network.
- The SIM monitors and controls the ship's instrumentation complex.
- The Designate Controller supports the SIM by assigning source data and antennas for acquisition and tracking phase of mission.

The master systems console is manned by both the SOM and the SIM. The SOM position has communication and display capabilities which enable him to monitor and control the ship to support Range missions. During Apollo missions, the SOM mans the M&O console in the MCC. An alternate mans the SOM console. The console provides for bilateral information transmission with four sources: The National Range Network, the bridge, the Maintenance and Operations Supervisor (M&O) in the shipboard Mission Control Center, and the shipboard instrumentation complex. The SIM position has communication and display capabilities which enable him to monitor and control the shipboard instrumentation complex. The SIM can exchange information with the SOM, Designate Controller, MCC, M&O, and each instrumentation system.

The designate control console is manned by the Designate Controller, who assigns the source and appropriate antenna or antennas for the acquisition phase of the ship's mission as directed by the instrumentation plan of the mission. The Designate Controller has information on the quality of the data obtained from the designate sources. Information is exchanged between the designate console and the instrumentation systems, the SIM console, and the M&O Console in the MCC.

The Trajectory Plotting Boards in the OCC consist of two 30- by 30-inch plotting boards and one height recorder. These units display the target's present position in Cartesian coordinates along the surface of the earth as determined by the computer from the radar data or orbital parameters.

