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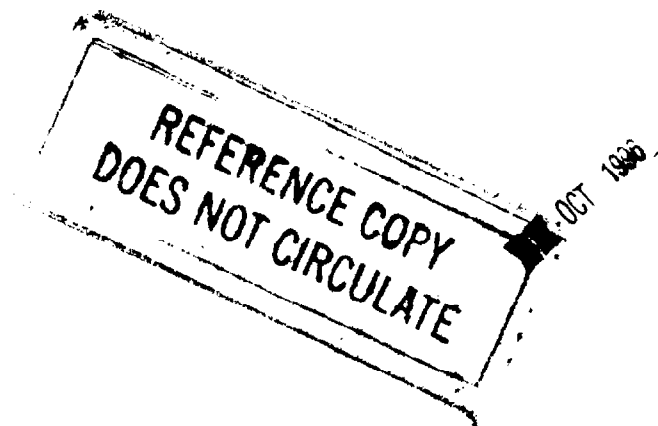


# The HEL Counter-Air Program (HELCAP) Combined Arms Counter-Air Simulation Facility

Gordon L. Herald

ARL-MR-19

December 1992



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## The HEL Counter-Air Program (HELCAP) Combined Arms Counter-Air Simulation Facility

Gordon L. Herald

December 1992

The Human Engineering Laboratory (HEL) referenced in this report has been reorganized as the Human Research and Engineering Directorate of the U.S. Army Research Laboratory effective 1 October 1992. This program and facility described here were completed before the organizational change. This report is the third in a series of four reports.

Approved:



ROBIN L. KEESEE  
Directorate Executive

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U.S. Army Research Laboratory  
Human Research and Engineering Directorate  
Aberdeen Proving Ground, Maryland

## ACKNOWLEDGMENTS

The development of the HEL Counter-Air Program (HELCAP) spanned 4 years. In this time there were many contributors, almost all of whom have transitioned to other Army and industry positions. The concept originated with Mr. Clarence Fry, the former chief of the Aviation and Air Defense Division, U.S. Army Human Research and Engineering Directorate.

The author would like to thank those who contributed to the design, operation, and demonstration of HELCAP: CPT Shell, MAJ Elliot, CPT Bates, CPT Schmidt, SGT Eatman, CPT Maks; Messrs. Gary Kurtz, Alan Dorney, Chris Smyth, Jeff Wall, William Harper, Frank Malkin, William DeBellis; Drs. Paul Rose, James Walrath; Ms. Mary Besterfield-Sacre, Ms. Mary Dominessy, and Ms. Andrea Hynes.

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Finally, special thanks go to the members of the System Simulation Team - Ms. Maria Lopez, Ms. Teresa Branscome, Ms. Kim Fluitt; Messrs. Neal Ware and Paul Supik for their exceptional programming support and skills in integrating the entire concept for a highly successful demonstration.

## Terms, Abbreviations, and Acronyms

|          |                                                          |
|----------|----------------------------------------------------------|
| ADTOC    | Air defense tactical operations center                   |
| ASE      | Aircraft Survivability Equipment                         |
| AVTOC    | Aviation tactical operations center                      |
| BSD      | Battlefield situation display                            |
| CREWS    | Cockpit research experimentation and work load simulator |
| CRT      | Cathode ray tube                                         |
| DLRP     | Data link reference point                                |
| EPLRS    | Enhanced position location reporting system              |
| Ethernet | Local area computer networking system                    |
| FDL      | Forward area air defense system (FAADS) data link        |
| FEBA     | Forward edge of the battle area                          |
| FLIR     | Forward-looking infrared                                 |
| FLOT     | Forward line of own troops                               |
| HELCAP   | Human Engineering Laboratory counter-air program         |
| HMD      | Helmet-mounted display                                   |
| IP       | Internet protocol                                        |
| IWSD     | Integrated weapons system display                        |
| PL       | phase line                                               |
| PMS      | Pedestal-mounted stinger                                 |
| PPI      | Plan position indicator                                  |
| PTL      | Primary target line                                      |
| SIMNET   | Simulator network                                        |
| TCP      | Telecommunications protocol                              |
| TIDP     | Technical interface design plan                          |
| VSD      | Vertical Situation Display                               |
| WCO      | Weapons Control Order                                    |

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## THE HEL COUNTER-AIR PROGRAM (HELCAP) COMBINED ARMS COUNTER-AIR SIMULATION FACILITY

### INTRODUCTION

The HEL counter-air program (HELCAP) was initiated in 1987 with the objective of optimizing soldier-machine interfaces in command-control networks that integrate Army air and counter-air operations.

The thrusts of the HELCAP initiative were to (a) provide soldier-compatible interface designs for the command and control nodes which would demonstrate integration of counter-air operations between air defense and aviation units through interactive laboratory simulation, and (b) validate these soldier-interface criteria through laboratory testing of the command and control concepts. Figure 1 illustrates the time line and approach for the HELCAP development until the Army demonstration in July 1991.

The development of HELCAP started as members of the Aviation and Air Defense Division traveled to various Army commands, schools, and centers to brief the concept, obtain information, solicit potential requirements, and elicit comments. In parallel with these activities, the aviation, air defense, and systems simulation teams were developing the functional requirements for the HELCAP nodes and developing the scenario. In early 1991, the systems simulation team performed a requirements analysis of each of the node requirements leading to the HELCAP Design Guide (internal document). This guide was followed for hardware and software development for each node and communications between nodes.

HELCAP provides a warfighter-in-the-loop simulation and focuses on the command, control, and communications (C<sup>3</sup>) issues in a limited combination of aviation and air defense teams. These teams were a small battalion slice consisting of four manned nodes: a helicopter node, an air defense tactical-operations center (ADTOC) node, an aviation tactical-operations center (AVTOC) node, and an integrated weapon's system display/pedestal-mounted stinger (IWSD/PMS) node. Each of these nodes is described briefly in the following paragraphs.

The helicopter node in the HELCAP demonstration used the cockpit research experimentation and work load simulator (CREWS). This is a low cost, warfighter-in-the-loop, real-time helicopter simulator for research into the human factors issues that affect the development of new helicopters. CREWS provides a method to evaluate the human factors issues in a part task simulation within a crew station environment. (Part task simulation is a term used when the simulation does not provide all the tasks involved in the actual system.)

CREWS is designed as a flexible, generic, fixed base, single-place helicopter crew station capable of being quickly reconfigured. Four small cathode ray tube (CRT) monitors and a helmet-mounted display (HMD) are used to present a vertical and horizontal situation, subsystems, mission management, electronic maps, and air situation displays.

CREWS has an external scene generator, an advanced version of the low cost systems used in the simulator network (SIMNET) simulators, and provides the pilot subjects with a 40°-by-40° out-the-window scene.

The ADTOC and AVTOC nodes are identical in design. TOCs are real-time, warfighter-in-the-loop simulators. The designs are not human engineered but are provided as vehicles to explore the counter-air operations and communications procedures that may define future TOC designs for counter-air operations. The operations at these nodes will be to monitor the battle situation,



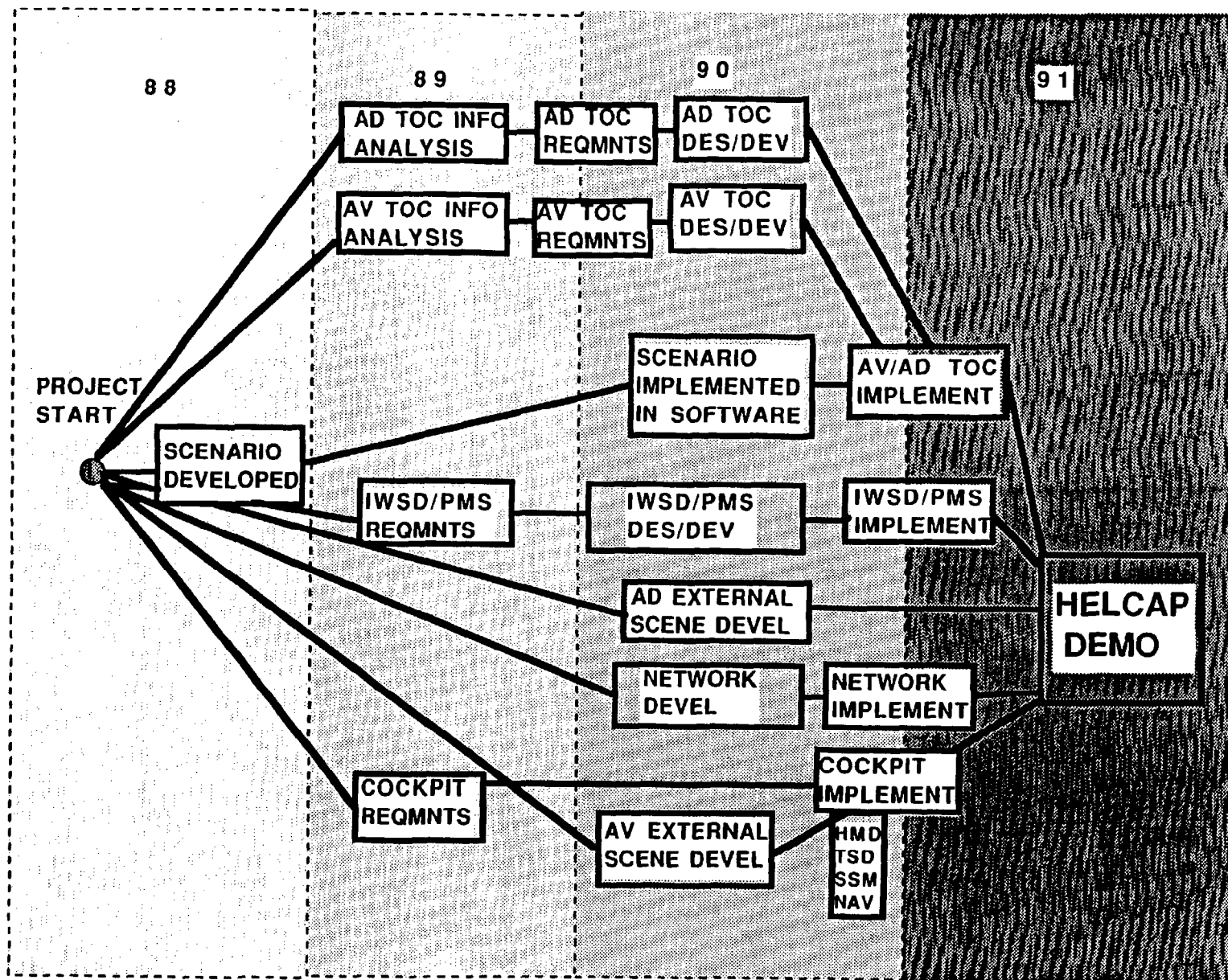


Figure 1. HELCAP approach and development.

execute weapons control and fire control orders, communicate with their respective upper and lower units and with each other, and initiate and transmit changes to subordinate units with mission objectives controlling the course of the battle.

The remaining node in the HELCAP simulation is a PMS simulator, which is called the IWSD/PMS node. It provides a real-time, warfighter-in-the-loop capability to simulate an air defense fire unit and is manned by a PMS gunner. Details of this node are described in Herald (1992).

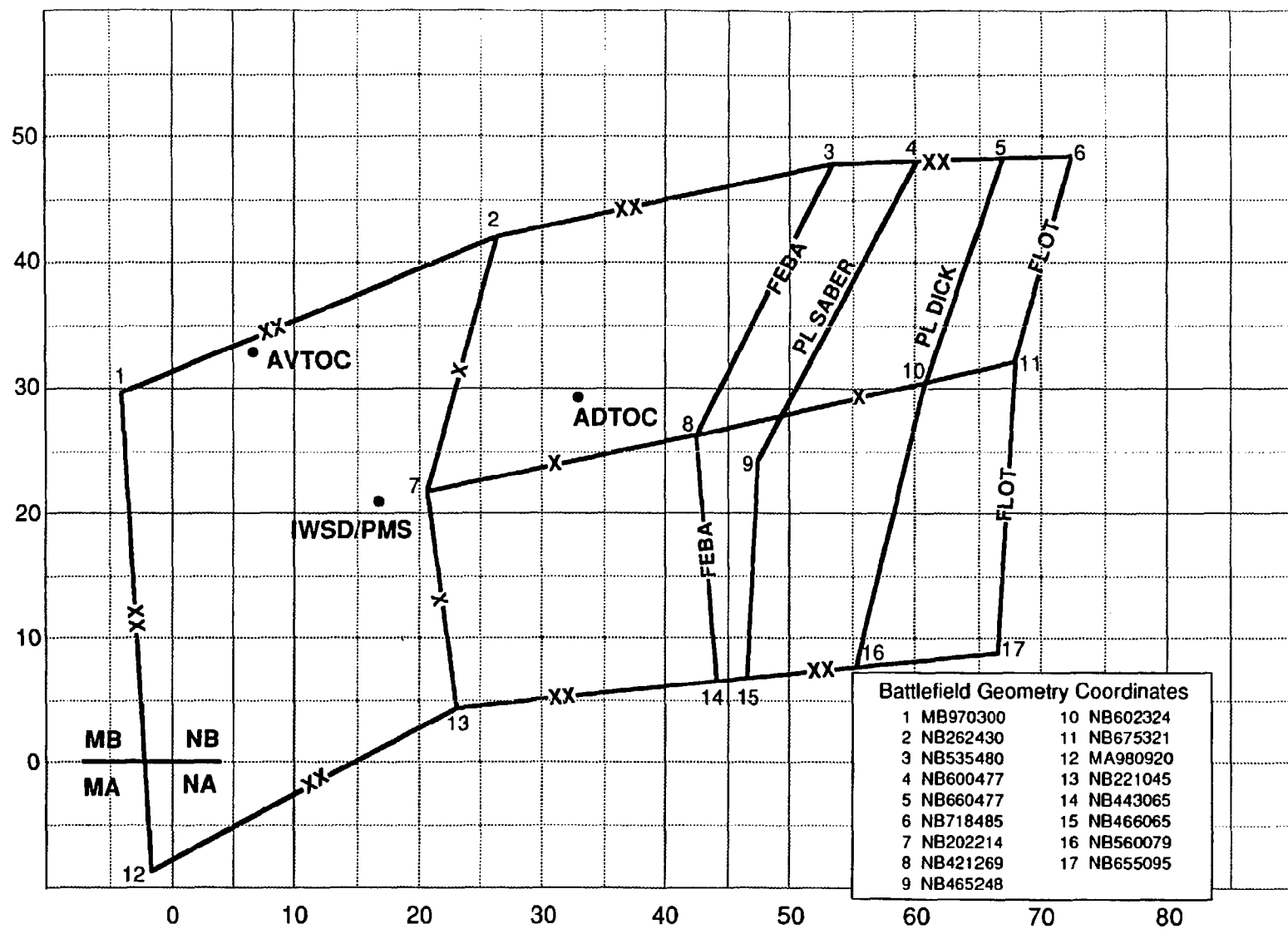
All node host computers are connected by Ethernet, a local area computer-networking system. The telecommunication protocol/internet protocol (TCP/IP) is used to communicate between nodes using the Ethernet local area network. HELCAP communication between nodes is primarily digital and uses the format defined by the forward area air defense system data link (FDL) technical interface design plan (TIDP) (MICOM, 1988). Simulated voice radio can also be used to communicate between nodes. On the air defense side, communications occur among ADTOC and other air defense units and AVTOC. On the aviation side, AVTOC communicates with other aviation units and ADTOC. Communication paths among units in counter-air operations in the HELCAP design are limited. For example, there is no direct communication link between a helicopter flight and an IWSD/PMS squad. Communications affecting a flight or an air defense squad first go to its associated TOC, then pass between TOCs.

