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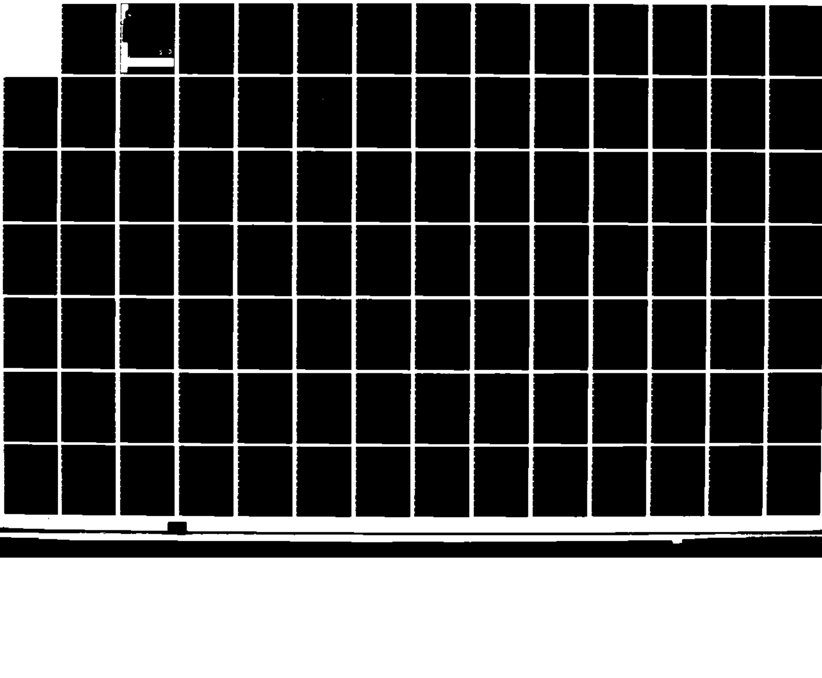

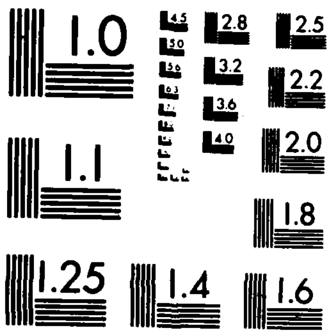


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Technical Report: NAVTRAEQUIPCEN 81-M-1121-1

# DEVICE 2F112 (F-14A WST) INSTRUCTOR CONSOLE REVIEW

AD A136965

John P. Charles
ICON, Inc.
San Diego, CA 92106

December 1983

Final Report



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|---|---|---|
| 1. REPORT NUMBER<br>NAVTRAEQUIPCEN 81-M-1121-1 | 2. GOVT ACCESSION NO.<br>AD A136 965 | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle)<br>DEVICE 2F112 (F-14A WST)<br>INSTRUCTOR CONSOLE REVIEW | | 5. TYPE OF REPORT & PERIOD COVERED<br>Final Report |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s)<br>JOHN P. CHARLES | | 8. CONTRACT OR GRANT NUMBER(s)<br>N61339-81-M-1121 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>ICON, Inc.<br>3401 Bangor Place<br>San Diego, CA 92106 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS<br>PE63733<br>NAVTRAEQUIPCEN Task No.<br>1783-1P2 |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>Naval Training Equipment Center<br>Orlando, FL 32813 | | 12. REPORT DATE<br>December 1983 |
| | | 13. NUMBER OF PAGES<br>138 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) | | 15. SECURITY CLASS. (of this report)<br>Unclassified |
| | | 15a. DECLASSIFICATION DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

-

18. SUPPLEMENTARY NOTES

-

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Simulator Training
Instructor Console
Simulator Instructor
Design Guidelines
Device 2F112

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A survey and analysis of Training Device 2F112 (F-14A Weapon System Trainer) instructor console operating problems was conducted. Feasible solutions were developed. General design guidelines were prepared.

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## SUMMARY

Following reports on operating problems with some of the newer airborne weapon system trainers (WST). The Human Factors Laboratory of the Naval Training Equipment Center undertook a critical review of the instructor operator stations of selected trainers. The initial review was of the EA-6B WST (Device 2F119) and was documented in technical report NAVTRAEQUIPCEN 81-M-1083-1. The results verified that significant problems did exist and constrained training effectiveness.

This report covers a review of the WST for the F-14A aircraft, Device 2F112. The device differs from the 2F119 in simulation features, operating philosophy and relationship to other training devices utilized in the training program.

The WST located at the Naval Air Station, Miramar was used for the review. Problems and operations were discussed with personnel at the Fighter Airborne Early Warning Wing Pacific, the Fleet Readiness Squadron (VF-124), fleet squadrons, the Navy Fighter Weapons School, and the Fleet Aviation Specialized Operational Training Group Detachment, all located at the Naval Air Station Miramar. Training operations were observed, documentation was reviewed and analyses of the instructor operating console were conducted. The goal was to identify console design deficiencies and feasible solutions. In addition, the identification of "design guides" which would help preclude similar problems from occurring in the future was undertaken.

A wide variety of problems ranging from basic human engineering defects to utilization and related instructor manning and training problems were found. The employment of professional Mission Operators to operate the trainer, while solving the basic simulator operating problems, has created a new set of problems.

Among the conclusions reached was that while the trainer potentially offers a wide variety of training capabilities, console design deficiencies severely limit its use. These problems include:

a. The instructor stations are too complex for operation by an instructor without extensive training. Displays required for monitoring and evaluating aircrew performance are difficult to access and compete for display space with data needed for control functions. No changes were made to the controls and displays or station design when the Mission Operator concept was implemented. Thus, while the trainer can now be brought "on line" by the Mission Operators, the instructors are still unable to effectively utilize the available displays and related controls to access student data and monitor performance.

b. The Operator Station is inadequate to support the Mission Operator functions. This results in the Mission Operator

utilizing instructor station displays and controls which interferes with instructor functions.

c. The instructor console operability problems result from a general lack of application of existing human engineering and aviation design standards and specifications and accepted aviation aircrew station design practices. Serious layout and arrangement problems, confusing labeling, inconsistent color coding, and poor control mechanization were among the deficiencies found.

d. The device as designed and implemented, is primarily usable only in the preprogrammed mode since the instructor "interface" was not designed to support training operations or to be operated by a "novice" or relatively naive operator. The utilization is further constrained by the fact that the console is simulation parameter, not training function oriented.

The recommendations which followed included:

a. A detailed analysis of user requirements and characteristics should be undertaken prior to modifying the instructor console and trainer interfaces.

b. The operator station should be redesigned to meet Mission Operator display and control requirements.

c. The instructor station displays and controls should be redesigned so as to be usable by weapon system instructors for training with minimal instruction in operation of the device.

d. Trainer software should be modified to permit effective use of trainer modes other than the preprogrammed or "formulated" mode of operation.

e. Trainer operating software should be redesigned to provide support to additional training functions such as brief and debrief.

f. Communications simulation capabilities should be incorporated to reduce instructor-student ratios, especially for the air battle or war-at-sea training events.

g. Performance measurement and mission effectiveness models should be designed and implemented to aid in crew and unit proficiency and readiness assessment.

# PREFACE

As has been frequently pointed out, a survey to identify problems and deficiencies (if initiated by valid inputs) will find some and in the process, raise the issue of why and how they occurred. The opportunities are manifold in the case of a complex piece of equipment such as a weapons system trainer for the F-14 system. Even greater possibilities can arise when changes in technology, management personnel, performance requirements and training strategy occur after the trainer Military Characteristic is drafted. In short, while some of the basic human engineering deficiencies which were found in the review should not have occurred, many of the problems have arisen from the changes which occur during the evolution of the device and do not reflect on the personnel who contributed to this survey.

While a great many officers and men contributed and helped in coordinating the data collection and analyses, the efforts of the following personnel should be recognized:

Mr. James Bolwerk, Commander Naval Air Force, U. S. Pacific Fleet staff, who sponsored and guided the survey at NAS Miramar, California,

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Device 2F112 Mission Operators

Mr. J. Wise
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The support of the staff at the FASOTRAGRUPAC Detachment, Miramar, was essential to the survey and the data and inputs of the technicians and operator personnel were invaluable.

Overall, the interest and support of all the personnel involved with Device 2F112 were outstanding and their interest in assisting in identifying problems and structuring feasible solutions was instrumental in the completion of the report.

## FOREWORD

This report documents the second in a series of human engineering analyses designed to provide data for the development of guidelines and specifications to support training device procurement. In it, the problems of operational usage of device 2F112 are described. As in the previous report, NAVTRAEQUIPCEN 80-M-1083-1, the problems of designing equipment to support multiple-instructor, multiple-crew training systems are highlighted. Device 2F112 is of special interest in this regard as it is the first where the Navy has employed contract personnel to serve as device instructor-operators in order to obtain individuals adequately trained in the use of a particular trainer.

G. L. Ricard

G. L. RICARD
Scientific Officer

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# SECTION I

# INTRODUCTION

## BACKGROUND

A review [1] of the instructor/operator console of the EA-6B Weapon System Trainer (WST) Device 2F119 was conducted in late 1981 by the Human Factors Laboratory of the Naval Training Equipment Center (NAVTRAEQUIPCEN) following reports from the users of operating problems. The survey looked at both the design and use of the device. A wide variety of human engineering design deficiencies in addition to some basic utilization problems were found. The review concluded that a rework of the console and supporting software to reduce squadron instructor training requirements was needed, especially if fleet squadrons were to effectively use the trainer. The addition of specialized "instructor-operators" to support mission training and the continued use of skilled operators to support the instructor staff were recommended. Changes to the console in terms of displays and controls and the implementation of a mission operator-station were also recommended.

As a result of these findings, the NAVTRAEQUIPCEN initiated a review of console problems of another trainer with operating problems, the F-14A WST, Device 2F112. While the EA-6B system is a complex four-man, electronic warfare system, the F-14 is a two-man, all weather air superiority fighter. In addition to weapon system differences, the trainers are also significantly different in simulation features. Device 2F112 for example, is equipped with a high fidelity full visual system but does not have a motion platform. Acceleration is simulated by "G suits" and "G seats." Utilization of the devices also differs since the F-14 trainer assets include, in addition to the WST, part-task trainers (PTT), one for the Radar Intercept Officer (RIO) - Device 15C9, and one for the Pilot - Device 2F95.

The objectives were similar to those of the earlier review of Device 2F119 in that an analysis of the console operation was conducted, deficiencies identified and feasible solutions were generated. In addition, design guide material was developed which could be applied to future trainer acquisitions to avoid similar problems.

## DEVICE 2F112 OVERVIEW

GENERAL. Device 2F112 is a fixed base full weapon system trainer

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1. Charles, John P. Device 2F119 (EA-6B WST) Instructor Console Review. Technical Report NAVTRAEQUIPCEN 81-M-1083-1, Naval Training Equipment Center, Orlando, FL. November, 1982.

integrated with a sophisticated wide-angle visual system (WAVS). A replica of the tandem F-14A cockpit is mounted inside a 40 foot diameter spherical dome on which is projected the visual environment including targets and weapons effects. Figure 1 depicts the layout of the trainer. It consists of five major subsystems:

a. Cockpit Section-Trainee Station,

b. Instructor Operator Station (IOS),

c. Computer System,

d. Wide-Angle Visual System (WAVS),

e. Auxiliary Systems.

The cockpit section is a full-scale high fidelity mockup of the pilot and RIO cockpits and is equipped with "G suits" and "G-seats" to simulate accelerations. The cockpit canopy is clear to permit viewing the projected visual scene.

The device control console as designed, consists of three stations, one for the Instructor Pilot (IP), one for the Instructor Radar Intercept Officer (IRIO) and one for a Simulator Operator (SO) technician. The general relationship of the three stations can be seen in Figure 1. The stations will be reviewed in greater detail in following sections.

The computer system includes the hardware and software to simulate the F-14 weapon system and its operating environment. This includes the Digital Radar Land Mass Simulation system and the interfaces to other systems.

The auxiliary systems include the usual support systems such as hydraulics, air and electrical subsystems.

GENERAL CAPABILITIES. In addition to simulation of the F-14 aircraft and weapon systems, the WST provides for simulation of:

a. Land-mass, environment and radio facilities,

b. Buffet, acceleration and aural effects,

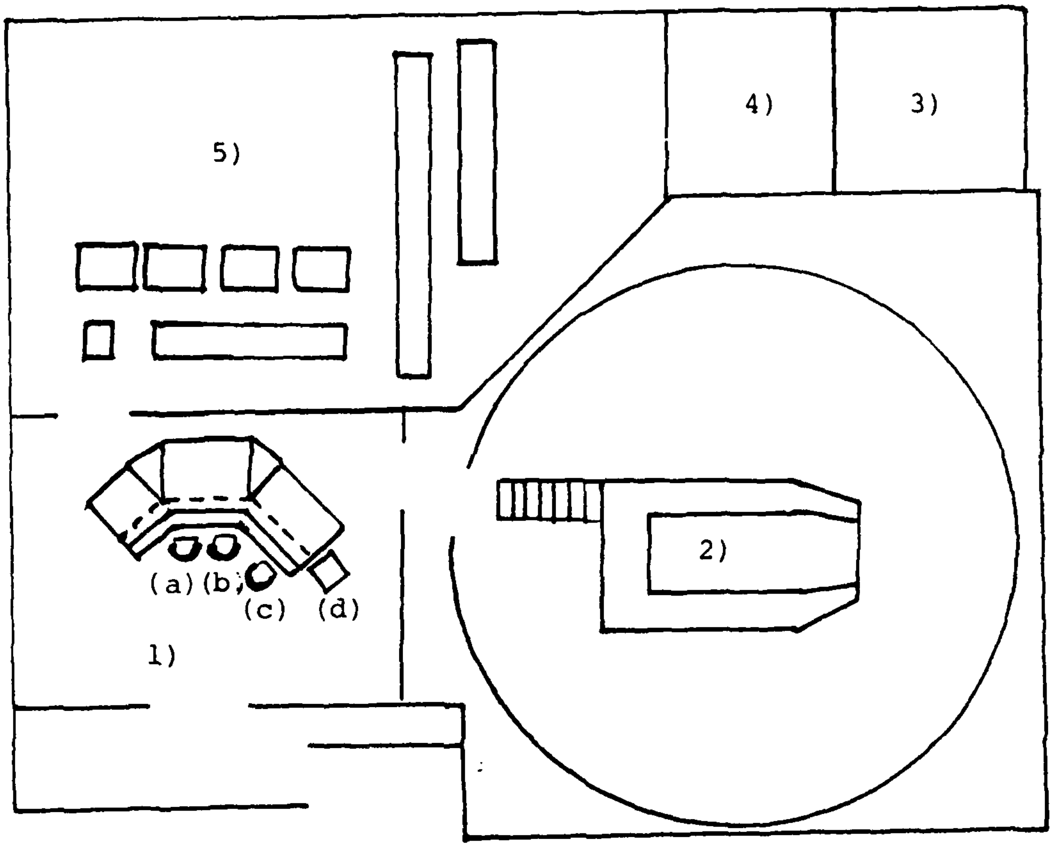
c. Up to 24 air-to-air targets of six types, large or small bomber, large or small fighter, and large or small missile,

d. Up to 10 air-to-surface missiles,

e. One E-2 aircraft,

f. Up to four sea targets,

g. One carrier,




LEGEND:

1) IOS AREA
   (a) IRIO Station
   (b) IP Station
   (c) SO Station
   (d) Printer
2) TRAINEE AREA
3) HYDRAULIC POWER ROOM
4) ELEC. POWER/AIR COMPRESSORS
5) COMPUTER/PERIPHERAL AREA

Figure 1. Device 2F112 general layout

h. Up to eight targets designated as data link,

i. Up to five SAM (surface-to-air missile)/GCI (ground controlled intercept) sites,

j. Up to five AAA (anti-aircraft artillery)/GCI sites,

k. Visual simulation of:

(1) sky-sea background (day/dusk/night), five mile visual range,

(2) carrier (CV) approach and landing,

(3) one Soviet cruiser,

(4) two threat aircraft,

(5) one SAM,

(6) one air-to-air missile/gun firing,

l. Up to 11 simultaneous jammers (of 65 available in various modes),

m. Chaff effects,

n. IFF/SIF (Identification Friend or Foe/Selective Identification Feature),

o. 254 different malfunctions/emergencies,

p. A wide variety of stores and load configurations.

MODES OF OPERATION. The trainer has two primary modes of operation controllable from the console. These are:

a. EXERCISE

b. REPLAY

The two modes are mutually exclusive, e.g., REPLAY cannot be utilized while the trainer is in the EXERCISE mode.

The EXERCISE Mode incorporates two submodes:

a. Train - Manual: Training event is instructor controlled,

b. Train - Formulated: Training event is preprogrammed.

The Manual submode can employ various options of preprogrammed (Formulated) support.

The REPLAY mode provides for a dynamic review of up to the last 60 minutes of simulation. Replay time is selected in terms of Mission Elapsed Time (MET). Replay is terminated only by FREEZE and FLYOUT, FREEZE and reintialization or by deselecting FREEZE after completion of the replay.

TRAINER OPERATING CONSOLE. The three operator stations which comprise the operating console are illustrated in Figure 2. As can be seen, the SO station incorporates one cathode ray tube (CRT) display, while the flight instructor and tactics instructor stations each have two CRTs. The flight instructor station is manned by the IP, and the tactics station by the IRIO. In addition, each of the stations has:

a. a function keyboard (FKB) with a numeric keypad (NKB),

b. a Communications/Trainer control panel,

c. a speaker panel.

The FKB provides for selection of CRT displays and numeric data entry. The Communications/Trainer control panel provides for selection of communications options, "stopwatch" start and stop, CRT selection, and FREEZE and replay control.

<u>Flight Instructor Station</u>. The flight instructor station has in addition to above displays and controls, repeater and simulator controls including:

a. a joystick control,

b. a Training Systems control panel,

c. a WAVS System panel and monitor display,

d. a WAVS "repeater" display,

e. instrument panel repeater displays.

Figure 3 depicts the layout of the station.

The joystick control is a three-axis controller (fore-aft, left-right and knob turn) providing options to:

a. FLY - fly a selected target or threat including the visual target,

b. MOVE - move a selected symbol on the WST CRTs,

c. CTR - shift (in xy) the display grid on the WAVS ACM (Air Combat Maneuvering) display,

d. ORT - reorient the viewing angle of the grid on the WAVS ACM display.

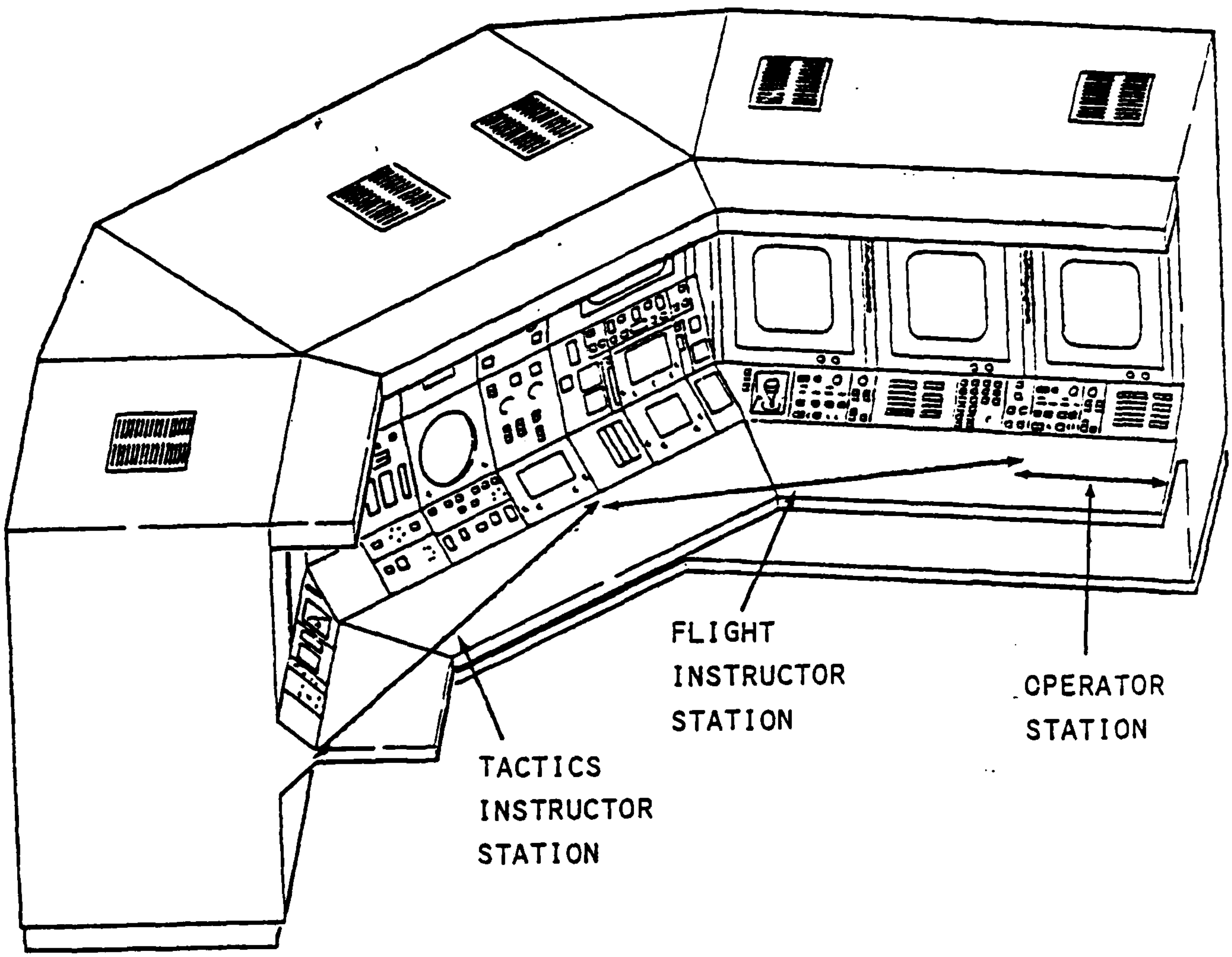



Figure 2. Instructor console station arrangement

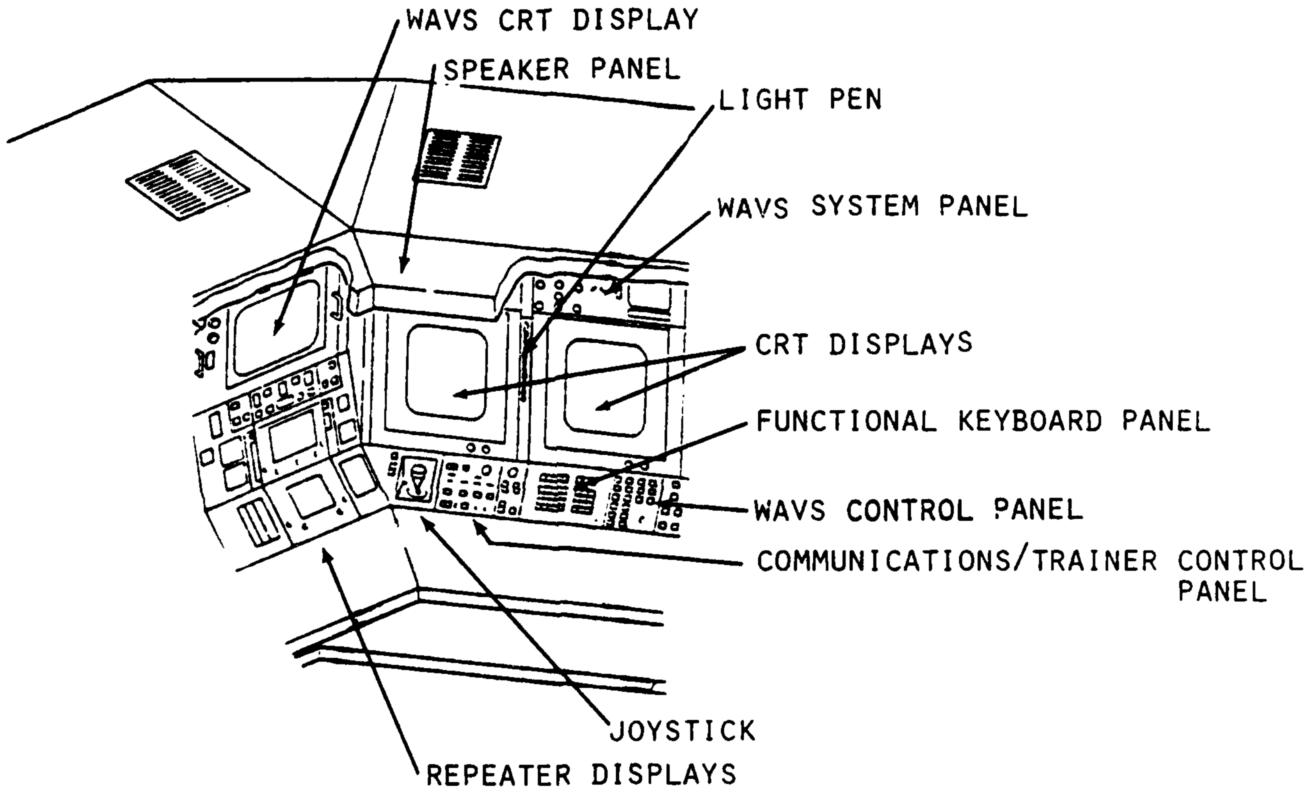



Figure 3. Instructor pilot station layout

The Training Systems Control panel provides controls for turning the visual system off (not on), turning the laser on and off, printing hard copy of the WAVS CRT, and for operating the Fresnel Lens Optical Landing System (FLOLS) "cut" and "wave-off" lights.

The WAVS System panel provides indicators for visual system status, controls for day or night scene, scan converter (for debrief), video recorder and carrier lighting and a display of the model mounted in the visual display model projection box.

The WAVS CRT display has four options:

a. The visual system initialization data page which describes the initial conditions which can be selected or edited,

b. The carrier display page which shows the carrier as seen through the heads-up display (HUD),

c. The ACM display page which presents a three-dimensional graphic projection of the spatial relation of the F-14 and the visual target with a readout of basic parameters for each.

d. The pilot view display page which provides a display of the pilot's view as seen through the windscreen of the cockpit of either the F-14 or target aircraft along with basic flight data.

The instrument panel repeater displays include:

a. the vertical display indicator (VDI),

b. the horizontal situation display (HSI),

c. the engine tachometer (RPM), turbine inlet temperature (TIT) and fuel flow (FF) indicators,

d. the altitude, MACH/airspeeed, vertical speed, angle-of-attack, accelerometer, and bearing-distance-heading indicators,

e. selected warning and caution lights,

f. the ACM panel displays.

Tactics Instructor Station. This station has in addition to the common controls and displays discussed earlier, simulator status panels, a joystick and set of RIO system repeater panels. Figure 4 depicts the layout of the station. The two simulator status panels, which are shared with the IP, include a warning panel for simulator systems and the lighting intensity controls for panels, indicators and room lighting.

