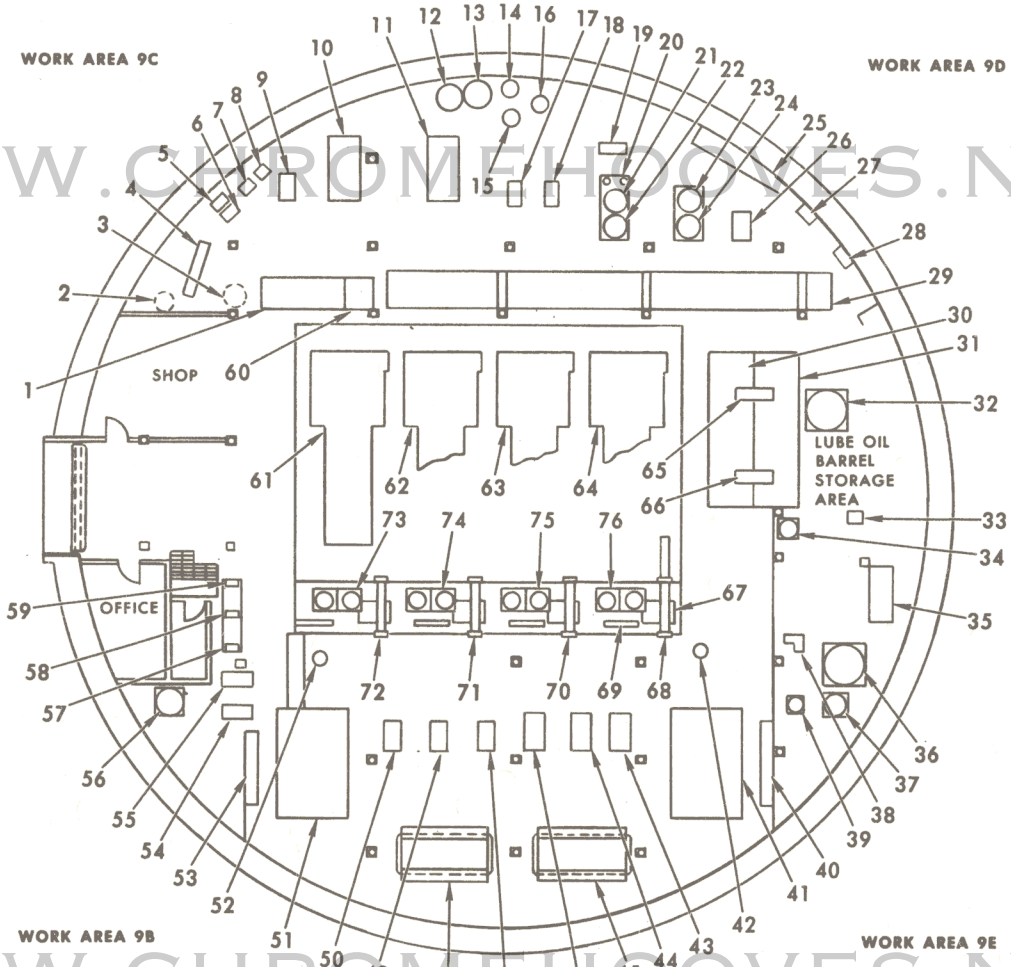

1. SUBSTATION SUB1010
2. PROCESS DRAIN SUMP PUMP SP3138
3. SUMP PUMP 3136
4. MOTOR CONTROL CENTER MCC1031
5. PNL1041
6. TR1090
7. PNL1042
8. PNL1043
9. JOCKEY PUMP 3096
10. FIRE PROTECTION PUMP P3094
11. FIRE PROTECTION PUMP P3095
12. WATER SOFTENER T3052
13. WATER SOFTENER T3053
14. WATER SOFTENER T3055
15. WATER SOFTENER T3054
16. WATER SOFTENER T3056
17. RAW WATER PUMP P3080
18. RAW WATER PUMP P3081
19. UTILITY AIR COMPRESSOR CC5021
20. UTILITY AIR DRYER AD5015
21. UTILITY AIR TANK T5010
22. UTILITY AIR TANK T5011
23. START AIR TANK T1001
24. START AIR TANK T1002
25. BATTERY PACK BAT1020
26. START AIR COMPRESSOR CC1001
27. BATTERY CHARGER REC1020
28. FUEL TRANSFER PANEL PNL1040
29. MAIN SWITCH GEAR
30. ICE BANK 1B3001
31. ICE BANK 1B3002
32. CLEAN LUBE OIL TANK T1005
33. CENTRIFUGE LUBE OIL HEATER
34. CE1001, P1002, P1007 AND HE1001
35. FUEL SLOP TANK
36. DIRTY LUBE OIL TANK T1006
37. PROCESS DRAIN SUMP PUMP P3136
38. DIRTY LUBE OIL PUMP P1003
39. BLOWDOWN TANK
40. MOTOR CONTROL CENTER MCC1030
41. WATER CHILLER WC3002
42. DEEP WELL PUMP NO. 2 P3140
43. CHILLED WATER PUMP P3085
44. CHILLED WATER PUMP P3086
45. COOLING TOWER CT3001
46. ICE BANK PUMP P3087
47. COOLING TOWER PUMP P3131
48. COOLING TOWER CT3002
49. COOLING TOWER PUMP P3089
50. COOLING TOWER STANDBY PUMP P3133
51. WATER CHILLER WC3001
52. DEEP WELL PUMP P3139
53. MOTOR CONTROL CENTER MCC1039
54. HOT WATER PUMP P3089
55. HOT WATER PUMP P3088
56. SEWAGE EJECTOR P3108 AND P3109
57. CONDENSATE PUMP P3006
58. CONDENSATE PUMP P3142
59. CONDENSATE PUMP P3141
60. 1000KVA TRANSFORMER
61. DIESEL DG1004
62. DIESEL DG1003
63. DIESEL DG1002
64. DIESEL DG1001
65. CONDENSING UNIT 1B3001H
66. CONDENSING UNIT 1B3002H
67. LUBE OIL SUMP (4 PLACES)
68. LUBE OIL COOLER HE1006
69. ENGINE PANEL (4 PLACES)
70. LUBE OIL COOLER HE1005
71. LUBE OIL COOLER HE1004
72. LUBE OIL COOLER HE1003
73. LUBE OIL FILTER F1004
74. LUBE OIL FILTER F1005
75. LUBE OIL FILTER F1006
76. LUBE OIL FILTER F1007

500L302

Figure 1-29. Power House Lower Level Typical Equipment Location (Operational Bases)

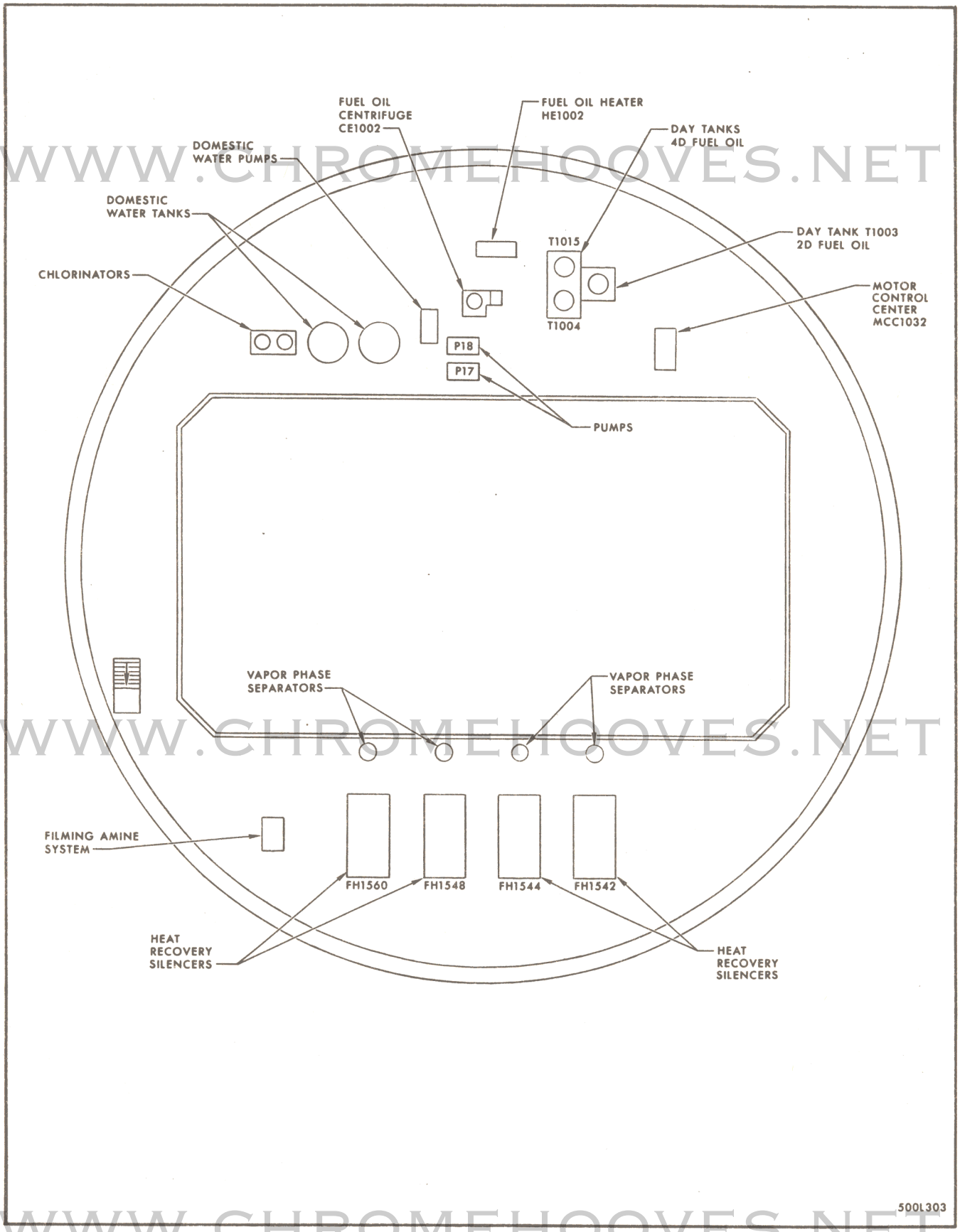

Figure 1-30. Power House Mezzanine Typical Equipment Location (Operational Bases)

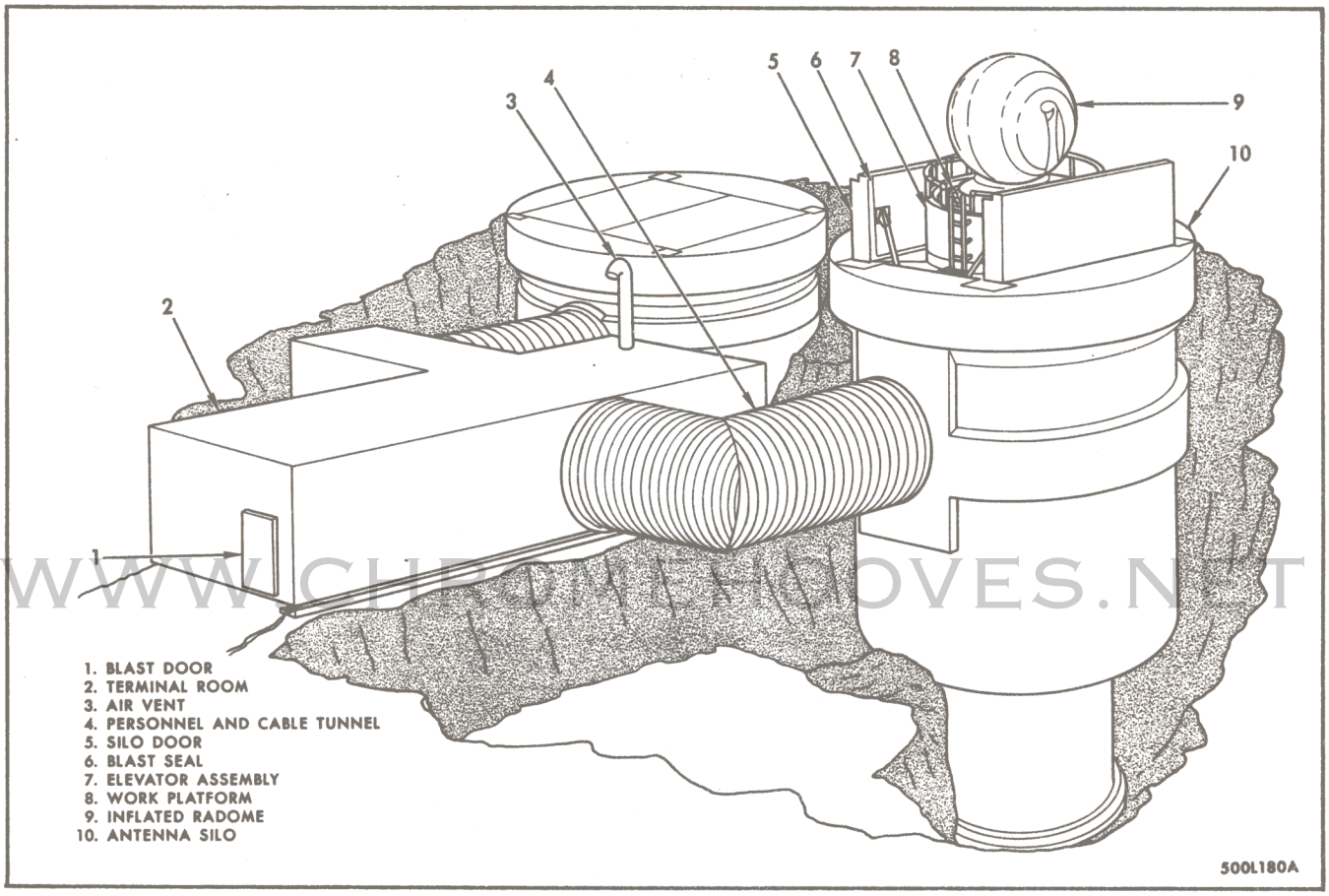

Figure 1-31. Antenna Terminal (VAFB)

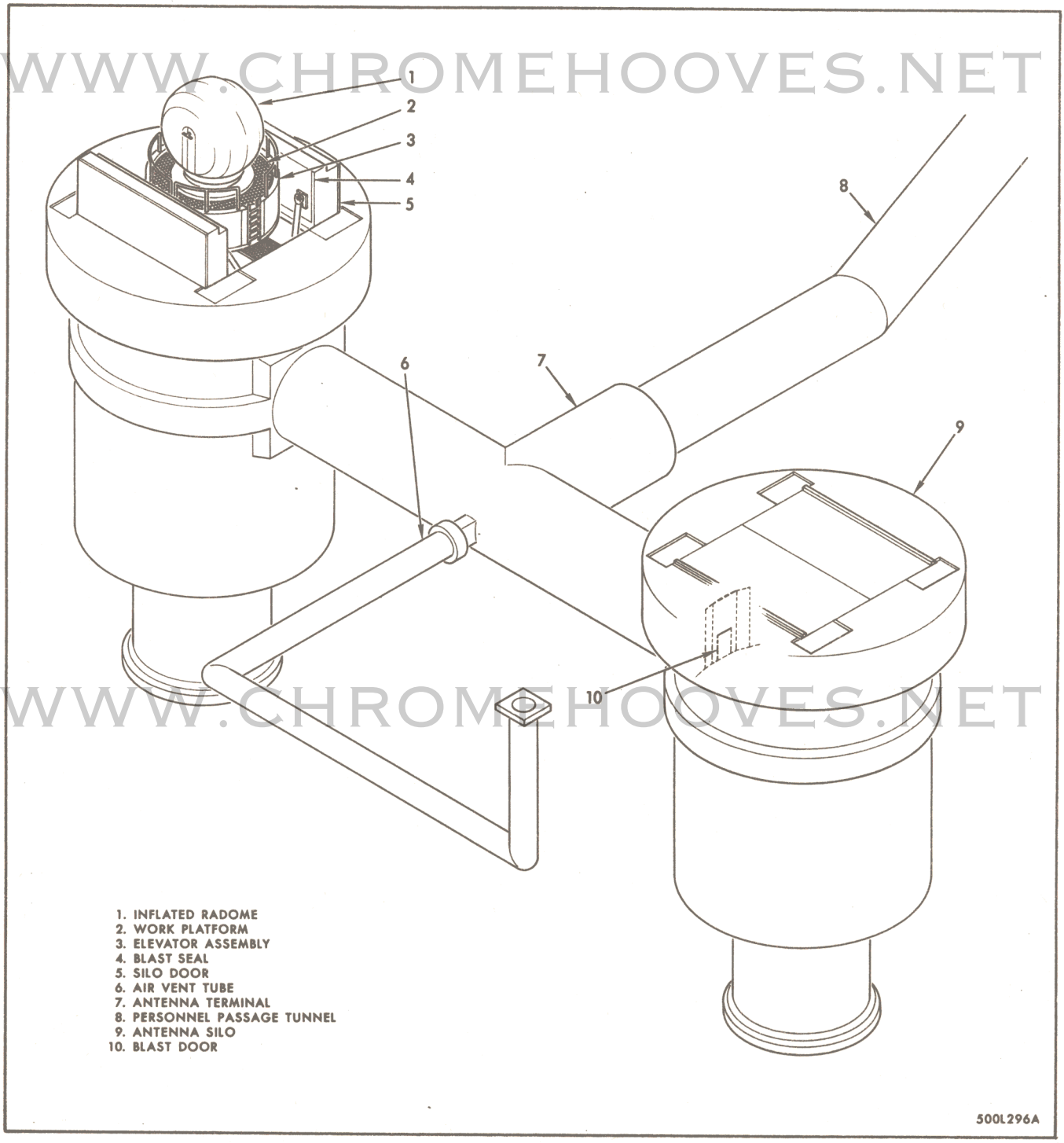

Figure 1-32. Antenna Terminal (Operational Bases)

(Text continued from page 1-42.)