Communication between nodes uses the message set in Appendix A. This message set is a subset of the messages defined in the FDL TIDP. Some of the messages have been modified, and additions to the message set are required to meet both aviation and air defense needs (see messages F60 and F61 in Appendix A). However, the message priority assignments will remain the same. Additional details related to software supporting communications between nodes is described in Lopez (1992).

A 38-minute scenario has been developed for the HELCAP gaming area. A computer scenario data base describes the tactical situation for each 2-second step of the scenario. Each node has a host computer that executes its own local copy of the scenario data base using a scenario generator. The local copy of the data base is adjusted as targets are destroyed by means of messages sent from the destroying node (either IWSD/PMS or CREWS) to all other nodes. As the scenario runs, it provides airborne track updates at 2-second intervals for 103 friendly and hostile aircraft operations and for static hostile and friendly ground force situations.

Figure 2 shows the tactical boundaries for the HELCAP simulation. The division area is indicated by the symbol "XX" in the figure and brigade areas within the division are identified by lines with the "X" symbol. The forward edge of the battle area (FEBA) is shown by the line connecting points 3, 8, and 14. The phase lines (PL) Saber and Dick are also shown. The forward line of troops (FLOT) is indicated by the lines connecting points 6, 11, and 17, and the area in which CREWS can fly is indicated by the rectangular region, and the visual and forward-looking infrared (FLIR) range limit for the IWSD/PMS is indicated by the circular region. The three fixed HELCAP nodes (AVTOC, ADTOC, and IWSD/PMS) are also indicated in this figure. The CREWS helicopter node is free to fly anywhere within the rectangular region. The numbers at the periphery of the figure indicate meters east and north of the common reference point.

The overall gaming area for the HELCAP simulation is a 180-km x 160-km region of the Fulda Gap area of Germany and is enclosed by map coordinates MB333995 on the northwest, PB133995 on the northeast, MA333395 on the southwest, and PA133395 on the southeast. (Map coordinates are given using the U.S. Army military grid reference system. See Department of the Army [1987] for additional details.) Each of the four HELCAP nodes may include all or some part of this gaming area.



Battlefield Geometry (s)

Figure 2. Tactical boundaries for the HELCAP simulation.

The gaming areas for the ADTOC and AVTOC locations are 180 km x 160 km, and each covers the same area as the overall HELCAP gaming area. The HELCAP ADTOC is located at map coordinate NB333295, and the HELCAP AVTOC is located at map coordinate NB065335. The IWSD/PMS node is located at map coordinate NB165212 at an altitude of 325 meters above mean sea level. Its gaming area extends outward 30 km in all directions from its fixed location. During the simulation, its primary search sector is from a compass bearing of 30° to 150°, and the primary target line (PTL) is oriented at a compass bearing of 90°. The visual range for the IWSD/PMS infrared system and unaided eye extends outward 9 km in all directions from the IWSD/PMS location.

Unlike other nodes, which are at fixed positions during the simulation, the helicopter node, CREWS, is free to move in a data base region developed for the external visual scene which is 11 km x 18 km. This external scene gaming area is within the simulation gaming area and is bound by map coordinates NB240320 on the northwest, NB350320 on the northeast, NB240140 on the southwest, and NB350140 on the southeast.

Although CREWS is limited to flight operations within the external scene gaming area, its tactical situation display extends the total gaming area outward 40 km in all directions from the helicopter location. The cockpit displays include an air-picture (AP) display for the helicopter pilot, which displays all air tracks reported by the simulated HELCAP sensors within 40 km in all directions from the helicopter's position within the external scene gaming area.

A common reference point for the simulation, the data link reference point (DLRP), has been selected 5,600,000 meters north of the equator and 500,000 meters east of the Greenwich prime meridian at map coordinate NB000000. This provides a common reference for all HELCAP sensor simulations. The DLRP is a point at mean sea level that is the center of a plane containing a master grid oriented on True North. All HELCAP simulated sensors report target positions in X, Y, and elevation relative to the master grid coordinate.

Before starting the simulation, each node will have completed an initialization procedure to establish its data base. The simulation starts with the IWSD/PMS emplaced, initialized, and fully operational. The helicopter is started on the pad and awaits orders. Scenario generators at each node have been initiated and airborne target tracks become active.

The IWSD/PMS fire unit has its orders which include the PTL and primary search sector. The operator begins to monitor the plan position indicator (PPI) display for track information, alerting, and cuing information.

When the scenario begins, the 23rd Infantry Division defends in place along the FEBA. The 208th Armored Cavalry Regiment had been delaying on PL Dick and is now withdrawing to PL Saber. The division has ordered attack helicopters from the 23rd Aviation Brigade to assist in the withdrawal; they are initially laagered at map coordinate NB260160.

The aircraft are notified by AVTOC that the 144th Motorized Rifle Regiment (MRR) is moving rapidly along autobahn E-4. The attack aircraft lift off to attack the MRR which is in the vicinity of map coordinate NB333269. While the attack helicopters are en route, ADTOC detects an enemy rotary-wing aircraft on an intercept heading (Track 211). ADTOC notifies AVTOC that there are no air defense units in that area to counter the threat. AVTOC notifies the flight, and one aircraft is assigned to intercept the incoming hostile aircraft so that it does not interfere with the attack of the armored column. From this point, the combat activities are determined in part by the actions taken at each node.

## FACILITY OVERVIEW

The remainder of this document provides an overview of the HELCAP facility that was developed to study counter-air program issues. Descriptions of each of the following HELCAP nodes are included: (a) TOCs, which include AVTOC in Figure 3, and ADTOC in Figure 4; (b) the air defense fire unit or IWSD/PMS in Figure 5; and (c) the counter-air helicopter cockpit in Figure 6.

## TOC DESIGNS

The design and interactions for both AVTOC and ADTOC are described in Ware (1992). This design is a development baseline and is not intended to be a human engineered TOC design. Both AVTOC and ADTOC are identical in design. It is anticipated that the designs will diverge as experience and research define the unique requirements and operational needs for each.

### Simulation Equipment

The operator stations for ADTOC and AVTOC consist of a 19-inch (48.26-cm) diagonal high-resolution color monitor, an alphanumeric keyboard, and a conventional mouse. The ADTOC node is implemented on a Silicon Graphics model IRIS™ 3130 workstation (SGI 3130). A 19-inch (48.26-cm) color, 1024-pixel x 768-pixel resolution CRT monitor refreshed at 60 Hz is used to display the tactical situation.

A Silicon Graphics model IRIS™ 4D/85GTB is used to implement the AVTOC node. A 19-inch (48.26-cm) color, 1280-pixel x 1024-pixel resolution monitor refreshed at 60 Hz is used to display the tactical situation.

### TOC Displays

The TOC display is divided into a battlefield situation display (BSD) and a data area. The BSD occupies the left two-thirds of the screen, and the data area occupies the right one-third.

### Battlefield Situation Display

The BSD shows the battlefield in real time and assists the commanders in making instant decisions. An example BSD on a scale of 120 km x 120 km is shown in Figure 7. This default CRT display shows unit boundaries; FLOT; FEBA; phase lines; grid lines; air corridors; command posts for platoons and above; assembly areas; all hostile, friendly, and unknown air tracks; all hostile ground units; air track numbers; and ground unit numbers.

The background screen color is light gray. Colors assigned to the screen elements are as follow: Friendly forces are blue, hostile forces are red, unknown tracks and units are light yellow, battlefield geometry lines are black, and grid lines are light blue.



**Figure 4. Air defense tactical operations center.**



Figure 5. Air defense fire unit IWSD/PMS.





Figure 6. Counter-air helicopter cockpit.

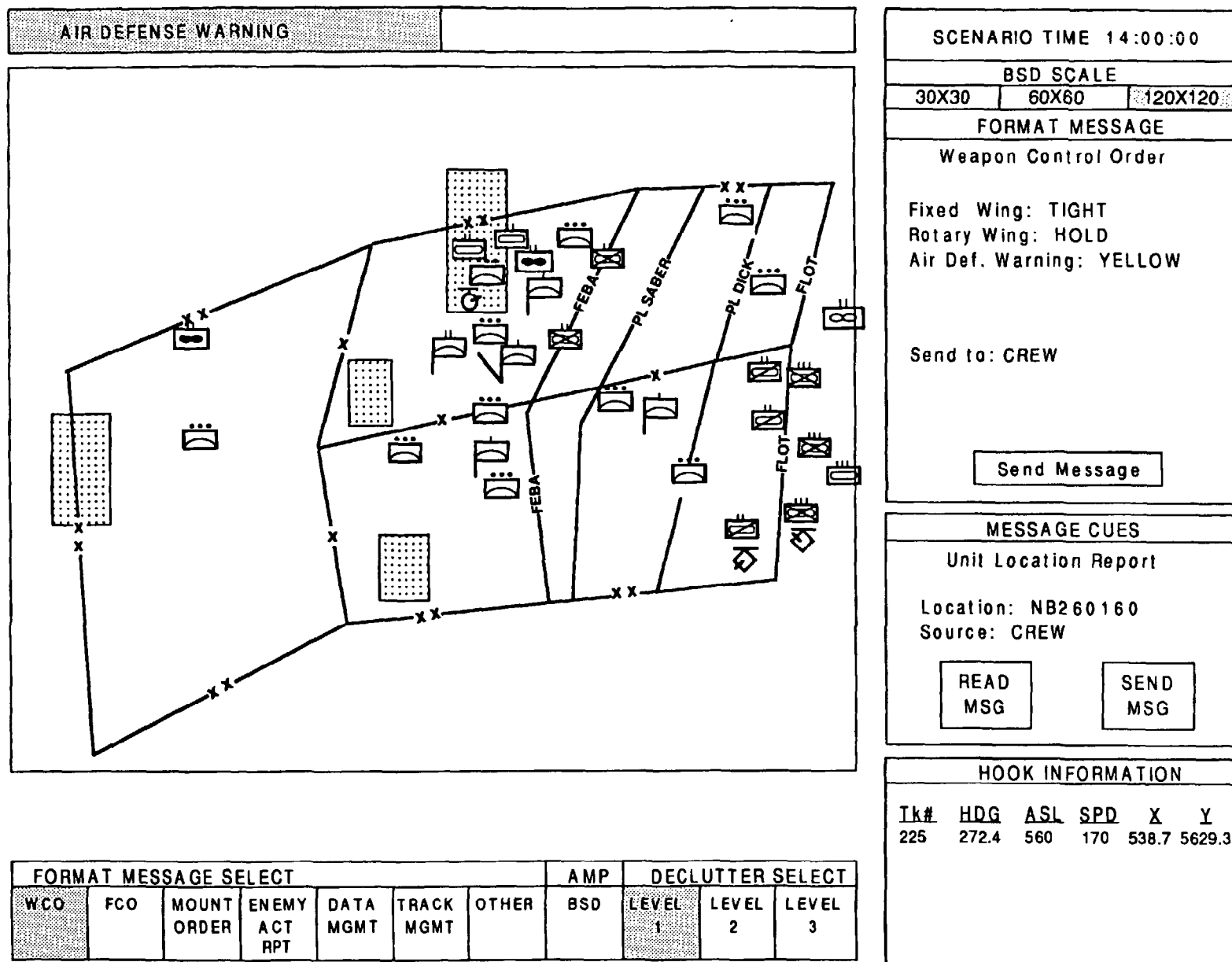


Figure 7. Battlefield situation display .

The top of the BSD area is used to present critical states and alerts. The air defense warning state will be either red, yellow, or white (red - attack imminent or in progress, yellow - attack probable, white - attack not probable). The bottom of the BSD area (the area below the "FORMAT MESSAGE SELECT" region) is an interactive area which enables the operator to perform selected operations in other areas of the display.

## Data Display

The right side of the display is devoted to information and data. The space at the top is reserved for the date and time information. The areas marked 30 x 30, 60 x 60, and 120 x 120 are related to the scale of BSD in kilometers.

An area is reserved just below the label "FORMAT MESSAGE" to enter data by keyboard into a preformatted message form. The format of the message is selected from one of the four format message select areas.

Messages received from sources external to TOC will appear in the "MESSAGE CUE" area. As this view port fills with messages, the oldest message will scroll toward the top (it may scroll out of the window) and new messages enter at the bottom. (Out-of-sight messages can be scrolled into the view port by employing the cursor in the right-hand region of the view port shown with up and down scroll arrows.) These messages are defined by FDL TIDP.

The beginning phases of this design provided for only three messages. They are the weapons control order (WCO), unit location report (Unit Loc Rpt), and fire control order (FCO).

Hook information is presented in the bottom view port. Hooking is accomplished by placing the cursor on a tactical symbol and double clicking the right mouse button. Data base information pertaining to the hooked symbol is presented in the view port. Information includes the position of the unit in military grid reference system (MGRS) coordinates, mission, supported element, type unit, and organizational relationships. Hooked airborne targets include additional information such as heading, altitude, and air speed.

Three levels of declutter are available to improve the recognition of critical situations. The default display, no declutter in effect, shows unit boundaries including FLOT; FEBA; PLs; grid lines; air corridors; command posts for platoons and above; assembly areas; all hostile, friendly and unknown air tracks; all hostile ground units; air track numbers; and ground unit numbers. Note that section and squad locations are not displayed at the default level. Amplification methods (described later) are provided to display the locations of these units on BSD. The declutter levels are as follow:

Level 1 - removes air track numbers, ground unit numbers, and grid lines from the default BSD.

Level 2 - displays friendly, unknown, and hostile air tracks with track numbers, unit boundaries, including FEBA, FLOT, PLs, assembly areas, air corridors, grid lines, and friendly and hostile sensor locations.

Level 3 - displays friendly, unknown, and hostile ground units with unit numbers, unit boundaries, including FEBA, FLOT, PLs, assembly areas, air corridors, grid lines, and friendly and hostile sensor locations.

Amplification is similar to a zoom function. It allows the user to get detailed information in a particular region of the battlefield. When amplification is selected, an automatic zoom of the selected point results in a 1:4 increase of the original size. Next, the display will translate the zoomed image to the screen center and will display all relevant information about the area of interest.

## HELICOPTER NODE

This node provides a capability to include pilot interactions with HELCAP in real time while performing target acquisition, engagement, and kill functions. Moving targets that become visible in the external visual scene come under engagement by the helicopter pilot. The helicopter pilot receives the data for airborne engagements through a system of panel-mounted displays. If a target is fired upon and destroyed, the visual image and its related symbol presented in situation displays at all nodes are removed, and the data base at each node is modified. If the engaged target is fired upon and missed, then the target will continue to be displayed and no modifications of the data bases are made. Ground-based targets can also be engaged and destroyed as part of the mission within HELCAP. The pilot further interacts in the HELCAP scenario by sending situation reports, spot reports, and kill reports based upon actions and observations in the assigned mission.

## Simulation Equipment

The helicopter node uses an existing helicopter simulator, the CREWS. Four panel-mounted, 9-inch (22.86-cm) diagonal CRT monitors and a helmet-mounted display are used to present vertical and horizontal situations, subsystems, mission management, electronic maps, and air situation displays. The helicopter simulator cockpit is shown in Figure 8. In Figure 9, these displays are D1 - communications; D2 - vertical situation display; D3 - tactical situation display; D4 - subsystem monitor display; and D8 - programmable keyboard display (displays D5, D6, D7 are not programmed for use in HELCAP).