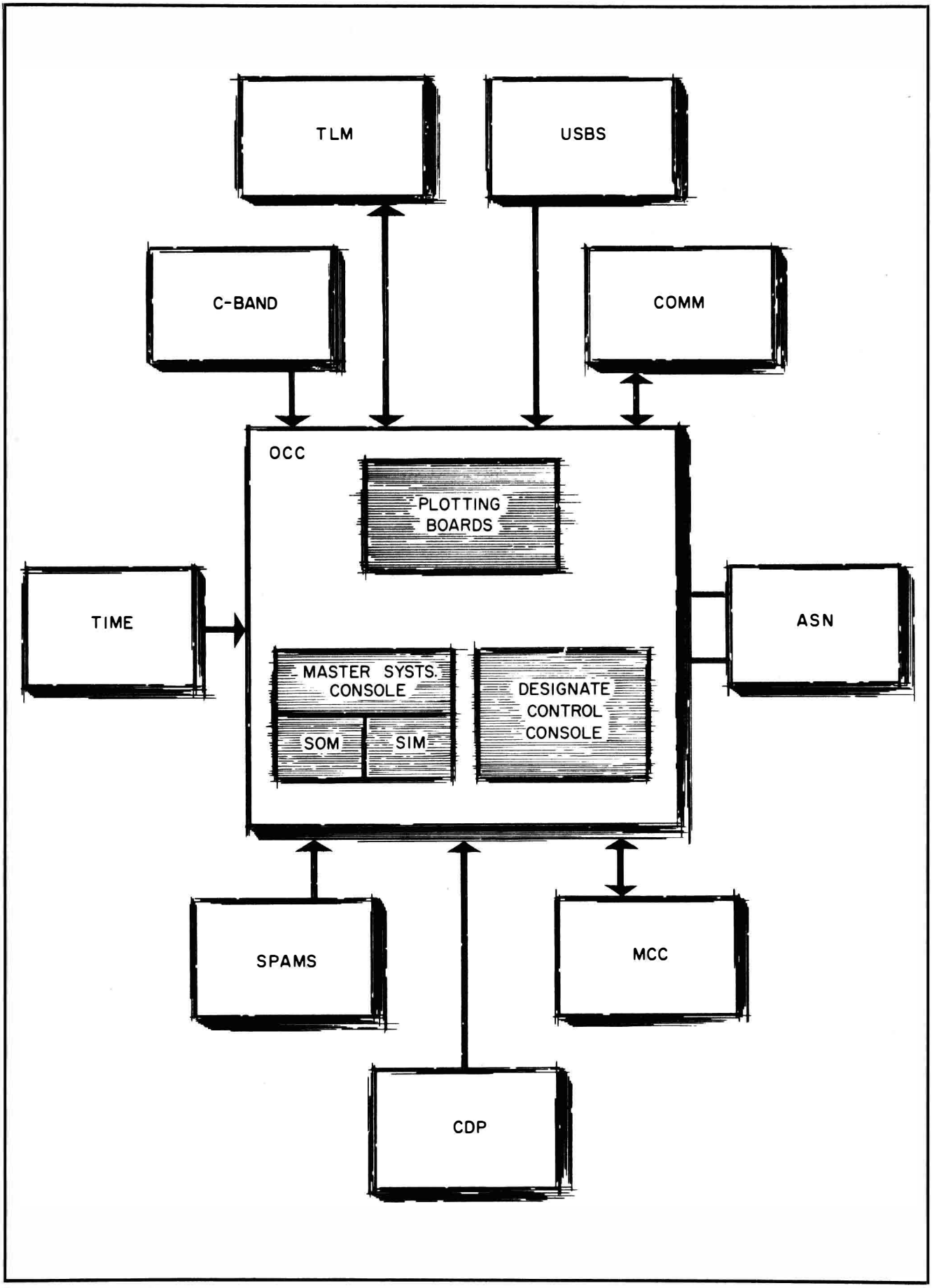


Figure 2-21. Operations Control Center Simplified Data Flow and Block Diagram

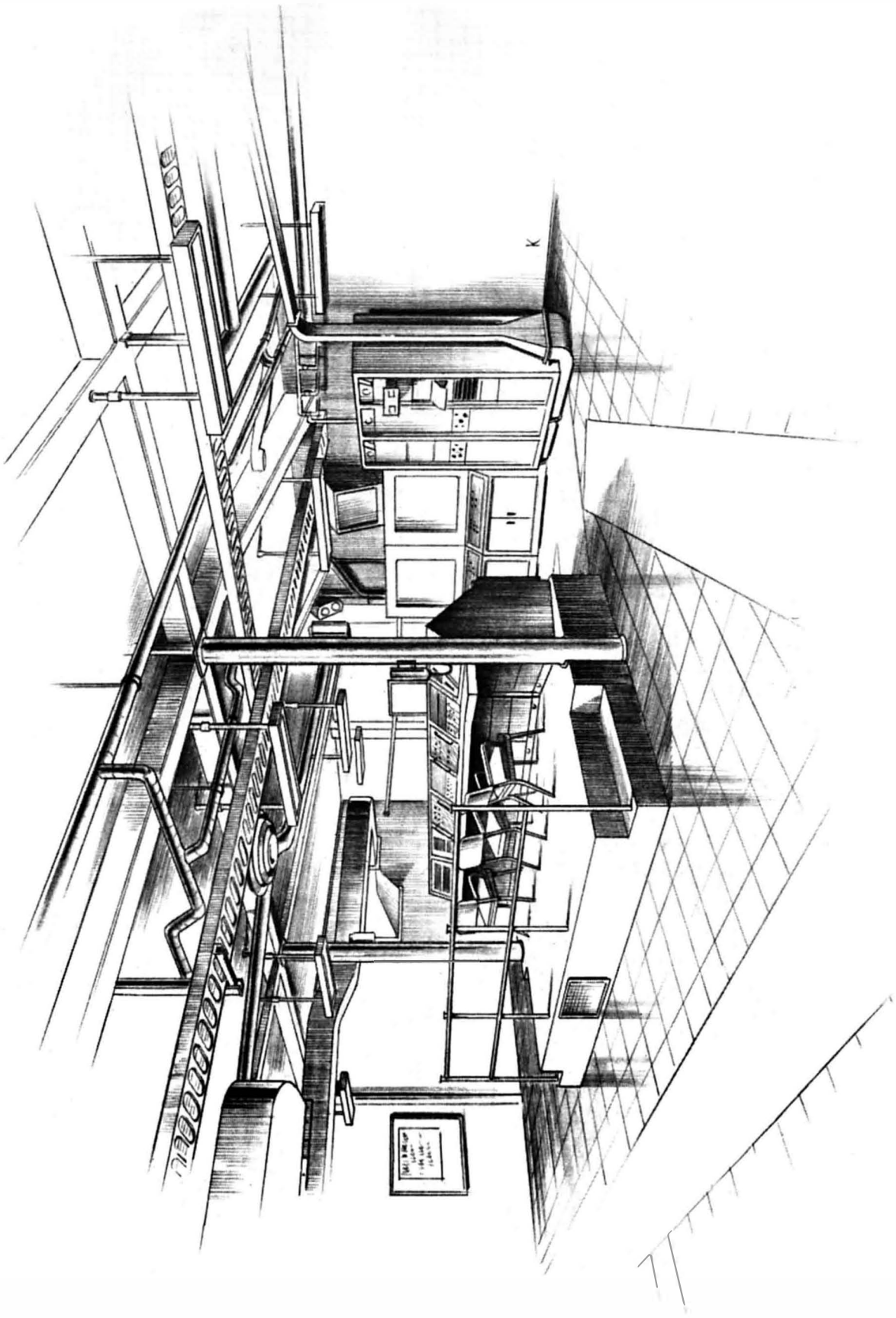


Figure 2-22. 19-Class Operations Control Center

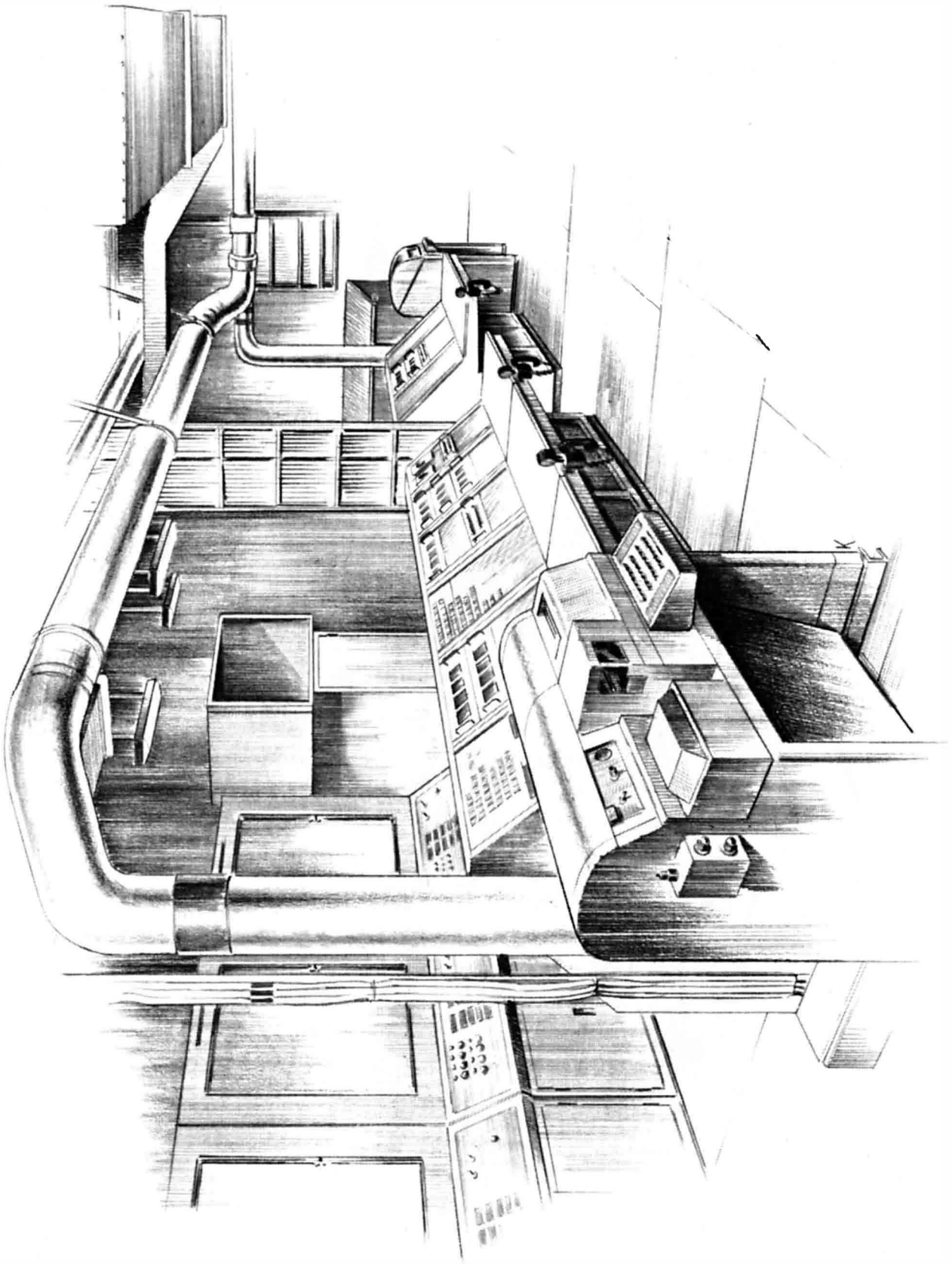


Figure 2-23. 6-Class Operations Control Center

MCC

MISSION CONTROL CENTER (19-Class Only)

The Mission Control Center (MCC) is the centralized control facility from which NASA Flight Control personnel monitor the shipboard instrumentation status and the APOLLO spacecraft data and communicate with the NASA Network and spacecraft. Figure 2-24 depicts the data flow and system block diagram. Figure 2-25 shows the Mission Control Center.