1-84. The antenna terminal contains electrical and air conditioning equipment for control of two separate radar guidance antennas. Two complete systems are provided; one to be used for standby and one to be used for back-up or maintenance.

1-85. TERMINAL ROOM. The terminal room contains a motor control center, missile guidance equipment, antenna elevator control equipment, lighting control equipment, electrical receptacles, sump pump, air compressor, de-icer controls, and air conditioning equipment for the terminal room and silos.

1-86. ANTENNA SILOS. Each antenna silo contains an elevator assembly that raises the antenna to the above ground operating position. The operation of the elevator assembly is controlled by equipment in the terminal room. This equipment responds to signals received from the guidance station in the control center. Above ground equipment is used for the orientation and alignment of the antennas.

1-87. FUEL TERMINAL.

1-88. The fuel terminal contains the fuel storage tank and necessary controls for handling fuel. The area is connected to each launcher through the tunnel network and supplies fuel for each of the three missiles in the launch complex. The fuel terminal is located underground adjacent to tunnel junction 10 (figure 1-33) at VAFB and adjacent to tunnel junction 12 (figure 1-34) at the operational bases. The storage area contains a ground level valve box, fuel storage tank, a nitrogen blanket tank, a fuel filter, a fuel transfer pump, a fuel transfer panel, fuel transfer valves, and a carbon dioxide fire fighting system. Fuel servicing is accomplished through above ground fill lines.

1-89. GROUND LEVEL VALVE BOX. The ground level valve box is located above the fuel terminal area. The box contains terminal caps and fittings for the fuel recirculating, fuel fill, and nitrogen charge pipe lines. The ground level valve box is accessible from the road network and the fuel fill pad.

1-90. ACCESS ROOM. A circular section of tunnel forms the access room to the fuel storage tank and the nitrogen blanket tank. A fuel transfer pump in the access room transfers fuel to each launcher.

1-91. Ventilation is provided by a fan mounted above the fire door which pulls air from the tunnel junction into the access room. This fan is equipped with a fire damper which closes automatically in the event of a fire.

1-92. FUEL STORAGE TANK. The fuel storage tank is located lateral to the tunnel junction, with one end of the tank entering the access room. The tank serves as the main fuel storage tank for the three launchers. Fuel in the storage tank is blanketed with gaseous nitrogen. Three fuel lines are connected to the storage tank; one for initial fill, the second for unloading to the surface and transferring fuel to and from the launchers, and a third line is used for a fuel drain line from the launchers back to the storage tank.

1-93. NITROGEN BLANKET TANK. The nitrogen blanket tank is located lateral to the fuel storage tank. The nitrogen tank supplies gaseous nitrogen for blanketing the fuel tank and lines.

1-94. FUEL TRANSFER CONTROL PANEL. (See figures 1-33 and 1-34.) The fuel transfer control panel is located inside the tunnel junction. The panel contains controls

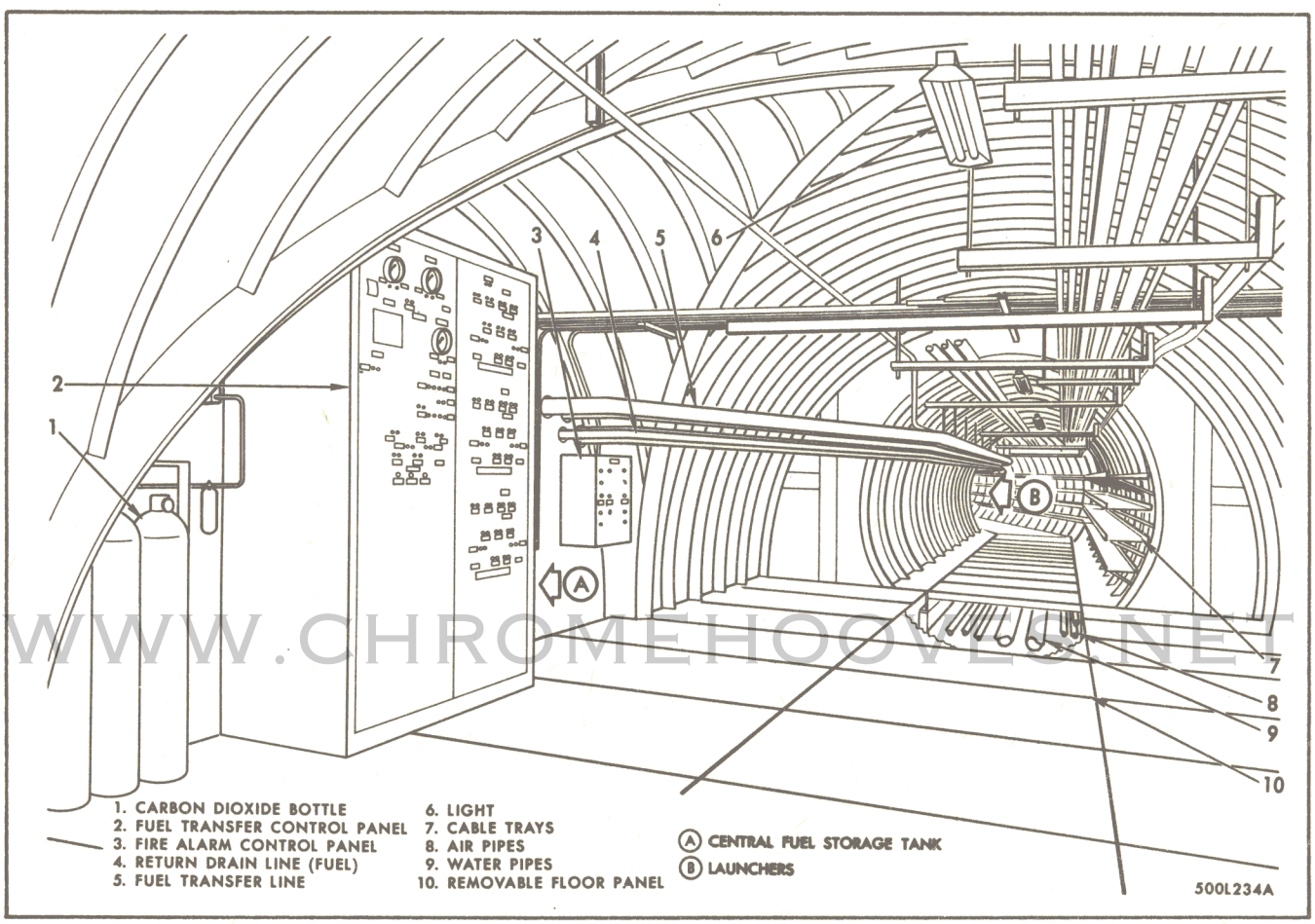

Figure 1-33. Tunnel Junction 10 (VAFB)

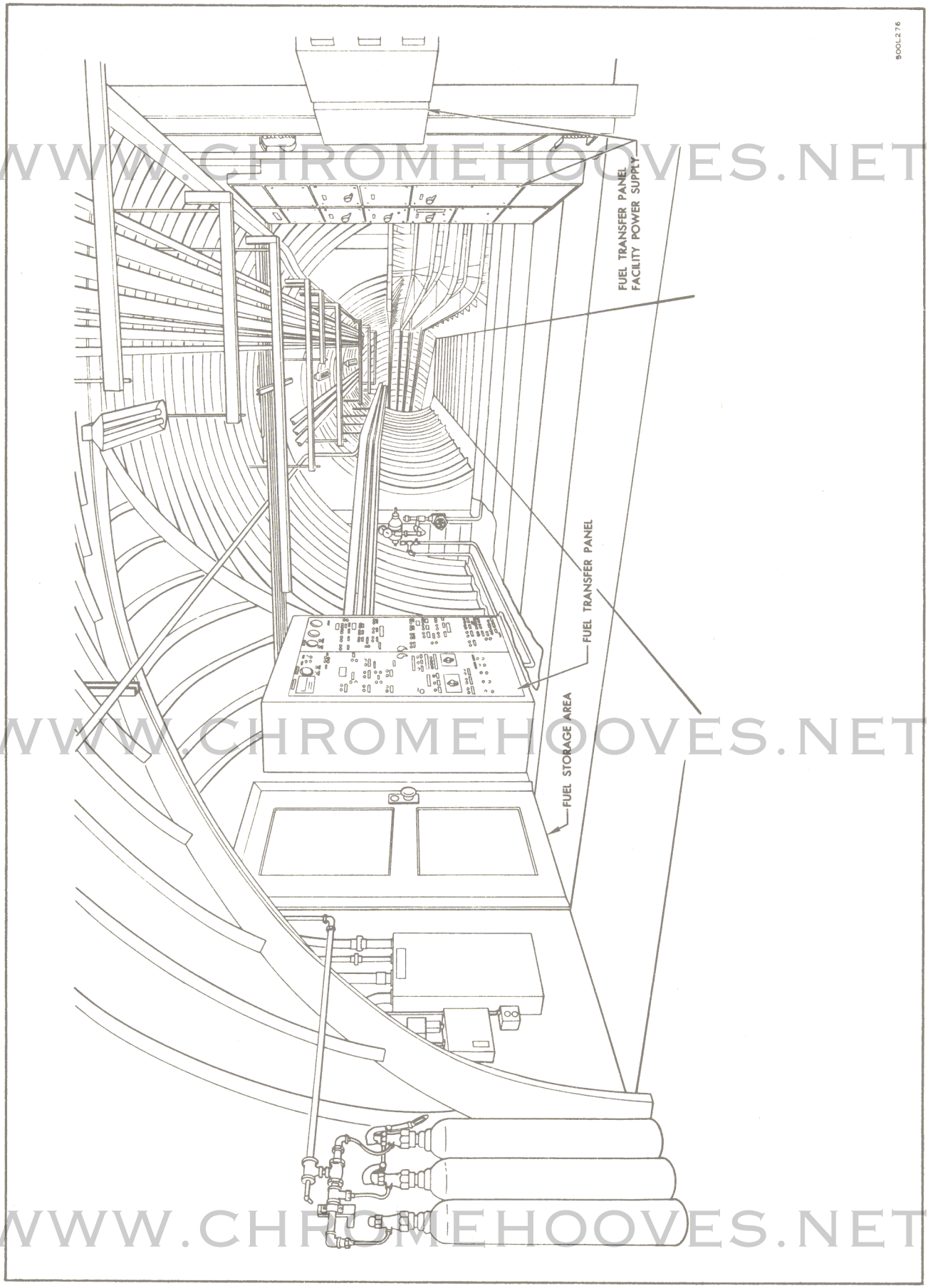

Figure 1-34. Tunnel Junction 12 (Operational Bases)

That effect fuel transfer operations to each missile launcher. Fuel transfer consists of loading and unloading fuel from the missile tanks and loading and recirculating fuel in the fuel storage tank.

1-95. FIRE FIGHTING SYSTEM. The fire fighting system for the fuel storage area consists of three 75-pound carbon dioxide cylinders (in the tunnel junction) connected to four distribution nozzles (in the access room). A fuel fire alarm control panel, located adjacent to the access room in the tunnel junction, controls the cylinders and the warning devices. The panel contains automatic relays; indicators for visual indications of safe, corrective, or unsafe conditions; and pushbuttons for silencing the alarm devices. The panel also contains a reset button for resetting the fire alarm electrical system.

1-96. There are two fuel fire sensors installed on the ceiling of the access room. These sensors are connected electrically to a relay in the alarm panel and respond to a predetermined temperature setting.

1-97. The alarm panel warns of an unsafe condition in the access room by causing an alarm horn and bell to sound simultaneously for fire.

1-98. PORTAL.

1-99. The portal provides access to the launch complex. At the operational bases, the portal contains a freight elevator for handling heavy equipment.

1-100. TUNNELS.

1-101. The tunnels at VAFB (figure 1-5) connect the control center with each of the three launchers. At operational bases (figure 1-4) the tunnels connect each missile launcher with the control center, power house, and antenna terminal. At VAFB the antenna terminal contains a separate tunnel system to connect the terminal room to the two antenna silos. The main tunnel system includes tunnel junctions, blast locks, and branch tunnels for each launcher, propellant terminal, and equipment terminal. The branch tunnels are connected to the main tunnel at tunnel juctions. In each missile launcher there is a liquid oxygen tunnel from the propellant terminal to the missile silo, and a utilities tunnel from the equipment terminal to the missile silo.

1-102. BLAST LOCKS. Each of the three launchers is isolated from the main tunnel system and the control center by reinforced concrete blast locks, as shown in figure 1-35. The blast locks are designed to provide continuous safety to the personnel in the tunnel system by having double blast doors leading to each launcher branch tunnel. The doors are equipped with safety devices which prevent personnel from opening both doors at the same time. At VAFB each blast lock has an overhead escape hatch at surface level. Personnel may leave the blast lock by means of an overhead ladder in the shaft of the escape hatch. Blast lock tunnels are vented to the surface with each air vent terminating in a blast valve at the surface. The blast valves close automatically when subjected to surface overpressures. Cables and utilities are routed through the locks into the branch tunnels.

1-103. Hazard warning lights located at the tunnel entrance to the missile silo, equipment terminal (Level III), propellant terminal, and blast locks indicate

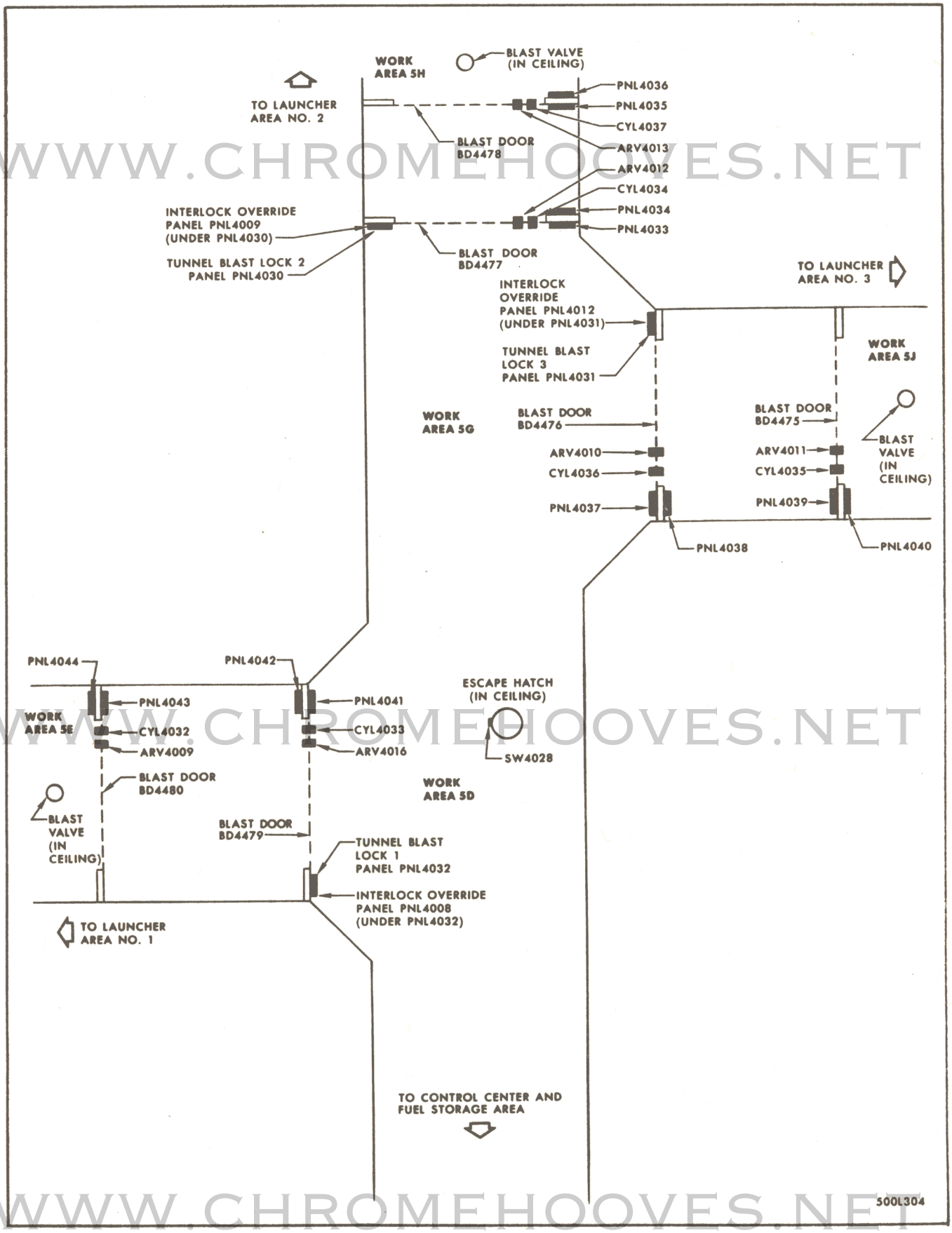

Figure 1-35. Tunnels and Blast Locks Location Diagram

conditions in those areas at all times. Red indicates a hazard, do not enter; amber (missile silo entrance only) indicates caution, permission required before entering; green indicates that normal conditions exist, access is permitted.