The helicopter equipment configuration is shown in Figure 10. Computers include a VAX® 6410, PDP®11/23 with an array processor, and a MicroVAX II® (MVII). Adage graphics system A generates the communications-related graphics, and Adage graphics system B generates the vertical situation display and navigation displays. The data translation graphics system generates the tactical situation display. The air picture graphics is generated by a Peritek graphics system. A second Peritek generates the weapons, aircraft survivability, and system monitor displays. Video switches and video-merge devices are used to switch on video cockpit monitors and to merge video from various sources to create composite images. The GT110™ system, described in the following paragraph, generates the out-the-window scene.

A BBN Systems and Technologies Corporation GT110™ external scene generator provides the pilot subjects with a 40°-by-40° out-the-window scene (see Figure 11). GT110™ texture capabilities provide a highly realistic scene, which consists of trees, roads, buildings, rivers, and hills. Static and dynamic objects such as other helicopters and fixed-wing aircraft are included as well as military tanks, trucks, and other ground vehicles. For HELCAP, the out-the-window scene models an 11-km x 18-km region of the Fulda Gap in Germany. (This region can be expanded by enlarging and populating the terrain data base.)

The helicopter simulator uses force, moment, and acceleration-motion equations based on the UH60 Blackhawk helicopter. Because of the part task and nontraining application of the simulator, it is not necessary to model the engine or main rotor systems in detail. While retaining most of the handling characteristics, complexity reductions in the equations of motion help retain a low-cost simulator capability.

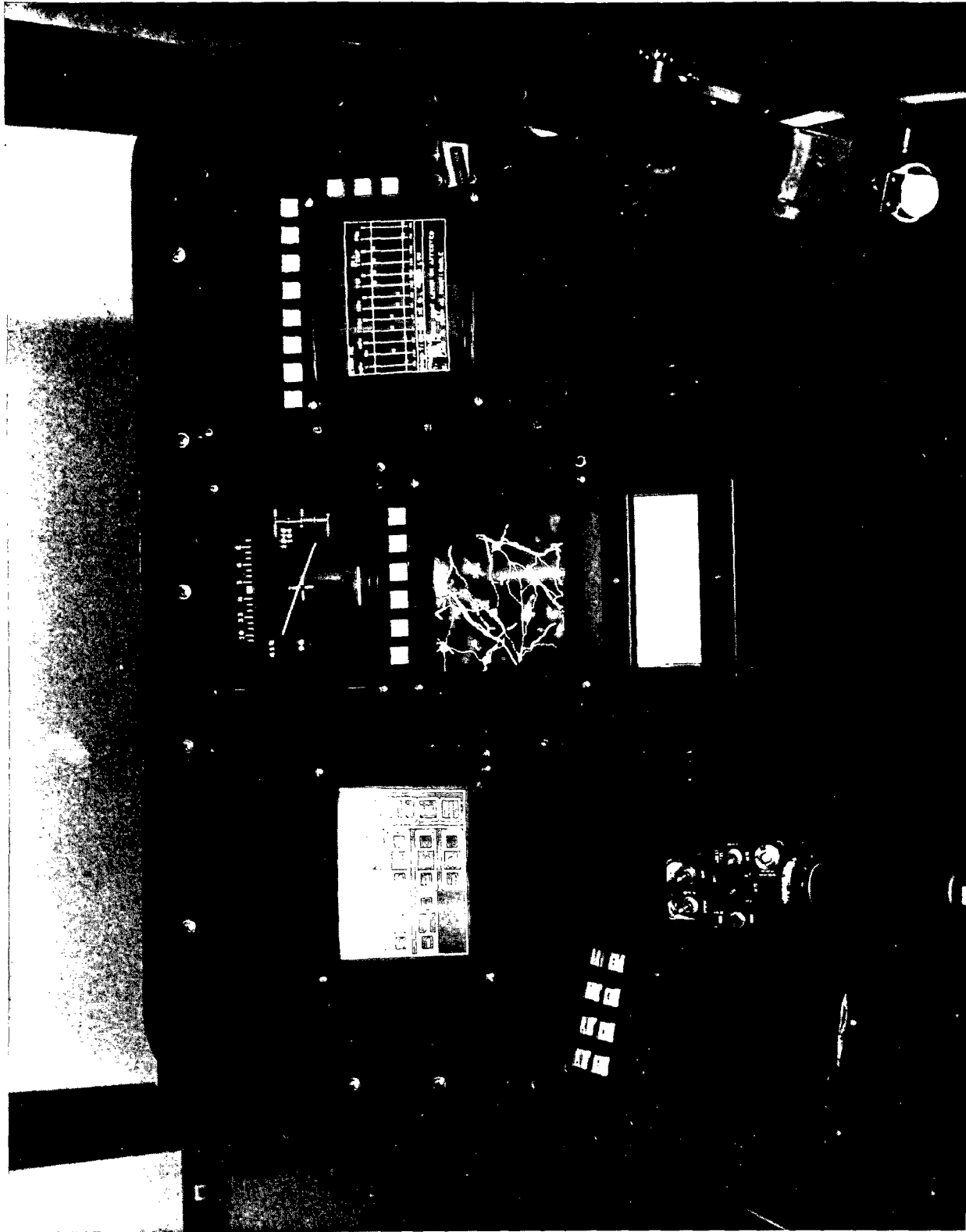


Figure 8. Helicopter simulator cockpit.

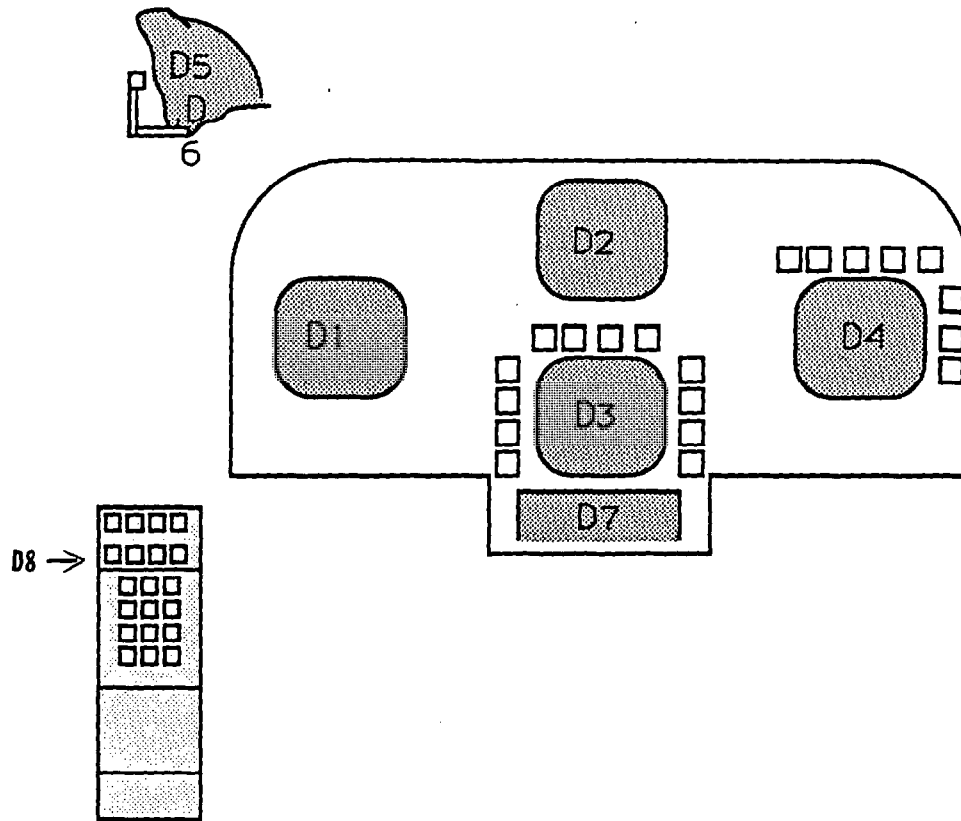


Figure 9. HELCAP cockpit panel.

Other equipment available but not specifically required by HELCAP includes a variety of control input devices which can be selected to make special cockpit research configurations. This equipment includes special key pads, function keys, joysticks, speech-recognition devices, and speech-output devices. Also, a system of video-switching and video-merging equipment is available to form composite images in which the external scene may be overlaid by other critical operational displays. These images can be presented on either the cockpit monitors or the helmet-mounted display.

#### HELCAP Design Modifications

The helicopter simulator design for HELCAP consists of a number of displays and pilot interfaces that have been reconfigured for HELCAP. The out-the-window scene (refer to Figure 11) for HELCAP has been modified to include airborne moving targets on preprogrammed flight paths and a variety of static ground units such as tanks and trucks. New designs and modifications were made for communications, vertical situation, tactical situation, subsystem status, aircraft survivability, and weapons systems in the helicopter simulator.

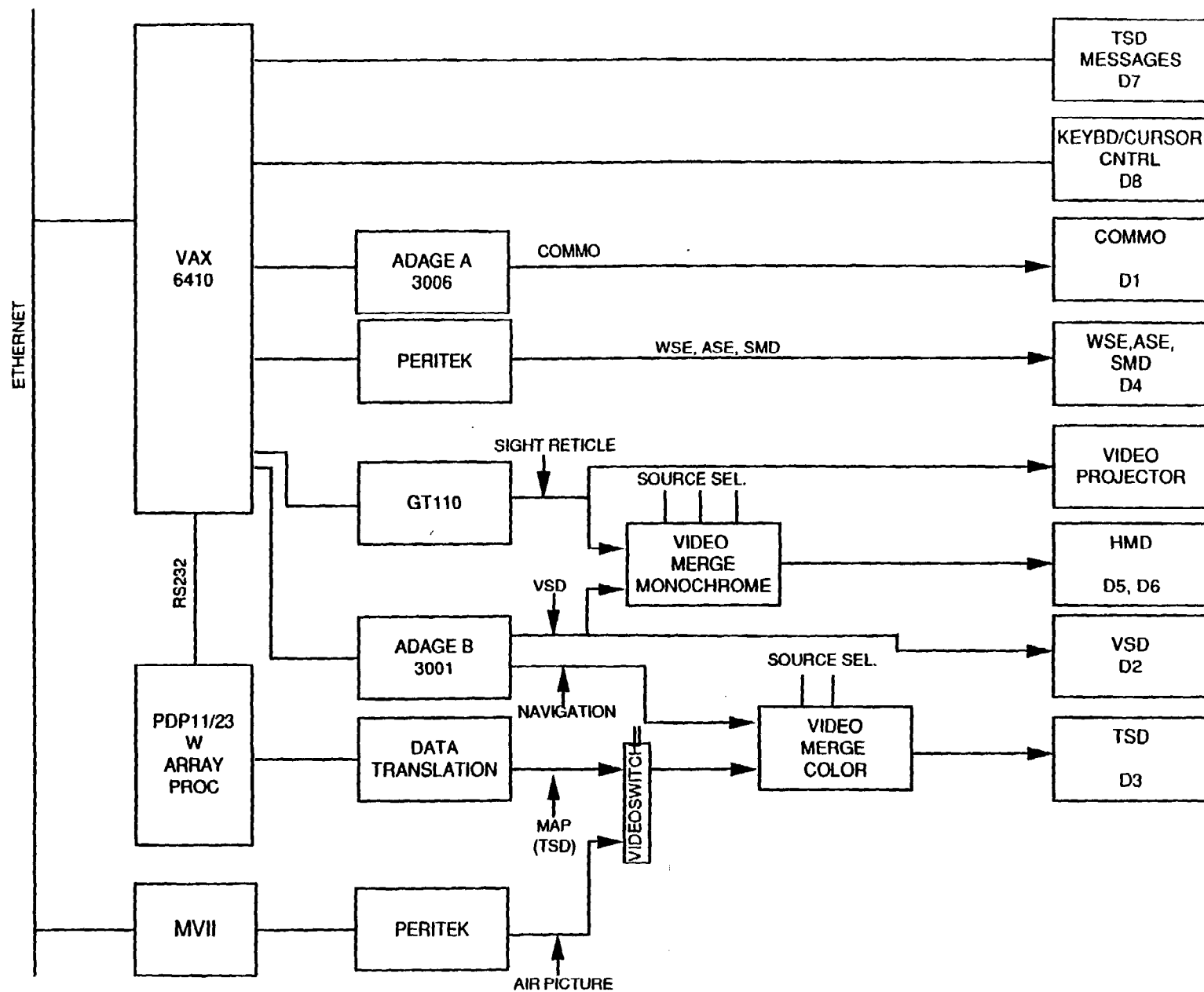


Figure 10. Helicopter simulator equipment configuration.



Figure 11. GT110™ external screen for HELCAP.

### Communications Display

The communications display and its operation are critical to HELCAP. The pilot's interactions with the display are not demanding; however, the underlying design to accomplish this is complex and is presented in detail in Appendix B.

This display and underlying computer software logic assists pilots to send and receive messages. These messages use the FAAD combined, control, and intelligence (C<sup>2</sup>I) TIDP format. The display is not a complete communications system but assists the pilot with routine messages. Examples of routine incoming messages include weapon control orders, fire control orders, and mission orders.

Pilot-initiated outgoing messages include reports that consist of situation reports, spot reports, and kill reports. These generally follow a standard format where the pilot simply fills in the blanks. (The left panel display in Figure 8 shows the location of the communication display in the panel.)

### Vertical Situation Display

The vertical situation display (VSD) is the primary vehicle control and navigational tool in the helicopter cockpit. VSD (see Figure 8 top center display) shows the aircraft heading, altitude (barometric and above ground level), vertical speed, and aircraft attitude. This display is modeled after the video display unit in the AH-64 Apache. Additionally, flight envelope cuing has been included in this display.



The counter-air role may result in close-in, air-to-air combat, which may require the pilot to operate the aircraft close to its maximum limitations. Flight envelope cuing warns the pilot that he or she is maneuvering the aircraft in a manner that is about to exceed one or more aircraft limitations.

Three possible aircraft limitations have been selected for presentation to the pilot: (a) Transmission (XMSN), (b) rotor (RTR), and airframe (AFRM). The criteria for determining when one of these limitations is exceeded are correlated to flight-control inputs. When one of these limits is about to be exceeded, the appropriate message appears flashing at the bottom center portion of VSD or HMD. The flash rate is three times per second with equal on and off times. The message text will read

XMSN LIMITS  
RTR LIMITS  
AFRM LIMITS

The visual signal is accompanied by an auditory message. The auditory messages are

"TRANSMISSION LIMITS"  
"ROTOR LIMITS"  
"AIRFRAME LIMITS"

The visual and auditory messages will repeat until the pilot either touches the acknowledgment switch on the subsystem status monitor or terminates the critical flight maneuver.

### Tactical Situation Display

The tactical situation display (TSD) is important in the HELCAP concept because it becomes the central focus for many tactical decisions. TSD is implemented in two modes. One mode is a short range tactical mode display providing a ground and air tactical situation overlaid on a map; another model is a long range air-picture mode (see Figure 12 - shown in a 30-km range) which shows the air situation at ranges of 30 km or 80 km from the helicopter (the tactical mode is visible in the display in Figure 8 bottom center display). Switching from mode to mode is accomplished by using a switch on the cyclic control. Information displayed in either mode is updated at 2-second intervals from the node data base. If another node destroys a track, the destroying node sends information to every other node to cause each node to mark that track in the data base and to remove it from the list for display and position update. An associated electroluminescent (EL) display overlaid with a touch-sensitive device (EL/T) allows the pilot to interact with TSD (see Figure 12).

The functional tasks that pertain to TSD are (a) situational awareness - awareness of the location of friendly assets, hostile and friendly air and ground targets and ground forces, hazardous areas, air defense threats, safe corridors; and (b) communications - receive mission-related information from the simulated enhanced position location reporting system (EPLRS) network. This information will include friendly and hostile target information (speed, heading, altitude, numbers, range), target assignments, and target engagement activity.

