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DEPARTMENT OF THE ARMY FIELD MANUAL

U.S. ARMY AIR DEFENSE FIRE DISTRIBUTION SYSTEM AN/FSG-1 (MISSILE MASTER)

HEADQUARTERS, DEPARTMENT OF THE ARMY
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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Purpose and Scope

This field manual is a guide for commanders and operating personnel in the utilization of the U.S. Army Air Defense Fire Distribution System AN/FSG–1 (Missile Master). The Missile Master is the means used by the commander to coordinate the fires of a number of Army air defense missile firing units. This manual contains a general description of the system, a discussion of organization, a description of operating equipment, and detailed operating instructions. This manual is applicable to nuclear and nonnuclear warfare.

2. Changes or Comments

Users are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded to Commanding Officer, Air Defense Combat Developments Agency ,ATTN: CAGAD–D, Fort Bliss, Tex.

3. References and Abbreviations

References containing material supplementing this manual are listed in appendix I. Appendix II defines abbreviations pertaining to the Missile Master system.

4. Safety

a. This equipment employs dangerous voltages which may be fatal if contacted. Extreme caution should be exercised when working with the equipment.

b. While every practical safety precaution has been incorporated in the equipment, the following rules must be strictly observed:

(1) *Keep away from live circuits.* Operating and maintenance personnel must follow safety regulations at all times. Do not change tubes or make adjustments inside equipment with high voltage supplies energized. Connect measuring instruments to circuits with voltages in excess of 300 volts before energizing high voltage supplies, and do not touch meters or test leads when taking measurements.

(2) *Discharge circuit capacitors.* Some capacitors retain lethal voltages even after high voltages have been removed from circuits, and high voltages may appear at normally low voltage terminals due to equipment failures. Discharge circuits by grounding them or by shorting capacitors before touching circuit components or terminals.

(3) *Do not tamper with interlocks.* Under no circumstances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with in any way by other than authorized maintenance personnel. Do not rely on interlock switches to remove high voltages from the equipment.

(4) *Do not service or adjust alone.* Under no circumstances should any person reach inside the equipment without the immediate presence of another person capable of rendering aid.

c. FM 21–11 describes first aid treatment for electrical shock.

5. Maintenance

a. General.

(1) Maintenance procedures for electronic components of this equipment are

similar to those procedures for air defense missile systems.

(2) Any significant reduction in maintenance personnel requirements will be in the procedures area (i.e., maximum utilization of available personnel in the using unit will reduce support requirements).

(3) The operational requirement of the AN/FSG–1 system is such that the maximum practicable maintenance capability is necessary on site to insure prompt and continuous maintenance support.

(4) Repairs will be accomplished as close to the origin of failure as possible based on the combat situation where the controlling factor is what can be done and not what may be done.

b. Maintenance Concept.

(1) The maintenance concept is based on DA guidance for this specific system. It provides for use of the artillery personnel, Signal Corps repairmen, and civilian contract personnel.

(*a*) Essentially, two levels of maintenance are employed:

1. On-site maintenance (organizational and field).

2. Off-site (depot).

(*b*) On-site maintenance consists of first through fourth echelon including limited overhaul.

(*c*) Off-site maintenance will be performed at the depot or manufacturer's installation.

(2) All maintenance personnel responsible for performing on-site maintenance and repair functions are assigned or attached to the appropriate air defense artillery (ADA) unit.

(*a*) The artillery technician is primarily concerned with organizational maintenance and has a thorough understanding of electronic theory, practical application of this theory, and the functions of all components within his area of organizational maintenance.

1. Replacement of those repair parts, assemblies, subassemblies, components, and chassis authorized at organizational maintenance level by AR 750–5.

2. All checks, adjustments, and alinements required to maintain the system in peak operational readiness that are authorized by the maintenance allocation charts (MAC's) formulated in accordance with AR 750–6.

(*b*) The Signal Corps repairmen attached to the ADA unit will be responsible for overall system analysis and repairs. This involves operation and maintenance of special type test equipment required to perform assigned maintenance responsibilities. Components will be repaired to the maximum extent possible on site. Where on-site repair is not possible, the mission depot will be requested to furnish disposition instructions.

(3) The Signal Corps repairmen attached to the appropriate ADA unit will be primarily concerned with logistic support for the maintenance of the AN/FSG–1 as well as overall maintenance supervision of contract personnel and radar maintenance (Army radars only) through fourth echelon at all Missile Master sites.

(4) Air defense personnel will perform first echelon maintenance on Missile Master systems and first and second echelon maintenance on battery terminal equipment (BTE).

6. Symbology

The symbols shown and defined in this manual are correct. Those symbols encountered in the field will not differ from those used in subsequent chapters of this manual.

7. Fire Units

A fire unit is the smallest tactical unit that is capable of operating autonomously. The unit can independently detect, attack, and destroy hostile airborne objects. A battery is a group of weapons set up under one tactical commander in a certain area. Although a battery may contain more than one fire unit, the terms

"battery" and "fire unit" are synonomous as used throughout this manual.

8. Fire Unit Numbers

It is recommended that fire units be designated by numbers higher than 49, in order to avoid confusion with track channel numbers. (Track channel numbers run from 01 through 48 inclusive.)

9. Supporting Acquisition Radar

Because of its limited use, the supporting acquisition radar is given only limited coverage in this manual.

Section II. THE MISSILE MASTER SYSTEM

10. General

a. In order to exploit the effectiveness of guided missiles in the air defense mission, it is essential that guided missile fire units be furnished timely information on potential air defense targets. They must be informed continuously of actions of other fire units to avoid duplication of fire and to aid in achieving a more equitable distribution of fire. The continuous improvement in performance of military aircraft and the threat of air-to-surface missiles require exceedingly rapid and accurate transmission of warning, recognition, and commands to fire units. The increased demands on air defense artillery resulting from probable use of nuclear warheads by attacking forces in the event of an air attack on the United States require air defense commanders to be informed continuously of the progress of the attack and of the operational and attack status of their own fire units.

b. The fire distribution system AN/FSG–1 (Missile Master) is the means used by the Army Air Defense Commander (AADC) to coordinate the fires of a number of air defense missile firing units. The system receives and correlates data from semiautomatic ground environment (SAGE), ground-controlled interception (GCI) stations, local defense acquisition and height-finding radars, and missile fire units. The AN/FSG–1 uses these data to control and monitor the operations of the associated missile fire units.

c. The fire distribution system AN/FSG–1 (Missile Master) provides rapid and accurate flow of information from higher headquarters and organic radars to U.S. Army air defense fire units concerning potential targets, and rapid and accurate transmission of information from Army air defense fire units, through the Missile Master element at the Army Air Defense Command Post (AADCP), to adjacent AADCP's. The Missile Master system provides for instantaneous transmission of commands from the AADCP in a form that can be rapidly and accurately displayed by associated missile fire units. Information is also available to fire units concerning aircraft being tracked by other fire units.

d. In order to obtain more efficient use of the Missile Master system, operating personnel must know and understand the system's functions and its modes and methods of operation.

11. System Functions

The system performs the following major functions:

a. Automatically transmits SAGE and locally generated reference track data (X and Y coordinates, velocity, and height) on as many as 48 tracks to all associated fire units.

b. Automatically retransmits data from each fire unit to all other fire units associated with the system.

c. Automatically transmits battery track data (H, X, and Y coordinates of tracks being tracked by fire unit target tracking radars) to adjacent AADCP's and receives battery tracking data from the fire units associated with these AADCP's.

d. Monitors all SAGE reference data, battery tracking data, and battery auxiliary data (battery status indicating out of action, ready, tracking, firing, effective or ineffective, raid size estimate or no estimate) at the AADCP.

e. Transmits specific target to fire unit designations and commands from the AADCP to associated fire units as required.

f. Utilizes reference track data from local radars and voice communication with the NORAD sector direction center (NSDC) or GCI station when SAGE data is unavailable.

g. Automatically transmits channel status data and fire unit status data to SAGE.

h. Manual facilities permit auxiliary (track channel members, target identity, raid size, and track priority status) and reference data to be taken from the manual plotting board and sent by voice communication to associated fire units and supporting air defense (AD) units as required.

12. Modes of Operation

a. SAGE (NORAD) Mode I. SAGE direction centers are responsible for and exercise complete control over the conduct of the air battle within their assigned sector boundaries. In this mode, all target assignments within a sector will normally be made by that sector's SAGE direction center. However, any NORAD direction center or control center with acquisition and control capability within the sector may be required to undertake the engagement of targets within a specified airspace within the sector, and to provide the necessary tactical control of weapons employed.

b. SAGE (NORAD) Mode II. In the event a SAGE direction center becomes inoperative, adjacent SAGE direction centers will accept complete air defense responsibility over specified portions of the disabled sector. These direction centers will conduct the air battle in their assigned portions of the disabled sector in the same manner and with the same responsibilities as apply within their own sector boundaries. When a sector takes over responsibility for a portion of a disabled sector, all operations within that portion of the disabled sector will be classified as mode II.

c. SAGE (NORAD) Mode III. In the event two adjacent SAGE direction centers become inoperative, or a situation develops that precludes the utilization of modes I or II, mode III will be adopted. In this mode, responsibility for conducting the air battle will be exercised by the NORAD numbered sector or region commander through the designated commander at the NORAD control center (NCC). (All NCC's with AN/FSG–1 systems are collocated.) Within their areas of responsibility, NCC's will exercise full operational control, coordinate all air defense actions, make target assignments, and coordinate weapon commitment to the maximum extent consistent with the tactical situation.

13. Methods of Operation

a. Under the SAGE (NORAD) modes of operation there are four system options of operation. The decentralized (reference) option is used tactically. The centralized (ATABE) option is a nontactical option used for test and exercises. Manual and lateral-tell are emergeny options controlled by SOP.

(1) *Decentralized (reference).* In this option, the Army Air Defense Commander may control ADA fire unit engagement from the AADCP, directing target selection and fire distribution through maximum use of the AN/FSG–1 (Missile Master) system. Only reference track data are sent from SAGE to Missile Master. This option is for tactical operations and is the *normal* method of operation.

(2) *Centralized (ATABE).* This option is used for test purposes and for specified NORAD directed exercises only. The ATABE option *is not used* for tactical operations. Whenever ATABE option is mentioned throughout this field manual it refers to testing and special exercises.

b. The AADCP utilizes one of the two following weapon control statuses when operating under the reference option:

(1) *Centralized.* Direct target to fire unit assignments are made by the tactical monitors (TM) at the AADCP (Missile Master).

(2) *Decentralized.* The fire units select the targets using reference data from the AADCP. The tactical monitors at the AADCP monitor the actions of the fire units. This is the normal method of operation.

CHAPTER 2
SYSTEM DESCRIPTION

Section I. BASIC DESCRIPTION

14. General

The Missile Master system of the AADCP consists of the following major components:

a. The Army air defense operations room (AADOR).

b. The defense acquisition and height-finder radars.

c. Battery terminal equipment (BTE); also known as the fire unit integration facility (FUIF).

15. AADCP

The Missile Master is the operations center in the command post of the Army Air Defense Commander (AADC) wherein representatives of his staff sections insure continuous and efficient control, coordination, and integration of the current tactical operations of his assigned and attached forces. It is operated on the principle of maximum decentralization of target assignment and fire control. Here, all available air defense information is collected, evaluated, and disseminated as intelligence to the fire units. A typical Missile Master site is shown in figure 1 and the floor plan in figure 2.

16. Army Air Defense Operations Room (AADOR)

a. General. The operations room contains the following consoles and equipment:

(1) *Tactical display equipment consoles.*

(*a*) *Army Air Defense Commander (AADC) console.* This console is located to permit the AADC an unobstructed view of the operations room. The console contains facilities to monitor the actions of all missile fire units, to control the operating mode, to permit verbal dissemination of the weapons control status and states of alert to fi units, and to light appropriate inc cators automatically on the manu facilities.

(*b*) *Air defense artillery operations o ficer (ADAOO) console.* This co sole is located to permit close s pervision of tactical monitors an supervision of activities within th operations room by the ADAO also know as the tactical directo It is identical to the defense com mander console.

(*c*) *Tactical monitor (TM) consoles* Each of these consoles has the fa cilities to monitor fire units and t designate targets to these fire units

(*d*) *Friendly protector (FP) console* This console contains facilities t monitor all system tracks and t prevent attack of friendly tracks by the fire units.

(2) *Tracking subsystem consoles.*

(*a*) *Surveillance and Entry (S & E) consoles.* There are two S & E consoles separated by the channel status unit. All the system tracks may be monitored, and all the tracking operations may be directed from either S & E console. One S & E officer can handle all the surveillance and entry functions, and the other may be used for supervision of the trackers. Newly activated SAGE track channels are displayed on only one S & E console depending on the position of a switch on the channel status unit. This switch controls the initial display of SAGE track channels.

(*b*) *Channel status unit.* The purpose of this unit is to display the status

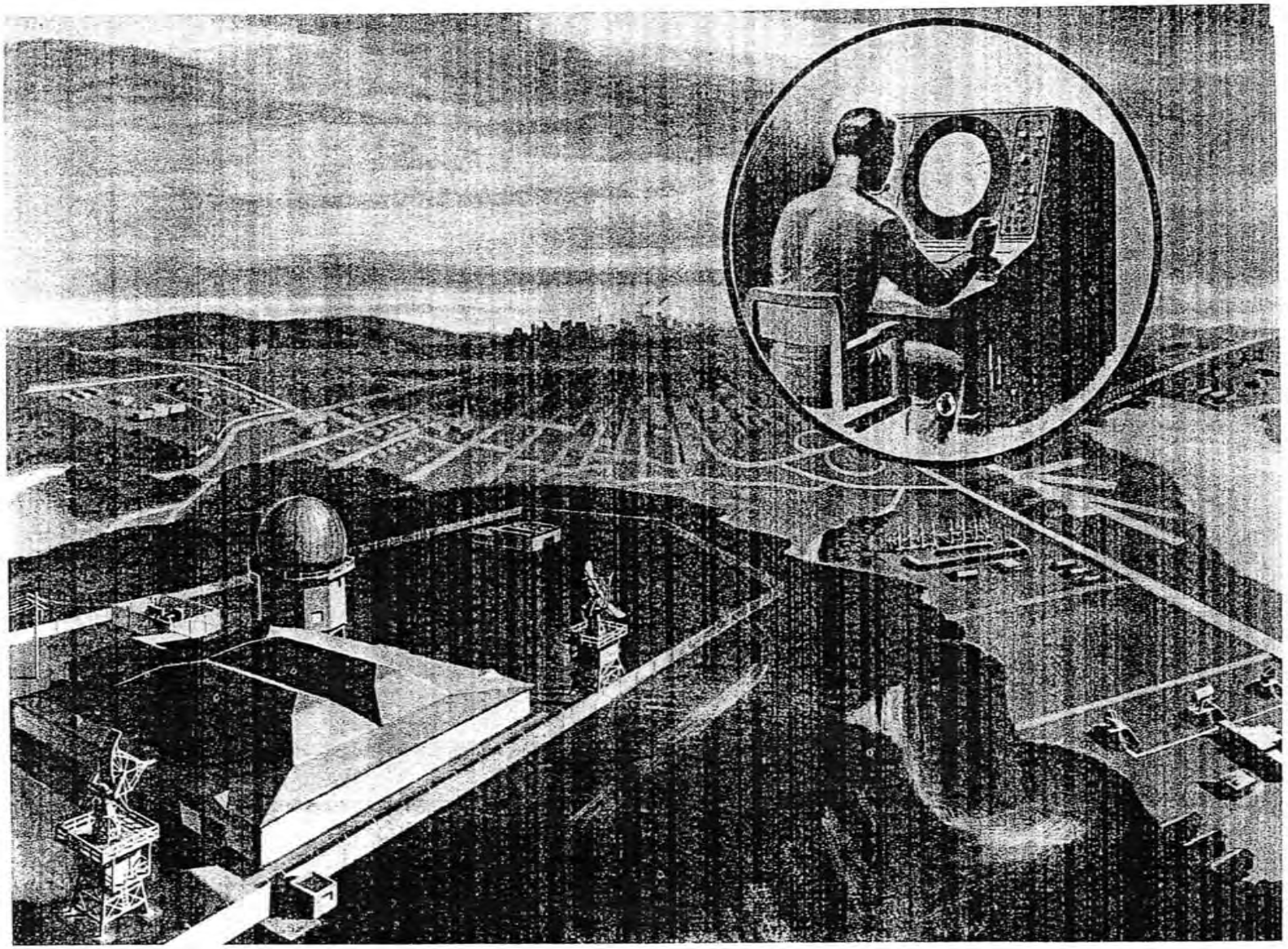


Figure 1. Typical AADCP Missile Master site.

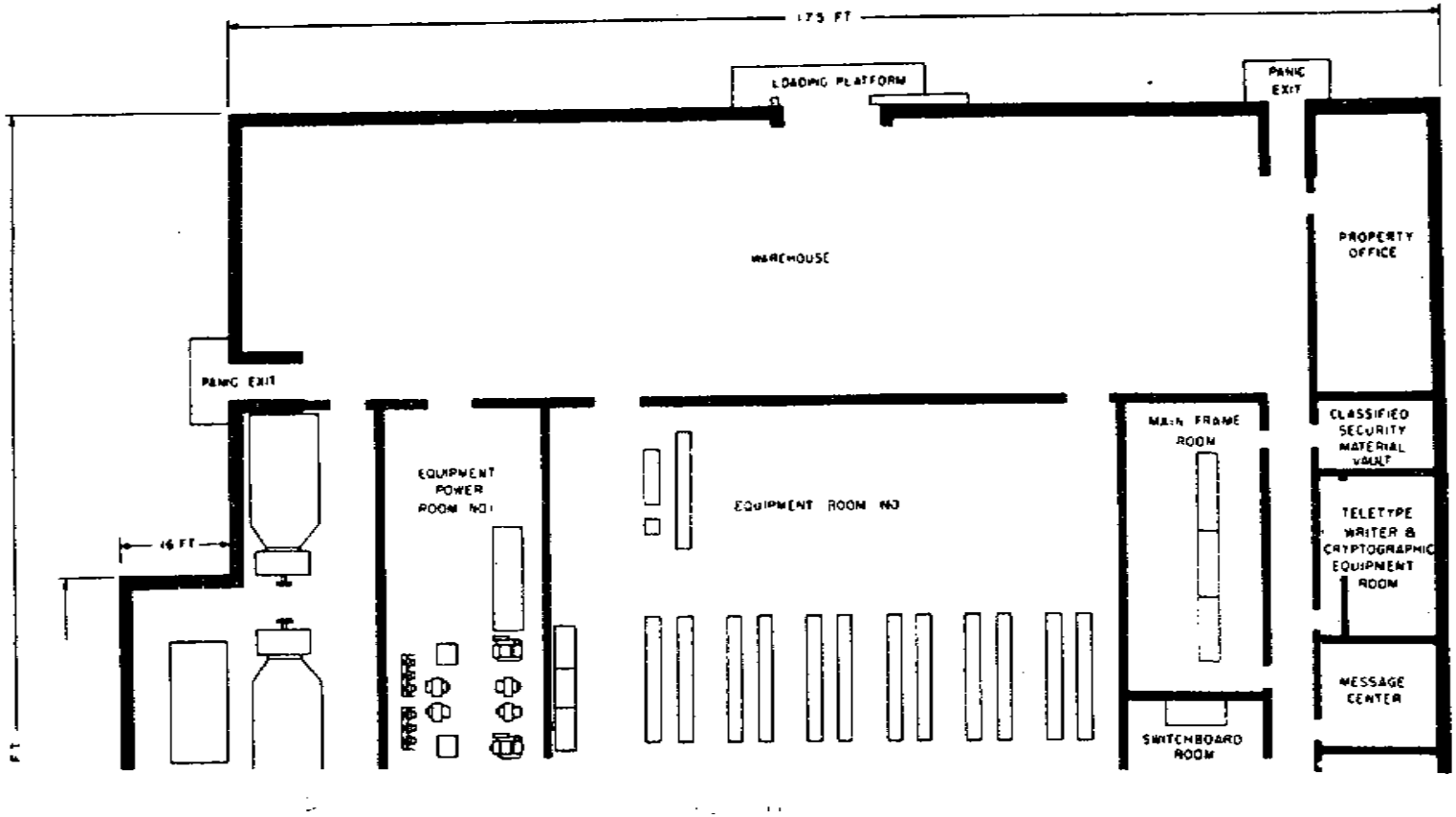


Figure 2. AADCP floor plan.

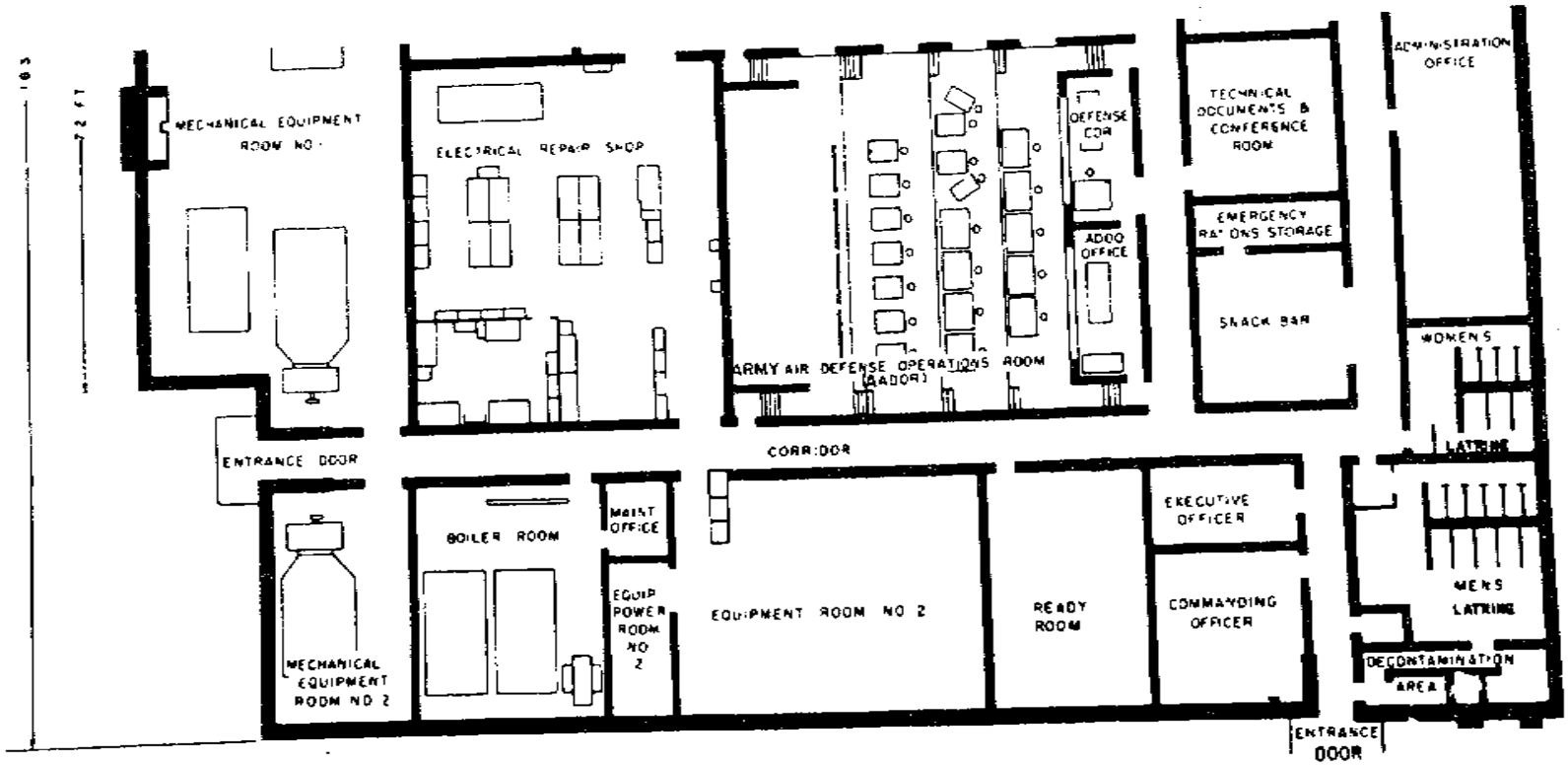


Figure 2—Continued.

of each track channel as to whether channels are in use, out-of-action, a SAGE activated channel, locally activated, hostile, friendly, and priority.

(c) *Tracking consoles.* Identical tracking consoles are provided to insure close symbol to video registration on those track channels assigned to the respective tracker. Each console contains facilities for control of reference data on any track channel in the system. All tracks can be given to one tracker, or any desired assignment of tracks can be made to the trackers. The consoles are located to facilitate supervision of the trackers by the S & E officers.

(d) *Range-height subsystem.*

1. *Range-height indicator (RHI) consoles.* There are two RHI consoles, one adjoining each S & E console. Each RHI console contains facilities to determine height on all tracks in the system, but normally the work-load is divided. The services of both RHI consoles are available to both S & E officers.
2. *Antenna control units.* There are two of these control units, each located close to its associated RHI console. These units permit each RHI operator partial or complete control of the associated height-finder radar antenna.

(3) *Supporting acquisition evaluator console.* This console is present only when the defense employs a supporting acquisition subsystem. The supporting acquisition evaluator console is used to examine the reference data sent in from the supporting acquisition radar consoles located at the supporting radar sites and to assign pertinent supporting acquisition data for viewing by tracking subsystem personnel. If the S & E officer desires, the supporting acquisition data may be utilized as a basis for activation of a local reference track channel.

(4) *Manual facilities.* These facilities provide for manual display of system tracks, operational status of fire units, and other pertinent information. Manual facilities serve as a backup for semiautomatic operation, an emergency means of operation in event of failure of the semiautomatic facilities, and as a means of monitoring the fire of associated air defense systems such as naval gun and missile systems integrated into the defense.

b. Appearance and Lighting. The interior of the operations room is designed to minimize eye fatigue caused by prolonged operation with equipment displays. A blue-light system installed over a hexagonal honeycomb of gray-painted aluminum foil prevents annoying reflections and reduces the period of dark adaptation normally required upon entering a darkened room from a normally lighted area. The blue-light intensity may be adjusted by dimmers located in various sections of the operations room.

c. Air Conditioning. To insure optimum operation of electronic equipment, the operations room and operation consoles are maintained at 68° Fahrenheit ±2° and at a relative humidity of not more than 50 percent.

17. Defense Acquisition and Height-Finding Radars

There are a variety of defense acquisition and height-finding radars used that provide video inputs to the AN/FSG–1 system. Current types of defense acquisition radars are as follows: AN/FPS–20 (with the addition of ECCM modifications the designation changes to AN/FPS–67), ARSR–1A, AN/FPS–8, AN/FPS–24, AN/FPS–27, and AN/FPS–35. Current types of height-finding radars are AN/FPS–6A (with the addition of ECCM modifications the designation changes to AN/FPS–54) and AN/FPS–7.

18. Battery Terminal Equipment (BTE)

The battery terminal equipment (BTE), also known as fire unit integration facility (FUIF), serves as a link between the AADCP and the fire units. It decodes the command, designate, and battery track messages and converts them

into a form compatible with the fire unit equipment. The BTE also encodes battery track and battery status information originating at the fire unit into battery track messages. Battery track messages are transmitted over the automatic data link (ADL) network to the AADCP and other fire units. Figures 3 and 4 show a typical BTE installation.

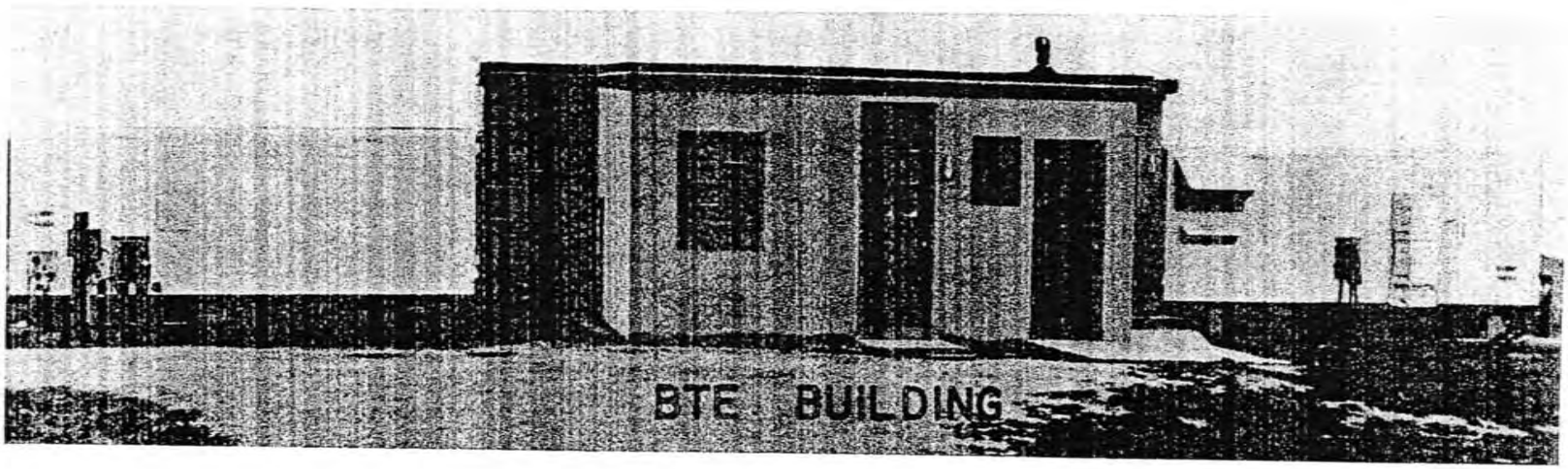


Figure 8. Exterior view of a typical BTE installation.

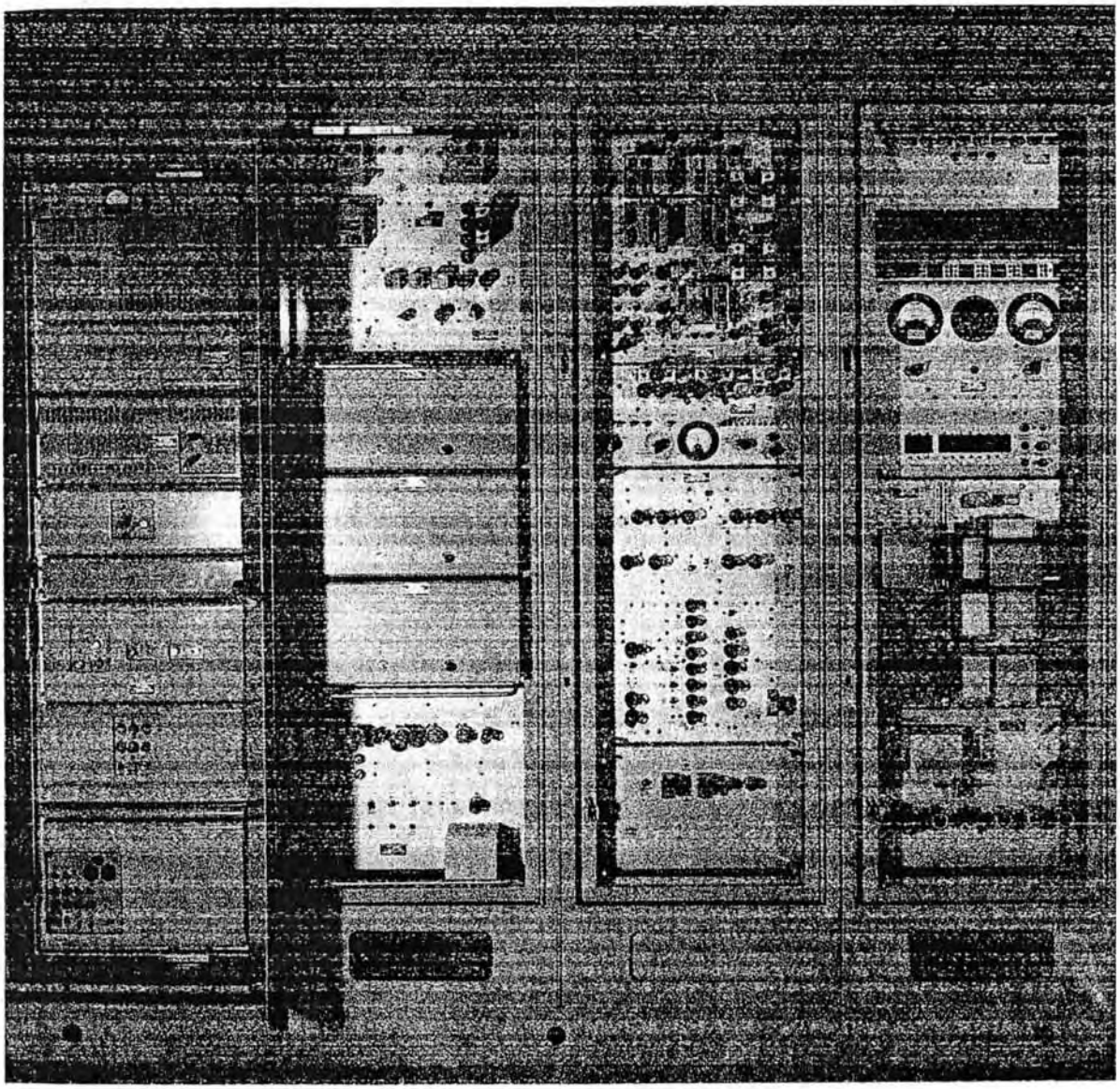


Figure 4. A typical BTE installation.

Section II. FUNCTIONAL DESCRIPTION

19. General

The functions of the Missile Master system are varied with the system modes and methods of operation. Some functions are used independently; others are performed regardless of mode of operation. In the reference data option, SAGE data is used to provide auxiliary, command, and reference data. Local reference data are used to correlate SAGE reference data and, in addition, are transmitted to fire units as reference data. In normal tracking, the S & E officers can use local reference data and SAGE data for updating fire unit data and in determining less critical targets. The target track data are transmitted to the AADCP and other fire units. These data inform each associated fire unit of all other fire unit actions and inform the AADC of the tactical situation. When ad-

jacent AADCP's overlap fire unit coverage, control from one or both may be necessary as the situation demands. The tactical monitoring duties performed by tactical monitors, ADAOO, and the Army Air Defense Commander are controlled by SOP's, modes of operation, and methods of operation. Since there is monitoring and correlation of fire units, there is also a necessity for monitoring of friendly aircraft to prevent firing by fire units on these aircraft. This duty is performed by the friendly protector operator. With all the functions that are available within the Missile Master system there exists the possibility of malfunctions which may prevent automatic distribution of all data that are necessary to the fire units. Therefore, manual facilities are included in the system for emergency backup operation.

20. Sage Data

a. Reference Data.

(1) The data flow diagram of the Missile Master system is shown in figure 5. Track position, velocity, and auxiliary data such as size, priority, and identity are received from the SAGE direction center. This information is stored in electronic memory units, and predicted track position is generated. After track data have been processed as described in the following paragraphs, reference and auxiliary data on all active track channels in the system are transmitted to all fire units. All tracks, friendly tracks only, or hostile tracks will be transmitted in accordance with the air defense weapon control status and the local SOP. At the fire unit, symbols (representing the reference data) appear on the battery acquisition radar display. These symbols will be correlated with the acquisition radar video.

(2) Early warning is provided by SAGE or local source with assignment control exercised by the AADCP. At times, air defense artillery director (ADAD) manual actions are required at SAGE to transmit tactical data and specific control instructions.

(3) Control established by the AADCP will not prevent an unassigned fire unit from—

(*a*) Detecting, locking on, and reporting significant targets (pop-up) not already represented by an entered track channel.

(*b*) Locking on an assigned or unassigned HOSTILE.

b. ATABE Data. See paragraph 13*a*(2).

21. Local Reference Data

The video from the defense acquisition radar and the supporting acquisition radar reference data are displayed on the tracking and S & E consoles. Local track reference data are generated by positioning a tracking symbol over the video and utilizing the manual-rate-aided tracking facility provided. Height data are introduced from either of the two height-finder radars, and identity and auxiliary data that are obtained from either the SAGE DC or a GCI station are added. These data then become part of the track reference data transmitted to the fire units and displayed on the various consoles within the AADCP.

22. Normal Tracking

The S & E officers and the trackers monitor the SAGE reference track data in relation to local radar video and supporting acquisition reference symbols. They correct the SAGE position data if necessary. Local reference track data are added by utilizing a tracking channel not used by a SAGE activated channel. If no channels are available, all channels may be inspected to determine the less critical targets. These targets may be dumped from the system.

23. Battery Track Data

When an Army air defense fire unit is tracking a target, battery track data, from its target track radar (TTR), and battery status data are transmitted to the AADCP by automatic data links (ADL). The battery track data are then rerouted to all other fire units within the defense and places a symbol on the battery acquisition radar PPI screen when a spring-loaded switch is pressed at the receiving fire unit. Thus, each Army air defense fire unit

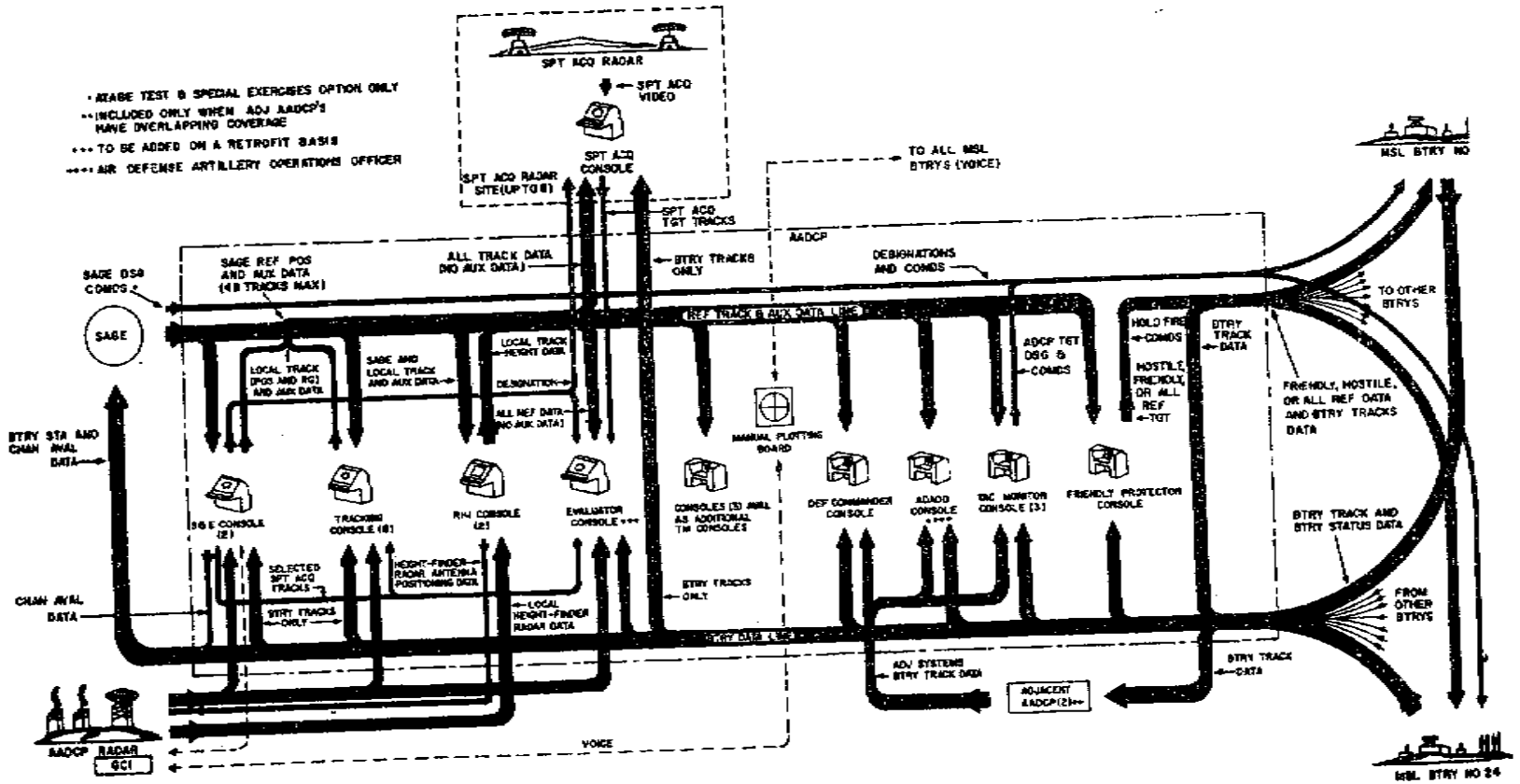


Figure 5. Data flow of the Missile Master system.

commander knows which targets are being tracked by other fire units, and is able to select the target presenting the greatest threat to the defense within the range of his weapons not already under engagement by another battery. Battery track data can be selected for display on the S & E and tracking consoles at the operator's discretion. Battery status and track data can be displayed on all tactical consoles (defense commander, operations officer, tactical monitor, and friendly protector) within the AADCP and battery status can be transmitted to the SAGE DC from the AADCP.