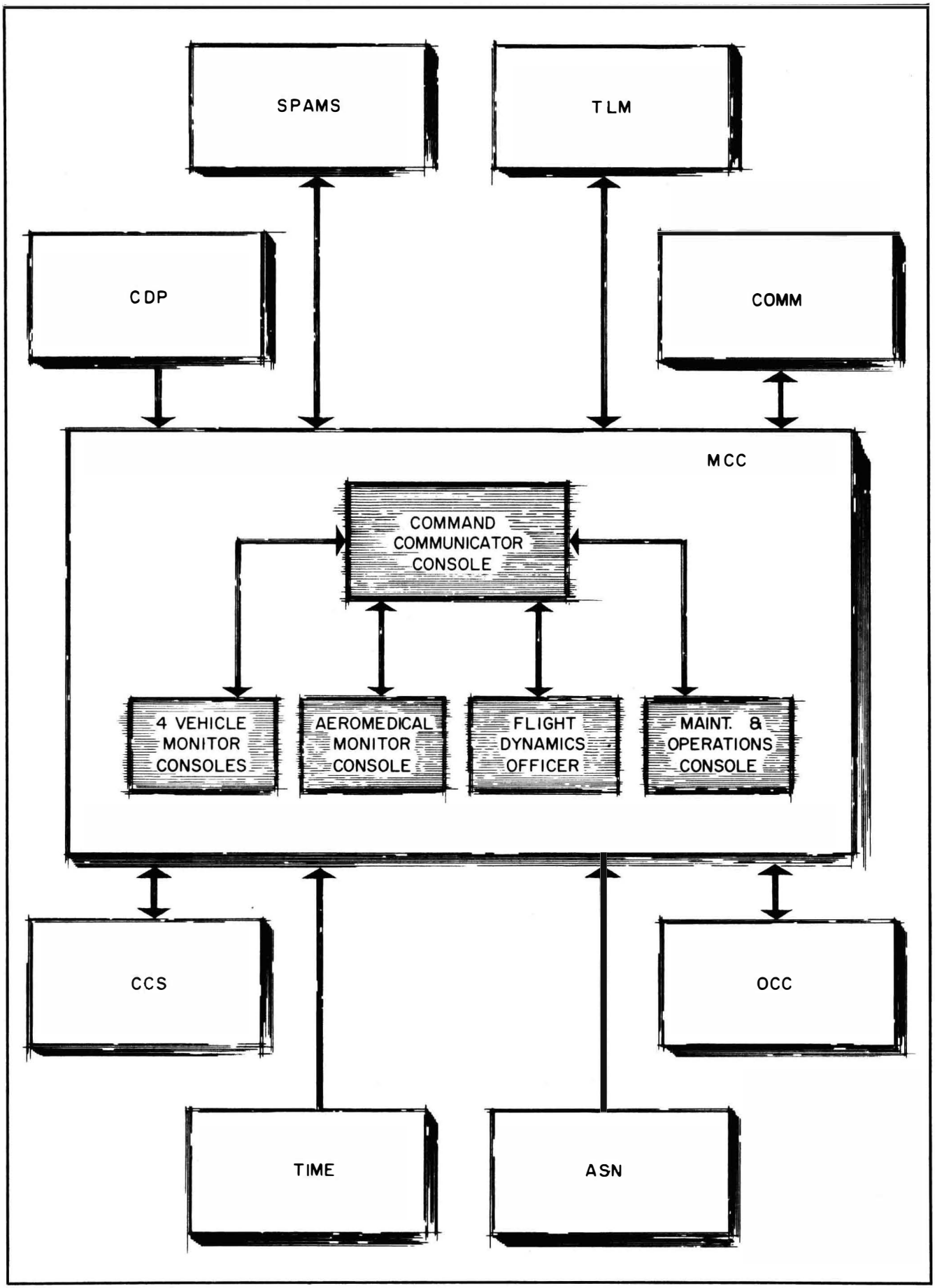
The MCC leading particulars are as follows: Apollo Mission Monitoring contains consoles, displays, communications, and instrumentation for NASA Flight Controllers.

Consoles

- Command Communicator . . determines status of spacecraft and astronauts by communication with spacecraft and vehicle, flight dynamic, and aeromedical monitors, forwards data to network
- Vehicle Monitors (4) . . . two command service modules, one S-IVB/LEM and one LEM monitor — displays: CRT's, pen recorder, and teletype
- Aeromedical Monitor . . . . . displays: CRT's, pen recorder, and cardioscope for monitoring astronauts' and life-support functions
- Flight Dynamics Officer . . . . . monitors insertion and injection trajectories for emergency evaluation of cutoff conditions and flight commitment
- Maintenance and Operation . . monitors shipboard instrumentation status and displays instrumentation status on flight control consoles

The Command Communicator has the responsibility of determining the status of the spacecraft and the astronauts by means of direct communications with the spacecraft and by reports from the vehicle monitor and aeromedical members of his flight control team. He reports this status to the network and receives his instructions from the network. In event of failure of the data and communication links to the network, the Command Communicator has the responsibility for choosing and initiating the spacecraft commands necessary for the success of the mission and the well-being of the astronauts.

Four Flight Controllers man the vehicle monitor subsystem, comprised of two command services module consoles, one S-IVB/LEM console, and one lunar excursion module system monitor console. The Flight Controllers have the responsibility of monitoring the status of the spacecraft instrumentation and reporting this status to the Command Communicator. Spacecraft data is selected from the telemetry signals and printed by a high-speed printer. Other displays include event-indicating lights and a vertical pen recorder. They have the capability to take direct action concerning the spacecraft instrumention in event of data and communications link failure to the network.



2-54 Figure 2-24. Mission Control Center Simplified Data Flow and Block Diagram

Figure 2-25. Mission Control Center

The aeromedical monitor console is manned by a medical team which monitors the performance of the astronauts and the operation of the life support systems and reports of the Command Communicators. The monitoring is accomplished by observing electrocardiograms, a display module, event indicators, and a pen recorder.

The Flight Dynamics Officer (FDO) is responsible for monitoring, during powered flight, the insertion and injection trajectory of the Apollo spacecraft from the standpoint of crew safety and mission success. The FDO evaluates the cutoff conditions and commits the flight as a "go" or a "no go." The FDO function is normally accomplished only in the Integrated Mission Control Center (IMCC), Houston, Texas. However, during periods of interrupted communications or severely degraded performance, the shipboard FDO assumes this responsibility.

The Maintenance and Operations (M&O) Supervisor monitors the status of the shipboard instrumentation systems and displays this status on the flight controller's consoles. He requires communications with the flight controllers, the Ship's Operation Manager's (SOM) Console, the Ship's Instrumentation Manager (SIM), the Designate Controller, and the ship's instrumentation systems.

SATCOM

SATELLITE COMMUNICATIONS TERMINAL (19-Class)

The Satellite Communications Terminal (SATCOM) is the primary communications system aboard the 19-Class for voice, tracking, and telemetry data to GSFC and MCC-H. Figure 2-26 is a composite data flow and system block diagram of the SATCOM Terminal. Each of the subsystems that comprises the SATCOM Terminal is briefly described in the following paragraphs.

ANTENNA SUBSYSTEM

The antenna is a 30-foot parabolic antenna on a tracking mount. It has three axis characteristics: azimuth, elevation, and traverse; therefore, it is capable of complete hemispherical coverage. The design is such that it automatically tracks a communications satellite from aboard ship and is controlled by: 1) a computer subsystem, or 2) antenna control console, or 3) remote-controlled position on the antenna mount, or 4) from the servo amplifier cabinet test panel. The antenna subsystem includes:

a. mount
b. feed
c. reflector
d. subreflector
e. RF transmission lines to the transmit and receive subsystems
f. servo drives
g. reference stable element

RECEIVE SUBSYSTEM

The receiver is capable of simultaneous reception and demodulation of any two communications frequencies in a 150-MHz band and anywhere within the frequency range of 3.700 GHz to 4.200 GHz.