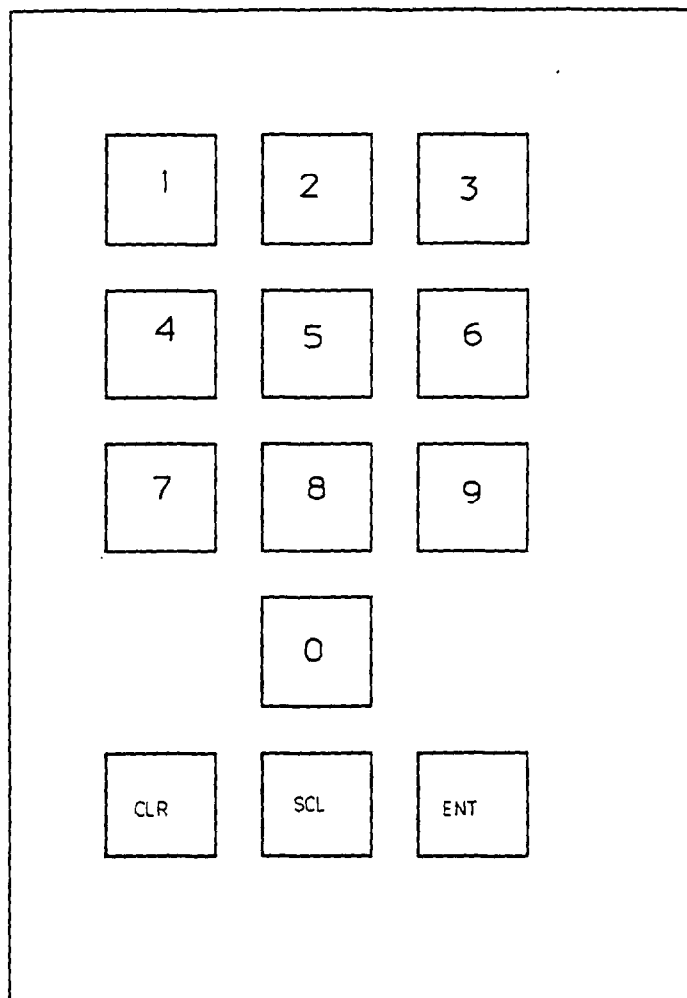
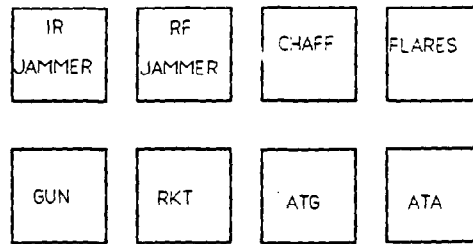


Figure 12. The helicopter simulator left console.

The simulator cockpit components required to implement TSD are a 9-inch (22.86-cm) color monitor and an EL display panel with a touch-sensitive overlay. The EL panel is contained within the cockpit left console (see Figure 9 [Item D8] and Figure 12). The graphics displayed on the EL display are a numeric keyboard including scale, clear, and enter keys. A graphic keyboard was selected to permit the touch sensor and EL display combination to be used for other purposes, such as a navigational aid by erasing the numeric keypad and drawing another display having features specific to the new application.

The air picture display shows the tactical air situation in relation to the helicopter (see Figure 13). Symbolic data in the form of circles indicating friendly tracks, diamond shapes indicating hostile tracks, and U's indicating unknown tracks are displayed. (Symbols with a short line above them indicate that the track is a helicopter.) The aircraft direction vector and a track number are also displayed. An 80-km scale with a 20-km radius range ring and a 30-km scale with a 7.5-km range ring are provided. Target tracks are always shown relative to the current heading of the helicopter (heading up presentation) and will rotate on the display as the helicopter makes turning maneuvers. Ownship position is indicated by a plus (+) symbol at the center of the air-picture screen.

In Figure 13, the pilot has selected the 30-km scale as indicated by the 30 in the box at the top right of the display and hooked track 66 by entering the track number by using the EL/T panel (see Figure 12) to press 66 then pressing ENT (enter). The hooked track, a hostile helicopter, is filled in the air picture display to indicate that the track has been hooked. Hooking causes information to appear across the lower part of the air picture display, which shows the hooked track number, the tracks present heading, the range of the track from ownship, air speed, the track's altitude, the bearing from ownship to the track, and the estimated time of arrival (ETA was not defined for HELCAP implementation). Another track can be hooked by pressing CLR on the EL/T panel, and then entering the new track number and pressing ENT on the EL/T. The scale of the air picture can be changed from the 30-km to 80-km scale by pressing the SCL and ENT keys.

The tactical mode of TSD is provided by a color map display which rotates and translates as the aircraft maneuvers. This presentation has additional details not provided by the air picture display and is used for providing the tactical situation at full screen scales of 12 km to 5 km. In addition to the tactical information, this presentation provides the pilot with cultural and geographical features such as roads, rivers, terrain elevation, towns, power lines, and so forth and shows terrain elevation by color shading. Both ground and airborne targets are symbolically shown in addition to text and symbols which indicate air corridors, defended areas, and tactical boundaries.

### Subsystem Status Monitoring Display

The subsystem status monitoring display (see Figure 14 and right CRT in Figure 8) is a multifunction display and is designed to alert the pilot when a problem is developing in a particular system. The concept of display by exception is followed for most of the aircraft system's parameters except for fuel status. In the event of a problem, the monitoring system will alert the pilot visually. The multifunction display also performs on demand.

The display has a row of eight fixed bezel switches located above the display; each is capable of being illuminated when pressed. Each switch is approximately 1.92 cm (0.75 inch) on a side and is spaced about 0.64 cm (0.25 inch) apart. These dimensions satisfy military standard (MIL STD) requirements outlined in MIL-STD-1472D. One switch is dedicated to WEAP ASE, six switches correspond to the subsystems (engine, transmission, fuel, hydraulics, electrical, and auxiliary power unit-APU), and the last switch is a checklist switch. Three additional interactive

switches are an acknowledge switch, a page-up switch, and a page-down switch. These three switches are located on the upper right-hand side of the display. The six subsystem switches illuminate and flash when an out-of-tolerance situation is first detected. The flash rate is approximately three flashes per second (see Figures 8 and 14).

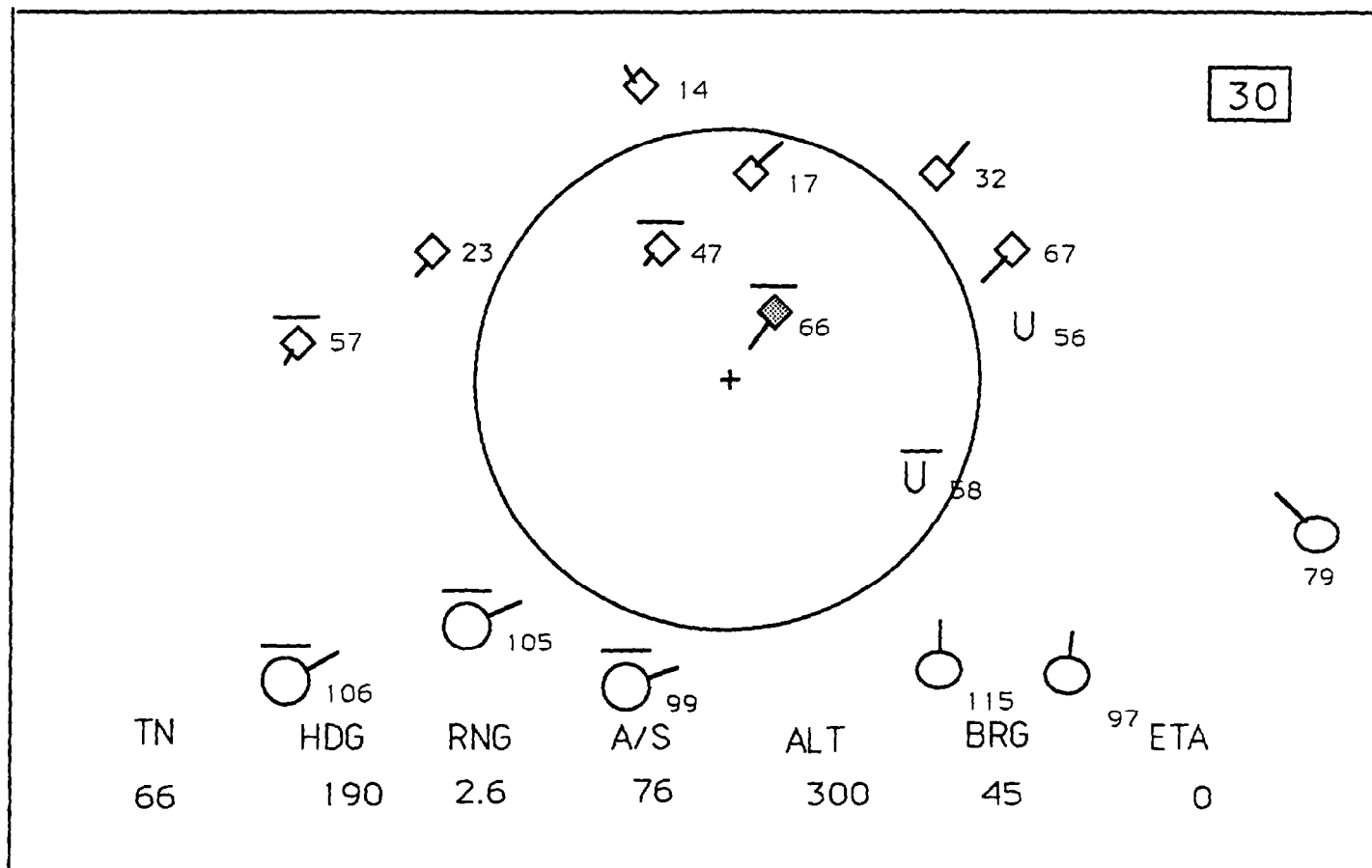


Figure 13. Air picture display.

If a parameter is out of tolerance, a bezel key (located above the subsystem display) will begin flashing. The pilot must press the acknowledgment button and the bezel key will then stop flashing. The bezel key will stay illuminated until the situation is under control or until it is replaced by a higher priority warning. The pilot may press the illuminated bezel key to see more information about that subsystem. Such a selection will show the parameters and their current levels. A dedicated line states the condition, and a computer data base of procedures will state corrective procedures to be followed. If the pilot is unsatisfied with the recommended procedure, he or she may also use an emergency procedures checklist.

#### Aircraft Survivability Equipment Display

Aircraft survivability equipment (ASE) consists of on-board techniques for defeating radar, electronic, and infrared weapon systems. These systems function automatically and only require that they be turned on or off.

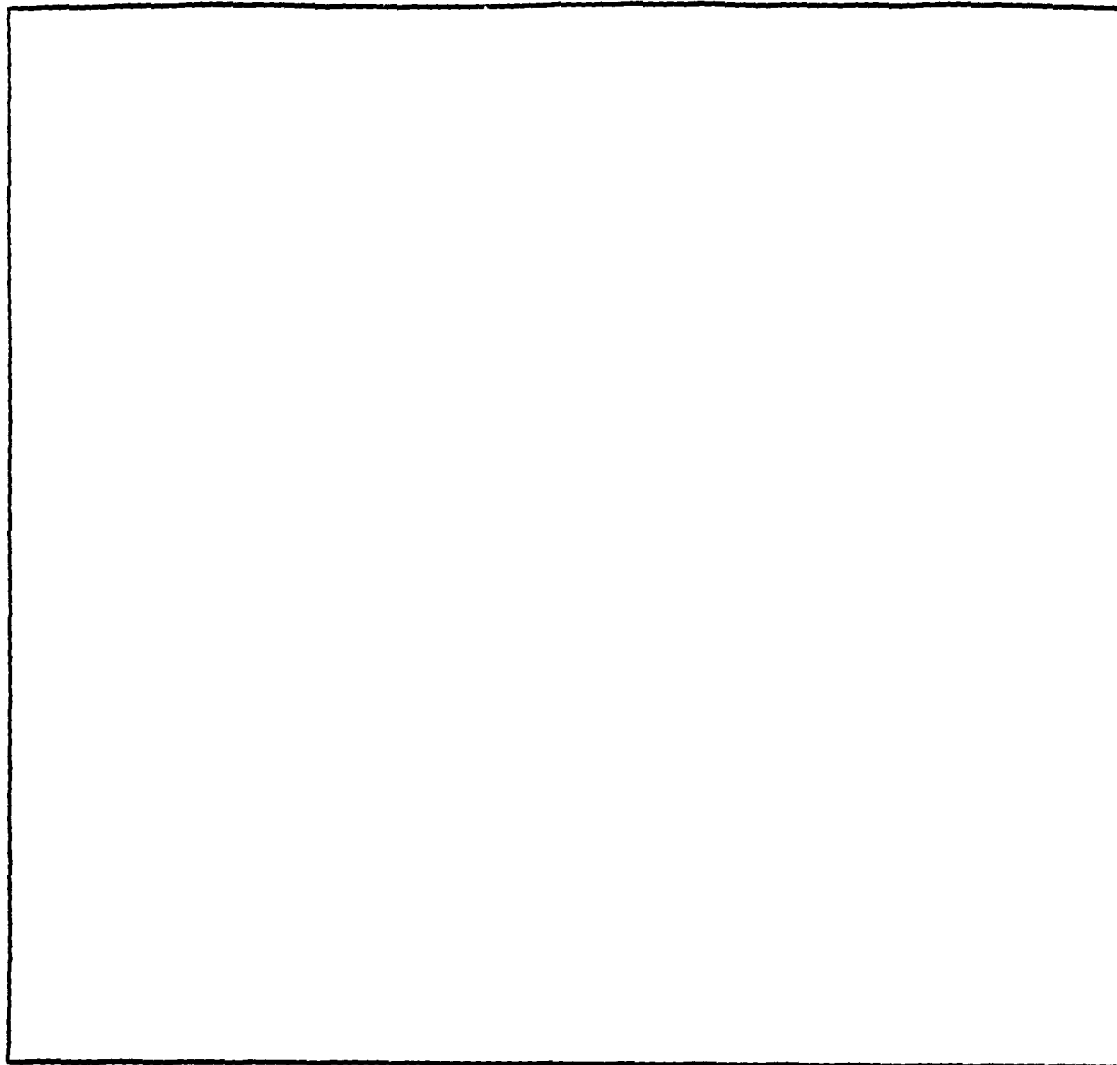
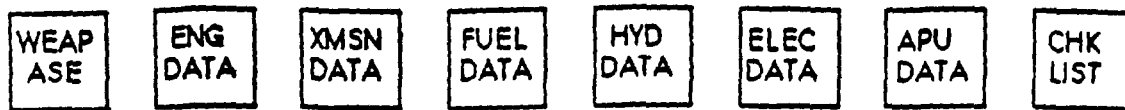


Figure 14. Subsystem monitoring display.

Four dedicated push buttons located on the left console (see Figure 9 [Item D8] and Figure 12) are used to turn on or off the IR JAMMER, RF JAMMER, CHAFF, and FLARES. The push buttons are an alternate action switch/lamp combination. They illuminate when on.

An ASE display is required to show the quantity of CHAFF and FLARES remaining on board. The ASE display is combined with the weapons system's status. The display is shown on the right-hand CRT by pressing the WEAP ASE dedicated push buttons at the top of the screen.