24. Adjacent AADCP'S

Where other AN/FSG–1 systems are located close enough to the AADCP for overlapping fire unit coverage, battery track data are sent to the adjacent AADCP. Battery track data received from the adjacent AADCP's are displayed on the consoles of the defense commander, operations officer, and tactical monitor.

25. Tactical Monitoring

The tactical monitors (TM), the ADAOO, and the Army Air Defense Commander monitor all fire unit sections with respect to reference tracks and fire unit actions of adjacent systems. Each tactical monitor is associated with a maximum of eight fire units. In accordance with established SOP and under supervision of the ADAOO, a specific track may be assigned to a fire unit, or one or more fire units may be ordered to *cease engage* or *hold fire* on a track. When a track is assigned, the reference track data and battery track data of all other track channels are cut off from the selected fire unit. In their place, either a REMOTE (meaning *engage*), CEASE ENGAGE, or HOLD FIRE lamp lights, a buzzer sounds, and a hostile symbol is displayed on the fire unit PPI screen pointing out the target on which action is to be taken. When the fire unit commander acknowledges the command, the assignment data are cut off and battery and reference track data are reinstated until another command is transmitted. In ATABE option, assignment and control by the tactical monitor are replaced by assignment and control by the SAGE DC. The tactical monitor is responsible for the fire unit-to-target correlation.

26. Monitoring of Friendly Aircraft

The friendly protector monitors fire unit actions for the purpose of preventing engagement of friendly aircraft. If a fire unit tracks a target that should not be attacked, the friendly protector immediately orders the fire unit to *hold fire*. The appropriate tactical monitor will then verify the action taken by the friendly protector and, if appropriate, transmit a *cease engage* command to the fire unit concerned or, with the concurrence of the ADAOO, cancel the original *hold fire* command. The original *hold fire* command from the FP overrides all other commands in the system at that time.

27. Manual Operation

Manual facilities are included in the system to provide tactical personnel and the defense commander with the operational status of elements of the defense; for example, a fire unit out of action and the reason, or the reason for reduced effectiveness of any fire unit that is in action but not completely effective. A clock also is included as well as indicator lamps showing the air defense warning and the weapon control status.

Section III. ORGANIZATION

28. General

The Air Defense Artillery Command Post platoon consists of the command post headquarters and data and monitoring sections. These sections include personnel for sustained operation of the Missile Master system. The operations officer is responsible to the Army air defense commander for the two sections and operations of the system. The assistant operations officer is the assistant and adviser to the operations officer. The Air Defense Direction Center (ADDC) section is at SAGE and is the responsibility of the assistant operations officer at Missile Master. The Signal Corps maintenance detachment is responsible to the defense commander for the maintenance of the system.

29. ADA Command Post Platoon (Missile Master), Artillery Brigade (Air Defense)

The platoon is a special augmentation to the headquarters of an Army air defense brigade

TOE that has the responsibility of an Army air defense utilizing a Missile Master system and functions as a separate staff section. The platoon contains the command post headquarters and data and monitoring sections with the personnel required to sustain continuous operation of the AN/FSG–1.

30. Command Post Headquarters and Data Monitoring Sections

a. The command post headquarters section is responsible for training, effectiveness, and operations of the platoon personnel.

b. The data and monitoring section is responsible for operation of all tracking and monitoring consoles and the AADCP switchboard.

31. Operations Officer and Assistant

a. Missile Master Operations Officer. This officer is responsible to the Army air defense commander for all activities of the section. He is responsible for the training and effectiveness of detachment personnel. The maintenance responsibility is carried out by command supervision of the Signal Corps maintenance facility (par. 33). The operation officer may act as the Army air defense operations officer (par. 87).

b. Assistant Missile Master Operations Officer. This officer acts as the principal assistant and adviser to the operations officer (*a* above). He coordinates and supervises operational details and acts as the primary ADAOO. He has direct responsibility for the Air Defense Direction Center (ADDC) section.

32. Air Defense Direction Center Section (SAGE)

The ADDC section is composed of Army SAGE console operators and a liaison officer stationed at NORAD SAGE direction centers. These personnel operate the air defense artillery director (ADAD) consoles in the weapons direction of the DC. An Army field grade officer serves as the ADA battle staff officer on the NORAD sector commander's operational staff. The ADA battle staff officer advises the NORAD sector commander and his staff on Army air defense matters.

33. Signal Corps Maintenance Facility

This facility consists of Signal Corps personnel attached to the defense headquarters. They perform maintenance as outlined previously in paragraph 5.

CHAPTER 3
THE SURVEILLANCE AND ENTRY CONSOLES

34. General

The two *surveillance and entry* (S & E) consoles in the operations room are separated by a *channel status unit* on which the status of each of the 48 tracking channels is displayed. Each S & E console (fig. 6) has a PPI screen that may display video from the defense acquisition radar; reference symbols from supporting acquisition radars; track reference data from the system data storage; fire unit track data from the battery; reference symbols from SAGE, IFF video, range and angle marks, map video, and contour video. The range-angle marks and map video cannot be displayed simultaneously, nor can the battery track data symbols and supporting acquisition radar symbols. The controls and indicators required for operation of the S & E console are located adjacent to, and on the shelf beneath, the display panel. The two consoles are situated so that each officer has a clear view of the channel status unit. To perform efficiently, each S & E officer must know and understand preliminary control settings, start-stop procedures, preliminary adjustments, responsibilities, operating procedures, and antijamming measures.

35. Symbols and Displays

Figure 7 depicts symbols that are displayed on the S & E console PPI screen. The video is "painted" (made visible) on the PPI screen by a sweep line rotating about the center of the screen. The following types of information may be displayed:

a. Fixed Returns. Fixed returns are echoes returned from permanent features such as towers, buildings, and land masses. They are displayed as bright spots of various sizes and shapes. Fixed returns are characterized by their immobile and persistent nature. Since fixed returns are undesirable, they are minimized by radar operators through adjustment of the radar beam elevation and use of the moving target indicator (MTI).

b. Moving Target Returns. These retur are recognized by the change of position on t PPI screen with each successive radar sca Intensity and size of the return will vary ac cording to its change in range, azimuth, elev tion, and attitude.

c. Symbology.

(1) Local or SAGE-manual tracks will a pear as video or supporting acquis tion reference symbols surrounded b a ¼-inch circle or partial circle on th console to which the track is assigne On the other tracking system consol a dot is superimposed on the video.

(2) SAGE track position data will be in dicated by the center of a ⅛-inch ci cle or partial circle "painted" on th PPI screen. Video or a supporting ac quisition reference symbol will appea within the ⅛-inch circle or partial ci cle if the track is being detected b Missile Master organic radars.

(3) Video being tracked by the adjacen S & E console or by the tracking con soles may be displayed as normal vide with a sharp, bright spot superim posed.

(4) Battery track data received by ADL is displayed as video (if this aircra is being tracked by the defense ac quisition radar) with a bright, flash ing cross superimposed when the RE MOTE DATA switch is in the BD position.

(5) The supporting acquisition radar ref erence symbols appear as flashing dot when the REMOTE DATA switch is in the GAP FILLER position. Since supporting acquisition radar tracks usually appear only when the video is not detected by the defense acquisition radar, supporting acquisition radar markers normally will not correlate with defense acquisition radar video

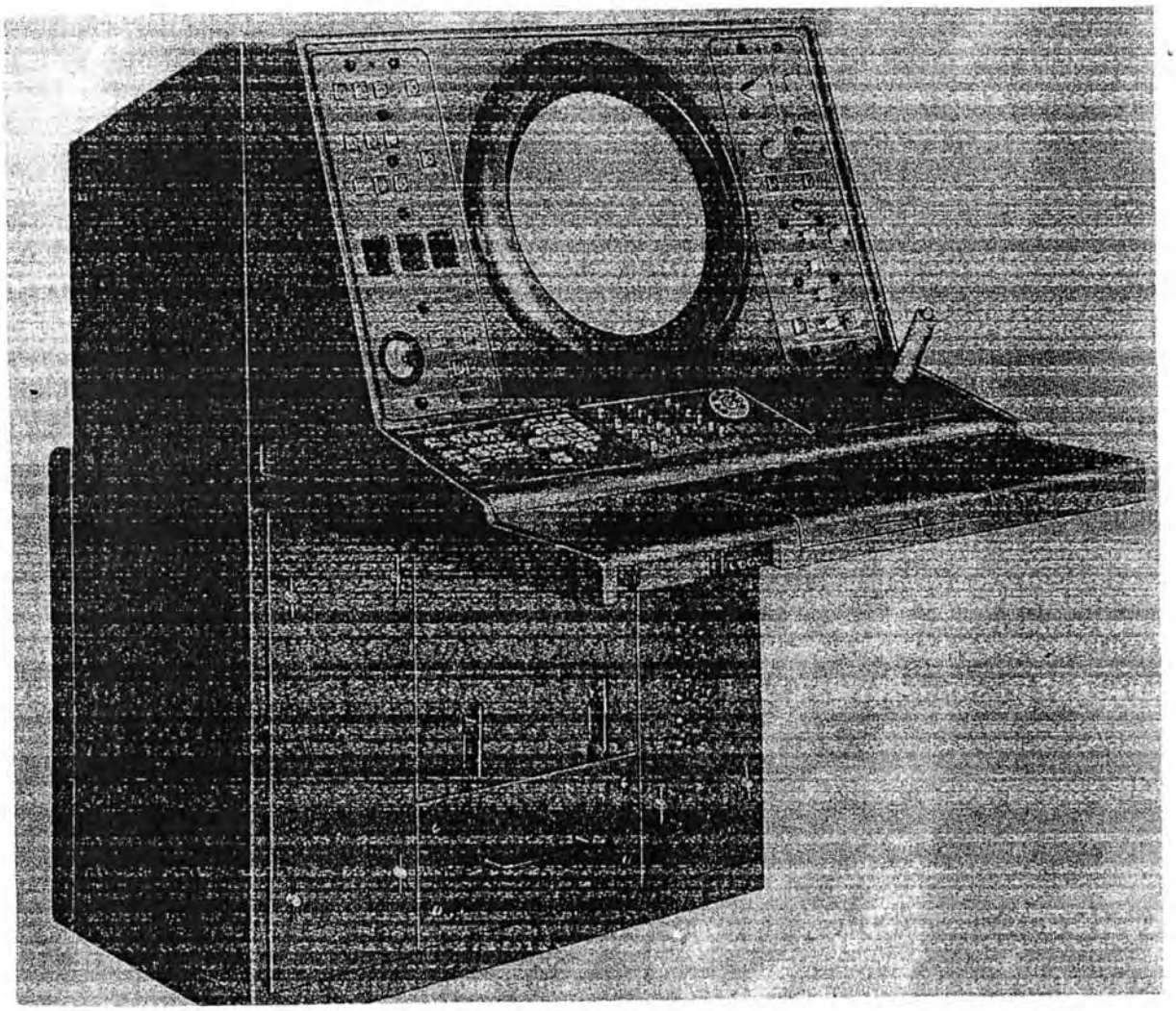


Figure 6. The S & E console.

(6) IFF video appears as short arcs at the same azimuth but at greater range than the target. IFF video is present only when the IFF pushbutton is depressed. The number of arcs appearing on the screen depends on the mode of IFF operation.

(7) Track reference data under control of Missile Master personnel may appear as video or supporting acquisition radar reference symbols surrounded by a symbol on the screen of the console to which it is assigned. Unidentified symbols will appear as a ∪. Friendly symbols will appear as a ∩, and hostile symbols will appear as a complete circle. These symbols are ¼-inch in diameter. On the other S & E console, a dot is superimposed on the video.

(8) SAGE track position data may be indicated by the same type of symbols as local tracks but half-size (⅛-inch). Video or a supporting acquisition radar reference symbol will appear within the symbol if the track is being detected by the Missile Master organic radars.

d. The Track Channel Leader. A leader line pointing from the center of the PPI display toward a tracking symbol identifies the symbol associated with the tracking channel selected by the operator. All indications on the left control panel pertain to the channel whose target is indicated by the leader.

36. Controls and Instruments

a. Left Control Panel (fig. 8). This panel is mounted to the left of the PPI display panel.

(1) SAGE pushbutton-indicator: Indicates that the channel is being utilized by SAGE. Illuminated indicator shows that the track reference and auxiliary data of the selected channel are controlled by SAGE.

(2) SAGE MANUAL pushbutton-indicator: When pressed, transfers control of track position reference data from SAGE to Missile Master. A lighted lamp indicates that the selected track channel was originated by SAGE but that Missile Master has assumed responsibility for track reference data. When SAGE positional data are incorrect, the officer may depress the SAGE MANUAL pushbutton, allowing him to correct the error. In SAGE MAN-

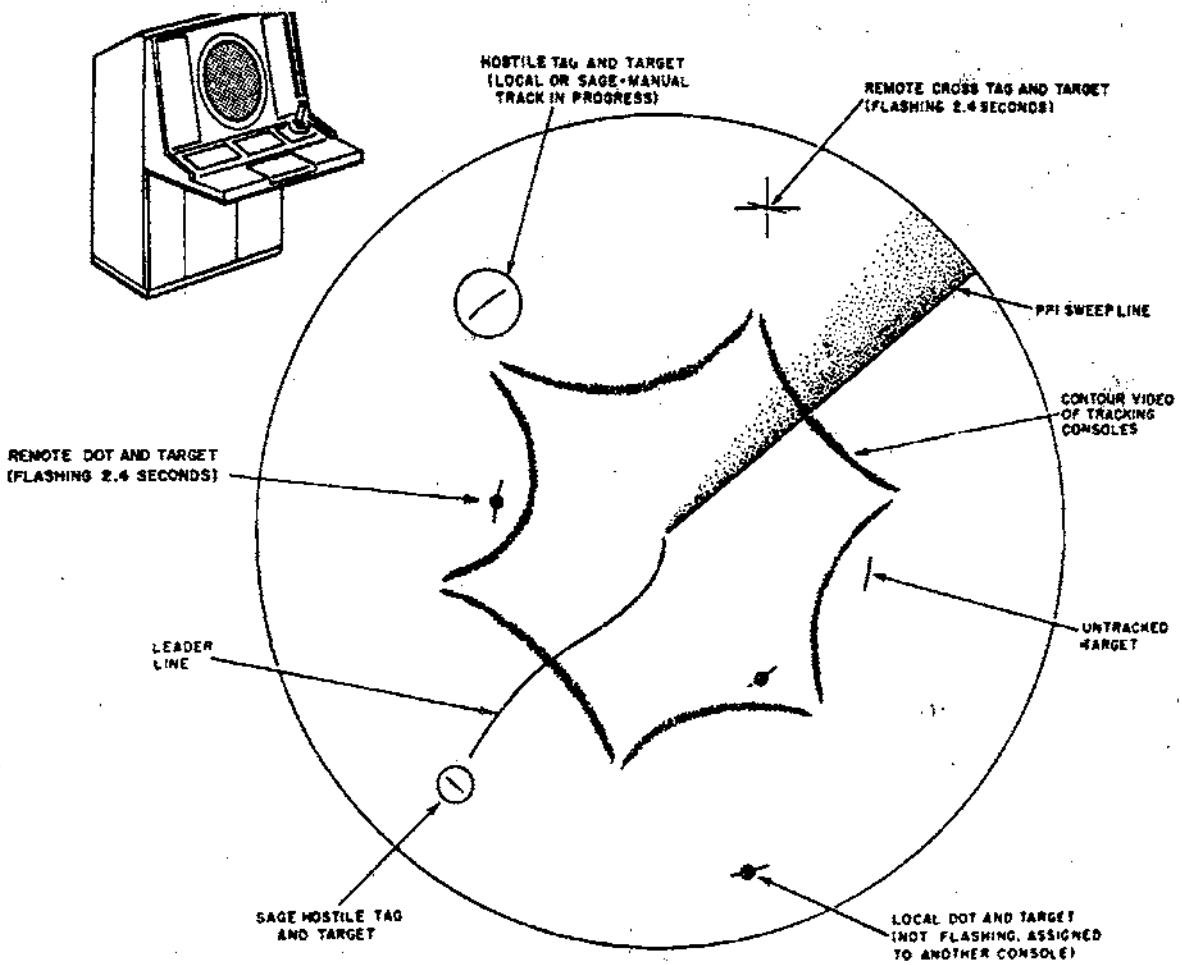


Figure 7. S & E console PPI display.

UAL, auxiliary data will remain as broadcast by SAGE.

(3) LOCAL pushbutton-indicator: Indicates that the channel under close control is a locally activated track channel. A SAGE or SAGE MANUAL channel may be placed under local control by depressing the LOCAL button. Once the track channel has been taken over locally, the auxiliary data may be changed.

(4) SAGE INSPECT pushbutton: When pressed, allows SAGE position data to replace local position data if the selected track channel is in SAGE MANUAL control. This action permits inspection of SAGE data to determine if the selected track channel should be retained in the SAGE MANUAL control or returned to SAGE control.

(5) RAID SIZE (ONE, FEW, MANY) pushbutton-indicators: When pressed, enter size of raid into auxiliary data stores if the selected track channel is under local control. The RAID SIZE lamp, when lighted, indicates the number of targets in the selected track channel whether the track channel is controlled locally or by SAGE.

(6) IDENTIFY (FRIENDLY, HOSTILE, BOGEY) pushbutton-indicators: When pressed, enter particular identity into the auxiliary data stores if the selected track channel is under local control. A lighted lamp indicates the identity assigned to a track channel either locally or by SAGE. Pressing either the FRIENDLY or HOSTILE pushbutton permits reference data to be transmitted to tactical consoles and to the fire units. Locally entered track channels automatically receive *bogey* identity. Pressing the BOGEY pushbutton cancels PRIORITY or HOSTILE IDENTITY indications. Reference data on track channel designated as *bogey* are received and stored in the track channel memory stores but are not broadcast to other parts of the system. Either a FRIENDLY or HOSTILE IDENTITY pushbutton must be pressed before reference data are transmitted.

(7) PRIORITY pushbutton-indicator: When pressed, assigns a priority status to the selected track channel if it is under local control. When lighted, the lamp indicates that priority status has been assigned to the selected track channel either locally or by SAGE.

(8) CONSOLE indicator: Indicates the number of the console to which the selected track channel has been assigned.

(9) CHANNEL indicator: Displays the number of the selected track channel.

(10) TARGET HEIGHT X 1,000 FT. METER: Indicates height of the selected track channel determined by SAGE when under SAGE control or height determined by the local radars when under SAGE manual or local control.

(11) HEIGHT FADE indicator lamp: When lighted, indicates that no height video was observed the last time the track channel was serviced by the RHI. The pushbutton is provided to enter a height fade on a new track.

(12) RADAR FADE indicator: When lighted, indicates that the FADE button on the numerical unit was pressed on each of the previous successive observations. The RADAR FADE button is provided to check operation of the lamp. Pressing the SEQUENCE button (S & E numerical unit) (*e* below) for the faded track channel cancels any previous fade count memory for that track channel.

(13) KILL pushbutton: When pressed, transmits total kill to SAGE if the selected track channel was SAGE originated. It dumps the selected track channel if it is under local control, returns the selected track channel to the available status, and cancels the target designations to fire units.

b. Right Control Panel (fig. 9). This panel (same as that utilized on the tracking console) is mounted to the right of the PPI display.

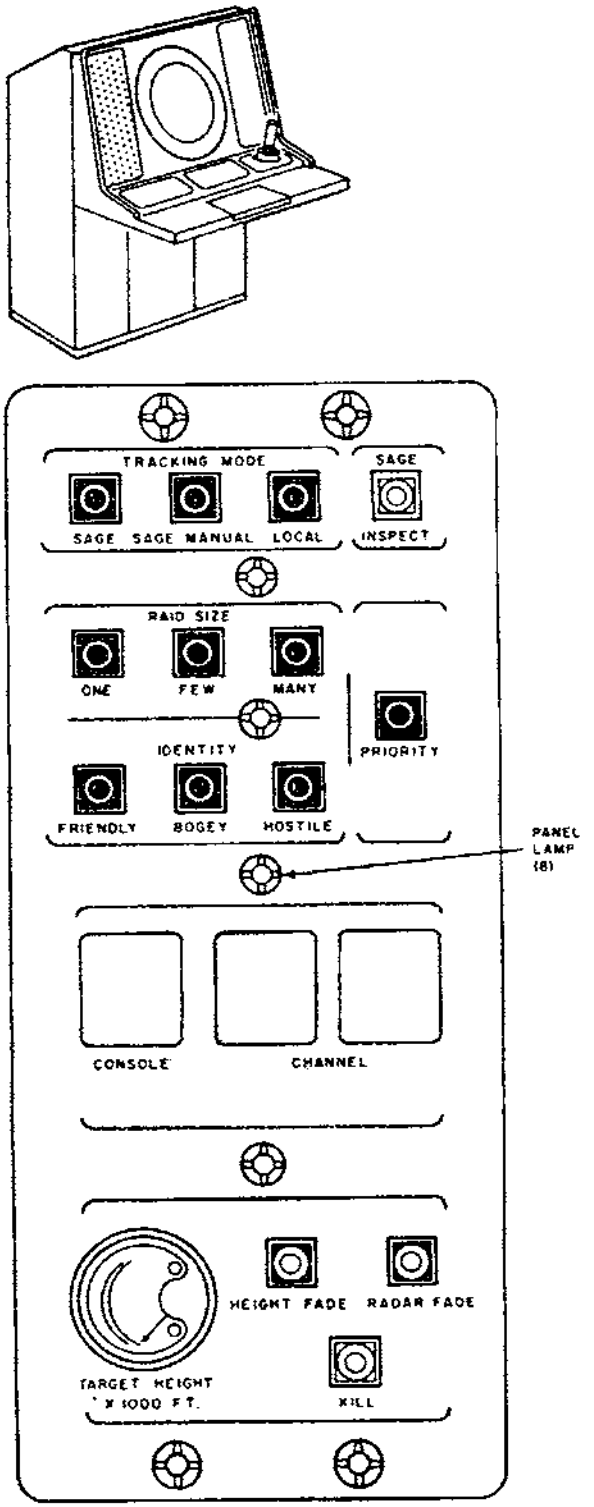


Figure 8. The S & E left control panel.

(1) RANGE X 1,000 YD. seven-position switch: Selects range of display presented on the PPI.

(2) DISPLAY OFFSET X 1,000 YD. thirteen-position switches (one for east-west and one for north-south offset): Control the location of the center of the display with respect to location of the AADCP.

(3) BUSY locking-type pushbutton-indicator lamp: When on, lights the associated transfer pushbutton indicator on all other consoles to show that this operator does not want additional tracks.

(4) MARKERS (RANGE ANGLE-OFF-MAP) three-position switch: Selects range and angle (azimuth) marks, a predetermined map showing GEOREF coordinates, or neither for PPI screen display.

(5) INTENSITY potentiometer: Controls intensity of range and angle marks or video map display on the PPI screen.

(6) REMOTE DATA (BDL-OFF-GAP FILLERS) three-position switch: Selects display of battery tracks, supporting acquisition radar tracks, or neither for PPI screen display.

(7) CATEGORY DISPLAY (FRIENDLY - ALL - HOSTILE) three-position spring-loaded switch: Normally in the ALL position. This switch is used to cause tracking symbols for hostile or friendly tracks only to be momentarily displayed on the PPI screen when desired by the officer.

(8) IFF pushbutton: When pressed, initiates the IFF (identification, friend or foe) challenge and enables the IFF display circuits of the console. IFF will be observed on the PPI screen when the officer operates this switch but not when the operator at any other console operates his IFF switch.

(9) ADJ AADCP DATA three-position switch: This switch is not used.

c. The Tracking Stick. A tracking stick is utilized for manual rate-aided tracking. The tracking stick is a swivel-mounted handle lo-

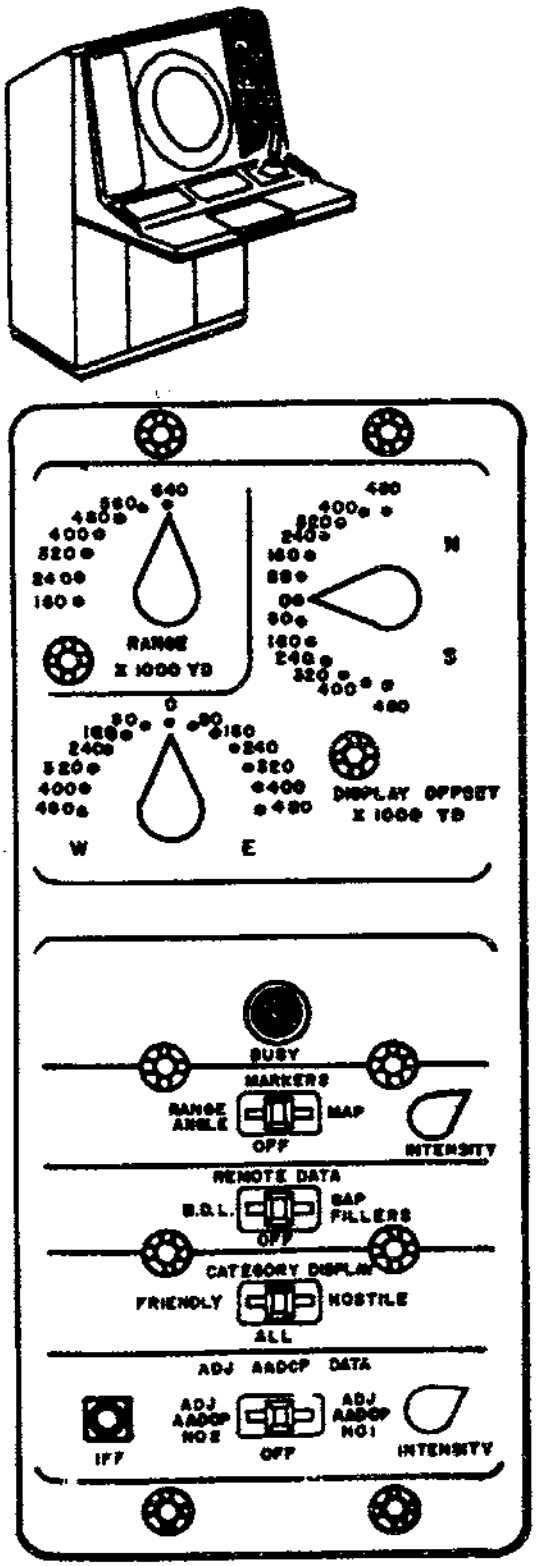


Figure 9. The S & E (and tracking console) right control panel.

cated at the right of the shelf control panel. The tracking symbol is positioned on the PPI screen by displacing the tracking stick in the desired direction. A pushbutton located on the top of the tracking stick performs the following functions:

(1) When the pushbutton is fully depressed, the tracking stick motion results in a coarse (large) displacement of the tracking symbol of the selected channel. Position data only are entered into the track channel stores.

(2) When the pushbutton is released to the first detent after having been fully depressed (depressed to second detent is fully depressed), the tracking stick motion results in a vernier (small) displacement of the tracking symbol of the selected track channel. Position data only are entered into the track channel stores.

(3) When the pushbutton is depressed to the first detent from a released position at least one but not more than 10 radar scans after the last tracking correction, the tracking stick motion results in a vernier displacement of the tracking marker of the selected channel. The position data stored in the channel are corrected, and the velocity data for the aided tracking operation are established. If a correct rate has been established, and the track does not change course or speed, the marker will then follow the video.

(4) When the pushbutton is released, the tracking stick is disconnected from the system to prevent accidental displacement of the tracking markers.

d. The Telephone Panel. The telephone panel is located in the center of the shelf control panel.

e. S & E Numerical Unit (fig. 10).

(1) NEW pushbutton: When pressed, selects the next numerically available track channel for entry of a local track.

(2) HEIGHT DEMAND pushbutton-indicator: When pressed, lights the HEIGHT DEMAND lamp on the range-height indicator (RHI) console,

allowing the RHI operator to service the selected track channel before servicing any other. When lighted, indicates that a *height demand* signal has been established.

(3) NORMAL pushbutton. When pressed, terminates parallel operation of S & E console with any tracking console or reestablishes normal sequencing after a particular track channel has been selected out of order. Pressing this button extinguishes the CHANNEL SELECT or the CONSOLE SELECT indicator lamp.

(4) TRANSFER pushbutton: When pressed, transfers the selected track channel to the console for which a *number* button has been pressed.

(5) CONTOUR pushbutton: When pressed, in conjunction with a *number* button and the CONSOLE SELECT button, causes a contour of the area displayed on the selected console to appear on the S & E console PPI display. If no *number* button has been pressed, pressing the CONTOUR pushbutton and the CONSOLE SELECT button causes the contours displayed on all track consoles *to appear* on the S & E console PPI display.

(6) CONSOLE SELECT pushbutton-indicator: When pressed, places the S & E console in parallel with the tracking console for which a *number* button has been pressed. When the S & E console is in parallel with a tracking console, the pressing of the CONSOLE SELECT button, when no *number* button has been pressed, connects the S & E console in parallel with the tracking consoles in numerical order. When lighted, it indicates that the S & E console is connected in parallel to one of the tracking consoles.

(7) FADE pushbutton: When pressed, enters a fade count into the track channel stores and sequences to the next active track channel. It is used when radar video of the selected track channel has disappeared. Three successive operations of the FADE pushbutton on the same track channel causes the RADAR FADE lamp to light upon returning to this track channel.

(8) SEQUENCE pushbutton: When pressed, selects the next assigned track channel in numerical order or, when operating in parallel with a tracking console, selects the next track channel assigned to that console. This button is used when a track channel has been successfully serviced. Its operation destroys all fade counts for that track channel.

(9) CHANNEL SELECT pushbutton-indicator: When pressed, selects the track channel for which a number has been entered on the *number* panel. When the console is in the *channel select* mode and no *number* button has been pressed, pressing the CHANNEL SELECT button sequences the console to the next numerical track channel. The indicator lights to show that a particular track channel has been selected.

(10) S pushbutton-indicator: When pressed, in conjunction with the TRANSFER button, transfers the selected track channel to the adjacent S & E console. When lighted, it indicates that the associated S & E console is busy.

(11) Number pushbuttons and pushbutton-indicators (0 to 9): When pressed permit track channel or console selection and transfer operations described in paragraphs (4), (6), and (9) above. Lighted pushbutton-indicators (1 to 6) indicate that the associated tracking consoles are busy and desire no further tracking assignments. *Number* pushbuttons 0, 7, 8, and 9 do not have an associated indicator lamp.

(12) CLEAR pushbutton: When pressed releases any entries on the number panel and permits a new entry to be made.

f. Concealed Adjustment Control Panel (fig 11). This panel is located under a hinged cover in the center of the S & E console shelf.

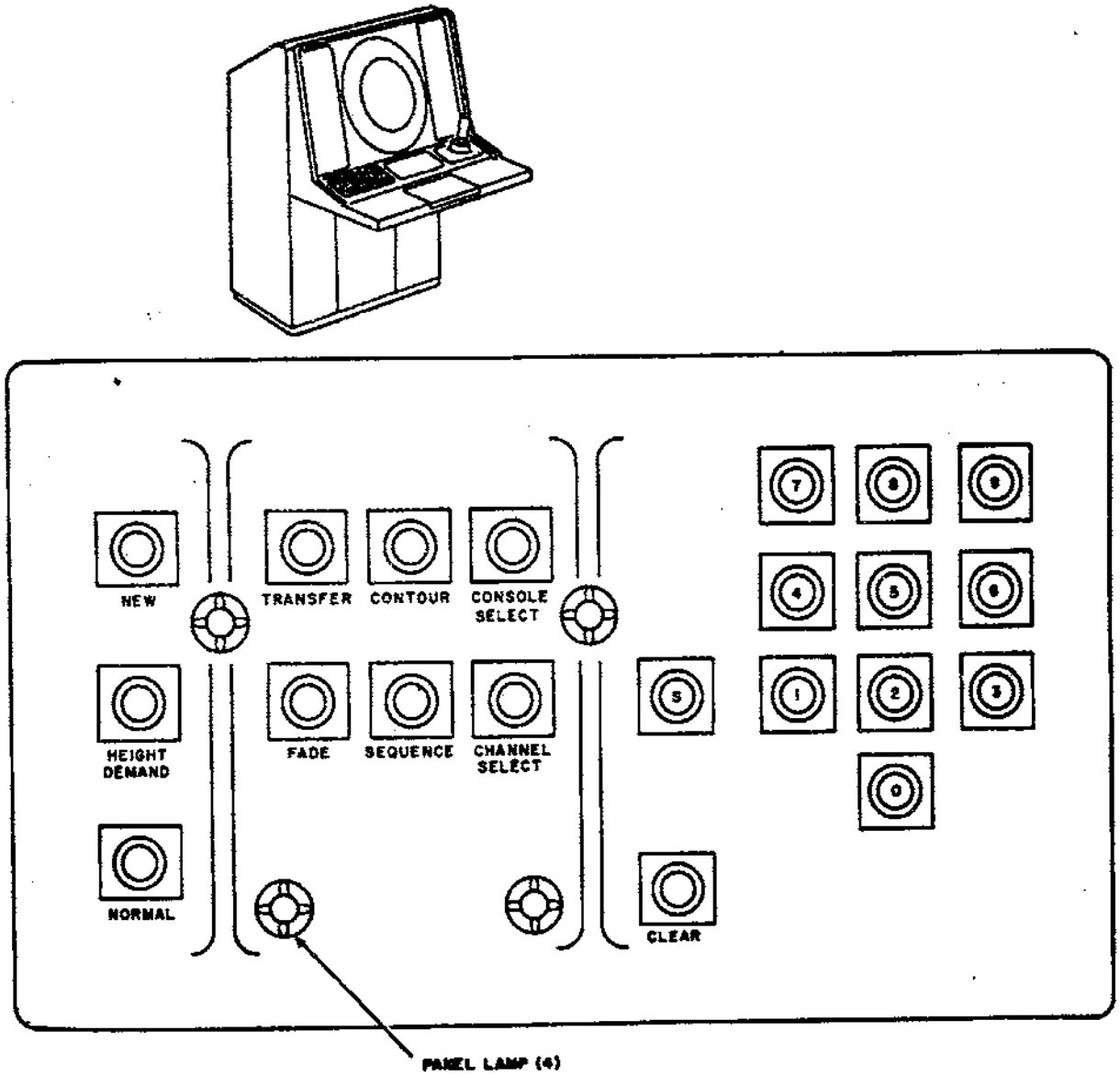


Figure 10. The S & E numerical unit.

(1) SWEEP INTENSITY control knob: Adjusts brilliance of the sweep on the PPI display.

(2) LEADER INTENSITY control knob: Adjusts brightness of the leader identifying the selected track channel.

(3) CIRCLE INTENSITY control knob: Adjusts brightness of both SAGE and local tracking symbols.

(4) LOCAL DOT INTENSITY control knob: Adjusts brightness of tracking symbols for tracks assigned to the other consoles.

(5) REMOTE DOT INTENSITY control knob: Adjust brightness of fire unit tracking and supporting acquisition radar symbols. A locking feature prevents accidental displacement.

(6) X and Y CENTERING controls: Control knobs for centering the PPI display. A locking feature on both knobs prevents accidental displacement after the display has been adjusted.

(7) VIDEO GAIN control knob: Adjusts brightness of radar video on the PPI display.

(8) TEST VOID pushbutton: Used in conjunction with the *number* buttons and the CHANNEL SELECT button to test the inactive or out-of-action track channels.

(9) IFF GAIN control knob: Adjusts brightness of the IFF video. A locking device prevents accidental displacement of the knob.

(10) DISPLAY RADIUS control knob: Adjusts the sweep length. A locking device prevents accidental displacement of this control.

(11) PANEL LIGHT DIMMER five-position switch: Adjusts brightness of panel lights on all S & E console control panels.

(12) TEST eight-position switch: Used for maintenance and testing of the track channels. The switch is in the USE position for normal operation. In the DUMP position, all active track channels are dumped.

g. S & E and Tracking Console Power Control Panels (fig. 12). The following controls are found on the S & E and tracking console power control panels:

(1) FILAMENT SUPPLY two-position switch and indicator: When the switch is placed in the ON position, the indicator lamp lights to indicate that power has been applied to the filament circuits of the console.

(2) HIGH VOLTAGE ON AND OFF: A two pushbutton switch used to apply direct current (dc) operating voltages. An interlock prevents operation of the ON pushbutton until filament voltages have been applied.

(3) High Voltage Indicator Lamps: These four lamps light when the high voltage ON button is pressed. This indicat that the various dc operating voltag have been supplied to the console.

(4) Fuses, Lamps, and Spares: There a six fuses that protect the alternati current (ac) input power circuits the console. When a fuse fails, tl associated lamp lights.