1-104. UTILITIES TUNNEL. The utilities tunnel located in each launcher connects the second floor of the equipment terminal to the missile silo. Missile and silo air conditioning, water, hydraulics, air, and electricity are routed through the utilities tunnel to the missile silo.

1-105. LIQUID OXYGEN TUNNEL. A liquid oxygen tunnel connects each propellant terminal to its respective missile silo. This tunnel contains the lines that supply liquid oxygen, helium, and nitrogen to the missile. Fuel lines are not routed through the liquid oxygen tunnel, but are routed to the missile silo through the missile silo branch tunnel.

1-106. LOCAL CONTROL STATIONS.

1-107. Missile installation and maintenance of the missile launcher systems and the missile are simplified by local controls operating through a logic rack. The ground level control, the tunnel entrance control, and the local pushbuttons and key switches can be used only when the power pack is in the remote operating condition.

1-108. The ground level control station (figure 1-36) is a portable console used to control the launcher platform operation from outside the missile silo during the installation or removal of a missile.

1-109. The tunnel entrance control station (figure 1-37) is used to control the silo doors, power pack, crib locks, and the launcher platform. This control station operates through a logic rack and all safety interlocks must be closed before the equipment will operate.

1-110. Local control pushbuttons are positioned about the crib structure to facilitate the operation of launcher equipment during maintenance operations. Key switches are used to operate the work platforms.

1-111. PUMP HOUSE AND SPRAY PONDS (VAFB).

1-112. The pump house and spray ponds (figure 1-38) are located adjacent to the power house and are connected to the power house by various water lines. The spray ponds serve as water reservoirs for the fire pumps and as cooling units for the diesel generators.

1-113. Water for the launch complex is piped through a 12-inch fresh water main located near the pump house. The water main supplies the domestic plumbing system and the spray ponds. The domestic water is distributed to the launch complex through the power house pump room. In the power house, makeup water from the domestic water system services the cooling system of the diesel generators, chilled water system, boilers, hot water system, blow down tank, and condensate pump.

1-114. FACILITY SYSTEMS.

1-115. The facility systems consist of various support systems located throughout the launch complex. These systems include:

a. Facility air conditioning, heating, and ventilating system.

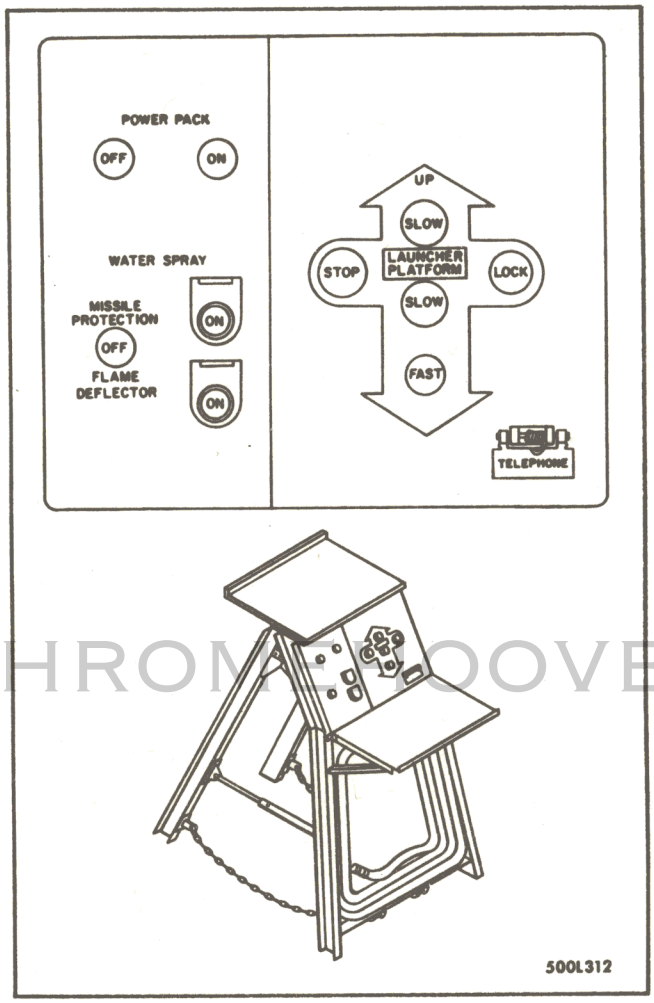

Figure 1-36. Ground Level Control Station

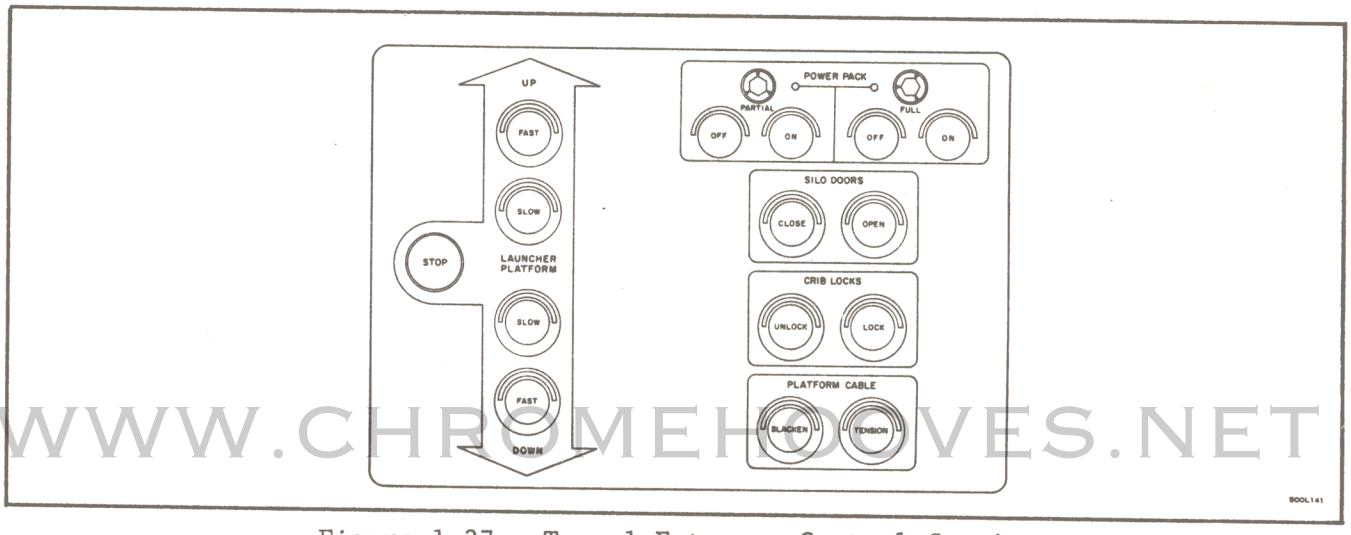

Figure 1-37. Tunnel Entrance Control Station

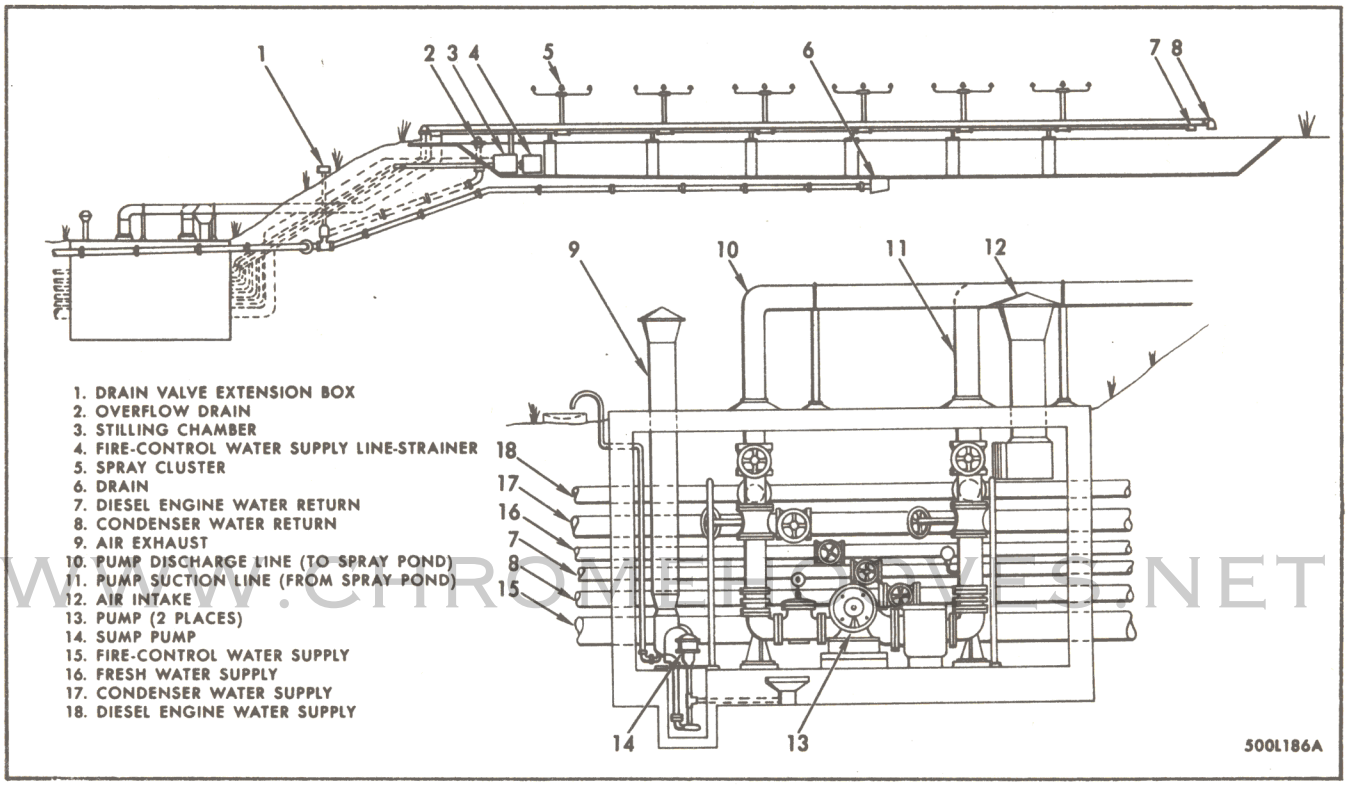

Figure 1-38. Pump House and Spray Ponds (VAFB)

b. Power generation system.

c. Power distribution system.

d. Water supply, distribution, and waste system.

e. Sensing, warning, and blast protection system.

f. Utility compressed air system.

g. Plant compressed air system.

h. Portal hydraulic system.

i. Instrument and TV camera mount elevators.

j. Antenna silo personnel elevators (operational bases only).

1-116. FACILITY AIR CONDITIONING, HEATING, AND VENTILATING SYSTEM.

1-117. The facility air conditioning, heating, and ventilating system consists of supply fans, dust collector, heat exchanger, hot water coil, circulating pump, and air compressor. The launcher air filtration facility supplies filtered and preheated air to the launcher area, fuel terminal, control center, antenna terminal and antenna silos, launcher (missile silo), equipment terminals, and propellant terminals.

1-118. EQUIPMENT TERMINAL AND MISSILE SILO AIR CONDITIONING, HEATING, AND VENTILATING SYSTEM. The equipment terminal and missile silo air conditioning, heating, and ventilating system consists of air conditioning units, exhaust fans, methylene chloride degreasing fan, transfer air fan, recirculating fan, circulating pump and an air compressor. This system controls temperature, humidity, and ventilation throughout the equipment terminals and missile silos.

1-119. PROPELLANT TERMINAL AIR CONDITIONING, HEATING, AND VENTILATING SYSTEM. The propellant terminal air conditioning, heating, and ventilating system consists of air conditioning units, circulating fans, exhaust fan, unit heater, and circulating pump. This system controls temperature, humidity, and ventilation in the propellant terminals and lox tunnel.

1-120. FUEL TERMINAL AIR CONDITIONING, HEATING, AND VENTILATING SYSTEM. The fuel terminal air conditioning, heating, and ventilating system consists of air conditioning units, circulating fans, exhaust fan, unit heater, and circulating pump. This system controls temperature, humidity, and ventilation in the fuel terminal.

1-121. CONTROL CENTER AIR CONDITIONING, HEATING, AND VENTILATING SYSTEM. The control center air conditioning, heating, and ventilating system consists of air conditioning units, centrifugal fans, exhaust fan, outside air fan, return air fan, transfer air fan, hot water circulating pump, and an air compressor. This system controls temperature, humidity, and ventilation throughout the control center.

1-122. ANTENNA TERMINAL/SILOS AIR CONDITIONING, HEATING, AND VENTILATING SYSTEM. The antenna terminal/silos air conditioning, heating, and ventilating system consists of air conditioning units, hot water circulating pumps, and an air compressor.

This system controls the temperature and humidity and cools the ground guidance operating equipment in the antenna terminal and antenna silos.

1-123. PORTAL AND ANTENNA SILO ENVIRONMENTAL SEAL HEATING SYSTEMS.

1-124. The three environmental seal heating systems consist of glycol circulating pumps and heat exchangers. These systems control the temperature of the ground level door seals to prevent the formation of ice. These systems are located in the portal and antenna silos.

1-125. POWER GENERATION SYSTEM.

1-126. At operational bases the power generation system supplies all of the electrical power required for the complex. This power is supplied by four diesel-driven generators located in the power house, each producing 1000 KW, 2400 V, 3-phase, 60 CPS power. The output of three generators in parallel will supply all the necessary electrical power for a missile launching. At VAFB power is generated by three diesel generators located in the power house, each producing 1000 KW, 4160 V, 3-phase, 60 CPS power.

1-127. POWER DISTRIBUTION SYSTEM.

1-128. Power is distributed at various voltages and phases throughout the complex by main switchgear feeders, unit substations, motor control centers, and lighting and power panels to individual equipment items. The 120 VDC power is provided by battery packs located throughout the complex and distributed by DC power panels and emergency lighting panels.

1-129. WATER SUPPLY, DISTRIBUTION, AND WASTE SYSTEMS.

1-130. RAW WATER SYSTEM. The raw water system supplies, stores, and distributes water to the fire water, domestic water, hot water, and chilled water systems. The raw water system normally consists of deep well pumps, raw water storage tanks, raw water pumps, and a water softener or demineralizer. Components of the raw water system are located in the power house and in tunnel junction 10.

1-131. The fire water system draws water from the raw water storage tank and distributes the raw water to fire hydrants and standpipes at ground level, and to the fog spray system, flame deflector, and engine compartment spray chamber in the missile silo for each launcher area. This system consists of a jockey pump, two fire water pumps, and the fire water distribution system and its necessary control panels. Components of the fire water system are located in the power house, tunnels and blast locks in each missile silo, and at ground level.

1-132. The treated water system distributes water to the diesel equipment. This system demineralizes and softens raw water to protect equipment.

1-133. Domestic water is provided for human consumption and use. The domestic water system consists of pressure regulating valves, chlorination system, domestic accumulator tank, domestic water pump, hydro-pneumatic tank, instantaneous water heaters, excess flow valves, pressure relief and associated valves, and piping, and indicators located throughout the launch complex.

1-134. Hot water is provided for personal use and for air conditioning throughout the complex. The hot water system consists of heat exchangers, hot water pumps, compression tanks, flow control valves, pressure differential controllers, and pressure differential valves. Components of the hot water system are located in the power house, tunnels and blast locks, control center, antenna terminal, launcher air filtration facilities, and propellant and equipment terminals of each complex.