A tracking receiver within the receive subsystem automatically searches a frequency spectrum, locates and locks on to the instantaneous frequency of the selected satellite beacon, and tracks the satellite frequency. In addition, the tracking receiver extracts tracking error signals which arise from an offset of the electrical axis of the antenna system in respect to the arrival of beacon signals from the true RF axis of the satellite.

The receive subsystem consists of the following:

a. low noise amplifiers
b. receiver translators
c. communication demodulators
d. tracking receiver and demodulator

TRANSMIT SUBSYSTEM

Transmitter operation is in any frequency in the band of 5.925 to 6.425 GHz. Power output is sufficient to deliver a maximum of 70 dbm into the transmit feed horn and is continuously adjustable down to 30 db below full power output.

The transmit subsystem is comprised of:

a. high power amplifiers
b. exciters
c. modulators
d. baseband equipment
e. protection and control circuits
f. heat exchangers
g. associated peripheral equipment

COMPUTER INTERFACE

The computer interface includes the equipment necessary to interface the Satellite Communications (SATCOM) System with the existing CDP System. The computer is also used with the other tracking systems.

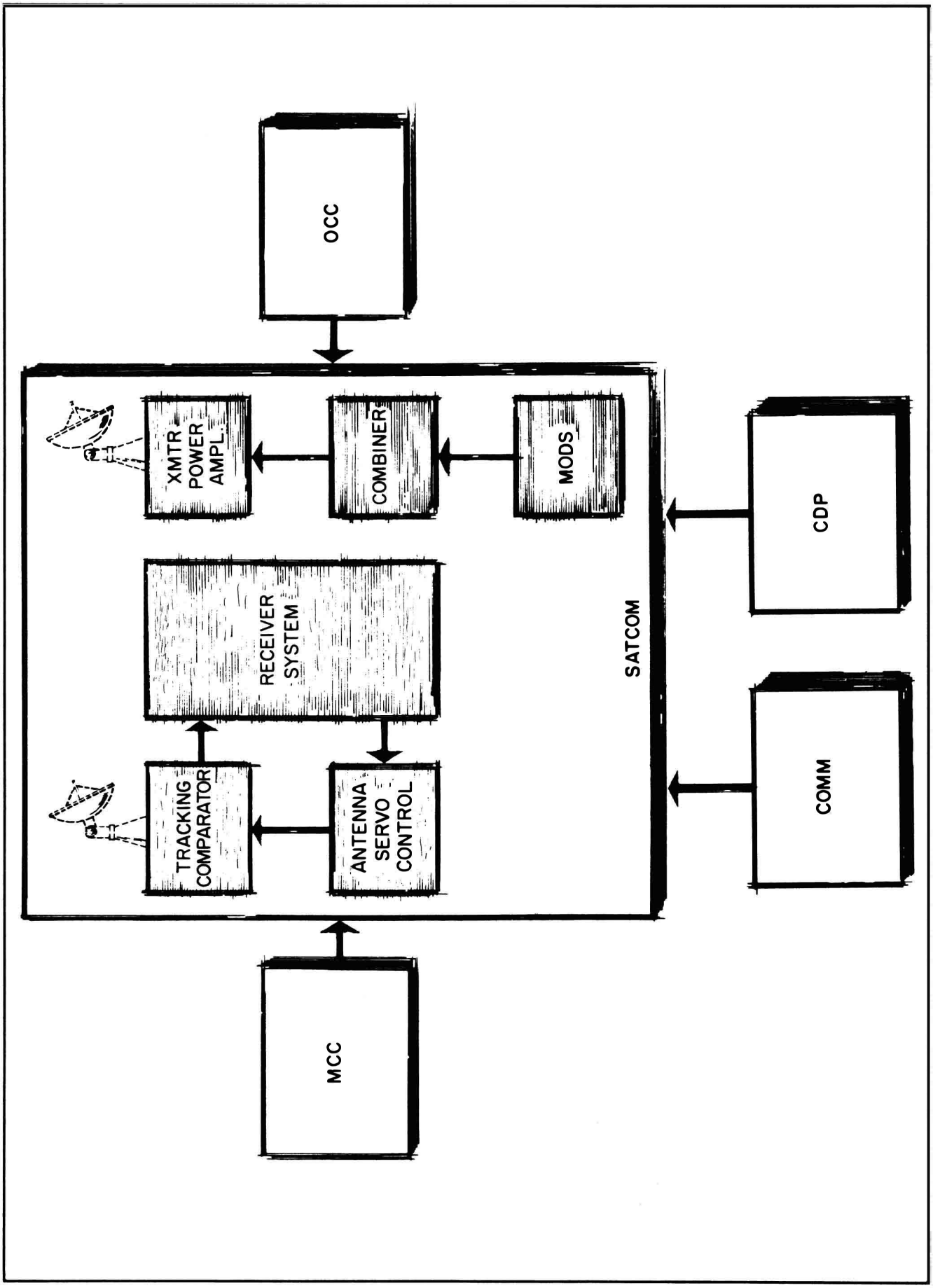


Figure 2-26. SATCOM System Simplified Data Flow and Block Diagram

The computer interface in conjunction with the CDP performs the following functions:

a. Computes in real time the stabilized pointing angles required by the antenna subsystem to acquire and track on the satellite of interest
b. Computes in real time programed tracking angles required by the antenna subsystem for maintaining data tracking when the same cannot be accomplished actively
c. Computes line-of-sight information for the satellite of interest
d. Provides necessary buffering and signal conversion to guarantee signal compatibility at the computer subsystem interface with the antenna subsystem (including the stable reference element) and the system time code generator
e. Computes other auxiliary functions within the limits of the subsystem which may be required or proof of interest in the operation of the system

COMPUTER SUBMODES

The SATCOM priority of computer operation is established at the computer input/output console. The computer, while in its internal standby mode, responds to the operator's SATCOM submode selection. The SATCOM submode selection is not possible during computer internal acquisition or tracking modes. Provisions are made for the following submode operations:

Satellite Designate

This submode is for the purpose of acquisition. The computer calculates the required antenna line of sight on the basis of previously stored acquisition parameters for the selected satellite and the present position of the ship. The computer generates error signals for each antenna axis by comparing the antenna axis angles with the line of sight which has been corrected for ship's attitude.

The antenna is incrementally designated to avoid the ship's structure. The operator is notified by a printout when the desired line of sight is pointing into prohibited zones.

Manual Designate

The computer stabilizes and holds the antenna to a fixed line of sight as selected by a manual input. The input of designate angles is initiated from the tracking console.

Computer Designate

The computer designate submode is available for acquisition and track modes of operation.

Manual Mode

The computer is not required for antenna control in the manual mode, but does compute true antenna bearing and elevation angles for display on the tracking console.

Automatic Track Mode

The computer in this mode provides tracking memory and control when the tracking signal is lost, provided that the computer is not in real-time control of the telemetry system.

FUNCTIONAL DESIGN

The CDP System is used to designate the SATCOM antenna in three coordinates and to provide display of true bearing and elevation angles on the tracking console.

COMMUNICATIONS TERMINAL EQUIPMENT SUBSYSTEM

The communications terminal equipment subsystem provides the necessary equipment and facilities to implement six voice/data channels, two teletype channels, and one order wire voice channel.