37. Channel Status Unit (fig. 13)

The channel status unit is located betwe the two S & E consoles to provide both S & officers with channel status information on 48 tracking channels. All indicators are nur bered for easy identification. See figure for indicators and controls described in through *m* below.

a. OUT OF ACTION (O/A) 48 red indic tors (first column): When lighted, indica that the associated track channel is out of a tion.

b. AVAILABLE (A) 48 white indicato (second column): When lighted, indicate th the associated track channel is operable but n in use.

c. SAGE (S) 48 green indicators (third c umn): When lighted, indicate that the tra channel was originated by SAGE.

d. LOCAL (L) 48 red indicators (four column): When lighted, indicates that the tra channel was originated locally.

e. FRIENDLY (F) 48 green indicato (fifth column): When lighted, indicate th a friendly identity has been assigned to tl track in the associated track channel.

f. HOSTILE (H) 48 red indicators (six column): When lighted, indicate that a hosti identity has been assigned to the track in tl associated track channel.

g. PRIORITY (P) 48 white indicato (seventh column): When lighted, indicate th a priority status has been assigned locally by the SAGE DC to the track in the associat track channel.

h. EFFECTIVE (E) 48 red indicato (eighth column): When lighted, indicate th a fire unit has reported an effective engag ment on the track in the associated track cha nel. The indicator lamp is extinguished selecting the track channel and pressing tl

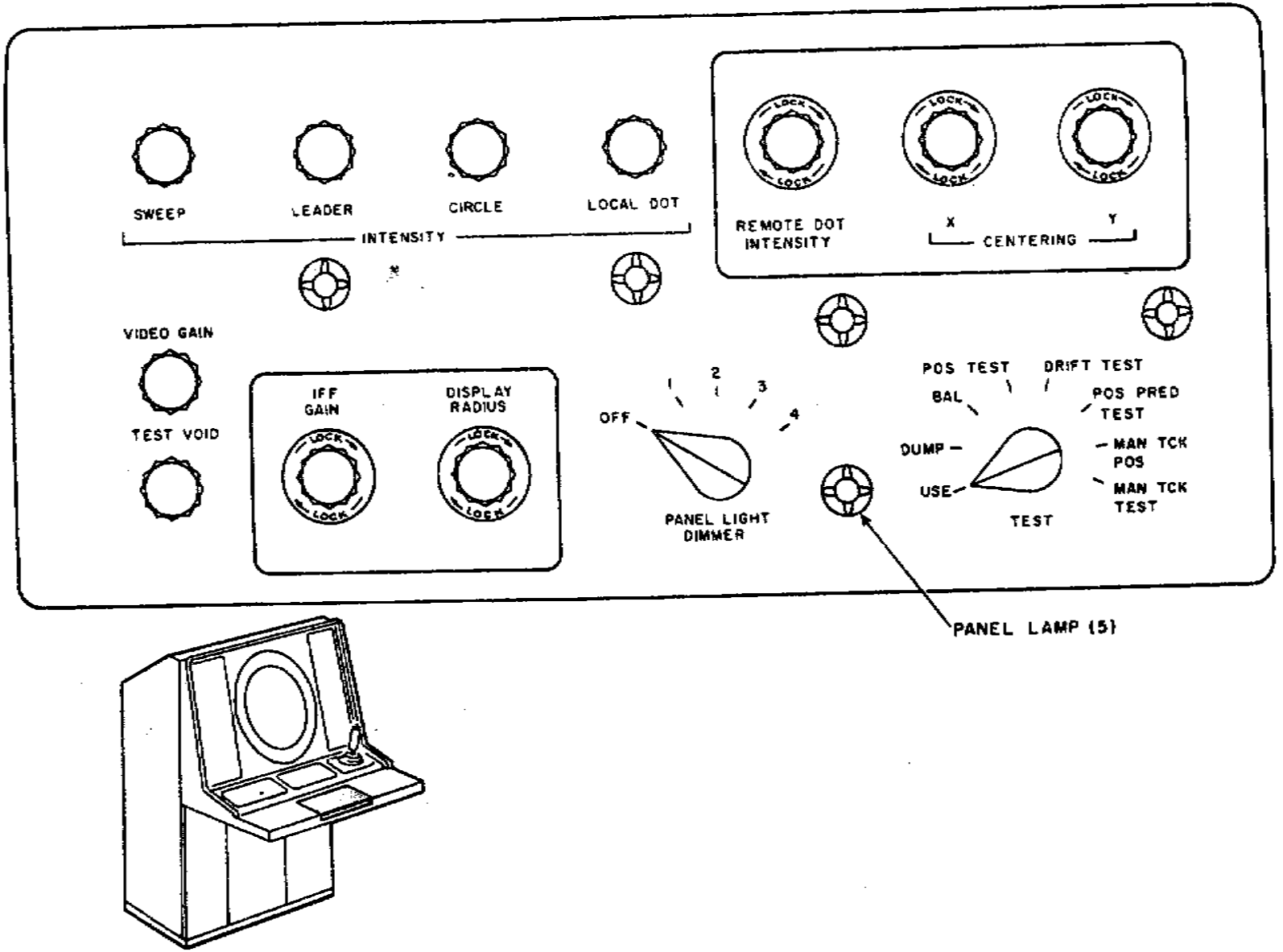


Figure 11. The S & E console concealed adjustment control panel.

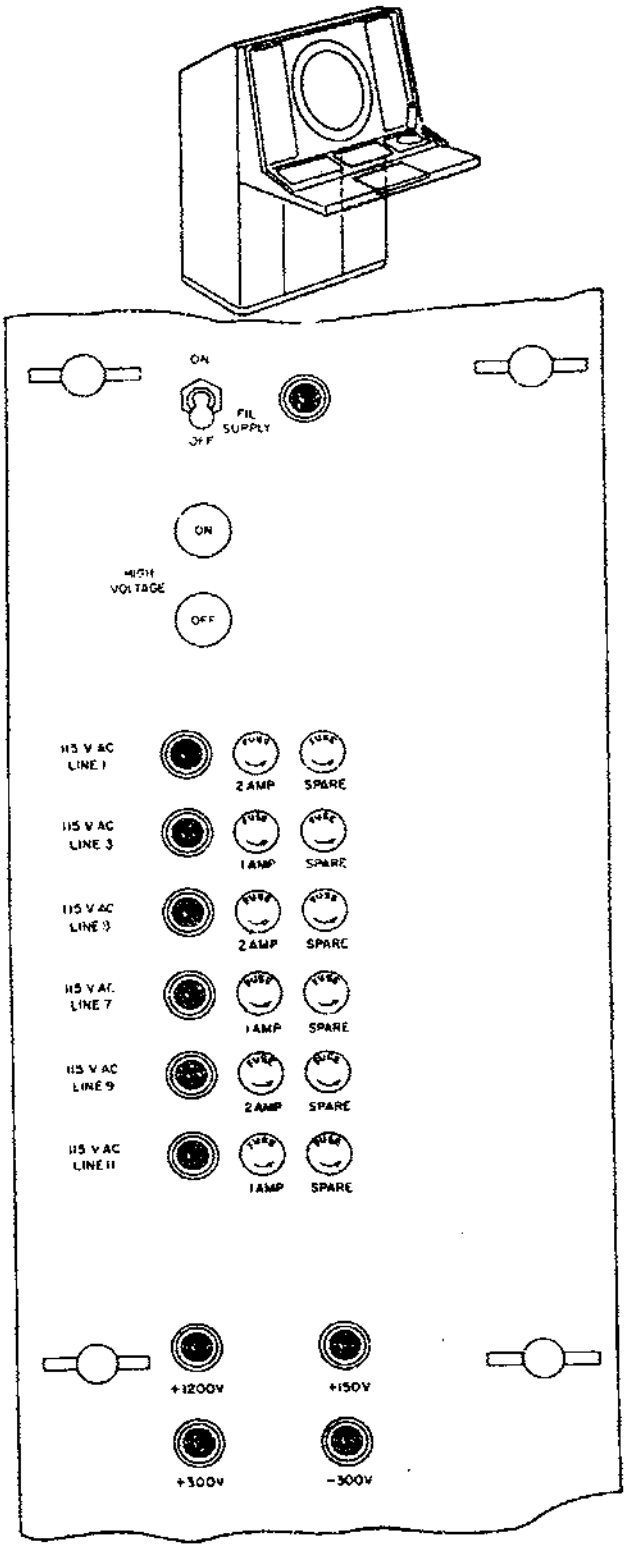


Figure 12. The S & E and tracking console power control panel.

KILL or the SEQUENCE button on an S & E console or by selecting the track channel and pressing the DUMP or SEQUENCE button on a tracking console.

i. HEIGHT REQUEST CONTROL two-position switch: When placed in LOCAL, causes the height-finder equipment to sequence only to locally controlled track channels for height servicing. In the ALL position, permits height-finder equipment to sequence and service all track channels (local and SAGE).

j. IFF MODE four-position switch: Selects IFF operating modes.

k. SAGE READOUT pushbutton switch: When pressed, causes all current fire unit status and track channel status information to be transmitted to SAGE.

l. SAGE INPUT CONTROL two-position switch: Selects the S & E console to which new SAGE track channel entries are automatically assigned.

m. SAGE SELECTOR two-position switch: Selects SAGE 1 or SAGE 2 (primary or alternate SAGE DC) as the source of SAGE data.

38. Preliminary Control Settings (Power Off)

a. Right Control Panel (fig. 9). At the right control panel set the—

(1) RANGE X 1,000 YD knob at the 640 position.

(2) DISPLAY OFFSET X 1,000 YD knobs at the *zero* position.

(3) MARKERS switch at the OFF position.

(4) Marker INTENSITY knob at the fully counterclockwise position.

(5) REMOTE DATA switch at the OFF position.

(6) CATEGORY DISPLAY switch at the ALL position.

(7) ADJ AADCP DATA switch at the OFF position.

b. Concealed Adjustment Control Panel (fig. 11). At the concealed adjustment control panel (concealed shelf panel) set the—

(1) SWEEP INTENSITY knob at the fully counterclockwise position.

(2) LEADER INTENSITY knob at the fully counterclockwise position.

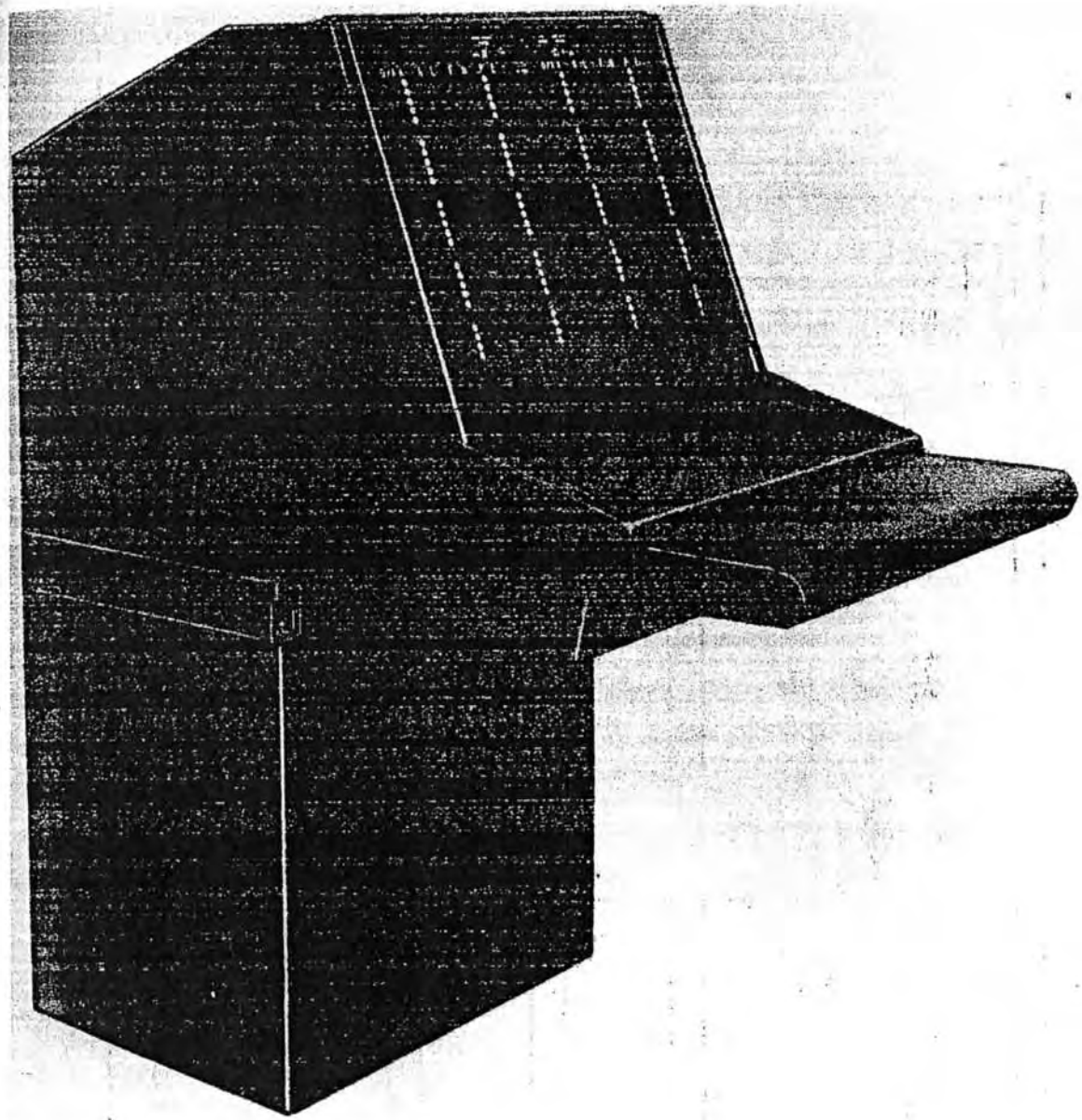


Figure 13. The channel status unit.

(3) CIRCLE INTENSITY knob at the fully counterclockwise position.
(4) LOCAL DOT INTENSITY knob at the fully counterclockwise position.
(5) VIDEO GAIN knob at the fully counterclockwise position.
(6) TEST switch at the USE position.

Note. Operators will *not* adjust any other knobs on the concealed shelf panel.

39. Start-Stop Procedures (figs. 11 and 12)

a. Energizing.

(1) Set the FILAMENT SUPPLY switch at the ON position. After the FILAMENT SUPPLY indicator lamp lights, *wait 3 minutes* before proceeding to step (2).

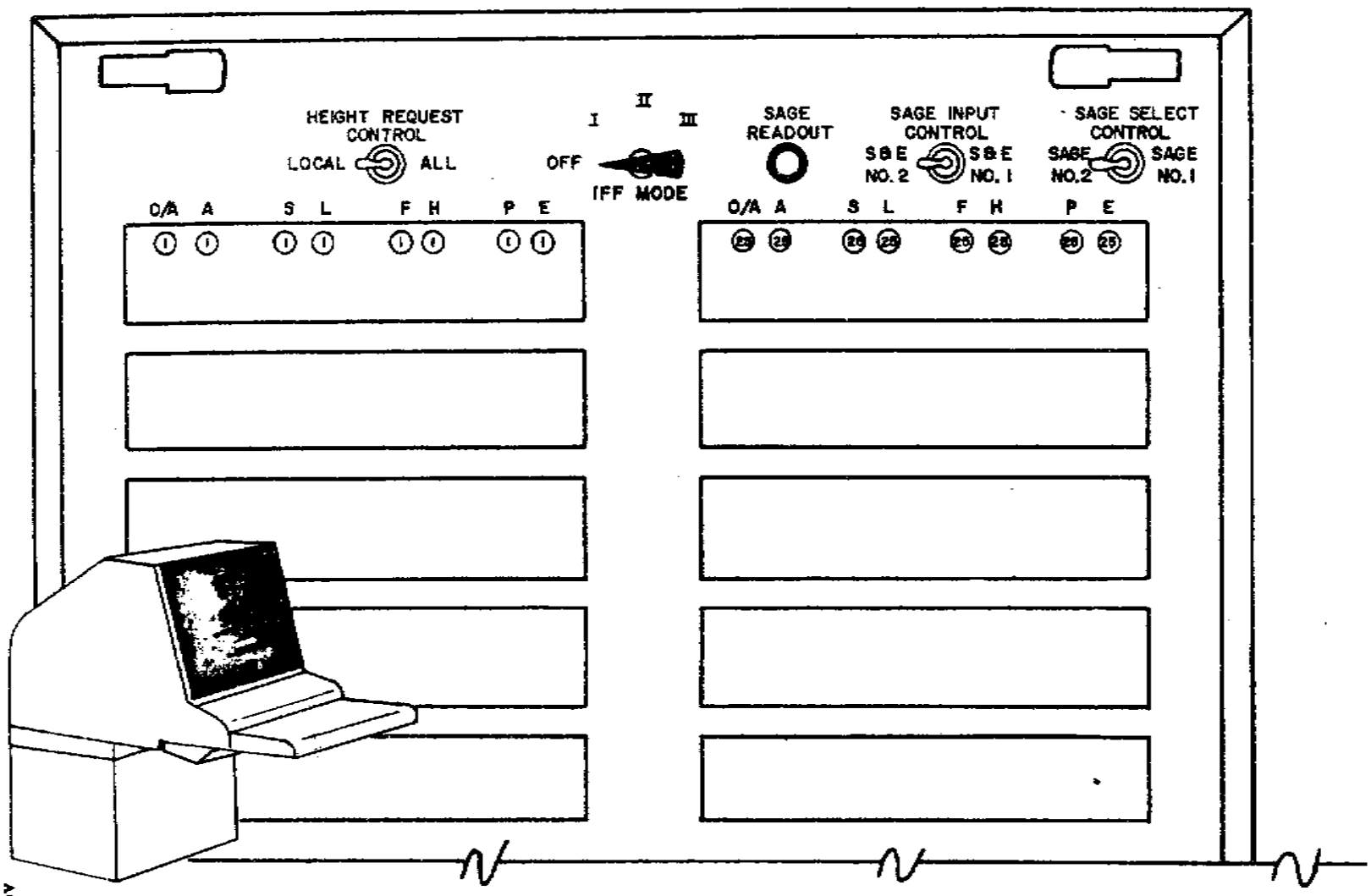


Figure 14. The channel status panel.

(2) Press the ON pushbutton of the HIGH VOLTAGE switch. The HIGH VOLTAGE indicator lamps light. *Wait 5 minutes* for warmup before proceeding to the preliminary adjustments.

b. Standby. To place the console in a standby condition, rotate all the controls mentioned in paragraph 40 to the maximum counterclockwise position and press the OFF pushbutton of the HIGH VOLTAGE switch on the power control panel. Only the HIGH VOLTAGE indicator lamps are extinguished. The console may be reenergized by pressing the ON pushbutton of the HIGH VOLTAGE switch.

c. Deenergizing. To completely shut down the console, press the OFF pushbutton of the HIGH VOLTAGE switch and then set the FILAMENT SUPPLY switch at the OFF position. All power supply indicator lamps go out.

d. Emergency Deenergizing. In an emergency, the console may be deenergized by setting the FILAMENT SUPPLY switch at the OFF position. This action automatically disconnects the high voltage power supply as well as the filament supply. All power supply indicator lamps are extinguished.

40. Preliminary Adjustments (fig. 11)

a. Rotate the PANEL LIGHT DIMMER control until the desired illumination of all control panels is obtained.

b. Rotate the SWEEP INTENSITY control clockwise until the sweep line is barely visible on the PPI screen.

c. Rotate the VIDEO GAIN control clockwise until a sharp and persistent video is observed on the screen.

d. Activate any tracking channel as described in paragraph 42*b*. Rotate the CIRCLE INTENSITY control clockwise until the symbol setting does not cause the symbol to obscure the afterglow of any target.

e. Rotate the LEADER INTENSITY control until the leader line is clearly visible but not blossoming.

f. While another console is tracking a target and the RANGE control is set at 640, adjust the LOCAL DOT INTENSITY control until the local dot is clearly visible over the target video but not blossoming.

41. S & E Officer Responsibilities

The S & E officer is directly responsible to the ADAOO. His specific duties vary with the option in effect.

a. In the reference option he will:

(1) Establish communications with the ADAD.

(2) HEIGHT DEMAND all SAGE channels on initial entry into the system. Operate in SAGE MANUAL for servicing of the channel when the RHI operator reports a difference in altitude of 2,000 feet or more, and notify the ADAD of the discrepancy.

(3) Transfer all entered track channels to target trackers for monitoring and updating after establishing symbol-video correlation and altitude determination. Equalize the workload at tracking consoles in the transfer of track channels or on a basis of areas or sectors assigned.

(4) Supervise and monitor target trackers, insuring that symbol-video correlation is determined by the following and maintained throughout the life of each track:

(*a*) Video is within limits specified by the appropriate NORAD commander.

(*b*) Video is traveling in the same direction and speed as the symbol.

(*c*) When more than one target appears within specified limits of the symbol, that video is used which is nearest the center and which meets the criteria in (*b*) above.

(5) Report to the ADAD the position or behavior of any SAGE track channel symbol that does not correlate with video.

(6) Maintain continuous surveillance of the air picture and enter LOCAL channels with UNKNOWN identity for significant airborne objects that have not been entered into the system by SAGE. Assign to each locally acquired track a local track designator and interrogate each to determine positive or negative SIF return.

Identify the LOCAL track as HOSTILE if it meets the criteria of a pop-up target as established by the sector commander. Forward tell to the ADAD for identification if the track does not meet pop-up criteria, the local track designator, GEOREF, estimated speed, heading, SIF response, and time. Obtain and enter auxiliary information such as identity, priority, and raid size from SAGE by voice for locally initiated tracks.

(7) Report significant characteristics of targets to the ADAOO.

(8) Monitor continuously the channel status panel and supervise the activities of the channel status panel operator.

(9) Transmit a SAGE readout:

(*a*) When requested by the ADAD.

(*b*) Upon entering or dumping a LOCAL channel.

(10) Direct target trackers to voice tell specific tracks to ADA fire units or AADCP plotters.

(11) Monitor the acquisition and RHI video for the use of ECM. Report ECM activity and take action as required by SOP.

(12) Inspect for the presence of video on all track channels on which an EFFECTIVE has been reported. If no video is present and the channel is—

(*a*) SAGE: Send a REQUEST FOR DUMP to SAGE.

(*b*) LOCAL: DUMP the channel.

(13) Initiate action to dump track channels in the following priority when all track channels have been entered and a track channel is required for a PRIORITY target:

(*a*) Tracks that are heading away from the defense.

(*b*) Tracks at the greatest range.

(*c*) Tracks whose position and heading indicate they will not penetrate the defense.

b. In ATABE option, he will refer to SOP for duties to be performed.

42. Operating Procedures

a. Monitoring and Assignment of SAGE Track Channels.

(1) The track channels that are operable but not in use are available for SAGE entries and are shown by lighted indicators in the *available* column on the channel status unit. When SAGE activates a new track channel, the *available* (A) lamp extinguishes and the SAGE indicator lamp in the SAGE column lights. The *hostile* (H) or *friendly* (F) indicator lamp in the *identity* columns lights and, if SAGE has assigned priority to the track, the priority (P) indicator lamp lights. The track channel is assigned to the designated entry S & E console for control. A SAGE symbol appears on the entry S & E console PPI screen as positioned by SAGE. The SAGE INPUT CONTROL on the channel status unit selects the S & E console that initially receives the new SAGE activated track channel. The S & E officer monitors these new entries and may reassign them to tracking consoles either on a sector basis or in a manner to equalize the trackers' workloads.

(2) The transfer of tracks from an S & E console to a tracking console is accomplished by selecting the track channel number, pressing the *number* button corresponding to the tracking console to which it is desired to transfer the track channel, and then pressing the TRANSFER button on the S & E numerical unit (fig. 10). The track channel may be selected either by using the SEQUENCE switch until the PPI leader points to the new track symbol or by pressing the *number* button corresponding to the desired track channel and then pressing the CHANNEL SELECT button. If any *number* button is lighted by the *busy* signal, it indicates that the associated console is having difficulty in tracking or has already received all the assignments it can handle. When a track

channel is transferred, the symbol on the S & E console PPI changes to a dot, and the console automatically sequences to the next new channel.

(3) The S & E officer may transfer an assigned track channel from a tracking console to his own console at any time. To accomplish this, he selects the desired track channel by using the *number* buttons and the CHANNEL SELECT switch, and then presses the TRANSFER button.

(4) If the new entries are arriving faster than the S & E officer can handle them, preference may be given to certain track channels according to their priority status and identity. Normally, track channels with a priority status are serviced first.

b. Local Entries.

(1) A track channel may be selected for entry of a local track by pressing the NEW button on the numerical unit. Pressing the NEW button automatically selects the next numerically available track channel as indicated on the channel status unit by a lighted lamp in the *available* (A) column, and makes this track channel unavailable to SAGE. The *available* (A) indicator lamp extinguishes on the channel status unit for this track channel and the *local* (L) indicator lamp lights. By depressing the track stick button fully, the track stick may be used to slew the channel tag, which will appear at the center of the PPI, from the center of the display to the video selected for entry. A fine position correction of the tracking symbol may be made by releasing the track stick button to the first detent and moving the track stick in the desired direction. To establish rate-aided tracking of the video, which causes the tracking symbol to move at the estimated velocity of the video, the track stick button must first be fully released until the radar sweep has passed the track symbol at least once but not more than 10 times. The track stick button then is depressed to the first detent, and another fine correction of the tracking symbol can be made. Further changes of the aided tracking rate are made by additional fine position corrections after depressing the track stick button to its first detent from the fully released position. A new local track is entered automatically as a *bogey* and the BOGEY indicator lamp lights on the S & E left control panel. This action prevents data in the track channel from being height serviced (unless the S & E officer places a *height demand* for the track channel) or transmitted to the tactical consoles and missile fire units, thus preventing display of a slewing spot at these locations. Identity, priority (if any), raid size, and other auxiliary data are obtained from the SAGE DC or GCI station. These are entered into the channel stores by pressing the appropriate HOSTILE or FRIENDLY; ONE, FEW, or MANY; and PRIORITY pushbutton-indicators. Having slewed the track channel symbol to the video position, established a tracking rate, and entered identity and other auxiliary data, the S & E operator may transfer the track channel to a tracking console in the same manner as described in *a*(2) above. The entry of a *hostile* or *friendly* identity lights the corresponding indicator lamp, extinguishes the BOGEY lamp, and permits the transmission of the track channel data to the tactical consoles and missile fire units. A raid size estimate may also be obtained from examination of PPI and RHI video or from Army air defense fire unit reports.

(2) If it is desired to enter a track into a particular track channel, the S & E officer obtains the track channel number from the channel status unit and enters it on his *number* buttons. The track channel is then selected for entry by pressing the CHANNEL SELECT and the NEW button in that order. A track may now be entered

into this track channel as described in (1) above.

(3) If no track channels are available and the track to be initiated is of sufficient importance, a track channel can be taken away from SAGE. To do this, the desired track channel is transferred to the S & E console as described in *a*(3) above and, by pressing the LOCAL pushbutton-indicator, control of the track channel is assumed by the S & E console. If the S & E officer does not know the track channel number of the SAGE channel to be taken over, he may sequence with the CONSOLE SELECT button until the S & E console is in parallel with the tracking console to which the track channel is assigned. To prevent destruction of fade counts in other track channels assigned to this tracking console, the S & E officer then sequences with the FADE button until the leader of the PPI points to the selected track channel, and control may be assumed by pressing the LOCAL button as before. Since the latter method enters false fade counts into the track channel stores, the first method of taking control of a SAGE channel should be used whenever possible. When control of the track channel is established, the SAGE indicator lamp will extinguish on the channel status unit, the LOCAL indicator lamp will light, and the track channel tag on the PPI will change from a SAGE to a local symbol. The track stick may now be used to establish the new local track. Identity and other auxiliary data can be entered as described in (1) above.

(4) In operation without SAGE data, the S & E officer activates all track channels on the basis of his PPI screen display, where new video may be detected and identified as such by absence of a tracking symbol or a dot. Voice communications to the SAGE DC or GCI stations, using GEOREF coordinates, provide identity and other auxiliary data. All selections of available track channels for new entries are made by the NEW button, and tracks are entered in the manner described above. The target may be challenged by pressing the IFF button on the right control panel, and the IFF response will be displayed on the PPI screen. A raid size estimate for locally entered track channels may be obtained from the PPI or from inspection of the RHI video display after assigning the track channel to the RHI by use of the HEIGHT DEMAND button on the S & E numerical unit.

(5) Any track channel that is activated locally must be dumped by the S & E officer, or by a tracking console operator as directed by an S & E officer, when it is no longer of interest to the defense or if a track channel is needed for a more important track. Having determined from his PPI display that a track channel should be dumped, the S & E officer may select the track channel by any method previously described and then dump it by pressing the KILL button. The KILL button erases all stored reference track information and returns the track channel to the *available* condition. The KILL button will not dump any SAGE activated track channel; however, it will transmit a total *kill* signal to the SAGE DC, and the SAGE DC will transmit automatically a *dump* signal for the track channel. Dumping a track channel extinguishes the indicators on the channel status panel, lights the *available* indicator lamp, and makes the track channel available for new SAGE or local entry.

c. Monitoring of Effective Engagement Reports.

(1) *Effective engagement* reports from fire units are displayed on the channel status unit by track channel number. When an effective report is reported, the S & E officer checks to see whether the target has been completely destroyed (since the report is at

best an estimate and, if correct, may refer to only part of a multiple target). The S & E officer sequences to the track channel on which an *effective* report has been received and inspects the video on the PPI screen. It is noted whether the track had a single or multiple size from the RAID SIZE indicators on the S & E left control panel and whether the tracker and RHI operator reported a fade on their last reading from the RADAR FADE and HEIGHT FADE indicators. If no height fade has been reported, the S & E officer examines the video on the adjacent RHI display by pressing the HEIGHT DEMAND button on the S & E numerical unit. The RHI operator then sequences to the selected track channel as soon as the current track channel is serviced. Thus, it is determined whether or not video still exists for the target on the RHI display. A check is made to determine if any other fire unit is still tracking the target by placing the REMOTE DATA switch in the *battery tracking data* (BDL) position on the S & E right control panel. Flashing crosses will then appear on the PPI screen at the location of all targets tracked by fire units. If one of these crosses coincides with the track channel symbol in question, the target still is present and is being tracked by a fire unit. If the S & E officer determines that the target has not been destroyed completely, he sequences to the next track channel. This action extinguishes the *effective* (E) indicator lamp on the channel status unit. However, if the S & E officer decides that the target has been destroyed, the KILL button is pressed.

(2) As an additional aid in this operation, the SEQUENCE switch on the tracking console to which the track channel is assigned for control will also extinguish the EFFECTIVE indicator lamp when used to sequence from this track channel. Since this switch is used only if video is seen, its use is an indication that video still exists on the tracking console and this fact should be brought to the attention of the S & E officer for appropriate action.

d. Monitoring and Aiding Tracking Console Operations.

(1) The surveillance and entry officer responsible for monitoring operations of the tracking consoles can accomplish the monitoring function by sequencing with the CONSOLE SELECT pushbutton on the S & E numerical unit. This operation enables him to connect his console in parallel with any of the other consoles so that the S & E console has the same displays and control as the selected console. Either console may then be used to sequence for selection among the track channels assigned to the tracking console, and thus the officer can point out track channels to the tracker. Since the S & E officer can see exactly what the tracker is doing when in parallel operation, suggestions or commands can be given by voice. A tracker having difficulties may ask the S & E officer to establish parallel operation, or a specific track channel may be verbally referred to by track channel number. In the former case, parallel operation can be obtained immediately by pressing the *number* button corresponding to the requesting tracking console number and then the CONSOLE SELECT button. In the latter case, the S & E officer can identify the track channel on the S & E console by means of the *number* pushbuttons and the CHANNEL SELECT button.

(2) The S & E officer may determine to which tracking console a track channel has been assigned by sequencing with his CHANNEL SELECT button until the PPI leader points to the track channel. The CONSOLE indicator on the S & E left control panel will then show the desired tracking console number, and the S & E officer can establish parallel operation direct-

ly by means of the *number* buttons and the CONSOLE SELECT button on the S & E numerical unit. Either S & E console can be placed in parallel with any tracking console. Parallel operation with any tracking console is terminated by pressing the NORMAL button.

e. Supporting Acquisition Radar (SAR) Tracks.

(1) When the supporting acquisition subsystem is in manual operation, only those tracks passed by the supporting acquisition evaluator are presented on the PPI screen as flashing symbols when the REMOTE DATA switch is in the GAP FILLERS position. In this case, the supporting acquisition tracks are handled by the S & E officer in a manner identical to a local track except that the tracking operation is accomplished by tracking the flashing supporting acquisition symbol rather than local video.

(2) When the supporting acquisition subsystem is in automatic operation, all supporting acquisition radar tracks appear on the PPI screen as flashing symbols when the REMOTE DATA switch is in the GAP FILLERS position. Inaccuracies in position of supporting acquisition symbols may result from lack of accurate height information. In this case, the S & E officer first checks by relation of the supporting acquisition tracks to the track channel symbols and local video on the PPI screen to see if this is actually video not seen by the AADCP or SAGE or whether it is being ignored for some good reason. If the latter, the S & E officer instructs the supporting acquisition operator to cease tracking and the symbol disappears. If it is a new track not seen by the AADCP or SAGE, the S & E officer first checks to determine if a fire unit is tracking the target by placing the REMOTE DATA switch in the BDL position. Since a battery track is also displayed by means of the same type flashing symbol as used for supporting acquisition data, a missile fire unit is tracking the target if the flashing symbol remains, and no further action is required. If no missile fire unit is tracking the supporting acquisition track, the S & E officer may enter the track into the system and transfer it to a tracking console in the same manner as for a local track.

(3) When a radar fade on a local track occurs and it is suspected that the track has passed into a dead zone of the defense acquisition radar, the S & E officer may assign this reference track data to a particular supporting acquisition radar if the track is of sufficient importance. When a track is designated to a supporting acquisition radar, this track will have priority for entry into the system over all other supporting acquisition tracks presented on the supporting acquisition evaluator console.

f. Miscellaneous Operations.

(1) DISPLAY OFFSET and RANGE controls are provided on the right control panel to permit flexibility in display selection. The display may be expanded from 160,000 yards (146,304 meters) to 640,000 yards (585,216 meters) in 80,000-yard (73,152 meters) increments, and the display center may be offset in any cardinal direction by amounts from 0 to 480,000 yards (438,912 meters) in 80,000-yard (73,152 meters) steps. This feature is included on all tracking and S & E consoles and may be used to assign sectors to individual consoles in order to gain greater accuracy in tracking and monitoring operations.

(2) To facilitate correlation and voice tell of GEOREF coordinates, range and angle markers or GEOREF coordinates may be displayed by use of the MARKERS switch on the right control panel. Marker displays may also contain miscellaneous information such as primary target lines and restricted areas. The INTENSITY

control adjacent to the MARKERS switch is used to adjust the brightness of the marker displays.

(3) The CATEGORY DISPLAY switch on the right control panel is used when it is desired to display either friendly or hostile track channels other than the one presently selected by the operator. The CATEGORY DISPLAY switch permits display of the channel symbols for friendly tracks only, hostile tracks only, or all tracks. This is a spring-loaded switch and all tracks will be displayed except when the switch is held in the FRIENDLY or HOSTILE position.

(4) The TARGET HEIGHT meter on the left control panel indicates the height received from SAGE for a SAGE reference track or the height determined by the local height-finding radar. According to local SOP, the S & E officer may use the height reading for selective entry of tracks when the system is overloaded.

(5) Track channel and fire unit status data are normally transmitted automatically to SAGE whenever a change of status occurs and then only once. Therefore, SAGE occasionally may request that all such data in the stores be transmitted in order to check this information. This request is complied with by pressing the SAGE READOUT button on the channel status unit.

(6) The HEIGHT REQUEST CONTROL on the channel status unit is used to control the track channels to be monitored or serviced by the height-finding equipment. If the PPI screen shows a multitude of track channels that are mostly SAGE controlled, the S & E officer may place this switch in the ALL position. This position allows the height-finding equipment to inspect height data on SAGE originated track channels and provides height correction for locally controlled track channels. Thus, the RHI operator can detect SAGE height errors that make it desirable to place a track channel in the SAGE manual tracking mode. When many of the system track channels are under local or SAGE manual control, the S & E officers places the HEIGHT REQUEST CONTROL in the LOCAL position so that monitoring of SAGE track channels will not prolong the height reading interval for local tracks.

(7) The S & E officer determines the mode of IFF challenge by means of the IFF MODE switch on the channel status unit.

(8) A *busy* signal may be established by the S & E officer.

(9) On occasion it may be desirable to place the two S & E consoles in parallel with each other. In effect, S & E consoles may be paralleled electrically by placing each in parallel with the same tracking console. They cannot otherwise be placed in parallel.

43. Antijamming Measures

a. Since the S & E console utilizes radar video, the display will be affected by external and internal electrical interference and by reflected and transmission jamming. State-of-the-art devices have been affixed to the prime radar of the AN/FSG–1 system, and can be employed by the radar operator. When electronic countermeasures (ECM) activity is intense and interferes with tracking, the S & E officer, by voice communication with radar operators, can coordinate the application of specific antijamming devices. The only *direct* antijamming measure that the S & E officer and tracking operators can take is to control the intensity and focus of the display in order to obtain the best possible picture and to *continue to operate*. Some relief from ECM may be obtained by expending PPI screen displays. The S & E officer may assign sectors of operation to all trackers for this reason. The S & E officer should make an immediate report of electronic countermeasure activity to the ADAOO. The ADAOO reports ECM to the NORAD direction center (SAGE).

b. The S & E officer monitors for ECM spoofer targets to minimize waste of tracking chan-

nel availability. Evidences of such targets are found by examination of PPI video and from RHI and tracker *fade* reports. Spoofers may appear as a regular pattern of target video on the PPI screen. Any target suspected of being a spoofer should be assigned to the RHI equipment by use of the HEIGHT DEMAND button. Since the height-finder radar operates in a different frequency range from that of the defense acquisition radar, spoofer targets probably will not appear on the video presentation at the RHI console screen. When a spoofer is located, the channel is dumped if it was locally originated, or SAGE is notified verbally if it is a SAGE track. The S & E officer also notifies acquisition radar personnel when one or more spoofer targets exist so that antijamming techniques may be employed. A more detailed discussion of radar interference and electronic countermeasure effects on radar displays and of operator and technician antijamming techniques are given in FM 24–150, FM 44–7, (CMHA) TM 11–750, and (CMHA) TM 11–751.

CHAPTER 4

THE RANGE-HEIGHT INDICATOR SUBSYSTEM

44. General

a. Equipment. The two RHI consoles (fig. 15) and their associated equipment are used to ascertain the height of tracks and enter these height data into the stores of the tracking system. The two consoles are RHI units modified to provide a HEIGHT CORRECTION wheel, RANGE and HEIGHT MARKERS, and a TARGET NUMBER indicator.

b. Data. The height data serve a twofold purpose in the Missile Master system:

(1) The defense acquisition radar of the Missile Master system provides positional information on video based on *slant range*. This slant range must be converted to *horizontal (ground) range* in order to transmit valid data to the fire units and also to provide a ground range display for the tactical consoles. In the conversion from slant range to ground range the height of the target is used.

(2) The second reason for determining height is to compute the velocity data of targets. This computation cannot be made without an exact knowledge of the changing height of a target.

c. S & E Application. The RHI, used in conjunction with S & E functions, also has other purposes:

(1) The RHI operator can assist the S & E officer in following the track when the S & E screen is cluttered or receiving ECM.

(2) The powerful and highly discriminating beam of the height-finder radar makes possible the detection of individual aircraft in close flying formations.

(3) By careful manipulation, the RHI operator can aid the S & E officers in following faded or lost tracks.

(4) In emergencies, the height-finder radar can be placed in manual operation and used as an acquisition radar.

d. Operator. The operator of the RHI consol can accomplish his duties more efficiently by knowing the range-height subsystem, symbols and displays, controls and instruments, preliminary control settings, energizing-deenergizing procedures, preliminary adjustments, operating procedures, operator responsibilities, and antijamming measures.