1-135. Chilled water is used for air conditioning throughout the complex. The chilled water system furnishes chilled water for the heating and ventilation system, diesel engine lube oil coolers, and utility air after-cooler. This system consists of two cooling towers and/or a flash tank, water chillers, chilled water compression tank, chilled water pumps, ice banks, ice bank booster pumps, chilled and condensing water pumps, and differential pressure controller. The system can be operated either manually or automatically.

1-136. SANITARY SEWAGE SYSTEM.

1-137. A sanitary sewage system is provided to pump sewage topside to the sewage stabilization ponds. This system consists of sump pumps, controllers, injectors, and stabilization ponds. The major components are located in the control center, power house, equipment terminal, and at ground level.

1-138. NON-SANITARY WASTE SYSTEM.

1-139. Non-sanitary waste such as wash down, spillage, equipment drainage, and seepage water, is picked up by sump pumps and pumped directly to sealed chambers at ground level. The major components of this system are located in the power house, missile silo, propellant terminal, tunnels, and blast locks.

1-140. SENSING, WARNING, AND BLAST PROTECTION SYSTEMS.

1-141. Sensing and detection devices are located throughout the missile complex to detect hazardous situations and to relay such information to the control center and/or initiate automatic corrective action. Hazard indications are provided by lights, bells, and horns. Figure 1-39 lists sensing, warning, and blast protection indications for various systems throughout the complex.

1-142. UTILITY COMPRESSED AIR SYSTEM.

1-143. The utility compressed air system supplies compressed air for instrument operation and valve actuation throughout the facility systems. The major components of the utility compressed air system are located in the power house.

1-144. PLANT COMPRESSED AIR SYSTEM.

1-145. The plant compressed air supply system compresses, stores, and supplies unfiltered, undried compressed air to the pneumatic sewage ejector, utility outlets in the missile silo, propellant terminal, equipment terminal, and the filtered portion of the filtered compressed air system.

1-146. The filtered compressed air supply system supplies dry filtered air to the propellant loading system to operate control devices and valves and to the sensing, warning, and blast protection system to operate the blast valve in the propellant terminal access tunnel in sub-area 3B.

HAZARD	LCFC						ET AP		FT AP				MS AP			PT AP		BLAP	CC AP		C-216			Analyzer	Reset	Bells in silo
Note There are no bells at VAFB	Flashing red	Red	Flashing white	Amber	White	Buzzer	Red	Horn	Red	White	Horn	Bell	Red	White	Horn	Red	Horn	Red	Red	Amber	Red	White	Horn	Red		
Fire equipment terminal	X					X	X	X																	X	
Hydraulic fire C-216	X		X			X															X	X	X		X	
Fuel fire fuel terminal	X		X			X			X	X	X	X													X	
Fire missile silo	X		X			X							X	X	X			X							X	X
Gox vapor missile silo	X		X			X							X	X	X			X						X	X	
Lox sump missile silo	X		X			X							X		X											
Explosion silo (No reset at VAFB)	X					X							X		X			X		X					X	
Lox fire propellant terminal	X					X										X	X	X							X	
Gox vapor propellant terminal	X					X										X	X	X						X	X	
Lox empty		X																								
Power House emergency	X					X																			X	
Attack (Except VAFB)	X					X													X	X						
Radiation-launcher, CC, P.H. & above Gnd (Except VAFB)	X					X														X						
Battery power		X																								

Figure 1-39. Table of Sensing, Warning, and Blast Protection Systems (Sheet 1 of 2)

HAZARD	LCFC						ET AP	FT AP			MS AP			PT AP		BLAP	CC AP		C-216			Analyzer	Reset	Bells in silo
Note There are no bells at VAFB	Flashing red	Red	Flashing white	Amber	White	Buzzer	Red	Horn	Red	White	Horn	Bell	Red	White	Horn	Red	Horn	Red	Red	Amber	Red	White	Horn	Red		
Lox P.T. vent (Except VAFB)	Indicates "flashing red" on lox P.T. vent indicator																								
Launcher antenna #1 or #2		X																							
Oepn and blast door open		X																							
Antenna #1 or #2 open only				X																					
Blast door to antenna #1 or #2 open only		X																							
Wind above 60 MPH		X																							
Escape hatch		X																							
Auto-fog disables				X																					
Fog-on			X																						
Blast valve air intake																		X							
Hazard light	X	X		X																					
Portal doors open only				X																					
Portal doors and blast door open		X																							

Figure 1-39. Table of Sensing, Warning, and Blast Protection Systems (Sheet 2 of 2)

1-147. The plant compressed air system consists of a plant compressed air supply system and a filtered compressed air supply system. The plant compressed air supply system has components located in the equipment terminal, propellant terminal, missile silo, and adjacent personnel tunnels. The filtered compressed air supply system is located on Level I of the equipment terminal with other major components in the propellant terminal.

1-148. PORTAL HYDRAULIC SYSTEM.

1-149. The portal hydraulic system consists of a hydraulic power unit, accumulators, valve panels, hydraulic actuating cylinders, door control panels, and limit switches.

1-150. The hydraulic power unit supplies and maintains hydraulic pressure to the portal hydraulic system accumulators. The portal hydraulic system accumulators supply a working pressure to the hydraulic actuating cylinders to raise or lower the portal doors. Operation of the portal doors is controlled by the door control panels and the limit switches. The flow of hydraulic fluid in the system is controlled at the valve panels.

1-151. INSTRUMENT AND TV CAMERA MOUNT ELEVATORS.

1-152. The instrument and TV camera mount elevators are hydropneumatically operated by compressed air from the utility compressed air system. The major components are located in the portal work area. Controls are located in the control center and consist of an accumulator, filter, pressure reducing valves, solenoid operated valves, pneumatic operating cylinders, spring latches, and gate valves necessary to operate the system.

1-153. ANTENNA SILO PERSONNEL ELEVATORS. (Operational bases)

1-154. Antenna silo personnel elevators consist of two separate elevator systems. Each elevator is individually operated by a drive unit, governor, controller, and roller guides. The elevators provide a rapid means of transporting personnel and small items of equipment from the base of the antenna silos to the equipment level of the antenna elevator and to the upper catwalk of the antenna.

1-155. SUBSYSTEMS.

1-156. The missile subsystems (figure 1-40) consist of aerospace operating equipment (AOE), aerospace ground equipment (AGE) and airborne equipment. The AOE and airborne equipment contain all equipment required to launch a missile including rocket engine system, propellant system, electrical system, hydraulic system, air conditioning system, flight control system, guidance system, launch sequencer, launch control system, control center circuits, instrumentation and range safety systems (VAFB only), and re-entry vehicle system. This equipment is utilized to monitor status and checkout of the subsystems.

1-157. The AGE is utilized during missile handling, repair, adjustment, and calibration of missile systems and components.

1-158. GUIDANCE SYSTEM.

1-159. The guidance system (figure 1-41) of the SM68 missile weapon system is comprised of ground equipment that contains ground-based radar (missile guidance set

SYSTEM	COMPONENTS	FUNCTION
Rocket engine system	Stage I booster engine, Stage II sustainer engine, and engine control system.	Boosts the complete missile to stage separation altitude, and sustains Stage II flight to re-entry vehicle separation.
Propellant system	Stage I and Stage II propellant equipment and PLPS.	Supplies fuel and liquid oxygen to the rocket engines during flight.
Hydraulic system	Stage I and Stage II hydraulic equipment and hydraulic pump unit.	Supplies hydraulic power to the missile.
Missile air conditioning system	Air conditioning ducting.	Supplies conditioned air to the missile.
Electrical system	Distribution circuits, accessory power supply, and Stage II hydraulic pump batteries.	Provides electrical power for the missile.
Flight control system	Movement sensing devices, amplifiers, hydraulic actuators, and control assemblies.	Maintains the missile on its proper flight path and accepts control signals from the guidance system.
Guidance system	Ground guidance station, airborne receiving equipment, and GMTS.	Guides the missile on an exact trajectory that will enable the re-entry vehicle to hit the target area.
Instrumentation and range safety system (VAFB)	Airborne data sensing transmitting devices, airborne command destruct components, and ground receiving and transmitting stations.	Gathers missile flight data and, in an emergency, ruptures the propellant tanks to terminate powered flight.
Re-entry vehicle	Ablative structure, payload, and RVS.	Contains and protects the payload during re-entry into the earth's atmosphere.
Launch sequencer	Launch sequential timer, two launch sequence controller assemblies, and a filter assembly.	Sequences and monitors related systems during countdown operations.
Missile launcher system	Crib structure and suspension, launcher platform, criblocks, silo doors, and operating hydraulic system.	Provides structural support for the missile, positions missile for launch and protects personnel and components from nuclear attack.
Control center circuits	Launcher assemblies for each launcher, common assembly, and hazard warning assembly.	Distributes signals between the control center and other parts of the complex.

Figure 1-40. Table of Missile Subsystems

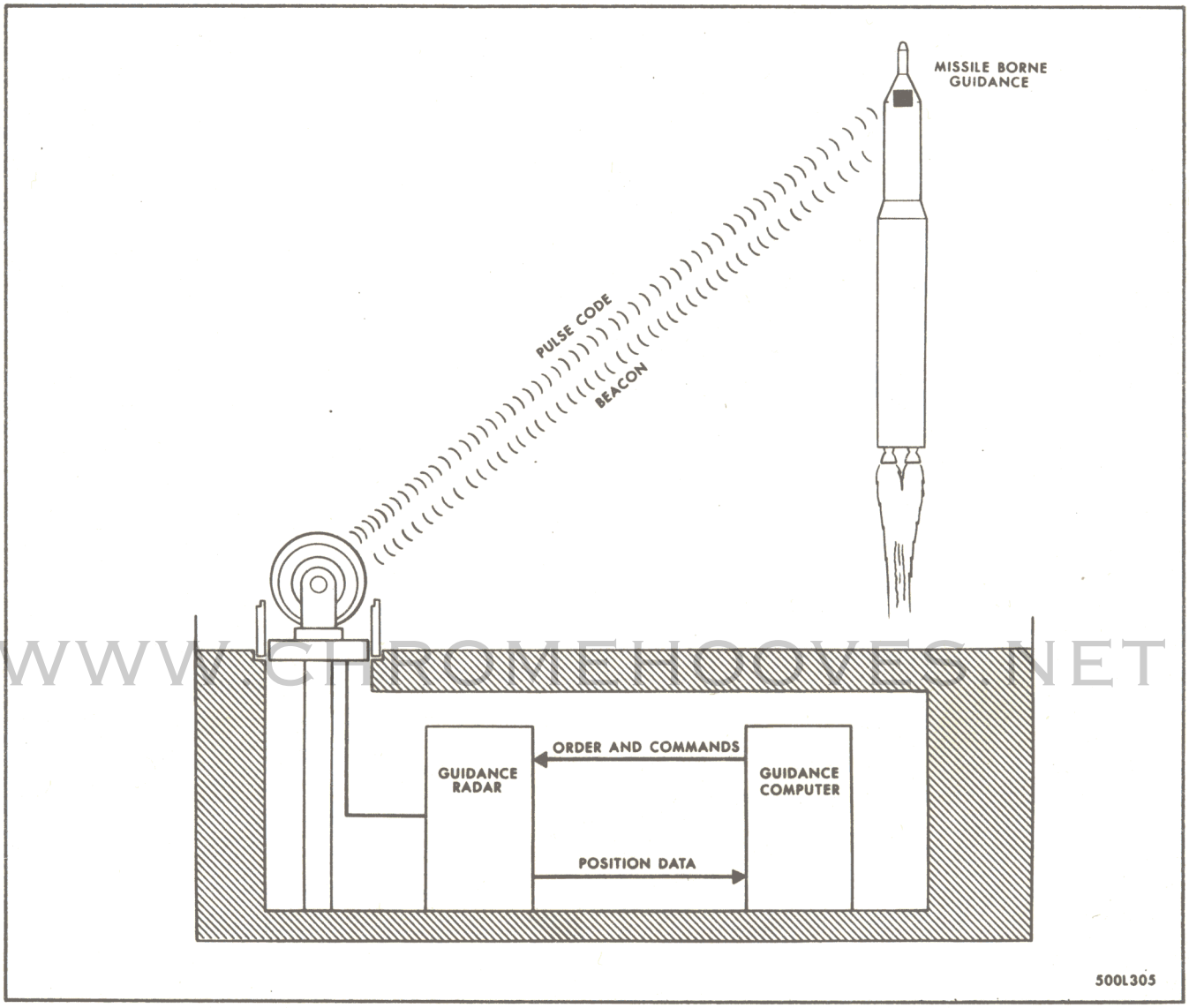

Figure 1-41. Guidance System

AN/GRW-5) and a computer (missile guidance computer set AN/GSK-1), missileborne equipment (missile guidance set AN/DRW-18, AN/DRW-19, AN/DRW-20, AN/DRW-21, or AN/DRW-22), and miscellaneous equipment. The guidance system controls the missile during the guidance phase of flight in order to project the re-entry vehicle to the selected target. The guidance system continuously determines the precise missile position and from this data determines missile velocities in three coordinates. Position and velocity data are compared to predetermined information stored in the ground equipment, and coded steering orders based upon this comparison are continuously issued to correct missile attitude. Commands to accomplish non-steering functions are issued as programmed by the computer. Steering orders and commands are transmitted by the ground-based radar, in the form of coded signals, to the airborne equipment. The airborne equipment decodes the signals and transmits a beacon signal to the ground-based radar for use in tracking.

1-160. GROUND EQUIPMENT. The ground equipment for the guidance system is located in the control center, antenna terminal, and antenna silos.

1-161. The control center operations room (figure 1-22) contains most of missile guidance set AN/GRW-5 and all of missile guidance computer set AN/GSK-1. The equipment is housed in air conditioned cabinets. Excessively high temperatures within the cabinets are thermostatically detected by an over-temperature alarm. Figure 1-42 lists the operations room equipment functions.

1-162. The power conversion equipment for the missile guidance set and missile guidance computer set is located in the electrical equipment room of the control center (figure 1-43). The equipment supplies 3-phase, 120 V 400 CPS power to the ground guidance radar equipment. An additional power plant is used to supply the 3-phase, 208 V 420 CPS power to the computer equipment.

1-163. Operational and checkout equipment associated with the antennas is located in the antenna terminal. (See figure 1-44.) Control equipment for the antenna elevators is also located in the antenna terminal. Construction of the antenna terminal is similar to that of the operations room, permitting interconnecting cables and air conditioning ducts to be routed beneath a false floor. Figure 1-45 lists antenna terminal equipment and functions of the equipment.

1-164. The antenna silo (figure 1-46) contains two antennas (primary and alternate back-up) and associated equipment. Figure 1-47 lists antenna silo equipment and functions of the equipment. The antennas are emplaced so that either one can guide any of three missiles in the complex. Each antenna and maintenance platform for the missile guidance set is mounted on an elevator in a silo-lift enclosure similar to that used for the missile. This affords protection against nuclear attack for the entire antenna assembly. To protect the antenna from shock effects while in the hardened condition, the entire assembly is nested in a crib suspended by shock mounts from the silo wall. Concrete doors over the antenna silo provide overpressure and radiation protection. The operating antenna is elevated during the final phase of countdown and throughout the guidance portion of missile flight. Precise orientation of the elevated antenna is provided by locking the elevator platform rigidly with respect to the silo.

1-165. MISSILEBORNE EQUIPMENT. The missile guidance set (figure 1-48) consists of a radio transmitter, a coordinate data receiver, a command signals decoder, a waveguide group, a dorsal antenna, and a ventral antenna. The missile guidance set is mounted below the re-entry vehicle in Stage II and is accessible through access

(Text continued on page 1-76.)

EQUIPMENT	FUNCTION
Missile guidance system exercise set AN/GRM-40	Simulates a missile on a reference trajectory during checkout and countdown. It consists of three cabinets containing circuitry for distribution of power throughout the exercise set, generation of typical in-flight signals, and conversion of these signals for input to the radar equipment.
Signal data recorder RO-146/GRW-5	Records system functions during checkout or guidance operation for later study and evaluation.
Power switchboard SB-1168/GRW-5	Controls and routes 3-phase, 120 V 400 CPS power from the electric power plant to ground radar equipment.
Power supply set OA-2898/GRW-5	Supplies regulated DC power to radar equipment in the operations room.
Command signals decoder KY-344A/GRW-5	Monitors and decodes radar transmitter signals and supplies the decoded orders and commands to the signal data recorder and guidance exerciser.
Reference signal generator TD-409A/GRW-5	Supplies timing signals for radar and computer equipment.
Signal data converter CV-967C/GRW-5	Processes azimuth, elevation, and range data for the computer and changes computer orders and commands into pulse code groups which serve as the radar trigger.
Range computer CP-560A/GRW-5	Generates missile range data in binary form for the computer and center tracking gates, in time, about the missile return signal.
Antenna control C-3360C/GRW-5	Generates antenna positioning signals that keep the feedhorns of the antenna-receiver-transmitter group positioned on the missile.
Receiver group OA-3034B/GRW-5	Covers azimuth and elevation IF signals into DC error signals for the antenna control, and converts the sum IF signal into range video signals for the missile guidance console and the range computer.