The weapon system repeater displays provide a readout of the

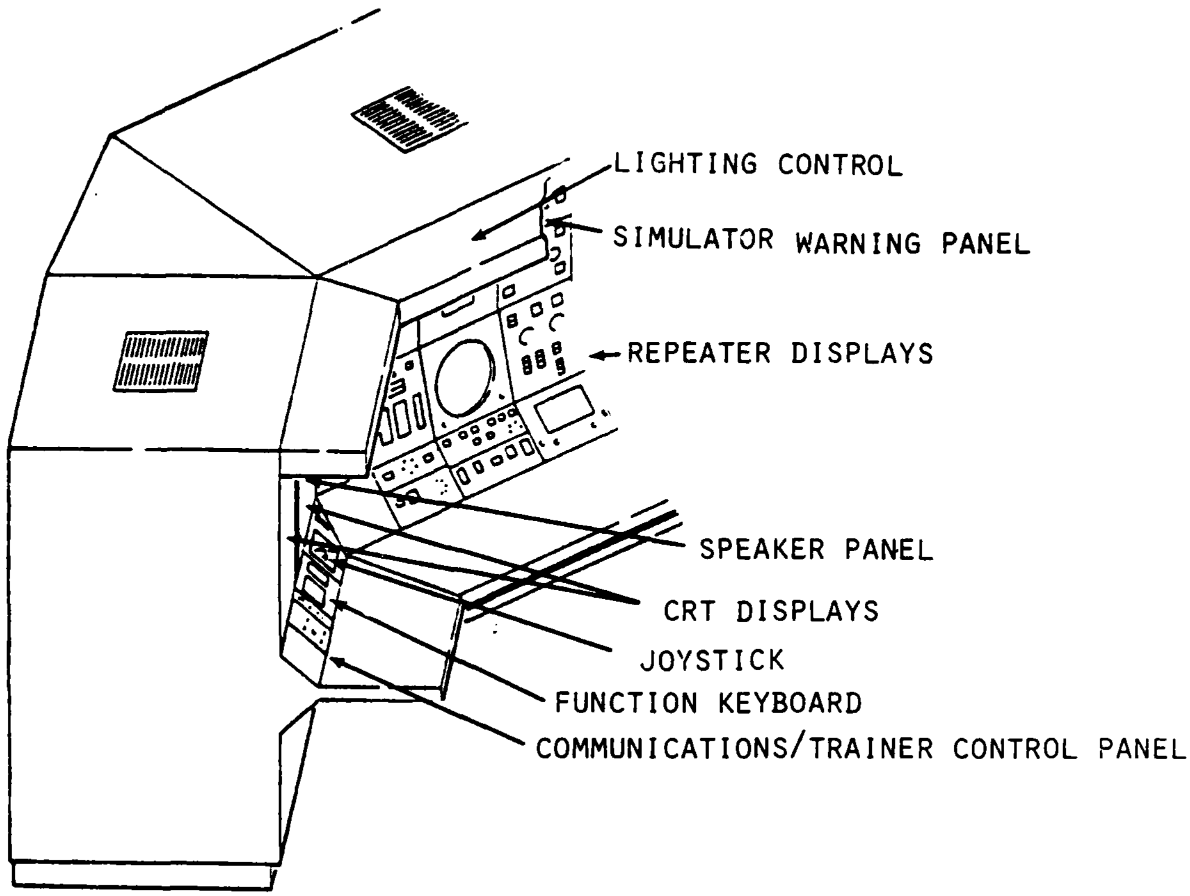



Figure 4. IRIO station layout

primary weapons system controls and displays.

Simulator Operator Station. Figure 5 depicts the arrangement of the SO station with its CRT display, function keyboard and Communications/Trainer Control panel.

CRT DISPLAY OPTIONS. Any CRT can display any available display page utilizing the FKB. Either a map or an index page can be selected and additional pages within each function can then be selected by either depressing the PAGE ADV (advance) or BACK SPACE on the FKB or "hooking" "BACKUP" or "ADVANCE" at the top of the CRT page utilizing the light pen. The overall display size is 12 by 16 inches. Map displays contain a 12 by 12 inch map with a 4 by 12 inch data summary section at the bottom of the CRT display. Page advances or backups affect only the data summary display of the map pages.

The data displays, which are initiated with an index page, occupy 8 by 12 inches or half of the CRT display area. Thus two data pages can be displayed on the same CRT, one on the upper half and one on the lower half by selecting the desired display area on the Communication/Trainer Control panel.

Table 1 summarizes the map display options and Table 2 summarized the data display options. Samples of the display pages are presented with the discussion of related design problems in the Results section.

In addition to the primary display area utilized for the displays outlined in Table 1 and 2, two "strip" displays are incorporated in each CRT display, one at each side of the primary display page. They are used both for information and control. The left hand strip presents time information and a "CLEAR PEN" control option for light pen operation. The right hand strip presents error messages and data on the number of malfunctions active, playback time (MET) selected and control options for hard copy (SNAP) and for declassifying the copy. The strip displays are always displayed.

TABLE 1. 2F112 CRT MAP DISPLAY OPTIONS

| | Number of Pages | |
|---|---|---|
| Title | Maps | Data Summaries |
| Tactical Situation Display | 1 | 9 |
| Maps | 6 | 4 |

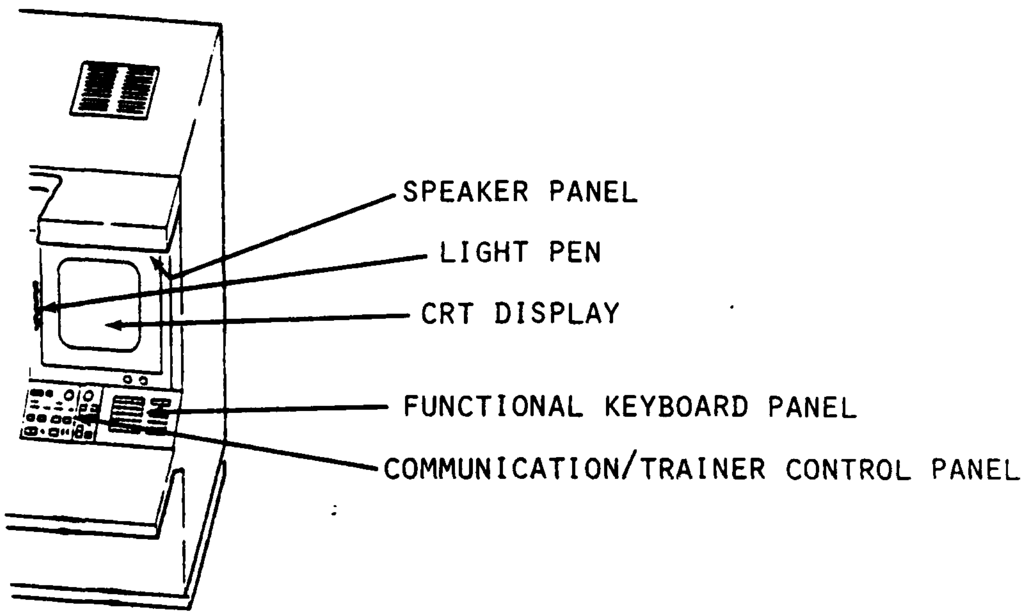



Figure 5. SO station layout

TABLE 2. 2F112 CRT DATA DISPLAY OPTIONS

| TITLE | Number of Pages: Index | Data Pages | Total |
|---|---|---|---|
| Target Threat | 1 | 32 | 33 |
| Carrier | 0 | 1 | 1 |
| Data Link | 1 | 18 | 19 |
| Stores | 0 | 3 | 3 |
| Facilities | 1 | 14 | 15 |
| Malfunctions | 1 | 27 | 28 |
| Weapons Scoring | 1 | 22 | 23 |
| Status Monitor | 1 | 21 | 22 |
| Time Event Monitor | 0 | 1 | 1 |
| Formulate | 1 | 5 | 6 |
| Initial Conditions | 5 | 0 | 5 |
| Repeater Data | 0 | 1 | 1 |
| Flyout Mismatch | 0 | 1 | 1 |
| Trainer Status | 0 | 1 | 1 |
| Test | 1 | 6* | 3 |
| TOTAL | 13 | 153 | 162 |

*Only two of the six test pages are used by instructors
In addition to these WST CRT displays, the five display options for the WAVS are also available.

UTILIZATION OVERVIEW

Device 2F112 at NAS Miramar supports the training programs of the operational fleet squadrons, the Fleet Readiness Squadron (VF-124) and the Navy Fighter Weapons School (NAVFITWEPSCOL). Fleet squadrons have priority. The NAVFITWEPSCOL use of the 2F112 is in support of the operational fleet squadrons.

# SECTION II

# METHOD

## GENERAL

The same approach utilized in the earlier study of Device 2F119 was employed. This included a review of trainer documentation, syllabi and related guides and schedules, observation of training operations, interviews of instructors, managers, operators and Fleet Project Team (FPT) members, and analysis of training requirements and device implementation.

## SURVEY

The Naval Air Station Miramar was utilized in the review of Device 2F112. Personnel from Fighter Airborne Early Warning Wing Pacific (COMFITAEWWINGPAC), Fighter Squadrons 124 and 114, the Navy Fighter Weapons School and the Fleet Aviation Specialized Operational Training Group Pacific (FASOTRAGRUPAC) Detachment Miramar were interviewed. Training operations utilizing Device 2F112 were observed and data was collected on procedures used and problems encountered.

## ANALYSES

Following data collection, analyses were completed to identify and structure:

a. functions of the instructor(s) and operator(s) implicit in the design of the trainer,

b. functions of the instructor(s) and operator(s) in ongoing training,

c. operating problems,

d. design deficiencies,

e. implementation problems.

Functions flow diagrams and time line charts were developed where required to expose problems or verify data collected. The function flow diagrams utilized in the earlier study were again used to structure the overall analyses. The function flow approach relates the training tasks involved from reviewing the training objectives to debriefing of student and staff.

The results of the analyses were then categorized under two types, namely:

a. Device 2F112 design deficiency,

b. Device 2F112 utilization problem.

Feasible solutions were then developed. In addition, the design problems were subsequently reviewed for general application to other trainers and trainer procurement procedures.

# SECTION III

# RESULTS

## GENERAL

The results of the study of the design and operation of Device 2F112 will be presented under the following major topics:

a. current operation of the console,

b. basic design deficiencies,

c. functional deficiencies.

The manning of the console for the different types of syllabus events and by the different users will be reviewed under the area of current operations of the console. In addition, the actual operation will be contrasted with the operation implicit in the design and as outlined in the specification.

Human engineering problems and deficiencies, both static and dynamic, will be presented under the topic of basic design deficiencies. The static problems include both display and control design and the layout or arrangements of the displays and controls on the console. The dynamic problems reflect the use and operation of the displays and controls including interactions between the displays, controls, instructor, operators and training functions.

The functional deficiencies consider the problems involved in utilizing the trainer in meeting training requirements. The generic set of training functions outlined in an earlier study will be utilized (see Appendix B).

## CURRENT CONSOLE OPERATION

During the implementation and early utilization of Device 2F112, the Navy came to realize that squadron instructor personnel would be unable to effectively operate the trainer without extensive training and dedicated assignment. This requirement could not be met by fleet squadrons. Furthermore, it could probably not be met by the Fleet Readiness Squadron (FRS) without increasing its instructor assets. An analysis of the problem resulted in the creation of two special billets called WST Mission Operators (MO). The job description included three tasks:

a. Task 1. Operate the 2F112/WAVS simulator in support of the Fleet Readiness Squadron, the Navy Fighter Weapons School, and Fleet Squadron training.

b. Task 2. Formulate missions and modify existing formulated missions as required to provide adequate scenarios for training.

c. Task 3. Conduct training and briefings to increase instructor knowledge of device operation and its capabilities and limitations.

The billets were filled and current utilization of the device is supported by the MOs.

The implementation of the MO billets has changed the role of the technician Simulator Operator (SO). Since full-time professional mission operators are available to support the instructors, the SO is no longer required at the console, nor is there a station or position for the SO to occupy. Thus, the SO tasks have been modified to an "on-call" status to support maintenance requirements including troubleshooting and re-initializing of the simulation systems as required.

The operation of the consoles by the different users will be reviewed within this manning framework. The utilization of the different modes of trainer operation will also be reviewed.

FLEET SQUADRON OPERATION. Table 3 summarizes the fleet squadron syllabus for utilization of the 2F112. With the exception of the annual Naval Air Training and Operating Procedures Standardization (NATOPS) and instrument checks, the training events are mission oriented.

TABLE 3. F-14 FLEET SQUADRON 2F112 SYLLABUS SUMMARY

| Event Title | Number of Hours |
|---|---|
| ACM 1 | 1.0 |
| Airborne Intercept I | 1.0 |
| Airborne Intercept II | 1.0 |
| Airborne Intercept III | 1.0 |
| Airborne Intercept IV | 1.0 |
| Airborne Firing Exercise I | 1.0 |
| Airborne Firing Exercise II | 1.0 |
| Airborne Firing Exercise III | 1.0 |
| EW/Missile Defense | 1.0 |
| MAS/EW I | 1.0 |
| MAS/EW II | 1.0 |
| Annual NATOPS Check | 2.0 |
| Annual Instrument Check | 2.0 |

Although the syllabus is just being implemented, the planned console manning will consist of the MOs and as needed, an IP or IRIO (except for NATOPS and instrument checks which will be conducted and monitored by specially designated check pilots and RIOs). The instructor(s) utilize the repeater displays and generally one of the flight or tactics station CRTs. The MO utilizes the SO CRT and one of the flight CRTS and tactics CRTs as required. Figure 6 depicts this arrangement. As can be seen, the squadron instructors have excellent access to the repeater displays and to one of the flight station CRTs. The problems which are caused by the sharing of the flight station CRTs, the operating of the WAVS displays and the instructor's operation of the displays will be discussed under design deficiencies. For routine training events, no squadron training officers are required since the events are generally pre-programmed and no critique is involved.

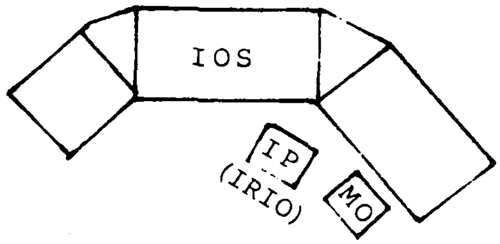



Figure 6. Typical squadron manning arrangement.

The Operational Flight Trainer (OFT), Device 2F95, can be utilized for the NATOPS and instrument check if Device 2F112 is not available.

FIGHTER WEAPONS SCHOOL OPERATION. The NAVFITWEPSCOL utilizes the 2F112 in the implementation of the Fleet Airborne Superiority Training (FAST) Program and the syllabus is summarized in Table 4. The console manning, except for the battle problem (event FAST 200), is the same as utilized by the fleet squadrons. The instructor utilizes a CRT for monitoring performance, especially weapons effects, and for control of the problem or scenario evolution. The syllabus requires a full mission capable trainer.

TABLE 4. NAVFITWEPSCOL FAST 2F112 SYLLABUS SUMMARY

| Designation | Title | Hours/aircrew |
|---|---|---|
| FAST 100 | Clear Air Vector Logic | 1.0 |
| FAST 101 | ECCM Tactics | 1.0 |
| FAST 110 | ECCM/Vector Logic I | 1.0 |
| FAST 111 | ECCM/Vector Logic II | 1.0 |
| FAST 200 | Vector Logic Battle Problem | 1.0 |

The battle problem event poses several problems since three instructors are required to support the event. Although the event is extensively preprogrammed, two instructors are required to support the scenario evolution, primarily in communications simulation. The third instructor is the problem controller or "game director." No console position is available for him since the MO(s) and other instructors utilize the three console stations. One of the instructors utilizes the flight instructor station with its microphone and Tactical Situation Display (TSD) as well as the counter area for note-taking. The second instructor, who also assists in the communication simulation problem, utilizes the tactics station, primarily because it provides a counter for use in recording the aircrew's communications (for integration in subsequent training events). The problem or scenario controller is forced to sit behind the other two instructors and utilize the displays as best he can to direct the scenario. This arrangement is depicted in Figure 7. The mission controller typically uses a clipboard for recording aircrew performance and debriefing notes as well as to hold his notes on scenario control.

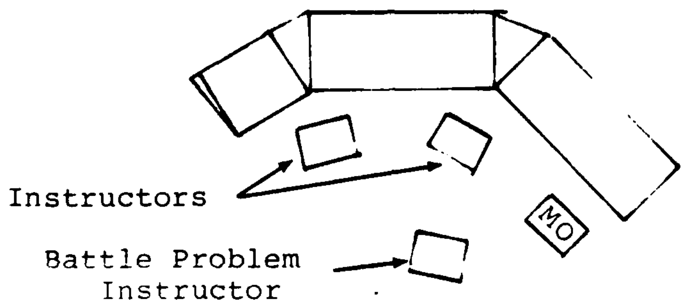



Figure 7. Typical battle problem console manning arrangement

The battle training events are run sequentially (aircrews man the 2F112 in sequence) but are built about a single threat problem, i.e., each aircrew is involved in the same air battle. Therefore the initial conditions for each aircrew event must be updated based on the previous training event results in terms of aircraft losses, raid penetration, and related parameters. In addition the background communications simulation must be updated to reflect past battle events. The update task after three or four training "flights" becomes almost unmanageable and problems do arise. For example, an aircraft shot down by an earlier flight, but late in the mission, may be attacked by a subsequent flight earlier in terms of battle time with obviously confusing results. In addition, because of the workload involved, relief instructors and MO(s) are generally involved, adding the problem of briefing them on the problem status.

FLEET READINESS SQUADRON OPERATION. The FRS utilizes the 2F112 to implement the syllabus outlined in Table 5. Since the fleet squadrons have priority on the 2F112, the events may be given on the other trainers, i.e., the OFT Device 2F95 or the mission trainer (MT) Device 15C9. In addition the FRS can utilize the 2F112 for training events normally given on the 2F95 such as carrier approachs and instrument landings as well as a general backup for the MT and OFT.

TABLE 5. FLEET READINESS SQUADRON 2F112 SYLLABUS SUMMARY

| Designation | Title | Hours |
|---|---|---|
| AEBT 010 | EECM Screened Target I | 1.0 |
| AEBT 020 | EECM Screened Target II | 1.0 |
| AEBT 110 | Advanced Tactics Battle Problem | 2.5 |
| AEBT 110 | 1 vs 1 VIDS Introduction | 1.0 |
| ASBT 070 | High Alpha Maneuvering | 1.0 |
| AABT 020 | 1 vs 2 VID | 1.0 |
| AABT 025 | 1 vs 2 VID Jinkers | 1.0 |
| AABT 030 | 2 vs 2 VID | 1.0 |
| AABT 035 | 2 vs 2 VID Jinkers | 1.0 |
| AABT 100 | EW/Missile Defense | 1.0 |
| CQPF 050 | Carrier Controlled Approaches | 1.0 |

With the following exceptions, the console is manned by one or two MOs and a squadron instructor (IP or IRIO) as shown in Figure 6. The high alpha maneuvering event (ASBT 070) and the carrier controlled approach event (CQPF 050) are normally conducted by an IP and an MO. The MO utilizes the SO CRT and one of the flight CRTs. Operating problems will be discussed under design deficiencies. The battle problem event (AEBT 110) is conducted utilizing four instructors, two IPs and two IRIOs, and one or two MOs in a similar arrangement to that utilized by the NAVFITWEPSCOL.

MODE UTILIZATION

THE 2F112 has two basic modes of operation which are mutually exclusive, the Exercise Mode and the Replay Mode. The Replay Mode which provides dynamic replay for up to the last 60 minutes of training, is seldom used either during training or for debriefing. It is not used during training primarily because of the reluctance of instructors to stop a mission type of event. It is not used for debriefing primarily because simulator time is utilized and thus the trainer is not available for training.

The Exercise Mode includes two training submodes and a non-training submode (Formulate) to review preprogrammed or "formulated" training events. The training submodes range from manually controlled to fully programmed mission events.

The manually controlled training event is seldom used because of operating limitations and problems which will be discussed under design deficiencies.

The majority of the training events are extensively preprogrammed. Partially programmed missions have proven difficult to control since modifications to the simulation parameters may, and probably will, impact the programmed portion of the mission at some point in the scenario with undesirable results. Thus, most aircrew mission training events are executed as programmed or formulated with very few changes being made prior to or during the execution of the training event.

Air Combat Maneuvering (ACM) training utilizing the WAVS generally involves an IP monitoring the flight repeater displays, the WAVS display and one of the flight CRTs. WAVS utilization is not formulated and thus requires greater participation of the MO as well as IP experience in WAVS/2F112 operations to exploit the systems training capability. For example, selection and control of the visual target in terms of performance (size, speed, location and weapons) and tactics, requires knowledge of the WAVS/2F112 target simulation options. Utilization of the CRT to monitor the attack requires knowledge of WAVS display operation. Since mechanization problems effectively preclude manually flying the target aircraft, program control is utilized. The instructor must be aware of the techniques for altering target behavior to preclude the aircrew "learning" the target. Close cooperation between the IP and the MO is therefore essential for effective ACM training. The many display and control problems which affect this submode of operation are discussed under design deficiencies.

SUMMARY. Although the 2F112 can operate in a variety of modes from manual to fully programmed exercises with various replay options, design console limitations have resulted in the device being utilized almost exclusively in the programmed mode with the exception of ACM training events. Replay is essentially unusable because training time is consumed. The WAVS replay using a video recorder (which was provided with the trainer) does not meet the simulation replay requirements since it provides essentially no aircraft or weapons system data. The ACM training utilizing the WAVS is basically a manual mode requiring an IP both knowledgeable and experienced in device operation and utilization in training as well as close cooperation between the IP and MO.

## BASIC CONSOLE DESIGN DEFICIENCIES

The instructor console design was analyzed in terms of console station arrangements, control and display design and mechanization, and console operation. The station arrangement analysis reflected the manning approach actually being utilized with reference to both the arrangement outlined in the specification and to that designed. The control and display analysis considered the characteristics of the controls and displays in terms of basic human engineering design criteria. The analysis of the operation of the console considered the use of the displays and control in terms of a generic human operator. the problems and deficiencies identified will be numbered sequentially for each problem area for further reference in the discussion and recommendations sections. The problems will be identified as layout problems (LP-"n"), control/display problems (CDP-"n") and operating problems (OP-"n"). Illustrations of typical controls and displays not included in this section are contained in Appendix A.

LAYOUT PROBLEMS. The analysis of the manning of the console to accomplish the training implemented by the different users exposed several console layout problems. The 2F112 was originally designed for operation by an IP at the flight station, an IRIO at the tactics station and a SO at the operator station as depicted in Figure 2. The implementation of the professional mission operator billet, while solving some of the operating problems, has created a new set of console arrangement or layout problems in addition to those which existed in the original design.

LP-1. MO Station Problem. The MO requires two CRTs to effectively operate the trainer. The existing SO station which the MO now occupies has only one CRT (see Figure 5). The MO is therefore required to utilize one of the flight station CRTs. This necessitates the use of two different light pens and FKBs since the SO station light pen and FKB do not function on the flight station CRTs. In addition, several WAVS and 2F112 control panels are at the flight station. The end result is a cumbersome and error producing operation for the MO as well as interfering with the IP operation of the Flight Station.

LP-2. Battle Event Control Station Problem. The "battle problem" or game controller instructor has no console position at which to implement his task, that of directing the scenario involved. He is forced to operate from a seat behind the instructors and MOs at the console stations (see Figure 7). From this position, he cannot read the displays, much less select or control the displays. In addition, the lighting is generally inadequate to read the clipboard he is forced to use.

LP-3. Tactics Station Problem. The tactics CRTs are not used as designed. At most, one CRT is used by IRIO to monitor data since he has extensive weapon system repeater panels. The second CRT is often used by the MOs to supplement their single display although it is too distant from their normal seated position (at the SO station) to be used effectively. It is also difficult for the MO to support the IRIO in trainer operation because of this separation.

CONTROL/DISPLAY PROBLEMS. As reviewed in the Introduction Section, the 2F112 console consists of three stations which have both common displays and controls as well as unique ones. Common display and control problems will be reviewed first. CRT display page problems will be reviewed separately.

CDP-1. Similarity of Indicators and Switches. Most indicators and switches used on the console are identical in shape (square), size, color (white) and are intermixed on the panels. While the collocation is often required for effective operation, the similarity leads to confusion as to the function of the unit, especially for the instructors who do not operate the device on a daily basis. Examples: "CRASH", "OVERRIDE", "HI PRI HARD COPY", visual system power indicators and switches.

CDP-2. Non-functional Arrangement of Indicators and Controls. Many indicators and controls are not grouped or arranged on the panel by function or sequence of operation which can lead to errors as well as slow operation. Examples: "CUT" and "WAVE OFF" are located on the WAVS Control panel while other carrier lighting controls are on the WAVS System panel; the PRIORITY PRINT switch is on the Trainer System panel and the other hard copy switch is on the CRT strip display requiring light pen operation; the video recorder scan converter switch is on the WAVS System panel but the run and pause switches are on the WAVS Control panel; "RUN/STOP" and "RESET" controls are with the trainer freeze and replay controls but control the stop watch, not the trainer.

CDP-3. Inconsistent and Unclear Panel Labeling. Most switch functions are not system referenced or labeled. Examples: Most communications indicator and CRT selection control panels are unlabeled. Stop watch controls and trainer controls are intermixed and unlabeled as such.

CDP-4. Non-standard and Inconsistent Indicator Color Coding. Examples: Laser "on" is orange, communications "on" are green, visual "on" is white, video record "on" is blue.

CDP-5. Duplicated Indicators and Switches. Examples: visual system status lights on the WAVS Control panel and on the Trainer Systems panel; visual system power lights on the WAVS Control and the Trainer System panel. (Note: in addition, one is labeled "VISUAL ON," the other "VISUAL SYSTEM OFF.")

CDP-6. Non-functional Switches. Examples: CRT selection switches on the SO Trainer Control panel; display switches on the FKB.

CDP-7. Small CRT Character Size. The alpha-numeric characters are essentially unreadable if the instructor is seated so that he can view the repeater displays as well as the CRTs. Thus sharing the displays without moving is impossible. (The character size is the minimum allowed by the specification.)

Specific control and display panels will be reviewed next.

CDP-8. Communications Panel. Communications monitoring and control options are excessive and confusing. As a result the features are not utilized and the communications system is left in the "override" condition. Thus, when the instructor's microphone button is depressed, all stations receive the transmission. This includes both cockpits and all console speaker positions. No attempts are made to use the inter-instructor communication options. Headsets are not used and therefore the headset volume and selection controls are not utilized. Close monitoring and simulation of aircrew communications are not considered necessary at the advanced mission training level for which Device 2F112 is used. The panel is depicted in Figure 8.

CDP-9. Trainer Control Panel. The Trainer Control panel contains unrelated switches and none are functionally labeled (see Figure 8). Included are the stop watch controls "RUN/STOP" and "RESET", the trainer controls "FREEZE" and "PLAYBACK INIT" and the CRT selection controls "L", "R", "UPPER" and "LOWER."

CDP-10. Trainer Systems Panel. The visual systems status lights and controls are redundant (they are duplicated on the WAVS panels) and are not used. The crash override switch is routinely set to preclude the lengthy crash recovery operation required. The crash indicator light is white in color, implying that the lighted state is the normal condition. The panel is depicted in Figure 9.

CDP-11. WAVS Control Panel. Only some of the WAVS controls are located on this panel. The remainder are on the WAVS Systems panel. The separation is not logical. In addition, a variety of other switches such as video record and carrier light controls are included.

CDP-12. Alphanumeric Keyboard (ANKB). The ANKB is a standard computer keyboard of little meaning to the instructors. It is used primarily by the technicians and programmers. Yet it occupies prime console space.

CDP-13. Functional Keyboard (FKB). The FKB (Figure 10) is common to all console stations. Many of the functions are utilized only by the MO. Unused blank keys are scattered throughout the panel rather than systematically grouped at the panel bottom or edge. Labeling is confusing, e.g., "BACK SPACE" is used for back paging. The close proximity of "INSERT" to "PAGE ADVANCE" is error producing since accidental actuation of the insert button will input data into the system. The instructors do not effectively use the panel because of its poor design.