45. Range-Height Subsystem

a. Equipment. The range-height equipment consists of two RHI consoles (fig. 15) and two *antenna control* units. Each of the two RHI consoles is associated with one of the two height-finder radars. Each of the consoles with its associated antenna control unit is located so as to afford the adjacent S & E officer a clear view of the RHI display.

b. Height Determination. In order to determine the height of a specific track, the height-finder antenna is positioned automatically in azimuth according to stored coordinate data. As the antenna nods up and down, the video is displayed on the vertical scan display on the RHI console.

c. Servicing of Tracks. Servicing track channels for height is accomplished as follows. Automatic equipment sequences through track channels under local control, connecting each in turn to one of the height systems. Priority is given to new track channels in the sequencer so that readings will always be made on newly entered track channels before routine sequencing of those that have already been serviced. SAGE track channels may also be sequenced to the consoles for inspection along with local track channels by placing the HEIGHT REQUEST CONTROL (LOCAL-ALL switch) on the channel status unit in the ALL position. Corrections cannot be made on SAGE track

channels while the track channel is under the SAGE control, and SAGE track channels do not receive any sequencing priority when newly entered. A *height demand* established by the S & E officer will interrupt normal sequencing and cause the selected track channel to appear on the RHI console when the RHI operator next sequences.

d. Modes of Operation. The RHI console can operate in two modes: manual and automatic.

(1) In the manual mode, the display may be varied from zero to a maximum of 300 nautical miles (555.9 kilometers).

(2) In the automatic mode, a 50-nautical mile (92.65-kilometer display is centered about the video of the track channel being serviced.

46. Symbols and Displays

Figure 16 shows an RHI display. Video is "painted" on the display by a sweep line pivoted at the lower left of the display and sweeping the face of the display in synchronism with the nodding height-finder radar antenna.

a. Fixed Returns. Since the RHI display employs radar video, it is subjected to fixed

Figure 15. The range-height indicator console.

...ms. Video from ground clutter is con...ated toward the lower portion of the dis...and varies at different azimuths.

...Range-Height Cursor. The range-height ...or is a horizontal line indicating height in...ation presently stored in the selected track ...nel. For local or SAGE manual tracks, the ...GHT CURSOR may be centered over the ...eturn of the track channel being serviced ...se of the HEIGHT CORRECTION wheel ...hershelf control panel. This action causes ...ect height information to be entered into ...rack channel height stores. When the ...k channel being serviced is under SAGE ...ol, the cursor is positioned automatically ...AGE data and no local correction can be ... The range-height cursor also serves to ...ect the track in range. Therefore, when ...k channel is connected to the RHI in the ...matic mode, the range-height cursor posi...itself to the range of the track. This ..., together with fixed azimuth of search, ...des sufficient discrimination to permit the ...operator to service the correct track.

Controls and Instruments

...Shelf Control Panel. The RHI shelf con...panel (fig. 17) is located below the front ...

(1) RANGE meter: Indicates approximate slant range from height-finder radar to the selected track channel in nautical miles.

(2) SWEEP control: Adjust brightness of the sweep line trace.

(3) VIDEO control: Controls brightness of radar video display.

(4) CURSOR control: Adjusts intensity of range-height cursor line on display.

(5) DISABLE (D) indicator lamp: Lights to indicate that this RHI console is not operating when the DISABLE-OPERATE switch on the RHI front panel is in the DISABLE position.

(6) SEQUENCE controls:

(*a*) FADE (F) pushbutton: When pressed, generates a *fade* signal that sequences the height correction system to the next active track channel to be serviced and returns the track channel to its original height-servicing priority status. The FADE (HF) lamp on the RHI console is lighted the next time the track channel is serviced. The HEIGHT FADE lamp is lighted whenever this track channel is selected on a tracking or S & E console.

(*b*) COMPLETE (C) pushbutton: When pressed, sequences to the next active track channel for which a height correction is to be made and assigns a *routine* priority to the track channel just serviced. Any previous *fade* signal is canceled.

(7) CHANNEL STATUS indicators:

(*a*) Height DEMAND (D) indicator lamp: When lighted, indicates that a particular track channel selected by the S & E officer will be connected to the RHI console where sequenced. The lamp remains lighted after the RHI console is sequenced to the track channel selected by the S & E officer.

(*b*) SAGE (S) indicator lamp: When lighted, indicates the selected track channel is SAGE controlled and that no local height correction can be made.

(*c*) CAPTURE (CS) indicator lamp: When lighted, indicates that the RHI equipment has sequenced to a track channel for which a height demand was established.

(*d*) FADE (HF) indicator lamp: When lighted, indicates that the previous height correction attempt for the selected track channel was unsuccessful.

(*e*) ROUTINE (R) indicator lamp: When lighted, indicates that the selected track channel has been serviced previously and should require only a small correction. When the track channel has been serviced, the RHI operator may sequence to the next active track channel in accordance with the priority contained in the track channel memory stores.

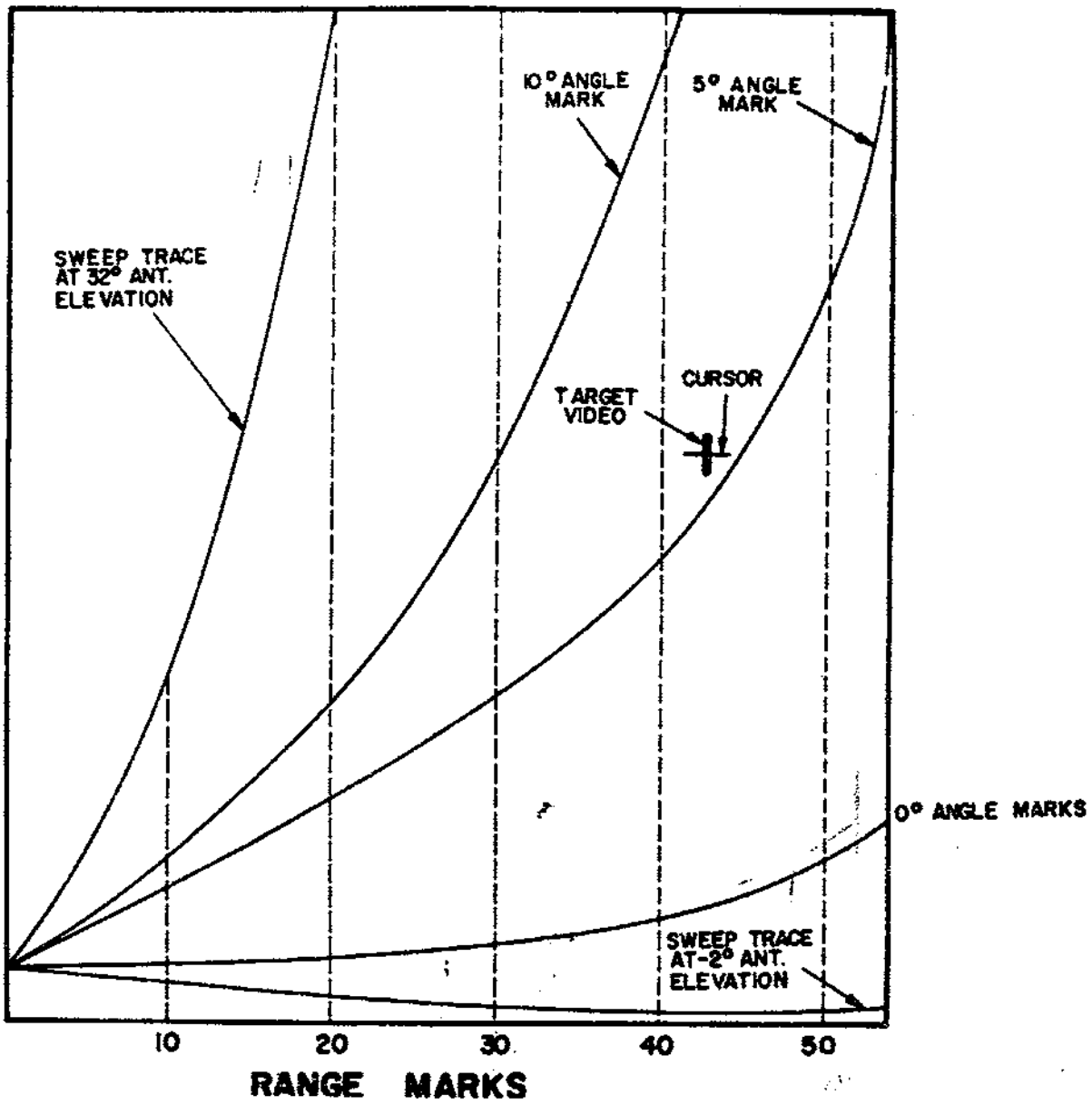


Figure 16. An RHI display.

(*f*) NEW (N) indicator lamp: When lighted, informs the RHI operator that the track channel being serviced contains a track that has not been serviced previously.

(8) TARGET NUMBER indicator: Indicates the number of the track channel presently connected to the RHI system.

(9) HEIGHT CORRECTION wheel: When operated in conjunction with one of the insert pushbuttons, adjusts the height cursor line over the video and changes the height data stored in

the connected track channel if the track channel is under local or SAGE manual control.

(*a*) COARSE insert pushbutton (located on the height correction wheel): When depressed, permits a rough adjustment of the height cursor line if the connected track channel is under local or SAGE manual control. When released, permits the height correction wheel to return to its center position without changing the position of the height cursor line.

(*b*) FINE insert pushbutton (located on the height correction wheel): When depressed, permits a fine adjustment of the height cursor line of a connected local or SAGE manual tracking channel. When released, allows the wheel to return to its center position without moving the position of the height cursor line.

b. RHI Front Panel (fig. 18). The controls and instruments of the front panel are located under hinged covers over and adjacent to the RHI display screen. To gain access to the left and right sections of the front panel, the latches on the left and right panel covers are lifted and the covers are swung sideways.

(1) ANGLE MARK two-position switch and control knob: When the switch is in the *on* position, it causes angle (elevation) marks to appear from −2° to +30° in 5°-increments on the display screen and permits adjustment of the intensity of angle marks by operating the control knob.

(2) PANEL DIMMER control knob: Controls brightness of panel lamps.

(3) RANGE LINE two-position switch and control knob: The switch and control knob are present on the console but inoperative.

(4) RANGE MARK two-position switch and control knob: When the switch is in the *on* position, it causes range lines to appear on the display screen and permits adjustment of range line intensity by use of the control knob. Range marks can be made to appear at 10- (18.53-), 20- (37.06-), and 50-nautical mile (92.65-kilometer) increments as determined by the setting of the RANGE-MILES control and indicator.

(5) COUNTER DIMMER control knob: Controls brightness of scale lighting.

(6) SHELF DIMMER control knob: Controls brightness of shelf lamps.

(7) RANGE CONTROL two-position switch: In the MAN (manual) position, permits the range-height cursor to be positioned manually and the display to be varied manually from a minimum of 50 nautical miles (92.65 kilometers) to a maximum of 300 nautical miles (555.9 kilometers). In the AUTO (automatic) position, the switch causes the range-height cursor to be automatically positioned in range.

(8) RANGE-MILES control and indicator: Controls and indicates choice made in the manual mode for the range display. The RANGE-MILES control also determines the distance between range marks.

(9) RANGE MARKS indicators: The appropriate indicator lamp lights to indicate the distance between range marks being displayed on the screen. The possible settings are 10, 20, or 50 nautical miles between range marks.

(10) ABS HGT (*absolute height*)—REL HGT (*relative height*) two-position switch: When placed in the ABS HGT position, the range-height cursor indicates the height of the target above the AN/FSG–1 data plane. In the REL HGT position, the range-height cursor indicates the difference in height between two targets.

(11) ABS HGT-FT dial: When the ABS HGT-FT HGT switch is in the ABS HGT position, indicates the height of the target above the AN/FSG–1 data plane. This information is converted to height above sea level for use throughout the system.

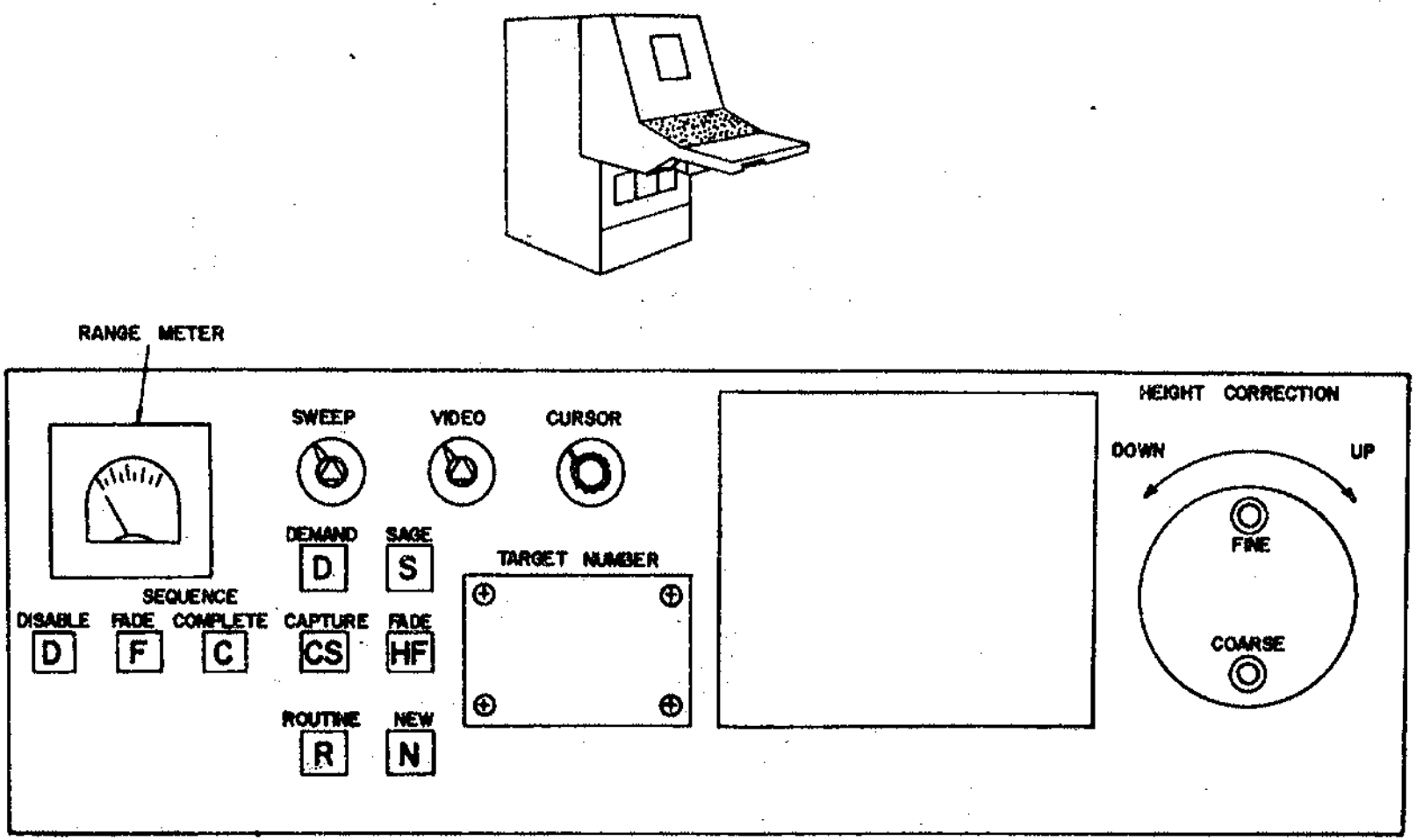


Figure 17. RHI shelf control panel.

(12) REL HGT X 1,000-FT dial: When the ABS HGT-REL HGT switch is in the REL HGT position, indicates the difference in height between two targets.

(13) CURSOR control stick: A manual control stick used to position the cursor in range and height. This control stick is made operative by means of the EXTERNAL CURSOR switch located on the RHI power panel.

(14) OPERATE - DISABLE two - position switch: When in the OPERATE position, connects the RHI console to the Missile Master system. When in the DISABLE position, disconnects the RHI from the system. This switch must be set at the DISABLE position whenever the operator leaves the console.

(15) Vertical range scale (located on the screen): Indicate height of the RHI display in thousands of feet above the radar.

c. RHI Power Supply Panel (fig. 19). The power supply panel is located below the shelf on the center vertical panel of the RHI console. Mounted on the panel is a two-position POWER switch that permits power to be applied to or removed from the RHI console. A red indicator lamp located just below the switch is lit when power is applied to the console. A 120-volt convenience outlet is also provided on the panel.

d. Antenna Control Unit. The antenna control unit is a separate unit that enables the RHI operator to either completely or partially control the antenna in azimuth. The unit is located adjacent to the RHI console. Of the many controls located on the unit, only three are used by the RHI operator: the MODE five-position rotary switch, the VERNIER CONTROL knob, and the ANTENNA AZIMUTH control. The number 1 position on the MODE switch gives the operator partial control of the antenna (up to 5° in either direction) by means of the VERNIER CONTROL knob, while the antenna remains principally under system control. The number 2 position gives full azimuth control to the operator by means of the ANTENNA AZIMUTH control. The other three positions of the MODE switch are not used by the operator.

48. Preliminary Control Settings (Power Off)

Place all controls in the OFF or maximum counterclockwise position on the shelf control panel (fig. 17) and the front panel (fig. 18).

49. Energizing-Deenergizing Procedures (fig. 19)

Energizing and deenergizing is accomplished by positioning the ON-OFF switch on the power supply panel to the desired position. All time delays are automatic.

50. Preliminary Adjustments (figs. 17 and 18)

a. On the front panel, adjust the PANEL DIMMER control until desired brightness of control panel is obtained.

b. Adjust the shelf control panel SWEEP control until a faint sweep trace appears on the display.

c. Adjust the shelf control panel VIDEO control until a sharp, persistent video is observed on the display.

d. Repeat steps *b* and *c* above until a maximum contrast between video and display background (noise) is obtained.

e. Adjust the shelf control panel CURSOR INTENSITY control until the range-height cursor is plainly visible on the screen without causing excessive glare or blossoming.

f. On the front panel, place the RANGE CONTROL switch in the AUTO position and the OPERATE-DISABLE switch in the OPERATE position.

51. Operating Procedures

a. Absolute Height Determination.

(1) With the HEIGHT REQUEST CONTROL on the channel status unit in the LOCAL position, only locally controlled tracks are sequenced to the RHI console. When a track channel is connected, the video for the assigned track channel should appear at the same range as the range-height cursor. The range-height cursor line indicates the current height existing in the track channel stores. Either the shelf control panel ROUTINE or NEW indicator lamp lights. The TARGET NUMBER indicator shows the number of the connected track

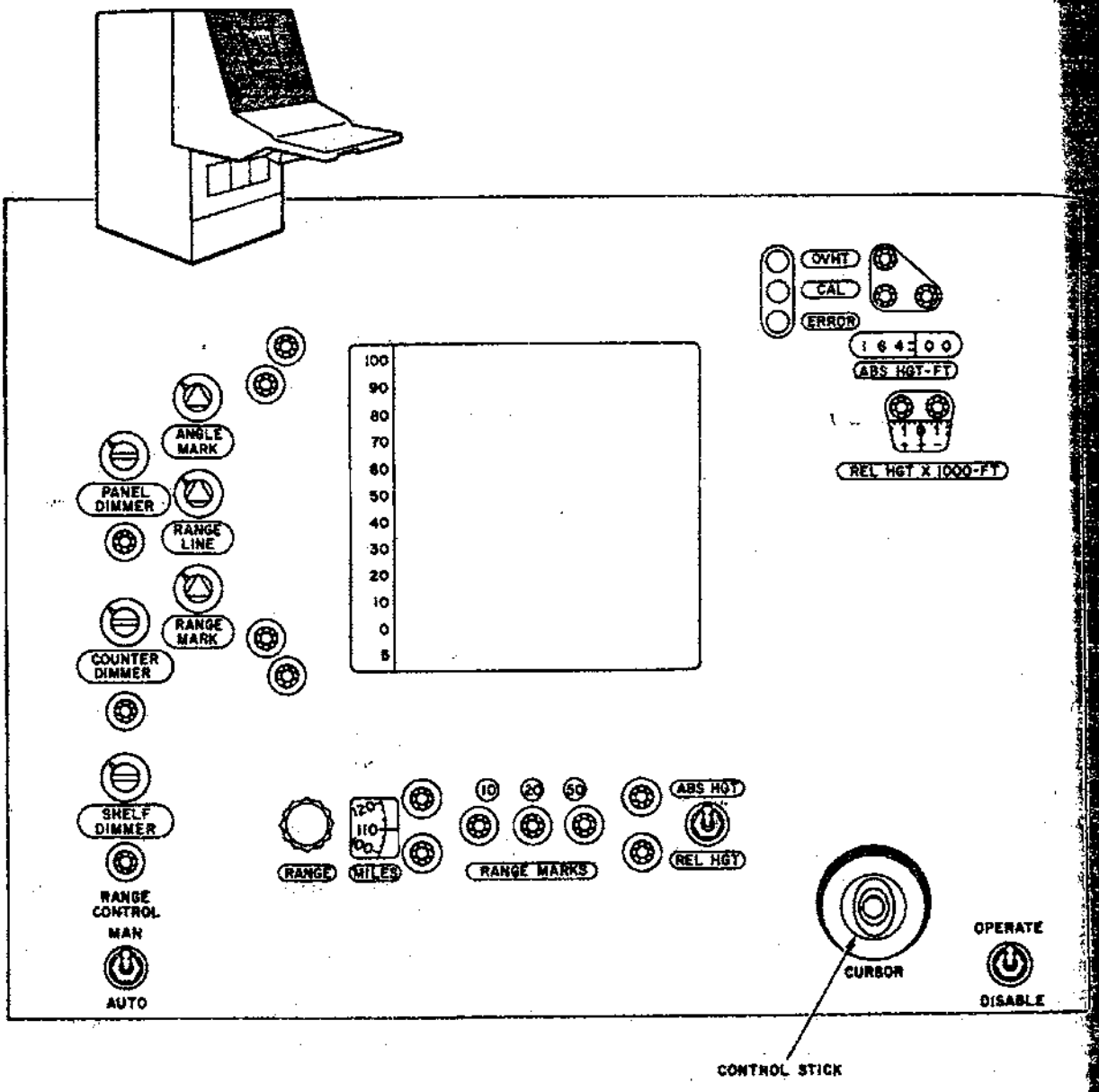
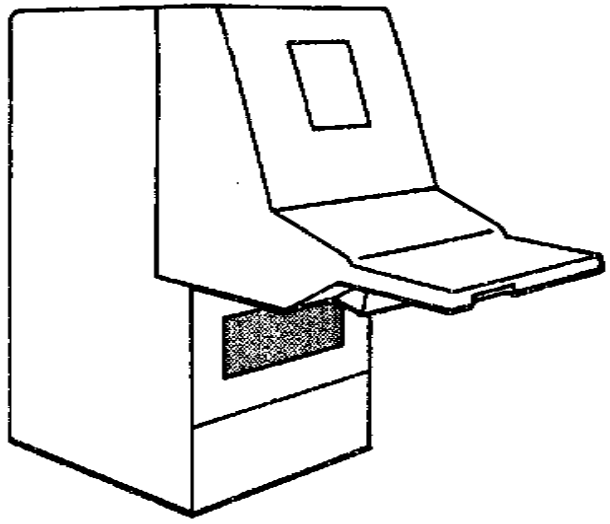


Figure 18. The RHI front panel.

channel and the *range meter* shows the slant range of the track.

(2) The operator inspects the position of the range-height cursor with respect to the video. If the track being serviced is new, a relatively large height correction will probably be required. To do this, the operater positions the cursor roughly over the video by depressing the COARSE insert pushbutton and operating the HEIGHT CORRECTION wheel. After releasing both the COARSE insert button and the wheel, a fine correction of the cursor may be accomplished by depressing the FINE insert pushbutton and again operating the wheel. If the track being serviced is not new, no



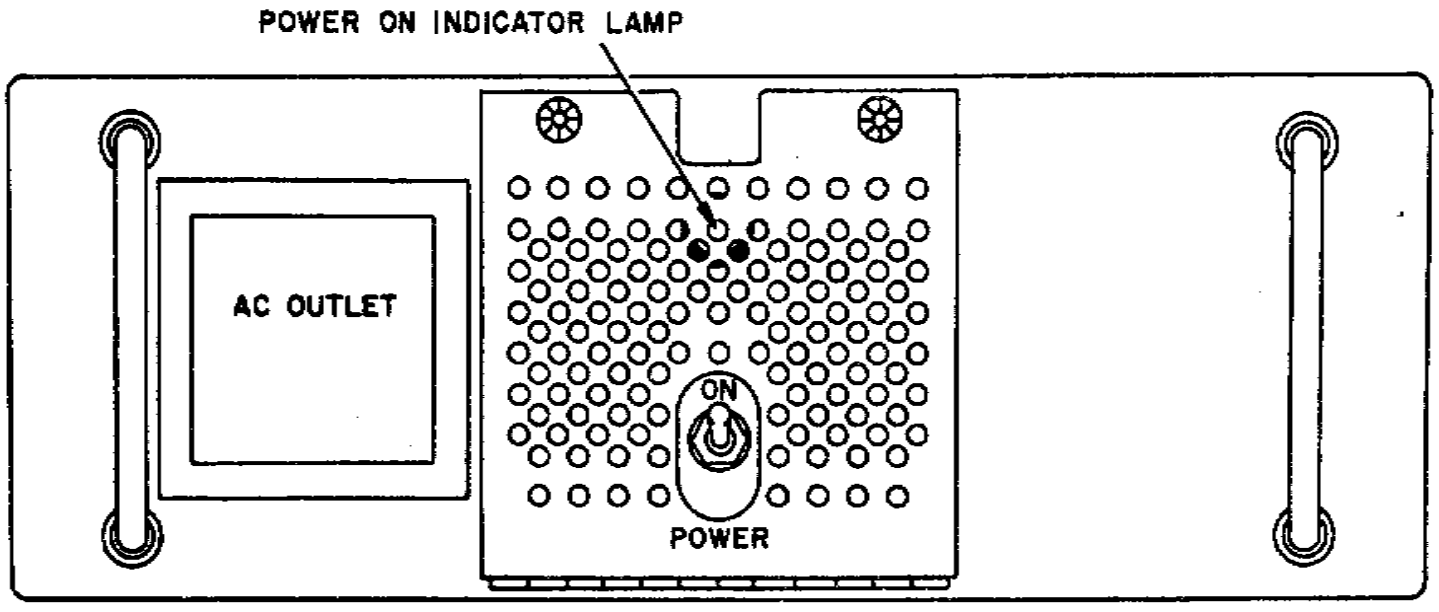


Figure 19. The RHI power supply panel.

correction or only a small correction will be required in most cases. Necessary corrections of the range-height cursor in this case are accomplished by using the HEIGHT CORRECTION wheel and the FINE insert button. When the RHI operator is satisfied that the range-height cursor intersects the correct video, he presses the COMPLETE button. This causes the equipment to sequence to the next active track channel to be serviced according to a priority status assigned to each track channel by the RHI equipment.

(3) If, because of fades or other reasons, the operator cannot obtain a satisfactory height correction, he sequences with the FADE button rather than the COMPLETE button. This lights the HEIGHT FADE indicator lamp for that track channel on the responsible S & E or tracking console and also lights the FADE indicator lamp when the RHI console is again sequenced to this track channel. If a fade is again encountered on this track channel, the track may be a spoofer and the S & E officer should be notified. When the FADE button is used on a track, the connected track channel status is changed. Releasing the FADE button sequences the system to the next track channel.

b. Inspection of SAGE Track Channels. With the HEIGHT REQUEST CONTROL on the channel status unit in the ALL position, SAGE-controlled track channels are sequenced to the RHI console in numerical order along with locally controlled track channels. The SAGE-controlled track channels are identified by lighting of the SAGE indicator lamp. No correction can be made on SAGE-controlled track channels. However, the operator inspects these tracks and reports large errors or the absence of video to the associated S & E officer.

c. Height Demand Operation. A height demand is initiated by an S & E officer by pressing the HEIGHT DEMAND pushbutton of an S & E console numerical unit and thus lighting the *height* DEMAND (D) indicator lamp. The assigned track channel is sequenced to the RHI console as soon as the currently connected track channel is released by pressing the COMPLETE or the FADE button. Upon command from the S & E officer, the RHI operator resumes normal sequencing. The height demand status is canceled when the COMPLETE or FADE button is pressed.

d. Relative Height Determination. The height difference between two system tracks or the height difference between video of known height and a SAGE track or video not entered into the system can be determined as follows:

(1) The height of one aircraft is determined by positioning the range-height cursor.

(2) Place the ABS HGT-REL HGT switch on the RHI front panel in the REL HGT position and move the range-height cursor to the second aircraft. The ABS HGT-FT dial will then read the absolute height of the second aircraft, and the REL HGT X 1,000-FT dial will indicate the difference in height of the two aircraft.

e. Display of Height, Range, and Angle Marks. Height marks at —5,000 feet and zero and from 10,000 to 100,000 feet in 10,000-foot increments; range marks every 10- (18.53-), 20- (37.06-), or 50- (92.65-kilometers) nautical miles; and angle marks at —2° and zero and from 5° to 30° in 5°-increments may be displayed by operating the appropriate switches on the RHI front panel and by adjusting the associated control knobs for desired marker intensity. These marks are used for testing purposes and as a reference for correlating tracks with other displays in the system.

f. Antenna Control Operation. The RHI operator can take partial or complete control of the height determination equipment antenna. The major control utilized by the operator is the MODE switch.

(1) By placing the MODE switch in the number 1 position and using the VERNIER CONTROL knob, the antenna can be slewed in either direction a maximum of 5°. The knob is spring-loaded and must be permitted to return to zero offset after each use. If

the VERNIER CONTROL is not allowed to zero itself, a small amount of azimuth deviation will be present on all tracks. This deviation will result in an excessive number of *fades*.

(2) By placing the MODE switch in the number 2 position and using the ANTENNA AZIMUTH control, the operator can obtain complete azimuth control of the antenna. Under this condition, the Missile Master system will not operate in the usual tactical manner as the system cannot direct the antenna. In this mode of operation, the range height subsystem can actually be used as an acquisition radar. In emergency operation, tracks can be manually entered into the system by the S & E officer from information given by the RHI operator.

52. Operator Responsibilities

The RHI operator is directly responsible to his associated S & E officer. In reference option he will:

a. Height service all entered track channels.

b. Report height to the tactical action plotter when observed height differs with reported data over 2,000 feet, or height is not furnished.

c. Depress FADE when no video is present within a given track channel for three consecutive sweeps.

d. Assist the S & E officer in obtaining target positional data (range and azimuth).

e. Report to S & E officer when:

(1) A discrepancy of 2,000 feet or more exists between SAGE and LOCAL height data.

(2) Observed raid size differs from that carried on the tactical action board giving:

(*a*) Number of aircraft.

(*b*) Relative altitude.

(3) ECM is encountered, giving type, intensity, and track channel number.

f. Monitor SAGE data for height errors and presence of spoofers when the HEIGHT REQUEST CONTROL on the channel status unit is in the ALL position. Report errors and indications of ECM to the associated S & E officer.

53. Antijamming Measures

a. Since the RHI display utilizes radar video, it is subject to the same types of accidental and deliberate interference discussed in paragraph 43. Because the RHI can detect the vertical motion of slowly descending radar reflectors, it has a unique capability for detecting this type of deception device ((CMHA) TM 11–750). It is also a valuable aid for detection of spoofers since it operates at a different frequency from that of the defense acquisition radar and detects aircraft in the vertical rather than in the horizontal plane.

b. The RHI operator can adjust the RHI display to produce maximum contrast between a jamming pattern and an aircraft echo. The antenna control unit and the antijamming devices mounted adjacent to the antenna control unit can be used by the RHI operator to obtain maximum performance in the ECM environment. Other antijamming measures include reporting jamming to the S & E officer and coordinating radar antijamming measures with radar operators at the defense acquisition radar site.

CHAPTER 5

THE TRACKING CONSOLE

54. General

a. The six *tracking* consoles (fig. 20) are almost identical to the surveillance and entry consoles (fig. 6) described in chapter 3. The only difference between these consoles is that the console indicator on the left control panel and some controls on the numerical unit and the concealed adjustment control panel have been omitted from the tracking console and a DUMP pushbutton has been substituted for the KILL pushbutton on the left control panel.

b. Each target tracking operator must know and understand symbols and displays, controls and instruments, preliminary control settings, energizing-deenergizing procedures and preliminary adjustments, operator responsibilities, operating procedures, effect of operating modes, and antijamming measures.

55. Symbols and Displays

Tracking console symbols and displays are identical to those discussed in paragraph 35.

56. Controls and Instruments

Because of the similarity to the S & E console, only the DUMP pushbutton, the *numerical unit*, and the *concealed adjustment control panel* are discussed in this paragraph.

a. When pressed, the DUMP pushbutton erases all memory stores of the connected track channel if the track channel is a local track, and returns the track channel to the *available* condition. The only difference between the DUMP button and the KILL button on the S & E console is that the DUMP button does not cause a *kill* signal to be transmitted to SAGE.

b. The numerical unit (fig. 21) contains those controls most frequently used by the tracking console operator.

(1) Functions of the NEW, FADE, and SEQUENCE pushbuttons are identical to those discussed in paragraph 36*e*.

(2) The eight pushbutton indicators are used to transfer the track channel selected by the operator to any other tracking console or to either S & E console. A lighted indicator lamp shows that the console associated with this bushbutton cannot handle any more tracks and does not desire additional transfers.

c. The tracking console concealed adjustment control panel (fig. 22) is identical to the S & E console concealed adjustment control panel (fig. 11) except for the omission of the TEST switch. Functions of the controls are as explained in paragraph 36*f*(1) through (10); in addition a PANEL LIGHT DIMMER five-position switch adjusts the brightness of the panel lights on the tracking console control panels.

57. Preliminary Control Settings (Power Off) (figs. 9 and 22)

Preliminary control settings for the tracking console are identical to those described in paragraph 38, except for paragraph 38*b*(6) which does not apply because the tracking console does not have a TEST switch.

58. Energizing-Deenergizing Procedures and Preliminary Adjustments (figs. 12 and 22)

Energizing-deenergizing procedures for the tracking console are identical to procedures described in paragraph 39.

59. Operator Responsibilities

The target tracking operator is directly responsible to the S & E officer. In reference option he will:

a. Undertake manual-rate-aided tracking of locally originated track channel assigned to the

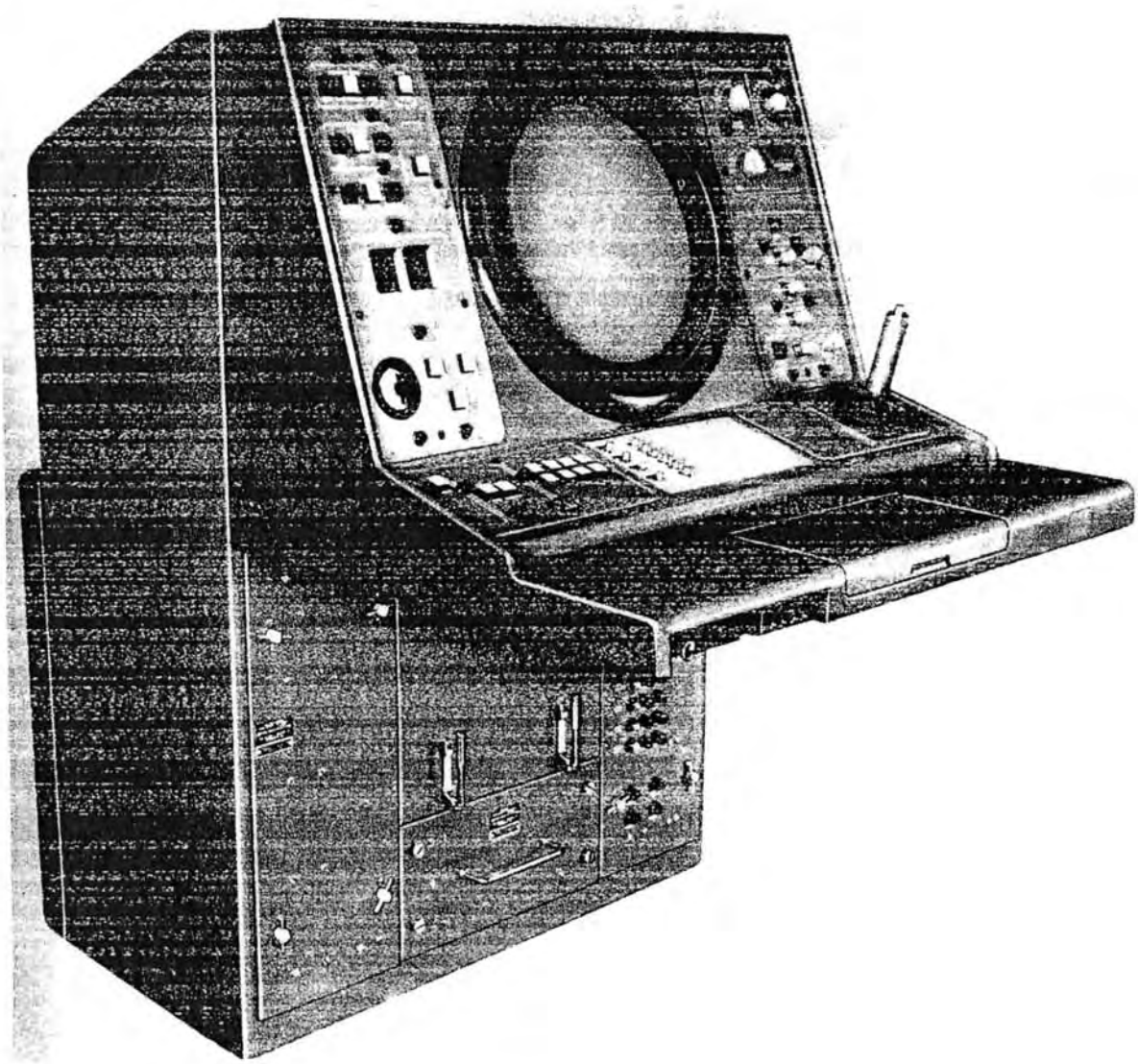


Figure 20. The tracking console.

console by the S & E officer. This tracking may involve defense acquisition radar video or supporting acquisition radar tracks.

b. Transfer control of tracking channels to other tracking consoles: When overburdened with too many tracks (after authorization by the S & E officer), when directed by the S & E officer to operate in a particular area or sector of the radar coverage, or when a track leaves an assigned sector. Similarly, he will receive transfers from other consoles.

c. Establish a *busy* signal to the S & E consoles and other tracking consoles when overburdened by present assignments because of their number or because of difficulties in tracking.

d. Employ IFF challenge on locally entered or suspected hostile tracks in accordance with SOP. Determine raid size from the PPI display and enter the raid size into the auxiliary data stores.