Figure 1-42. Control Center Operations Room Equipment Functions (Sheet 1 of 3)

EQUIPMENT	FUNCTION
Antenna position programmer C-3362B/GRW-5	Provides preset antenna position signal to enable the antenna-receiver-transmitter group to slew to the above-ground missile launch positions and designated test positions.
Missile guidance console OA-3101G/GRW-5 or OA-2897G/GRW-5	Controls and monitors guidance operation during countdown and missile flight.
Digital data printer RO-144/GSK-1	Supplies a printed record of computer calculated results for reference or maintenance purposes.
Signal data recorder group OA-2660/GSH-4(VAFB)	Records magnetically, computer equipment operation for postflight evaluation, and presents a readout (on paper tape) of computer instructions for verification.
Computer set console OA-2654/GSK-1	Operates and controls the computer during checkout maintenance and the loading and verification of computer programs.
Simulator-verifier SM-203/GSK-1	Generates programmed signals approximately equivalent to an in-flight missile, used for computer checkout.
Signal data reproducer group OA-2658/GSK-1	Converts computer instructions, which are inserted on punched paper tape, into electrical impulses for magnetic drum storage.
Power distribution group OA-2655/GSK-1	Rectifies AC power into DC power for computer equipment.
Power supply group OA-2656/GSK-1	Controls and routes 208 V 420 CPS power for the electric power plant to computer equipment.
Data storage magnetic drum MU-422/GSK-1	Stores computer information and instructions in the form of magnetized areas on the surface of a cylinder.
Data input processor-verifier CM-166/GSK-1	Controls functions of the perforated tape photoelectric reader assembly.
Recording set control C-3206/GSH-4(VAFB)	Processes and routes data used by the magnetic and perforated tape recorder assembly.

Figure 1-42. Control Center Operations Room Equipment Functions (Sheet 2 of 3)

EQUIPMENT	FUNCTION
Computer control C-3205/GSK-1	Controls the computations and routing of computer data as instructed by the magnetic drum control.
Core memory unit MU-423/GSK-1	Stores computer information in small magnetic cores; used by the computer arithmetic unit as a scratch pad.
Computer arithmetic unit CP-539/GSK-1	Performs the computations for the computer.
Digital to digital converter CV-929/GSK-1	Stores and routes all input for computer equipment; also stores and routes steering orders and discrete commands of the computer for the radar equipment.

Figure 1-42. Control Center Operations Room Equipment Functions (Sheet 3 of 3)

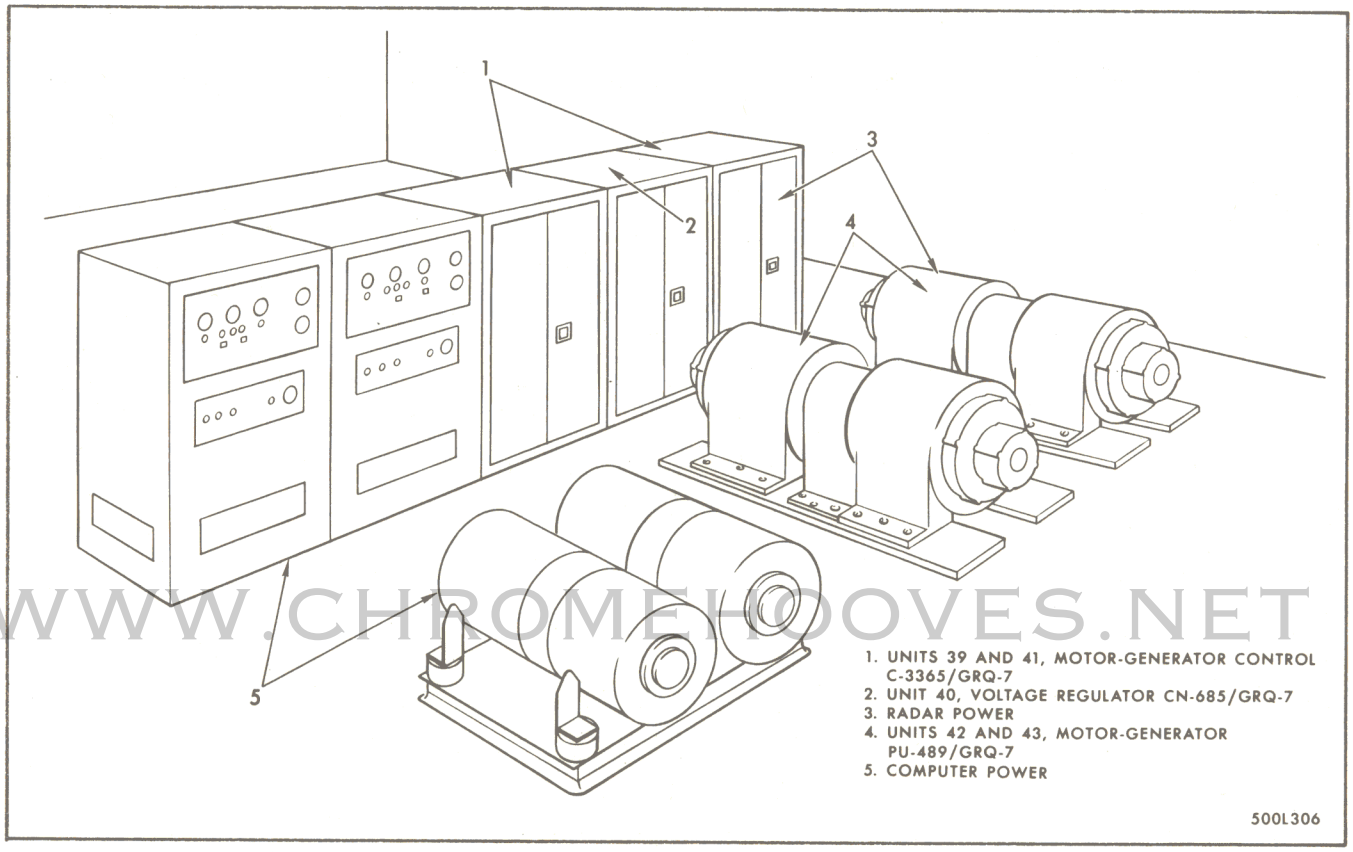

Figure 1-43. Control Center Electrical Equipment Room, Radar Equipment

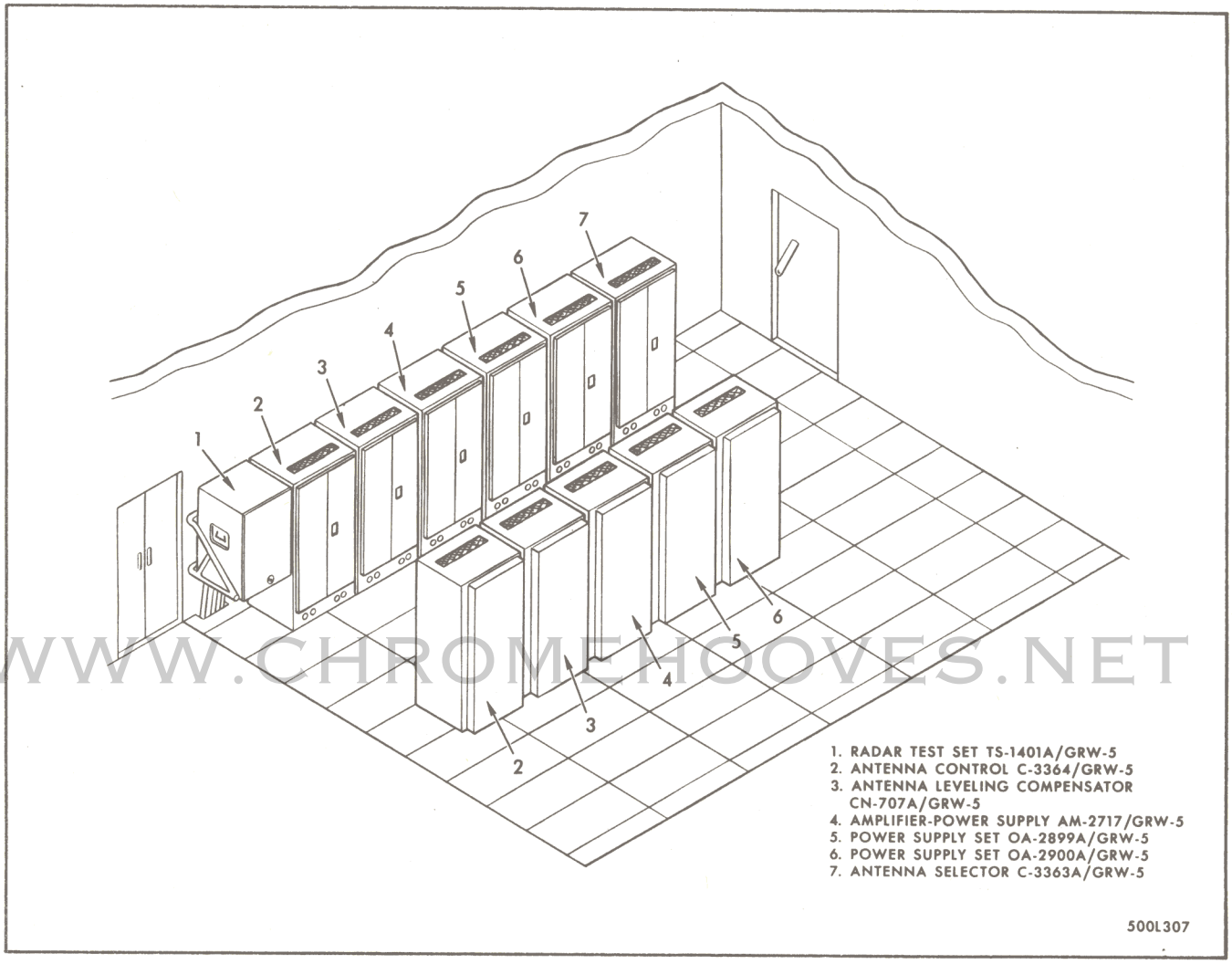

Figure 1-44. Antenna Terminal Equipment Location

EQUIPMENT	FUNCTION
Antenna selector C-3363A/GRW-5	Couples signals from the operations room to the appropriate antenna terminal and antenna silo equipment, and indicates operation, standby, or maintenance of the antenna silo.
Power supply set OA-2899A/ GRW-5 and OA-2900A/GRW-5	Supplies AC and DC power to antenna terminal equipment.
Amplifier-power supply AM-2717/GRW-5	Amplifies servo drive signals for the antenna positioning circuits and supplies high voltage to the antenna-receiver-transmitter group.
Antenna leveling compensator CN-707A/GRW-5	Senses antenna tilt error in the event of a nuclear blast.
Antenna control C-3364/GRW-5	Controls, locally and remotely, the raising and lowering of the antenna-receiver-transmitter group.
Radar test set TS-1401A/ GRW-5	Performs system tests while the antenna is lowered.

Figure 1-45. Antenna Terminal Equipment Functions

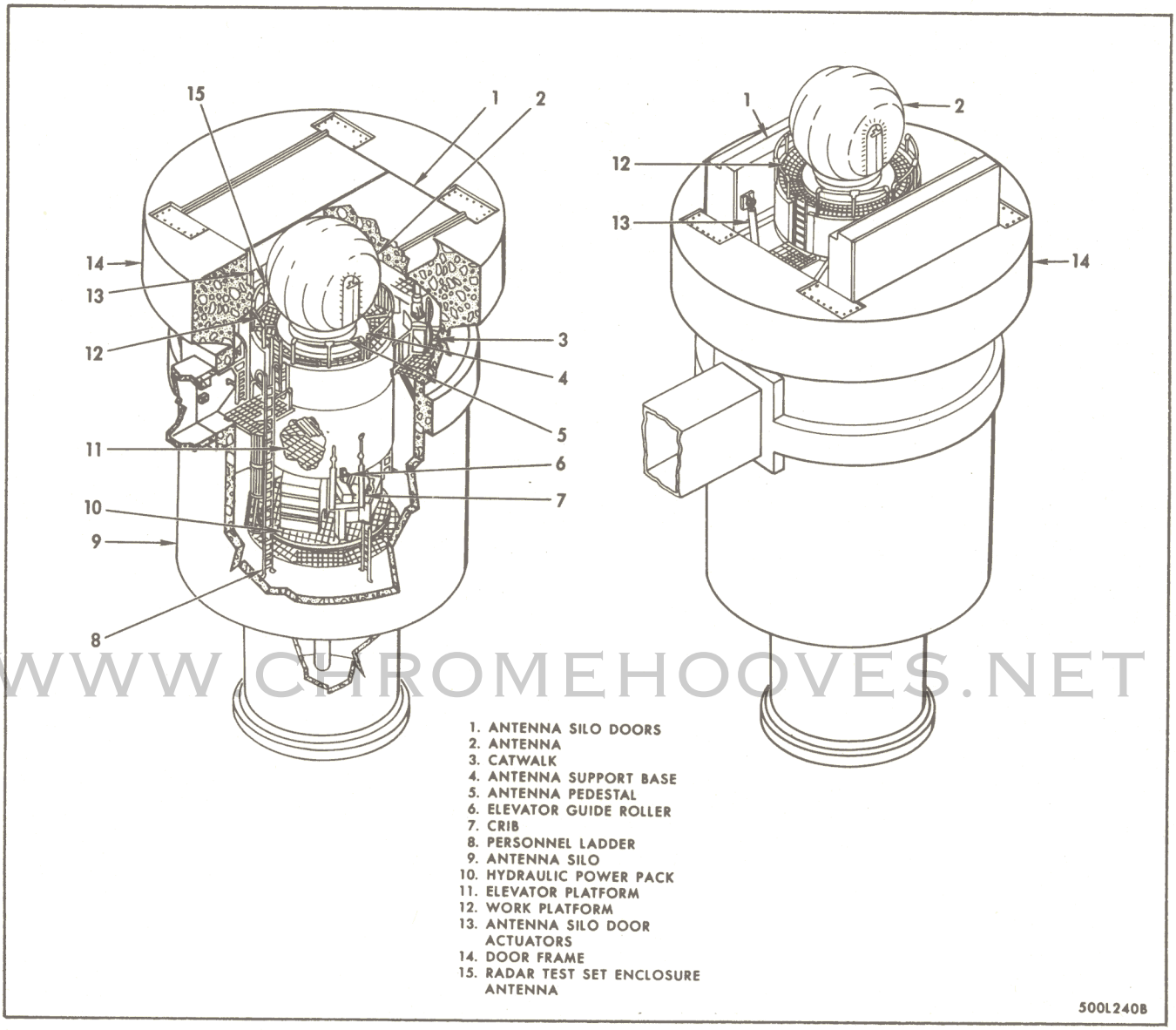

Figure 1-46. Antenna Silo Equipment Location

EQUIPMENT	FUNCTION
Lid assembly	Protects antenna silo equipment when the silo is in the lower (hard) position. It consists of the silo doors, the hydraulic antenna silo door actuators, and the door foundation.
Missile tracking antenna-receiver-transmitter group OA-2896A/GRW-5	Radiates RF guidance signals to the missile guidance set and receives RF tracking pulses. Receiving and transmitting equipment for the antenna is housed immediately behind the antenna feedhorns and reflector. The antenna is covered with an inflated cloth radome.
Catwalk	Allows passage around the interior of the antenna silo.
Antenna support base	In conjunction with the antenna pedestal, the antenna support base supports the antenna.
Antenna pedestal	In conjunction with the antenna support base, the antenna pedestal supports the antenna.
Crib	Supports the elevator assembly. Mechanical crib suspension springs act as shock absorbers for the elevator assembly. Elevator guide rollers are used to center the crib within the silo.
Elevator guide roller	Maintain the elevator within its crib.
Personnel ladder	Provides personnel access between work levels in the antenna silo.
Antenna silo	Houses the antenna and provides the necessary protection from static overpressures and nuclear radiation.
Power pack	Supplies hydraulic pressure for the antenna silo door actuators, the crib positioners, and the elevator platform.
Elevator assembly	To raise the antenna and its receiving and transmitting equipment (antenna-receiver-transmitter group) to the above-ground (soft) position. It is supported by the crib and consists of a hydraulic elevator, which raises the assembly, an elevator platform, and a work platform.

Figure 1-47. Antenna Silo Equipment Functions (Sheet 1 of 2)

EQUIPMENT	FUNCTION
Radar test set enclosure antenna	In conjunction with radar test set TS-1401A/GRW-5 used to check system operation in the "hard" condition.