CDP-14. WAVS System Panel. The WAVS System panel (Figure 11) includes a closed circuit television monitor display of the threat model installed in the model box. The display is not utilized since it provides no useful data to the instructor. The model installed need not agree with the threat selected. As discussed under general control and display problems, the indicators and switches are identical in shape and color and

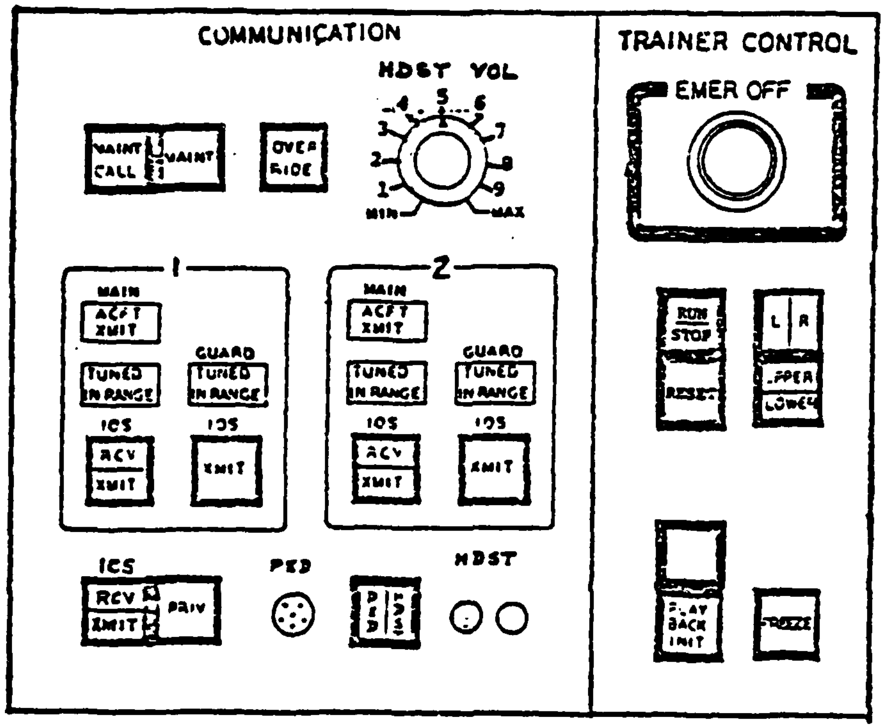



Figure 8. Communication/trainer control panel

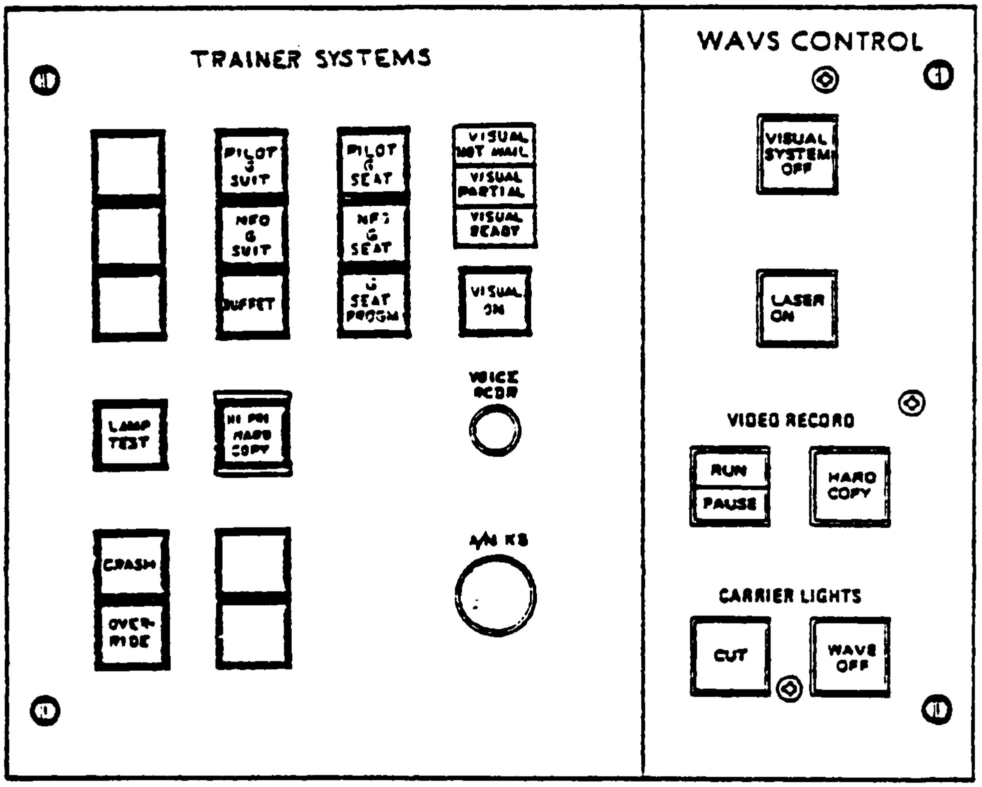



Figure 9. Training system/WAVS control panel

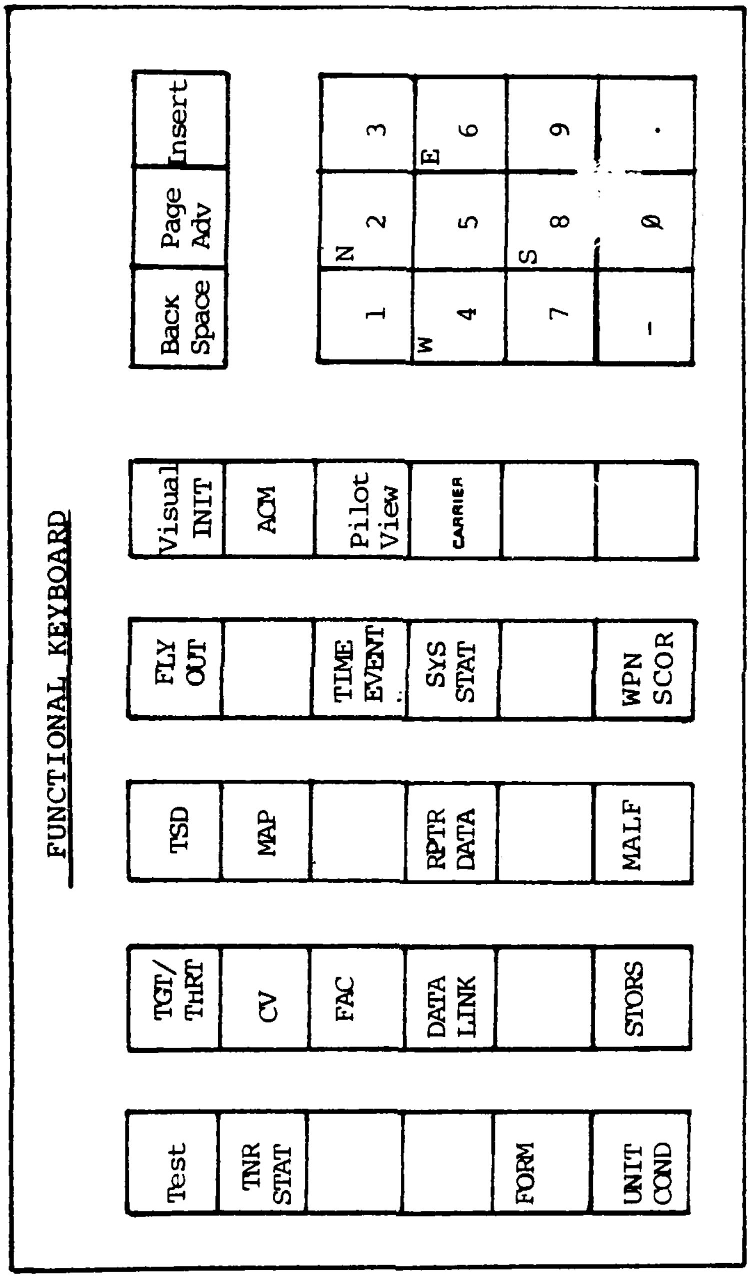



Figure 10. Functional keyboard

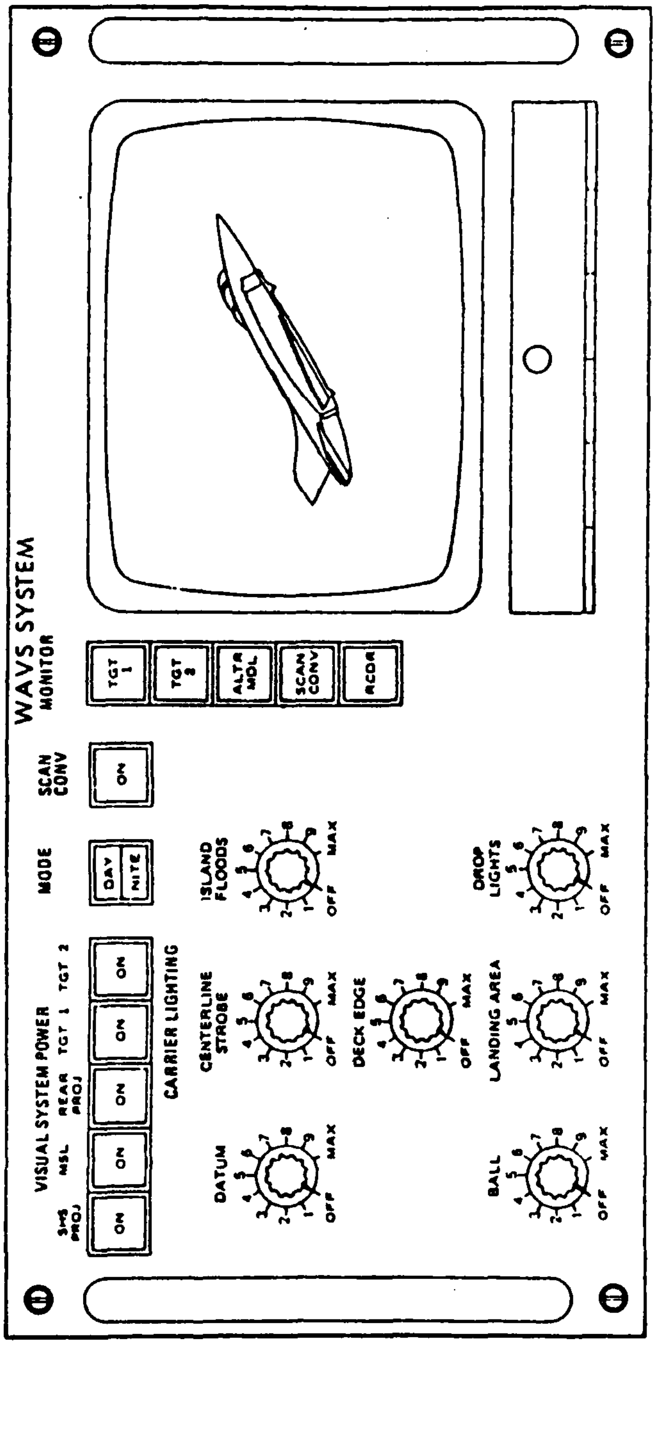



Figure 11. WAVS system panel

functionally poorly labeled. Most are of use only to the technicians. The carrier lighting controls, while well labeled in terms of identification, are not labeled in terms useful to the IP or Landing Signal Officer (LSO) Instructor. For example, intensity controls labeled from "0" to "MAX" have little operational meaning. The panel is not physically integrated with the WAVS CRT or the WAVS Control panel.

CDP-15. Flight Station Joystick Control. The IP's joystick control (Figure 12) has four modes of operation. Three are used to control the ACM display. The fourth mode provides the option to manually fly the target aircraft. It is not used because of the poor control dynamics, throttle interactions and the inadequate flight information provided. In addition, the location of the control to the right of the display involved would require the IP to look over his shoulder to observe the aircraft being flown.

CDP-16. Tactics Station Joystick Control. The IRIO's joystick, which is similar to that at the flight station, is not utilized. Again, poor control-display dynamics preclude its use.

CDP-17. Rear Cockpit Repeater Displays. The rear cockpit repeater displays (Figure 13) are not identical to those in the aircraft nor are all of the required displays provided at the station. As a result, the IRIO who also instructs in-flight and on the mission trainer has difficulty in monitoring and evaluating student RIO performance. For example, the 2F112 RADAR IR/TV panel displays uniquely only eight of the 16 controls or indicators on the actual panel. The JAM/JETT and clear and clutter gain controls are not repeated. The Tactical Information Display (TID) controls and indicators have been assembled into a unique panel called the "Navigation Control and Data Readout Panel" and is located to the side of the TID. Thus the IRIO has trouble locating the information needed, is required to read the display (it is not in cockpit format), and is not provided all of the information needed. The simulation of the Detailed Data Display (DDD) has proven to be of too low fidelity to be useful. The lack of an instructor controlled "pointer" symbol on the TID handicaps the instructor in critiquing student operations. In summary, although repeater information is needed to monitor aircrew performance, the 2F112 tactics repeater displays provide insufficient data and are difficult to interpret by IRIOs who train on other devices and in the aircraft as well.

CDP-18. Front Cockpit Repeater Displays. The pilot repeater displays are also incomplete and do not provide the IP the information needed to monitor and evaluate Replacement Pilot (RP) performance. For example, oil and hydraulic system pressures are required for monitoring malfunction procedures. Most of the console control panels are not displayed. While some of the data are available on CRT pages, e.g., Status Monitor pages, the complexity of CRT operation and the resultant requirement to

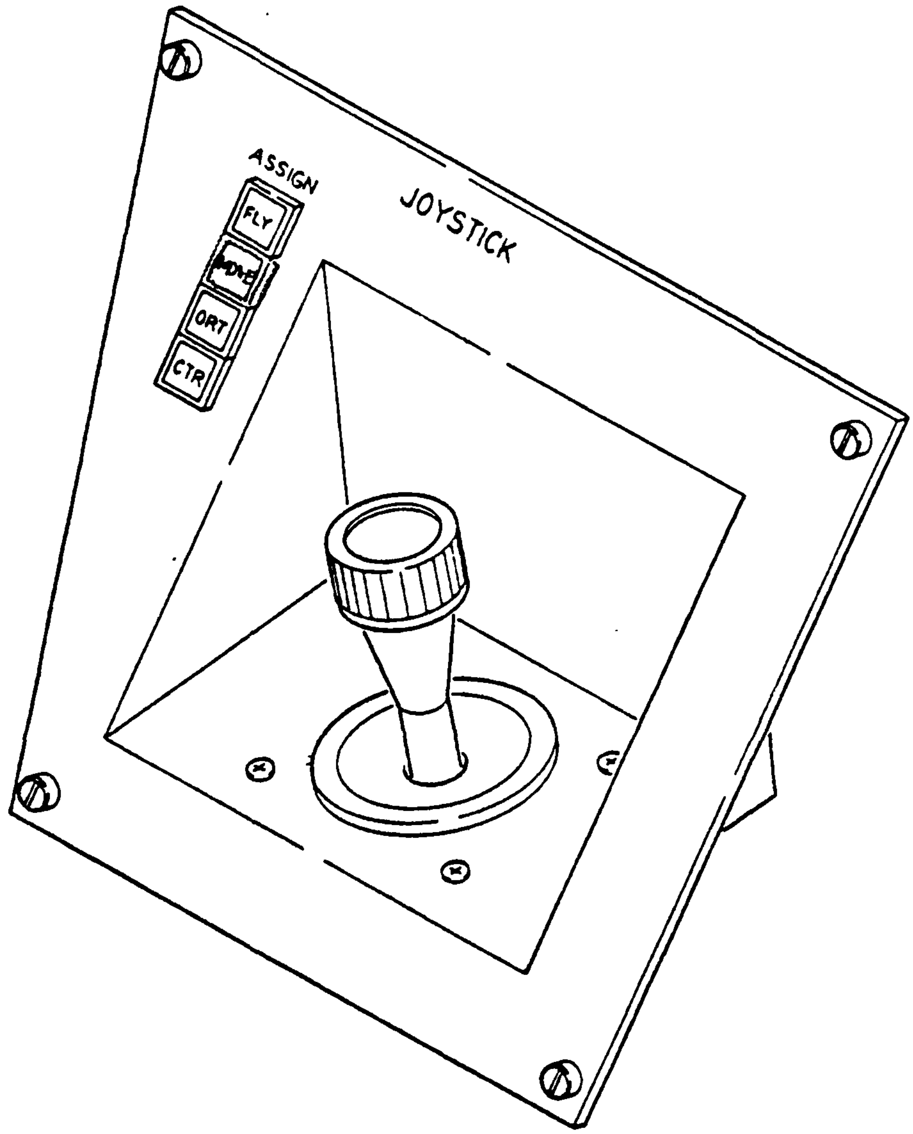



Figure 12. Instructor pilot's joystick

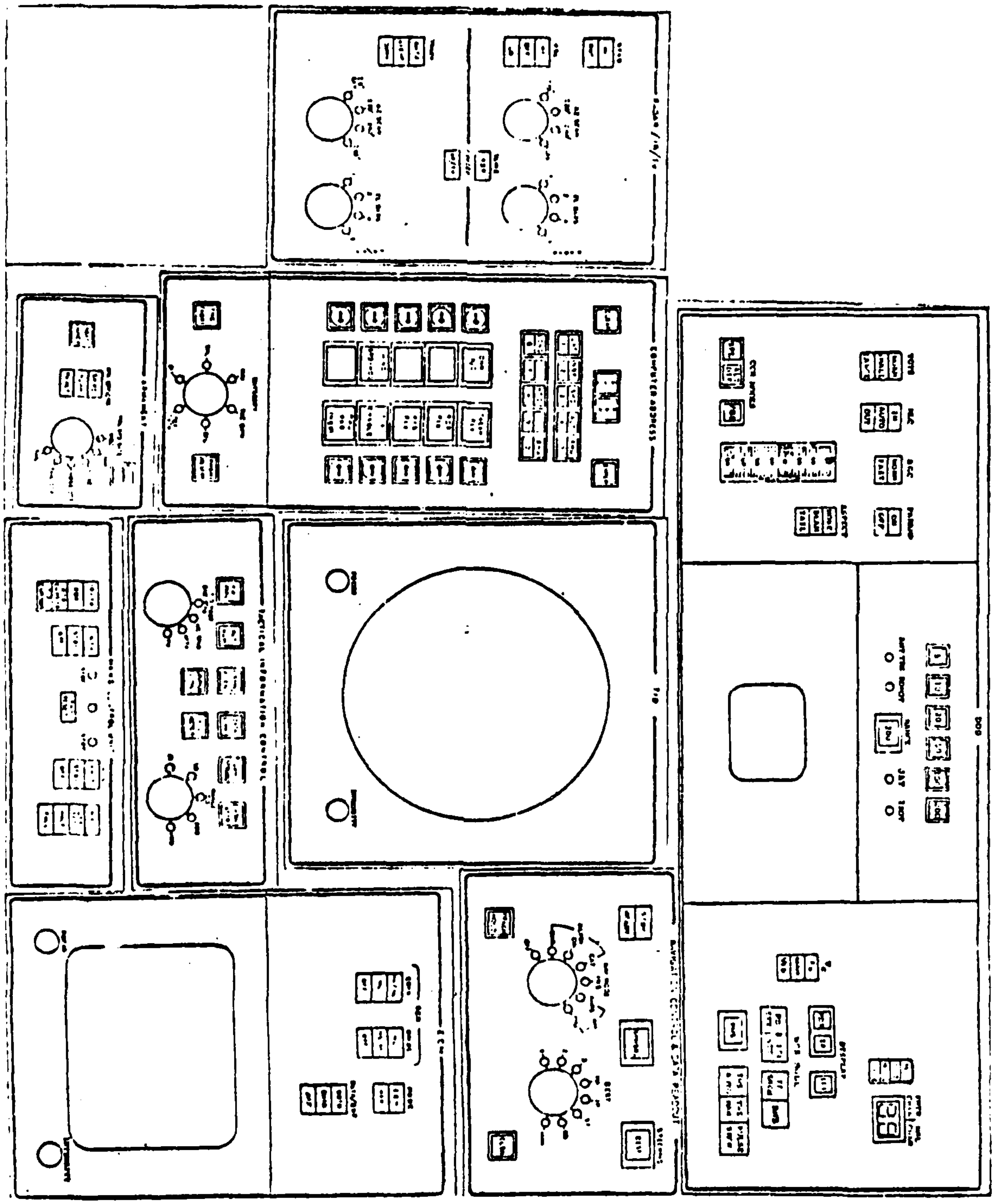


Figure 13. IRIO repeater display layout

search for data across several types of displays and display areas presents a difficult if not impossible task of the IP. Figure 14 depicts the pilot station repeater displays.

CDP-19. Trainer Warning Display. The trainer warning system contains a mix of trainer system malfunction indications including emergencies (e.g., overheats, filter blocks) and alerts (e.g., interlocks open, breathing air shortage). Many are redundent (e.g., buffet interlock) and some are no longer relevant (e.g., breathing air shortage). Figure 15 depicts the panel.

CRT Display Problems. The display formats and their usage present a wide variety of problems. Therefore, each major display option will be reviewed separately.

CDP-20. TEST Displays. Although the test displays are intended for maintenance and daily readiness checks, page two of the flight parameter set must be routinely used to verify and set initial conditions (IC). Some IC options can only be set from this page. Data relevant only to maintenance functions are also on the page. Figure 16 is a sample of this page. The parameters which are monitored and edited for IC settings are checked. However, as will be discussed under the "FLYOUT MISMATCH" page, the configuration indicated may not agree with the cockpit selections since the trainer is normally in "FREEZE" when the test page is displayed. Control actuations in the cockpit have no effect on the computer program under this condition. The problem will be discussed further under operating problems.

CDP-21 TRAINER STATUS Display. The status display was designed to permit entry of the aircrew names and weights and to edit the "g" simulation (suit pressure program). In addition, readout of simulation system status (on-off) and interlock closures are provided. Figure 17 is a sample of the display page. Names and weights and "g" suit pressure data are not normally entered since the data is of no use to the instructors nor is the pressure data needed. However, since data must be entered on this page to initiate training, fictitious names and weights such as shown in Figure 17 are left in the system. A modification to incorporate a fixed "g" suit pressure schedule is planned. G-system status information is duplicated on the Training Systems panel. In short, only the interlock status data are utilized from this page. These data could be better displayed with indicator lights.

CDP-22. FORMULATE Display. The Formulate display includes an index page and a set of pages of verbal descriptions of the missions. Figure 18 is a sample of the index and mission description pages. The index page lists the available formulated (programmed) missions or problems and provides for selecting the description display page, for initializing the problem (EXECUTE) and for terminating the formulated mission. The latter step is required at the end of the training session to return the program

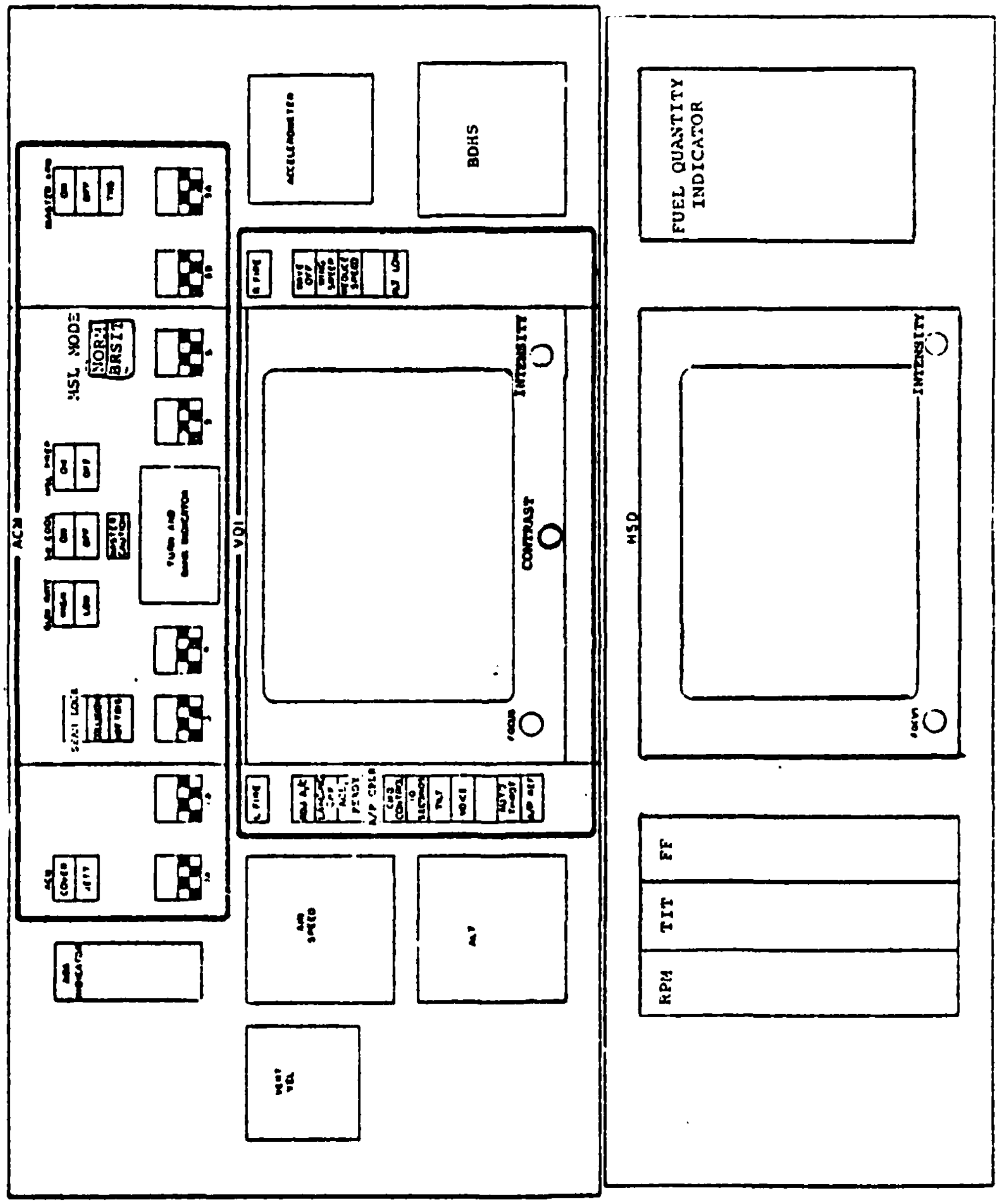



Figure 14. Flight instructor repeater displays

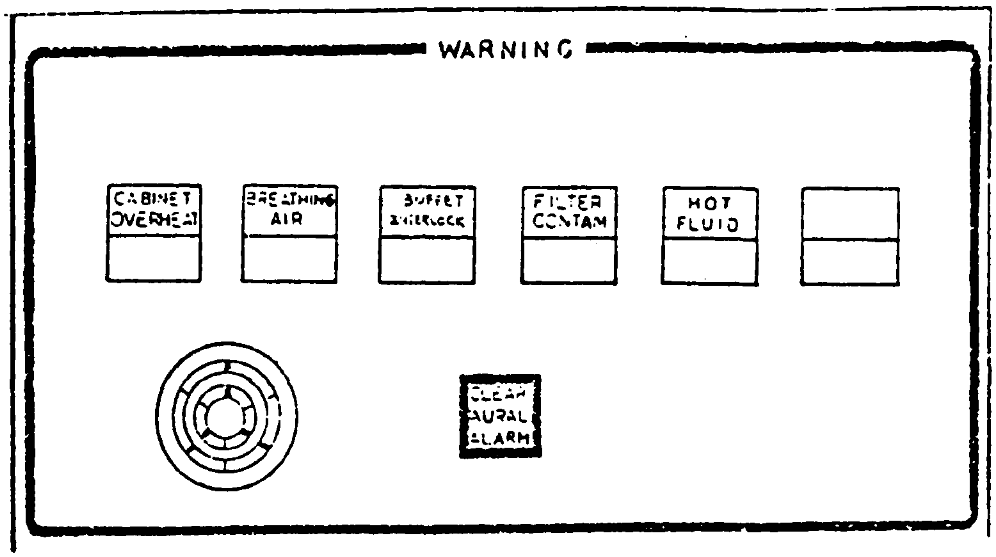



Figure 15. Warning panel

| | | | | |
|---|---|---|---|---|
| *TEST - PARAMETER SET PANEL* | *FLIGHT 2* | | CLEAR TEST | BACKUP *PAGE* ADVANCE |
| *FREEZE* | *DEMANDED VALUES* | | | BUS ENERGIZED |
| | | | | TAKEOFF RESET |
| ALTITUDE | *ALTITUDE FT* | 483 | | ENG FIRED BYPASS |
| AOA | *AOA DEG/UNITS* | - 0.27 | / *3.49* | STD DAY |
| BETA | *BETA DEG* | 69.90 | | W/V & HF=0 |
| | | | | HF= -1000 |
| WT & CG | *WEIGHT LBS* | 55648 | | |
| | *CG % MAC* | 13.29 | FLD ELEV MAN *FT* | 477.00 |
| | *IXX SLUG-FT2* | 107646 | | |
| | *IYY SLUG-FT2* | 240014 | POSITION FRZ | |
| | *IZZ SLUG-FT2* | 339898 | | |
| | *IXZ SLUG-FT2* | - 3036 | ZERO TRANSPORT ANGLE | |
| FUEL | *FUEL INT LBS* | 15733 | | |
| | *FUEL EXT LBS* | 0 | MAG VAR MAN *DEG* | E 14.[illegible] |
| WING SWEEP | *WING SWEEP DEG* | 20.0 | NAV INITIALIZE | INS TRUE |
| FLAPS | *FLAPS NORM* | 1.00 | | |
| LAND GEAR | *LAND GEAR NORM* | 1.0 | NAV ISOLATE - FLT | NO OBC |
| SPEED BRK | *SPEED BRAKE NORM* | 0.00 | | |
| | | | NAV ISOLATE - TAC | |
| PLA | *PLA DEG* | 48.61 | | |
| THRUST | *THRUST LBS* | 25258 | FLT ISOLATE - TAC | |
| SPARE 1 | *VARIABLE 1* | 0.00 | | |
| SPARE 2 | *VARIABLE 2* | 0.0P | *SOUND LEVEL 0-9* | 7 |