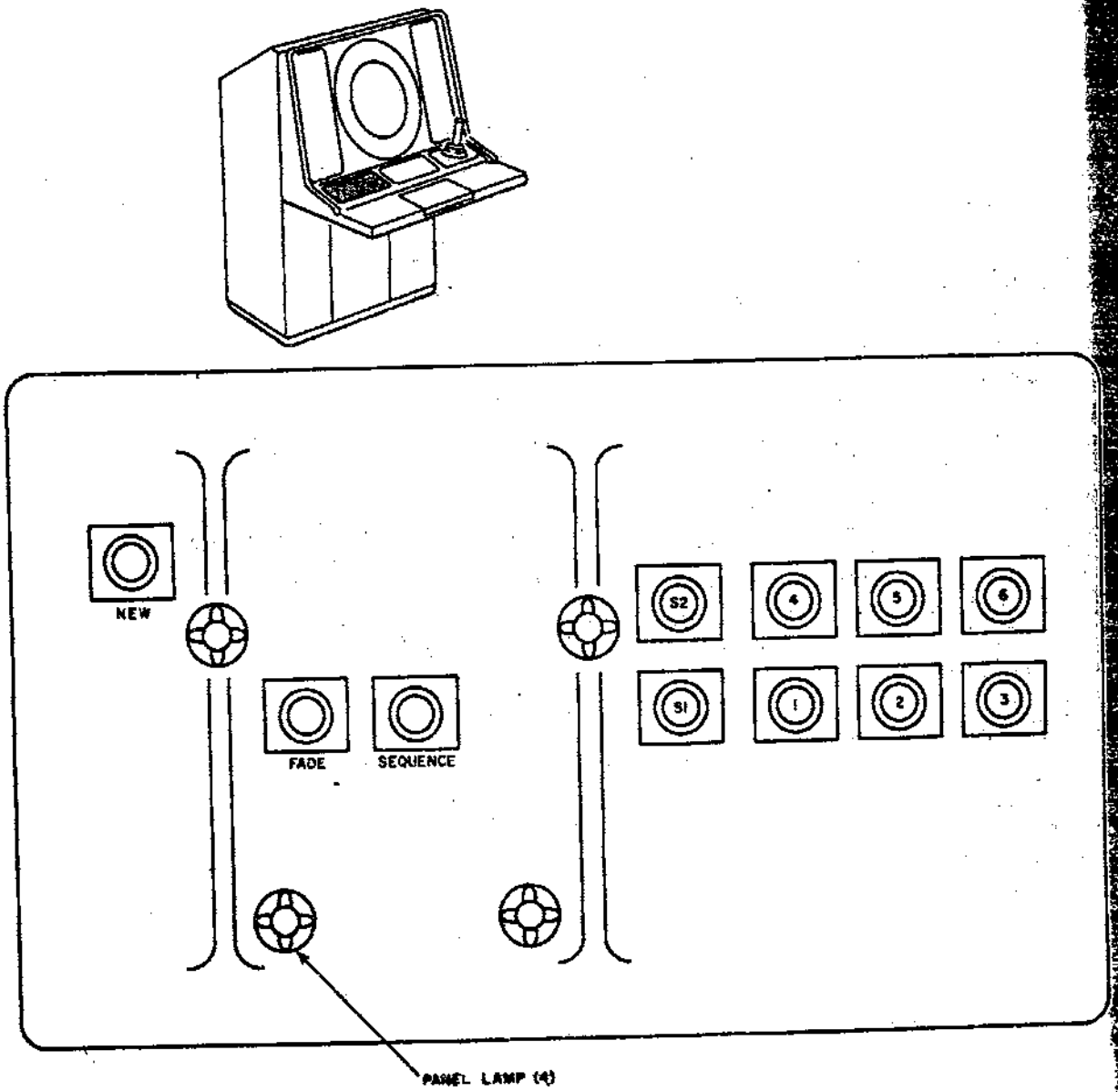


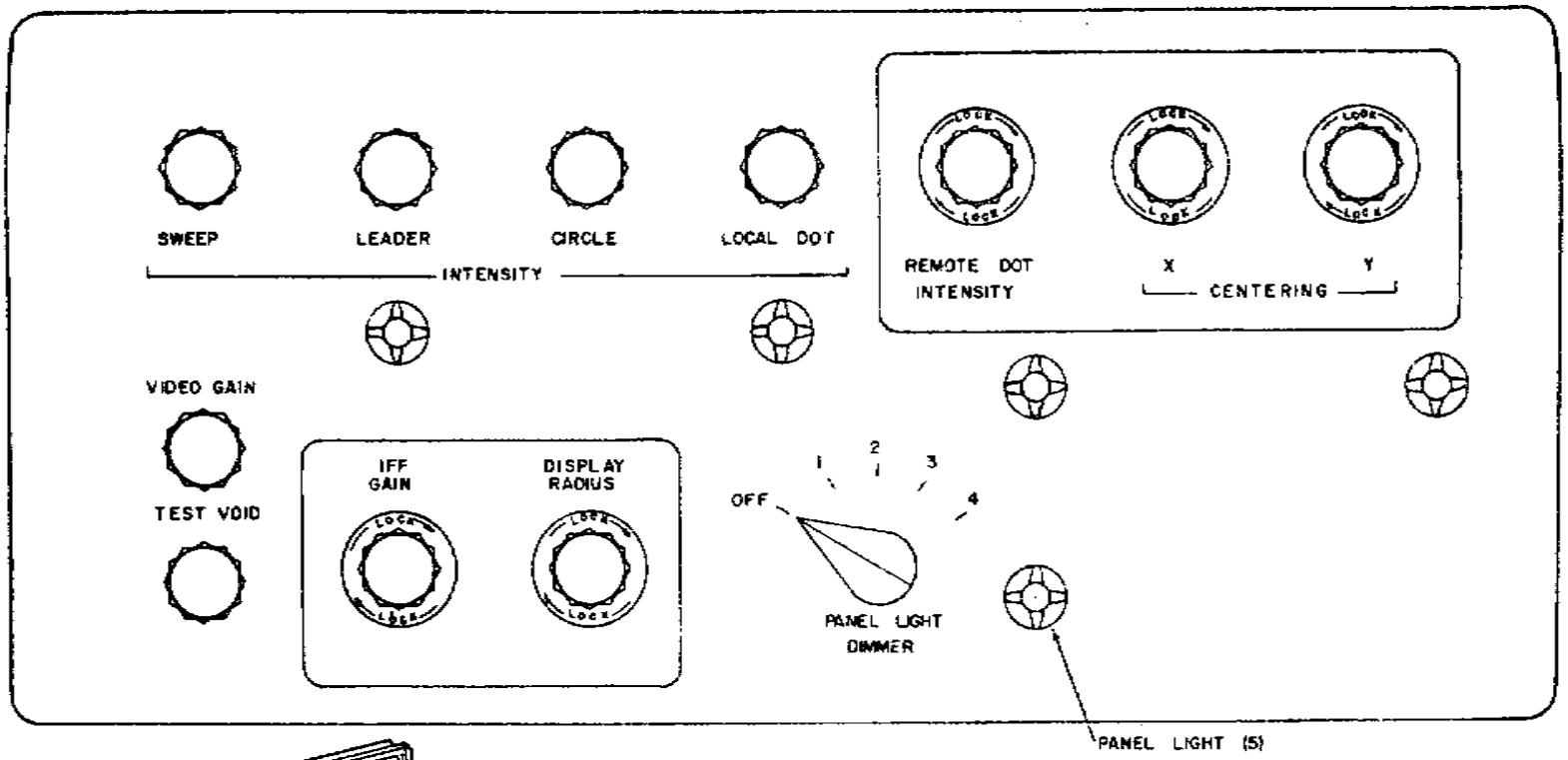
Figure 21. The tracking console numerical unit.

e. Watch for untracked video when directed and notify the S & E officer by voice for coordination with SAGE or GCI stations to aid the S & E officer in performing the surveillance and entry function.

f. Take control, under limitations of SOP, of the positional stores of any tracking channel assigned to the console for which SAGE data is in error, and track the associated video locally to provide better reference data to the associated fire units.

g. Enter locally detected tracks into the system within limits of SOP and on orders from the S & E officer. (This may involve entry into a track channel that is not being used, or taking over a SAGE-controlled track channel.)

h. Update SAGE positional data after correlation if any of the following occur:



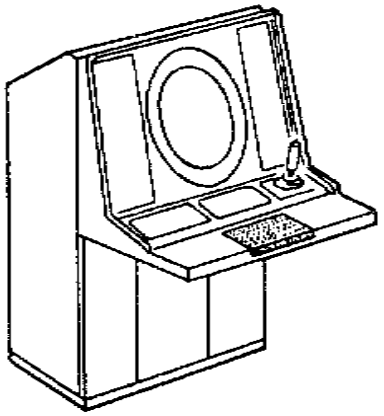


Figure 22. The tracking console concealed adjustment control panel.

(1) Video moves more than 1½ miles from the symbol.

(2) Video is not traveling in the same direction or at the same velocity as the symbol.

i. Depress SAGE INSPECT every five sweeps, when in SAGE MANUAL, to determine current SAGE positional data.

j. Return a SAGE MANUAL track channel to SAGE when loss of video occurs or symbol-video correlation exists.

k. Depress FADE when no video is present within a track channel for three consecutive sweeps.

l. Transfer track channels on direction of the S & E officer only.

m. Dump or enter LOCAL track channels on direction of the S & E officer only.

n. Voice tell track GEOREF to ADA fire units or to the AADCP plotters on direction of the S & E officer.

o. Report orally to the S & E officer when:

(1) Any of the criteria established in *h*(1) or *h*(2) above are not met.

(2) A radar FADE or a track channel has been registered.

(3) A discrepancy is noted between RAID SIZE indicator and observed number of targets.

(4) ECM is encountered by:

(*a*) Type.

(*b*) Direction of source.

(*c*) Intensity.

(5) Significant changes occur in target flight characteristics.

(6) Console or track channel malfunctions occur.

60. Operating Procedures

a. Local Entry of Tracks. Tracks are entered into the system by the S & E officer. A target tracking operator can perform this function when required. Tracks are entered by the operator as described in paragraph 42*b*.

b. Tracking. The tracking function is performed by sequencing through the track channels assigned to the console and correcting the symbols of all local or SAGE manual track channels by using the tracking stick to center the symbols over the video. After correctic of a track channel, the SEQUENCE switch c the tracking console numerical unit is used select the next active track channel. Howeve if many tracks are assigned to the console f tracking and the operator finds that the trac ing symbol of the selected track channel do not correlate with video, he sequences wit the FADE pushbutton. Thus, no time is lo for servicing other track channels while wai ing for video to return. If fades are encou tered on three successive looks at a track cha nel, the RADAR FADE indicator on the le control panel will light to warn the operator difficulty in this track channel when the tra channel is again selected. The operator the checks supporting acquisition and fire un track reference data by using the REMOT DATA switch on the right control panel. H can then request the S & E officer to initia a height demand to the RHI operator for th track channel in order to determine if the tra channel is seen by any system radar. If it ca be determined that the aircraft is being tracke by any radar, the operator continues efforts reestablish the track, but if no other trackir information is present, he notifies the S & officer who then determines whether the tra channel should be dumped from the syste The operator may at any time request aid fro the supervising S & E officer when having di ficulty with a track channel.

c. Monitoring of SAGE Data.

(1) When a track is entered into a tra channel by SAGE, it will first be a signed automatically to the control one of the surveillance and entry co soles. The S & E officer can assig SAGE track channels to the trackir consoles on a sector basis or divi them to equalize the workload of t operators. Until control of a tra channel is transferred to a trackir console, the track symbol appears a bright dot that will be associat with local video on all tracking co soles if the track channel is being d tected by the defense acquisitic radar.

(2) When a SAGE track channel is tran ferred to a tracking console, the d associated with the track channel w

change to a SAGE symbol surrounding the video or supporting acquisition track on the console selected by the S & E officer. The operator then monitors the position of the SAGE symbol in relation to local video or the supporting acquisition track in order to detect tracking errors.

d. Improvement of SAGE Data (SAGE Manual Tracking).

(1) When an operator determines that SAGE positional data are in error, he may, within established SOP, take local control of the position and velocity stores for track channel, while the auxiliary data stores remain under SAGE control.

(2) To take over a SAGE-controlled track channel, the operator first sequences to the proper track channel using the SEQUENCE switch on the numerical unit. Each time this switch is pressed the console selects the next assigned track channel in numerical order as evidenced by changing of the track channel leader on the PPI screen from one tracking symbol to another. When the leader points to the SAGE symbol of the track channel in question, all indications on the left control panel pertain to that track channel. The SAGE pushbutton indicator lamp will be lighted, indicating that the track channel is under control of SAGE.

(3) To establish local control of the track channel for improvement of reference data, the operator presses the SAGE MANUAL pushbutton-indicator on the left control panel. This action switches control of position and velocity stores to the console, extinguishes the SAGE pushbutton-indicator lamp, lights the SAGE MANUAL pushbutton-indicator lamp, and changes the SAGE symbol on the PPI screen to a local symbol. The operator may then center the symbol over the video and establish rate-aided tracking of the video by using his tracking stick (par. 42*b*(1)). The symbol will remain as a local symbol as long as the track channel remains under SAGE manual control. The SAGE MANUAL indicator lamp will light each time the track channel is selected. This light indicates to the operator that he is responsible for the track channel but that the data were originated by SAGE.

(4) Pressing the SAGE INSPECT pushbutton on the left control panel will cause the SAGE positional data to appear on the PPI screen and enable the operator to inspect these SAGE data. If the symbol is within a reasonable distance of the target, the track channel may be returned to SAGE control by pressing the SAGE pushbutton. This action extinguishes the SAGE MANUAL indicator lamp, lights the SAGE indicator lamp, and changes the tracking symbol on the PPI screen from a local to a SAGE symbol. If it is decided to retain the track channel under SAGE manual control, releasing the SAGE INSPECT pushbutton returns the tracking reference data to SAGE manual control. The symbol still indicates the erroneous SAGE position but velocity stores will contain local tracking rates. Thus, only a small position correction is required after releasing the SAGE INSPECT pushbutton.

e. Miscellaneous Operations.

(1) When raid size is received or can be determined from the tracking display, and after identity is determined, the operator enters these data for all locally controlled track channels by pressing the corresponding pushbutton-indicator. This is done, provided that these data have not been entered previously, and after coordination with the S & E officer. If a track is SAGE-controlled, a change of auxiliary data is reported to the S & E officer who relays this information to the SAGE DC or GCI station. A change of auxiliary data such as raid size, identity, and priority is originated by agencies external to the AADCP and required changes of

auxiliary data are relayed to the tracker through the S & E officer.

(2) When operating on a sector basis and a track leaves the assigned sector, when overloaded with tracks, or upon order from the supervising S & E officer, an operator may transfer assignment of a tracking channel to one of the other tracking consoles or to the supervising S & E console. If the operator knows which console is to receive a track channel, the transfer may be accomplished by first selecting the desired track channel with the SEQUENCE switch and then pressing the *transfer (number)* button for the console to which the track channel is to be reassigned. If it is not known to which console a track channel should be transferred, the desired track channel is transferred to the supervising S & E officer's console for reassignment by pressing the *transfer* button for this console. Pressing a transfer button causes the tracking symbol to change from a local or SAGE symbol to a dot.

(3) When overburdened because of the number of track channels assigned to the console or because of difficulties in tracking, the operator establishes a *busy* signal that requests other operators and the S & E officers not to transfer any more track channels to that console. This signal is activated by pressing the BUSY pushbutton-indicator on the right control panel. This lights the associated indicator lamp to remind the operator that the *busy* signal is on. At all other tracking and S & E consoles, the *transfer* button indicator lamp for the console initiating the *busy* signal is lighted.

(4) The dumping of a locally activated track from a track channel is the responsibility of the S & E officer. However, an operator may be ordered to perform this function. To dump a track, the operator first sequences with the FADE pushbutton on the numerical unit to select the proper track channel and then presses the DUMP button on the left control panel. This erases all track reference data in the track channel stores for that track channel and returns the track channel to the *available* condition. The tracking symbol on the PPI screen disappears, and all status indicator lamps extinguish for this track channel. Since use of the SEQUENCE pushbutton would destroy any previous fade counts and release any *effective* engagement indications in track channels sequenced through, the FADE switch is used here for rapid sequencing. Use of the FADE pushbutton enters false fade counts into track channels sequenced through but this will have no serious effect on overall operation.

(5) The operator may request information or aid from the supervising S & E officer in either of two ways. Since the CHANNEL indicator on the left control panel always shows the number of the selected track channel, the operator may sequence to the desired track channel and may communicate with the S & E officer by telephone referring to the track channel by number. In this way, the S & E officer can select this track channel directly. Alternatively, the operator may request the S & E officer to place their two consoles in parallel. The leader on the S & E PPI screen will then point to the track channel selected by the operator, and either individual may point out a track channel to the other by use of the FADE push button.

(6) IFF is available at the tracking console by pressing the IFF button on the right control panel. This initiates the IFF challenge and enables the IFF circuits of the PPI. IFF will appear on the PPI only while the IFF button on a particular console is held down and will not appear when the button on any other console is pressed.

(7) The tracking console has the same provisions for expanded display, range

and angle (azimuth) marks, map display, height indication, and display selection by identity category as does the S & E console.

61. Effect of Operating Modes

Duties and procedures used by the operators are identical in all operating modes.

62. Antijamming Measures

ECM and radar interference affect the tracking console displays in the same manner as discussed in paragraph 43. However, the operator can adjust only focus and intensity of the tracking console display and depends on the S & E officer and radar operators to coordinate and accomplish other radar antijamming measures. As mentioned in paragraph 43, the operator may be ordered to operate in a sector so that his display may be expanded. Some additional relief from ECM may be obtained by adjusting DISPLAY OFFSET and RANGE controls on the right control panel in order to avoid areas of very heavy jamming. This adjustment will reduce blossoming on the PPI screen and may enable the operator to locate aircraft that cannot be seen otherwise.

CHAPTER 6
THE TACTICAL MONITOR CONSOLE

63. General

Each of the *tactical monitor (TM)* consoles (fig. 23) included in the Missile Master system is associated with a maximum of eight missile fire units. The 19-inch display, located to afford an easy view to the tactical monitor, presents symbols and display of the enemy air attack as it relates to the associated fire units. Controls to adjust the display are located on the indicator panel (fig. 24). Controls and instruments located on the display control panel (fig. 25), to the left of the indicator panel, permit display of a wide choice of data. The tactical monitor control panel, located to the right of the indicator panel, contains all controls and indicators required for monitoring the associated missile fire units. To perform efficiently, each tactical monitor should know and understand preliminary control settings, start-stop procedures, preliminary adjustments, operating procedures, responsibilities, and effect of ECM.

64. Symbols and Displays

Figure 24 depicts symbols that are displayed on the tactical display equipment (TDE) presentations. The TDE of the tactical monitor console utilizes track information stored in the track channel stores. The display consists of a sharp synthetic video presentation of the air situation. No radar video is displayed; also, the rotating sweep line usually found on PPI displays is not present.

a. Reference Track Data. Reference track data are those data stored in the system as distinguished from battery track data. Reference track data originate from Missile Master radars or from SAGE. The positions of all reference track data in the system stores may be displayed either as complete symbols, including the track or channel number, code dots, and velocity vectors, or as vectors only. When a *priority* status has been assigned to a track, its reference data symbol flashes continuously.

(1) The complete track symbol consists o a two-digit number denoting the chan nel number with auxiliary dot code above, below, and adjacent to both sides of the number (fig. 24). N dots, or one, two, or three dots, abov the number represents raid size o the track as no estimate, one, few, o many, respectively. One to four dot to the right of the number indicate height of the track in 20,000-foo (6,096-meters) brackets. One dot 0–20,000 feet (0–6,096 meters); tw dots, 20,000–40,000 feet (6,096 12,192 meters); and three dots 40,000–60,000 feet (12,192–18,28 meters). Four dots represent height above 60,000 feet (18,288 meters) One dot below the number indicates friendly track, while four dots in th position signifies a hostile track. Fou dots to the left of the number indica a track assigned to a fire unit, and o dot to the left of the number ind cates that the track has not been a signed to a fire unit. A dot near th center of the symbol shows the actu position of the track, and a vect leading from this dot indicates cour and velocity relative to other trac displayed.

(2) At the tactical monitor's discreti some tracks may be displayed as d and vector only by use of the STAT SELECTOR on the display cont panel (fig. 25). In this case, the d again represents the present positi of the track and the vector indica its course and relative speed.

(3) All reference data vectors may be e tended to predict the track positio minutes in the future, provided t track does not change course or vel ity. When vectors are extended,

other symbols disappear from the display to prevent interference with reading of vectors.

b. Battery Track Data. Track data received over the ADL from fire unit target track radars, may be displayed either as fire unit numbers with raid size-dot code above each number or as circles.

c. Fire Unit Location. The ground location of a fire unit may be displayed as the fire unit number superimposed on a dot representing the location of the fire unit. Fire unit location symbols blink once a second in sequence.

d. Adjacent AADCP Targets. The positions of targets being tracked by fire units assigned to adjacent AADCP's are displayed as dots blinking once every 2 seconds.

65. Controls and Instruments

a. Display Control Panel. This panel (fig. 25) is mounted to the left of the indicator panel.

(1) *Reference data blanking* (REF-DATA BLANKING) 50-position switch: Causes all reference data symbols, except the symbol whose reference track number corresponds to

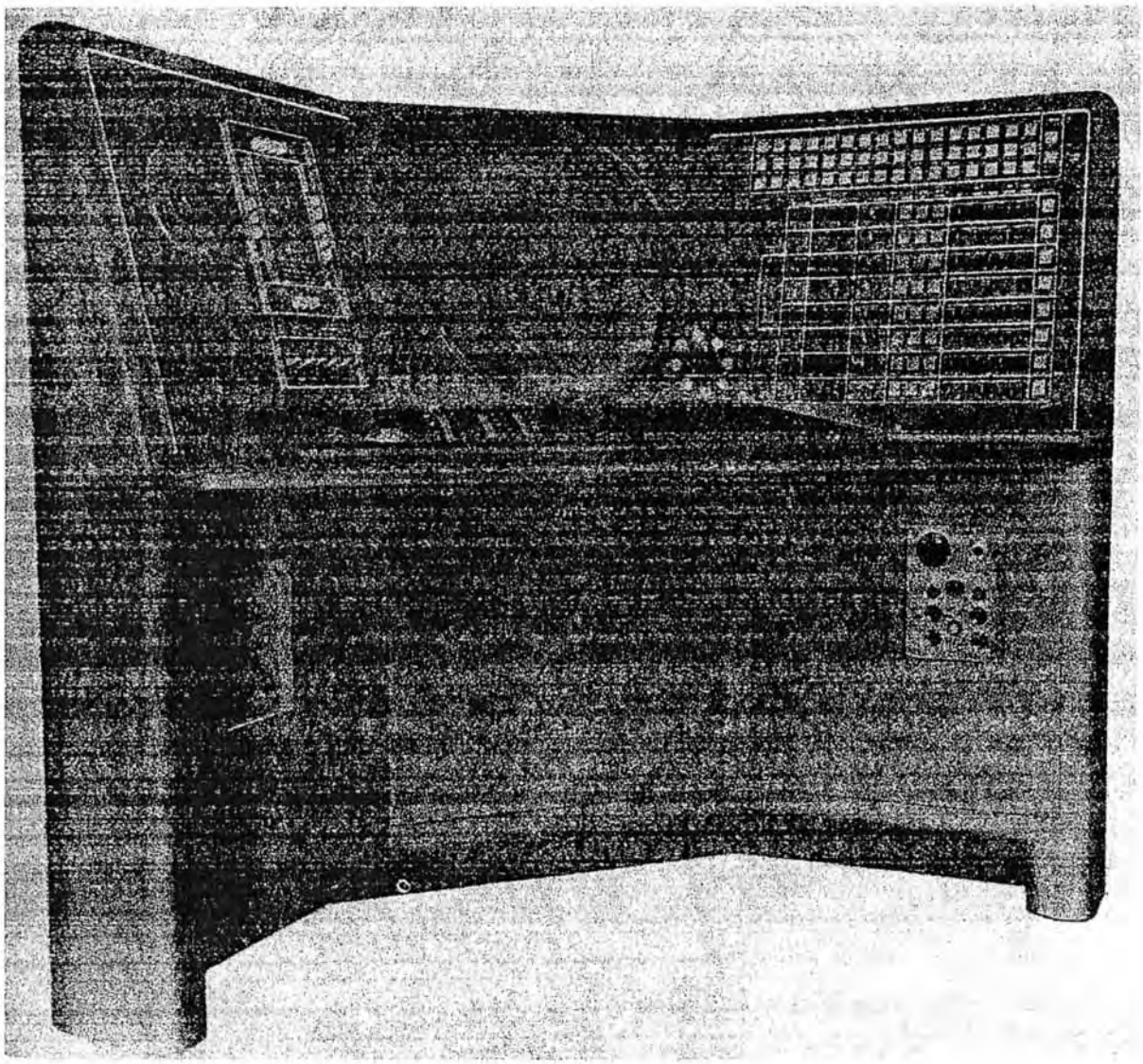


Figure 23. The tactical monitor console.

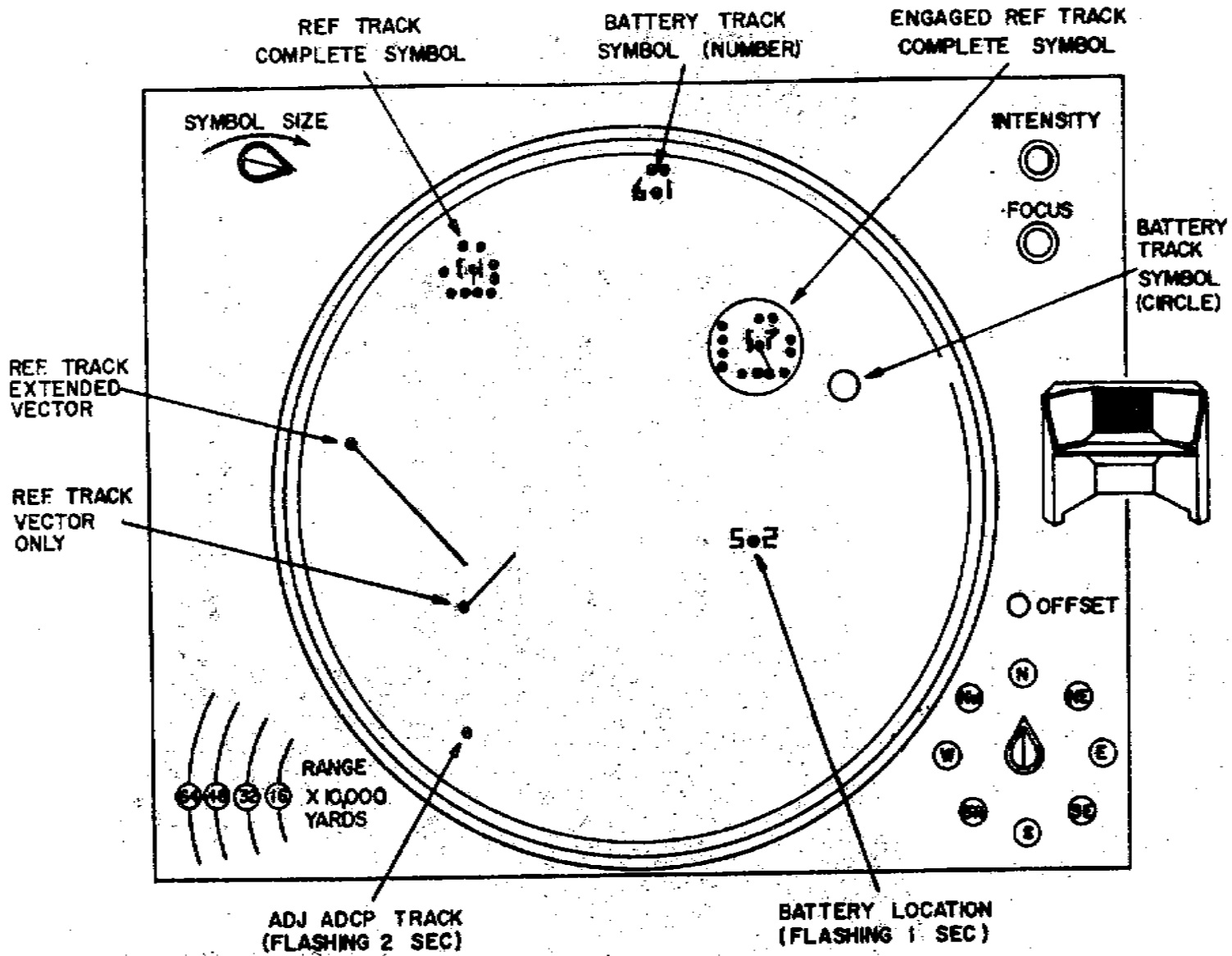


Figure 24. The tactical monitor (and tactical operations) console indicator panel.

the selected switch position, to disappear from the TDE display. The two end positions (OFF) of the switch permit normal display of all reference data tracks.

(2) *Reference data* STATUS SELECTOR four-position switch: Used in conjunction with *status code selector* pushbuttons. This switch permits a choice of the following display categories:

(*a*) *Position A.* All reference track data are displayed as complete symbols. *Status code selector* pushbuttons have no effect in this position.

(*b*) *Position B.* Tracks selected by *status code selector* pushbuttons are displayed as complete symbols. Other reference track data are displayed as dots and vectors only.

(*c*) *Position C.* Tracks selected by *status code selector* pushbuttons are displayed as complete symbols. All other reference track data are blanked.

(*d*) *Position D.* Tracks selected by *status code selector* pushbuttons are displayed as dots and vectors only. All other reference track data are blanked.

(3) *Status code selector* pushbutton switches (15): Are arranged about the reference data STATUS SELECTOR switch in the same manner as dot codes are arranged in complete reference track symbols (par. 64*a*(1)) (figs. 24 and 25). By pressing the pushbutton switches, all tracks or any combination of tracks according to height, identity, raid size, and assignment status may be selected for display in a manner determined by the position of the STATUS SELECTOR switch as described in (2) above. An additional button is added to each group of buttons to permit cancellation of status codes selected for display.

(4) BATTERY POSITION two-position switch: In the ON position, causes display of fire unit location symbols.

(5) DISPLAY SELECTOR three-position switch: Selects a display of reference track data only (REF position), fire unit tracks only (BATTERY position), or both (BOTH position).

(6) BATTERY SYMBOL two-position switch: Selects a display of all fire unit tracks as circles (CIRCLE position) or as battery numbers (NUMBER position).

(7) *Adjacent AADCP's* (ADJACENT AAOC NO. 1 and ADJACENT AAOC NO. 2) two, two-position switches: Permit a display of data from either of two adjacent Missile Master systems, from both adjacent systems, or from neither adjacent system.

(8) EXTENDED VECTOR two-position switch spring-loaded to the OFF position: In the ON position, extends the vectors of all reference data track symbols to 2-minute prediction of future position and eliminates all other symbols in order to prevent interference in the reading of vectors.

b. Indicator Control Panel (fig. 24). This panel is located at the center of the tactical monitor console. It contains the controls necessary for adjustment of the display and serves as a mount for the TDE display tube.

(1) INTENSITY control knob: Adjusts the brightness of the TDE display.

(2) FOCUS control knob: Adjusts sharpness of TDE symbols.

(3) SYMBOL SIZE control knob: Provides continuous adjustment of all symbol sizes (except size of the extended vector symbol) from a dot to a diagonal dimension of approximately one inch.

(4) RANGE X 10,000 YARDS four pushbutton-indicator switches: Permit selection of the radial display range of TDE presentation from 160,000 to 640,000 yards (146,304 to 585,216 meters) in 160,000-yard (146,304-meters) steps and lights the associated lamp. If any pushbutton is pushed in only partially and then released (so that all buttons are out), the range becomes 640,000 yards (585,216 meters).

(5) OFFSET pushbutton: When pushed, makes effective the *offset direction* switch. When pushed again, causes a return to normal display.

(6) OFFSET DIRECTION switch: Displaces the selected sector to the center of the screen and expands the sector to fill the entire area of the screen. There are eight buttons arranged in a circle so that each button indicates a cardinal or intercardinal offset direction. A magnified presentation, offset in a specified direction, is provided by the offset function. If the OFFSET switch pushbutton is pressed and one of the eight available directions is selected by use of the *offset direction* switch, the display is offset one radius in the particular direction selected. For a south offset display, the old normal south *radius* is doubled in length and moved north and becomes the north-south *diameter* of the new offset display. Figure 26 is a graphic illustration of the offset function. The offset function thus provides a magnified view of a circular section of the normal display. Indicator lamps will light in the appropriate switch position as the various *offset direction* switches are activated. The radius of the offset display is always one-half the range indicated by the activated RANGE X 10,000 YARDS switch pushbutton-indicator on the indicator panel.

c. Tactical Control Panel (fig. 27). This panel is located to the right of the indicator panel.

(1) *Reference track data number* pushbuttons (48): Used in conjunction with a *command* pushbutton (ENGAGE, HOLD FIRE, or CEASE ENGAGE) when assigning a track to a fire unit, or in conjunction with the CORRELATION switch when correlating a fire unit track to a reference track data. When pressed, in conjunction with a *command* button or a CORRELATION switch, the track channel number appears on the proper fire unit TRACK NO. inditron. (The inditron is a gas filled tube that will glow to indicate the selected number when voltage is applied. The plates of the tubes are shaped to indicate numbers from zero through nine.) A button, marked X, is used to prevent false designations to the fire unit in conjunction with commands relative to a fire unit track for which there is no reference track data.

(2) *Incomplete assignment* (INCOMP ASSIGN.) (I) pushbutton-indicator. Lights whenever a reference data track number pushbutton is depressed. The light glows until the track channel number has been assigned to a particular fire unit or until the I pushbutton is pressed. Pressing the I pushbutton cancels a track channel number selection.

(3) BROADCAST DATA indicators (3): Show that *friendly* (F), *hostile* (H), or *both* (B) types of reference data have been selected for broadcast to fire units. A pushbutton feature permits checking of lamps for failure.

(4) BATTERY NO. indicator: Indicates fire units associated with controls and indicators of this panel row. The two indicator lamps alongside the fire unit number extinguish when the fire unit is out of action. *Ready* is indicated by a lighted green indicator lamp on the left. A red indicator lamp on the right lights when the fire unit acknowledges an assignment or has designated a target to the TTR. Numbers above 49 are assigned to fire units under the control of a tactical monitor to prevent confusion with track channel numbers (01–48).

(5) TRACK NO. indicator: Displays the number of the reference data track being attacked by the associated fire unit. Two zeroes indicate the fire unit is attacking a track not entered into the reference data stores.

(6) CORRELATION, spring-loaded three-position switch: When placed in the BLANK position, removes all

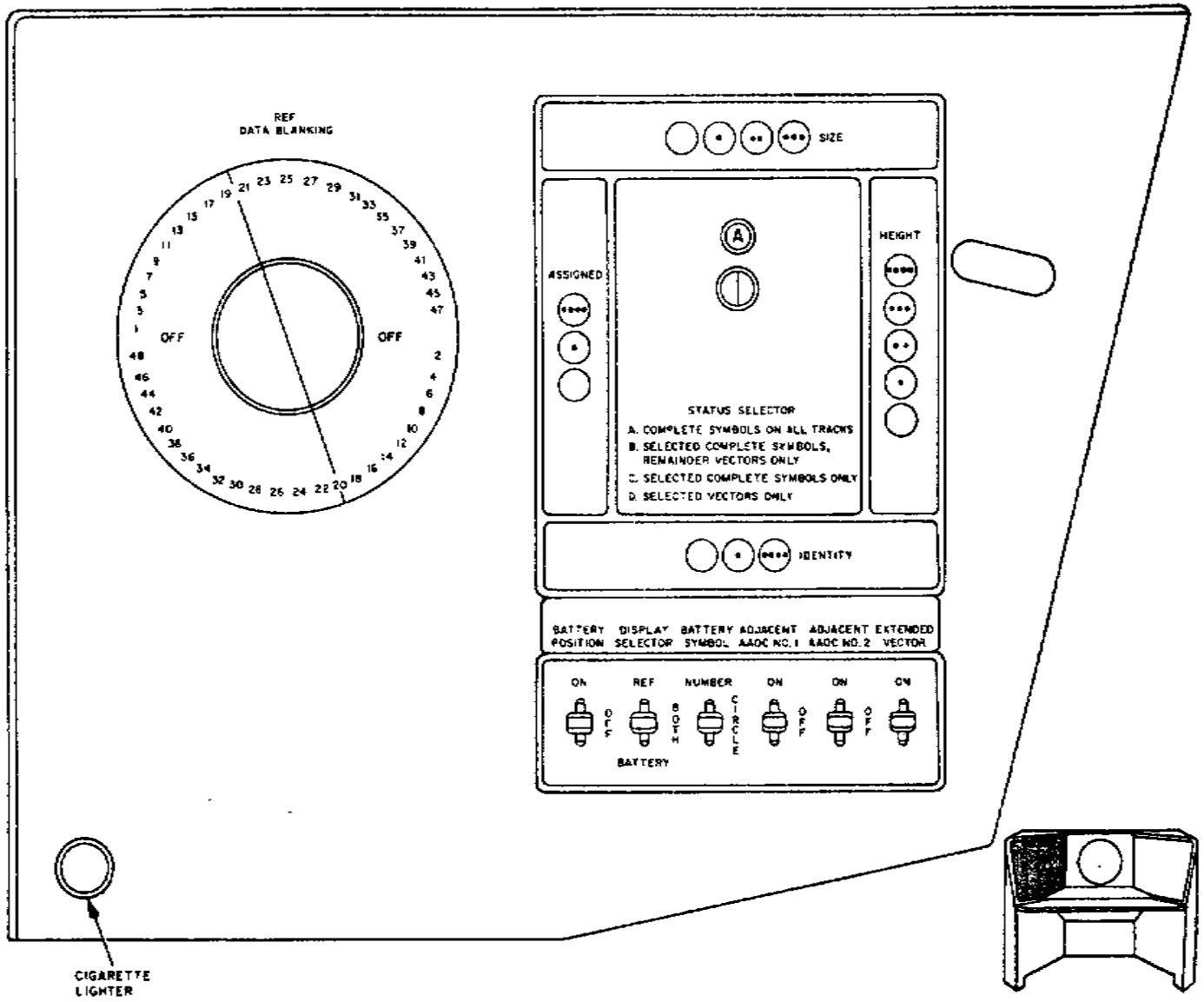
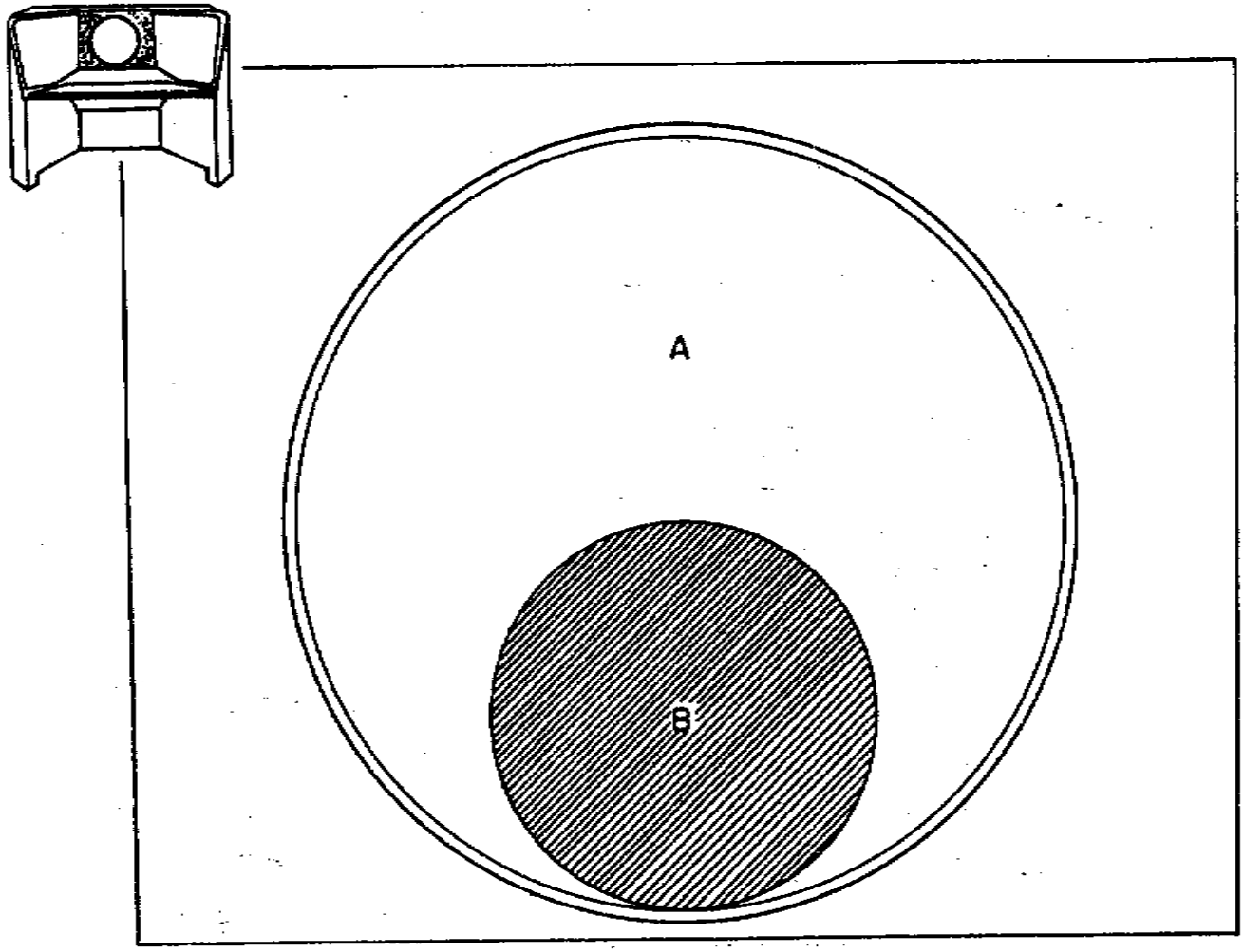


Figure 25. The tactical monitor display control panel.