OPERATIONS AND CONTROL SUBSYSTEM

An integrated operations control center is provided to facilitate the operation of the shipboard satellite communication system with a minimum number of operators. Operation of the entire terminal is possible from this center, including operation of the Apollo communications transmitters, receivers, antenna subsystem, computer subsystem, time standard, and telephone and interphone systems. Status of the equipments is displayed at the Control Center to aid in system operation. The antenna tracking console is located adjacent to the communications control console to achieve physical integrity.

The communications console section provides monitoring and controlling functions for both transmitter and receiver subsystems.

The tracking console provides controls and indicators for use in establishing position and track operation and status displays.

The power and station control console contains indicators and meters for selecting standby and ON modes of operation for continuously monitoring station ac and dc powers. In addition, this console contains the necessary warning lamps and audible alarm and control circuits to ensure against equipment damage due to loss of critical power sources.

The communications system patch panel is located in the communications central area to facilitate interconnecting of terminal equipments.

COMM

COMMUNICATION SYSTEM (INSTRUMENTATION)

Included in the Instrumentation Communication System are a radio subsystem, an instrumentation interphone subsystem, a dial telephone subsystem, and entertainment subsystem. Figures 2-27 and 2-28 depict the systems for each class of ships in data flow and block diagram form. Figure 2-16 shows the Communications and Timing Room and Figure 2-29 shows the Transmitter Room for the AIS. The SATCOM System (19-Class) is treated as a separate system from the Communication System; however, the interphone and teletype facilities in the Communication System (radio subsystem) are used in common with the SATCOM System.

RADIO SUBSYSTEM

The radio subsystem provides radio communications in the high frequency (HF), very high frequency (VHF), and ultra high frequency (UHF) bands with voice, radio telegraph, radio teletype, and Hi-Speed Data transmission (19-Class) capabilities. Secure means for teletype radio communications are included in the HF subsystem circuitry.

The HF facility serves as a long haul or point-to-point, ship-to-shore voice, teletype, and data transmission medium. The HF is a backup for the SATCOM System (T-AGM-19-Class) and is used during SATCOM failure and as a supplement to the SATCOM System.

The VHF facility serves as a short haul ship-to-ship or ship-to-aircraft voice medium.

The UHF facility serves as a line-of-sight ship-to-spacecraft or ship-to-aircraft voice medium. A VHF homing beacon is included to permit aircraft to use the VHF facility for navigation. An automatic keyer incorporated in the ship's radio system allows use of the ship's MF radio transmitter as a homing beacon.

The LF-VLF receiver facility provides for the reception of VLF teletype and CW signals.

The HF Ionospheric Sounder Receiver is used in conjunction with one of any number of shore sounder transmitters and displays the usable (propagating) frequencies at a given time between the geographical location of the ship and the sounder transmitter to which it is turned.

Radio subsystem leading equipment and characteristics are as follows:

- Transmitters
  - HF-10 kw PEP output, 2-32 MHz, frequency synthesized, stability 1 part in 10^8 per day, remotely tuned, ISB, SSB, AM, CW, FAX, FSK
  - UHF—225-400 MHz, AM, 15w
  - VHF—118-151.9 MHz AM, 25w
- Transmitter/Receivers
  - UHF—225-400 MHz, AM 100w
  - VHF—116-149.5 MHz, AM, 40w
  - HF—2-30 MHz, ISB, SSB, AM, FSK, MCW, CW, 500w
- Receivers
  - LF-VLF—70 kHz-30 MHz, AM, CW, MCW, SSB, FSK
  - HF—2-30 MHz, stability 1 part in 10^8 per day, ISB, SSB, AM, CW, MCW, FSK, FAX, remotely tuned
  - HF General Coverage—2-30 MHz, ISB, SSB, AM, CW
  - VHF—118-151.9 MHz, AM
  - UHF—225-400 MHz, AM
  - Ionosphere Sounder—2-30 MHz, 80 or 160 channels, stability 5 parts in 10^9 per day

- Antennas

  Transmitters-HF Log Periodic—7.5-30 MHz, steerable, 6-10db gain, 10 kw PEP, horizontal beamwidth 60°, vertical beamwidth 120°

  Transmitters-HF Folded Monopole (Hairpin)—2-30 MHz, omnidirectional, 10 kw PEP, remotely tuned.

  Transmitters-HF Helical (6-Class)—2-28 MHz, 10 kw PEP, remotely tuned, omnidirectional Receive HF 20 ft, 25 ft, and 35 ft whips, untuned, end fed.

  Transmit/receive (UHF and VHF aircraft—Navy type dipole

  Transmit/receive (UHF spacecraft)

  6-Class—Modified AGAVE

  19-Class—Elements in Command Control Antennna and Secondary/Telemetry Antenna

- Teletype Machines

  Keyboard Send Receiver (KSR), Automatic Send Receiver (ASR), Transmitter Distributor (TD), Reperforator (ROTR) are all Teletype Corp. Model 28 and are capable of 60, 66, 100 wpm.

- Teletype Terminal

  16-channel frequency division multiplex 60 ma, 60-66-100 wpm, frequency shift ±42.5 cycles.