Figure 16. Sample test page

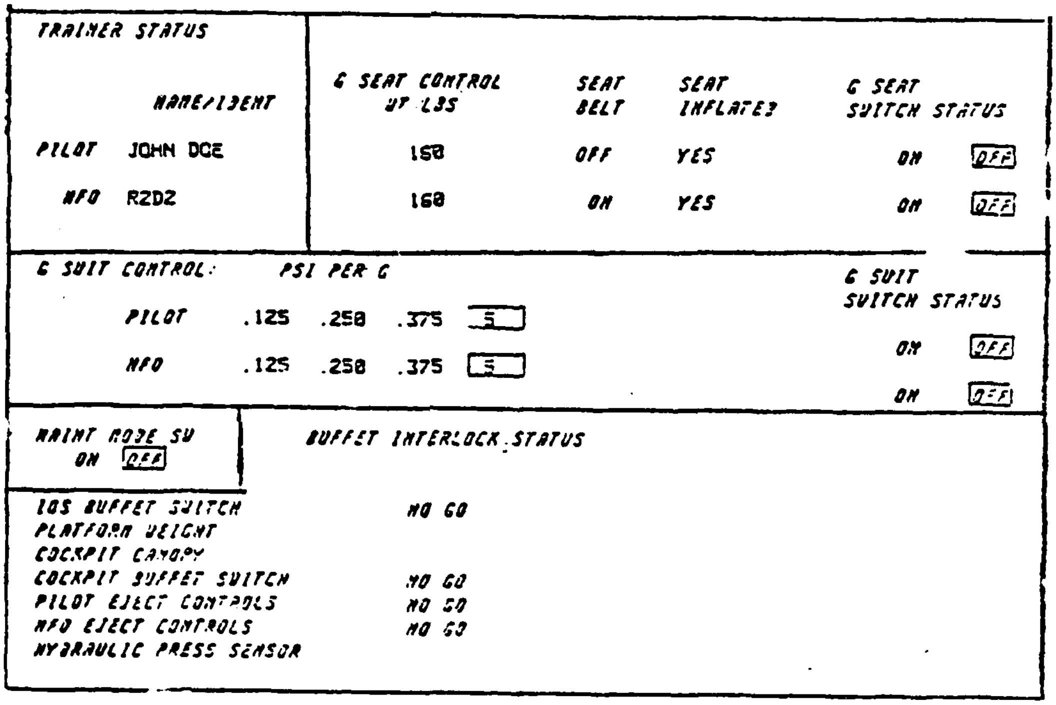
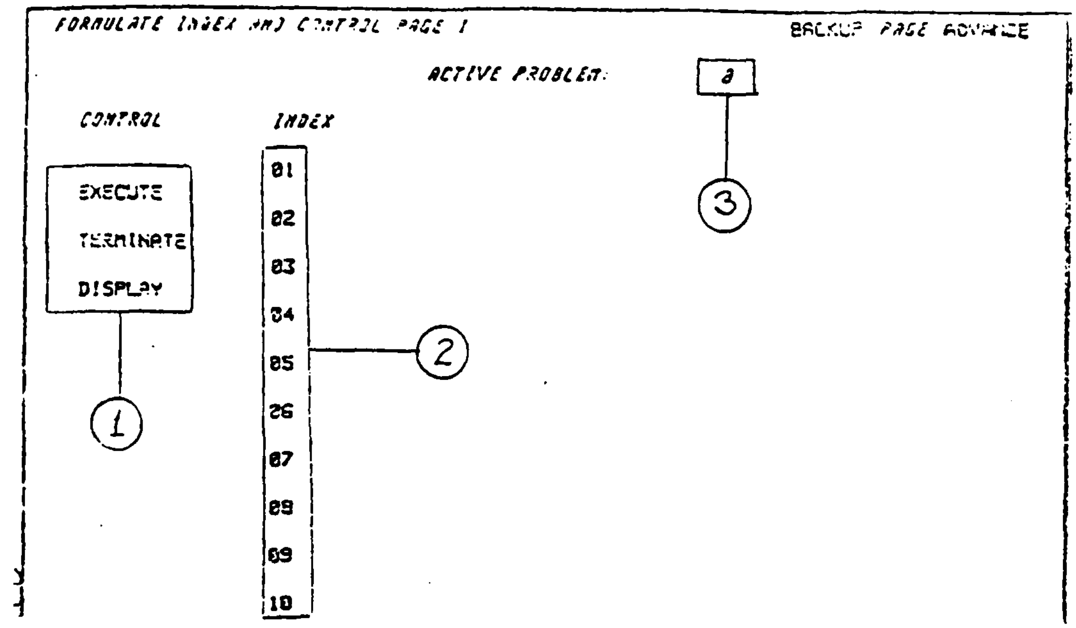



Figure 17. Sample trainer status page




FORMULATE - PROBLEM DESCRIPTION #04

NAME: MEDITERRANEAN AREA, PRIORITY ATTACK, MULTIPLE TARGETS

THE STUDENT IS BRIEFED TO RENDEZVOUS OVER GIOIA DEL COLLE WITH TWO ITALIAN AIR FORCE G91Y'S WHICH WILL BE AT 10,000 FT. THE F-14 MISSION IS TO FLY COVER FOR THE G91Y'S WHILE THEY PHOTO RECCY A RUSSIAN TASK FORCE OFF THE COAST. THE RECCY PASS IS MADE WEST TO EAST AND THE RUSSIANS FIRE A SAM NARROWLY MISSING THE F-14. THE G91Y'S RETURN TO BASE AND THE F-14 IS DIRECTED VIA DATA LINK TO ATTACK TWO BOMBERS AND TWO FIGHTERS THAT HAVE APPEARED IN THE NORTHEAST QUADRANT. THE BOMBERS ARE DESIGNATED PRIORITY THREATS SINCE THEY ARE SUSPECTED TO CARRY ASM'S. THE F-14 TASK IS COMPLICATED BY BOMBER JAMMERS AND CHAFF, FIGHTER HARASSMENT, AND ADDITIONAL DATA LINK TARGETS. IF THE F-14 FAILS TO DESTROY THE BOMBERS THEY FIRE TWO ASM'S AT THE CARRIER.

Figure 18. Sample formulated index and problem description page

to the disc. A problem number must be "hooked" before the control options are available. If "display" is selected, the problem description page is overlayed on the index page unless a different CRT selection has been made at the Trainer Control panel. Once overlayed, the only means of recalling the index page is to return to the FKB and reselect the Forumlate function which will then display the index page on the CRT selected.

Once "EXECUTE" has been selected, the problem initialization starts and the "Flyout Mismatch" page is automatically displayed <u>if</u> an IC is part of the formulated mission. If not, an IC must be selected from the available IC set ("Initial Conditions" display page) or manually created. Neither is used because of the possibility of interferring with the programmed mission and the effort required to create an IC manually. This problem is reviewed with the "Initial Condition" display. The automatic appearance of the Flyout Mismatch page can cause loss of a desired display if the CRT selection has not been appropriately set. The programmed ICs are normally not included in the problem description because of space limitations. Therefore, the programmed ICs can only be reviewed (and edited) after EXECUTE has been hooked and the trainer initialized (the FREEZE light on steady). The complex problem of reviewing the IC will be discussed further with the Initial Conditions display. The mission description is too brief to be of use to the instructor.

In summary, the following problems with the Formulate display exist:

a. The problem scenario cannot be reviewed without replacing the index page with the description page unless another CRT selection is made. The index page which is required to initialize the mission can only be redisplayed if it was overlayed by the description page, by returning to the FKB.

b. The IC associated with the problem cannot be reviewed unless the problem is loaded and initialized (executed) and the complex process of accessing an IC undertaken.

c. Alternative IC options other than that formulated, are not used because of the potential for conflicts during the subsequent evolution of the programmed mission.

d. The description pages are too brief a summary to be useful to the instructors.

CDP-23. INITIAL CONDITIONS Display. Up to 50 ICs can be stored. Ten index numbers and titles are displayed on each page. Figure 19 is a sample page. Names <u>must</u> <u>be</u> attached to the IC when created or the IC cannot be recalled. The ICs themselves cannot be reviewed prior to initialization and then only by accessing a variety of summary pages on other display functions. No clues are provided as to the extent of the IC or to the parameters which have been defined by the IC.

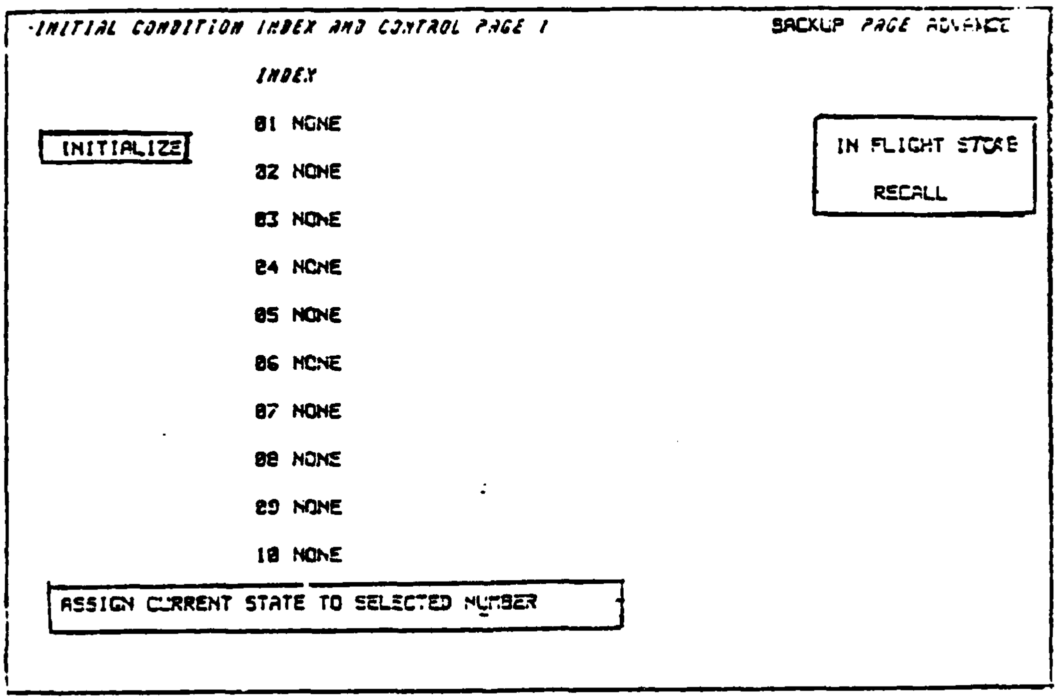



Figure 19. Sample initial conditions index

Once initialized, the Flyout Mismatch page automatically appears. Because of the magnitude of parameters which can be involved, only the "cold start" IC or a few ICs familiar to the MO are utilized. Again, the most common mode utilized is the formulated mission with a preprogrammed IC which simplifies the initializing operation and avoids "crashing" the system.

In summary, the IC display is of little use except to the MO, and then only if he remembers or has notes on IC content since no meaningful summary of the IC is available on the CRTs. Review and editing of the IC set requires accessing the nine tactical summary pages, the four flight summary pages, the Parameter Set Flight 2 page, and other target, facility and related pages as required. Most ICs are created by editing the environment and aircraft configuration parameters, than manually flying the trainer to the desired point in space, stabilizing all flight parameters, freezing the trainer and then storing the frozen set of conditions. Thus, all simulation parameters are either directly or indirectly stored. Review of the IC, therefore, requires accessing literally all display pages defining parameters. Editing can be hazardous since a change in one parameter may be incompatable with others in the IC. There is no easy way of establishing incompatability short of trial and error.

CDP-24. TARGET THREAT Display. The Target Threat display includes an index and status plan for the various targets available (24 airborne targets, the carrier, five seaborne targets, five SAM/GCI sites, five AAA/GCI sites, a test aircraft, the airborne controller, and the special pages for customizing radars and assigning IFF transponders) and 31 pages of detailed data on these targets. Figure 20 depicts the index and summary page. The comlexity and time required to edit the data pages literally precludes their use during a training event. For example, while air targets can be activated or deactivated on the index page, any air target designated as a SAM (which can only be accomplished on the index page and only for air targets four to 24) can only be activated on Tactical Summary Page one. The same is true for SAM/GCI/AAA sites. While the logic is rational, the target selection and control options are confusing to anyone not intimately familiar with the mechanization.

A more serious problem exists with the details of the targets. Figure 21 illustrates the data page for an air target and Figure 22 for a sea target. The air target position on the TSD is difficult to establish from the information on the data page since only latitude and longitude or range and bearing from the F-14 are provided. The display provides no index or guide marks. Thus, trying to locate a target on the TSD from target threat data is difficult, if not impossible, especially in a multiple threat scenario.

Most of the target data can be edited. However, since most

```
TARGET THREAT - SUMMARY & INDEX                              BACKUP PAGE ADVANCE

  AIRBORNE TARGETS                25   CARRIER      INAC
     # OF ASN'S   0
  1    INAC                       SEABORNE TARGETS            ASSOC
  2    INAC                                               SAM/GCI   AAA/GCI
  3    INAC                       26    INAC                 0         0
  4    INAC                       27    INAC                 0         0
  5    INAC                       28    INAC                 0         0
  6    INAC                       29    INAC                 0         0
  7    INAC
  8    INAC
  9    INAC                       SAM/GCI SITES           AAA/GCI SITES
  10   INAC
  11   INAC                       30    INAC              35    INAC
  12   INAC                       31    INAC              36    INAC
  13   INAC                       32    INAC              37    INAC
  14   INAC                       33    INAC              38    INAC
  15   INAC                       34    INAC              39    INAC
  16   INAC
  17   INAC
  18   INAC                       40   TEST AIRCRAFT        INAC
  19   INAC
  20   INAC                       41   AIRBORNE CONTROLLER        INAC
  21   INAC
  22   INAC                       RADAR PAGE (CUSTOM)
  23   INAC
  24   INAC                       IFF TGT TRANSPONDERS
```

Figure 20. Sample target threat summary and index page

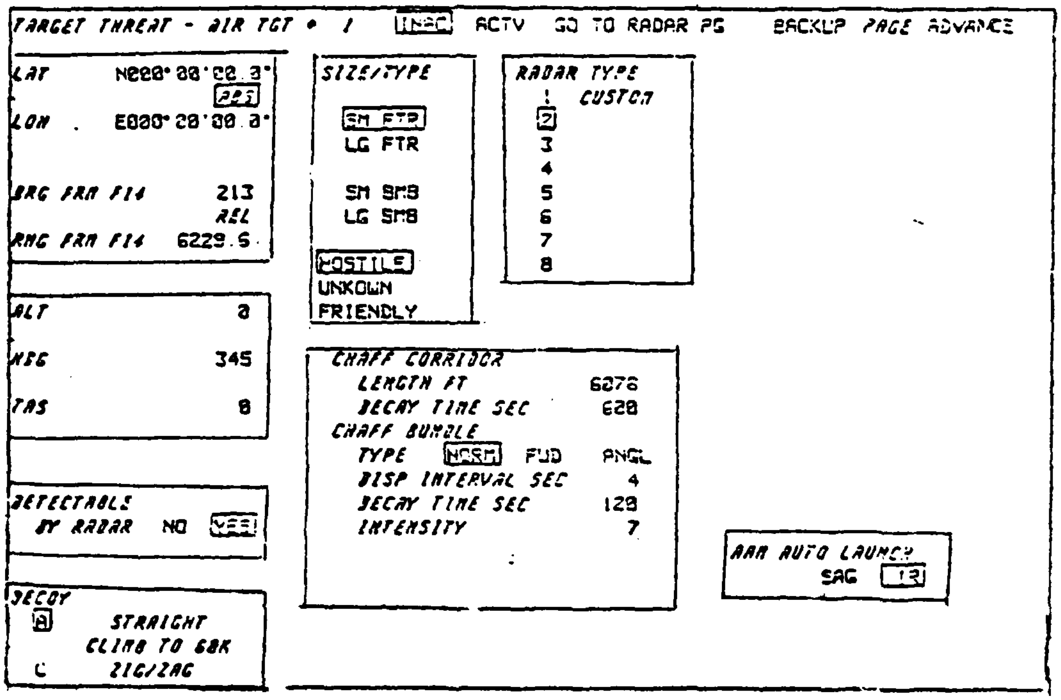



Figure 21. Sample air target data page

TARGET THREAT - SEA TARGETS BACKUP PAGE ADVANCE

| TGT # | 26 | 27 | 28 | 29 |
|---|---|---|---|---|
| | INAC ACTV | INAC ACTV | INAC ACTV | INAC ACTV |
| | HOSTILE | HOSTILE | HOSTILE | HOSTILE |
| | UNKNOWN | UNKNOWN | UNKNOWN | UNKNOWN |
| | FRIENDLY | FRIENDLY | FRIENDLY | FRIENDLY |
| LAT | N000° 00'00.0° | N000° 00'00.0° | N000° 00'00.0° | N000° 00'00.0° |
| | RES | RES | RES | RES |
| LON | E000° 00'00.0° | E000° 00'00.0° | E000° 00'00.0° | E000° 00'00.0° |
| BRG FROM F14 | 213 | 213 | 213 | 213 |
| | REL | REL | REL | REL |
| RNG FRM F14 | 6229 | 6229 | 6229 | 6229 |
| HDG RAG | 345 | 345 | 345 | 345 |
| SPD KTS | 0 | 0 | 0 | 0 |
| ASSOC SAM/GCI | 0 | 0 | 0 | 0 |
| ASSOC AAA/GCI | 0 | 0 | 0 | 0 |

Figure 22. Sample sea target data page

training events are formulated, the capablity is rarely used since target parameter changes could significantly affect the evolution of the programmed mission.

Some target data of concern to the tactical situation such as target threat classification, radar detectability and launch mode, are available only in the data pages . As will be discussed under the TSD display mode, unless the instructor or operator can identify the target number, there is no means of verifying what systems are active on the target since the target threat data page can only be addressed by target number.

Finally, a review of the target data does not identify what weapon system is being simulated. Thus, unless the instructor is thoroughly familiar with the threat characteristics and how they relate to the descriptions on the target threat pages, he has no way of relating the 2F112 threat to any current threat system.

Sample data pages for SAM/AAA/GCI are shown in Figures 23 and 24. Again, the problems of correlating the threat data with a TSD displayed target and of identifying the simulated threat systems exist. Thus, unless the instructor is intimately familiar with the relation of operational threats to 2F112 simulated threats and the location of these threats in terms of air and surface targets, he will be unable to meaningfully evaluate their contributions to the training problem.

The carrier page is accessible through the target threat index or directly from the FKB as "CARRIER." Access to the data on the data page is critical for carrier launch and recovery as can be seen in the sample data page (Figure 25).

Again, certain critical information is displayed only on the data page. For example, if "BOLTER" is activated, all carrier passes will be bolters. Unless the instructor recalls that this condition is set or checks the data page, he has no other system indication that this will occur. The same holds true for "WAVE-OFF" and catapult pressure setting.

In summary, the target threat pages can be characterized as:

a. difficult to relate to relevant threat systems,

b. difficult, if not impossible, to relate to targets on the TSD,

c. difficult to integrate with other control operations and pages such as tactical and flight summary pages.

d. difficult to use to generate or create and control meaningful threats.

In short, the target pages are rarely used by instructors who are not 2F112 sophisticated. Since most of the training

| TARGET THREAT - SAM/GCI SITES | | | | | BACKUP PAGE ADVANCE |
|---|---|---|---|---|---|
| TGT # | 30 | 31 | 32 | 33 | 34 |
| | INAC [ACTV] | INAC [ACTV] | INAC [ACTV] | INAC [ACTV] | [INAC] ACTV |
| ASSOC SEA TGT | 26 | 0 | 0 | 0 | 0 |
| LAT | N 40°28'10" | N 40°27'00" | N 40°30'00" | N 40°40'00" | N 00°00'00" |
| | [ABS] | [ABS] | [ABS] | [ABS] | ABS |
| LON | E018°26'00" | E018°10'00" | E018°00'00" | E017°30'00" | E000°00'00" |
| BRG FRM F14 | 159 | 150 | 143 | 130 | 100 |
| | REL | REL | REL | REL | REL |
| RNG FRM F14 | 96 | 95 | 100 | 140 | 2738 |
| ELEVATION FT | 0 | 1000 | 975 | 1200 | 0 |
| SAM/GCI | [SAM] GCI | SAM [GCI] | SAM [GCI] | SAM [GCI] | [SAM] GCI |
| RADAR TYPE | 14 | 19 | 28 | 24 | 9 |

| SAM RADAR TYPES | | GCI RADAR TYPES | |
|---|---|---|---|
| 9 NAMEXXXXXXXX | 14 NAMEXXXXXXXX | 19 NAMEXXXXXXXX | 24 NAMEXXXXXXXX |
| 10 NAMEXXXXXXXX | 15 NAMEXXXXXXXX | 20 NAMEXXXXXXXX | 25 NAMEXXXXXXXX |
| 11 NAMEXXXXXXXX | 16 NAMEXXXXXXXX | 21 NAMEXXXXXXXX | 26 NAMEXXXXXXXX |
| 12 NAMEXXXXXXXX | 17 NAMEXXXXXXXX | 22 NAMEXXXXXXXX | 27 NAMEXXXXXXXX |
| 13 NAMEXXXXXXXX | 18 NAMEXXXXXXXX | 23 NAMEXXXXXXXX | 28 NAMEXXXXXXXX |

Figure 23. Sample SAM/GCI sites data page

| TARGET THREAT - AAA/GCI SITES | | | | | BACKUP PAGE ADVANCE |
|---|---|---|---|---|---|
| TGT # | 35<br>[INAC] ACTV | 36<br>[INAC] ACTV | 37<br>[INAC] ACTV | 38<br>[INAC] ACTV | 39<br>[INAC] ACTV |
| ASSOC SEA TGT | 0 | 0 | 0 | 0 | 0 |
| LAT | N020° 00'29" | N220° 00'22" | N000° 20'29" | N220° 20'20" | N220° 20'22" |
| | [ABS] | [ABS] | [ABS] | [ABS] | [ABS] |
| LON | E000° 00'00" | E200° 20'22" | E300° 20'20" | E220° 20'23" | E220° 20'00" |
| BRG FRM F14 | 213 | 213 | 213 | 213 | 213 |
| | REL | REL | REL | REL | REL |
| RNG FRM F14 | 6229 | 6229 | 6229 | 6229 | 2229 |
| ELEVATION FT | 0 | 0 | 0 | 0 | 0 |
| AAA/GCI | AAA [GCI] | AAA [GCI] | AAA [GCI] | [AAA] GCI | [AAA] GCI |
| RADAR TYPE | 24 | 25 | 26 | 29 | 30 |

| AAA RADAR TYPES | | GCI RADAR TYPES |
|---|---|---|
| 29 | 19 | 24 |
| 30 | 20 | 25 |
| 31 | 21 | 26 |
| 32 | 22 | 27 |
| 33 | 23 | 28 |

Figure 24. Sample AAA/GCI sites data page

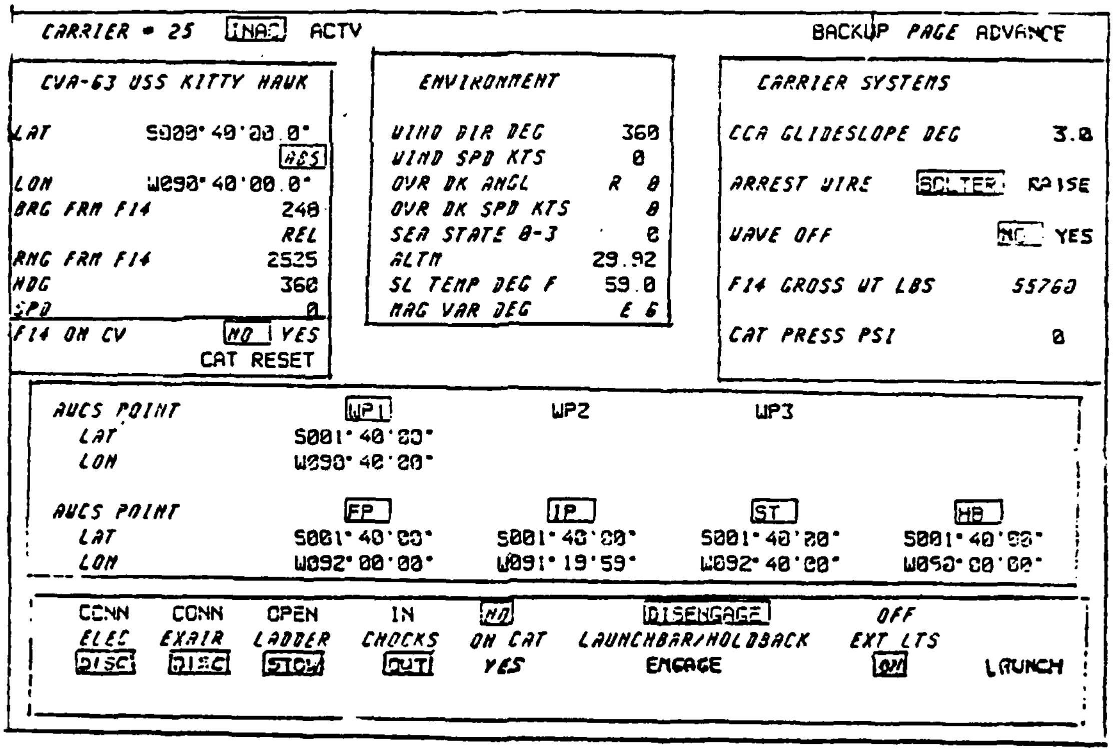



Figure 25. Sample carrier data page

events are formulated, the MOs utilize the pages only for target activity data and seldom edit the data to avoid any conficts in the evolution of the programmed event.