NOTE:

NORMAL PPI DISPLAY AREA INCLUDES AREAS A AND B.
SOUTH OFFSET PPI DISPLAY AREA INCLUDES AREA B EXPANDED TO THE SIZE OF AREA A.

Figure 26. Graphic illustration of the offset function.

symbols from the TDE display except the symbol for the tracking position of the associated fire unit. When placed in the *correlate* (CORR) position, causes the track channel number to appear on the associated TRACK NO. inditron for tracks not previously assigned to the fire unit. The center position is the normal location of the switch. The *correlate request* lamp to the right of the switch lights whenever correlation is required and extinguishes when correlation is effected. The *correlate request* lamp lights when an *on target* signal is received from the associated fire unit.

(7) ENGAGE (E) pushbutton-indicator: When pressed, orders the associated fire unit to attack the track entered by a reference data track number pushbutton and lights the indicator lamp. The indicator lamp is extinguished upon transmission of a subsequent command or when the RELEASE (R) button is pressed.

(8) HOLD FIRE (H) pushbutton-indicator: When pressed, transmits a *hold fire* command to the associated fire unit for the track channel shown on the associated TRACK NO. inditron and lights the H indicator lamp. The indicator lamp is extinguished by any other command or release of the track by depressing the RELEASE button for the designated battery.

(9) CEASE ENGAGE (C) pushbutton-indicator: When pressed, causes a *cease engage* command to be transmitted to the associated fire unit for the track channel number shown on the *reference data track number* indicator and lights the C indicator lamp. The indicator lamp is extinguished when the RELEASE pushbutton or any other command button (E or H) is pressed.

(10) *Acknowledge* (ACK) (A) indicator lamp: When lighted, indicates that the associated fire unit has received the command just transmitted. The indicator lamp is extinguished by any other command or when the fire unit abandons the target.

(11) ON TARGET (T) indicator lamp: When lighted, shows that the associated fire unit is tracking the target associated with the track channel number shown on the TRACK NO. inditron. It extinguishes when the FIRING indicator lamp lights. It lights the second time during an engagement when the fire unit computer sends the BURST command.

(12) FIRING (F) indicator lamp: When lighted, indicates that the associated fire unit has fired a missile at the target indicated by the track channel number shown on the TRACK NO. inditron but that the missile has not yet reached the target. It extinguishes when the fire unit computer sends the BURST command.

(13) *Effective* (EFF ENGAGE) (E) indicator lamp: When lighted, indicates that a total kill against a target of the indicated track channel number has been scored by the associated fire unit.

(14) *Ineffective* (INEFF ENGAGE) (I) indicator lamp: When lighted, shows that the associated fire unit has fired on the target, that the firing was unsuccessful, and that the fire unit can no longer successfully attack this particular target.

Note. The A, T, F, E, and I indicators have an associated pushbutton capability for lamp testing only.

(15) RELEASE (R) pushbutton switch: When pressed, clears the associated fire unit command pushbutton, but does not release the command at the fire unit. The track number on the TRACK NO. inditron disappears, and the *correlate request* and ON TARGET indicator lamps will relight if the fire unit continues tracking the target.

d. Right Auxiliary Control Panel (fig. 28). This panel is actually a power supply panel and contains the controls necessary for application and removal of electrical power for the associated console. It is located in the console kneewell to the operator's right.

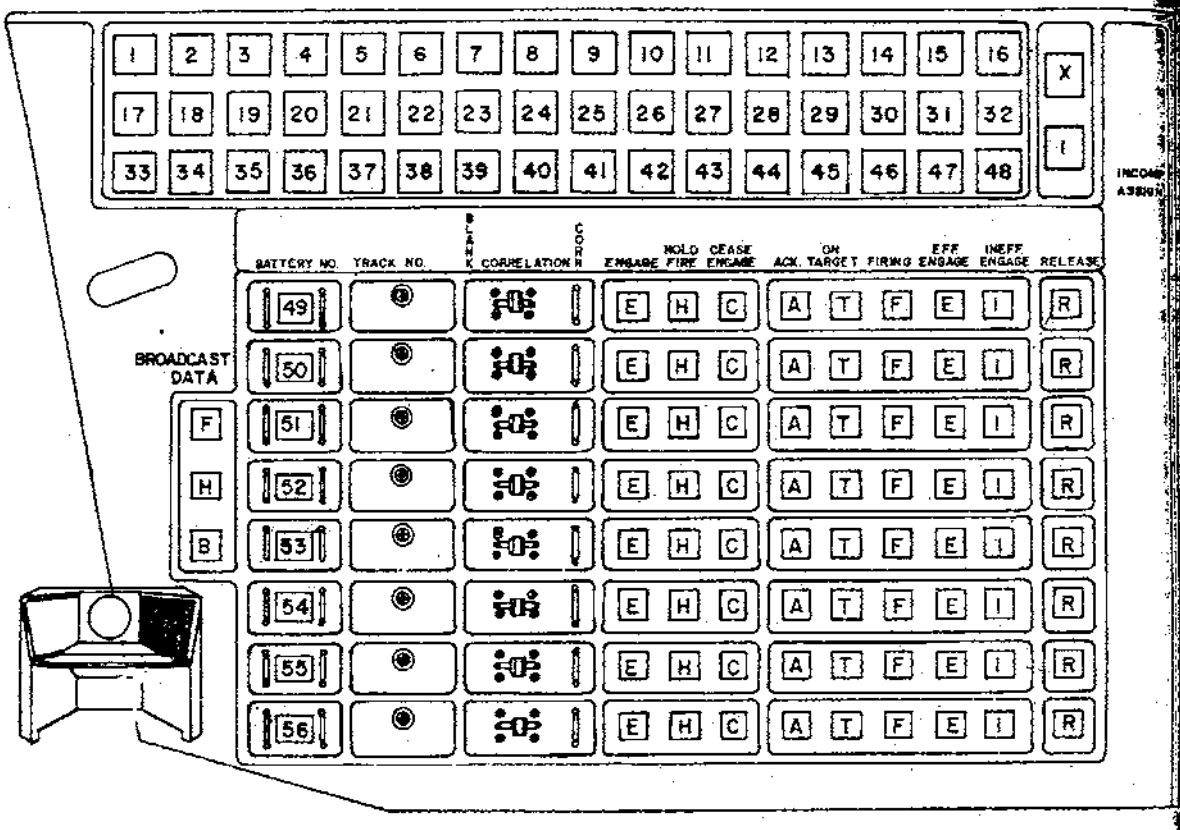


Figure 27. The tactical monitor tactical control panel.

(1) FILAMENT ON-OFF pushbutton switches: When the ON button is pressed, lights the red filament indicator lamp to show that filament power has been applied. When the OFF pushbutton is pressed, removes filament power from the console and extinguishes the filament indicator lamp. It also serves as a quick-disconnect switch for emergency shutdown of the console.

(2) B+ ON-OFF pushbutton switches: When the ON button is pressed, lights the red, plate voltage, indicator lamp to show that plate voltages have been applied to the console circuits. When the OFF button is pressed, removes plate voltages and extinguishes the B+ indicator lamp. A time delay in the circuit protects the circuit and insures that there is a suitable warmup period before high voltage is applied.

(3) LAMP DIMMER control knob: Adjusts brightness of indicator lamps on the tactical monitor control panel.

(4) TEST CLUSTER switch: Presents display for testing of complete symbols, vectors, and priority signal.

(5) TARGET NUMBER DIMMER control knob: Adjusts brightness of the TRACK NO. inditron on the tactical monitor control panel.

(6) PANEL LAMP FUSE and indicator. Protect panel lamp circuits against overload. The indicator lamp lights if the fuse fails.

e. Left Auxiliary Control Panel (fig. 29). This panel is located in the console knee-well to the operator's left.

(1) INTERLOCK BY PASS key-operated switch: Permits access to console chassis without interruption of power. This bypass is used by maintenance personnel only.

(2) ZERO RANGE TEST ON-OFF rotary selector switch: Permits display of all symbols as a dot at the center of the display tube for testing purposes.

(3) *Convenience outlets (two 120-volt outlets)*: Permit use of auxiliary equipment at the console.

(4) *Telephone jacks*: Accept standard plug-in type telephone headset-handset for use with built-in communications circuits (ch. 14).

66. Preliminary Control Settings (Power Off)

a. Left Auxiliary Control Panel (fig. 29). Check the INTERLOCK BY PASS switch and insure that it is in the *safe* position. Insure all console access doors and panels are securely closed.

b. Right Auxiliary Control Panel (fig. 28).

(1) Turn the LAMP DIMMER control knob fully counterclockwise (CCW).

(2) Turn the TARGET NUMBER DIMMER control knob fully CCW.

c. Indicator Panel (fig. 24). Turn the indicator panel INTENSITY control fully CCW and the SYMBOL SIZE control knob fully clockwise (CW).

d. Display Control Panel (fig. 25).

(1) Turn the REF DATA BLANKING switch to its CCW (OFF) position.

(2) Set the reference data STATUS SELECTOR switch at position A.

(3) Press all *status code selector* canceling buttons.

(4) Aline all level switches with the EXTENDED VECTOR switch.

67. Start-Stop Procedures

a. Energizing.

(1) Press the ON button of the FILAMENT switch at the right auxiliary control panel. After the red filament indicator lamp lights, wait one minute before proceeding.

(2) Press the ON button of the B+ switch. Check to see that the plate supply indicator lamp lights. Wait 45 seconds for application of high voltage.

b. Deenergizing.

(1) Turn the INTENSITY control on the indicator panel fully CCW.

(2) To place the console into a *standby* condition, rotate all controls mentioned in paragraph 68 to the maximum CCW position and press the OFF button of the B+ switch. The console can be reactivated by pressing the ON button of the B+ switch.

(3) To completely shut down the console, first press the OFF button of the B+ switch, then press the OFF button of the FILAMENT switch.

(4) In an emergency, the console may be shut down by pressing the OFF button of the FILAMENT switch. This action removes plate and filament supply voltages automatically and extinguishes both power supply indicator lights.

68. Preliminary Adjustments

a. Adjust the INTENSITY control on the indicator panel until symbols are clearly visible without glare.

b. Adjust the FOCUS control on the indicator panel until symbols are sharp and clear.

c. If necessary, repeat *a* and *b* above.

d. Adjust the LAMP DIMMER control on the right auxiliary control panel until the indicator lamps on the tactical monitor control panel are at a satisfactory brightness.

e. Adjust the SYMBOL SIZE control on the indicator panel until the symbols are of a convenient size.

69. Operating Procedures

a. Monitoring of Fire Unit Target Selections.

(1) For this operation, the TDE display is set to show all reference track data as complete symbols. All friendly tracks are shown as complete symbols and all hostile tracks are shown as vectors only or erased.

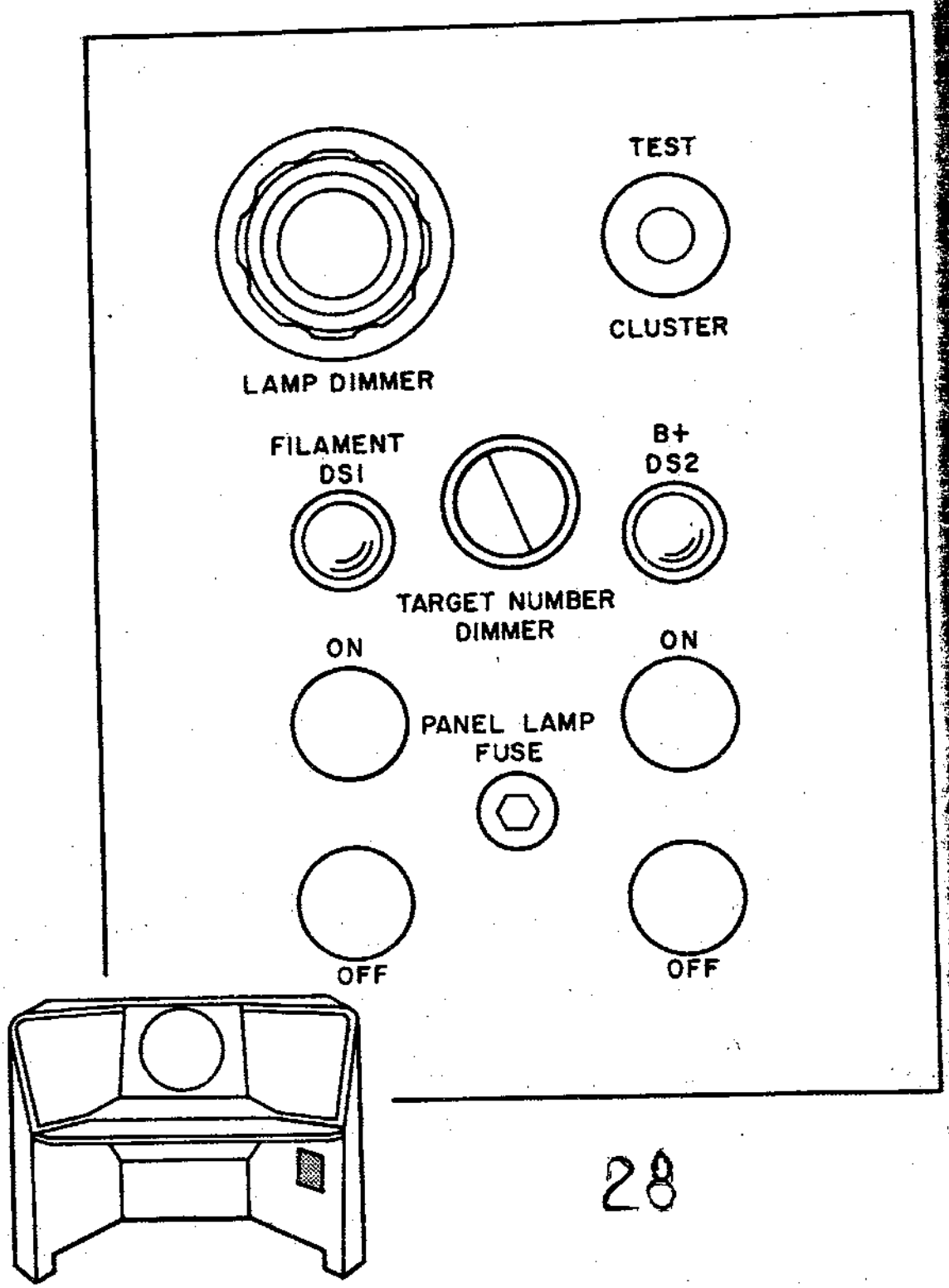


Figure 28. The tactical monitor (and tactical operations and friendly protector) console right auxiliary control panel.

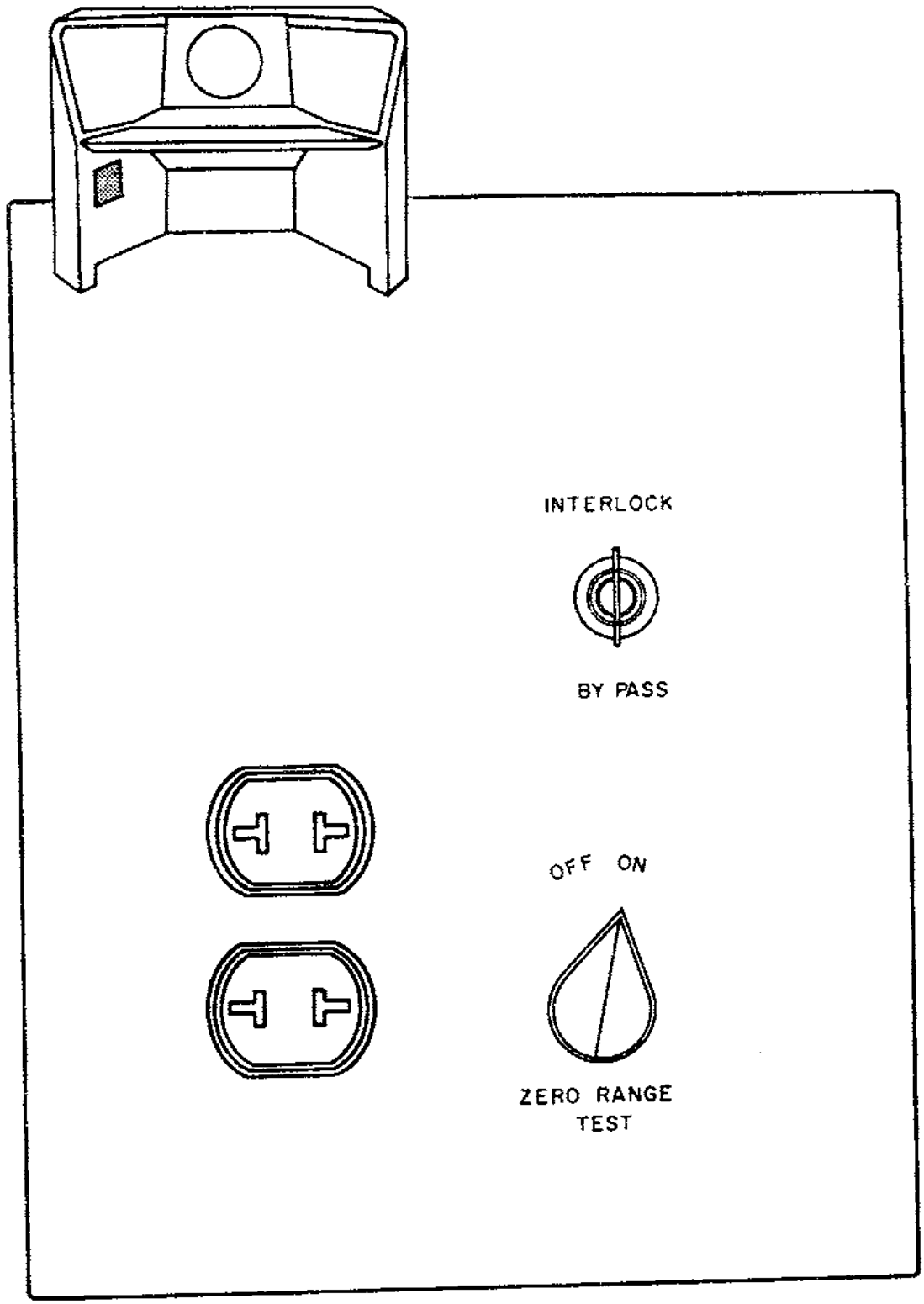


Figure 29. The tactical monitor (and tactical operations and friendly protector) console left auxiliary control panel.

(2) The first indication to the tactical monitor that a fire unit has selected a target for attack is the lighting of the red indicator lamp associated with the fire unit number on the tactical control panel (fig. 27). At the same time, the green indicator lamp is extinguished. When the fire unit target track radar has locked on a target, the ON TARGET indicator lamp lights on the tactical control panel, and the *correlate request* lamp lights to indicate that correlation is required. At the same time, a circle or a fire unit number (depending on the position of the BATTERY SYMBOL switch on the display control panel) will appear on the TDE display at the reference track symbol for the track. The tactical monitor then presses the CORRELATION switch to the BLANK position that causes all symbols except the associated fire unit track circle or fire unit number to disappear from the display. The tactical monitor now has located the correct circle or fire unit number, and by releasing the CORRELATION switch to the *neutral* position, all other symbols are redisplayed so that the track channel number of the track channel being tracked by the fire unit appears within the circle or superimposed over the fire unit number. The tactical monitor now completes his correlation by pressing the indicated *reference data track number* button and then placing the CORRELATION switch momentarily in the CORR position. This action extinguishes the *correlate request* lamp, enters the track channel number in the appropriate TRACK NO. inditron, adds the assigned dot code to the reference track symbol, and permits the system to transmit data for that track channel to SAGE if it is a SAGE activated track channel.

(3) If a fire unit tracks a target not contained in the system reference data stores, no track channel number is available and the track channel cannot be correlated in the usual manner. In this case, the correlation function is performed by pressing the X button and momentarily placing the CORRELATION switch in the CORR position. The *correlate request* lamp is again extinguished and the TRACK NO. indicator shows two zeroes to indicate that the fire unit track has been correlated with a target not tracked by the system. This prevents false designations to the fire unit when a command is sent.

(4) The progress of an attack is indicated by the battery action *status* lamps (T, F, E, I) on the tactical control panel. When a missile is fired, the ON TARGET indicator lamp extinguishes and the FIRING indicator lamp lights. Between successive missile firings of a multiple missile attack, the FIRING lamp extinguishes and the ON TARGET indicator lamp relights. The attack is terminated by the fire unit commander who transmits either an *effective engagement* or an *ineffective engagement* signal as an estimate of the success of the attack. This signal lights the corresponding indicator lamp on the tactical control panel and extinguishes the ON TARGET or FIRING indicator lamp and the red indicator lamp associated with the fire unit number. The green indicator lamp associated with the fire unit number lights to show that the fire unit is ready to attack another track. When the tactical monitor has noted the *effective engagement* signal, he presses the RELEASE button. This causes the TRACK NO. inditron lamp to extinguish. The EFF ENGAGE or INEFF ENGAGE indicator lamp is extinguished by transmission of the next command or receipt of the next *status* or *acknowledge* signal from the fire unit.

(5) Within limits of SOP, the tactical monitor may at any time order *hold fire*, order *cease engage*, or designate specific targets to his fire units. These

commands are initiated by pressing the HOLD FIRE, CEASE ENGAGE, or ENGAGE pushbutton-indicators when the associated fire unit is tracking one of the targets in the 48 tracking channels. When a fire unit symbol is correlated with a target track not entered into the Missile Master system, commands may be transmitted electrically, providing the track is correlated by means of the X button and the CORRELATION switch on the tactical control panel (fig. 27). After pressing the HOLD FIRE pushbutton, the tactical monitor may reinstate the attack by pressing the ENGAGE pushbutton-indicator. When any button is pressed, the associated lamp lights and other command indicator lamps extinguish. Thus, the command currently in effect is always indicated on the panel.

b. Designation of AADCP Selected Attacks.

(1) For target designation, the tracks to be attacked are shown as complete symbols, and those already under attack by fire units are enclosed by circles (fig. 24). In selecting tracks for designation to fire units, the tactical monitor occasionally may wish to make use of the fire unit locations and the extended vector display. If there are adjacent Missile Master systems with overlapping coverage, the tactical monitor may turn on either or both of the adjacent AADCP displays so that targets tracked by adjacent systems may be seen on the display. Thus, the tactical monitor can assign targets to fire units best suited to attack them and can insure maximum distribution of fire by avoiding doubling of fire units on targets being attacked by other systems. The status of fire units is shown by the color of the indicator lights associated with each fire unit number on the tactical control panel. If neither indicator lamp is lighted, the fire unit is out of action. (Both indicator lamps will extinguish also when a KILL is transmitted.) If the green indicator lamp is lighted, the fire unit is ready, and if the red indicator lamp is lighted, the fire unit is tracking a target.

(2) Having selected a track channel and a fire unit to attack it, the tactical monitor presses the desired *reference data track number* button on the tactical control panel and the ENGAGE button for the selected fire unit. This adds the assigned dot code to the track symbol on the TDE presentation. The track number immediately will appear on the TRACK NO. inditron of that fire unit. The ENGAGE indicator lamp will light, and the command will be transmitted instantaneously to the fire unit by automatic data link. When the fire unit commander acknowledges that the designated target video is seen and that the target will be attacked, the BATTERY NO. indicator lamp will change from green to red, and the ACK indicator lamp will light. When the fire unit commences tracking the target, the ON TARGET indicator and *correlate request* lamps will light. The tactical monitor then presses the CORRELATION switch to the BLANK position and checks correlation as described in *a*(2) above. If the tactical monitor is satisfied that the fire unit has acquired the target indicated on the TRACK NO. inditron, the tactical monitor presses the switch to the CORR position, which extinguishes the *correlate request* lamp.

(3) If a fire unit acquires a target on its own initiative (not designated from the AADCP) and if, from information available at the AADCP, the target is not determined to be friendly, the fire unit, under the provisions of SOP, usually is permitted to continue the attack. In order to provide the correct correlation for display on the tactical monitor console and for transmission of correct attack data to SAGE, the tactical monitor presses the *reference data track number* but-

ton for the fire unit track and presses the CORRELATION switch momentarily to the CORR position. It is possible that the AADCP may designate a target to a fire unit simultaneously with the fire unit's acquisition of a target on its own initiative. If it is decided at the AADCP to permit the fire unit to retain the target it is tracking automatically (as will usually be the case), the RELEASE button must be pressed on the tactical control panel before correlation can be made for this target. Pressing the RELEASE button terminates the attack at the AADCP for the AADCP-designated target and makes possible the correlation of the target tracked by the fire unit with the correct reference data track number. The X button is used for correlation if the target is not identified with a reference data track number.

(4) After correlation has been established properly, an AADCP-selected attack follows the pattern described in *a*(4) and (5) above.

c. Miscellaneous Operations and Controls.

(1) The tactical monitor may wish to know the number of a fire unit, not associated with his console, that is attacking a target, or he may wish to monitor *size* reports from the fire units. Either kind of data can be obtained by moving the BATTERY SYMBOL switch on the display control panel from CIRCLE to NUMBER and the DISPLAY SELECTOR switch to BATTERY. This operation will display fire unit tracks as numbers, with size-code dots above, and remove reference track symbols to prevent interference.

(2) The remaining controls of the display control panel and the indicator panel provide great flexibility in controlling TDE display. The REF DATA BLANKING switch permits clarifying the display when reference symbols are superimposed. Only the reference symbol for the selected switch position and battery symbols are shown on the TDE display. All other symbols disappear.

(3) The reference data STATUS SELECTOR switch and pushbuttons permit a wide selection of track symbol display. The pushbuttons on the four sides of the switch (*status code selector* pushbutton switches) correspond to the height, identity, fire unit assignment, and raid size dot codes of the reference track symbols. Tracks may be selected for viewing by any combination of these categories. *For example*, by pressing three buttons, *hostile* tracks of *large* size at *high* altitude may be selected. The A position displays all tracks as complete symbols. With the control switch in the B position, selected tracks appear as complete symbols, and all others appear as dots and vectors only. In the C position, selected tracks appear as complete symbols and all others blanked, and in the D position, selected tracks appear only as dots and vectors and all others are blanked.

(4) When aircraft are closely spaced, the display can be expanded and offset, and the symbol size can be readjusted to improve resolution by use of the indicator control panel controls (fig. 24).

70. Monitor Responsibilities

The tactical monitor is responsible to the ADAOO for tactical supervision of the fire units under his control. His specific duties vary with the option in effect.

a. In reference option he will:

(1) Transmit orally to ADA fire units the required alert status, defense readiness condition, air defense warnings, weapon control status case, the SAGE/Missile Master operating option, and the broadcast data.

(2) Conduct time checks with ADA fire units at times prescribed by the ADAOO.

(3) Act as net control insuring communications discipline and security.

(4) Notify the ADACO of any changes in ADA fire unit readiness status.

(5) Insure that information displayed on the defense readiness board reflects the correct status of ADA fire units and missiles.

(6) Insure that necessary recorders and recording materials are available and that the recorders are properly instructed in their specific duties.

(7) Advise the fire units of significant enemy tactics and techniques.

(8) Relay to the tactical action plotter the ADA fire unit engagement status.

(9) Correlate and closely monitor all tactical action by ADA fire units. Correlation of fire unit tactical action will be determined as follows:

(*a*) With the Range Selector switch in the 32 position, the engage track circle will be adjusted to a diameter of one-half inch.

(*b*) The dot of the dot and vector symbol must be within or touching the engage track circle of the fire unit.

(10) Insure that BCO's electronically transmit a raid size of ONE, FEW (two or three), or MANY (four or more) with oral verification of exact raid size when fire unit achieves lock on.

(11) Take action prescribed in (18) and (19) below if correlation cannot be accomplished and the following conditions exist:

(*a*) *Incorrect lock on.* The engage track circle correlates with a track channel that is not assigned to the fire unit.

(*b*) *Uncorrelated lock on.* The engage track circle cannot be correlated with the assigned or any other track channel.

(*c*) *Unassigned lock on.* A fire unit that has not been assigned a track channel locks on a target.

(12) Insure that if a successful lock on has occurred, the BCO continues the engagement without further orders, and that upon completion of the engagement, the BCO reports a KILL, EFFECTIVE, or INEFFECTIVE as follows:

(*a*) *KILL.* A single object in a multiple object track has been destroyed.

(*b*) *EFFECTIVE.* All objects in a track have been destroyed.

(*c*) *INEFFECTIVE.* The fire unit is unable to complete successful engagement on a track. (In a multiple object track, a fire unit may report KILL on destruction of one object in the track and subsequently report INEFFECTIVE on failure to destroy remaining objects in the track.)

(13) Transmit orally to ADA fire units under his control a weapon control instruction as specified: ENGAGE (type warhead), HOLD FIRE, and CEASE FIRE.

(14) Assign targets to specific fire units at maximum range using criteria for target selection and fire distribution including the elements of priority, raid size, missiles available in fire units, fire unit engagement capability, and characteristics of the target.

(15) Question the BCO and direct appropriate action if, after 30 seconds from assignment the BCO has not designated to the target tracking radar; or, after 60 seconds from assignment the fire unit has not locked on the target and the fire unit has not electronically reported INEFFECTIVE.

(16) Take the following actions immediately if, prior to lock-on by a fire unit on an assigned target, an unassigned fire unit locks on the target:

(*a*) Determine if the unassigned fire unit has the capability to complete the engagement.

(*b*) Assign the target to the unassigned fire unit if it is determined that it has the capability to complete the engagement.

(*c*) Send a CEASE ENGAGEMENT to the fire unit originally assigned the target.

(17) Take the following actions immediately if an unassigned fire unit locks on a target after the assigned fire unit has locked on the target:

(*a*) Direct orally the unassigned fire unit to CEASE FIRE.

(*b*) Establish track channel to fire unit pairing by use of CORRELATE switch.

(*c*) Direct orally the unassigned unit to CEASE ENGAGEMENT if the assigned fire unit engages the target.

(*d*) Assign the target to the unassigned unit with an ENGAGE and send a CEASE ENGAGEMENT to the other unit if the unassigned unit is capable of firing prior to the assigned unit.

(18) Direct orally the fire unit to CEASE FIRE and insure correlation and identification before permitting continuation of the engagement if an unassigned fire unit locks on a target that is not assigned to a fire unit, or locks on an airborne object not entered as a track channel.

(*a*) Assign the track channel to the fire unit with an ENGAGE if the fire unit tactical action correlates with a track identified as HOSTILE.

(*b*) Direct the fire unit to complete the engagement if the fire unit tactical action does not correlate with a HOSTILE track channel but falls within the criteria of a pop-up target as established by the sector commander. (The S & E will enter a LOCAL track channel for the track and assignment will be made to the fire unit with an ENGAGE. Oral engagement instructions will be issued immediately.)

(*c*) Direct orally the fire unit to CEASE FIRE if the fire unit lock-on cannot be determined under (*a*) or (*b*) above.

(19) Send CEASE ENGAGEMENT on incorrect lock-on by a fire unit and reassign the correct target to the fire unit with an ENGAGE.

(20) Ascertain from the ADAOO the nature of a friendly protector initiated HOLD FIRE.

b. In the ATABE option he will refer to SOP for duties to be performed.

71. Effect of ECM

Since the tactical monitor console utilizes information stored in the electronic memory units and does not depend on radar video, the tactical monitor display is not directly affected by enemy electronic countermeasures. ECM activities will manifest themselves on tactical consoles mainly by the lack of information if S & E officers, trackers, or local or SAGE radar operators are unable to work through the jamming.

CHAPTER 7

THE FRIENDLY PROTECTOR CONSOLE (FPC)

72. General

The general configuration of the *friendly protector* (FP) console (fig. 30) is similar to that of the tactical monitor console (fig. 23). The only differences between the FP console and the tactical monitor consoles are that the two consoles utilize different operations panels and a BATTERY BLANKING switch has been added to the FP display control panel. To perform efficiently, the friendly protector must know and understand symbols and displays, controls and instruments, preliminary control settings, start-stop procedures and preliminary adjustments, operating procedures and responsibilities, and effect of ECM.

73. Symbols and Displays

Friendly protector console symbols and displays are identical to those described in paragraph 64 except that extended vectors, adjacent AADCP tracks, and ground location of fire units cannot be displayed.

74. Controls and Instruments

Controls and instruments of the FP console are identical to those described in paragraph 65 except as indicated below.

a. The ADJACENT AAOC, BATTERY POSITION, and EXTENDED VECTOR lever switches have been omitted from the FP display control panel, and a 26-position BATTERY BLANKING switch has been added. This switch prevents display of all symbols except for the tracking position of the fire unit selected by the switch. The two end, or *Off* positions, permit normal presentation of all reference data and fire unit tracking symbols as determined by settings of other controls.

b. The *FP tactical control panel* (fig. 31) is located to the right of the indicator panel and bears no resemblance to that of the tactical monitor console.

(1) HOLD FIRE (24 numbered pushbutton-indicators): When a pushbutton is pressed, a *hold fire* command is displayed at the appropriate tactical monitor console and is only transmitted to the associated fire unit if the tactical monitor concerned has effected target-unit correlation for that fire unit. The indicator lamp lights as a reminder that *hold fire* command is in effect. The *hold fire* command cannot be released by the FP operator. This command must be released by the tactical monitor. To release a *hold fire* command from the FP console, the tactical monitor must press the RELEASE pushbutton on the tactical monitor operations panel or change the command to *engage* or *cease engage*.

(2) BROADCAST DATA (three pushbutton-indicators (F, H, and B)): Pressing the pushbuttons determines the identity category of *friendly*, *hostile*, or *both* types of reference data being transmitted to fire units. One of the indicator lamps is always lighted to indicate the identity category of reference data being transmitted at any time.

75. Preliminary Control Settings (Power Off)

a. Left Auxiliary Control Panel. Make settings as described in paragraph 66*a*.

b. Right Auxiliary Control Panel. Make settings as described in paragraph 66*b*.

c. Indicator Panel. Make settings as described in paragraph 66*c*.

d. Display Control Panel.

(1) Turn the REF DATA BLANKING and the BATTERY BLANKING switches to their CCW (OFF) position.

(2) Set the reference data STATUS SELECTOR switch at position A.

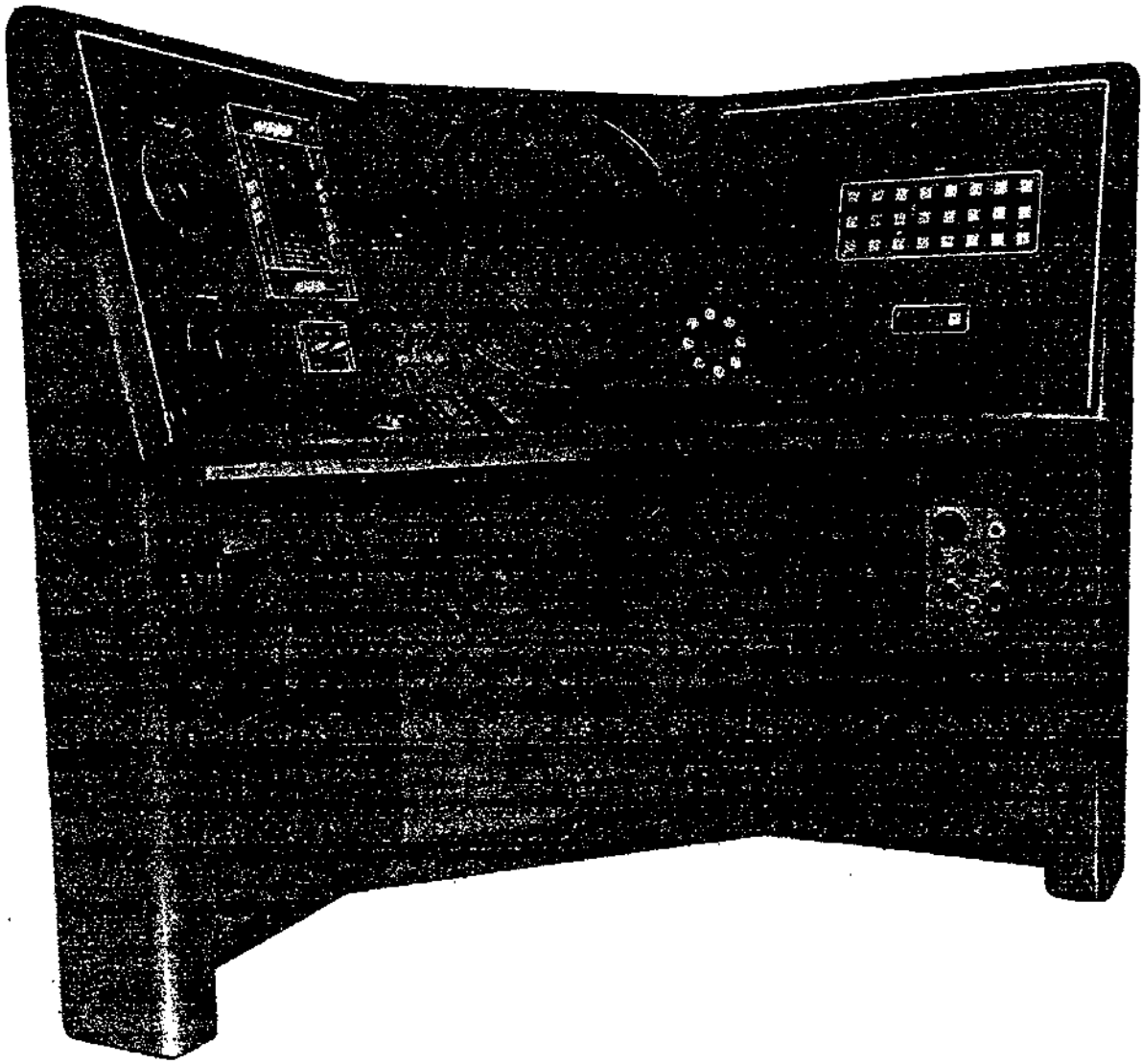


Figure 30. The friendly protector console.