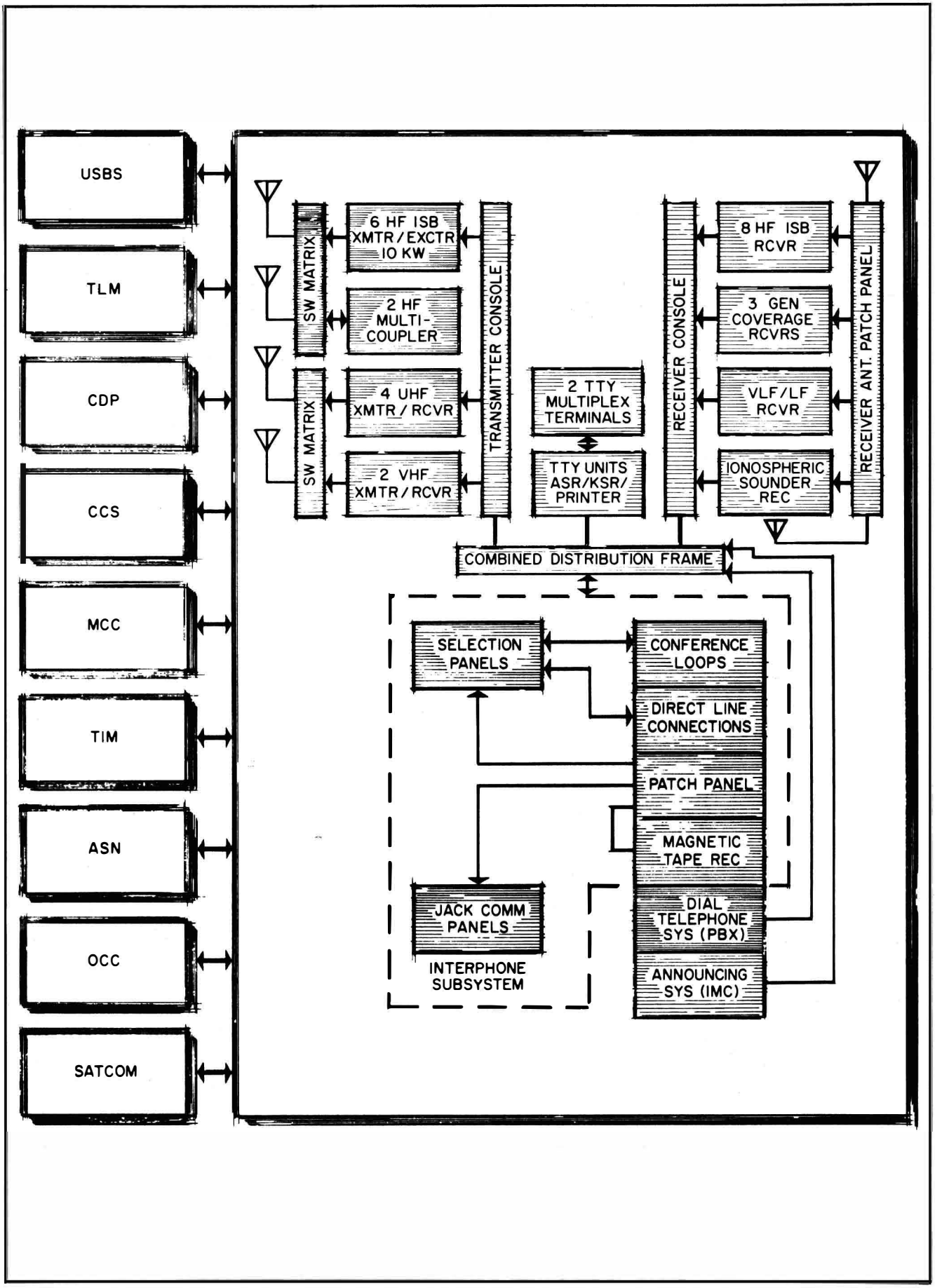
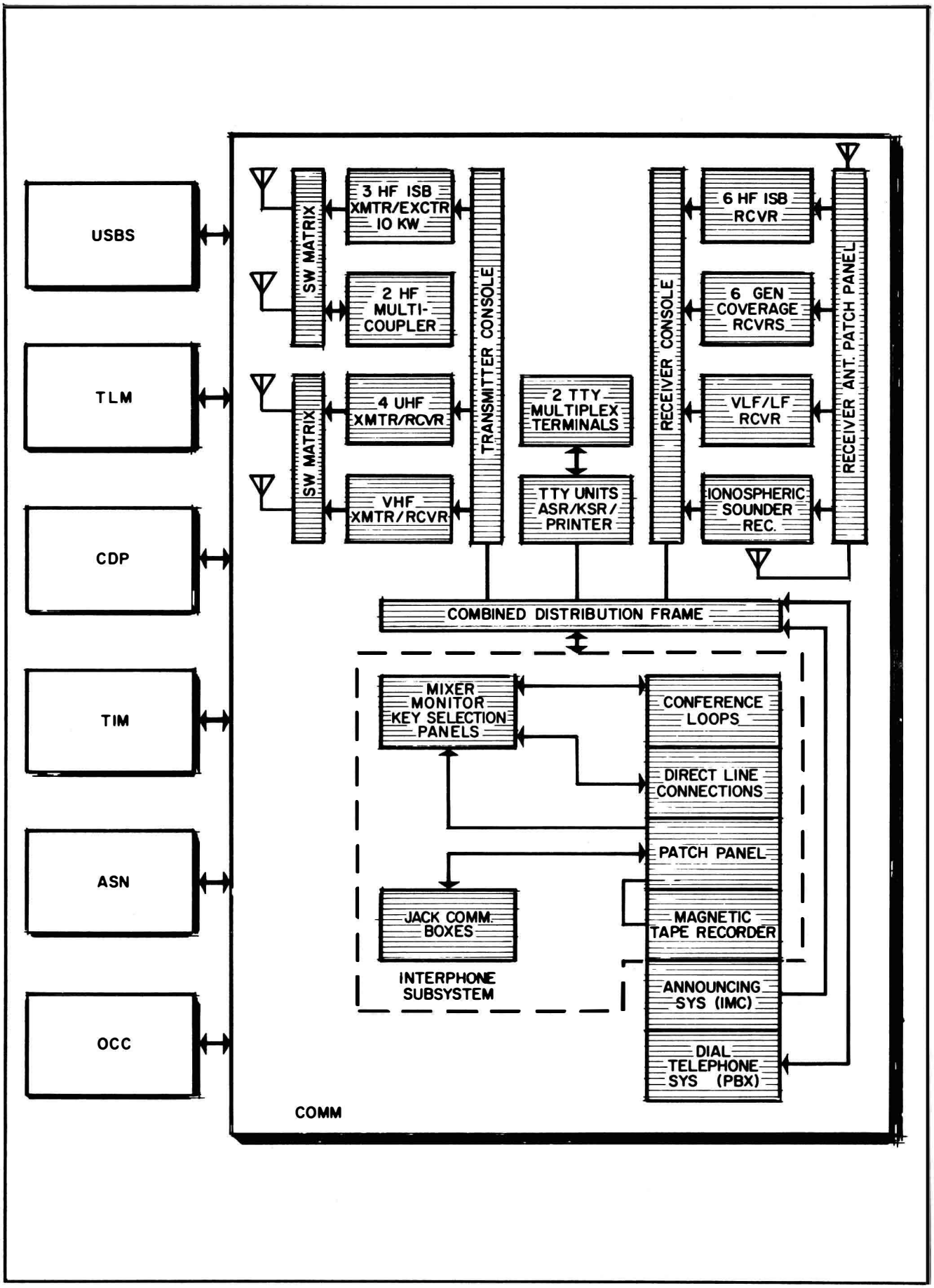


Figure 2-27. 19-Class Communications System Simplified Data Flow and Block Diagram



2-64 Figure 2-28. 6-Class Communications System Simplified Data Flow and Block Diagram