### Weapons System's Status and Weapon's Engagement Display

The weapons system's status is displayed with CHAFF and FLARES status on the right-hand CRT when the WEAP ASE push buttons at the top of the CRT are pressed. For the pilot to activate weapons systems, one of four dedicated push buttons installed on the left console must be pushed. The push buttons (see Figure 12) are used to select guns (GUN), rockets (RKT), air-to-ground (ATG) missiles, or air-to-air (ATA) missiles. When pressed to select the appropriate weapon, the push button illuminates. The thumb-controlled switch on the side-arm flight controller will be used to cycle through SAFE, STBY, and ARM positions. (The switch status is displayed on the right-hand CRT in Figure 8.) When the switch is placed in either the STBY or ARM position, an aiming reticle is presented in the center of the visual scene. This is performed to simulate a head-up display. The only weapon active for the HELCAP demonstration will be the ATA weapon.

### ATA Missile

When the ATA switch is selected and placed at STBY using the thumb-controlled switch, a missile-aiming reticle appears in the center of the visual scene. The reticle is maintained on target by the pilot maneuvering ownship into position. When either the ATA push button is pressed to OFF or the thumb-controlled switch is cycled to the SAFE position, the aiming circle is deleted from the visual scene.

### Guns and Rockets

These weapons were not used in the initial HELCAP cockpit design.

### ATG Missile

This system was not used in the initial HELCAP cockpit.

### IWSD/PMS NODE

An IWSD is incorporated into the IWSD/PMS weapon system. The PMS is a limited adverse-weather, heat-sensitive missile system. It is used to counter the threat of low-flying aircraft and helicopters as well as moving or stationary ground targets. Two Stinger pods, each containing four missiles, and a 50-caliber machine gun are mounted onto a gyro-stabilized turret which is rotatable 360° in azimuth. The weapon system is mounted onto a high mobility multipurpose wheeled vehicle (HMMWV) as shown in Figure 15. IWSD/PMS sensor packages include a FLIR imaging system and a laser range finder.

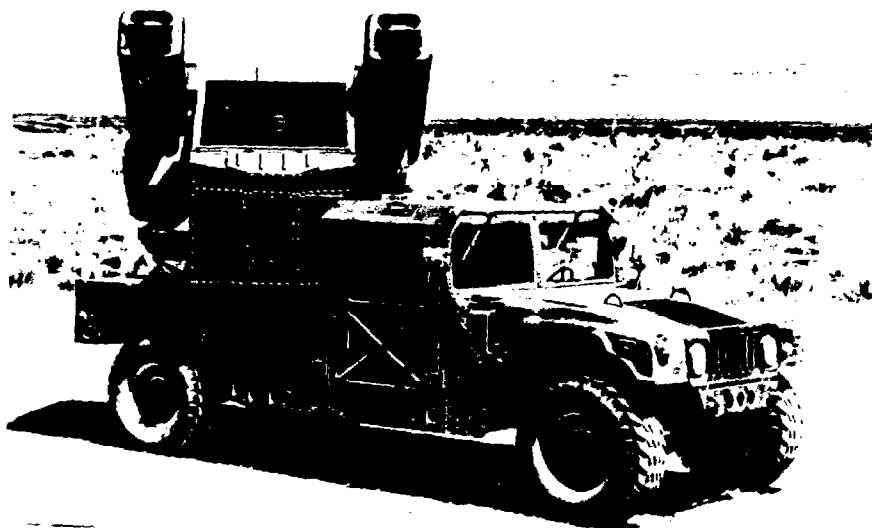


Figure 15. A pedestal-mounted stinger on a HMMWV.

The IWSD/PMS crew station simulation provides a display that presents a scenario-driven scene image. FLIR is represented with symbology in one mode (see Figure 16) or with a symbolic display representing radar imagery in another mode (see Figure 17). The gunner's control panel has been modified (see Figure 18) to compensate for functions incorporated into the IWSD. Images will be presented on a 9-inch (22.86-cm) color monitor with touch sensor within a 640-km x 480-km raster scan mode. The symbols are in color and the target image will simulate a monochrome FLIR image. A wide field of view (1.8 times magnification 20° FOV) and a narrow field of view (7.2 times magnification 5° FOV) are provided. The viewing range is 9 km. Terrain in the immediate vicinity of the crew station is displayed, and symbology-positioning data are received from the node data base. Additional information related to the IWSD/PMS simulation can be found in Herald (1992).

The IWSD/PMS node is located at map coordinate NB165212 at an altitude of 325 meters above mean sea level. Its gaming area and alert cuing extends outward for a distance of 30 km in all directions. The visual range of the IWSD/PMS infrared system and unaided eye will extend outward in all directions for a distance of 9 km from the IWSD/PMS location. The IWSD/PMS node is oriented so that its primary search sector is from 30° to 150°, and the primary target line is oriented at a compass bearing of 90°.

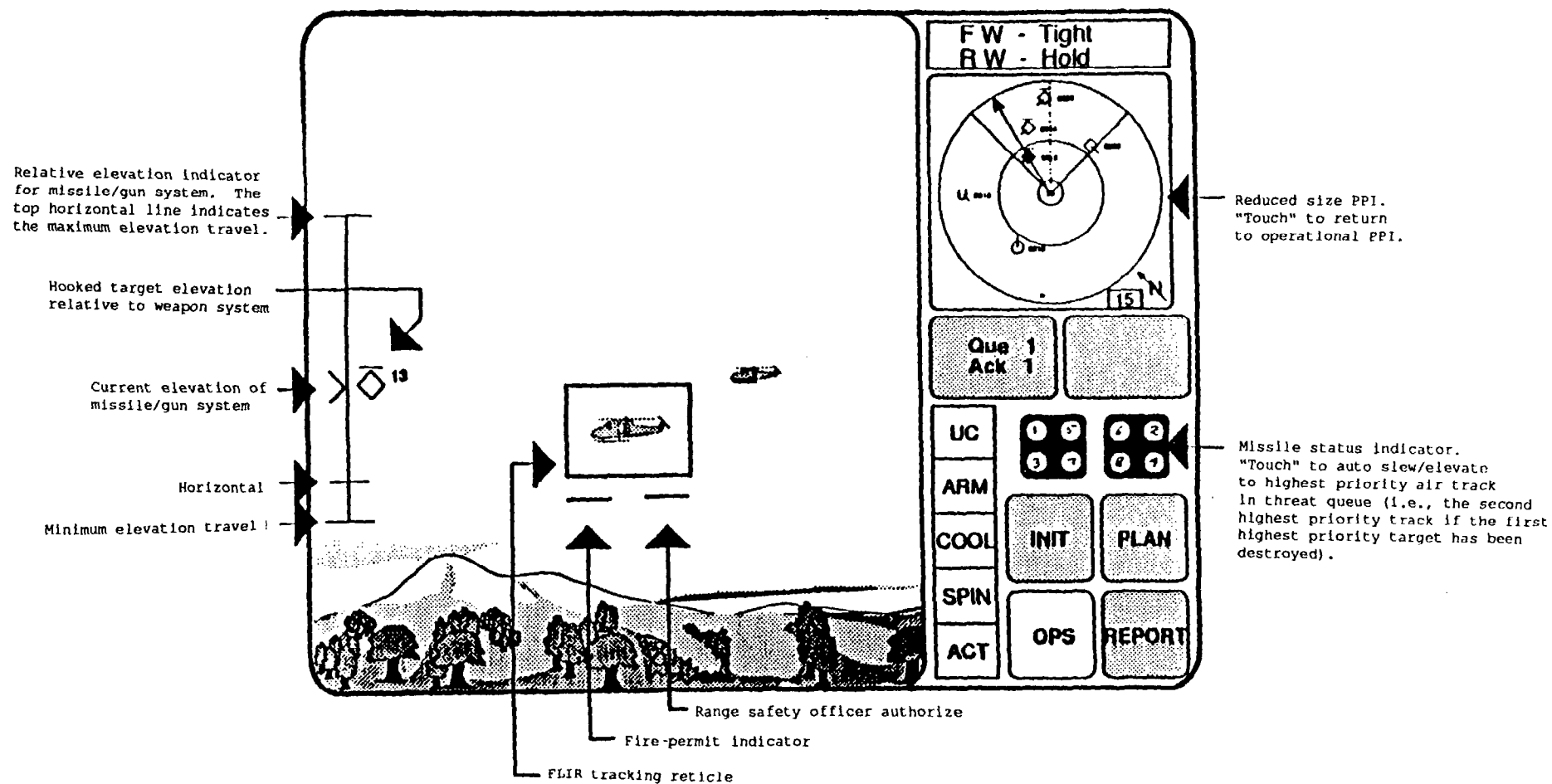


Figure 16. FLIR IWSD/PMS Mode.



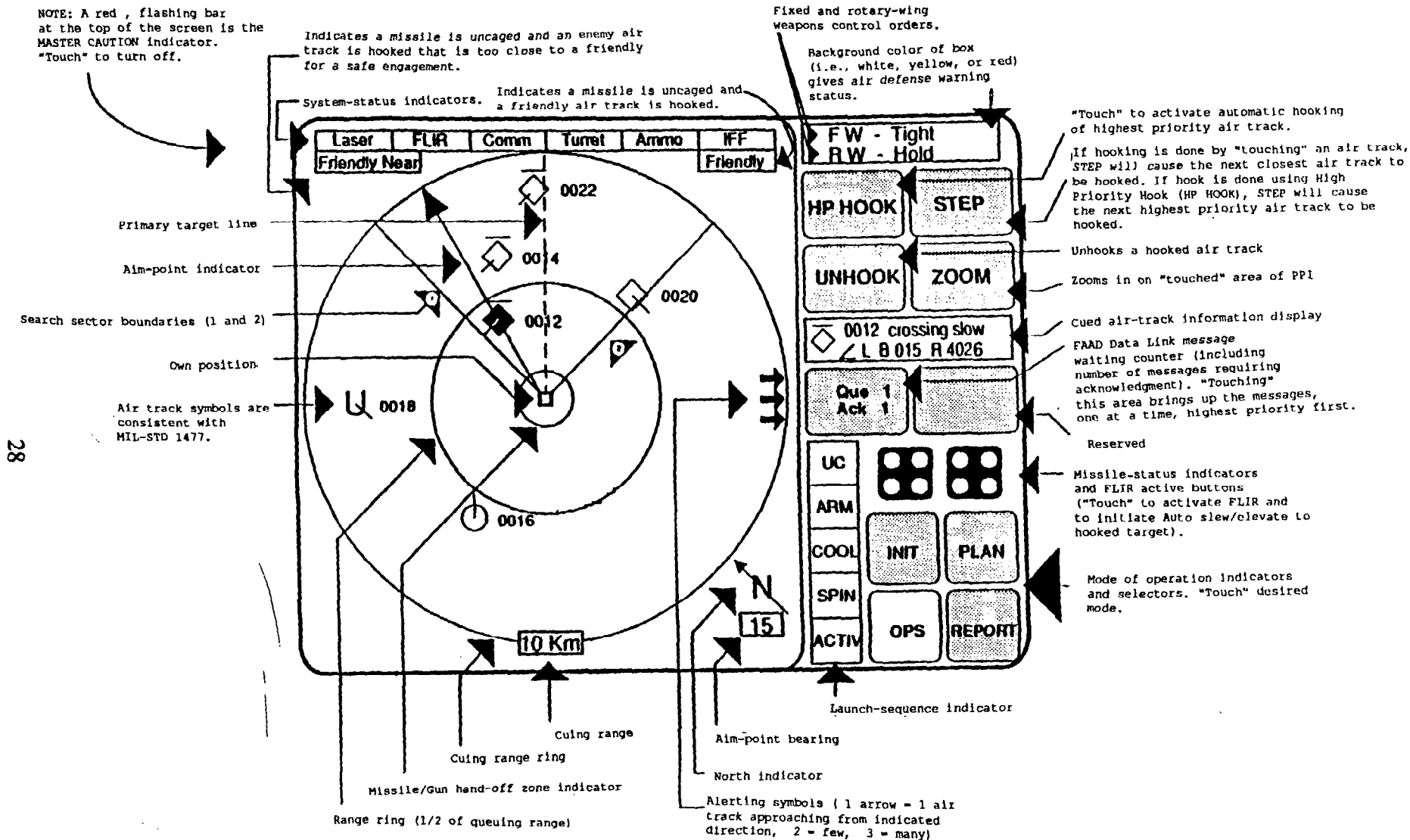


Figure 17. IWSD/PMS symbolic display mode.

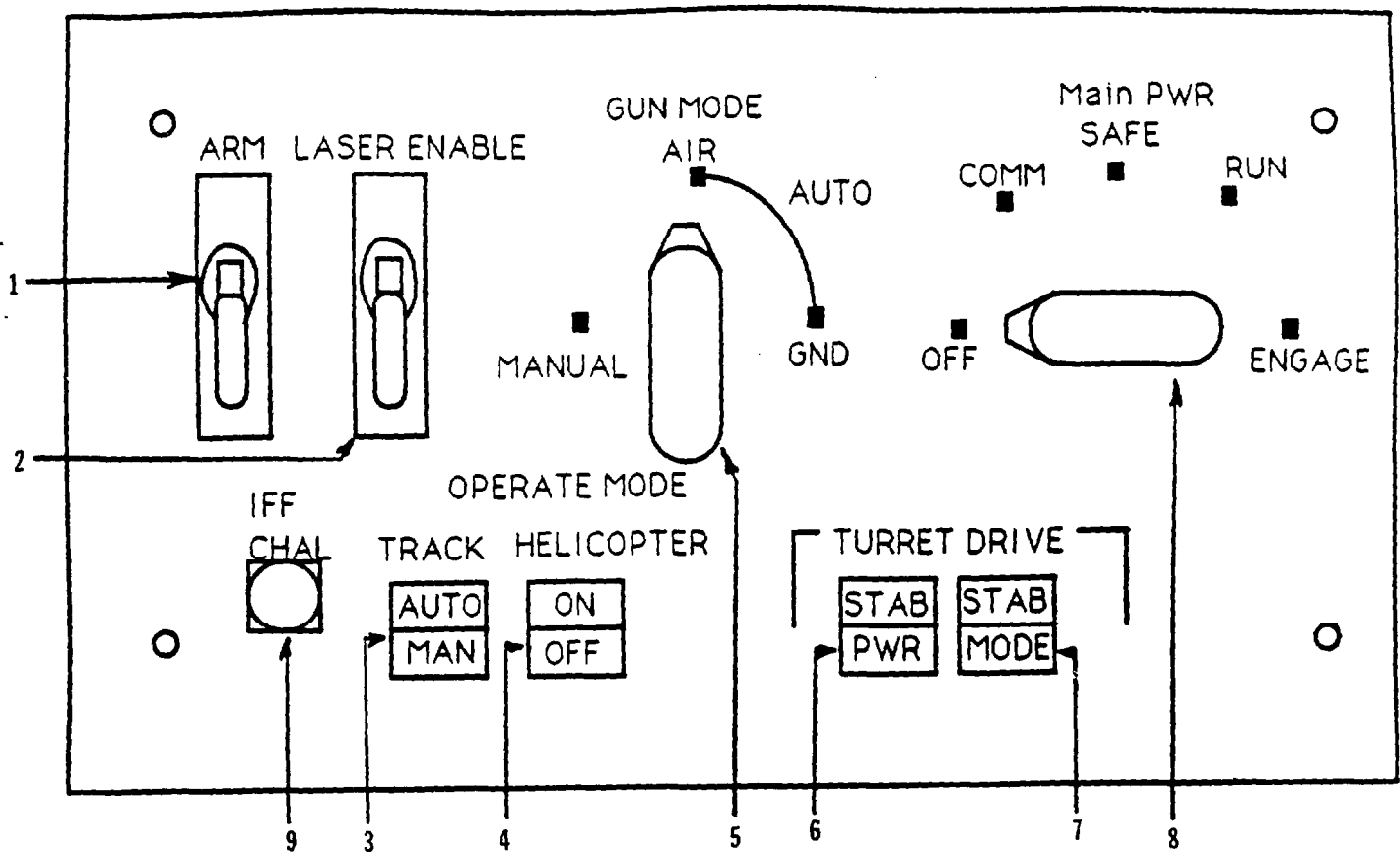
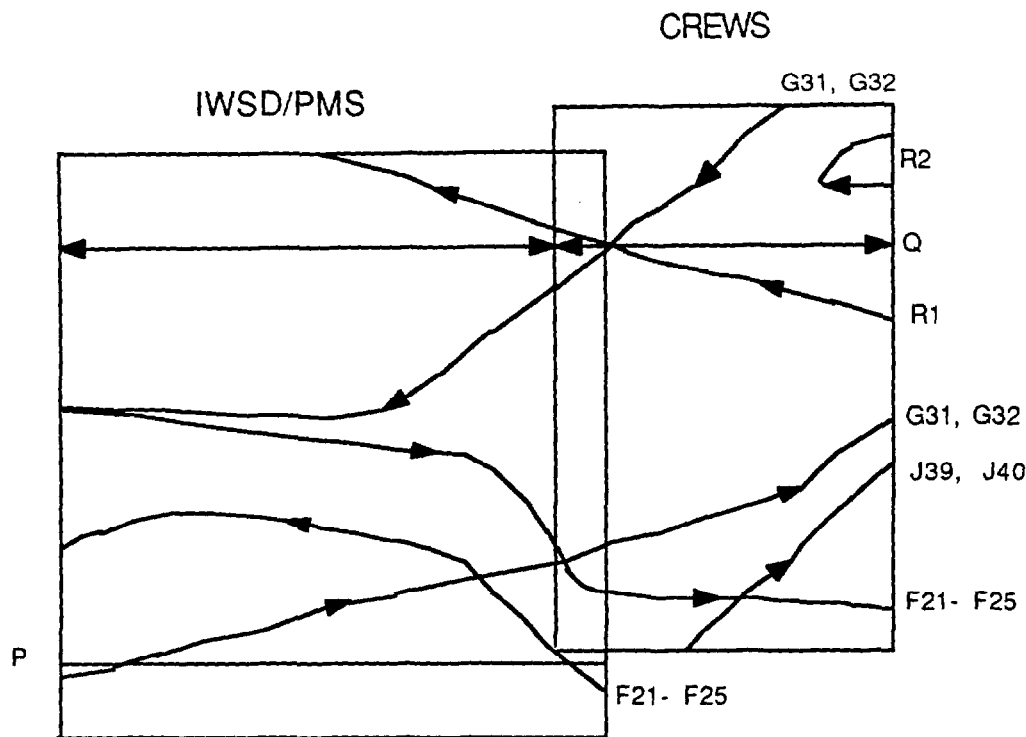