(3) Set both lever switches at the middle (horizontal) position.

76. Start-Stop Procedures and Preliminary Adjustments

The friendly protector console start-stop procedures and preliminary adjustments are identical to those described for the tactical monitor consoles in paragraphs 67 and 68, respectively.

77. Operating Procedures

a. Protection of Friendly Targets.

(1) The TDE display is set up to show *friendly* reference data tracks as dots and vectors only, and to show fire unit tracks normally as numbers with size-code-dots. With this display setup, the fire unit tracking sym-

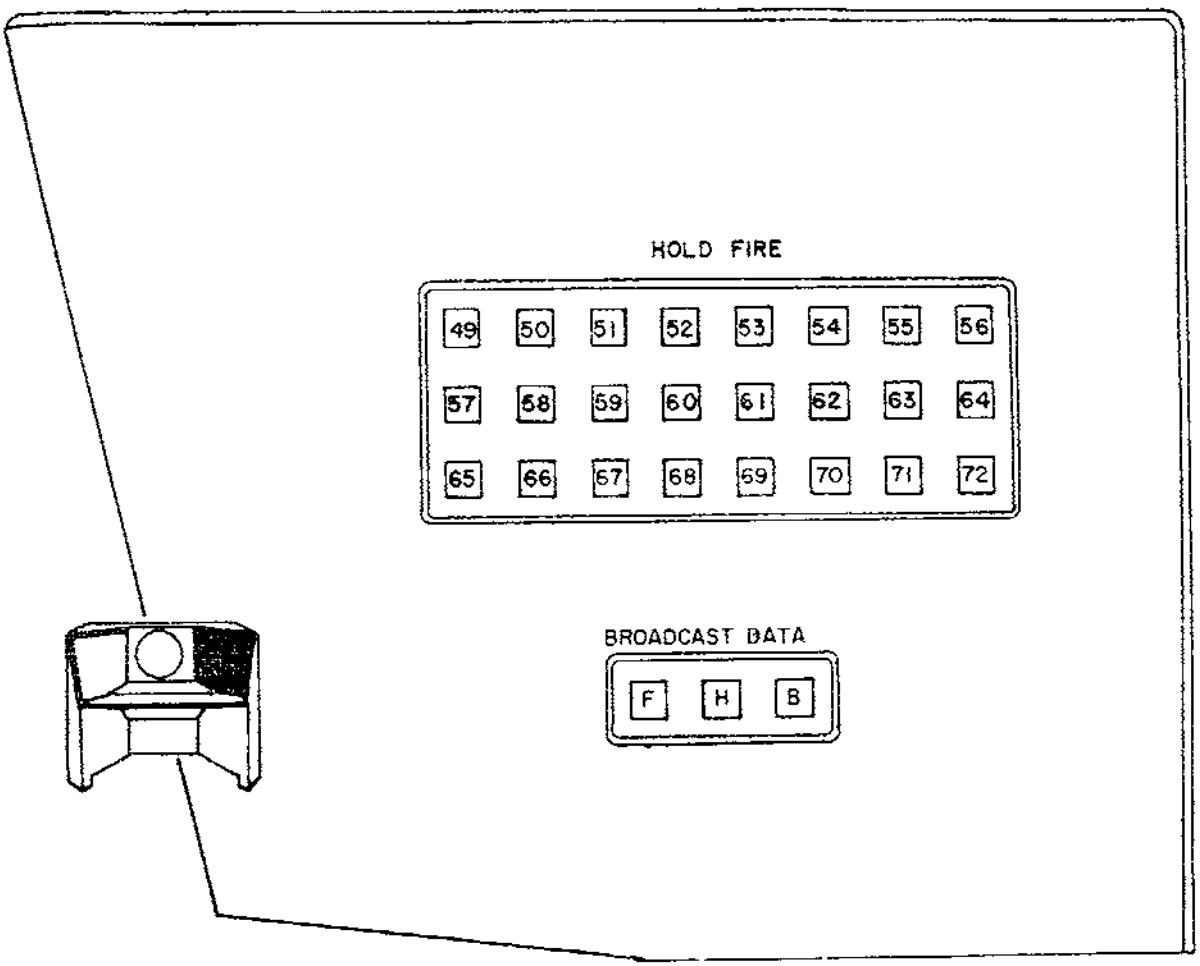


Figure 31. The friendly protector tactical control panel.

bol (full circle) for a fire unit tracking a friendly aircraft will be superimposed around the vector. The FP then reads the fire unit number directly from the display and is able to transmit an immediate *hold fire* command by pressing the appropriate button on the tactical control panel if the tactical monitor has the switchboard set up properly.

(2) In the situation described in (1) above, fire unit numbers are clearly displayed on the TDE except when two or more fire units are tracking the same friendly aircraft. In this case, fire unit tracking symbols will be superimposed on each other with the possibility that fire unit numbers cannot be identified. If this occurs, the FP sequences the BATTERY BLANKING switch through its 24 positions, and at each position all fire unit tracking symbols but one are blanked, and the FP can then determine the numbers of all fire units tracking the friendly target and transmit all required *hold fire* commands.

(3) The FP may set up his display as desired, depending on the situation.

b. Establishment of Broadcast Identity Category. Upon instruction from the ADAOO, the friendly protector establishes the identity

category of reference track data being transmitted to fire units by pressing the F *(friendly)*, H *(hostile)*, or B *(both)* pushbutton on the tactical control panel. Pressing any of these pushbuttons cancels any previous broadcast identity category established, lights the indicator lamps associated with the pushbutton, and lights appropriate indicator lamps on all other tactical consoles.

c. Miscellaneous Operations and Controls.

(1) The FP console has the same provisions for reference track blanking, reference data status selection, expanded display, and symbol size as the tactical monitor console.

(2) In addition to facilities for automatic transmission of *hold fire* commands, the FP has preempting telephone communications to all fire units. This permits transmission of *hold fire* commands upon failure of automatic facilities and enables the FP to pass supplemental information when required.

78. Friendly Protector Responsibilities

The friendly protector (FP) is directly responsible to the ADAOO and he will:

a. Insert the broadcast data selected by the AADC or ADAOO.

b. Send an oral or an electronic HOLD FIRE to a particular fire unit:

(1) When imposed by the AADC, ADAOO, or SAGE DC.

(2) If the fire unit is locked on a target whose identity is changed from HOSTILE to FRIENDLY.

(3) If the fire unit is locked on a target not identified as HOSTILE.

c. Inform the ADAOO when a track of FRIENDLY identity appears within the area or limits of the engage track circle of a fire unit tracking a hostile.

d. Establish with the tactical monitor reasons for a HOLD FIRE, or for the lifting of a HOLD FIRE.

79. Effect of ECM

Electronic countermeasures manifest themselves on the FP console by an absence of data. Otherwise, the operation of the FP console is not affected.

CHAPTER 8

THE ARMY AIR DEFENSE COMMANDER AND AIR DEFENSE ARTILLERY OPERATIONS OFFICER CONSOLES

80. General

a. The *Army air defense commander* (DC) console is identical to the *Army air defense artillery operations officer* (tactical director) (ADAOO) console. Because of their identical construction, the term *ADAOO/DC* console or the term tactical operations console (fig. 32) is applicable to both consoles.

b. The general configuration of the DC and ADAOO consoles is almost identical to that of the tactical monitor console (fig. 23). The main differences between these consoles are that the ADAOO/DC console utilizes a different tactical control panel (right panel) and that it utilizes fire unit blanking facilities on the display control panel (par. 74*a*) identical to those of the friendly protector console.

c. The Army air defense commander and Army air defense artillery operations officer must know symbols and displays, controls and instruments, tactical operations, and responsibilities.

d. The Army air defense commander and Army air defense artillery operations officer should be familiar with preliminary control settings, start-stop procedures, and effects of ECM on their console displays.

81. Symbols and Displays

The ADAOO console symbols and displays are identical to those discussed in paragraph 64.

82. Controls and Instruments

Controls and instruments of the DC and ADAOO consoles are identical to those discussed in paragraph 65 except as indicated below.

a. A BATTERY BLANKING switch has been added to the display control panel. This switch is identical to the BATTERY BLANKING switch discussed in paragraph 74*a*.

b. A TARGET NUMBER DIMMER control is present on the right auxiliary control panel but is not used because there are no TRACK NO. (target number) indicators.

c. The tactical control panel (fig. 33) is located to the right of the indicator panel on the console and contains the controls and indicators described below.

(1) BATTERY STATUS indicators (24 numbers): Identify all fire units associated with the Missile Master system. Two indicator lamps, one on each side of every number, show the status of the fire unit associated with the number. When the green lamp (on the left) is lighted, the fire unit is ready for action. When the red lamp (on the right) is lighted, the fire unit is tracking a target, and when neither lamp is lighted, the fire unit associated with the number is out of action or a KILL has been transmitted.

(2) ALERTS (three pushbutton-indicators and one *cancellation* button): When a pushbutton-indicator is pressed, the WHITE (W), YELLOW (Y), or RED (R) air defense warning indicator lamp on the tactical control panel and on the center panel manual facility lights. One indicator lamp is always lighted to indicate an existing air defense warning.

(3) MODE (two pushbutton-indicators): When pressed, select either the ARMY (A) or the SAGE (S) mode of system operation and cause all appropriate indicator lamps to light.

(4) BROADCAST DATA (three indicator lamps): Indicate whether a reference data identity category of *friendly* (F), *hostile* (H), or *both*

Figure 32. The tactical operations console.

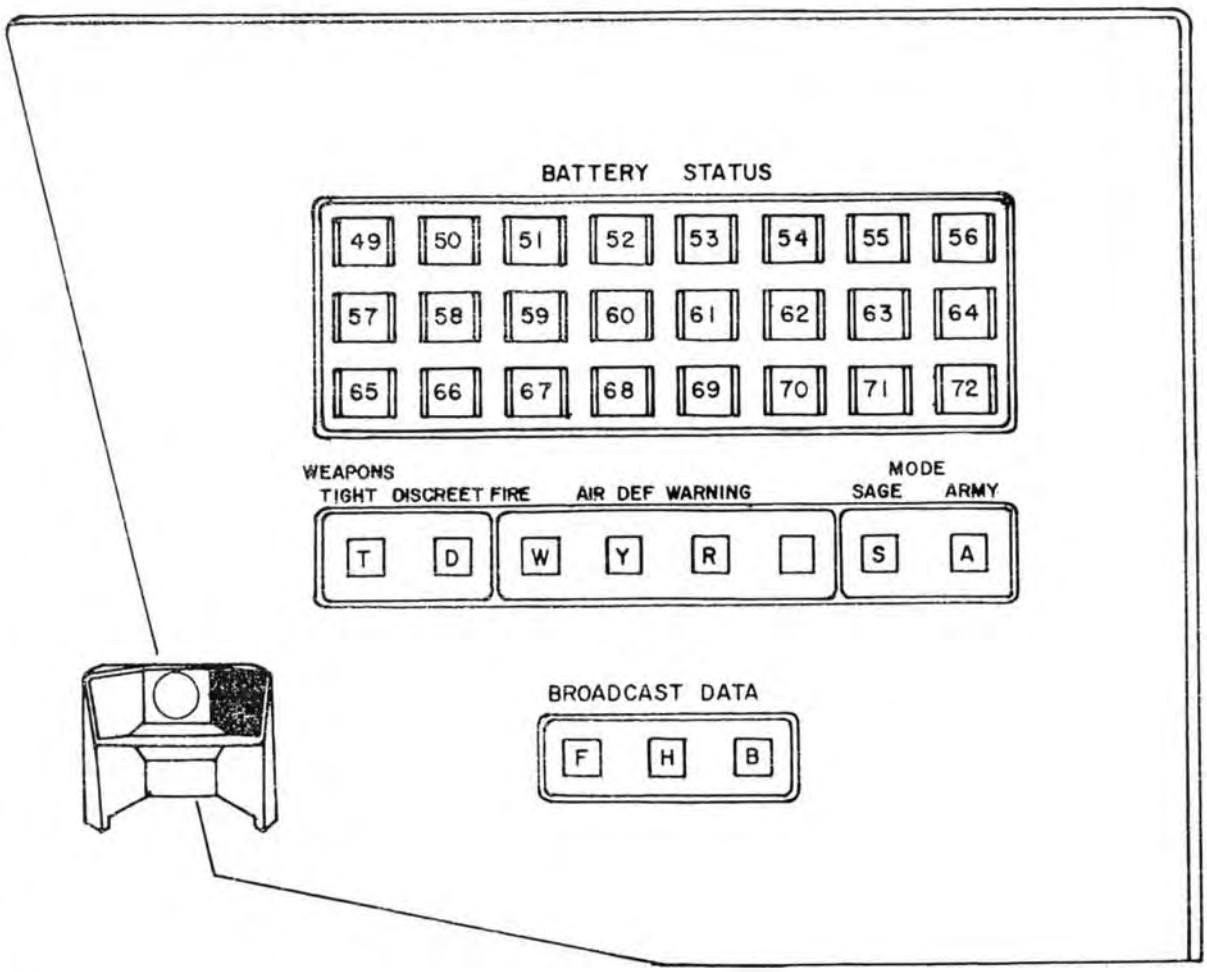


Figure 33. The tactical control panel of the DC and ADAOO consoles.

(B) is being transmitted to the fire units.

83. Preliminary Control Settings

a. Perform preliminary control settings as described in paragraph 66.

b. Turn the BATTERY BLANKING switch and REF DATA BLANKING switch to the CCW (OFF) position.

84. Start-Stop Procedures and Preliminary Adjustments

Start-stop procedures and preliminary adjustments for the tactical operations console are identical to those described in paragraphs 67 and 68, respectively.

85. Operating Procedures

a. Air Defense Warning and Weapon Control Status. Condition of air defense warning and weapon control status are received from the NORAD sector direction center (NSDC). The air defense warning may be displayed in the AADOR by pressing the button on the tactical control panel on the DC or ADAOO console that lights the associated indicator lamp and the corresponding indicator lamp on the manual display equipment (ch. 12). The ADAOO announces weapon control status by voice to operating personnel in the AADOR and to all associated fire units. This responsibility may be delegated to the tactical monitors.

b. States of Alert. The ADAOO determines the state of alert for the Army air defense according to current directives. The state of alert is displayed in the AADOR by means of manual facilities. The ADAOO may disseminate states of alert to fire units by telephone. This responsibility may be delegated to the tactical monitors.

c. Selection of Operating Modes. Normally, the ADAOO selects the system operating modes in accordance with SOP. Pressing the ARMY MODE (A) pushbutton on the DC or ADAOO console tactical control panel lights the associated indicator lamps and prevents SAGE designation commands from being passed to fire units. To put the system into the SAGE mode, the SAGE MODE (S) pushbutton is pressed. The ADAOO must inform the NSDC and tactical personnel within the AADCP by telephone whenever the system mode of operation is changed.

d. Supervision of Surveillance Functions. The ADAOO exercises general supervision of surveillance and tracking functions through the S & E officers. The principal indications of trouble in the surveillance and tracking subsystem are that fire unit tracking data do not correlate with reference track data, or that a large difference exists between the positions of the correlated fire unit and the reference track data. Abrupt changes in the length and direction of the extended vector lines indicate poor tracking. When the ADAOO determines that there is trouble in the surveillance and tracking functions, the S & E officer is consulted by telephone and appropriate corrective action is ordered. This action may consist of a closer check on the quality of SAGE reference data, increased emphasis on accuracy of local tracking procedures, or correction of system malfunctions.

e. Supervision of Tactical Operations.

(1) The ADAOO monitors tactical operations by means of the TDE presentation and the BATTERY STATUS indicator lamps on the tactical control panel. The ADAOO monitors for attack of priority tracks as indicated by flashing reference data symbols, for tracks approaching the defended area unattacked, and for undesirable duplication of attacks by fire units.

(2) To determine which fire units are engaged in undesirable actions, the ADAOO uses the BATTERY BLANKING switch as described in paragraph 77*a*(2). Having determined the numbers of these fire units, the ADAOO may issue necessary commands to the tactical monitors, to the friendly protector, or directly to the fire units concerned by telephone communication.

(3) The BATTERY STATUS indicator lamps on the tactical control panel provide the ADAOO with a continuous indication of the operational status and actions of all fire units. This information enables the ADAOO to redistribute fire if critical fire units are out of action, to coordinate Army air defense activities with SAGE commanders, and to evaluate performance of fire units.

f. Miscellaneous Operations. The ADAOO or the DC may perform the miscellaneous operations described in paragraph 69*c*.

86. Responsibilities of Army Air Defense Commander

a. The Army air defense commander is responsible to NORAD for the operation of the AADCP. He maintains close liaison with the NORAD sector commander at the NORAD sector DC, and insures that tactical doctrine is followed and SOP's are carried out.

b. The Army air defense commander may perform any or all functions of the ADAOO (par. 87) from his console.

87. Responsibilities of the ADAOO

The ADAOO will—

a. Supervise internal operations of the AADCP.

b. Implement the decisions of the AADC.

c. Inform the AADC of—

(1) Significant tactics and techniques of the enemy.

(2) Significant operational controls imposed by SAGE DC.

(3) Changes in operational status and posture of the defense.

d. Notify immediately the AADCP operations officer of any significant operational matters affecting AADCP operations.

e. Insure that the current air defense warning, defense readiness condition, state of alert, weapon control status case, operation option as directed by SAGE DC, and the broadcast data being used are properly displayed in the operations room and are disseminated to ADA fire units, as appropriate.

f. Maintain continuous communications with the air defense artillery director (ADAD) during all periods of increased readiness (actual or simulated) or when directed by sector DC.

g. Report to the ADAD at sector DC:

(1) Changes in ADA readiness.
(2) Changes in missile status.
(3) Malfunctions of the AN/FSG–1 or associated equipment.
(4) Presence of, or report of, ECM in the the defense area.
(5) Significant unidentified airborne objects for purpose of identification.
(6) Significant tactics or techniques of the enemy affecting the air battle.

h. Insure that the tactical monitor transmits orally to the ADA fire units under his control a weapon control instruction as specified: ENGAGE (type warhead), HOLD FIRE, and CEASE FIRE.

i. Obtain raid size orally from SAGE DC when a size of more than ONE is assigned to a track channel.

j. Insure that the reason for a PRIORITY on a SAGE track channel is determined and disseminated, and establish priority status for LOCAL tracks.

k. Take the following actions in processing UNKNOWNS:

(1) Monitor the track channel when informed by the ADAD that an UNKNOWN is being passed for intelligence purposes only (with receipt of initial plot and scramble status only). Inform the ADAD, if a significant change occurs, and request more current information on the UNKNOWN.
(2) Attempt to determine immediately from the ADAD the specific significance of the track channel when the UNKNOWN is passed to the AADCP without reference to the fact that it is for intelligence purposes only, or the ADAD changes the status of the track channel from intelligence to one of suspicious nature. (In this case, the track channel should be passed to the AADCP with priority, for ultimate assignment to a fire unit.)

l. Monitor assignments made by tactical monitors and coordinate and direct priorities in fire distribution by specific fire unit if necessary, particularly in the case of multiple assignments when an unassigned HOSTILE target approaches the defense.

m. Direct conversion to standby power upon receipt of:

(1) Severe weather warning of gale magnitude or higher.
(2) Actual change in condition of readiness.

n. Comply with established procedures for the briefing and debriefing of AADCP personnel.

o. Supervise and be responsible for the training of all personnel assigned to his section.

88. Effect of ECM

The DC or ADAOO console displays are affected by ECM only through absence of data. Placing the system in the *Army* mode of operation will allow the system to take full advantage of geographical dispersion and varied ECM capabilities of the several Army air defense radars.

CHAPTER 9

THE FIRE UNIT

89. General

a. The Missile Master AADCP is connected with its associated fire units by an automatic data link (ADL) that terminates at fire units with battery terminal equipment (BTE) (figs. 3 and 4), also known as the fire unit integration facility (FUIF). The special terminal equipment required by fire units to enable them to operate with Missile Master is located in a one-story, two-room permanent structure, adjoining the corridor that interconnects the tracking station and director station trailers at the fire unit sites. One room houses the BTE electronic equipment pallets, a work bench, a storage cabinet for tools and spare parts, and a junction box to connect the equipment to the required power supplies. The other room contains air-conditioning equipment for environmental control of electronic BTE components. The BTE equipment is connected to the director station trailer by flexible cables.

b. Reference and battery track data (based on an AADCP centered, universal Missile Master coordinate system) and auxiliary target information are received by BTE in digital form. Reference and battery track data are changed into local rectangular coordinates, converted into analog form, and used to position PPI display symbols produced by fire unit PPI display circuits. Auxiliary data determine the types of symbols and operate the auxiliary data signals. Conversely, BTE converts battery track data generated at the fire unit into digital form and transmits this information to the AADCP. Determination and setting of parallax corrections is a maintenance responsibility.

c. The fire unit PPI display circuits are modified to permit visual display of reference and battery track data on acquisition PPI screens. The fire unit command and status panel (fig. 34) containing lamps and signaling pushbuttons is installed at the battery control console, and an audible signal system is provided to warn personnel when a command is received from the AADCP.

90. Symbols and Displays

Figure 35 depicts symbols that are displayed on the fire unit PPI screen of the battery control officer's PPI. Reference "broadcast" or "normal" data and battery track symbols cannot be displayed simultaneously at the fire unit. A spring-loaded symbol selector switch (par. 91*b*), usually in the NORMAL position, is pressed to the BATTS position to view battery track symbols.

a. Hostile Targets. The PPI video for hostile tracks should be in the center of the hostile symbol. It is in the form of a semicircle (upper half) displayed on the PPI screen.

b. Friendly Tracks. Friendly tracks are indicated by a defocused spot superimposed over the video on the PPI screen (if the aircraft is detected by the acquisition radar). A reference track symbol alone may appear in cases where an aircraft cannot be detected by the fire unit acquisition radar because of coverage deficiencies or other reasons. In this case, the video, although not seen, will be assumed to be located approximately in the center of the reference track symbol.

c. Battery Track Data. Targets being tracked by other missile fire units are identified by a full circle superimposed on the approximate PPI screen location of these tracks.

91. Controls and Instruments

a. The *command and status panel* (fig. 34), used when the fire unit is operating with Missile Master, is located adjacent to the director station trailer PPI.

(1) REMOTE indicator lamp: Lights when an *engage* command is received from the AADCP. The LOCAL, HOLD FIRE, and CEASE ENGAGE

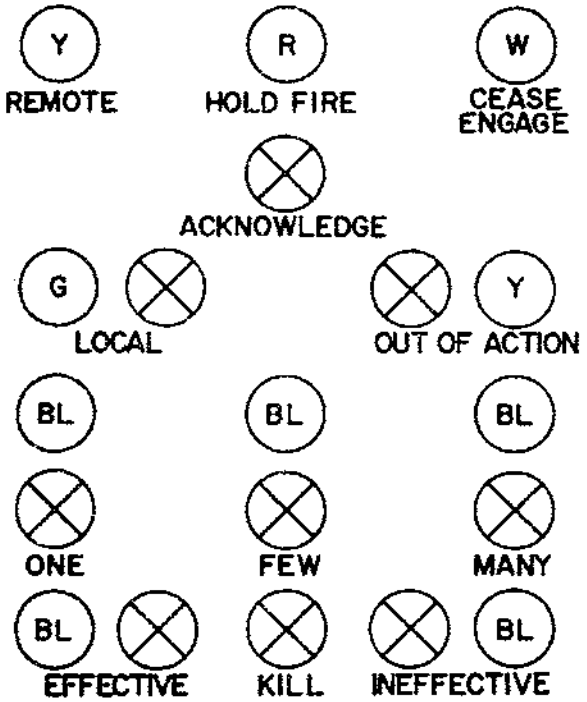


Figure 34. Fire unit command and status panel.

indicator lamps extinguish when the REMOTE indicator lamp lights.

(2) HOLD FIRE indicator lamp: Lights when a *hold fire* command is received from the AADCP. The LOCAL, REMOTE, and CEASE ENGAGE indicator lamps extinguish when the HOLD FIRE indicator lamp lights.

(3) CEASE ENGAGE indicator lamp: Lights when a *cease engage* command is received from the AADCP. The LOCAL, REMOTE, and HOLD FIRE indicator lamps extinguish when the CEASE ENGAGE indicator lamp lights.

(4) ACKNOWLEDGE pushbutton: When pressed, transmits an *acknowledge* signal to the AADCP to indicate that the battery control officer has received and is carrying out a command received from the AADCP, and the EFFECTIVE or INEFFECTIVE indicator lamp extinguishes.

(5) LOCAL pushbutton: When pressed, transmits a *ready* signal to the AADCP; at the battery the OUT-OF-ACTION indicator lamp extinguishes and the LOCAL indicator lamp lights.

(6) LOCAL indicator lamp: Lights by operation of the LOCAL, EFFECTIVE, or INEFFECTIVE pushbuttons. This indicator lamp is lighted only when the OUT-OF-ACTION, REMOTE, HOLD FIRE, and CEASE ENGAGE indicator lamps extinguish.

(7) OUT-OF-ACTION pushbutton and indicator lamp: When the pushbutton is pressed, an *out-of-action* signal is transmitted to the AADCP. The OUT-OF-ACTION indicator lamp lights, and all other indicator lamps extinguish.

(8) *Raid size* (ONE, FEW, MANY) (three pushbuttons and associated indicator lamps): When pressed, transmits the battery control officer's estimate of the size of the target he is attacking and lights the associated indicator lamp.

(9) EFFECTIVE pushbutton and indicator lamps: When pressed, an *effective engagement* signal is transmitted to the AADCP, the EFFECTIVE and LOCAL indicator lamps light, and the *raid size*, REMOTE, HOLD FIRE, and CEASE ENGAGE indicator lamps extinguish.

(10) INEFFECTIVE pushbutton and indicator lamp: When pressed, an *ineffective engagement* signal is transmitted to the AADCP. The INEFFECTIVE and LOCAL indicator lamps light, and the *raid size*, REMOTE, HOLD FIRE, and CEASE ENGAGE indicator lamps extinguish.

(11) In figure 34 the colors of the indicators are represented as follows:

(*a*) Y—yellow.

(*b*) R—red.

(*c*) W—white.

(*d*) G—green.

(*e*) BL—blue.

(12) KILL pushbutton: When pressed, transmits a kill signal to Missile Master in reference option.

b. A three-position DISPLAY SELECTOR switch is located in the BC console PPI panel. The three switch positions select displays as follows:

(1) OFF position: Displays normal video from the fire unit acquisition radar.

(2) NORMAL position: Displays normal video from the fire unit acquisition radar and reference track symbols from the AADCP.

(3) BATTS position: Only video from the fire unit acquisition radar and tracked target symbols are displayed. This switch is spring-loaded and will be in the BATTS position only as long as held there.

92. Checks and Adjustments

a. In addition to the PPI FOCUS and INTENSITY controls for adjusting the PPI screen, a separate INTENSITY control is provided for reference and tracked target symbols.

b. Signal light intensity of the command and status panel is adjusted along with other battery control console indicator lamps when adjusting the signal light control knob.

c. No operator adjustments of the BTE are required.

d. Battery terminal equipment located in the director station trailer is energized when computer and acquisition radar power is applied. No signal lamps are lighted, and the fire unit is in an out-of-action status until the battery control officer (BCO) presses the *ready* pushbutton to notify the AADCP that the fire unit equipment is energized and is ready for the attack of targets.

93. Operating Procedures

a. Attack of Targets With Missile Master in Decentralized Method of Operation.

(1) The battery control officer (BCO) selects hostile reference data tracks, or tracks not identified as friendly, in accordance with SOP and in accordance with the weapon control status received by voice from the AADCP.

(2) To attack a selected target, the target is acquired in the normal manner and designated to target track radar (TTR) operators. When a TTR operator presses the TRACKED pushbutton, an *on target* signal is sent automatically to the AADCP, and the *effective* or *ineffective engagement* indication from a previous attack extinguishes. The LOCAL indicator lamp remains lighted.

(3) As soon as possible after beginning to track a target, the BCO transmits an estimate of *raid size* to the AADCP by pressing the ONE, FEW, or MANY pushbutton on the command and status panel (fig. 34). The associated indicator lamp lights as a reminder of raid size transmitted. At the AADCP the raid size estimate received from the fire unit is displayed by the number and size-code dot fire unit tracking symbol on all tactical consoles.

(4) During attack of a target selected by the fire unit, the BCO, under limits of SOP, may receive *hold fire* or *cease engage* commands from the tactical monitor or the friendly protector at the AADCP. The command lights the HOLD FIRE or CEASE ENGAGE indicator lamp, extinguishes the LOCAL indicator lamp, activates an audible warning signal, and removes all reference and tracked target symbols except a symbol indicating the target on which action is to be taken. The fire unit BCO acknowledges the command by pressing the ACKNOWLEDGE pushbutton. This action transmits a signal to the AADCP indicating the command has been received, reinstates target reference and tracked target data, and lights the ACKNOWLEDGE indicator lamp. (If the fire unit has selected a target without reference track data, commands can still be received after the tactical monitor has correlated the track to track channel 00.)

b. Attack of Targets in Centralized Operating Modes.

(1) When a target is designated to the fire unit, all reference and battery track data disappear from the PPI screen except the symbol for the target des-

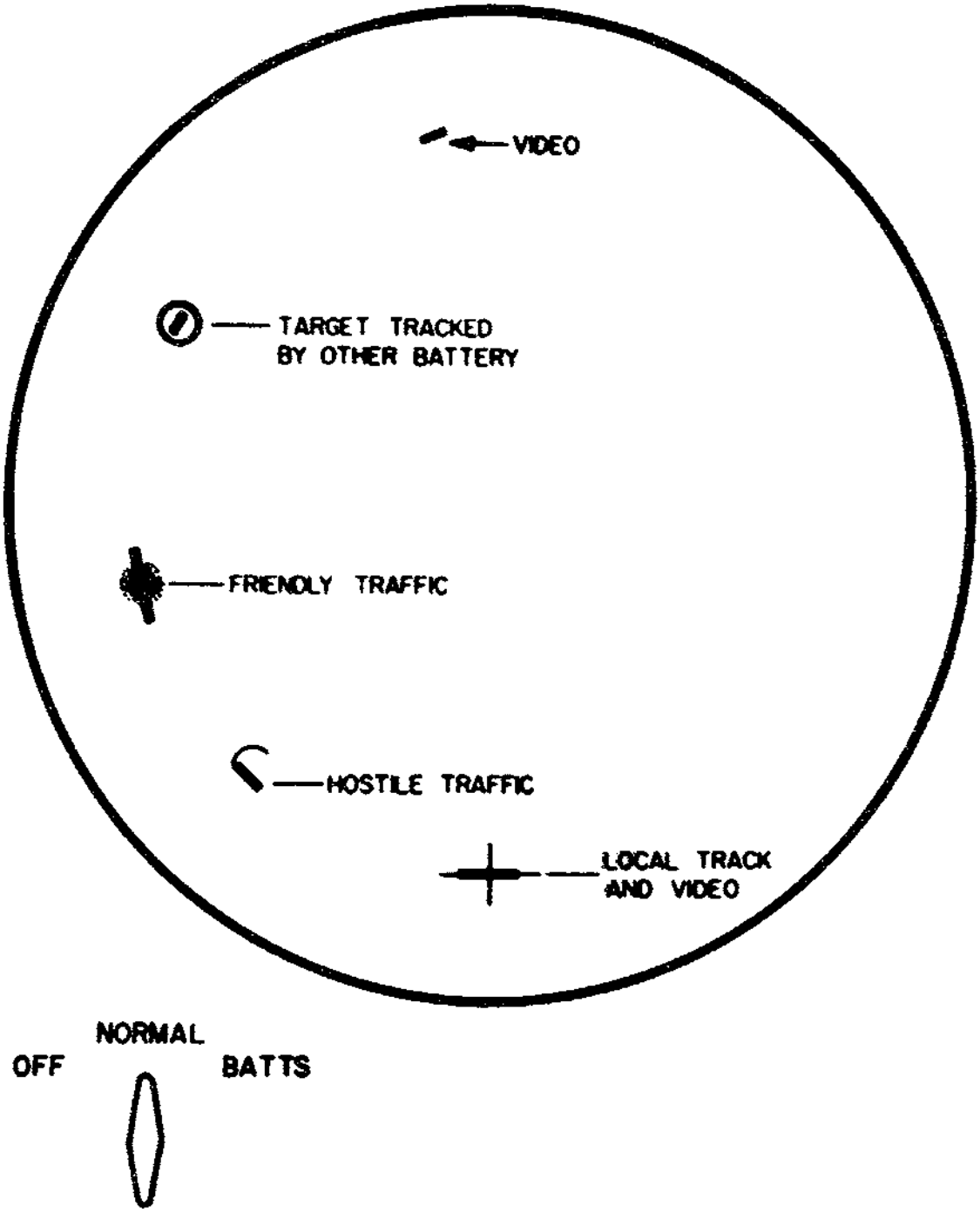


Figure 35. Fire unit PPI display.

ignated. Designation by the AADCP also extinguishes the LOCAL indicator lamp and the EFFECTIVE or INEFFECTIVE indicator lamp from the previous attack, lights the remote lamp, and activates an audible warning signal.

(2) On recognizing the designated target, the fire unit BCO presses the ACKNOWLEDGE button to notify the AADCP that the target is seen and action is being taken to acquire it. The ACKNOWLEDGE indicator lamp lights and reinstates the reference and battery data. After acquiring the target, a raid size estimate is transmitted as described below.

(3) During attack of a designated target, the fire unit may receive *hold fire* or *cease engage* commands from the AADCP. Either of these commands extinguishes the REMOTE indicator lamp, sounds the audible alarm, and displays the designation symbol on the PPI screen. Video continues to be displayed. Pressing the ACKNOWLEDGE button transmits an acknowledgment to the AADCP, lights the ACKNOWLEDGE indication lamp, and returns the PPI screen to a normal display. A *hold fire* command may be followed by a return to *engage* or by a *cease engage* command. Normal procedures for *engage* or *cease engage* commands are then followed.

c. Termination of Attack. Within SOP, any attack may be terminated by an automatic or verbal *cease engage* command from the AADCP, or it may be terminated at the discretion of the fire unit BCO. In either case, the fire unit commander terminates the attack by pressing the EFFECTIVE or INEFFECTIVE button, depending on the estimate of attack effectiveness. This action transmits the selected signal to the AADCP, lights the EFFECTIVE or INEFFECTIVE and the LOCAL indicator lamps, and extinguishes the *raid size* and *command* indicator lamps.

d. Operational Status. The OUT-OF-ACTION button is used to transmit an *out-of-action* signal to the AADCP whenever the fire unit is incapable of attacking targets. When this button is pressed, the OUT-OF-ACTION indicator lamp lights, and all other *command and status* indicator lights extinguish. The *out-of-action* status is canceled by pressing the LOCAL pushbutton.

94. Responsibilities of the Battery Control Officer

The battery control officer will—

a. Select targets for attack in accordance with SOP and based on reference track data received from the AADCP and battery track data received from other fire units when Missile Master is operating in the decentralized method.

b. Attack only those targets designated by the control agency when Missile Master is operating in the centralized method.

c. Acquire and attack specific targets assigned to the fire unit by the AADCP or as specified by SOP.

d. Select missile warheads as directed by the AADCP or as specified by SOP.

e. Place in effect a *hold fire* on a target on order from the AADCP or as specified by SOP. *Command-detonate* a missile already launched against the *hold fire* target when a *hold fire* command is received. Operate the FRIEND switch if the missile cannot be destroyed before reaching the kill point without endangering the aircraft.

f. Terminate the attack on order from the AADCP or as specified by SOP. Permit a missile already launched to proceed to the kill point when a *cease engage* command is received.

g. Transmit an estimate of the number of targets within the track when commencing an attack of a track. Transmit an estimate of effectiveness to the AADCP upon completion of the attack.

CHAPTER 10
OPERATIONS

Section I. DEFENSE READINESS CONDITIONS, STATES OF ALERT, ALERT REQUIREMENTS, AND AIR DEFENSE WARNINGS

95. General

The understanding of certain definitions and the concept of air defense operations is necessary for the establishment of defense readiness conditions, states of alert, alert requirements, and air defense warnings. CINCNORAD has the responsibilities and authority for declaration and termination of defense readiness conditions. However, the responsibilities for the defense of an assigned geographical area are delegated to lower echelon commanders.

96. Definitions

a. Defense Readiness Condition (DEFCON). A general indication of the type action that may be taken or directed to bring air defense systems to a desired readiness posture to meet any contingency. Defense readiness conditions consist of five numbered DEFCON's and air defense emergency. They are—

(1) *DEFCON 5.* A normal readiness posture which can be sustained indefinitely and which represents an optimum balance between the requirements of readiness and the routine training and equipping of forces for their primary mission.

(2) *DEFCON 4.* A readiness posture requiring increased intelligence watch and a continuing analysis of the military situation in the area of tension. To maintain this posture, it is necessary to review contingency plans for the area concerned and, based on the above analysis, make modifications or formulate new plans, as required; take actions to increase security and antisabotage measures, if necessary; and keep appropriate commanders informed of the developing situation. During this condition, no measures will be taken which could be considered provocative or which might disclose operational plans. Readiness actions should be accomplished without public notice.

(3) *DEFCON 3.* A readiness posture that requires certain portions of the assigned forces to assume an increased readiness posture above that of normal readiness. Generally, in this condition, all forces and resources will come from within the command. Plans of the next higher condition are reviewed and readied. During this condition, no measures will be taken which could be considered provocative or which might disclose operational plans. Readiness actions should be accomplished without public notice.

(4) *DEFCON 2.* A readiness posture requiring a further increase in military force readiness which is less than maximum readiness; certain military deployments may be necessary in consonance with the command's mission; resources may be made available from outside the command; preliminary measures are taken to permit the most rapid transition to maximum readiness, if necessary.

(5) *DEFCON 1.* A maximum readiness posture of military forces requiring the highest state of preparedness to execute war plans.