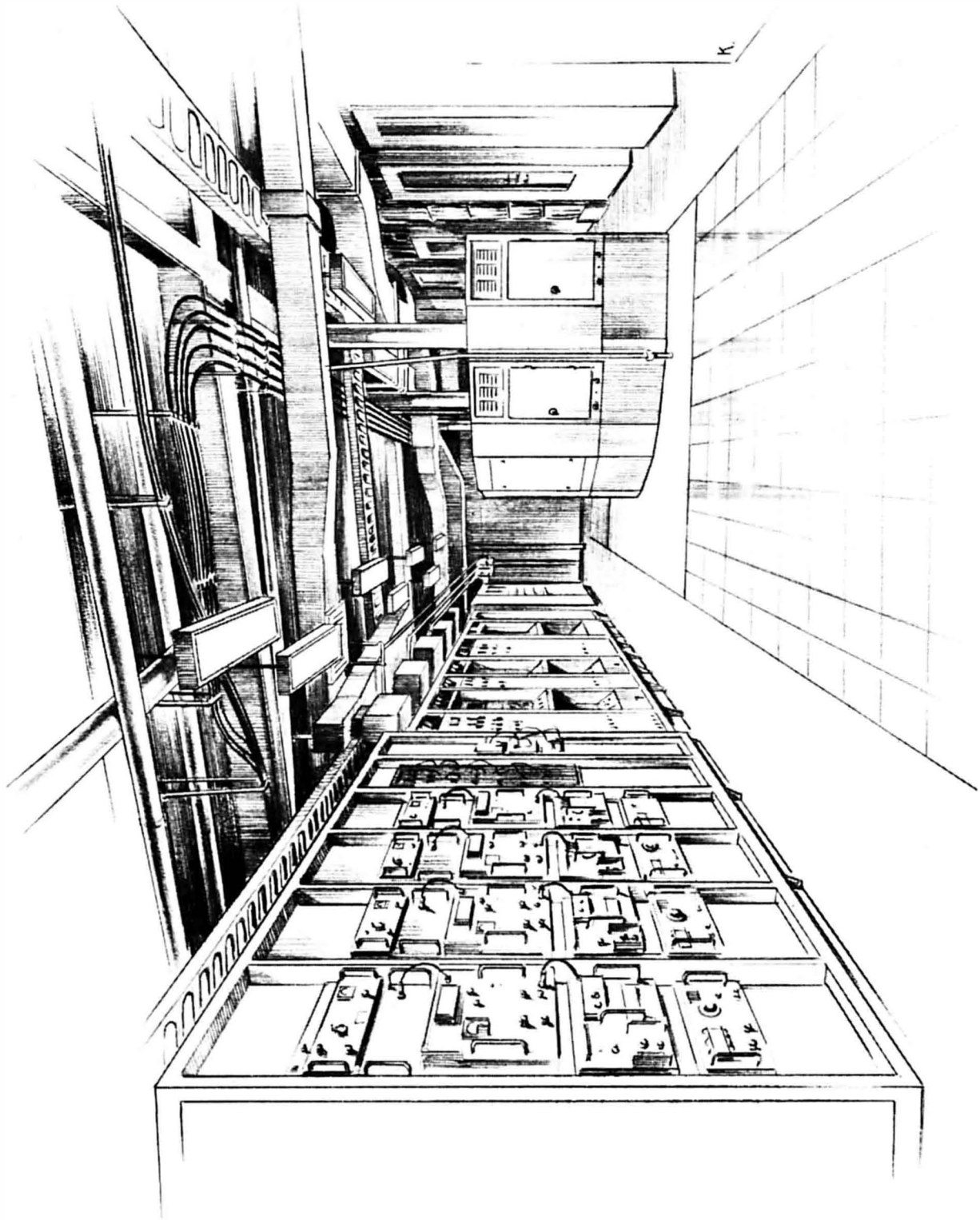


Figure 2-29. Typical Communications Transmitter Room

INTERPHONE SUBSYSTEM

The interphone subsystem provides the flexibility and service required to support operational missions.

The communications subcircuits are the conference loop type affording talk and/or monitor access at the control of the operators. Normally, each of the operators is assigned to monitor one loop and can be given talk and/or monitor capability of the other loops as required. There are two types of conference loops: local type and radio interface, which vary from 12- to 24-position capability each.

Direct lines are interconnected between two or more interphone positions with both visual and audible signaling on the key-selection panels.

The key-selection panels and mixer monitor panels contain the pushbuttons to control the access to conference loops.

Cross-connecting in the Combined Distribution Frame (CDF) and patching at the jack field provide for the following:

Communication between any selected shipboard instrumentation areas operating on a press-to-talk basis, conferencing of any selected combination of shipboard instrumentation areas, and two-way radio communications as required to any shipboard instrumentation area or conference net.

Seven-track and 14-track magnetic tape recorders are capable of recording selected, simultaneous communication circuits with time correlation.

The announcing system (1 Mc) input can be connected to any conference loop with local muting provided.

Radio contacts with other ships or shore can be made via the patch panel to any instrumentation area by conference loops or telephones. Voice-actuated electronic relays or press-to-talk switching provides for transmitter keying. Tone-actuated relays supply remote keying of UHF transmitters.

DIAL TELEPHONE SUBSYSTEM

The dial telephone subsystem is for general administrative and logistic support use.

The dial telephone (PABX) switchboard provides, in addition to the normal 3-digit shipboard extension dialing system (a secondary communication system), a capability for patching into the interphone conference loops, and a radio communications link to a ship extension number.

In port, an umbilical cable connects the subsystem to shore lines.

ENTERTAINMENT SUBSYSTEM

The entertainment subsystem consists of a radio broadcast antenna and a distribution facility to all staterooms, a television antenna system, and television antenna distribution facility to lounges and messrooms.

GLOSSARY OF NAUTICAL TERMS AND PHRASES

ABAFT: behind, or farther aft. The mainmast is abaft the foremast.

ABEAM: at right angles to the center line of the ship. Refers to an object outside the ship.

ABOARD: on or in a ship.

ACCOMMODATION LADDER: steps leading down a ship's side; used for boarding.

ACKNOWLEDGEMENT: a statement that a message has been received.

AFT: at, near, or in the direction of the stern.

ALL HANDS: refers to every man aboard.

AMIDSHIPS: in the line of the keel; sometimes halfway between the bow and stern.

ASTERN: behind the ship; on a bearing of 180° from ahead.

AUXILIARY: an assisting machine or vessel, such as an air-conditioning machine or a fuel ship.

BALLAST: heavy weights in the hold of a vessel or ship to increase stability by lowering center of gravity.

BEACON: an aid to navigation placed on or near a danger spot.

BEAM: the greatest width of a ship.

BEARING: the direction of an object expressed either in degrees either as *relative* or *true* bearing.

BELOW: beneath the main deck.

BERTH: a space for a ship to moor or anchor.

BILGE: lower part of a vessel where waste and seepage collect.

BILLET: an allotted place to sleep; refers also to a particular man's duties aboard ship.

BLINKER: a set of lights at the masthead or on the end of a yardarm, connected to a telegraph key and used for sending flashing light signals.

BOAT: a small vessel which can be hoisted onto or carried by a ship.

BO'SN'S CHAIR: a seat, consisting of a short board fastened in the end of a line, on which a man may be suspended for working aloft or over the side.

BO'SN'S PIPE: a small, shrill whistle used by the bo'sn's mate in passing a call or in piping the side.

BOW: forward part of a vessel.

BRIDGE: the raised platform in the forward part of the ship from which the ship is steered or navigated.

BULKHEAD: a partition separating compartments; corresponds to a wall in a building.

BUOY: a floating marker moored to the bottom which by shape and color conveys navigational information.

CABIN: the captain's quarters.

CAPSIZE: to overturn in a small boat.

CAST OFF: to let go.

CENTER LINE: imaginary straight line running from the bow to the stern of a ship.

CHART: a nautical map used as an aid in navigation.

CLEAR: to leave a port with all formalities concluded; to empty; to work clear, as of a shoal; to untangle.

CLOSE ABOARD: near to the ship.

COLORS: the national ensign.

COMMAND: term applied to a ship or ships under one officer; a directive indicating what to do and how to do it.

COMPANION WAY: passageway on board ship.

COMPARTMENT: a space below deck between bulkheads, corresponding to a room of a building.