Figure 18. IWSD/PMS gunner's control panel.

The primary targets of this node are low flying, hostile rotary-wing aircraft. The secondary targets are low flying, hostile fixed-wing aircraft. Figure 19 shows the flight paths for all aircraft in the 9-km FLIR region of IWSD/PMS. Thirty-two airborne tracks are active and pass through the FLIR portion of the gaming area. These flights consist of both friendly and hostile aircraft and include rotary-wing aircraft such as Hokums, Hinds, Havocs, and Hips and fixed-wing aircraft such as Floggers, Fitters, F15s, and F16s. The flight paths are identified by path names such as G31, G32, J39, and so forth. Several aircraft flights may use the same path at different times in the simulation.

#### Simulation Equipment for IWSD/PMS

A Silicon Graphics model 4D/85GT (SGI 4D/85GT) is used to implement the IWSD/PMS node. This node communicates with the other components of the HELCAP simulation equipment by Ethernet. A 9-inch (22.86-cm) color 640-km x 480-km resolution CRT monitor, refreshed at 30 Hz, is used for the IWSD display. The display has a capacitive-type touch sensor overlaid on the 9-inch (22.86-cm) CRT. An M60 tank gunner's control has been modified and fitted with rotary-variable inductive transformers to sense the gunner's control position. An analog-to-digital converter and switch sensor board has been installed on the Silicon Graphics 4D/85GT VME backplane to acquire the analog-positioning data from the gunner's control and also to sense gunner's control switches and foot-switch activity.



Path R1, R2 = Hostile Rotor Wing

Path P, Q = Friendly Fixed Wing

Path G31, G32, J39, J40 = Hostile Fixed Wing

Figure 19. Flight paths for IWSD/PMS and CREWS gaming area.

### IWSD/PMS Simulator Configuration and Operation

The IWSD/PMS crew station configuration for the simulation is shown in Figure 20. The detail of the gunner's control panel (as shown in Figure 18) is implemented in the HELCAP simulation.

The operator interacts with the IWSD/PMS simulator in three ways: (a) By using a touch sensor on the CRT screen to perform actions related to the weapon system, (b) by using a hand-control device (see Figure 21) to change the azimuth and elevation of the sighting system to acquire target, and (c) by switches. The hand control also provides switches to launch the missile and perform other functions. A foot switch is used to change the FLIR field of view.

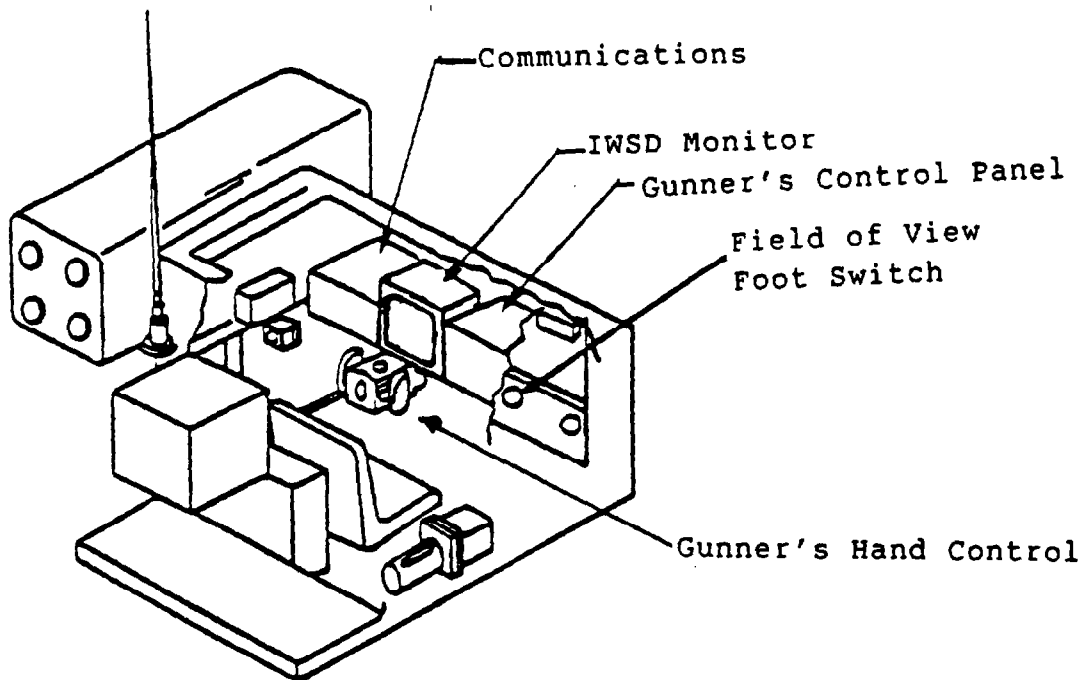


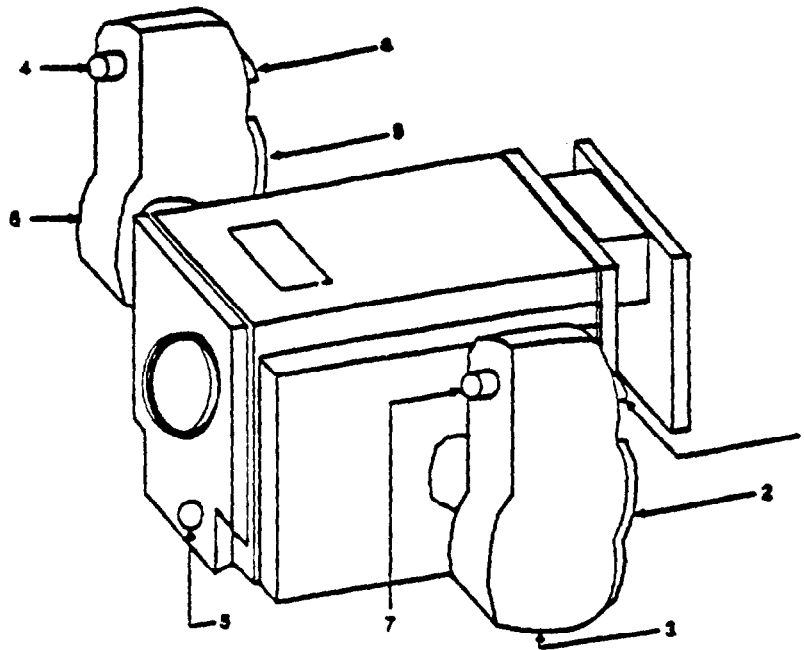
Figure 20. IWSD/PMS crew station.

The IWSD/PMS simulation is a fixed base simulation in which the FLIR visual simulation provides a full 360° apparent rotation. The rotational rate for the simulator is approximately 60° per second with the missiles caged and 30° per second when the missiles are uncaged. Elevation of IWSD/PMS ranges from -10° to approximately 70°. It takes approximately 3 seconds to change from -10° to 70° in elevation. The current turret-positioning system is a rate-control system in which the angular position of the hand control determines the rate of change in elevation or azimuth. The IWSD/PMS simulation will assume that the supporting vehicle is in a fixed position and will not move during the simulation.

#### Gunner's Control Panel Switches

The following describes the functions of the lights and switches on the IWSD/PMS gunner's control panel (refer to Figure 18).

1. ARM Switch - This is a two-position switch. When the switch is placed in the ARM position at beginning of simulation by the gunner, it operates the indicator lights only. The switch is not sensed by simulation software.



| Key | Control                                       | Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Fire switch<br>right trigger                  | Pressing switch will fire machine gun or a missile after its gyro has been uncaged.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 2   | Right-palm switch                             | Pressing switch performs the following: (a) Turns on the azimuth drive motor, (b) turns on the elevation drive motor, and (c) enables other hand station controls in ENGAGE mode.                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 3   | Right-hand controller                         | Controls azimuth and elevation rates of turret and launch beams when right- or left-palm switch (2 or 9) is pressed, and hand grips are rotated left/right or forward/rearward.                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 4   | Activate switch<br>left thumb                 | Switch works only when right- or left-palm switch is pressed, and ENGAGE mode is selected. Pressing switch will cause system to turn on proper SELECT light, begin gyro spin up and cool down of first missile, gyro spin up of second missile in other pod, and display activate symbol. Pressing switch a second time will do the following: (a) Turn on the machine gun as the selected weapon, (b) remove the missile activate symbol from sight and CRT symbology, and (c) stop the gyro spin up and cool down of all missiles. Turn off the missile status SELECT light on gunner control panel. |
| 5   | Drift-adjustment<br>switch                    | Pressing switch while right- and left-palm switches are released, vehicle is stationary and STAB mode is selected. This will null any turret drift created by gyros.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 6   | Left-hand controller                          | Operates the same as the right-hand controller (3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 7   | FLIR Automatic Video-<br>Tracker (AVT) switch | Press and release switch (7) to enable FLIR AVT. Press and release switch again to disable FLIR AVT. FLIR AVT overrides missile auto-track feature.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 8   | Uncage switch left<br>trigger                 | Pressing and holding switch performs the following: (a) Commands missile electronics to uncage missile gyro, (b) fires laser range finder when depressed and LASER-ENABLE switch on gunner-control panel is set to on, and (c) enables missile auto track. If AUTO-TRACK switch light is on, gunner control panel is set to AUTO, and FLIR AVT is not enabled with right-thumb switch.                                                                                                                                                                                                                 |
| 9   | Left-palm switch                              | Performs same as right-palm switch (2).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

Figure 21. Gunner's hand-control device.

2. Laser Enable Switch - This is a two-position switch. When the switch is placed in the "on" position at beginning of simulation by the gunner, it operates the indicator lights only. The switch is not sensed by simulation software.

3. Track Switch - This is a two-section switch with a lamp. The top half of the switch (labeled AUTO) will illuminate green when pressed and is dark when turned off. It also turns off the MAN light if AUTO is on. The bottom half of the switch (labeled MAN) will illuminate white when pressed and is dark when turned off. It also turns off the AUTO indicator. The gunner will place this switch in MAN mode at the start of the simulation, but the gunner may engage the auto track.

4. Helicopter Switch - This switch selects the lead angle for firing on a target. This angle depends on whether the target is a fixed- or rotary-wing aircraft. The helicopter switch is a two-section switch with a lamp. The top half of the switch (labeled ON) will illuminate green when pressed and is dark when off. It turns off the OFF indicator. The bottom half of the switch (labeled OFF) will illuminate white when pressed and turns off MAN and ON (see Switch 3 of Figure 18). The bottom half of the switch is dark when turned off. It is not sensed by the simulation software.

5. Gun Mode Switch - (cosmetic only)

6. STAB/PWR Switch - This switch turns on the turret stabilization system. It has a two-section switch with a lamp. The top half of the switch (labeled STAB) will illuminate green when pressed and is dark when turned off. It also turns off the PWR and STAB of the STAB/MODE indicator. The bottom half of the switch (labeled PWR) will illuminate white when pressed and turns off STAB. The bottom half of the switch is dark when off. The gunner will place this switch in the STAB mode at the beginning of simulation. It is not sensed by the simulation software.

7. STAB/MODE Light - Will illuminate green when STAB mode is selected.

8. Main PWR Switch - When this switch is in the run or engage position, it will turn on power to the IWSD display and gunner control panel. The engage position is sensed by simulation software.

9. IFF CHAL Switch - This switch sends an interrogation signal that activates the IFF. It is a spring-loaded switch and is not sensed by simulation software.

## CONCLUSION

HELCAP was successfully demonstrated in the HEL counter-air symposium on 17 and 18 July 1991. This simulation facility has the potential to further provide improved operational capability for the aviation and air defense community and may also be used to investigate the C<sup>3</sup> issues for optimizing soldier-machine interfaces in command control networks in combined arms aviation and air defense operations.

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**APPENDIX A**  
**HELICAP MESSAGE SUBSET**

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# HELCAP MESSAGE SUBSET

Table A-1

## HELCAP Messages

| Message type         | Crew | IWDS/PMS | AVTOC | ADTOC |
|----------------------|------|----------|-------|-------|
| WCO F12              | R    | R        | G     | G     |
| FCO F29              | R    | R        | G     | G     |
| MOVMT Ord F15        | R    | R        | G     | G     |
| Enmy Act Rpt F13     | G    | NA       | GR    | GR    |
| Kill Rpt F16         | NA   | G        | NA    | R     |
| Kill Rpt-AV F61      | G    | NA       | R     | NA    |
| Unit Loc Rpt F18     | G(A) | G(A)     | R     | R     |
| Data Mgmt F1         | R    | R        | G     | G     |
| Unit Oper Rpt F5     | NA   | G        | NA    | R     |
| Track Mgmt F4        | G/R  | G/R      | G/R   | G/R   |
| Simulation Ctrl F26  | R    | R        | G*    | R     |
| Situation Rpt-AV F60 | G    | NA       | R     | NA    |

G = generate; R = received; G/R = generated and received; NA = not applicable;

(A) = Message is automatically generated by the host computer for that node.