(6) *Air defense emergency.* The highest state of preparedness by the military forces whereby all air defense measures are readied for implementation. Declaration of an air defense emergency is the authority to implement approved military and civilian plans

and agreements for defense of the North American Continent. Subsequent to the declaration of air defense emergency, imminence of attack will be specified by air defense warning red, air defense warning yellow, or air defense warning white.

b. State of Alert. The availability of a weapon or unit for operations expressed in increments of time (battle stations, 5-minute, 15-minute, 30-minute, 3-hour). It represents the maximum period of time within which a weapon or unit (surface-to-air weapons fire unit capable of launching a missile) must be ready for employment following receipt of an execution order.

c. Alert Requirement. The requirement for a specific number or percentage of weapons or units to be brought to and maintained on a state of alert.

d. Alert Status. The actual number or percentage of weapons or units at various states of alert.

e. Imminence of Attack Designations.

(1) *Air defense warning red.* A declaration meaning that attack by hostile aircraft or missile is imminent or is taking place.

(2) *Air defense warning yellow.* A declaration meaning that attack by hostile aircraft or missiles is probable; intelligence has been received indicating that hostile aircraft or missiles are suspected of being en route toward the North American Continent, or unknown aircraft or missiles suspected of being hostile are en route toward the North American Continent.

(3) *Air defense warning white.* A declaration meaning that attack by hostile aircraft or missiles is not considered immediately probable or imminent. The declaration of air defense warning white does not cancel an air defense emergency or the established alert requirement.

97. Concept of Air Defense Operations

a. The immediate combat capabilities of the air defense systems, or any portion thereof, are the result of the current defense readiness condition (DEFCON) and alert status. During any given DEFCON the capabilities of the systems will vary with the alert requirement imposed.

b. The immediate combat capabilities of the air defense systems are established by designating a defense readiness condition (DEFCON) and an alert requirement. Measures to be taken in each condition may not occur in sequence. For execution to attain the desired defense readiness condition, minimum requirements are considered.

c. The appropriate defense readiness condition is established as indicated in paragraph 98 and implemented by subordinate NORAD region, division, sector (SAGE or manual), or control center commanders as outlined in table I.

d. Minimum alert requirements necessary to carry out a progressive build-up of combat capability can be applied to any defense readiness condition. Normally, weapons or units are not advanced to an alert status requiring 100 percent capability without a corresponding advance in a defense readiness condition.

e. Standing operating procedures are designed to provide for improving the air defense capability without having to encrypt any message.

98. Responsibilities and Authority

Defense readiness conditions are declared and terminated by Commander in Chief, North American Air Defense Command; Deputy Commander in Chief, North American Air Defense Command; or the Commander in Chief's General Duty Officer; except that a declaration of "air defense emergency" is restricted to Commander in Chief, North American Air Defense Command; Deputy Commander in Chief, North American Air Defense Command; or higher authority. During periods of international tension, it is the responsibility of the Chiefs of Staff of Canada and the United States, in consultation with their respective authorities, to reach agreement for increasing states of readiness of NORAD forces.

a. Air Defense Warnings. Air defense warnings (red, yellow, or white) are declared and terminated by Commander in Chief, North

American Air Defense Command or Deputy Commander in Chief, North American Air Defense Command, subsequent to the declaration of air defense emergency, when attack by aircraft or missiles is imminent or probable; or when attack by hostile aircraft or missiles is not considered immediately probable or imminent. The declaration of air defense warning red, yellow, or white applies to all echelons of command under the operational control of CINCNORAD.

b. Alert Requirements. The specified alert requirements are attained by each unit as rapidly as possible following the execution order. Normally, the declared alert requirement is applied command wide; however, the Commander in Chief, NORAD, or Deputy Commander in Chief, NORAD, may announce a lower or higher alert requirement for individual regions or divisions when the tactical situation warrants.

99. Responsibility for the Defense of an Assigned Geographical Area

a. Region, division, sector, or control center commanders are responsible for destroying hostile forces within their areas of responsibility, regardless of the defense readiness condition currently in effect, provided circumstances clearly justify such action.

b. In autonomous operations; i.e., when a region, sector, or control center commander, or an air defense weapon system, through loss of communications, can no longer receive defense readiness conditions, alert requirements, or air defense warnings, the commander concerned operates autonomously within his area of responsibility and takes action as necessary for continued air defense operations.

Table I. Defense Readiness Conditions (DEFCON) Implementing Measures

Minimum requirements	DEFCON 5	DEFCON 4	DEFCON 3	DEFCON 2	DEFCON 1	Air defense emergency
Increase number of air defense weapons on advanced state of alert.			X	X	X	X
Accelerate maintenance activities.			X	X	X	X
Intensify internal security measures.		X	X	X	X	X
Implement installation defense plans.				X	X	X
Maintain intensified intelligence vigilance.		X	X	X	X	X
Alert personnel not on leave or TDY (without public announcement).			X	X	X	X
Recall key personnel on leave or TDY (without public announcement).				X	X	X
Review requirements for next condition (last task).	X	X	X	X	X	
Defer all training.				X	X	X
Recall surface-to-air weapons fire units from special missions.				X	X	X
Recall surface-to-air weapons fire units from weapons training centers.**				X	X	X
Deploy available forces for air defense as required in accordance with procedures established in current operation orders.				X	X	X
Order-in desired military circuits.			X	X	X	X
Implement minimum communications.					X	X
Implement plans for control of electromagnetic radiations (CONELRAD).						X*
Disseminate to Military Air Defense Alert Key Points (MADA).					X	X
Implement plans for the integration of those active USA and USAF units that have been designated a secondary mission of augmenting air defense.					X*	X*
Implement plans for temporary employment of available forces in assigned area of responsibility.					X	X

Table I. Defense Readiness Conditions (DEFCON) Implementing Measures—Continued

Minimum requirements	DEFCON 5	DEFCON 4	DEFCON 3	DEFCON 2	DEFCON 1	Air defense emergency
Implement plans for the integration of U.S. Army and U.S. Air Force National Guard units when made available for temporary employment in air defense.					X*	X*

* When directed by CINCNORAD, or Deputy CINCNORAD.

** If an attack occurs without warning, operational control of air defense units temporarily deployed at weapons training centers passes to the region commander in whose area the center is located, subject to recall by the parent region commander and the approval of CINCNORAD. The declaration of a defense readiness condition requires the automatic implementation of those actions listed and marked by the letter X in the applicable columns as shown.

Section II. SEQUENCE OF OPERATION

100. General

To summarize overall operation of the Missile Master system, this section describes the attack of typical tracks that may be encountered. As each track progresses from detection to destruction, major changes on various displays are described and depicted in figures 36 and 37 in which the following abbreviations are used:

a. SEC—surveillance and entry console.

b. TC—tracking console.

c. RHI—range-height indicator.

d. TMC—tactical monitor console.

e. FPC—friendly protector console.

101. Attack of a Local Reference Track

a. Assumptions.

(1) The defense is operating in SAGE (NORAD) mode III, decentralized.

(2) All tactical consoles display reference data tracks as complete symbols. Fire unit tracked targets are also shown.

(3) The FP has selected position B on the status selector switch and depressed the friendly identity button to display complete symbology on friendly tracks, battery track data, and dot and vector on hostile tracks. (This differs from par. 77*a*(1) for demonstration purposes and is a matter of SOP.)

(4) The new track is detected by the Missile Master defense acquisition radar and entered by S & E officer number 1 into tracking channel number 37 before the track enters acquisition range of fire units.

(5) The track is assigned to tracking console number 2 for updating of reference data and is selected for attack by missile fire unit number 51.

(6) The defense is not saturated by hostile raids or friendly aircraft.

b. Attack Sequence Local Reference Track.

(1) *Step A.* New and unidentified track video is detected on S & E and tracking console displays.

(2) *Step B.* The track has been identified by the NCC as HOSTILE, the S & E officer has entered it into the system with HOSTILE identity.

(3) *Step C.* The track has been transferred from the S & E console to tracking console number 2. A height determination has been made, and the track has entered acquisition range of fire units.

(4) *Step D.* Fire unit number 51 has selected the track for attack, and the track is being designated to the TTR by the fire unit BCO. The track has been height serviced.

(5) *Step E.* The fire unit TTR is tracking the target, and the fire unit is proceeding with its attack.

(6) *Step F.* The tactical monitor has correlated the fire unit with its target.

(7) *Step G.* The fire unit has destroyed all targets in track number 37 and has reported an effective engagement.

(8) *Step H.* The track has been dumped by the S & E officer, and the fire unit is acquiring another track.

102. Attack of a SAGE Reference Track

a. Assumptions.

(1) The defense is operating in SAGE (NORAD) mode I or II, reference option, centralized.

(2) All tactical consoles display reference data tracks as complete symbols. Targets tracked by fire units are also shown.

(3) The FP console displays hostile reference tracks as dots and vectors only and fire unit tracks as a fire unit number with raid size-code dots.

(4) The new track is detected by the Missile Master defense acquisition radar, and SAGE reference data for this track are received before it enters fire unit acquisition range.

(5) The track is entered by SAGE into tracking channel number 13 with *hostile* identity and *few* raid size.

(6) S & E officer number 1 receives new SAGE entries and assigns the track to tracker number 3.

(7) The S & E officer has selected the "all" position for RHI servicing.

(8) Tactical monitor number 2 designates fire unit number 63 to attack the new track.

b. Attack Sequence.

(1) *Step A.* A presentation of unidentified video is displayed on the S & E and tracking consoles.

(2) *Step B.* Target reference and auxiliary data pertaining to the new video have been received from SAGE in channel number 13.

(3) *Step C.* The track has been transferred from the S & E console receiving new SAGE entries to tracking console number 3. The track has come within acquisition range of fire units and is displayed as hostile reference data track on fire unit PPI's.

(4) *Step D.* SAGE reference data have become inaccurate.

(5) *Step E.* The tracker has initiated SAGE-manual tracking and made a correction of reference data. The track had also been assigned to an RHI console for monitoring.

(6) *Step F.* The tracker has determined that SAGE data are again sufficiently accurate and has returned the tracking reference data to SAGE control.

(7) *Step G.* The tactical monitor for fire unit number 63 has assigned track number 13 to this fire unit.

(8) *Step H.* The BCO is designating the track to the target track radar operators.

(9) *Step I.* The target is being tracked by the TTR, and the fire unit is commencing with its attack.

(10) *Step J.* The fire unit has destroyed all targets in track number 13 and reported an effective engagement.

(11) *Step K.* The tactical monitor has canceled all commands for fire unit number 63.

(12) *Step L.* Reference track number 13 has been dumped by SAGE. The fire unit is standing by for further designation commands.

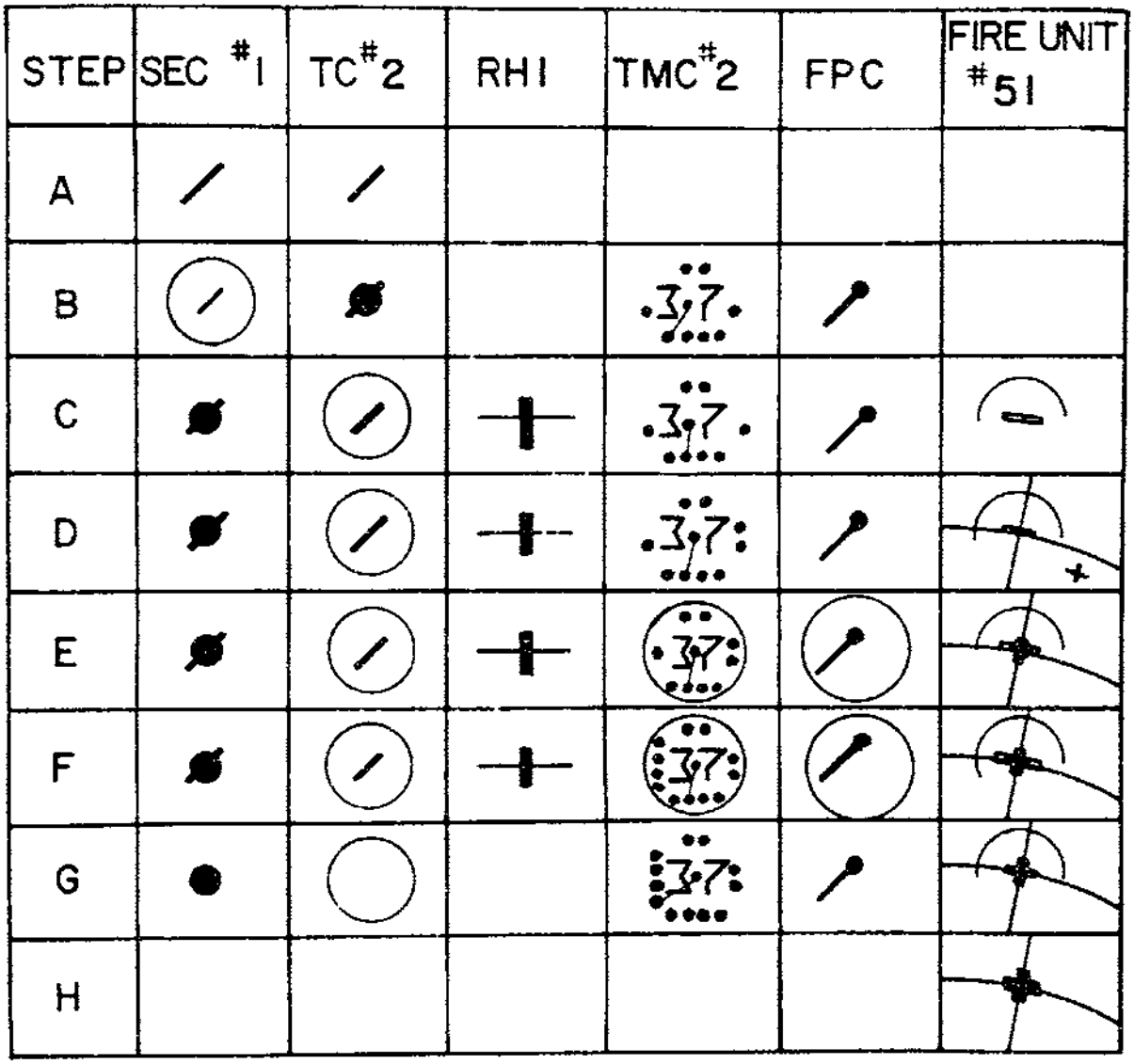


Figure 56. Attack of a local reference track.

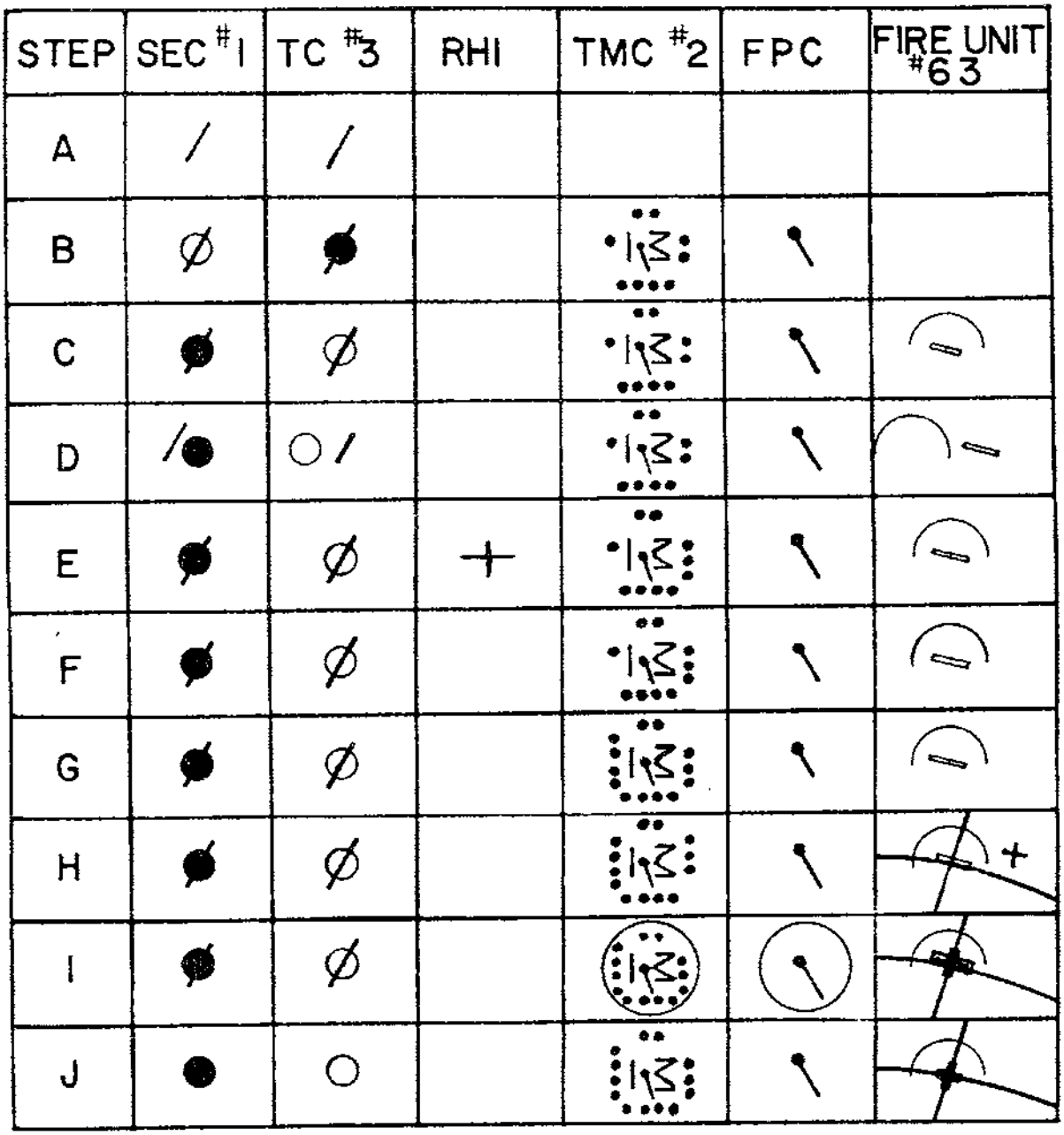


Figure 37. Attack of a SAGE reference track.

CHAPTER 11

SUPPORTING ACQUISITION FACILITIES

103. General

Some of the areas in which the Missile Master system is employed will require that supporting acquisition radar facilities be provided. Therefore, it is necessary to know the supporting acquisition subsystem, and processing of supporting acquisition radar (SAR) tracks; the supporting acquisition radar console; SARC operator responsibilities; the effect of ECM on the SARC and the supporting acquisition evaluator console; evaluation console operator responsibilities; and the effect of ECM on the evaluation console.

104. The Supporting Acquisition Subsystem

The Missile Master system may employ up to five supporting acquisition radars to compensate for siting deficiencies of the defense acquisition radar. The AN/FPS–36 is an example of this type radar. Each of the five radars is provided with a supporting acquisition radar console (SARC) that displays reference track and battery track data along with supporting acquisition radar (SAR) video and symbology, and from which up to six SAR tracks may be entered into the supporting acquisition subsystem. The tracks entered on supporting acquisition radar consoles are transmitted by automatic data link to the AADCP where they may be filtered for significance on the evaluator console (EC) before being assigned for viewing by the tracking subsystem, or all SAR tracks may be assigned automatically for viewing immediately upon receipt.

105. Processing of Supporting Acquisition Radar (SAR) Tracks

SAR tracks may be entered at the discretion of SARC operators or in response to a designation of a target to the SAR for tracking by the S & E officer at the AADCP when a reference data track is entering a known dead area of the defense acquisition radar. The S & E officer may also designate low priority targets to SARC's for tracking when a saturation raid is directed against the system and all tracking channels are being utilized by higher priority tracks, or high priority tracks may be designated to insure radar data for these tracks in case they are lost by the defense acquisition radar, or in the event the defense acquisition radar fails. Reference track data produced by tracking supporting acquisition targets tend to be inaccurate because height information is lacking and because supporting acquisition tracks are tracked by a manual-rate-aided tracking procedure both at the SARC and at the S & E or tracking console. For this reason, supporting acquisition tracks are utilized only if no other data are available.

106. The Supporting Acquisition Radar Console

Each supporting acquisition radar site is provided with a *supporting acquisition radar* console. The SARC displays supporting acquisition radar video, local tags (that may be circles), selected channel leader (to local tags), battery track (that may be flashing dots) and reference tags (that may be steady dots), designate leader (to reference tag during designation only), and IFF return. The console is connected to the AADCP by automatic data link and contains controls and indicators required for servicing tracks entered into the six tracking channels.

107. SARC Operator Responsibilities

The SARC operator will—

a. Monitor the display for video not covered by reference track or battery track data. Enter into the SARC tracking channels any undetected tracks discovered in the sector of responsibility.

b. Track, with the manual-rate-aided tracking facility provided, all tracks entered into local tracking channels.

c. Enter and track all tracks assigned to the console by the AADCP.

d. Utilize the IFF challenge as appropriate.

e. Dump tracks from the tracking channels upon order from the AADCP, when video is lost permanently, or when no longer of interest.

108. Effect of ECM on the SARC

The effect of ECM on the SARC display depends on the type of SAR used. Normal antijamming measures for the type of radar employed will apply for its operation with the SARC. The SARC operator coordinates antijamming measures with radar operators and readjusts the console display for maximum contrast of video against the jamming background when ECM are encountered. Since SAR characteristics generally differ widely from those of the defense acquisition radar, SAR's may be able to detect a target when the defense acquisition radar cannot. By concentrating the effort of SAR's on areas of heavy jamming, the SARC operator may be able to supply valuable information to the system when ECM is encountered. In the event of near saturation of the bands in which the defense acquisition radar and SAR's operate, and the ECM aircraft cannot be seen, the SAR symbology may be utilized to provide the ECM aircraft's location by triangulation. Upon orders from the S & E officer, the evaluator will direct two or more SARC operators to place three equally spaced tags along the center of the main jamming strobe. The ECM aircraft will be at the intersection of these tag lines.

109. The Supporting Acquisition Evaluation Console

The *supporting acquisition evaluation console (SAEC)* is located in the AADOR at the Missile Master site. The evaluation console (EC) receives radar video from the defense acquisition radar. It displays reference track, battery track, and supporting acquisition track symbols. The EC can service up to 30 supporting acquisition radar tracks from 5 radar sites (6 tracks each). It also supervises supporting acquisition radar operations and dumping of supporting acquisition tracks.

110. Evaluation Console Operator Responsibilities

The evaluation console operator will—

a. Monitor tracks entered by SARC operators at SAR sites for importance to the defense and permit only significant tracks to pass for viewing by the S & E and tracking console personnel.

b. Assist the S & E officer in designation of targets to the SAR's for tracking.

c. Supervise activities of all SAR's, and dump insignificant SAR tracks.

111. Effect of ECM on the Evaluation Console

The SAEC display is affected by ECM only through absence of data. The main contribution the evaluator can make to the Missile Master antijamming effort is to coordinate activities of the SARC operators.

CHAPTER 12

MANUAL FACILITIES

112. General

Normally, all electronic AADCP's have a manual backup facility. Therefore, it is necessary to know the references for establishing this facility, the use of the manual plotting board, emergency telling procedures, manual information displays, and manual tactical operations.

113. References

Manual facilities are a matter of SOP. However, *guides* to the preparation of such facilities are contained in FM 44–8 and FM 44–9. Certain *examples* of manual facilities are described below.

114. The Manual Plotting Board

A large vertical plotting board containing a World Geographic Reference (GEOREF) system grid that covers the defended area, including the area covered by the defense acquisition radar, is provided as a backup facility for the Missile Master tracking subsystem. The GEOREF grid is centered on the grid coordinates of the AADCP. Telephone outlets at the plotting board connect with plotting circuits and key stations.

115. Emergency Telling Procedures

a. The manual plotter stationed at the manual plotting board receives track information by voice from the SAGE DC or GCI stations, Missile Master acquisition radars, and fire units. Track information is received and plotted as described in FM 44–8 for manual AADCP's.

b. In the event of a tracking subsystem failure, track information displayed on the manual plotting board is voice told to the fire units. Telling procedures are those described in FM 44–8. A fire unit conference loop through the central AADCP switchboard or very high frequency (VHF) radio may be utilized.

116. Manual Information Displays

a. The Defense Status Board. A manual defense status board adjoins the manual plotting board. It provides the Army air defense commander and tactical operations personnel with information on the operational status of fire units, defense acquisition radars, supporting acquisition radars, and height-finder radars. The board may display such items of information as fire unit and radar designation numbers, minimum time to become operational, out-of-action status, estimated time of return to operational status, type of equipment inoperative, and reason.

b. The Center Panel. The center panel may display the following tactical information:

(1) *Air defense warning.* Three colored indicator lamps display the air defense warning (white, yellow, or red) currently in effect. The lamps are operated from the tactical control panels of the DC and ADAOO consoles (par. 82*c*).

(2) *Time clock.* A 24-hour clock for local and Zulu time.

c. Early Warning (EW) Plotting Board. This board shows a substantial area for the plotting of targets. A typical area might have a radius of 600 statutemiles (965.4 kilometers).

d. Miscellaneous Controls. On the back of the manual boards will be found controls as follows:

(1) *Power on-off.* These switches provide for application of power to signal and illuminating lamps.

(2) *Time dial.* This control permits correction of the clock when in error.

(3) *Light intensity.* These controls permit adjustment of illumination intensity of the various boards and panels.

e. Auxiliary Information. Auxiliary information such as air defense emergency, defense

readiness conditions, states of alert, operational status of communications networks, and surface-to-air weapon systems of other services that have been integrated into the Army air defense may be entered manually on a small information panel.

117. Manual Tactical Operations

In the manual operation of Missile Master, each tactical monitor monitors the action reports of eight fire units by means of an 8-fire unit conference loop and verbally orders changes of fire unit action when so required. Information displayed on the manual plotting board serves the tactical monitor as a reference to previous fire unit action reports and to reported target characteristics and locations. Tracks attacked by monitored fire units are generally located in or about the tactical monitor's zone of responsibility and may be shown by fire unit numbers displayed with each track. Other tactical operations of Missile Master remain unchanged.

CHAPTER 13

OPERATION UNDER ABNORMAL CONDITIONS

118. General

Due to the number of data links, radars, and subsystems in the Missile Master system, there may be a time that operation will be performed under other than normal conditions. Therefore it is essential to know what to do in case any of the following occur:

a. Failure of automatic data link (ADL) to SAGE.

b. Failure of radars.

c. Failure of automatic data links to fire units.

d. Failure of tracking subsystem.

e. Failure of the tactical display equipment (TDE).

f. Failure of data links to adjacent AADCP's.

g. Standby power.

119. Failure of Automatic Data Link (ADL) to SAGE

If the SAGE ADL fails, Missile Master will operate with locally generated reference data. Early warning tracks are received by automatic teletype and displayed on the manual plotting board of manual plotters, and auxiliary reference data are received verbally by S & E officers and entered locally into the electronic reference track channel data stores.

120. Failure of Radars

If the defense acquisition or height-finder radar fails, the acquisition capability is reduced and accuracy of reference track data furnished to fire units may be degraded due to loss of the updating facility. A limited acquisition capability is furnished by supporting acquisition radars. In this case, primary early warning of tracks is received by ADL from SAGE and target reference data are furnished by SAGE and SAR's. These target reference data are generally sufficiently accurate to enable fire unit lock on. Fire unit tracking data and SAR data are available to check on the quality of SAGE data.

121. Failure of the Tracking Subsystem

a. If the tracking subsystem fails completely, automatic processing of reference track data is impossible. However, the system retains some valuable features. Information transmitted by ADL still displays instantaneous action data of all fire units on fire unit PPI screens and makes it possible for tactical monitors to display ADL information as fire unit designation numbers with size-code symbols. Since SAGE reference data are processed through Missile Master reference data stores, operation in the SAGE mode is also impossible. Because verbal tactical control is considerably slower than automatic control, it becomes highly desirable that decentralized control be used if the tracking subsystem fails.

b. To prevent cluttering of the manual plotting board and extreme slowdown of verbal telling of targets, the teller at the manual plotting board normally plots and tells only hostile tracks when the weapon control status is decentralized.

c. Tactical monitors correlate attacks indicated on their displays with tracks plotted on the manual plotting board.

d. If only part of the tracking subsystem breaks down, all operational consoles are used and automatic reference data processing is supplemented by manual operation when the operational portions are saturated with tracks. When combined automatic and manual reference data processing is used, best results are obtained by decentralized operations with the automatic portions furnishing hostile track reference data and with manual portions furnishing verbal reference data for friendly tracks.

122. Failure of Automatic Data Links to Fire Units

a. Failure of broadcast data line to fire units does not affect the displays at the AADCP since information from fire units is received over the battery track lines. When the broadcast data line to fire units fails, reference track data can be sent to the fire units by verbal means only. The system should normally be used in the decentralized method, with tactical monitoring of BDL data from the fire units by the AADCP.

b. If the battery track line fails, reference and designate data can still be sent to the fire units from the AADCP.

c. Without the battery track data, fire units cannot monitor the actions of other fire units. Targets will be attacked as specified by SOP in order to attempt to attain efficient distribution of fire. Fire unit actions will be monitored and corrected by the AADCP using standard telephone procedures.

d. Fire unit attack reports at the AADCP are monitored by all tactical personnel and plotted on the manual plotting board. When an attack report is received, the tactical monitor responsible for the reporting fire unit checks the track against reference data displayed on the tactical monitor console to see if the track is already under attack. If not, the tactical monitor performs the correlation function, thus causing an assigned dot code to appear on the appropriate reference track symbol and causing the appropriate track channel number to appear in the fire unit's TRACK NO. inditron on the tactical monitor control panel (fig. 27). If the track is under attack, the tactical monitor may verbally direct the fire unit onto another track, or correlation may be achieved if the tactical monitor agrees with the fire unit commander's action. The friendly protector also checks attack reports against the FP display and issues *hold fire* commands when appropriate. The tactical monitors may aid the friendly protector by periodically checking identity dot codes of targets under attack.

123. Failure of the Tactical Display Equipment (TDE)

When the TDE fails, automatic commands cannot be transmitted, and tactical operations personnel must resort to manual operations.

124. Failure of Data Links to Adjacent AADCP's

Failure of data links to adjacent AADCP's does not affect the operation of the Missile Master system except that some duplicate attacks in areas of overlapping coverage may occur.

125. Standby Power

a. The system is placed on standby power immediately upon receipt of "increased readiness" "maximum readiness," "air defense emergency," severe weather warning, or failure of the commerical power supply.

b. The standby power supply consists of two 1,000-kw diesel engine-driven alternators. One of these generators is capable of fulfilling all system power requirements without becoming overloaded. This leaves one spare to assist in maintenance and to act as a backup in the event the generator supplying the system power becomes inoperative.

c. When the entire system fails, the AADCP reverts to manual operations, using commerical telephone or radio communications between critical stations. Even though this situation should rarely occur, emergency light sources such as flashlights or candles should be readily accessible at all times.

CHAPTER 14

COMMUNICATIONS

126. General

An extensive communications network is employed with the Missile Master system to interconnect important positions, both internal and external, to the AADCP. Standard commercial telephone lines are utilized in automatic data transmission systems between the AADCP and all external stations receiving or transmitting automatic data. This data system is supported by commercial radio and wire voice facilities interconnecting all functions of the system. Closed loop telephone circuits are used for maintenance purposes within the AADCP and for connecting the external stations with the AADCP. Therefore, a working knowledge of the AADCP communications equipment is required.

127. AADCP Communications Equipment

a. All tactical radio and telephone voice communications circuits terminate at operating consoles. Each console station has two pairs of telephone headset receptacles. Either receptacle may be used to gain access to tactical circuits or maintenance circuits or to connect the console to the main switchboard for further connection to circuits not terminating at the console or to a commercial telephone exchange. All receptacles accommodate conventional plug-in type telephone handset-headsets.

b. Tactical communications circuits terminate in six-position pushbutton, locking type key modules, located at each console. Each button represents a particular circuit and, when pressed, connects this circuit to the proper output receptacle. A small indicator is associated with each pushbutton.

c. Each console has one master module. In addition to the six locking type pushbutton keys and indicators found on other modules, the master module contains the following four pushbuttons:

(1) A common nonlocking type release button used to clear all other locked pushbuttons at the console.
(2) A common nonlocking pushbutton signal key to signal an external station selected by locked circuit buttons. When a tactical circuit contains both external and internal stations, only the external stations are signaled by pressing this button.
(3) A common cutoff button used to disable audible signals for incoming calls as desired.
(4) A locking type pushbutton to place nontactical calls from the switchboard in the "hold" status to permit answering incoming calls on tactical circuits.

d. Each console has a flush-mounted dial located adjacent to, and in line with, its key modules. This dial is used in conjunction with the switchboard extension pushbutton to dial the switchboard operator or to dial internal stations directly. At the plotting board where modular key equipment is not provided, a switchboard extension is terminated in a separate headset receptacle.

e. A commercial type switchboard with a maximum capacity of 100 extensions is provided to meet administrative requirements. The switchboard also can connect tactical stations not joined by a direct line. It automatically connects dial calls within the AADCP, but an operator is required for connection of internal to external circuits terminating at the switchboard.

128. Communications Circuits

Actual communications circuits employed will depend on the local situation and will be a matter of SOP. The types of circuits that can be established are listed below:

a. Two-way signaling.

b. Inward signaling only. Signals can be received but cannot be transmitted.

c. External signaling only. Signals may be transmitted but cannot be received.

d. Preempting station. A call made from or received by, this station automatically interrupts calls on nonpreempting stations on the circuit. All preempting stations have two-way signaling.

129. Operation of Communications Circuits

a. Wire Circuits.

(1) To contact a station connected to an internal circuit to which no external stations are connected, the console operator locates and presses the pushbutton associated with the desired circuit that initiates a visual and an audible signal at all other circuit stations. The signal lamp associated with the circuit on all key modules flashes until the call is answered by any of the circuit stations. An audible signal (buzzer) may or may not be generated at appropriate consoles, depending on the position of the buzzer cutoff keys. The answering operator must press the pushbutton associated with the flashing signal lamp. Thereupon, the indicator is continuously lit to show that the button is in a locked position and that reception and transmission over the associated circuit is possible. All connections can be broken by pressing any terminal pushbutton or unconnected circuits or by pressing the release pushbutton on the master module.

(2) To contact stations on circuits terminating at both external and internal positions, the appropriate button is pressed to connect this circuit to the telephone output jacks, but no signal is generated at other circuit stations by pressing this button alone. To signal external stations on these circuits, the signaling button on the master module is pressed; and to signal internal stations, the appropriate station number is selected by use of the telephone dial. Calls on these circuits are answered and broken down in the manner described in (1) above.

(3) To connect an external or internal circuit through one operating position to another where it is not normally available, two pushbuttons at the intermediate station must be depressed simultaneously to their locked positions. Both buttons will then stay locked, and the two associated circuits are interconnected.

(4) Pushbuttons for grouping circuits and a volume control for insuring proper speech level are provided at those operating positions where a grouping requirement exists.

(5) Because circuits terminate at more than one position in the AADCP, an SOP delineating the answering responsibility is required. Establishment of this SOP for periods of alerts is essential to avoid switchboard intervention and to insure immediate answering of important tactical calls.

(6) Busy circuit conditions are indicated in the AADCP by steadily lighted signal lamps.

b. Radio Circuits.

(1) Radio circuits are terminated at AADCP operating consoles in modular key equipment. At the plotting board, the circuit terminates in a jack that will accept a telephone headset. For press-to-talk operation, all terminations are provided with a foot switch, except the plotting board, where a nonlocking key is provided in the cord of the telephone headset.

(2) Two loudspeakers are used in the AADOR as a means for signaling on radio circuits. Circuits from all fire units and radar installations will terminate at these loudspeakers. A volume control on each speaker permits adjustment of the sound level. When an incoming call is noted, operation of the appropriate pushbutton on console key modules, or insertion of the telephone receiver plug into the radio jack at the plotter positions, removes that circuit from the loudspeakers.

(3) A pushbutton for grouping radio circuits is provided at operating positions where a grouping requirement exists. This capability provides for making group radio announcements from the AADCP. Operation of a grouping pushbutton removes the loudspeakers from grouped circuits.

APPENDIX I

REFERENCES

AR 220–50	Regiments; General Provisions.
AR 220–60	Battalions, Battle Groups, Squadrons; General Provisions.
AR 220–70	Companies; General Provisions.
AR 320–5	Dictionary of United States Army Terms.
AR 320–50	Authorized Abbreviations and Brevity Codes.
AR 750–5	Organization, Policies, and Responsibilities for Maintenance Operation.
AR 750–6	Maintenance Planning, Allocation and Coordination.
DA Pam 108–1	Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings.
DA Pam 310-series	Military Publication Indexes.
FM 21–5	Military Training.
FM 21–6	Techniques of Military Instruction.
FM 21–11	First Aid for Soldiers.
(C)FM 24–150	Electronic Warfare (U).
FM 44–1	U.S. Army Air Defense Employment.
FM 44–7	Electronic Search Central AN/GSS–1 and Radar Sets AN/TPS–1D, 1G and AN/FPS–36.
FM 44–8	Army Air Defense Command Posts.
FM 44–9	Service of the Operations Center AN/MTQ–1.
(CMHA)TM 11–750	Radar Electronic Counter-Countermeasures for the Operator (U).
(CMHA)TM 11–751	Radar Electronic Counter-Countermeasures for the Technician (U).

APPENDIX II

ABBREVIATIONS

AADC ——— Army Air Defense Commander
AADCP ——— Army Air Defense Command Post
AADOR ——— Army air defense operations room
ac ——— Alternating current
ADAD ——— Air defense artillery director
ADAOO ——— Air defense artillery operations officer
ADDC ——— Air Defense Direction Center
ADL ——— Automatic data link
AGC ——— Automatic gain control
ATABE ——— Automatic target and battery evaluation
BCO ——— Battery control officer
BTE ——— Battery terminal equipment (fire unit integration facility)
dc ——— Direct current
EC ——— Evaluator console
ECCM ——— Electronic counter-countermeasures
ECM ——— Electronic countermeasures
EW ——— Early warning
FP ——— Friendly protector
FPC ——— Friendly protector console
FUIF ——— Fire unit integration facility (battery terminal equipment)
GCI ——— Ground controlled intercept
GEOREF ——— World Geographic Reference System
HDE ——— Height determination equipment
IAGC ——— Instantaneous automatic gain control
IFF ——— Identification, friend or foe
kw ——— Kilowatt
mc ——— Megacycles (millions of cycles per second)
MTI ——— Moving target indicator
usec ——— Microsecond (one millionth of a second)
nm ——— Nautical mile(s)
NMDC ——— NORAD master direction center (manual)
NORAD ——— North American Air Defense Command
NSDC ——— NORAD sector direction center
PCM ——— Pulse code modulation
PPI ——— Plan position indicator
PPS ——— Pulses per second
PRF ——— Pulse repetition frequency
RF ——— Radio frequency
RHI ——— Range-height indicator
rpm ——— Revolutions per minute
SAEC ——— Supporting acquisition evaluation console
SAGE ——— Semiautomatic ground environment
SAR ——— Supporting acquisition radar
SARC ——— Supporting acquisition radar console
S & E ——— Surveillance and entry
STC ——— Sensitivity time control
TC ——— Tracking console
TDE ——— Tactical display equipment
TM ——— Tactical monitor
TMC ——— Tactical monitor console
TTR ——— Target track radar
VHF ——— Very high frequency

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NG: State AG (3).

USAR: Same as active Army except allowance is one copy to each unit.

For explanation of abbreviations used, see AR 320–50.

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