Figure 1-47. Antenna Silo Equipment Functions (Sheet 2 of 2)

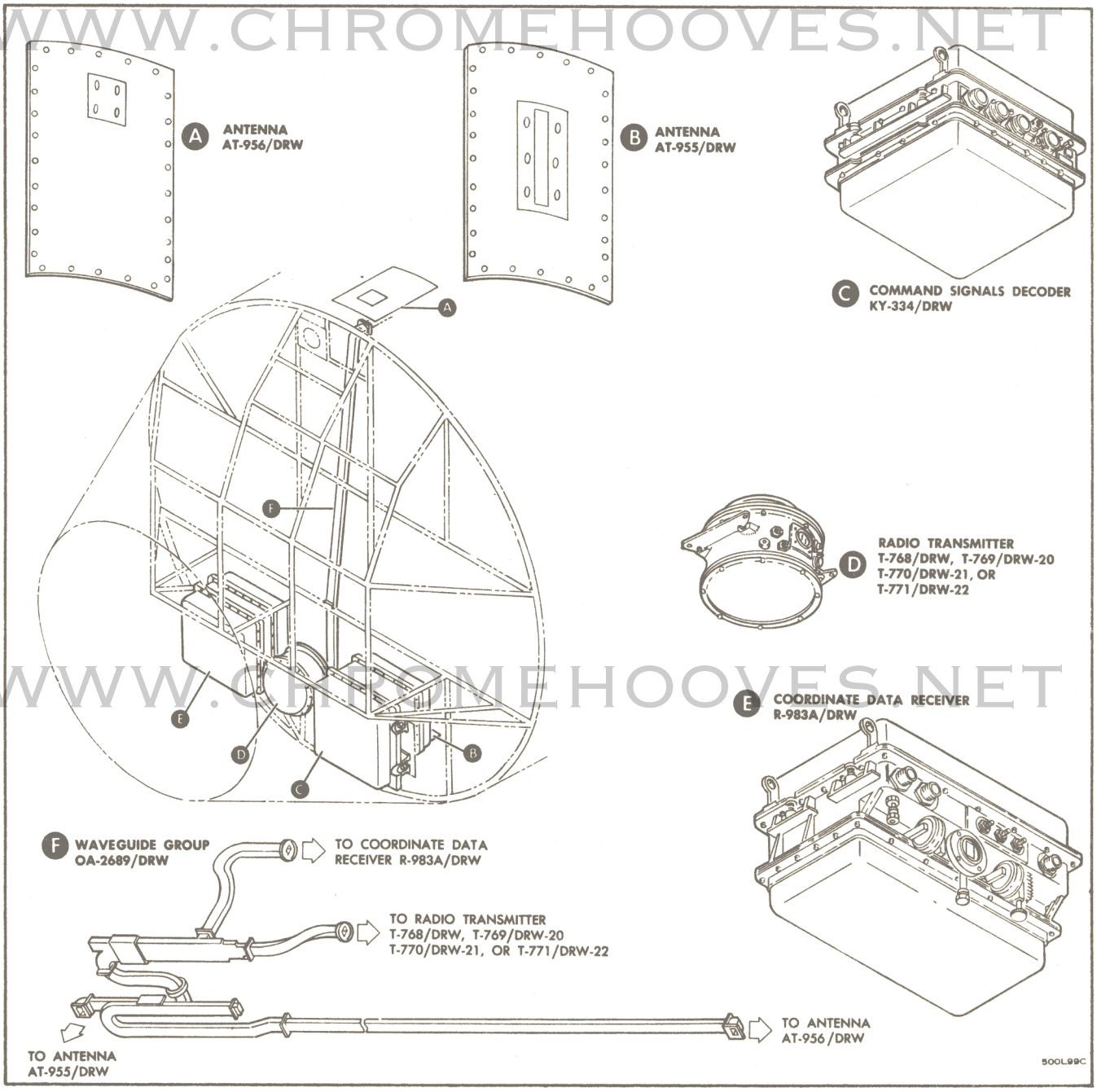

Figure 1-48. Missile Guidance Set

(Text continued from page 1-65.)
panels on the missile. The two antennas are mounted opposite each other on the missile skin and are connected to the radio transmitter and coordinate data receiver by the waveguide group. Power and signal cables interconnect the command signals decoder with the receiver and transmitter. Figure 1-49 lists missile guidance set equipment and functions of the equipment.

1-166. MISCELLANEOUS EQUIPMENT. The miscellaneous equipment of the guidance system consists of the antenna-mast group OA-2903A/GRW-5 or collimation antenna-mast group GS-58128, and a target assembly (orientation) GS-58156L1, L3 or optical camera-telescope target RR-101/GRW-5. These units are located on the surface of the launch complex.

1-167. The antenna-mast group (figure 1-50), located at each launch complex, is a soft test mast used to test and align the radar equipment and to boresight the antenna-receiver-transmitter group. The mast is 60 feet high and contains two feed horns, test flags, and a radar RF test set. Lamps mounted at the top of the mast are used to light the antenna-mast group during night testing operations.

1-168. The target assembly (orientation) or optical camera-telescope target (figure 1-51) is mounted on two cement pillars. An access platform is built around each of the pillars. The target is used to test and align the orientation and position of the radar antenna, using the antenna-mounted telescope and television camera. Three targets may be mounted: the optical azimuth (telescope) target, television camera target, and motion picture camera target. Only the telescope and television targets are normally installed. Floodlights, mounted on the pillars, are used to light the television target during night operations.

1-169. GROUND EQUIPMENT SYSTEM FUNCTIONS. System operation is divided into five phases: prelaunch, launch (countdown), Stage I guidance, Stage II guidance, and post launch. The phases cover the mission of the system beginning with the initial programming of the computer equipment and ending with the analysis of system performance.

1-170. During the prelaunch phase of system operation, periodic performance checks of the ground guidance equipment and missile guidance set are performed. A prepared program of instructions for solving the guidance equations and specific constants which differentiate one target from another are stored in the computer's memory sections. These instructions, once stored, remain in the computer until the complex target assignments or the ballistic equations are changed. During this period, numerical quantities representing systematic corrections for variables such as range, azimuth, and elevation reference, in addition to the latest index of refraction, are stored in the computer by means of electrically operated switches on the missile guidance console OA-3101G/GRW-5 or OA-2897G/GRW-5. These constants, with the exception of index of refraction, are checked periodically with the aid of computer programs and changed as required.

1-171. When an order to launch is received, preparation to fire a missile is started. Operation of the ground guidance system is keyed to match the missile countdown and to include the necessary functions required to prepare the guidance system for successful guidance. Countdown of the guidance system is subdivided into five phases: Start countdown, raise antenna, missile ready, lift-off, and end of guidance. The guidance electronics officer (GEO) positioned at the missile guidance console initiates the functions required for each phase in response to the information received from the launch control system. Completion of each phase is a

EQUIPMENT	FUNCTION
Coordinate data receiver R-983A/DRW	Receives the RF guidance signals transmitted by the guidance radar and inspects the codes for specified missile address.
Radio transmitter T-768/DRW, T-769/DRW-20, T-770/DRW-21, or T-771/DRW-22	Transmits the RF pulse used by the guidance radar for tracking.
Waveguide group OA-2689A/DRW	Routes RF guidance signals from the antennas to coordinate data receiver and routes RF tracking pulses from radio transmitter to the antennas.
Antenna AT-955/DRW or AT-955A/DRW and AT-956/DRW or AT-956A/DRW	Receives RF guidance signals and radiates RF tracking signals.
Command signal decoder KY-334/DRW	Decodes the orders and commands from the guidance signal and routes them to the applicable missile systems.
Band pass filter F-440/DRW-18, F-441/DRW-19, F-442/DRW-20, F-443/DRW-21, or F-444/DRW-22	Passes assigned frequency to coordinate data receiver.

Figure 1-49. Missile Guidance Set Equipment Functions

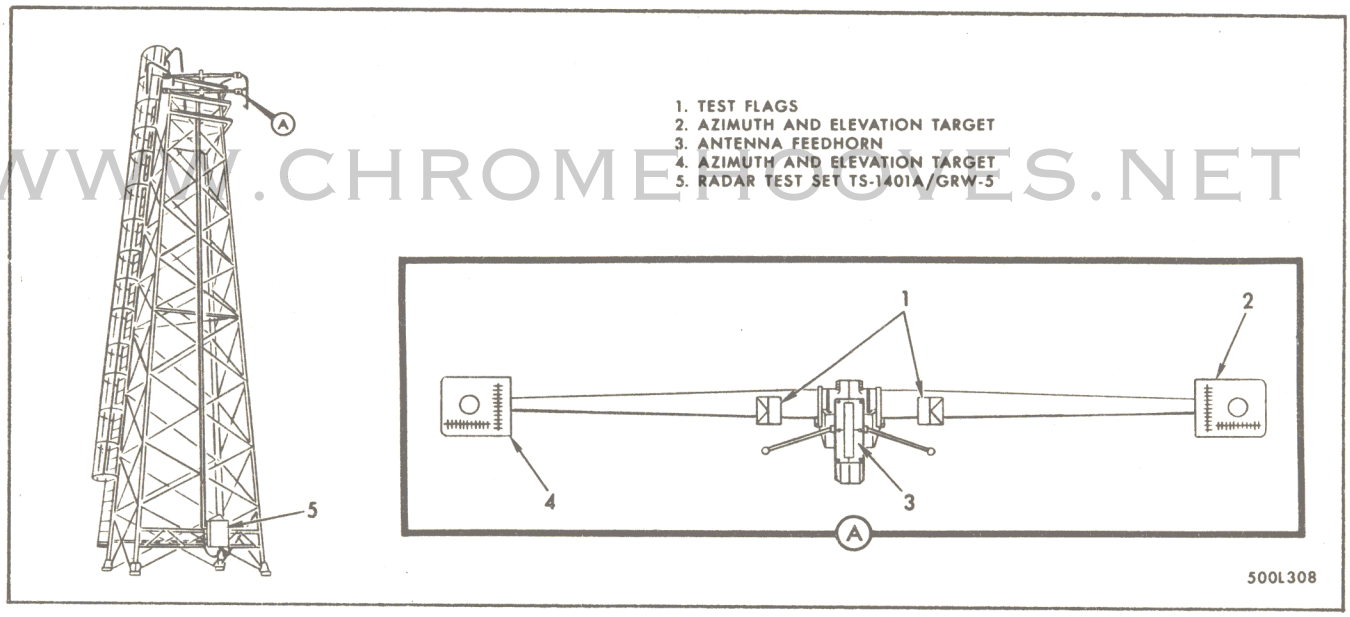

Figure 1-50. Antenna-Mast Group OA-2903A/GRW-5 or Collimation Antenna-Mast Group (GS-58128)

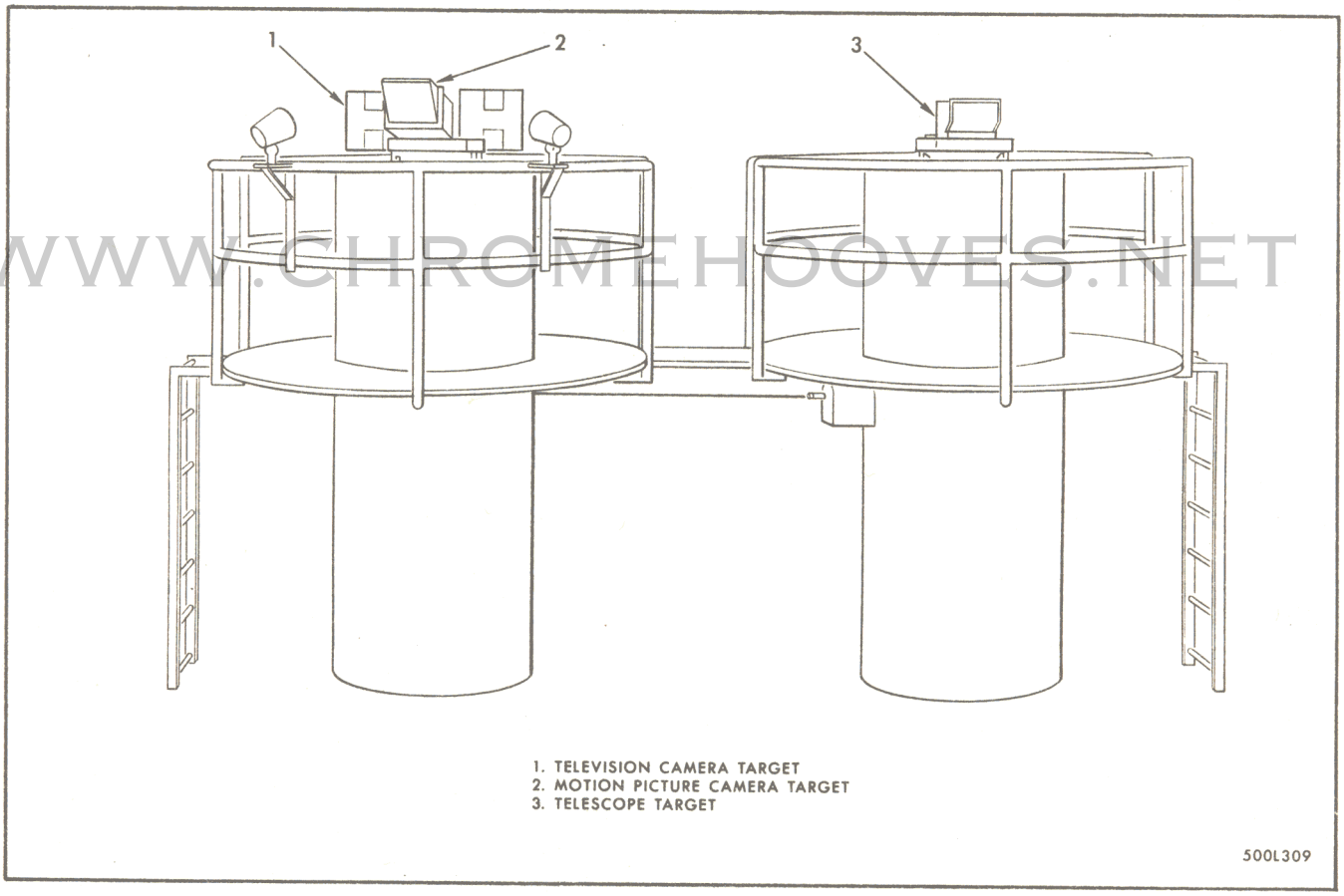

Figure 1-51. Optical Camera-Telescope Target RR-101/GRW-5

prerequisite to initiation of the next phase. The orderly progression of the countdown includes the procedures required to confidence-check the guidance system. These procedures include: Applying all ground guidance equipment power, performing a simulated guidance system exercise, raising the antenna, and acquiring the designated missile in its above-ground launch position. During this period, power to the missile guidance set is monitored with the guided missile test set AN/DRM-58(V) located in the equipment terminal. During the last few seconds of countdown, a combined guidance system/flight control system loop test is conducted to verify proper system performance. Emergency procedures, if required, can be initiated at the missile guidance console. If at any time the emergency procedures do not clear the fault in the ground guidance system, and countdown cannot be restored, the GEO advises the missile launch officer (MLO) to request handover.

1-172. A combined systems exercise (CSE) is an integrated weapon system operation wherein a missile and guidance system are counted down in an exercise mode. The CSE countdowns are identical to an actual launch as far as the MLO and GEO are concerned. Accidental use of a CSE program in the computer during a normal countdown is prevented by safeguards within the CSE program which will cause a GGS hold and prevent launching of a missile.

1-173. Handover is a mode of operation that retains within a squadron the capability of launching and guiding missiles of a complex which has lost the use of its guidance system. Handover is accomplished by using the guidance system of a complex which has completed its own countdowns to guide the missile of the complex requiring assistance.

1-174. The possible combinations of launchers and guidance system that can be used for handover, within the restrictions of the intervening terrain and targets, are specified in the handover target kit identification sheet which is parts of the targeting package.

1-175. The mechanics of operation consist of opening the interface signals between the launch control system and the ground guidance system of the two complexes involved by placing the appropriate systems in the handover mode and verifying the prerequisites of the handover launch countdown. Verbal communications are then used for pacing the launch control system and ground guidance system countdown. Only one function, lift-off, is electrically transmitted over the communications link. Electrically transmitting the lift-off signal over the communications link is necessitated by the guidance requirement for counting time to accurately generate acquisition and roll order functions during early stages of flight.

1-176. After the complete missile inventory has been fired and guidance completed, an analysis and interpretation is made of information recorded by signal data recorder RO-146/GRW-5 and digital data printer RO-144/GSK-1. Functions recorded by these units are, in general, initiated in other sections of the guidance system. The information recorded is used to analyze the quantitative and qualitative performances of the guidance system.

1-177. Ground control of the missile originates in a digital guidance computer that utilizes 23-bit input words from the guidance radar. The data contained in these binary words are the range, azimuth, and elevation positions of the missile as determined by the radar. Additional data required by the computer is the position of the target and various meteorological constants. This data is fed into the computer prior to launch. Using this information, the computer solves the ballistic flight problem and subsequently determines the corrections which will maintain the missile on an effective trajectory.