\* Sent by AVTOC to synchronize start of simulation at each node.

Message priority will be according to FDL TIDP MIS 36264B, page 13.

Messages F60 and F61, as defined on the following pages, would be additions to the FDL TIDP MIS 36264B to support HELCAP aviation requirements.

All messages for HELCAP have bits 80-87 appended to permit the identification of the message source for HELCAP.

| Value     | Source                                   |
|-----------|------------------------------------------|
| 87-----80 |                                          |
|           |                                          |
| 00000001  | = Aviation tactical operations center    |
| 00000010  | = Air defense tactical operations center |
| 10000000  | = IWSD/PMS fire unit                     |
| 10000001  | = Helicopter fire unit (crew)            |

Bit 87 = 1 source is a fire unit

Bit 87 = 0 source is a TOC or other command post

### F-60 Situation Report - Aviation

| Component                  | Quantity of bits | Bit numbers | Resolution coding (etc.) | Remarks                                                            |
|----------------------------|------------------|-------------|--------------------------|--------------------------------------------------------------------|
| Sublabel                   | 6                | 0-5         | 111100                   |                                                                    |
| Machine receipt            | 1                | 6           |                          | 0 = original message<br>1 = machine receipt                        |
| Spare                      | 6                | 7-12        |                          |                                                                    |
| Operational status         | 2                | 13-14       |                          | 00 = no statement<br>0 = limited operations<br>11 = non operations |
| Spare                      | 20               | 15-34       |                          |                                                                    |
| Rounds remaining           | 7                | 35-41       |                          | LSB = 50                                                           |
| Number of rockets          | 4                | 42-45       |                          |                                                                    |
| Number of air-air missiles | 4                | 46-49       |                          |                                                                    |
| Number of air-gnd missiles | 4                | 50-53       |                          |                                                                    |
| Fuel remaining             | 10               | 54-63       |                          | minutes                                                            |
| Spare                      | 16               | 64-79       |                          |                                                                    |
| Source ID                  | 8                | 80-87       |                          |                                                                    |

F-61 Kill Report - Aviation

| Component                       | Quantity<br>of bits | Bit<br>numbers | Resolution<br>coding (etc.) | Remarks                                     |
|---------------------------------|---------------------|----------------|-----------------------------|---------------------------------------------|
| Sublabel                        | 6                   | 0-5            | 111100                      |                                             |
| Machine<br>receipt              | 1                   | 6              |                             | 0 = original message<br>1 = machine receipt |
| Number of fixed<br>wing killed  | 5                   | 7-11           |                             | LSB = 1                                     |
| Number of rotary<br>wing killed | 5                   | 12-16          |                             | LSB = 1                                     |
| Number of missiles<br>killed    | 5                   | 17-21          |                             | LSB = 1                                     |
| Number of tanks<br>killed       | 5                   | 22-26          |                             | LSB = 1                                     |
| Number of AP<br>killed          | 5                   | 27-31          |                             | LSB = 1                                     |
| Number of AD<br>killed          | 5                   | 32-36          |                             | LSB = 1                                     |
| Number of<br>wheel veh killed   | 6                   | 37-42          |                             | LSB = 1                                     |
| Spare                           | 37                  | 43-79          |                             |                                             |
| Source ID                       | 8                   | 80-87          |                             |                                             |

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**APPENDIX B**  
**HELICAP COCKPIT COMMUNICATIONS DISPLAY SPECIFICATIONS**



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## HELCAV COCKPIT COMMUNICATIONS DISPLAY SPECIFICATIONS

The following describes the pilot communications interface applicable to HELCAV.

### Assumptions

The messages used for communication between the aircraft and TOC consist of the FAAD C<sup>2</sup>I messages with additional message types required to support the HELCAV aviation needs.

This display cannot satisfy the needs of a complete cockpit communications system. Further, this display cannot replace the pilot's secure frequency-modulator (FM) network to communicate with other aircraft. A "quick" solution is given in the section "FM Radio Network" which follows.

### To Activate and Deactivate the Communications Screen

The communications system is presented on CRT D1 (see Figures 8 and 9). This screen is provided with a touch-sensitive overlay device which will be used to implement the communications functions. Switches located on the collective (see Figure B-1) will also be used in the implementation of the communications functions.

The CRT for communications is shared with navigation. Collective Switch 5 will select the presentation. In the forward position, the CRT will implement communications. The aft position will implement navigation.

If Switch 5 is changed at any time during the use of the communications screen, any "work" not completed will be considered aborted. For example, if the pilot is reading a message, the message will be saved. However, if the pilot is formatting a message to be sent (or if an acknowledgment is returned for an incoming message) and a message has not been sent before switching back to the navigational screen, the message will not be sent, thereby aborted and canceled.

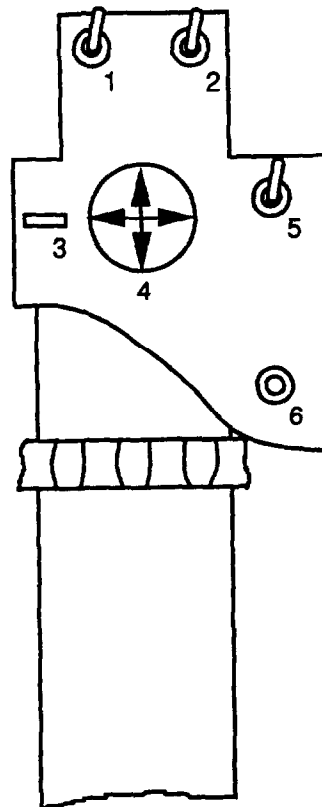
### Specifications for Display Screen, Collective Controls, and Voice System

#### Collective Controls

On the collective there are two controls used to manipulate the communications display (see Figure B-1). The Chinese hat, Switch 4, is used for the vertical and horizontal cursor control on the menus. The button to the lower right, Switch 6, is used as an "enter" key. An enter touch key that appears on the display serves the same function and can be used. Unless otherwise stated, these keys are interchangeable.

#### Modes

There are four modes for the communications screen: Format message, read message, incoming message log, and out-going message log (see Figure B-2). These four modes will remain on the screen at all times so that the pilot can switch from mode to mode. The last touch key located under the mode will be used as a control key within the modes. Its function serves as an enter touch key. The mode that the pilot is currently using will be displayed at the top of the screen (see Figure B-3). A digital time read out also appears at the top of the display.



1. Bat handle on-off-on
2. Bat handle on-off toggle
3. Flat handle on-none-on spring return to neutral
4. Four-way switch
5. Bat handle on-off-on
6. Push button SPST

Figure B-1. Collective switches.

|  |                                                                                                                                                                                                                                                                                            |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <div data-bbox="1285 521 1466 683">READ<br/>MSG</div> <div data-bbox="1285 725 1466 887">IN<br/>MSG<br/>LOG</div> <div data-bbox="1285 944 1466 1106">FORMAT<br/>MSG</div> <div data-bbox="1285 1164 1466 1325">OUT<br/>MSG<br/>LOG</div> <div data-bbox="1285 1361 1466 1523">ENTER</div> |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Figure B-2. Communication screen.

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## Feedback

Interim feedback to touch key or switch interaction is provided by highlighting the touch key to indicate that the action was sensed.

## Switching Modes

A pilot can exit the current mode and enter a new mode by selecting a new touch key.

## Voice System

Incoming messages to the pilot are voiced as well as displayed on the communications screen (a Digital Equipment Corporation DECtalk® voice synthesizer is used to convert ASCII messages to voice). The synthesized voice is female, and the context in which the pilot receives the information should be in a short sentence structure (Simpson & Williams, 1980).

## Mode Descriptions and Message Handling

### Read-Message Mode

There are two types of messages received by the helicopter crew. One requires an acknowledgment, the other does not. For the HELCAP demonstration, there are three incoming messages to the aircraft. All three are acknowledgment messages: Weapons control order, fire control order, and mission order. At present, there are no nonacknowledgment messages.

Incoming message priority is based on the FAAD C<sup>2</sup>I priority. A second priority is based on time. The highest priority message will have a queue number of "1." The second highest priority message will have a queue number of "2," and so on (see Figure B-4).

The pilot is notified of incoming messages by a voiced statement (see "Incoming Messages - Voice Alerting"). The pilot responds to an incoming message(s) by selecting the communications display. The read-message display shows the messages in order of priority (see Figure B-4). The information includes message priority and queue number, the time received, where the message is from, the message type, and whether the message requires an acknowledgment.

The first and highest priority message is highlighted. If this is the pilot's choice of message, the pilot will press ENTER resulting in the message being voiced to the pilot as it is displayed on the screen. However, if this is not the message of choice, the pilot selects another message by using the cursor control to highlight the message of choice. The pilot confirms the choice by pressing the ENTER switch or touch key.

|              |       |       |                  |     |             |
|--------------|-------|-------|------------------|-----|-------------|
| READ MESSAGE |       | 0000Z |                  |     | READ MSG    |
| 1            | 0931Z | AVTOC | WEAPONS CTRL ORD | ACK | IN MSG LOG  |
| 2            | 0930Z | AVTOC | FIRE CONTROL ORD | ACK |             |
| 3            | 0910Z | AVTOC | WEAPONS CTRL ORD | ACK |             |
|              |       |       |                  |     | FORMAT MSG  |
|              |       |       |                  |     | OUT MSG LOG |
|              |       |       |                  |     | ENTER       |

Figure B-4. Read message display.

## Acknowledgment Messages

The three acknowledgment messages for the HELCAP are weapons control order, fire control order, and mission order.

1. Weapons control order (WCO) - The WCO (see Figure B-5) serves two purposes. One, it alerts the pilot of activities by air defense units possibly in the area, and two, it informs the pilot of the alert state of the air defense unit and what their weapon status is regarding rotary-wing aircraft.
2. Fire control order (FCO) - The FCO (see Figure B-6) alerts the pilot of an airborne track number and gives him instructions about controlling the engagement of the assigned track number.
3. Mission order (MO) - The MO (see Figure B-7) is the same as a movement order for air defense. Its purpose is to direct the pilot or unit to change (or plan to change) the mission.

For acknowledgment-type messages, the information is voiced to the pilot as well as displayed on the communications display. Data titles are on the left side of the window, and the current data are displayed to the right of the data title (see Figures B-5, B-6, and B-7). Below the information will be the description RESPONSE. If this is present, the following three response touch keys will appear: WILCO (will comply), UNABLE (cannot comply), and COMPLETED (have complied). The pilot responds by either using the cursor control to highlight one of the touch keys or by touching one of the selections on the screen. Only one touch key can be selected. If a pilot makes an error in selection, he or she can correct the error by using the cursor control to highlight a new selection or by touching another comply touch key.

When the pilot presses ENTER, an acknowledgment is sent to the sender of the incoming message. Once the message is on its way, the screen defaults to the display that lists the remaining messages. The priority of the unread messages will move up in the queue so that the second message will become the first message, the third message will become the second message and so on (see Figure B-8). The read and acknowledged message goes to the incoming message log. This mode is described in a later section of this report.

If the pilot exits the READ MSG mode and has not listened to or read and acknowledged the message, the message will remain in the READ MSG queue as an unread message and retain the same priority.

## Nonacknowledgment Messages

Nonacknowledgment messages are treated in the same manner as acknowledgment messages, except no response is required. After the pilot has finished listening to or reading the message, the pilot presses ENTER which saves the message to the incoming message log. The screen defaults back to the display that lists the remaining messages. At this time, there are no such messages in the HELCAP demonstration.

## Incoming Message Log

The incoming message log (IN MSG LOG) is used to store all messages that the pilot has received and, where applicable, acknowledged. The log lists the messages in order from the most recent message entered to the oldest message received (see Figure B-9). The information shown on the display is the message number (Number 1 is the most recent message to enter the log), the time received, the source of the message, the message name, and the acknowledgment status. The



|               |        |                |             |
|---------------|--------|----------------|-------------|
| READ MESSAGE  | 0000Z  | WEAP CTRL ORD  | READ MSG    |
| EFFECTIVE DTG | 1015Z  |                |             |
| WCO ROTARY    | TIGHT  |                | IN MSG LOG  |
| WCO FIXED     | HOLD   |                |             |
| RELEASE DTG   | 1045Z  |                | FORMAT MSG  |
| RESPONSE      |        |                |             |
| WILCO         | UNABLE | COM-<br>PLETED | OUT MSG LOG |
|               |        |                | ENTER       |

Figure B-5. Weapons-control order display.

|              |             |                |             |
|--------------|-------------|----------------|-------------|
| READ MESSAGE | 0000Z       | FIRE CTRL ORD  | READ MSG    |
| TRACK NO.    | 4567        |                | IN MSG LOG  |
| TARGET ALT   | 1127 FT MSL |                | FORMAT MSG  |
| COORDINATE   | NB445401    |                | OUT MSG LOG |
| ACTION       | ENGAGE      |                | ENTER       |
| RESPONSE     |             |                |             |
| WILCO        | UNABLE      | COM-<br>PLETED |             |

Figure B-6. Fire-control order display.

|               |                 |           |             |             |
|---------------|-----------------|-----------|-------------|-------------|
| READ MESSAGE  |                 | 0000Z     | MISSION ORD | READ MSG    |
| EFFECTIVE DTG |                 | 0720Z     |             | IN MSG LOG  |
| MISSION       |                 | OPCON     |             |             |
| SUPPORT UNIT  | 1ST BN 440TH AD |           |             | FORMAT MSG  |
| PURPOSE       | ACTION          |           |             |             |
| RELEASED DTG  |                 | 0750Z     |             | OUT MSG LOG |
| RESPONSE      |                 |           |             |             |
| WILCO         |                 | UNABLE    |             | ENTER       |
|               |                 | COMPLETED |             |             |

Figure B-7. Mission order display.

|              |       |       |               |     |       |
|--------------|-------|-------|---------------|-----|-------|
| READ MESSAGE |       |       |               |     | 0000Z |
| 1            | 0931Z | AVTOC | MOVEMENT ORD  | ACK |       |
| 2            | 0930Z | AVTOC | FIRE CTRL ORD | ACK |       |

READ  
MSG

IN  
MSG  
LOG

FORMAT  
MSG

OUT  
MSG  
LOG

ENTER

Figure B-8. Read message display.

| INCOMING MSG LOG |       | 0000Z |                   |       |
|------------------|-------|-------|-------------------|-------|
| 1                | 0900Z | AVTOC | WEAPON CTRL ORD   | WILCO |
| 2                | 0859Z | A-CO  | SITUATION RPT     | N/A   |
| 3                | 0855Z | AVTOC | UNIT LOCATION RPT | N/A   |
| 4                | 0850Z | AVTOC | FIRE CTRL ORD     | WILCO |

READ  
MSG

IN  
MSG  
LOG

FORMAT  
MSG

OUT  
MSG  
LOG

ENTER

Figure B-9. Incoming message log display.

acknowledgment status gives the pilot's response to the message. Data for this field can be one of the following: WILCO, UNABLE, COMPLETED, or NA. NA is for incoming messages that do not require acknowledgment.

### Reviewing Previously Received Messages

If the pilot wants to reread a message, he or she selects the message to be reviewed by using the cursor control (Switch 4) on the collective. Once the message is highlighted, he or she presses ENTER. The message will be displayed and voiced to the pilot. Once the pilot has finished reviewing the message, he or she presses ENTER. This will take the pilot back to the incoming message log.

### Format Message Mode

This mode is used to write and send "canned" TIDP messages to critical aviation elements (i.e., TOC and other companies in the Battalion). Upon selecting the FORMAT MSG touch key, a screen will display messages that a pilot can send (see Figure B-10). For the current baseline design, there are only three messages: Situation report, spot report, and kill report.