COUNTRY: the space near to a compartment or quarters, such as wardroom country or officers' country.

COURSE: the direction steered by a vessel expressed in degrees.

COXSWAIN: the enlisted man in charge of a boat and usually serving as steersman.

DAMAGE CONTROL: maintenance of watertight integrity of the ship during batle or storms, including necessary repairs.

DAVIT: a curved metal spar fitting in a socket on the deck and projecting over the side of the ship for hoisting boats or handling weights.

DEAD AHEAD: directly ahead.

DEAD RECKONING: a navigator's estimate of the ship's position dependent upon course steered and distance run, independent of sights or bearings; derived from "deduced reckoning."

DECK: corresponds to the floor of a building.

DOCK: a landing pier for boats or ships.

DOG: a type of bolt and nut used to secure watertight doors, hatch covers, or manhole covers.

DOLDDRUMS: belts on each side of the Equator in which, ordinarily, little or no wind blows.

DOUBLE BOTTOMS: watertight subdivisions of a ship next to the keel and between the outer and inner bottoms.

DOWSE: to put out a light; to cover with water.

DRAFT: the depth of water from the surface to the ship's keel; a detail of men.

EBB TIDE: condition along the coast when the tide is going out.

EMBARK: to go on board ship.

EMERGENCY SPEED: all the speed of which a ship is capable.

ENSIGN: the national flag; a junior commissioned officer in the Navy.

EVEN KEEL: floating level.

FAIR TIDE: a tide running in the same direction as the ship.

FAIRWAY: an open channel.

FANTAIL: the part of the stern of the ship.

FAST: secure.

FATHOM: a unit of measurement equalling 6 feet.

FLANK SPEED: a certain prescribed increment above standard speed.

FLYING BRIDGE: a bridge on a ship having no supports and extending out from the control tower.

FORE AND AFT: running in the direction of the keel.

FORECASTLE: the upper deck forward of the foremast; a forward compartment where the crew lives.

FRAME: the ribs of a ship strengthening and supporting the plating.

FUNNEL: the smokestack of a ship.

GALLEY: the ship's kitchen.

GANGPLANK: a portable bridge used for boarding a ship from a dock.

GIG: ship's boat used by the commanding officer.

GUNWHALE: the upper edge or rail of a ship or boat's side.

HAND: a member of the crew.

HANDY-BILLY: a small portable pump.

HATCH: an opening in the ship's deck for communication or for handling stores and cargo.

HEAD: a ship's toilet.

HELM: a tiller; the gear by which the ship is steered.

HIGH SEAS: the entire ocean beyond the three-mile limit where no nation has special privileges or jurisdiction.

HULL: framework of a vessel together with all decks, deckhouses, inside plating or planking, exclusive of masts, yards, rigging, all equipment, and all items generally classed as superstructure.

INBOARD: toward the center line of the ship.

ISLAND: superstructure containing conning tower, navigation bridge, communication platform, flying bridge, etc.

JETSOM: goods which sink when thrown overboard at sea.

JETTY: a landing wharf or pier, a dike at a river's mouth.

KEEL: the backbone of a ship running from stem to sternpost at the bottom.

KNOT: one nautical mile per hour.

LADDER: a metal, wooden, or rope stairway.

LANDFALL: first sighting of land at the end of a sea voyage.

LASH: to tie or secure.

LEAVE: special permission to be absent from ship or station.

LEE: away from the direction of the wind.

LIFELINE: a line secured along the deck to lay hold of in heavy weather; a line thrown on board a wreck by a life-saving crew; a knotted line secured to the span of life boat davits for the use of the crew when hoisting and lowering.

LIGHTSHIP: a small ship equipped with a distinctive light and anchored near an obstruction to navigation or in shallow water to protect passing ships.

LINE: the Equator; a seagoing term for light rope or cable.

LINE OFFICER: an officer who holds military authority in the chain of command, as opposed to a staff officer such as a doctor or chaplain. May be important for NASA personnel to understand.

LOG: a book containing the official record of a ship's activities.

MAIN DECK: the highest complete deck extending from stem to stern and from side to side.

MOORING: securing a ship to a dock or buoy, or anchoring with two anchors.

NAUTICAL MILE: the length of a minute of a great circle of the earth or 6,080.20 feet.

OFFICER OF THE DECK: the officer in charge of the ship during each watch and on deck as the captain's representative.

OVERHEAD: equivalent to the ceiling in a building.

PASSAGEWAY: a corridor or hallway on board ship.

PILOT: an expert who conducts ships in and out of harbors and in dangerous waters.

POOP DECK: the partial raised deck and after structure at the stern over the main deck of a vessel.

PORT: the left side of a ship facing forward; an opening in the ship's side; a harbor.

QUARTERDECK: the part of the upper deck reserved for honors and ceremonies.

QUARTERS: living space; all hands assembled at established stations for review.

REEF: a chain or ridge of racks, coral, or sand in shallow water.

RUNNING LIGHTS: lights required by law which are carried by a ship underway.

SCREW: propeller.

SCUTTLEBUTT: a container of fresh water for drinking purposes used by the crew; a rumor.

SEA KEEPING: the ability of a ship to stay at sea for long periods of time.

SECOND DECK: a complete deck next below the main deck.

SECURE: to make fast; to tie; order given on completion of a drill or exercise on board ship.

SHAKEDOWN CRUISE: cruise of a newly commissioned ship to test out all machinery and train the crew.

SICKBAY: ship's hospital or dispensary.

SIDE LIGHTS: the red and green running lights carried on the part and starboard sides respectively.

SKIPPER: slang for the captain.

SMOKING LAMP: the expression, "the smoking lamp it lit," means permission is given to smoke.

SOUND-POWERED PHONE: a phone powered by voice; standard battle phone.

SQUARE AWAY: to get things settled down or in order; to complete a job.

STAFF OFFICER: an officer whose duties are special rather than military, such as a doctor or chaplain.

STARBOARD: the right side of a ship looking forward.

STATION BILL: a bill listing stations of the crew at emergency drills and other shipboard evolutions.

STERN: the after part of a ship.

SUBMERSIBLE PUMP: an electrically driven pump that can be lowered into a flooded compartment.

SUPERSTRUCTURE: all equipment and fittings except armament extending above the hull.

SWAB: a rope mop.

SWELL: the heave of the sea.

TAFFRAIL: a rail at the stern of a ship.

TOPSIDE: above decks.

UNDERWAY: a vessel is said to be underway when she is not at anchor nor made fast to the shore, nor aground.

UNDERTOW: a seaward current near the bottom in heavy surf.

WAKE: the track or trail in water which a vessel leaves behind.

WARDROOM: officers' assembly and messroom aboard a ship.

WATCH: a post or period of duty.

WATCH, QUARTER, AND STATION BILL: a list or chart giving the watch duties, billet and emergency, or battle station of every man aboard ship.

WEATHER DECK: the portion of the main, forecastle, poop, and upper decks which is exposed to the elements.

WINDWARD: into the wind; toward the direction from which the wind is blowing.

YARD: shipbuilding and repair depot for Navy vessels—as Boston Navy Yard.

YAW: to steer badly, zigzagging back and forth across the intended course.