CDP-25. FACILITIES Display. The facilities data pages include an index page and 14 data pages listing individual radio navigation facilities. Figure 26 illustrates these data pages. The displays are not used during training by either instructors or MOs. They are required only to update facilities data when necessary. This could be easily accomplished off-line.

CDP-26. DATA LINK Display. The data link display pages consist of an index and 18 data pages, eight for targets and 10 for control. The simulation of the data link is not current in terms of equipment installed in the aircraft. The differences preclude effective training and therefore is not used. However, even if the simulation were current, it is doubtful if the capability could be effectively used because of the complexity of the operations required. Figures 27 and 28 are samples of the display pages involved and illustrate the problems. Furthermore, the data entered must be correlated with the target threat data pages, the TSD and the tactical summary pages. No data link missions have been formulated nor has the practical feasibility of doing so effectively been demonstrated.

CDP-27. STORES Display. The stores data pages include both a "customizing" stores data page and a standard stores page for initializing F-14 basic stores configurations of missiles or bombs. Since bombs are not used, the two pages of related configurations are not used. The missile stores pages are used primarily by the MOs in establishing an IC since most of the missions are formulated. Instructors utilize the repeater displays for stores configuration information. Figure 29 is a sample of the missile customizing and standard configuration option pages.

CDP-28. TACTICAL SITUATION Display. The TSD pages consist of a map display and nine tactical summary ("TAC SUM") pages which occupy the bottom four inches of the map display. The map display is a plan view of the tactical world with four scale options. Figure 30 is a sample TSD and summary page. The TSD map presents several problems for the MO and the instructors.

a. No target track is available. Thus, unless the target is monitored continuously or the target isolated and hooked or identified and called up on the threat pages, the course of the target cannot be established. Even if the numerical data can be recovered from the threat pages, the course relative to other targets is difficult to estimate.

b. Estimating or establishing the range between targets is difficult and requires either estimating it directly from the display, which is not easy unless done routinely, or recovering the latitude and longitude of the target(s) and manually

FACILITIES INDEX — BACKUP PAGE ADVANCE

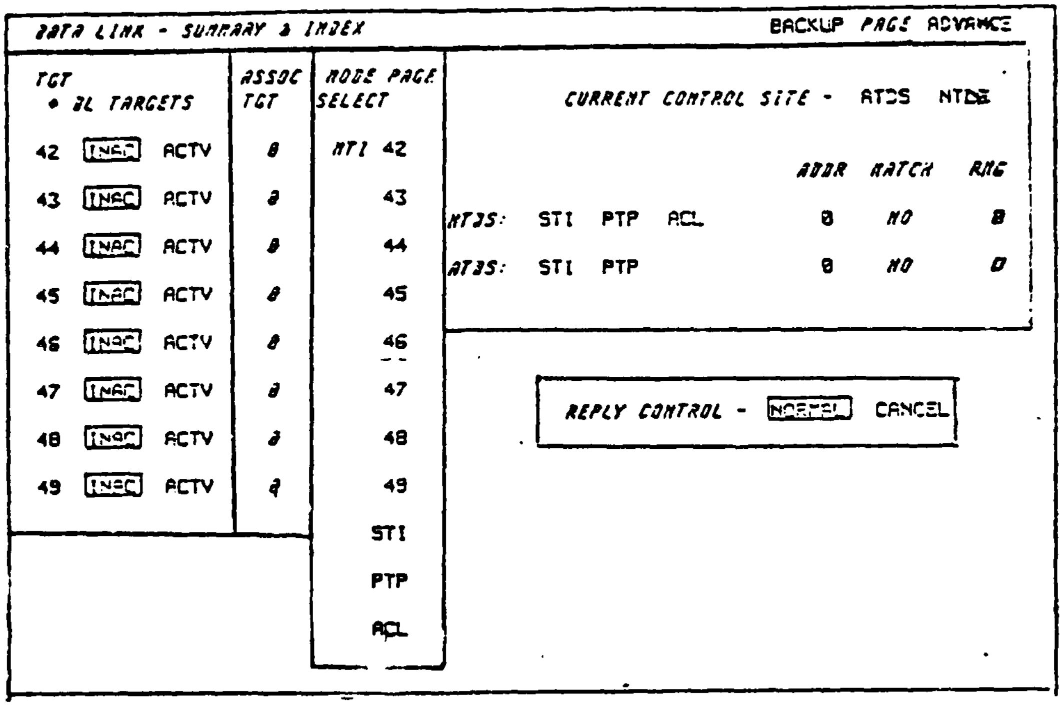
| PAGE # | AREA | PAGE # | AREA |
|---|---|---|---|
| 1 | EASTERN USA | 11 | EUROPE. AFRICA AND ATLANTIC |
| 2 | EASTERN USA | 12 | ASIA AND THE PACIFIC |
| 3 | EASTERN USA | 13 | ASIA AND THE PACIFIC |
| 4 | EASTERN USA | 14 | MOBILE |
| 5 | WESTERN USA | 15 | |
| 6 | WESTERN USA | 16 | |
| 7 | WESTERN USA | 17 | |
| 8 | WESTERN USA | 18 | |
| 9 | WESTERN USA | 19 | |
| 10 | EUROPE. AFRICA AND ATLANTIC | 20 | |

FACILITIES PAGE 01 — BACKUP PAGE ADVANCE

EASTERN USA

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 01 | AEX | ALEXANDRIA.LA VORTAC | CH108 | 21 | | BERMUDA NAS APP CON | 335 9 |
| 02 | AMG | ALMA.GA VORTAC | CH 98 | 22 | | BERMUDA NAS DEP CON | 338 0 |
| 03 | | ANDREWS AFB APP CON | 294.5 | 23 | | BERMUDA NAS GUARD | 243.0 |
| 04 | | ANDREWS AFB DEP CON | 269.5 | 24 | BDA | BERMUDA NAS TACAN | CH 23 |
| 05 | | ANDREWS AFB GND CON | 275.8 | 25 | | BERMUDA NAS TOWER | 291.6 |
| 06 | | ANDREWS AFB GUARD | 243 0 | 26 | | BERMUDA NS GCA RWY30 | 289 4 |
| 07 | | ANDREWS AFB TOWER | 289.6 | 27 | BHM | BIRMINGHAM.AL VORTAC | CH 91 |
| 08 | ADW | ANDREWS AFB VORTAC | CH 78 | 28 | BQN | BORINQUEN.PR VORTAC | CH 82 |
| 09 | | ANDREWS GCA RWY 01 | 309.8 | 29 | BRV | BROOKE.VA VORTAC | CH 55 |
| 10 | ATL | ATLANTA.GA VORTAC | CH116 | 30 | BGM | BROOME CO.NY VORTAC | CH 90 |
| 11 | AGS | AUGUSTA.GA VORTAC | CH 86 | 31 | CCV | CAPE CHARLES.VA VTC | CH 59 |
| 12 | BAL | BALTIMORE.MD VORTAC | CH 98 | 32 | | CECIL FIELD APP CON | 379 9 |
| 13 | | BEAUFORT APP CON | 301.2 | 33 | | CECIL FIELD DEP CON | 319.5 |
| 14 | | BEAUFORT APP CON | 314 0 | 34 | | CECIL FIELD GND CON | 384.4 |
| 15 | | BEAUFORT GND CON | 336 4 | 35 | | CECIL FIELD GUARD | 243.0 |
| 16 | | BEAUFORT GCA RWY 04 | 383 6 | 36 | NZC | CECIL FIELD NAS NDB | 276 2 |
| 17 | NBC | BEAUFORT MCAS NDB | 267.6 | 37 | NZC | CECIL FIELD NAS TCN | CH125 |
| 18 | | BEAUFORT MCAS GUARD | 243.0 | 38 | | CECIL FIELD TOWER | 360.2 |
| 19 | | BEAUFORT MCAS TOWER | 340.2 | 39 | | CECIL FLD GCA RWY36L | 299 6 |
| 20 | NBC | BEAUFORT MCAS TACAN | CH 42 | 40 | CRW | CHARLESTON.SC VORTAC | CH 82 |

Figure 26. Sample facilities index and data page



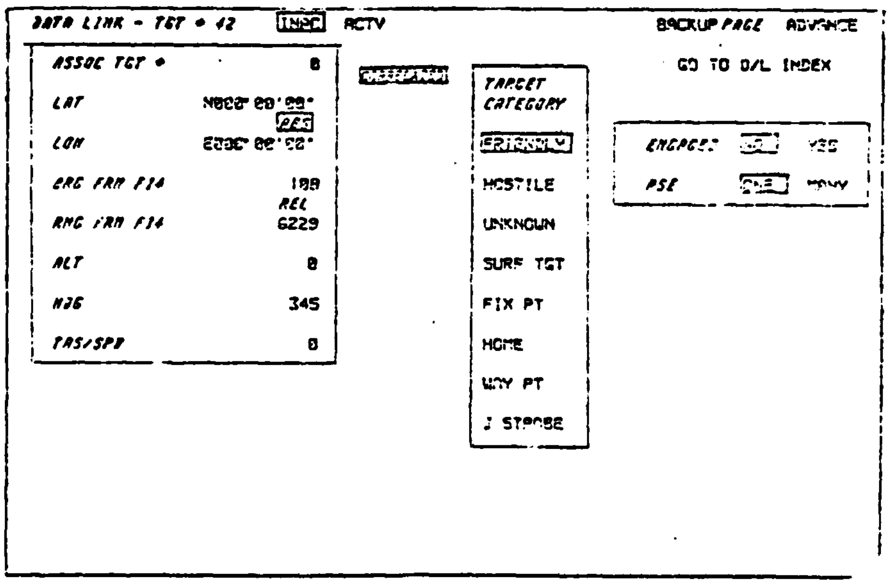




Figure 27. Sample data link index and target pages

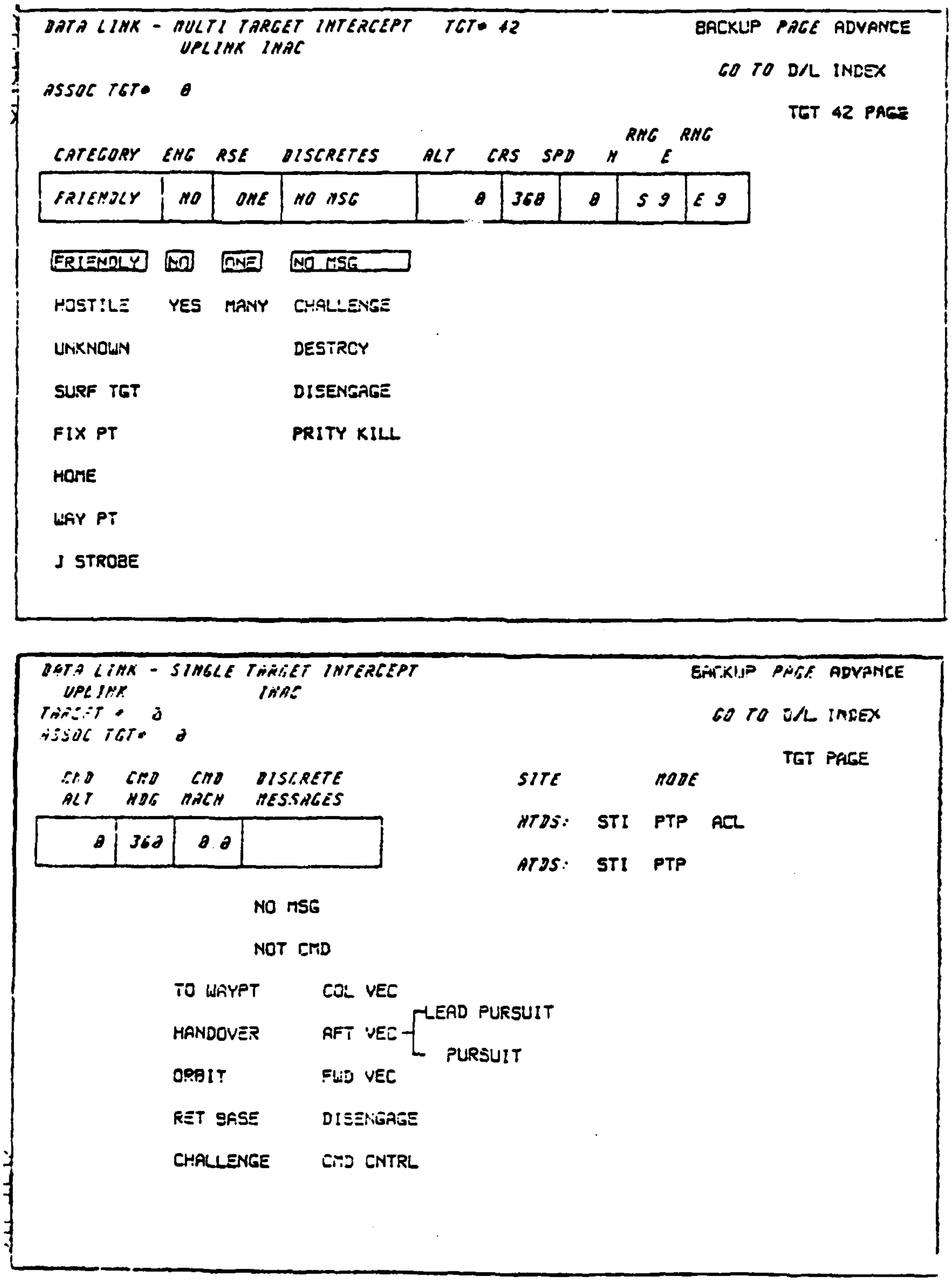
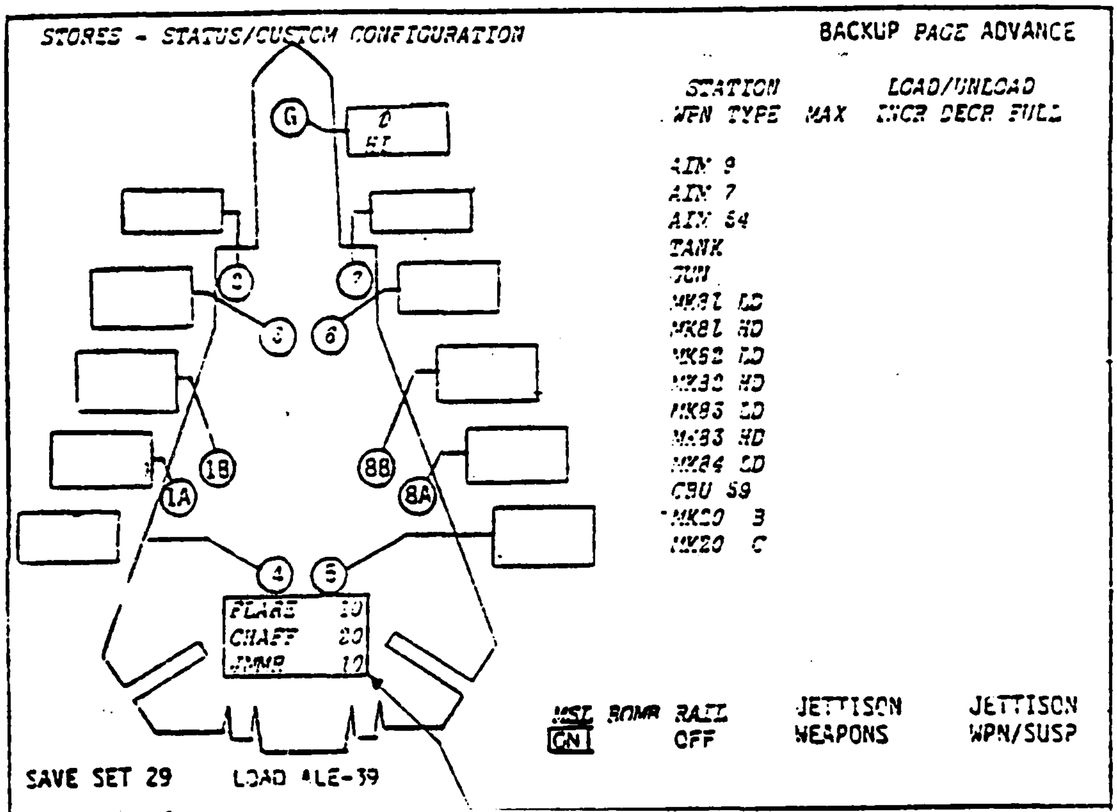



Figure 28. Sample data link target intercept pages




| • CONFIG | | | • CONFIG | | 1A | 1B | 2 | 3 | 4 | 5 | 6 | 7 | 8B | 8A | GUN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1A | CLEAN | 2 | -- | 9 | - | - | - | 54 | - | - | - | 7 | - | 670 |
| | | | 3 | | 9 | 7 | - | 54 | 54 | - | - | - | 7 | 9 | 670 |
| 4 | 1C | TK ONLY | 5 | 1B1 | 9 | 9 | - | - | - | - | - | - | 9 | 9 | 670 |
| | | | 6 | 1B2 | 9 | - | - | - | - | - | - | - | - | 9 | 670 |
| 29 | CUSTOM | | 7 | 2A | - | - | - | 7 | 7 | 7 | 7 | - | - | - | 670 |
| | | | 8 | 2B1 | 9 | 9 | - | 7 | 7 | 7 | 7 | - | 9 | 9 | 670 |
| | | | 9 | 2B2 | 9 | - | - | 7 | 7 | 7 | 7 | - | - | 9 | 670 |
| | | | 10 | 2B3 | 9 | 7 | - | 7 | 7 | 7 | 7 | - | 7 | 9 | 670 |
| | | | 11 | 2B4 | - | 7 | - | 7 | 7 | 7 | 7 | - | 7 | - | 670 |
| | | | 12 | 2C1 | 9 | 9 | TK | 7 | 7 | 7 | 7 | TK | 9 | 9 | 670 |
| | | | 13 | 2C2 | 9 | - | TK | 7 | 7 | 7 | 7 | TK | - | 9 | 670 |
| | | | 14 | 2C3 | 9 | 7 | TK | 7 | 7 | 7 | 7 | TK | 7 | 9 | 670 |
| | | | 15 | 2C4 | - | 7 | TK | 7 | 7 | 7 | 7 | TK | 7 | - | 670 |
| | | | 16 | 3B1 | 9 | 9 | - | 54 | 54 | 54 | 54 | - | 9 | 9 | 670 |
| | | | 17 | 3B2 | 9 | - | - | 54 | 54 | 54 | 54 | - | - | 9 | 670 |
| | | | 18 | 3B3 | 9 | 7 | - | 54 | 54 | 54 | 54 | - | 7 | 9 | 670 |
| | | | 19 | 3B4 | - | 7 | - | 54 | 54 | 54 | 54 | - | 7 | - | 670 |
| | | | 20 | 3B5 | 9 | 54 | - | 54 | 54 | 54 | 54 | - | 54 | 9 | 670 |
| | | | 21 | 3B6 | - | 54 | - | 54 | 54 | 54 | 54 | - | 54 | - | 670 |
| | | | 22 | 3C | - | - | TK | 54 | 54 | 54 | 54 | TK | - | - | 670 |
| | | | 23 | 3C1 | 9 | 9 | TK | 54 | 54 | 54 | 54 | TK | 9 | 9 | 670 |
| | | | 24 | 3C2 | 9 | - | TK | 54 | 54 | 54 | 54 | TK | - | 9 | 679 |
| | | | 25 | 3C3 | 9 | 7 | TK | 54 | 54 | 54 | 54 | TK | 7 | 9 | 670 |
| | | | 26 | 3C4 | - | 7 | TK | 54 | 54 | 54 | 54 | TK | 7 | - | 670 |
| | | | 27 | 3C5 | 9 | 54 | TK | 54 | 54 | 54 | 54 | TK | 54 | 9 | 670 |
| | | | 28 | 3C6 | - | 54 | TK | 54 | 54 | 54 | 54 | TK | 54 | - | 670 |

STORES - AIR INTERCEPT MISSILES, GUN AND TANKS — BACKUP PAGE ADVANCE

Figure 29. Sample missile store status and configuration pages

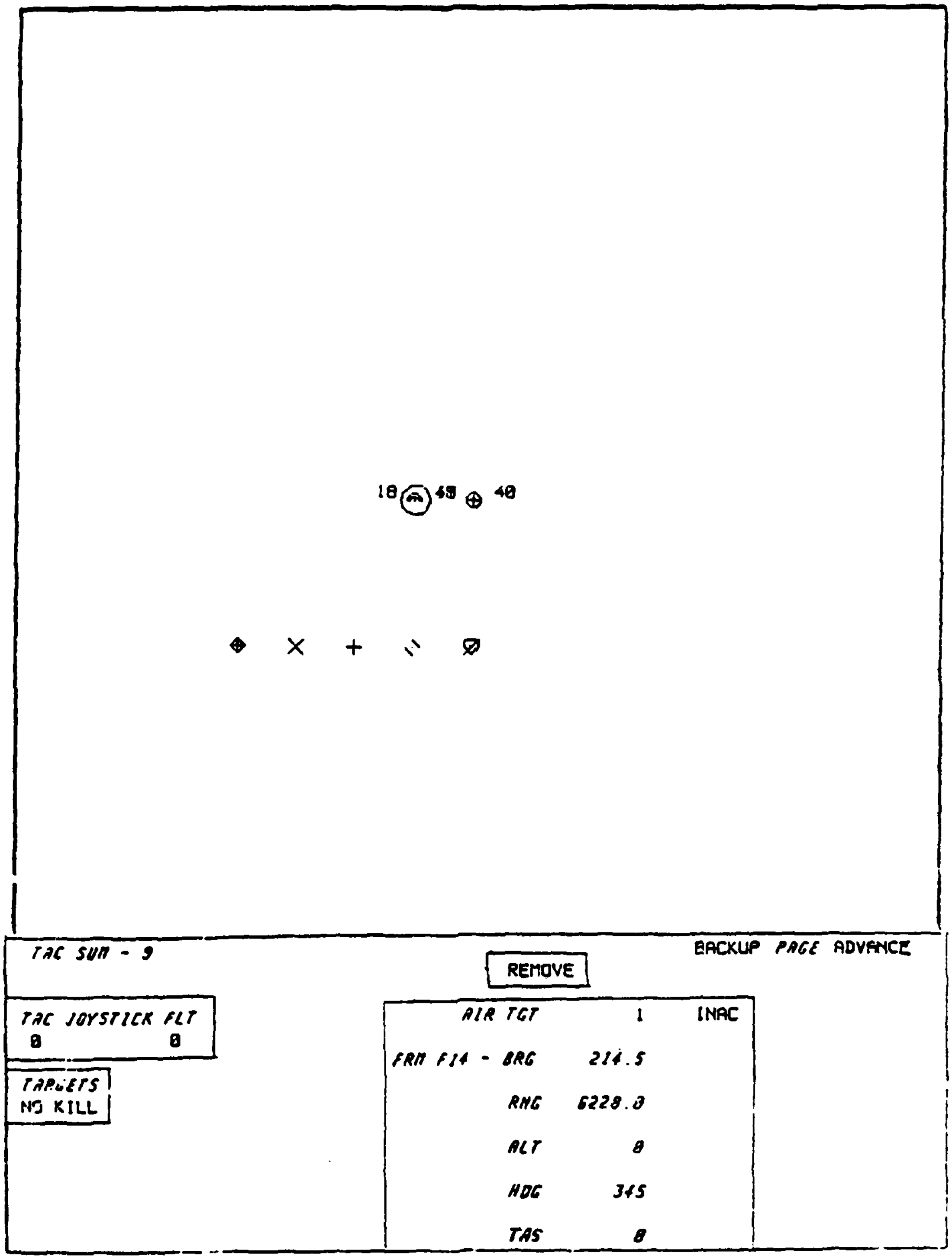



Figure 30. Sample TSD with TAC SUM 9 data display

computing the range, a time consuming task.

c. The type of target threat is not indicated and can only be derived from data on the target threat pages if the characteristics of the threat and the simulation parameters are known or can be correlated. The information is needed by the instructor to evauate aircrew performance.

d. The state of target activity is confusing since, for example, a target can be "active" but have an "inactive" radar.

e. The countermeasures displays which consists of "TAC SUM" displays two through eight (see Appendix A) are difficult to operate. As a result, unless the jammers are preprogrammed, the capability is not utilized. Manual operation requires skipping back and forth across the TAC SUM pages to control the jammers. In addition, detailed knowledge of the simulation of the jammers and the target threat characteristics relative to electronic countermeasures (ECM) capability is required.

f. Manual recentering of the TSD is rarely used since it requires estimating the latitude and longitude of the new center, entering these data and then activating "recenter." Estimating the desired new center is difficult if not done routinely.

g. Data page TAC SUM nine provides for assigning a target to the instructor for manual control using a joystick. The information and control available are inadequate for the task. Furthermore, the option is not used in formulated missions since the manually controlled target would probably be incompatible with the programmed scenario.

In summary, the TSD mode includes a complex set of displays which are unusable by the instructor (except for monitoring the displays provided) and confusing for the MOs in terms of target and countermeasures control and display centering. Lack of data on target track and ranges complicates the task.