1-178. The antenna-maintenance key is used to afford proper operational control of the antenna and to insure the safety of personnel. The keys are normally in the ANTENNA A and ANTENNA B key switches located on the rear of the missile guidance console. The two keys issued for use in a given complex are different for each antenna. The key switches are located as follows: on the rear of the missile guidance console; in the elevator control cabinet in the antenna terminal; on the control box at the entrance to the silo; and on the handrail of the antenna work platform.

1-179. Each key switch at the missile guidance console has two positions, identified MAINT and STBY. The key cannot be removed from the switch unless it is in the MAINT position. Removal of the key from the missile guidance console will cause the respective ANTENNA A FACILITY - MAINT or ANTENNA B FACILITY - MAINT indicator to light yellow. Turning the key to STBY position will restore the indicator to green. When the selected antenna is in a maintenance status, the ANTENNA A or B FACILITY - MAINT, and MAINT pushbutton indicator on the front panel of the missile guidance console will be lighted yellow. After maintenance has been completed, the key is inserted (if it has been removed), then turned to the STBY position. The STBY pushbutton indicator on the front panel of the missile guidance console is pressed to complete the change of status from maintenance to standby. The ANTENNA A or B FACILITY - MAINT indicator, and MAINT pushbutton indicator will now be lighted green.

1-180. When the antenna system is in a maintenance status the antenna cannot be raised by signals originated at the missile guidance console. In order to operate the antenna in the maintenance status, the key is inserted in the key switch located on the antenna control C-3364/GRW-5 at the entrance of the silo and turned to the desired position (OFF REMOVE KEY or ON-OPERATE AUTOMATIC). When personnel working on the antenna maintenance platform desire to raise or lower the elevator, the key is inserted in the control box (OFF position) and is turned to the OPERATE position. The key should be retained by personnel when working in the antenna silo to prevent movement of the antenna without their knowledge. The key can be removed from a key switch located in the antenna area only when the key switch is in the OFF position.

1-181. The computer set console may be operated only when the computer set is in the maintenance or hold maintenance condition.

1-182. MISSILEBORNE EQUIPMENT SYSTEM FUNCTIONS. The missile guidance set completes a link between the ground guidance equipment and the missile control devices. During flight operation, the missile guidance set receives RF guidance signals from the ground guidance station to provide the missile with commands and steering orders. The missile guidance set sends an RF beacon signal to the ground guidance station to indicate the position of the missile and to acknowledge acceptance and decoding of the RF guidance signal. Steering orders are issued by ground guidance to correct the missile course. Commands to accomplish non-steering functions are issued as programmed by the guidance computer. Both steering orders and commands are transmitted in the form of coded signals to the guidance set in the missile. The missile guidance set receives and decodes the signals, passes them on to the applicable missile system, and transmits a beacon signal to the ground based radar for use in tracking.

1-183. THEORY OF OPERATION. Tracking of the missile is accomplished by transmitting a coded signal over the ground-to-missile data link. As each signal is decoded, the missile guidance set transmits an RF signal (tracking pulse) from the radar transmitting units (figure 1-52) to the ground radar. The beacon system is

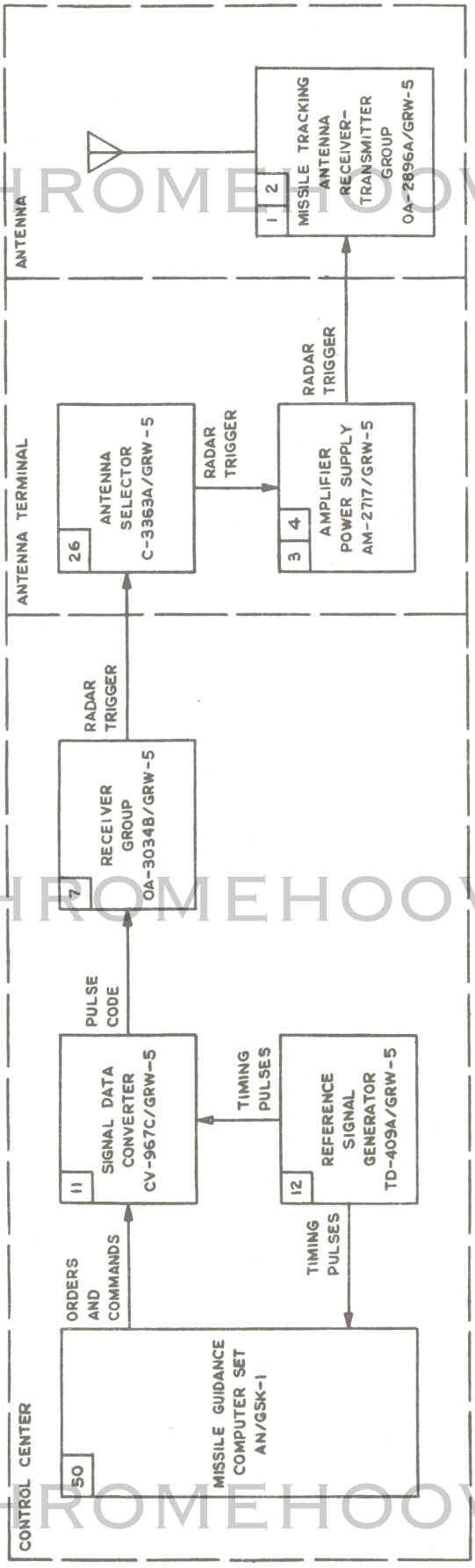

Figure 1-52. Radar Transmitting Units, Block Diagram

used in preference to an echo system to increase the tracking range and insure strong return signals from the missile. As the computer-generated steering orders and commands are issued, the ground guidance radar encodes this information. On receipt of the signal, the missile guidance set converts the coded signal into the steering orders (figure 1-53) and commands that actuate the missile flight control system. A stable reference along the pitch and yaw axis is provided by reference gyros in the flight control system. The steering orders from the missile guidance set are applied to the pitch and yaw gyros to adjust their reference axes. Deviations (error correction signals) from the established reference cause the thrust chambers of the missile rocket engines to gimbal to correct the missile attitude. Commands decoded by the missile guidance set complete the circuit in the flight control system corresponding to the particular command.

1-184. RF pulses from the missile guidance set are received by the missile tracking antenna-receiver group OA-2896A/GRW-5. The antenna is movable in azimuth and elevation and is kept locked on the missile by antenna positioning signals. The antenna contains four feedhorns, identified as A, B, C, and D which are mounted in a modified Cassegrainian reflector (figure 1-54). With each pulse received, azimuth and elevation information is determined by comparing the sum and difference of the energy received at the feedhorns. Range information is derived from the receiver sum signal compared with time.

1-185. The azimuth position of the missile is determined by the amount of energy received at horns AB in relation to horns CD, and antenna elevation position by the amount of energy received at horns AC in relation to horns BD. This energy difference is detected and converted to an IF signal by the receiver portion of the antenna-receiver-transmitter group (figure 1-55). The IF signals are routed to the receiver group in the operations room. The receiver group converts the azimuth and elevation IF signals to DC error signals and sends them to the antenna control. There, the signals are converted to antenna positioning signals and sent to the antenna servo drive motors via the antenna group in the antenna terminal. The drive motors, in turn, position the antenna in azimuth and elevation to reduce the error signals to zero.

1-186. The sum of the energy received by the four feedhorns (A+B+C+D) is detected and converted to a sum IF signal and is sent to the receiver group along with the azimuth and elevation IF signals. The receiver group converts the sum IF signal to range video signals for range computer CP-560A/GRW-5 and the missile guidance console. The range video signal is used in the range computer to center the tracking gates, in time, about the return signal from the missile guidance set. The range computer calculates target range and sums ten successive values of the target range. This summation, in the form of a binary number, is transmitted to signal data converter CV-967C/GRW-5 for presentation to the guidance computer equipment. The missile guidance console receives the range video signals and presents them in visual form for the operator.

1-187. As the antenna moves in response to the antenna positioning signals, digital signals representing azimuth and elevation positions are generated by code wheels mounted on the antenna and sent to the signal data converter. The signal data converter relays binary azimuth, elevation, and range data to the guidance computer equipment on a time-shared basis.

1-188. The azimuth, elevation, and range data sent to the guidance computer equipment is used in the guidance equations to solve the ballistic flight problem in real time. On the basis of these computations, the computer generates data in the form of steering orders and commands to guide and control the missile in flight.

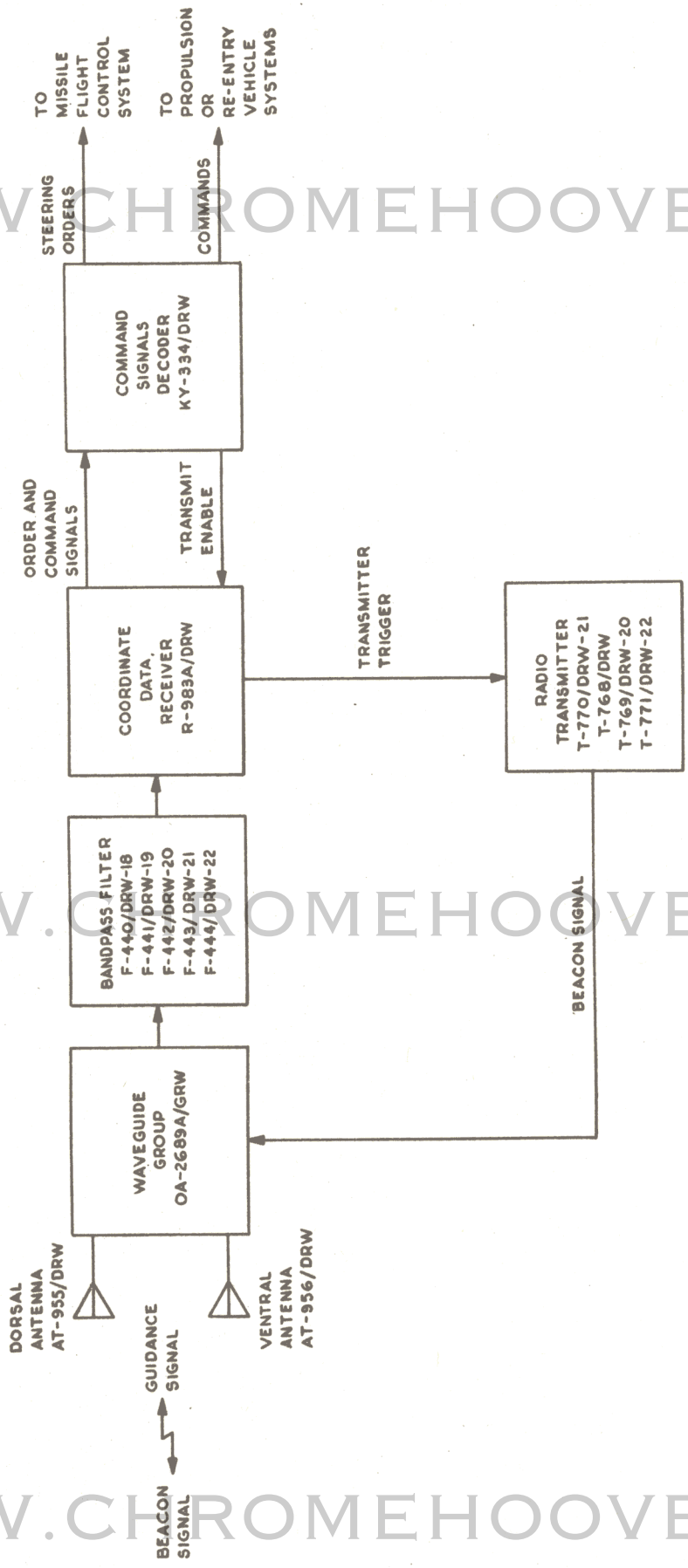

Figure 1-53. Missile Guidance Set AN/DRW-18, AN/DRW-19, AN/DRW-20, AN/DRW-21, or AN/DRW-22, Block Diagram