The pilot selects the message to be formatted and sent by using the cursor control to highlight the message and then presses ENTER. The screen changes to the selected message screen. The name of the report will be placed on the same line as the current mode (right justified).

### Situation Report - Aviation

The aviation situation report (see Figure B-11) is similar to the FAAD C<sup>2</sup>I unit operational report. Message type F60 has been created to support aviation needs. This is shown in Appendix A, Table A-1.

To format a message, the pilot will touch the designated touch key(s) for the following informational fields: Operational status, fuel remaining, and ammunition status. Some of the field designations allow for multiple touch entries; others do not. The informational fields are as follow: (a) Operational status allows one selection, (b) fuel remaining does not allow input from the pilot (the system data base monitors fuel and places the information in the data field), and (c) ammunition status allows multiple selections (the following paragraphs explain each field in detail).

The pilot makes his or her selection by touching the necessary entries. For single selection fields, a pilot can correct errors by simply selecting another touch key in that field or retouching the incorrect touch key and selecting the correct touch key. For multiple selection fields, the pilot must retouch the incorrect touch key to deselect his or her choice.

For the ammunition status field, the simulator's data base keeps a record of what remaining ammunition the pilot has on board the aircraft. The pilot has no need to change the data base values. If the pilot should want to change the values, he or she may do so by touching the clear area of the touch key to "zero" the data base values. The pilot touches the data area of the touch key to increase the value of ammunition. Each touch will increase the data value by one. In the case of ammunition rounds, each touch increases the data by "50." By touching the left side of the button CLR, the data values are cleared to zero. Note. The touch key area is divided into two active areas each equal to the size of 1.75 cm to 1.92 cm (0.7 to 0.75 inch) square with dead space (nonactive area) of 0.64 cm (0.25 inch). ENTER is pressed upon completion of the entries and causes the display to change to the distribution list.

|                           |               |                   |
|---------------------------|---------------|-------------------|
| FORMAT MESSAGE      0000Z |               | READ<br>MSG       |
| 1                         | SITUATION RPT | IN<br>MSG<br>LOG  |
| 2                         | SPOT RPT      |                   |
| 3                         | KILL RPT      | FORMAT<br>MSG     |
|                           |               | OUT<br>MSG<br>LOG |
|                           |               | ENTER             |

Figure B-10. Format message display.

|                                                           |  |                                                             |         |                                                                                                         |
|-----------------------------------------------------------|--|-------------------------------------------------------------|---------|---------------------------------------------------------------------------------------------------------|
| FORMAT MESSAGE                                            |  | 0000Z                                                       | SIT RPT | <div>READ MSG</div> <div>IN MSG LOG</div> <div>FORMAT MSG</div> <div>OUT MSG LOG</div> <div>ENTER</div> |
| STATUS                                                    |  |                                                             |         |                                                                                                         |
| <div>OPER</div> <div>LIMIT OPER</div> <div>NON OPER</div> |  |                                                             |         |                                                                                                         |
| FUEL REMAINING                                            |  |                                                             |         |                                                                                                         |
| <div>01:42 MIN</div>                                      |  |                                                             |         |                                                                                                         |
| AMMO REMAINING                                            |  |                                                             |         |                                                                                                         |
| <div>CLR</div> <div>ROUNDS</div> <div>0600</div>          |  | <div>CLR</div> <div>ROCKET</div> <div>0</div>               |         |                                                                                                         |
| <div>CLR</div> <div>AIR - AIR MISSILE</div> <div>3</div>  |  | <div>CLR</div> <div>AIR - GROUND MISSILE</div> <div>1</div> |         |                                                                                                         |

Figure B-11. Situation report display.



## Spot Report

The spot report for aviation is the same as the Enemy Activity Report for the FAAD C<sup>2</sup>I system (see Figure B-12). The report will send the same information in the "SALUTE" format (size, activity, location, unit, time, and equipment). To lessen pilot work load and declutter the display, the "system" sends the ownship military grid coordinate and the time the spot report is made. This information is not displayed but is kept by the simulator's data base. Like the situation report, there are some informational fields that are limited to one selection and some allow for multiple selections. The informational fields are as follow: (a) Unit size allows one selection, (b) activity allows one selection, (c) location is not displayed, (d) direction of movement allows one selection, (e) unit type allows one selection, (f) time is not displayed, and (g) equipment (same as weapons type) allows multiple selections.

Direction of movement is typically used when describing the location of the enemy activity. The rules for selecting and deselecting entries also apply to the spot report. Once the pilot has completed information on a page, ENTER must be pressed to proceed to the distribution list.

## Kill Report

The kill report is used to report back to TOC and essential elements the number of fixed- and rotary-wing aircraft killed or disabled and the number of missile kills. The FAAD C<sup>2</sup>I TIDP kill report does not meet the requirements for an aviation unit which might need to report tank, armored vehicle, and so forth killed. An aviation kill report (see Appendix A, Table A-1, and Figure B-13) was designed to be used instead of the air defense kill report.

To format the message to be sent, the pilot touches the designated data area of the touch key for air-to-air kills and air-to-ground kills. The default for the numbers in the data entry fields will be zero. If the pilot has made a mistake by touching a touch key, the error is corrected by touching the clear area of the touch key. For each touch in the data entry field, the number of kills increases by "one."

Once the pilot has completed the entries, ENTER is pressed to route the message to the distribution list.

## The Distribution List and Sending the Message

The distribution list is used for routing messages to various critical units (see Figure B-14). A single helicopter pilot will need to communicate with three companies (one being his or her own), and in the HELCAP demonstration, the TOCs. The pilot selects the units to receive the message by touching the listed designations. If a mistake is made on one of the selections, the error is corrected by selecting the touch key again to deselect it. Once the pilot has finished the selections, ENTER is pressed. In the HELCAP demonstration, the pilot only needed to select TOC, but he or she may have simulated sending the message to other units.

To select a different frequency for a unit, the pilot can touch the ALT touch key for alternate frequencies. While the alternate frequencies are in use, the ALT touch key will remain highlighted. Once the message is sent, the screen defaults to the display that lists the choices of message formats to be sent (refer to Figure B-10). The message will then be logged in the outgoing message log (OUT MSG LOG).

| FORMAT MESSAGE                                                                                                              |  | 0000Z                                                                                                                                |  | SPOT RPT               |  |
|-----------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------|--|------------------------|--|
| <div>SIZE</div> <div>GROUND      AIR</div> <div> <div>SQD</div> <div></div> </div>                                          |  | <div>N</div> <div>NW      NE</div> <div>W      E</div> <div> <div>NOT</div> <div>MOV</div> </div> <div>SW      SE</div> <div>S</div> |  | <div>READ MSG</div>    |  |
| <div>ACTIVITY</div> <div>FIRE</div>                                                                                         |  |                                                                                                                                      |  | <div>IN MSG LOG</div>  |  |
| <div>UNIT TYPE</div> <div> <div>TANK</div> <div>INF</div> <div>ART</div> <div>AD</div> <div>MECH</div> </div>               |  |                                                                                                                                      |  | <div>FORMAT MSG</div>  |  |
| <div>EQUIPMENT</div> <div> <div>TANK GUN</div> <div>ART</div> <div>APC</div> <div>AD MISSILE</div> <div>ROCKET</div> </div> |  |                                                                                                                                      |  | <div>OUT MSG LOG</div> |  |
|                                                                                                                             |  |                                                                                                                                      |  | <div>ENTER</div>       |  |

Figure B-12. Spot report display.

| FORMAT MESSAGE                                                                                         |         |   | KILL RPT      |              |    |
|--------------------------------------------------------------------------------------------------------|---------|---|---------------|--------------|----|
| AIR-TO-AIR                                                                                             |         |   | AIR-TO-GROUND |              |    |
| CLR                                                                                                    | FIXED   | 1 | CLR           | TANKS        | 50 |
| CLR                                                                                                    | ROTARY  | 0 | CLR           | APC          | 2  |
| CLR                                                                                                    | MISSILE | 0 | CLR           | AD           | 2  |
|                                                                                                        |         |   | CLR           | VEH<br>WHEEL | 2  |
| <div>READ MSG</div> <div>IN MSG LOG</div> <div>FORMAT MSG</div> <div>OUT MSG LOG</div> <div>SEND</div> |         |   |               |              |    |

Figure B-13. Aviation kill report display.

|                |      |       |     |                   |
|----------------|------|-------|-----|-------------------|
| FORMAT MESSAGE |      | 0000Z |     |                   |
| AV<br>TOC      | CO A |       |     | READ<br>MSG       |
| AD<br>TOC      | CO B |       |     | IN<br>MSG<br>LOG  |
|                | CO C |       |     | FORMAT<br>MSG     |
|                |      |       | ALT | OUT<br>MSG<br>LOG |
|                |      |       |     | ENTER             |

Figure B-14. Message distribution list display.

## Outgoing Message Log

The outgoing message log is used to store all the messages the pilot has sent. The log is listed in order from the most recent message sent to the oldest message sent (see Figure B-15). The information shown on this display is the message number ("1" being the most recent message sent), the time at which the message was sent, the receiver of the message, and the message name.

If the pilot wants to reread a message, the message is selected by using the cursor control (Switch 4) on the collective and pressing the ENTER switch (Switch 6) or the ENTER touch key. The screen will then go to the message screen selected.

## Reviewing Previously Sent Messages

If the pilot is rereading a message which has been sent, the previous selections from the canned messages will be maintained so that the pilot knows what messages have been sent. Therefore, any touch keys that were selected will remain highlighted, and the data entry fields that have entered data will be displayed. Once the pilot is finished reviewing the message, ENTER is pressed and the outgoing message log is displayed.

## FM Radio Network Introduction

The communications display does not implement a pilot's secure FM-net radio for communication with aircraft and other nearby ground units. To accommodate this problem, an FM-net radio can be simulated with the following additions to or modifications of the HELCAP cockpit communications display or system specifications.

### To Activate and Communicate by the FM-Net

Once the pilot is in the FM-net mode, the top of the display will say SEND MESSAGE (see Figure B-16). The purpose for this change in word choice makes the communications system sound compatible to both digital and voice messages.

### To Communicate by Simulated Radio

The pilot can communicate with a unit at any time by pressing the communication fore-finger switch, which is currently on the helicopter cyclic control, and speaking into the microphone.

### To Change Unit Frequencies

To change frequencies to communicate with a new unit, the pilot activates the communication screen by the dedicated switch and chooses the SEND MSG touch key either by touching it or by using the Chinese hat on the collective and pressing ENTER. A screen will display the messages that a pilot can send (Figure B-17). The current baseline design has three messages. At the bottom of this screen, a fourth choice "distribution list change frequency" will appear. The pilot selects this choice by using the cursor control to highlight the message and presses ENTER. The screen then refers to the distribution list (refer to Figure B-14) that is used to send TIDP formatted messages.

|                   |       |           |               |                   |
|-------------------|-------|-----------|---------------|-------------------|
| OUT-GOING MSG LOG |       |           | 0000Z         | READ<br>MSG       |
| 1                 | 0900Z | TOC, B-CO | SITUATION RPT | IN<br>MSG<br>LOG  |
| 2                 | 0859Z | A-CO      | SITUATION RPT |                   |
| 3                 | 0855Z | TOC       | UNIT LOC RPT  | FORMAT<br>MSG     |
| 4                 | 0850Z | TOC       | SPOT RPT      |                   |
|                   |       |           |               | OUT<br>MSG<br>LOG |
|                   |       |           |               | ENTER             |

Figure B-15. Outgoing message log display.

|                                                                       |                                                                                                       |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| <div>SEND MESSAGE</div> <div>0000Z</div> <div>↑</div> <div>MODE</div> | <div>READ MSG</div> <div>IN MSG LOG</div> <div>SEND MSG</div> <div>OUT MSG LOG</div> <div>ENTER</div> |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|

Figure B-16. Send message by FM-net display.

|              |                                    |       |                   |
|--------------|------------------------------------|-------|-------------------|
| SEND MESSAGE |                                    | 0000Z | READ<br>MSG       |
| 1            | SITUATION RPT                      |       | IN<br>MSG<br>LOG  |
| 2            | SPOT RPT                           |       |                   |
| 3            | KILL RPT                           |       | SEND<br>MSG       |
| 4            | DISTRIBUTION LIST/CHANGE FREQUENCY |       | OUT<br>MSG<br>LOG |
|              |                                    |       | ENTER             |

Figure B-17. Distribution list or change frequency display.



The distribution list establishes those critical units needed in communication (refer to Figure B-14). A single helicopter pilot will need to communicate with three companies (one being his or her own), and in the HELCAP demonstration, TOCs and ground fire units. The pilot selects a unit and establishes radio contact by touching the listed designation. (Corrections are made by selecting the touch key again to deselect it.) Once the pilot has finished the selections, ENTER is pressed and a simulated FM-net is established. The pilot simulates voice communications by pressing the communication switch on the cyclic and speaking into the microphone.

### Incoming Messages - Voice Alerting

When an incoming message is received in the cockpit, the voice system alerts the pilot that there are incoming messages and the number of messages received. "You have xx incoming messages." (number of messages). If there is no response by the pilot after 2 minutes, the voice system will repeat the announcement. If another message is sent in the meantime, a new statement will be announced. The pilot will then activate the communications voice and display system. Once the pilot has selected a message to hear or read, the voice system will begin to read the message as it is displayed. For example, all incoming messages are as follow:

"Incoming from ."  
(Weapons Control Order (the AVTOC  
Fire Control Order Company A, B, or C)  
Mission Order)

### Weapons Control Order

"Effective (see Note 1) Zulu time, (see Note 2) minutes from now"  
Note 1 gives the time, for example "o one hundred hours" is 01:00.  
Note 2 states the time equal to the effective time minus the current time.

"Weapons control for rotary wing is (free, tight, or hold)."

"Weapons control for fixed wing is (free, tight, or hold)."

"This order is in effect until (give time) Zulu time."

"A response is required. End of message."

If "no statement" has been submitted for weapons control, the voice system will not state the line.

### Fire Control Order

"Track number (track number voiced one numeral at a time) has been designated hostile or unknown."

"Target's altitude is (altitude expressed one numeral at a time) feet mean sea level."

"Target's coordinate is (coordinate expressed one alphanumeric at a time)." Letters are voiced in military terms such as A is "Alpha," B is "Bravo."

If the bearing and range are available, the voice system will inform the pilot of the bearing and range of the target by saying the following:

"Target's bearing is... Target's range is... "

(Engage Target; Cease Target Engagement; Hold Your Fire)

"A response is required. End of message."

If "no statement" has been submitted for the action required line, the voice system will not state the line.

#### Mission Order

"Effective (see Note 1) Zulu time, (see Note 2) minutes from now"

Note 1 gives the time, for example "o one hundred hours" is 01:00.

Note 2 states the time equal to the effective time minus the current time.

"You will  
(be in direct support of  
provide general support to  
provide general reinforcing support to  
be OPCON to  
be reinforcing)

"The  
("first battalion, four-fortieth air defense,"  
or another appropriate support unit)

If the bearing and range are available, the voice system will inform the pilot of the bearing and range of the support unit by voicing the following:

"The unit's bearing is... The unit's range is... "

"This mission change notifies you (to take action or to plan for action)"

"This message is in effect until (give time) Zulu time."

"A response is required. End of message."

If "no statement" has been submitted for the purpose line, the voice system will not state the line.

After message has been read and the pilot has entered a response, the voice system states the following:

"Response sent to (AVTOC or where the message originated)," the pilot then returns to the queue of unread and unheard messages, and the voice system informs the pilot of the number of messages remaining to be read.

"You have incoming messages."  
(# of messages)