CDP-29 MAP Display. The map display includes a cross-country map, a grid map, a polar grid map, a polar carrier map, an approach map and a GCA/CCA (Ground Controlled Approach/Carrier Controlled Approach) controller display. In addition, the bottom four inches of the display are utilized for data or flight summary displays. Four options are available. Figure 31 shows a cross-country map with the FLIGHT SUM one data page. Similar problems in using these displays as were found with the TSD exist.

a. Manual centering requires estimation of the latitude and longitude of the new center desired and inputting of these data. The task is difficult and time consuming. Therefore the automatic recentering feature is routinely used.

b. Range data must be estimated from the display unless

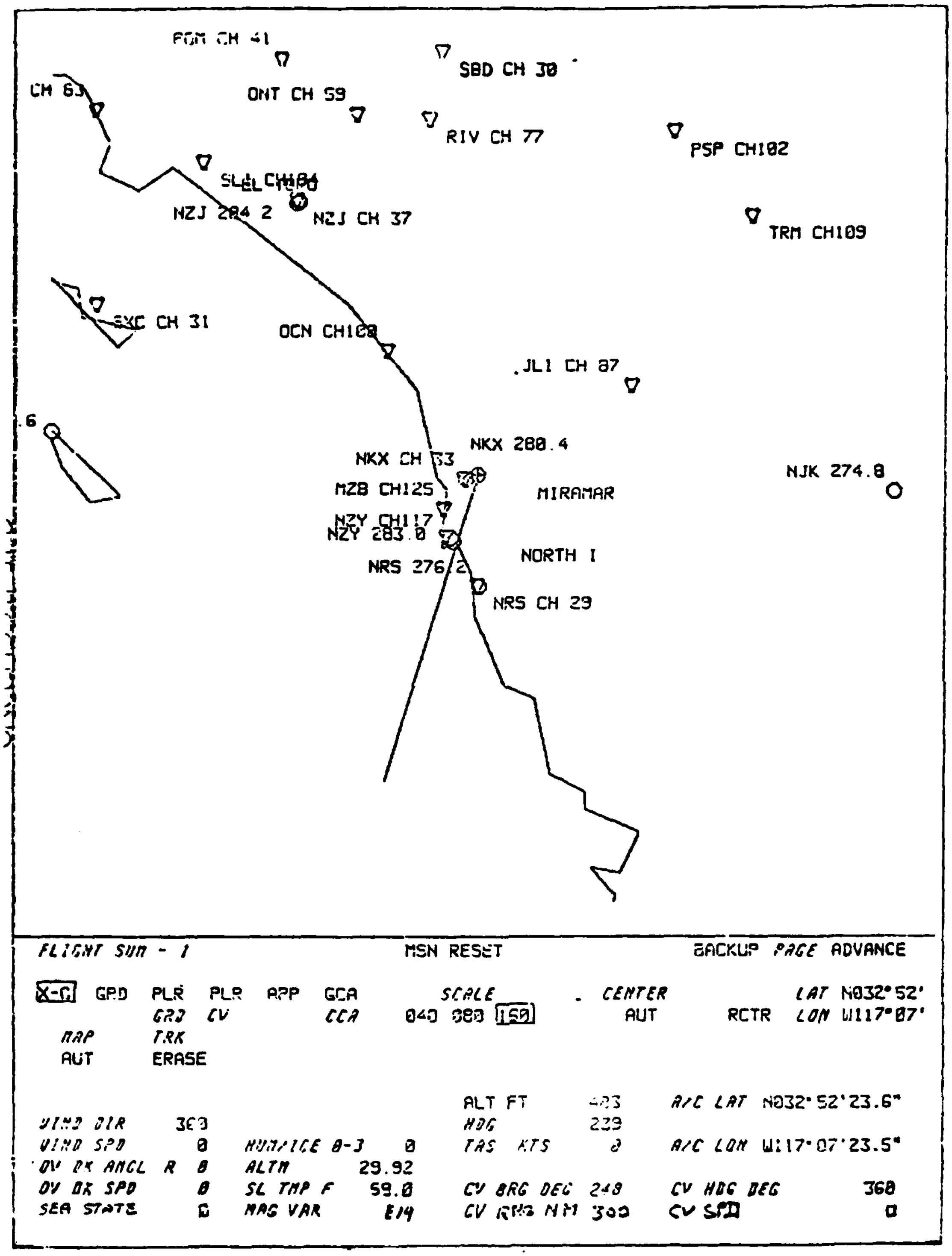



Figure 31. Cross country (X-C) map with flight summary display

navigation system readouts are accessed.

c. The grid and polar maps are not utilized.

d. The approach map data are inadequate. Approach plate data are needed, especially the descent heights, frequencies and missed approach data for alternative runways at local and deployed fields.

e. The automatic map change feature is not used since it results in display shifts not desired by the instructors, especially from approach to GCA or CCA pages.

f. The summary displays are cumbersome in that data required at any moment is probably spread across several summary pages. For example, radio data is on page two and aircraft flight and weather are on page three. Some data are duplicated on many pages (see Figure 32). A simple summary page is feasible and recommended.

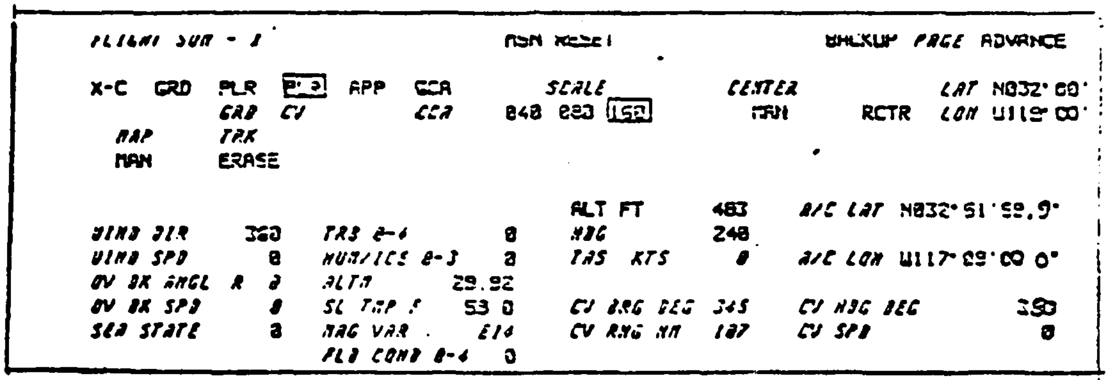
g. The GCA scoring data are not utilized since neither the scoring system or its operation is well understood nor is it adequately described in the documentation.

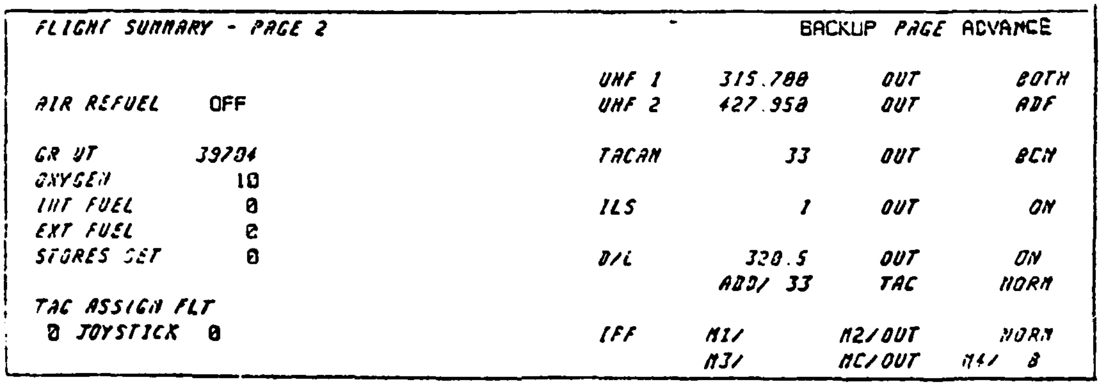
CDP-30. REPEATER DATA Display. This CRT display page is of selected system parameters. It is not interactive and is intended for hard copy output only. The data are available on other displays. It is not utilized since it generally does not include all of the data desired and its use requires selecting a CRT, selecting the display and then selecting hard copy. It is generally simpler to select a hard copy of the display being monitored, especially since the data involved are generally dynamic and unless the trainer is frozen, may have changed signficantly by the time the steps required for Repeater Data hard copy have been completed. In addition, the process disrupts monitoring of the displays on the CRTs.

CDP-31. MALFUNCTIONS Display. The malfunctions displays include an index page and multiple pages consisting of lists of malfunctions. Figure 33 is a sample of the index page and a typical list page. The index page provides for accessing malfunctions in terms of systems, mission phase or system acronym. The display also lists up to 10 currently active malfunctions. A wide variety of problems exist in the use of the malfunction displays as implemented.

a. The number of malfuctions available far exceeds the training requirement and results in complex operating problems. Time is also consumed in locating the malfunction desired.

b. No description of the malfunction simulation is available except in the instructor handbook. The document is not designed for console use as it is over 500 pages in length and not user formatted.



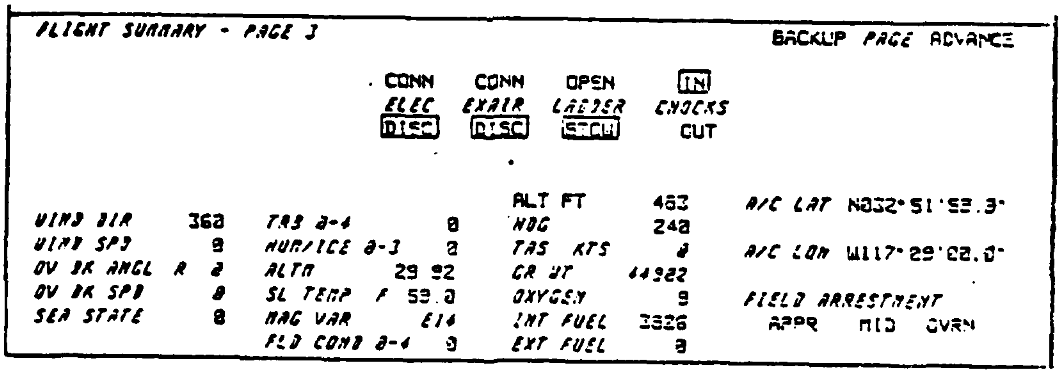




Figure 32. Sample flight summary displays

MALFUNCTIONS - SYSTEMS: FLT INSTR & CONTROL BACKUP PAGE ADVANCE

FLIGHT INSTRUMENTS

070 GEAR LT FAIL ON
071 GEAR LT FAIL OFF
074 AOA IND POSN FREEZE
075 CADC TOTAL FAILURE
076 RADAR ALTIM ERROR
077 PITOT HEAT FAIL RT
078 PITOT HEAT FAIL LEFT

FLIGHT CONTROLS

079 AFCS TOTAL FAIL
080 STICK SW- SPOIL ASYM
081 PITCH CHAN A FAIL
082 PITCH CHAN B FAIL
083 ROLL CHAN A FAIL
084 ROLL CHAN B FAIL
085 YAW CHAN A FAIL
086 YAW CHAN B FAIL
087 GLOVE VANE CAUTION
088 RUDDER AUTH FAIL
089 HORIZ TAIL AUTH FAIL
090 AFCS---FAIL ACL CPLR
091 AFCS---FAIL ALT HOLD
092 FLAP ASYM AND LOCKOUT
093 FLAP ASYM W/O LOCKOUT
094 SPOIL FAIL RETRACTED
095 MAIN FLAPS FAIL RETR
096 MAIN FLAPS FAIL DOWN
097 AUX FLAPS FAIL RETR
098 AUX FLAPS FAIL DOWN
099 WING SW AUT CNTR LOS
100 WING SW AUT/MAN LOSS
101 WING SW TOTAL LOSS
102 WING SW ADVISORY LT
103 RUNAWAY PTCH NOSE DN

FLIGHT CONTROLS

106 UNSCHED WING SWEEP (20-68 ) 0

MALFUNCTIONS - INDEX & SUMMARY BACKUP PAGE ADVANCE

| SYSTEM MALF INDEX : | PHASE MALF INDEX : | ACRONYM MALF INDEX : |
|---|---|---|
| L ENG & L ENG INSTR | PREFLT/START | FLIGHT SYSTEMS |
| R ENG & R ENG INSTR | TAXI/CATAPULT/TAKEOFF | AFCS/AICS/APC<br>CADC/UDU |
| FLT INSTR & CONTROL | TAKEOFF/MASTER TEST | NAV SYSTEMS<br>AHRS/BAG/CSDC/DDI |
| FUEL/ELEC/HYDR | CRUISE | UHF-DL/MDIG/APX-72<br>INS/RDR ALT/TCN |
| CIRCUIT BREAKERS | LANDING/SHUTDOWN | TACTICAL SYSTEM |
| COMM/NAV | ILS/GCA | CFB/CIAS/SSI/VDIS<br>ECM/FUZE/GUN/IFB |
| WCS | ACLS | APX-76/RAUS/ALR-50 |
| WCS VARIABLE | AIR-TO-AIR | |
| COCKPIT & AIRFRAME | AIR-TO-GROUND | |

ACTIVE MALFS - CLEAR

Figure 33. Sample malfunction index and list pages

c. Except for formulated malfunctions (which are not used), malfunctions must be individually activated and either individually or all cleared or cancelled. Since the malfunctions are addressed in 10 pages, the task becomes prohibitive if timely control of malfunction initiation and cancelling are to be achieved. The simultaneous initiation of malfunctions cannot be achieved manually.

d. Formulated malfunctions are not used since the result is considered too inflexible and unrealistic for training. The available controlling parameters do not provide meaningful "triggers" for programming malfunctions.

e. No display of relelvant check list items to be completed or completed is provided. The "Time Event Monitor" page could be used, but it does not directly address the procedure involved.

In summary, the malfunction display and control mechanization is difficult to employ and consequently is not used. While MO support is essential to implementation of malfunctions, selection and monitoring is an instructor function. Although malfunction procedures training is not a high priority item in the 2F112 syllabi, some procedures training and testing is included.

CDP-32. FLY OUT Display. The Flyout Mismatch display page (Figure 34) lists the cockpit controls which are not set to match the event initial conditions which have been initialized. Some of these could result in a crash or undesirable initial flight conditions when the trainer is unfrozen. The display appears automatically on the selected display during IC initialization and during some reset conditions. It can also be manually called from the FKB. The trainer <u>cannot</u> be unfrozen after initialization until the "INITIATE FLYOUT" on the flyout page has been hooked <u>although</u> the mismatch conditions need not have been corrected. Mismatches must be manually resolved by the aircrew through verbal comunication with the instructors at the console. Several problems exist in the use of the flyout mismatch page.

a. The automatic display of the flyout mismatch data can result in the loss of the display being used unless the CRT for display of the mismatch page is selected in advance and kept in readiness.

b. There is no way of calling the aircrew unless they have their helmets on, headset and microphone connected and the Intercommunications (ICS) panel set correctly. In addition, communications must be established <u>before</u> the IC is initialized.

c. No indication of many corrective actions taken by the aircrew will appear until the trainer is unfrozen. Thus, without verbal feedback, the console staff has no way of ascertaining the configuration of the cockpit or that the mismatch has been

FLYOUT MISMATCHES

| PANEL | SWITCH NAME | POSITION IS | POS SHOULD BE |
|---|---|---|---|
| F11 RAMPS/THROT | THROT TMP | NORM | NOT |
| F16 LDG GR CONT | LDG GR HDL | UP | DOWN |
| P55 DISPL CONT | HSD MODE | TID | NAV |
| P55 DISPL CONT | MODE BUTT | LDG | TO |
| P55 DISPL CONT | STR CMD BUTT | AWL/PCD | TACAN |
| N12 ARMAMENT | DLVY MODE (L) | RPL | STP |
| N12 ARMAMENT | DLVY MODE (R) | PRS | SGL |
| N12 ARMAMENT | ELEC FUSE | SAFE | DLY 2 |
| N12 ARMAMENT | A/G GUN | OFF | MIXED |
| N12 ARMAMENT | JETT OPT | WPNS | MER/TER |

MORE

CAUTION: FLYOUT WITH THE ABOVE MISMATCHES MAY PRODUCE UNDESIRABLE SIMULATOR MOTIONS AND TRAINING SITUATION DISCONTINUITIES

INITIATE FLYOUT

Figure 34. Flyout mismatches page

corrected.

d. Correction of some fly out conditions cannot be accomplished unless the trainer is unfrozen. Yet, for some mismatches, unfreezing the trainer will result in a crash if they exist. For example, if the IC involves a speed above gear door limits but the gear are down prior to initialization, raising the gear handle in the cockpit to correct the mismatch will not prevent a crash when the trainer is unfrozen. (The gear will not raise until the trainer is unfrozen even if the control is raised.) A condition such as this requires selecting or creating and implementing another IC compatible with the existing cockpit configuration, initiating fly out, unfreezing the trainer, directing the aircrew to fly the aircraft into a configuration compatible with the desired IC, freezing the trainer, reinitializing the desired IC, initiating flyout again and then unfreezing the trainer!

CDP-33. TIME EVENT MONITOR Display. This display lists the last 20 control actuations taken by either crewmember. Only discrete position switches are monitored. The display is rarely used because of poor design.

a. The IP and IRIO must separate out the data relevant to their interest, i.e., front and back seat aircrew actions.

b. The display to be effective must be continuously available to the instructor(s). However there are generally higher priority displays involved which require the available CRTs. Fortunately, the repeater displays can be used for some of the information desired.

CDP-34. SYSTEMS STATUS Display. The systems status displays include a pictorial index page and 22 detailed panel data readout pages accessed either by a light pen or by page advancing. Figure 35 depicts the index page and a typical panel monitor page. The displays are seldom used.

a. Most of the data are available in a more readable format from the repeater displays which does not result in CRT display competition.

b. The pictorial index does not logically parallel the aircrew's picture of the consoles. Therefore, instructor time is consumed in locating the panel(s) to be accessed. The alphabetic code used on the index page has no intrinsic meaning to the instructor and does not aid in indexing the panels.

c. The panel data must be read in detail to establish switch positions. The task is time consuming and satisfactory to instructors who are also instructing in-flight and at other trainers which do not employ this readout technique.

d. The data displays are not complete, being limited to

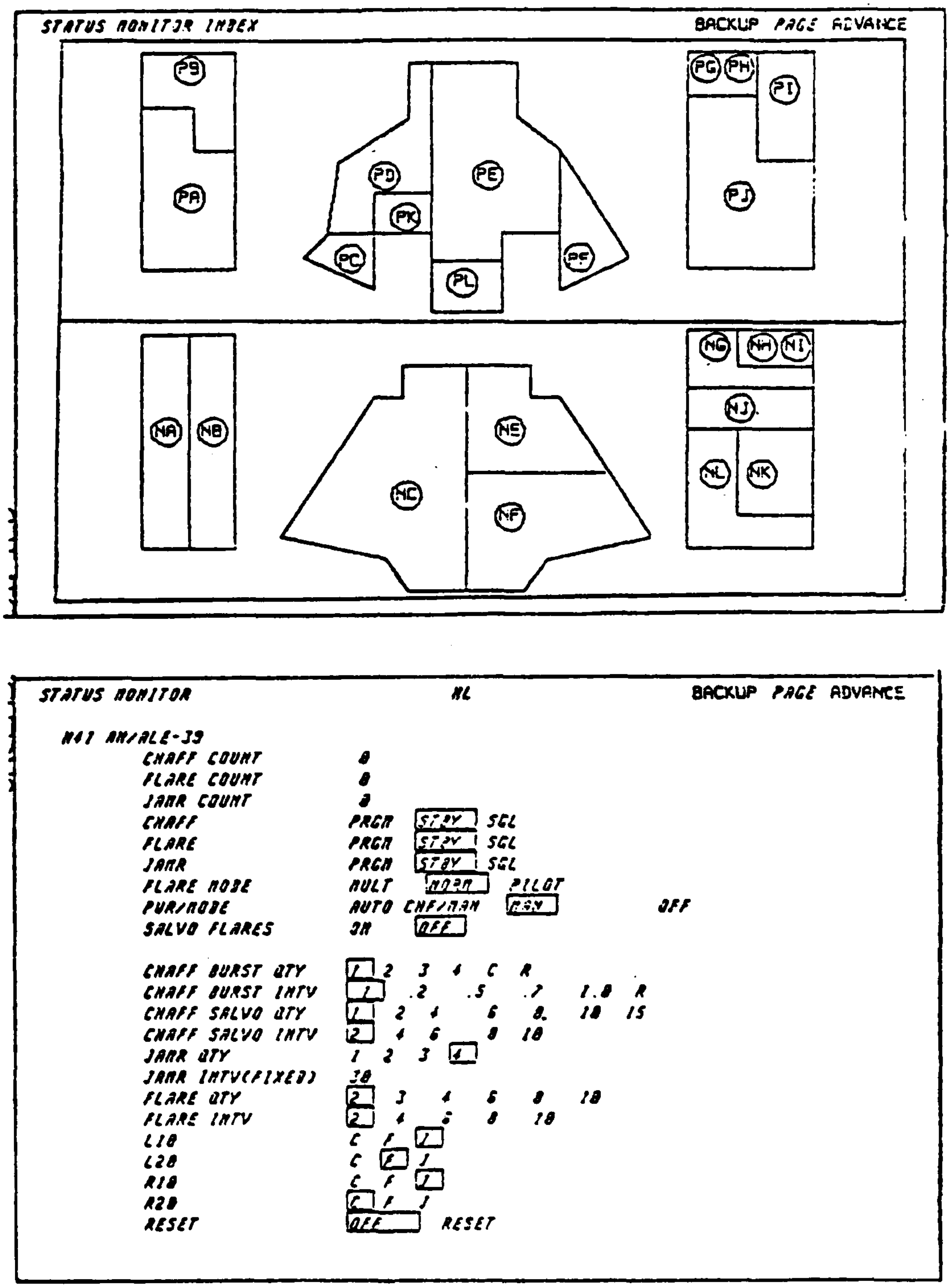



Figure 35. Systems status index and sample data page

only discrete switch position data.

In summary, the system status displays are not used because they do not provide the data required in a readily usable format and they are difficult to access. More complete data is available from the repeater displays and is in a more useable format.

CDP-35. WEAPONS SCORING Display. The weapons scoring displays consist of an index, detailed score "sheets" for each mode of delivery (air-to-air missile, air-to-air guns, air-to-ground guns and air-to-ground bombs) and a polar graphic display which can be used in connection with bomb scoring. Bombing and strafing are not involved in the syllabus so the six related scoring pages and the polar plot display are not used. Several problems limit the effectiveness of the air-to-air missile and gun scoring pages.

a. Codes are utilized to display the targets scored and the results. However, no "decoding" display is provided. The instructor manual is not useable at the console. Thus instructors are generally unable to decifer the data in a timely manner.

b. Although the target numbers are contained in the scoring data, the targets can rarely be isolated or identified on the TSD, especially in multiple threat scenarios.

CDP-36. VISUAL INITIALIZATION Display. Selection of "VISUAL INIT" on the FKB does not affect the WST CRTs, but selects the IC page on the WAVS CRT. The IC entered on the WST CRTs does not initialize the WAVS. Figure 36 is a sample of the visual initialization display. Several problems exist with the display and related controls.

a. The CRT is located near the top of the console above the flight repeater displays at the flight station. Thus the user (generally the MO) must stand up and reach across the IP to use the associated light pen required in the initialization process.

b. Numerical data entry requires use of a NKB which is some distance from the WAVS CRT and light pen (see Figure 5).

c. Aircraft threat control requires that the user know what threat "1" or "2" represent. Although the visual threat aircraft is displayed on the WAVS monitor display, there is no means of correlating the model with the threat selection on the CRT unless the user remembers which is which. The addition of a third model will further complicate the problem.

d. Loading weapons on the threat aircraft results in an error message on the WST CRT at the station being used.

e. The "LEVEL" refers to the maneuvering model program for

VISUAL SYSTEM INITIALIZATION

BLACKOUT SENSITIVITY

A B C D E OFF

WEATHER

CEILING – FT 3ØØ VISIBILITY -NM Ø.5

VISUAL TRAINING TASK: OFF A/A CAR S/A

AIRCRAFT THREAT ID: 1 2

AIRCRAFT THREAT CONTROL: PT IP

PROGRAM TARGET

| WEAPONS | NO | RELOAD |
|---|---|---|
| AIM 9L | 2 | ☒ |
| AIM 7F | 2 | ☒ |
| M61A1 | 25Ø | ☒ |

LEVEL 1 2 3 4

WPN OVERRIDE NO YES

Figure 36. Sample WAVS visual system initialization page

the target aircraft. The only source of information as to what the levels include is in the WAVS instructor handbook which is generally not available at the console.

f. The WAVS visual target aircraft has no relationship to the target(s) created or formulated for the WST.

In summary, the WAVS initialization display is not integrated with the 2F112 instructor console either in physical location or in operation, nor is the target simulation integrated with the WST simulations.

CDP-37. ACM Display. The WAVS ACM display provides a three dimensional (perspective) pictorial display of the relationship of the F-14 and the visual target aircraft. Figure 37 is a sample of the ACM display. It is used primarily by the IP in monitoring aircrew performance. Several problems exist for the IP in utilizing the display, especially if he is not highly experienced with the system.

a. The display will not appear if selection of the A/A (air-to-air) mode has not been initialized.

b. Mission number and date are not used and clutter the display.

c. "EL" (elevation) refers to viewing angle and is controlled by the joystick in the "ORT" (orientation) mode. The abbreviations and relationships are not obvious and hence are rarely used by the IP.

d. Display scale control labeling is not clear. The grid scale is interactive only in the "MAN" (manual) mode.

e. Joystick control option and operation are not clear nor are they well arranged in terms of control/display relationships. The options for recentering or reorienting the grid are not labeled. Unless the IP is experienced or well briefed or assisted by the MO, the control is seldom used.

f. Sparrow missile status for the two aircraft is confusing.

In summary, the ACM display is not designed for use by an IP who is not experienced in 2F112 and WAVS operation. Yet the display is basic to IP monitoring of the ACM event.