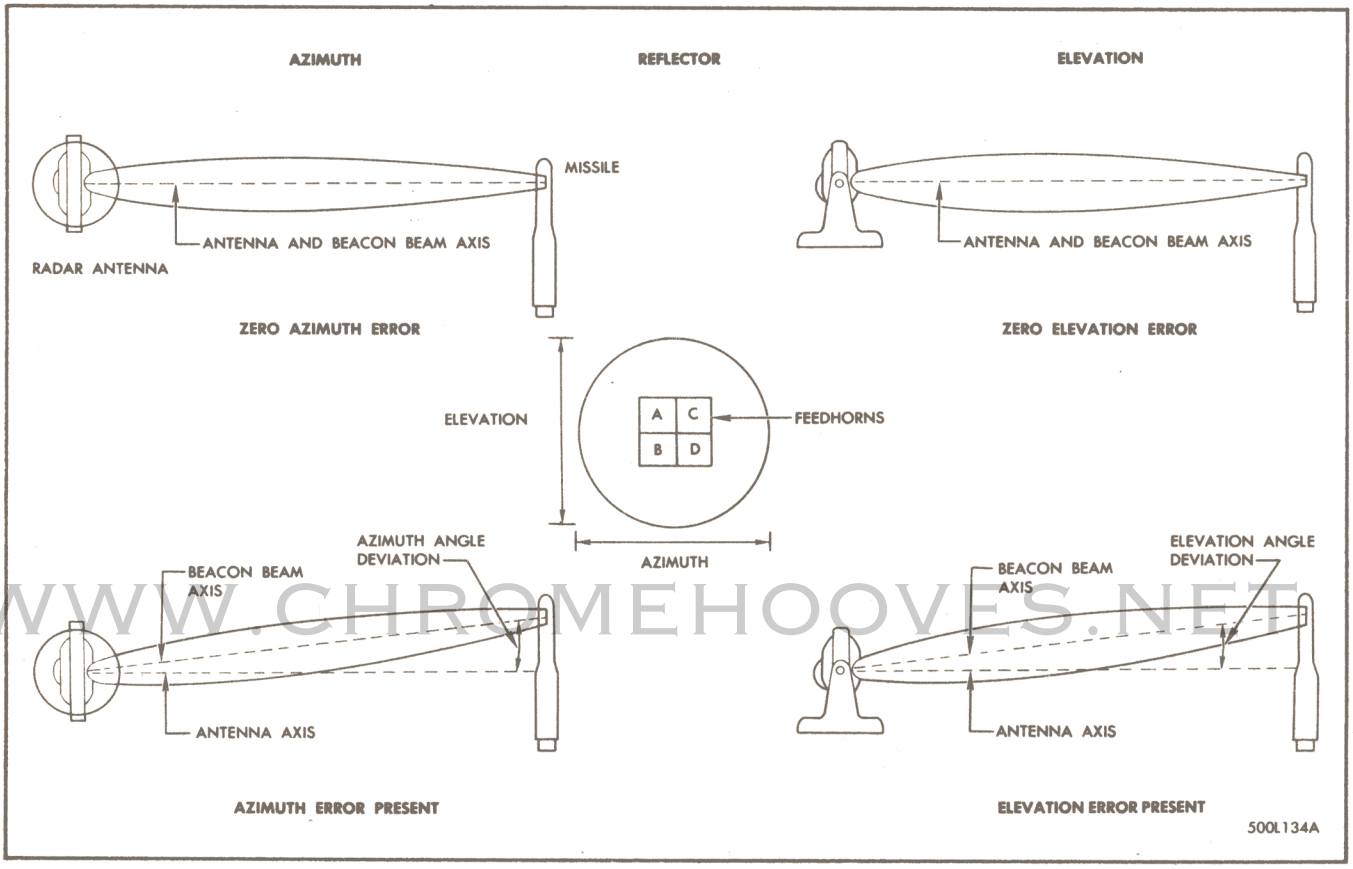

Figure 1-54. Azimuth and Elevation Error Detection

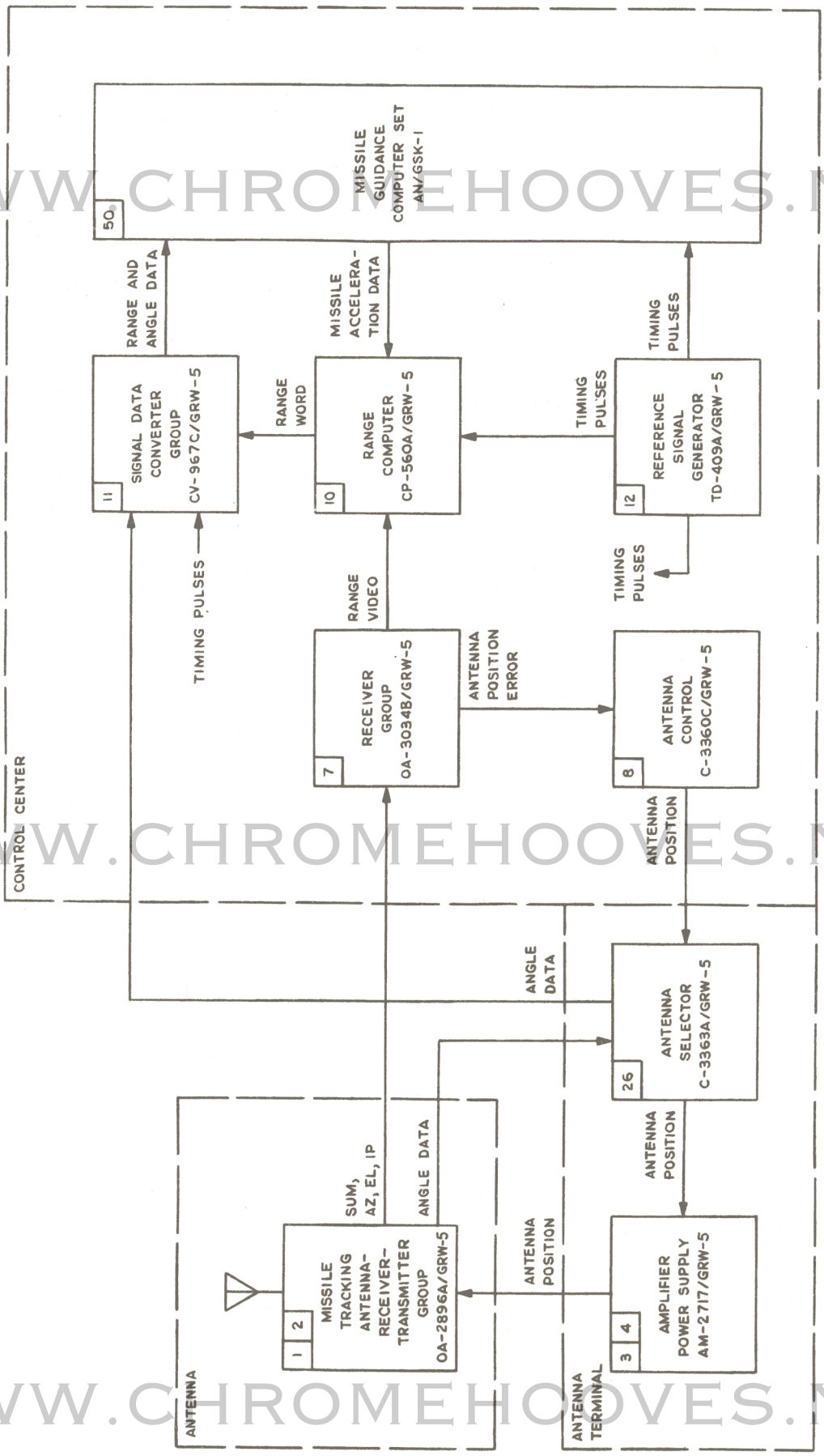

Figure 1-55. Radar Receiving Units Block Diagram

Several type of program constants are used by the computer during system operation. These include target constants which define the targets, prearm area, and trajectory shape. Eleven sets of these constants can be stored in the computer memory. These are known as the reference target and targets 1 through 10. The reference target constants will be used with the guidance exerciser. One of the other ten sets of target constants will be designated for use with an in-flight missile. Another type of constant describes the characteristics of the missile used in the launch complex. Other constants are guidance site constants which give the geographical location of the system.

1-189. The data representing the actual missile position is sent from the signal data converter to the digital-to-digital converter and then transferred into other computer circuitry; likewise, signals from other computer circuitry are sent to the digital-to-digital converter, then transferred to the radar.

1-190. The signal data recorder RO-146/GRW-5 provides a photographic record of important data, related to time, which reflects circuit operation and equipment performance during a data run or mission. The recorder has provisions for 24 channels; however, only 18 are used with this system. Each channel signal is recorded by means of a mirrored galvanometer which deflects when a signal current is applied. An optical system causes a light beam to be deflected from the galvanometer mirror onto a moving light-sensitive paper. The trace on the paper develops after exposure to fluorescent light. The 12-inch wide recorder paper is on a 200-foot roll and moves at variable speeds.

1-191. Digital data printer RO-144/GSK-1 located to the left of the missile guidance console is a parallel operation, eight-column printer. During countdown procedures, this unit prints data that is useful in evaluating the performance of the entire guidance system. The information printed may vary dependent on the portion of the operational program involved as shown in figure 1-56.

1-192. FLIGHT CONTROL SYSTEM.

1-193. The flight control system consists of ground and airborne equipment. The ground equipment checks and monitors airborne components during a system checkout and before launch. The airborne equipment consists of components that provide a programmed flight path during Stage I flight, stabilize the missile, and accept guidance commands to change missile attitude.

1-194. The ground equipment is located in control-monitor group OA-2441. During a system checkout, this equipment automatically and semiautomatically checks flight control equipment; during a launch countdown, it checks the airborne components on a go/no-go basis.

1-195. The airborne flight control components control missile attitude about the pitch, yaw, and roll axes during both stages of powered flight (figure 1-57). These components send electrical signals to airborne hydraulic equipment servoactuators, which position the thrust chambers, and they also receive signals from the missile guidance set to correct or refine the missile flight path or attitude.

1-196. GROUND EQUIPMENT. The flight control system ground equipment consists of one equipment rack in control-monitor group OA-2441. The rack contains a signal analyzer assembly, command assembly, programmer check assembly, comparator assembly, signal generator assembly, signal selector assembly, power supply assembly,

(Text continued on page 1-94)

LINE NO.	DATA PRINTED	WHEN PRINTED	PRINTED
	Note 1. If level correction guidance program is used, word 1 below will be 55555555. 2. Plus (+) sign equals north or east miss-distance. 3. For guidance exercise, lines 12 and 13 will print guidance exerciser code (+0111111). 4. Refer to target tape contents sheet contained in the guidance control target trajectory kit folder. 5. If a zero appears in the program codes in the applicable last three digits, emergency action listed in T.O 21-SM68-1FJ-1-2 should be taken when TEST FAULT lamp lights.		
	COMBINED SYSTEMS EXERCISE PROGRAM - GUIDANCE EXERCISE		
1	Guidance program code	After ACQ MISSILE push-button indicator lighted green; or after START GUID X pushbutton indicator pressed; or if 02 bit of the azimuth data word in the BDR is set. (Pressing LAUNCH EXERCISE pushbutton indicator to yellow sets azimuth 02 bit.)	
2	Space		
3	Constant register 0	Following line 2	Eight digit octal number
4	Constant register 1	Following line 2	Eight digit octal number
5	Constant register 2	Following line 2	Eight digit octal number
6	Constant register 3	Following line 2	Eight digit octal number
7	Constant register 4	Following line 2	Eight digit octal number
8	Constant register 5	Following line 2	Eight digit octal number

Figure 1-56. Digital Data Printer RO-144/GSK-1, Printout Data (Sheet 1 of 6)

LINE NO.	DATA PRINTED	WHEN PRINTED	PRINTED
	COMBINED SYSTEMS EXERCISE PROGRAM - GUIDANCE EXERCISE		
9	Constant register 6	Following line 2	Sign and seven digit decimal number
10	Constant register 7	Following line 2	Sign and seven decimal number
11	Space		
12	Miss-distance	At end of evaluation	Sign and latitude miss-distance in tenths of miles (Refer to notes 2 and 3)
13	Miss-distance	At end of evaluation	Sign and longitude miss-distance in tenths of miles. (Refer to notes two and three)
1 thru 13	Abort code (may occur on any line printout listed above)	Azimuth 02 bit not set	00777700
		Note Normal ABORT code will be printed on unsuccessful GX run if AZ 02 is lighted.	
	COMBINED SYSTEMS EXERCISE PROGRAM - NORMAL FLIGHT		
	Note Lines 1 thru 11 as above if 02 bit of the azimuth data word in the BDR is set (LAUNCH EXERCISE pushbutton indicator lights yellow).		Refer to note 1 for line 1
12	BDR range to missile	End of fixed sequence program	Eight digit octal number
13	BDR azimuth to missile	End of fixed sequence program	Eight digit octal number
14	BDR elevation missile	End of fixed sequence program	Eight digit octal number

Figure 1-56. Digital Data Printer RO-144/GSK-1, Printout Data (Sheet 2 of 6)

LINE NO.	DATA PRINTED	WHEN PRINTED	PRINTED
COMBINED SYSTEMS EXERCISE PROGRAM - ABORTED FLIGHT			
	(Lines 1-13 as above)		
1 thru 13	Abort code	At anytime Azimuth 02 bit is not set (after ACQ MISSILE pushbutton-indicator lighted green)	00777700
1 thru 13	Abort code	At anytime after ACQ MISSILE pushbutton indicator lights green if average elevation data word between two successive computer cycles differs by more than 2.5 degrees	00666600
COMBINED SYSTEMS EXERCISE PROGRAM - TARGET VERIFY PROGRAM			
1	Target verify program code	At target verify, or when ACQ MISSILE push-button-indicator is pressed	33333333 (Refer to note 5)
2	Sector number	At target verify, or when ACQ MISSILE push-button indicator is pressed	Two digit number
3	SAC control number	At target verify, or when ACQ MISSILE pushbutton indicator is pressed	Six digit number
4	SAC target island number	At target verify, or when ACQ MISSILE push-button indicator is pressed	Four digit number or five digit number (Refer to note 4)
5	SAC designated ground zero number	At target verify, or when ACQ MISSILE push-button indicator is pressed	Three digit number

Figure 1-56. Digital Data Printer RO-144/GSK-1, Printout Data (Sheet 3 of 6)

LINE NO.	DATA PRINTED	WHEN PRINTED	PRINTED
	COMBINED SYSTEMS EXERCISE PROGRAM - LEVEL MEASUREMENT PROGRAM		
1	Level measurement program code	ANT RAISE pushbutton indicator is pressed (blast detected)	22222222 (Refer to note 5)
2	Radial axis tilt	After program completion	Decimal value
3	Tangential axis tilt	After program completion	Decimal value
4	Space		
	COMBINED SYSTEMS EXERCISE PROGRAM - LOOP TEST PROGRAM		
	Test Fault Code	Azimuth 02 bit not set when computer receives start loop test signal	00777700
	GUIDANCE PROGRAM - EXERCISE OR NORMAL FLIGHT		
1	Guidance program code	After ACQ MISSILE pushbutton indicator START GUID X push-button indicator is pressed	11111111 (Refer to notes 1 and 5)
2	Space		
3	Constant register 0	Following line 2	Eight digit octal number
4	Constant register 1	Following line 2	Eight digit octal number
5	Constant register 2	Following line 2	Eight digit octal number
6	Constant register 3	Following line 2	Eight digit octal number
7	Constant register 4	Following line 2	Eight digit octal number
8	Constant register 5	Following line 2	Eight digit octal number
9	Constant register 6	Following line 2	Sign and seven digit decimal number

Figure 1-56. Digital Data Printer RO-144/GSK-1, Printout Data (Sheet 4 of 6)

LINE NO.	DATA PRINTED	WHEN PRINTED	PRINTED
GUIDANCE PROGRAM - EXERCISE OR NORMAL FLIGHT			
10	Constant register 7	Following line 2	Sign and seven digit decimal number
11	Space		
12	Miss-distance	At end of evaluation	Sign and latitude miss-distance in tenths of miles (Refer to notes 2 and 3)
13	Miss-distance	At end of evaluation	Sign and longitude miss-distance in tenths of miles (Refer to notes 2 and 3)
GUIDANCE PROGRAM - ABORTED EXERCISE OR ABORTED NORMAL FLIGHT			
(Lines 1 thru 11 as above)			
12	Miss-distance	At end of evaluation	+0099999
13	Miss-distance	At end of evaluation	+0099999
GUIDANCE PROGRAM - EXERCISE OR NORMAL FLIGHT (SUCCESSFUL - NO TERMINAL EVALUATION)			
(Lines 1 thru 11 as above)			
12	Miss-distance	No evaluation	+0070000
13	Miss-distance	No evaluation	+0070000
TARGET VERIFY PROGRAM			
1	Target verify program code	At target verify, or when ACQ MISSILE push-button indicator pressed	33333333 (Refer to note 5.)
2	Sector number	At target verify, or when ACQ MISSILE push-button indicator pressed	Two digit number

Figure 1-56. Digital Data Printer RO-144/GSK-1, Printout Data (Sheet 5 of 6)

LINE NO.	DATA PRINTED	WHEN PRINTED	PRINTED
		TARGET VERIFY PROGRAM	
3	SAC control number	At target verify, or when ACQ MISSILE push-button indicator pressed	Six digit number
4	SAC target data inventory number	At target verify, or when ACQ MISSILE push-button indicator pressed	Five digit number
5	SAC designated ground zero number	At target verify, or when ACQ MISSILE push-button indicator pressed	Three digit number
		LEVEL MEASUREMENT PROGRAM	
1	Level measurement program code	ANT RAISE pushbutton indicator pressed (blast detected)	22222222 (Refer to note 5.)
2	Radial axis tilt	After program completion	Decimal value
3	Tangential axis tilt	After program completion	Decimal value
4	Space		

Figure 1-56. Digital Data Printer RO-144/GSK-1, Printout Data (Sheet 6 of 6)

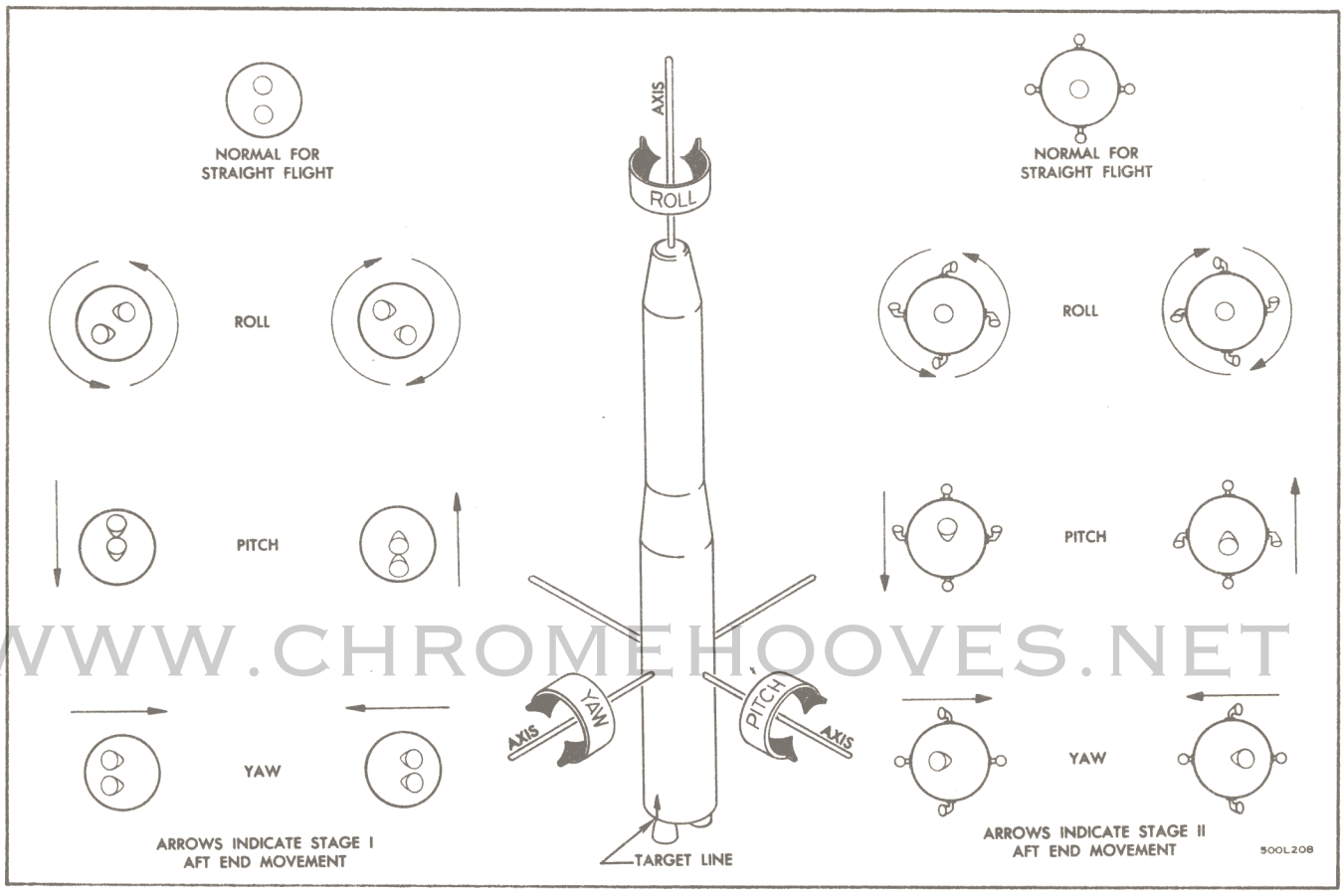

Figure 1-57. Missile Axes and Movement Diagram