CDP-38. PILOT VIEW Display. The pilot view display provides a view as seen by the pilot through the windscreen of either the F-14 or the visual target. Since the target aircraft cannot be effectively flown manually, the view from the target aircraft is seldom used. The data on mission number and date are again not used and clutter the display. The display cannot be called until the A/A mode has been initialized. Figure 38 is a sample of the

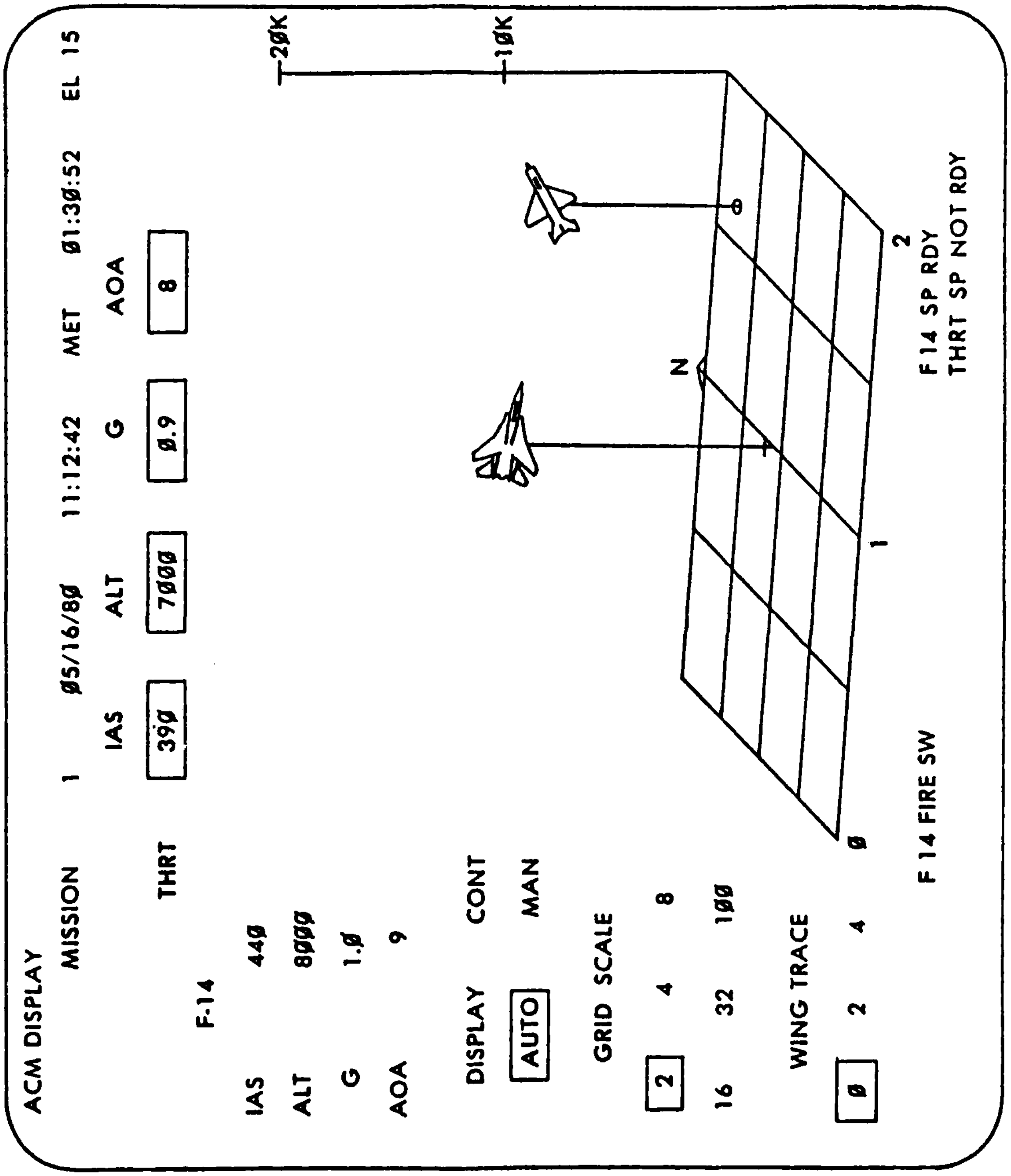



Figure 37. Sample WAVS ACM display page

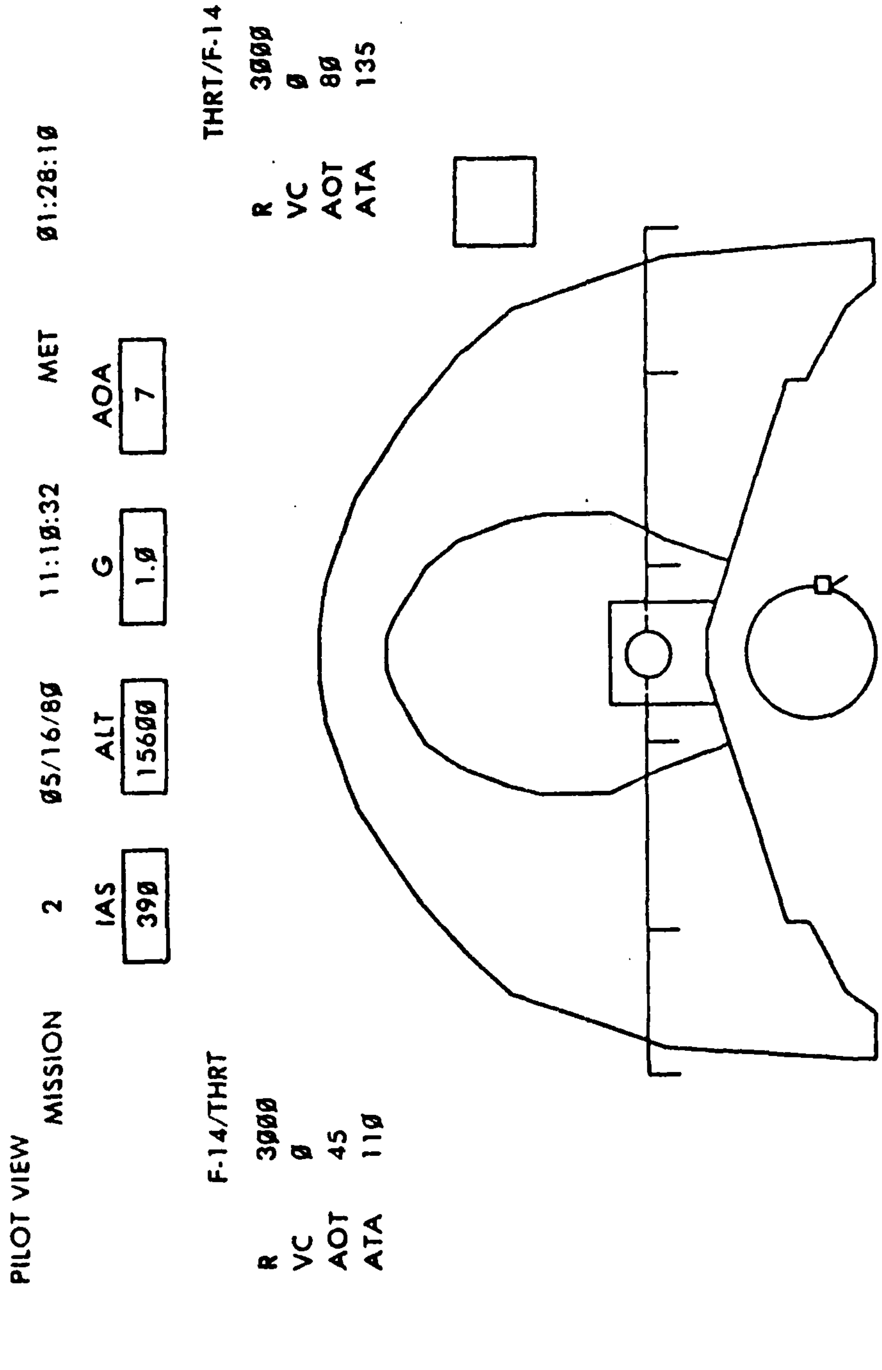



Figure 38. Sample WAVS pilot view display

pilot view display from the F-14.

CDP-39. CARRIER Display. The carrier display is a pictorial view of the carrier as seen on final approach through the Heads-Up display from the cockpit of the F-14. Figure 39 illustrates the display. Since the 2F112 is not utilized for carrier final approach and landing training, the display is not used. Several other problems will arise if the display is used.

a. The display is not presented when selected if the WAVS has not been initialized in the carrier mode.

b. No approach data are provided.

c. The carrier location is not automatically positioned in accordance with the IC established for the WST mission.

d. The carrier lighting environment must be manually selected at the WAVS System panel and the cut and wave-off lights at the WAVS Control panel.

e. Data, critical to evaluation of the approach such as sink rate, wire caught, and ramp clearance, are not displayed.

In summary, the carrier landing display is seldom used because of visual simulation limitations. In addition, the carrier display and approach lighting controls are poorly integrated into the WST. Switches and controls are located on several different panels functionally remote from the CRT. Insufficient data are displayed for evaluating the carrier approach.

OPERATING PROBLEMS. The characteristics of a generic human operator were utilized in analyzing console operations. Therefore, these problems reflect basic display and control interface deficiencies as well as basic dynamic control problems. The problems are numbered sequentially as OP-"n" for further reference.

OP-1 Light Pen Operation. Except for display mode selection and paging control, a light pen hook (LPH of a displayed character must be used for control of the trainer. Although improvements in light pen reliability have been made, the technique is unsatisfactory (even when functioning properly) for many trainer control operations. This is especially true for those requiring rapid positive control such as target and malfunction control. Many of these operations also require the monitoring of other displays to detect or select the condition for the LPH, since not all displays including the parameter are interactive. This necessitates that the page required for the LPH be displayed ready for use. It also requires that the user be familiar with the display so that when the "trigger" conditions are achieved, the selected character can be hooked accurately with minimum search time. The required

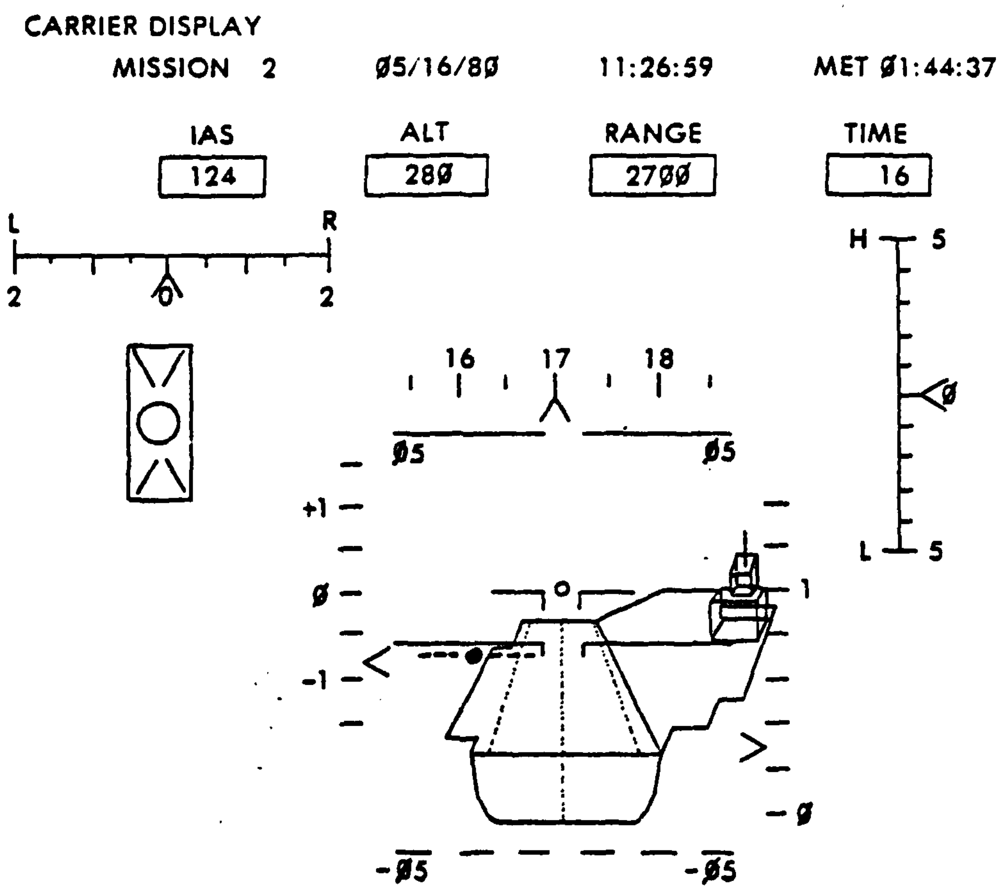



Figure 39. Sample WAVES carrier display page

visual attention to the display used in the LPH degrades monitoring of other displays. While the MO can be and is utilized to assist, the resulting operation is neither efficient nor user acceptable.

OP-2. Editing Conflicts. Simultaneous and conflicting display editing and control is possible. Any of the three stations may elect to edit the same display page at the same time.

OP-3. Display Selection Complexity. CRT display page options are identical at all stations. With the advent of the MO and his responsibility for operating the trainer, the display requirements for the instructors no longer include the many data displays used only for simulation initialization and control. The complexity of the display options precludes effective instructor operation of the available display system in monitoring aircrew performance and problem development. This further complicates the MO's job since he must assist the instructors in implementing display selections.

OP-4. Target Threat Identification. Targets must be created in terms of simulation design features rather than in terms of operational threat designation such as "MIG-25." Thus, an air target of relevance must be constructed by approximation from simulation parameters such as size (small or large), type (fighter or bomber) and radar type (one of seven types or a customized system). When created and the mission formulated, the type of threat simulated is difficult for the instructor to ascertain since the TSD and target threat pages do not identify it in user terms.

OP-5. Mission Control. The complexities and multitude of actions required to implement an "intelligent adversary," has resulted in most training missions being open-loop. The scenario is formulated and unfolds in a fixed pattern. Being extensively formulated, modifications to any scenario element could and probably would significantly interfere with the unfolding mission. However, if the mission is not formulated, controlling a scenario involving more than one or two threats, is impossible because of the number of control inputs required and the difficulty of manipulating the displays to isolate and hook the inputs required.

OP-6. Joystick "Move" Dynamics. The joystick is not utilized for relocating targets since the control dynamics do not provide the control required. The joystick response appears on the display as a step input which precludes any precise positioning. Yet the control potentially provides one of the simplest means for repositioning a target.

OP-7. Flyout Mismatch Problems: As discussed under the "FLYOUT MISMATCH" display, some mismatches cannot be resolved by correct placement of the control in the cockpit while the trainer is in the "FREEZE" state (control inputs are not updated in the frozen mode). Thus, not only will mismatches which broach the crash criteria impact the flyout, any cockpit control which affects flight performance can result in an undesirable "initial condition" when the trainer is unfrozen. This includes configuration controls, power controls and trim controls. The mismatches for these conditions can only be resolved by creating an appropriate "free-flight" IC and completing the procedure outlined earlier. The entire process of reinitializing the mission must be undertaken. Although mismatches can be resolved prior to the aircrew entering the cockpit, the same procedure is involved.

OP-8. Control/Display Access. The MO is responsible for basic operation of the trainer. This includes initializing the trainer for the mission. Figure 40 depicts the controls and displays required to accomplish this function. The problem of the widely dispersed panels is well illustrated. As can be seen, the MO must operate across or over the instructor at the flight station, especially to initialize the WAVS.

FUNCTIONAL DEFICIENCIES

A general set of tasks or functions involved in training utilizing a simulator, were developed as part of the study of the instructor pilot's role (Charles 1975). The functions which are not unique to any simulator, have been useful in highlighting many of the problems posed by existing trainers. Figure 41 outlines these functions.

This set of functions, utilized in the review of Device 2F119, was also utilized in this study. A detailed outline of the functions is contained in Appendix B. The basic functions include:

a. Prepare - assemble materials, review data, plan event,

b. Brief - review event with aircrew and staff,

c. Initialize - configure trainer, initialize system, establish readiness,

d. Train - instruct, control the simulator, monitor student performance,

e. Evaluate - evaluate progress and proficiency, diagnose aircrew problems,

f. Debrief - review event with aircrew and staff,

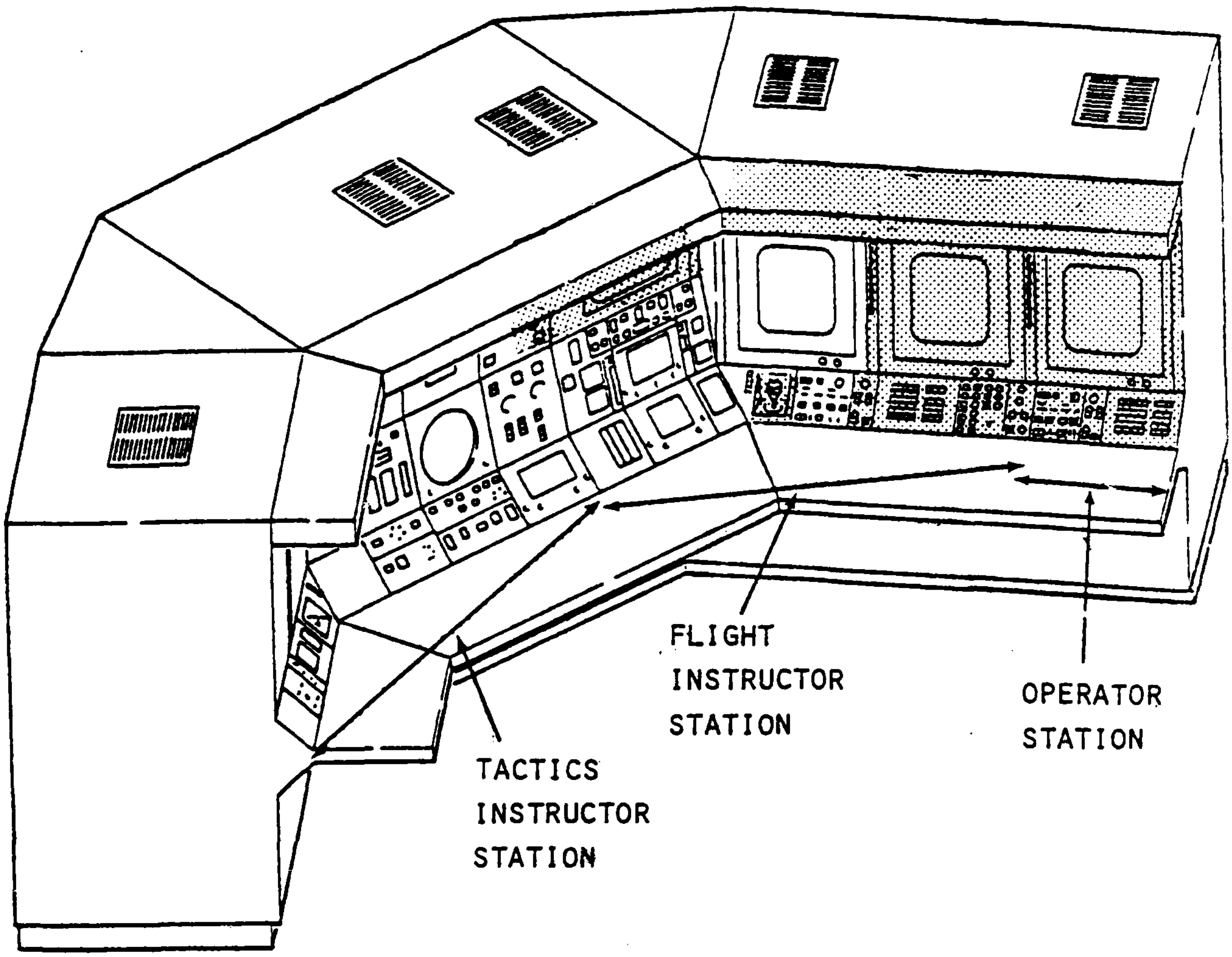



Figure 40. Controls and display used by the MO

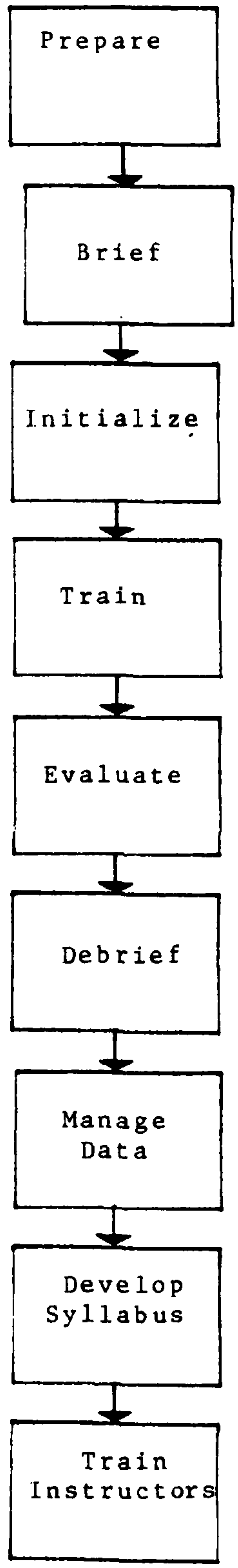



Figure 41. Training function flow.

g. Manage Data - update aircrew and staff training files and simulator usage data,

h. Develop Syllabus/Events - create and modify training events, ICs, and displays,

i. Train Instructor - train instructors in console operation and simulator based training,

j. Permit aircrew/peer training - support aircrew practice training.

Device 2F112 support to these training functions will be reviewed. The problems will be identified and listed as FP-"n" for further reference.

PREPARE FUNCTION. Preparation includes all of the tasks related to identifying who, what, when and where, as well as reviewing background material on the event and the aircrew involved.

FP-1. Training Scenario Review. The 2F112 displays could be utilized to review selected training event data. For example, the instructors could review the mission description data page (if they had access to a CRT). However, they could not access IC data such as threats or environment, since these data are only available after the trainer has been initialized for the mission.

FP-2. Initializing Data Review. Accessing IC data is a complex and laborious task since the data are contained in many pages and display modes (about 65 pages in the tactics and test display modes). There is rarely time available to seach through these pages after briefing the student and prior to starting the mission. As a result, the instructor is dependent on the MO and event guides for detailed mission data.

In summary, Device 2F112 provides little support to the prepare function.

BRIEF FUNCTION. The brief function includes the review of the training event with the aircrew and the training staff.

FP-3. Aircrew Briefing. No briefing area or CRTs are available to review the planned mission or training objectives utilizing any data stored by the device. Utilizing the instructor console CRTs for briefing would require the use of training time.

FP-4. Training Staff Briefing. Since the MO initializes the trainer as it is scheduled, the instructor(s) have little information on the details of the event implemented except for that contained in the lesson guides. Yet detailed briefings are essential for effective training, especially for the battle problems which require the coordinated efforts of three or four instructors. The 2F112 has no displays or meaninful scenario review capability available in a reasonable time to aid instructor staff briefing.

INITIALIZE FUNCTION. The initialize function includes configuring the simulator, initializing the simulation program and establishing readiness for training. The function is performed by the MO at NAS Miramar. Although the MOs have developed the capability to initialize the device, many design features constrain the process and result in the almost exclusive use of the programmed or formulated mode. Even this mode requires extensive interaction with many opportunities for errors. In addition, short cuts and "make-it-work" procedures have necessarily evolved, many of which are not documented and are dependent on personnal knowledge to implement.

Figure 42 is a first level flow chart of the initialization function. The exact sequence of operation is not critical although the general order must be preserved to simplify the operation since there are a multitude of initialization "interlocks." Each of the tasks, except for configuring the console, involves a complex series of actions. Configuring the console includes:

a. adjusting lighting controls,

b. adjusting speaker volume,

c. checking headset and adjusting volume (if used),

d. checking microphones,

e. setting communications switches,

f. checking console indicators and warning lights,

g. checking that the stopwatch is set to "STOP."

FP-5. Initialization Interlocks. Too many interlocks are involved in the initialization process. The following conditions and actions must be completed before the trainer can be unfrozen:

a. aircrew data must be entered on the Trainer Status Page

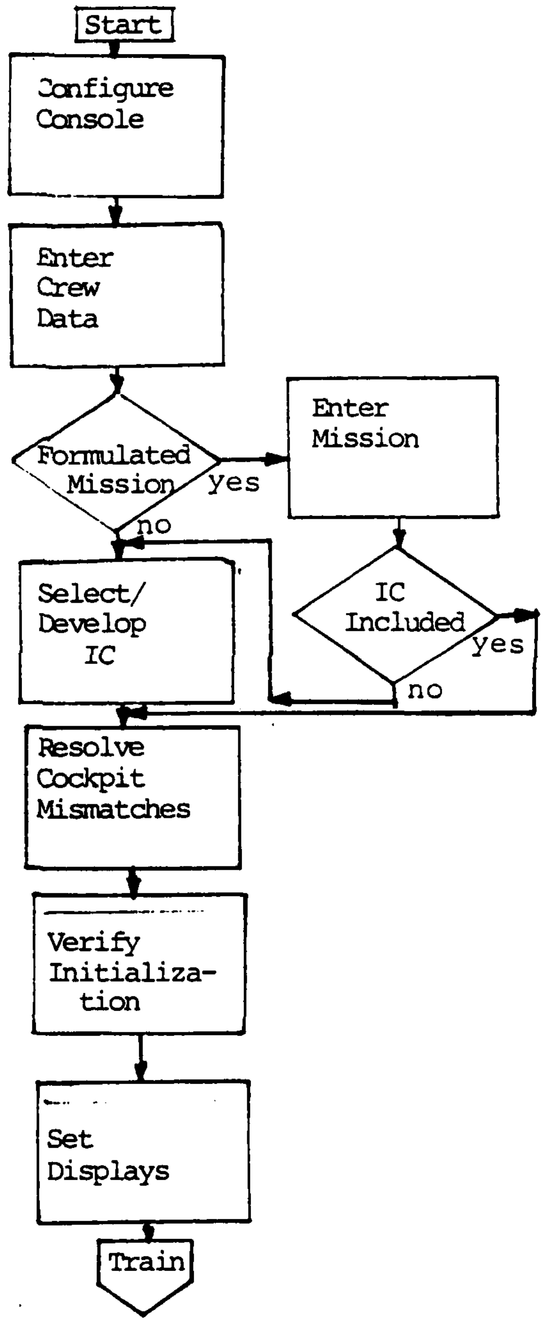



Figure 42. Device 2F112 initialization function flow

(names and weights),

b. -if a formulated mission: "EXECUTE" must be hooked on the Mission page,

c. -if a manual mission: "INITIALIZE" must be hooked on the IC page,

d. "INITIATE FLYOUT" must be hooked on the Flyout Mismatch page,

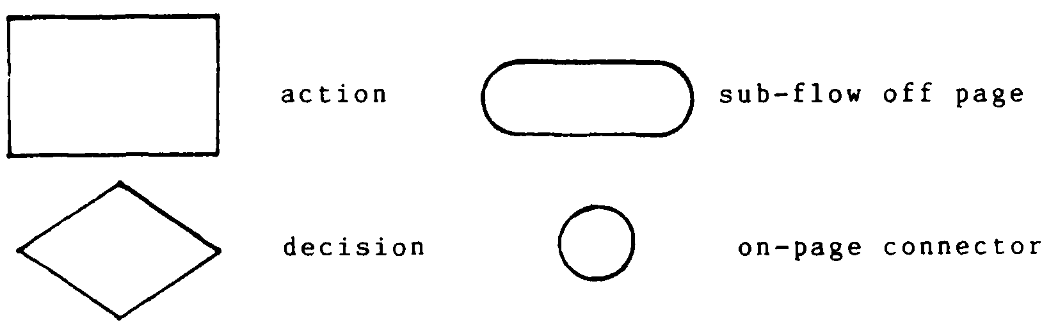
e. Buffet interlocks must be cleared,

f. "FREEZE" light must be on steady.

As discussed under the Trainer Status display, fake names and average weights are typically entered. This eliminates a minimum of 11 control inputs plus the alphanumeric entry of names and weights.

FP-6. Display/Control Entry Procedures. The review and editing of data and accessing control pages also involves many input actions with resultant delays in achieving the actions desired, opportunity for errors and temporary loss of displays being monitored.

Figure 43 summarizes in a flowchart, the minimum number of steps required *to select a formulated mission.* The flow utilizes the following symbols:




As can be seen, between four and 14 actions are required to select the mission number alone. Even if the desired mission number is on page one of the index and no review of the mission or editing is undertaken, a minimum of four switch actuations and one light pen hook are required to access the programmed mission. A review of the the mission description requires another three steps (if another display area is preselected). Review of the initial conditions is tedious since it requires accessing up to 65 pages of data across five functional display modes. Yet, review is essential to establish the configuration of targets in terms of location and state of the target site,

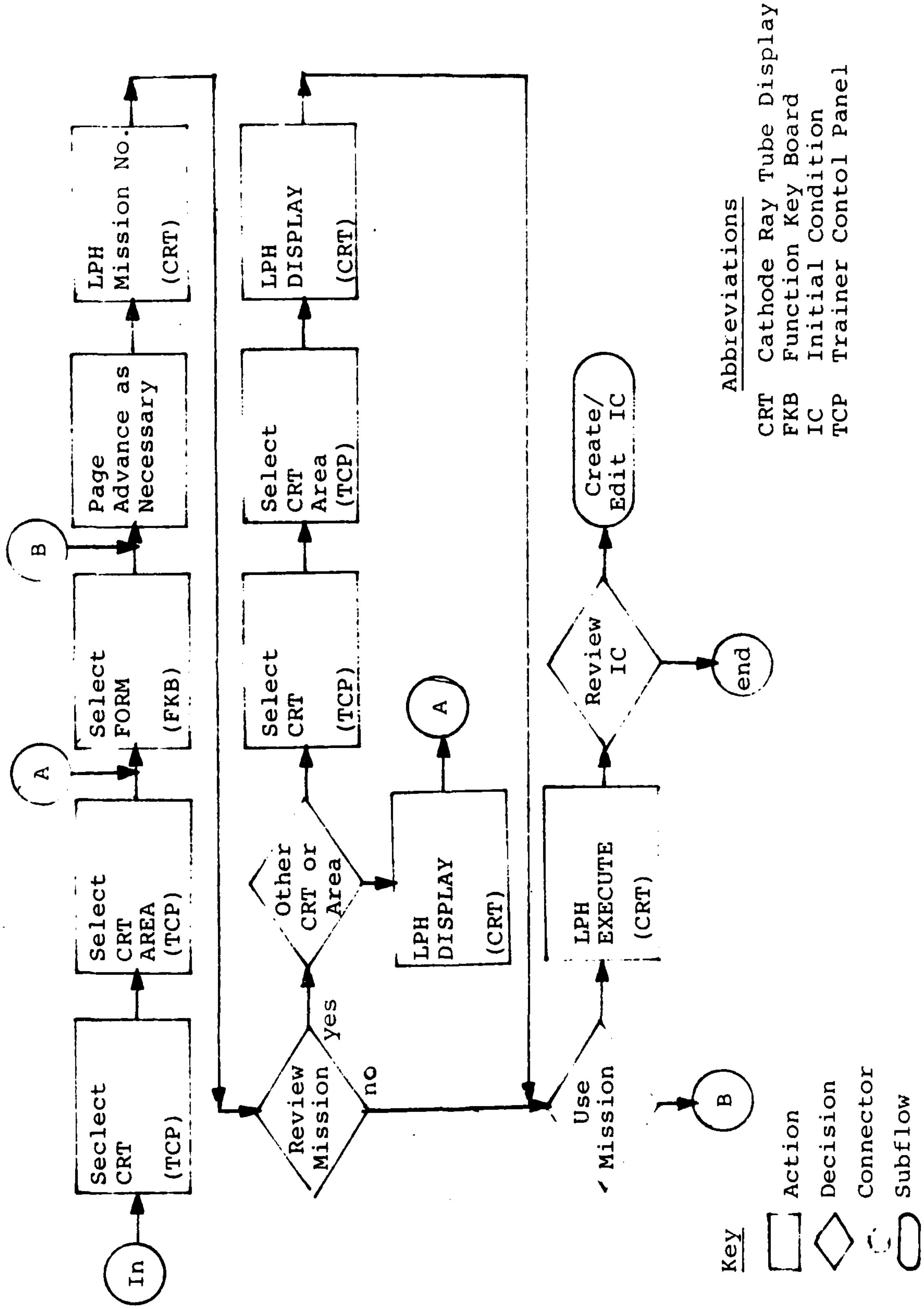



Figure 43. Formulated mission initialization flow

radars, jammers and weapons. The alternative which is often used, is to query the MO as to what has been initialized.

FP-7. WAVS Initialization. Although some of the WAVS initialization is normally incorporated in the formulated mission, some manual initialization is still required. Figure 44 is a flow chart of the tasks which must be manually implemented by the MO. As can be seen, it requires information on the weather and target type involved in the mission. The data are generally not available in the stored mission description. The "VISUAL INIT" display was illustrated in Figure 36. The initialization steps normally performed by the MO require the use of the flight or IP station.

FP-8. Flyout Mismatch. As discussed under basic design problems, a flyout "mismatch" can create a complex initialization problem if the cockpit control configuration is incompatible with the conditions involved in the IC.

FP-9. In-Flight Initializing. Many of the scenarios utilize an inflight initial condition. Because of the "interlocks" involved, the MOs have discoverd that some of the key data for this IC are displayed on TEST page "Flight Summary 2." However, much of the data on the page is irrelevent to this task. Consolidation of data for inflight initializing is required.

TRAIN FUCTION. The train function as defined includes all simulator operation and instructing tasks (except for performance evaluation) required to implement the syllabus event. These include the use of demonstrations (not incorporated in the 2F112), freeze, reset, replay, the creating of malfunctions and emergencies, tactical and environment control, manual simulations (e.g., controller operations), and performance monitoring and data recording. A variety of problems exist in the implementation of the train function in the 2F112.

FP-10. Communication Recording. Although a jack exists on the Trainer System panel for connecting an audio recorder, no recorder is available with the trainer. Since no means exist on the console for controlling a recorder, the addition of an off-the-shelf unit would place another operating burden on the instructor.

The recording of selected communicatons is needed, not only for debriefing and for aircrew review, but to facilitate communication simulation, especially for the battle problem.

FP-11. Mission Reset. Several training mission resets exist. These are:

a. reset by selecting replay and flyout (replay data are lost),

b. mission reset,

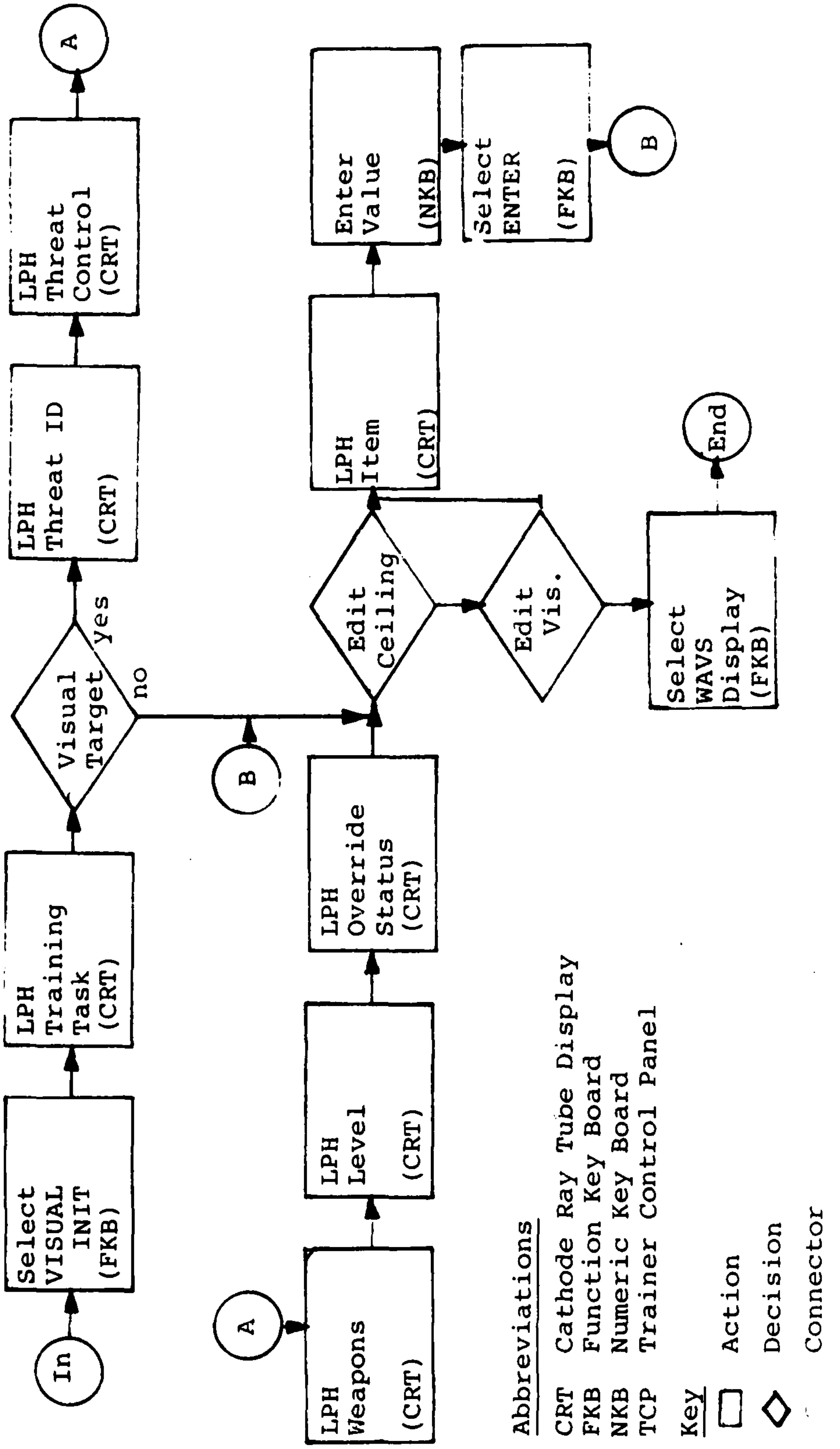



Figure 44. WAVS initialization flow

c. reset to a "flagged" point in the mission,

d. reset to carrier catapult.

Problems exist in the use of each one. The flyout mismatch problem exists for all resets. Unless the initiator of the reset can recall the cockpit configuration which existed or is required, the reset will typically result in the flyout mismatch problem, i.e., the need to create an intermediate IC to achieve the cockpit control configuration required for the reset.

FP-12 "Flagged" Reset. The reset to a flagged mission point is not used for two reasons. First, such a reset during a formulated mission may result in the "crash" of the mission although it is technically feasible. Second, inserting the "flag" is cumbersome and cannot be accomplished with the timeliness required. The steps involved in inserting a flag are flow diagrammed in Figure 45. As can be seen, a series of switch and light pen hook actions are required. In addition, a CRT must be "taken over." Because of the display interruption required and the number of actions involved, the flag reset is not a usable technique. The flyout mismatch problem also compounds the task.

FP-13. Replay. Replay is accomplished by:

a. light pen hooking the playback mission elapsed time (MET) on the right strip display,

b. entering the MET for the desired reset using the numberic keyboard,

c. selecting "PLAYBACK INIT" on the Trainer Control panel,

d. unfreezing the trainer when reinitialization is complete.

The procedure requires that the instructor continuously monitor the MET readout and record the MET for the reset desired. The feature is rarely used not only because of the necessity to monitor the MET, but also because of the potential interference with the continuation of the formulated mission. The flyout mismatch problem also exists.

FP-14. Malfunction Control. Although a total of 254 malfunctions can be simulated, they are rarely used since:

a. implementation is difficult and disrupts training,

b. the available set far exceeds needs and results in implementation problems,

c. descriptive data on the simulated malfunctions are not

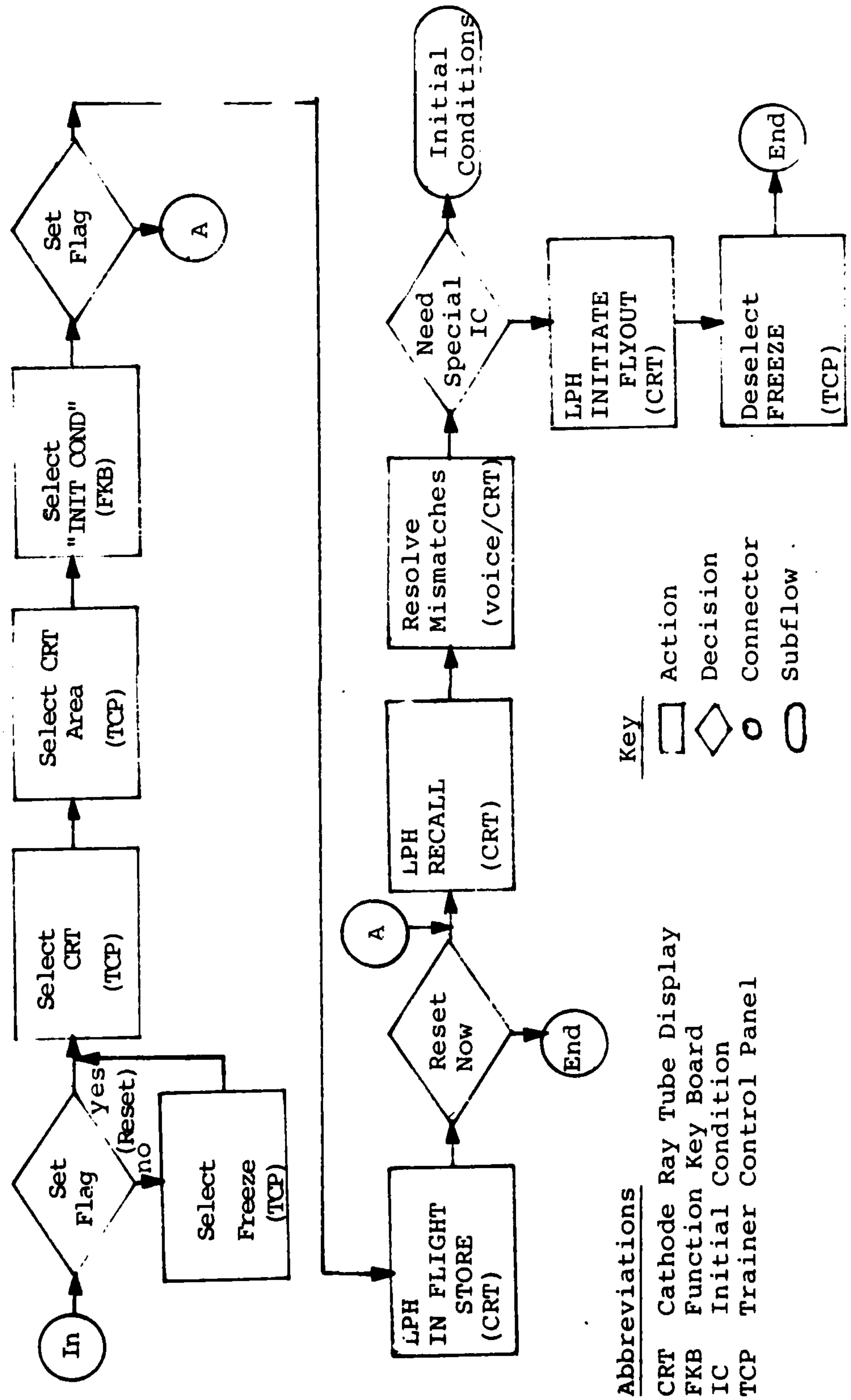



Figure 45. Flag reset flow

readily available,

d. formulating malfunctions has proven unsatisfactory.

Malfunctions can only be implemented individually in real time (since formulation is not effective) and requires CRT and light pen operations. The procedure interferes with the monitoring of performance. Timely insertion of malfunctions by a MO or instructor is difficult since location and hooking of the malfunction requires visual-motor concentration on the selected malfunction page. Multiple malfunctions must be created individually and except for the option of clearing all malfunctions, must be cleared individually by the same process.

FP-15. Battle Problem Tactical Environment Control. Because of the complexities of target/threat implementation, almost all training missions are formulated (except for basic ACM events which are manually controlled). However, a major implementation problem still occurs in the battle problem where the environment must be updated manually for each repeated evolution of the mission. This requires the keeping of records on changes required including the timing involved. Communications simulation is entirely manual and requires two instructors. Target conflicts occur which cannot be effectively resolved. For example, targets can be "killed" more than once during sequential events. The impact on communications is unmanageable.

FP-16. ACM Threat. Control of the air taret is limited to the programmed characteristics options since the target cannot be effectively flown with the joystick and flight information provided at the console. Four levels of programmed target maneuvering are available. Two are seldom used because of their simplicity, i.e., straight and level and regular reversing 2g "s" turns. Even the most difficult level can only be used for a few events since the aircrew learns the "canned" maneuvering rapidly. No other modes of target control are available. Thus a potential for negative training exists and limits the usefulness of ACM training capability.

FP-17. Hard Copy. Hard copy is selectable either from the strip display - for the WST CRTs, or from the WAVS Control panel - for the WAVS CRT. Up to 20 display frames may be stored for copying. In the normal mode, the output is too slow to be usable. In the high priority mode (selected from the Trainer System panel) the selected display is degraded during copy output. If the display is dynamic, such as a map display, the degradation is generally unacceptable. Hard copy cannot therefore be used effectively.

FP-18. TID Pointer. No instructor operated pointer is avaialble on the TID to assist the IRIO in coaching or briefing the RIO in the cockpit.

FP-19. Target Characteristics. The creation and control of targets is not accomplished in user-meaningful terms. The user is trained and operates in a world of NATO designated threat systems such as Backfire and Blinder or model designations such as MIG-23. Each has its specific weapons system. The associated performance characteristics and related tactics are part of the training program. Neither the student nor the instructor can meaningfully relate to the "small fighter" with an "IR" missile, a "spot jammer" and a "customized radar" available in the 2F112. Yet the target must be created in these terms and assigned characteristics within the options available. Many steps are required and as a result, almost all targets are formulated. Since this is accomplished by the MOs, the instructors have little appreciation for the targets created or threat systems they represent. They cannot meaningfully interact with the threat environment, much less create an "intelligent" adversary. While probably not required for basic tactics, the capability is needed for advance tactics training and for scenario development and test. Above all, knowledge of the threat systems being simulated is essential for instructor evaluation of aircrew performance.

FP-20. Communication Simulation. The 2F112 provides no capability for simulating radio communications or recording them, although, as discussed, a jack for plugging in an audio recorder does exist on the Trainer Systems panel. Three types of radio communications are required by the syllabus:

a. Controller communications - including air traffic, approach and tactical controllers,

b. Inter-aircraft communications - including threat, weapons and tactics calls by friendly aircraft,

c. Background communications - not directed to the F-14 aircrew, but essential to aircrew training.

The instructor(s) is required to provide all communication simulation. While approach control and air traffic controller functions have typically been provided by the instructor, tactical and background communciation requirements exceed the instructor's available capacity (and the aircrew's guilibility in accepting a single voice for different communicators). Where essential, such as for a battle problem, additional instructors are now added to perform the function. However background communications simulations are still minimal because of the problem of generating and outputting meaningful background messages along with required communications.

FP-21. Performance Measurement. Although hard copy display is available, no actual summarization of performance data is available with the exception of the GCA data page. Weapons "scoring" is provided and used. However, the output is a "snapshot" rather than any measurement or summarization of performance. Missile "shoot-off" requirements are foreseeable and some meaningful performance measurement or summarization with instructor input will be needed. While replay is available in the 2F112, the option does not solve the need for performance data. The Repeater Data display is too general to be useful and cannot be modified by the instructor to meet event requirements.

EVALUATE FUNCTION. The evaluate function includes assessing performance relative to criteria, diagnosing performance problems, modifying training as required and structuring feedback for the aircrew. During training it includes the use of freeze, reset, replay and performance recording. Since most training events in the 2F112 are formulated, reset, replay and even freeze are rarely used because of the real concern for catastrophically interfering with the programmed mission. This is particularly true in the battle problem where some modifications made during subsequent reruns of the problem preclude meaningful reset.

FP-22. Performance Evaluation. The instructors are required to perform all evaluation and recording of student performance from existing repeater panels and CRT displays. The task is difficult with the deficiencies which exist in these displays. The additional workloads imposed on the instructor such as communications simulation, controller functions and scenario controller, compound the problem and requires time sharing with the evaluation function. Little time is available to operate displays or to record results for debriefing, much less, time to analyze and evaluate performance or consider and implement freeze, reset or replay as training techniques.

DEBRIEF FUNCTION. Debrief includes reviewing the training event and the results with the aircrew and also with the instructing staff, especially where problems occurred either in the simulation program or in the implementation and conduct of the event. With the exception of hard copy, the 2F112 provide no support for the debriefing function. While a video recorder is available for recording WAVS video, these data are insufficient for debriefing purposes. In addition, no spaces dedicated to debriefing exist.

FP-23. Debriefing Replay. Although replay of the last 60 minutes of the simulation is available, the capability cannot be utilized for debriefing since:

a. training time is utilized - the trainer cannot replay and train simultaneously,

b. no satisfactory debriefing spaces are available,

c. no displays or controls are available.

In addition, "flags" cannot be set to identify mission occurrences of concern for debriefing. All such occurrences must

AD-A136 965 DEVICE 2F112 (F-14A WST (WEAPON SYSTEM TRAINERS)) INSTRUCTOR CONSOLE REVIEW(U) ICON INC SAN DIEGO CA J P CHARLES DEC 83 NAVTRAEQUIPC-81-M-1121-1 2/2

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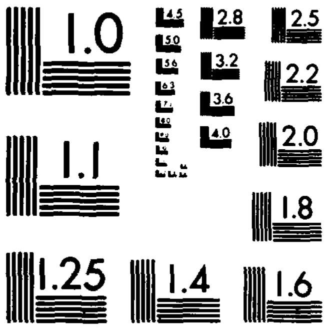


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

be manually recorded in terms of MET and replay accessed by entering the MET.

FP-24. Training Staff Debrief. Debrief and review of the training event with the training staff, especially for events such as battle problems utilizing several instructors and MOs are needed. Replay of the mission, which could be used for training event critique, is not used since training time is expended.

MANAGE DATA FUNCTION. This function includes updating and maintaining training and system records. It is not supported by the 2F112.

DEVELOP SYLLABUS FUNCTION. This function provides for creating and modifying simulator software and related materials supportable by the trainer such as hard copy of mission descriptions. It ranges from simple modifications of initial conditions to the programming of complete training missions. The programming of training events became the responsibility of the MOs when it became clear that programming (as well as operating the device) was beyond the capability of instructors who were not extensively trained on the device or in the programming method utilized for formulating training missions. The programming technique involves the use of code sheets, a special FORMULATE language and punched cards.

FP-25. Programmed Events. Formulating provides for preprogramming of:

a. initial condition setup,

b. malfunction insertion/deletion,

c. facility on/off control,

d. tactical environment specification,

e. display selection,

f. aircraft environment specification,

g. carrier parameter specification,

h. data link control.

Individual formulate commands enable set up of malfunctions, facilities and displays. These are not used. The programming of malfunctions has proven unacceptable because of the limited onset conditions (latitude, longitude, range, bearing, altitude, and mission elapsed time). The automatic changing of displays is generally unacceptable to instructors.

The data link control is not presently used since the simulation does not reflect the current fleet tactical tape.

The complexity of the programming process makes it difficult for users to comprehend the extensive simulation capabilities (and limitations) that exist in the 2F112.

TRAIN INSTRUCTOR FUNCTION. This function provides for instructor training in system operation and utilization including operating aids. The 2F112 does not support this function.

FD-26. Instructor Aids. The 2F112 provides no built-in-support to "help" the instructor in utilizing the displays and controls.

FD-27. Documentation. The instructor handbook is designed neither as a training manual nor as an operations manual. In effect, the manual is not usable at the console because of its size and design.

AIRCREW/PEER TRAINING FUNCTION. This provides for both training of "students" in the use of the trainer and the control of the trainer in self-train or practice mode. The 2F112 does not support this training function.

# SECTION IV

# DISCUSSION

## GENERAL

The F-14A Weapon System Trainer, Device 2F112, was designed with the capability to support aircrew training across the full spectrum of tasks from cockpit preflight and starting procedures to weapon system operation and tactical employment to landing and shutdown procedures. To achieve this capability, the design incorporated extensive control over a large set of simulation parameters. As a result, the skills required to effectively operate the trainer, necessitated an extensive instructor training program and regular operation of the trainer to maintain the required proficiency. It soon became clear that these instructor requirements could not be met by the fleet squadrons or by the fleet readiness squadron without increasing instructor assets. As a result, professional mission operator billets were established to operate the device in support of squadron instructors. While the mission operator billets solved the problem of trainer operation, they did not solve the variety of problems inherent in the design of the instructor console which limits training effectiveness. Some of the problems result from the creation of the mission operator billet; some result from changes in training requirements and emphasis; most reflect the lack of human factors engineering analysis and application of human factors criteria in the design.

These problems are discussed in detail in the following paragraphs in terms of console station layout and manning problems, console station control and display problems and training function problems.

## CONSOLE STATION AND MANNING PROBLEMS

The need to create the 2F112 Mission Operator billets resulted from the impracticability of meeting the extensive instructor training essential for effective use of the trainer, especially at the fleet squadron level. As pointed out in the Results Section, establishment of the MO billets, while solving the instructor console operating problems, created a new set of problems reflecting the change in the role of operator function and the design of the existing operator station. The operator station at the 2F112 console was designed for use by a technician operator functioning primarily in a support role to the instructors who were to be the primary operators of the device. Therefore, most of the routine operating functions and capabilities were allocated to the instructor stations (flight and tactics). The console, as currently manned by an MO at the SO station and instructors at the instructor stations, presents a new set of problems in that:

a. the instructor stations have operating capabilities which cannot be utilized by the instructors who are no longer trained in simulator operation,

b. the instructor station with its extensive operating capability is too complex for the untrained instructor to readily access the available displays needed for performance monitoring,

c. The operator station does not contain the displays and controls required by the MO to support the operation of the device.

Thus, the console station display and control layout is not optimum for either the instructors or the MO and degrades the effectiveness of the device. As pointed out in the Results section, the operating procedures require that the MO use one of the flight station CRTs and associated controls as well as the WAVS CRT (which is located on the far side of the IP station from the MO position). In addition, the MO must help the instructors in controlling the CRTs to access data. This requires that the MO either operate the instructor station CRT controls or coach the instructor in how to operate the controls to access the display desired.

Finally, simulation shortcomings, especially in the communications area, results in additional instructor manning requirements for battle type problems. The instructors require access to microphone and communications controls as well as a writing surface for manually recording communications. This generally results in the key instructor (the problem controller and evaluator) having no station to occupy. This forces him to sit behind the instructors and MO who man the console stations. He must then depend on them for information since the display character size is too small to be readable from his position. Thus, the console layout for one of the most important types of training exercises imposes severe limitations on instructor functioning and increases the workload of the MO.

CONTROL AND DISPLAY PROBLEMS.

Control and display problems are of particular significance to the instructor stations since a minimum of training in console operation will be provided. Therefore, it is essential for controls and displays to be as logically organized and easily operated as possible. No redundant or unused displays and controls should exist. The control and display problems, which were isolated can be summarized under two categories, those involving basic human engineering criteria and those involving operating or dynamic relationships and interactions. The human engineering problems involve mainly the design, the labeling and the arrangement of displays and controls. Application of basic human engineering criteria and data should have prevented the problems. They are summarized in the following paragraphs. The sequence numbers refer to the problem as identified in the

Results Section.

DISPLAY CONTROL CODING PROBLEMS. Many indicators and switches are identical in appearance. Color coding is neither consistent nor does it conform to standard aircraft systems color coding. Identical shapes should not be utilized for both indicators and switches and especially where they are collocated (Problems CDP-1,-3,-4,-10,-14).

DISPLAY/CONTROL LABELING PROBLEMS. To avoid errors and enhance operation, panel labeling must be consistent throughout the console. Since the instructors are weapon system users, the optimum approach is to parallel the cockpit labeling scheme. In general, this approach involves subsystem, function, and action labeling. Thus, the displays and controls for a specific subsystem or function are labeled for that function. Controls within the function are labeled for the action involved. Above all, unrelated functions if occupying the same panel, must be isolated and identified. Redundant labels, unless essential to resolve an ambiguity, should not be used (Problem CDP-3, CDP-9,-14).

DISPLAY CONTROL ARRANGEMENT PROBLEMS. Controls and indicators should be functionally arranged and subsystem located. Thus, for example, all control and indicators for the WAVS system should be collocated. The 2F112 panels are particularly deficient in control/display functional arrangement (Problems: CDP-2,-5,-9,-11).

MISCELLANEOUS DISPLAY/CONTROL PROBLEMS. A wide variety of related problems were presented in the Results Section.

a. Target Range and Heading Data. Accessing range data between the F-14 and targets is difficult and often impossible because of the processes involved and the difficulty in identifying clustered targets. For an instructor untrained in display operation, the only option generally available is to estimate range from the TSD display using only scale factor and map center data. While F-14 track data can be displayed, the historical nature of the data, coupled with slow display update rates, makes heading extrapolation of questionable value. Heading information can be accessed if the target number can be identified and the appropriate target threat data page displayed. This requires a second CRT unless the TSD is replaced with the threat data (CDP-28,-29).

b. Approach Plate Data. The approach map display does not include all related approach data. Thus approach plates must be provided by the instructor. The data are not stored in the system nor is readily accessible storage provided at the console for such publications. The data are required by the instructor for monitoring and controlling approaches (CDP-29,-39).

c. Procedures Data. Procedures checklists are not displayed nor is completion of checklist items monitored and displayed.

While the data could be sorted out of the Time Event Monitor display, the process is time consuming and requires the use of a CRT. Readily accessible storage for the NATOPS pocket checklist is not provided. However, manually accessing and monitoring checklists detracts from the instructor aircrew monitoring task (CDP-31,-33).

d. Automatic Display Change. Automatic display change is generally unacceptable to instructors and MOs and can create problems when editing is being performed or continuous monitoring is required. The available criteria for initiating display changes are not meaningful in terms of instructor operations (FD-27).

CONTROL SELECTION PROBLEMS. The selection or design of a control mechanism must reflect all aspects of the related task and be operable within the response times involved. The use of light pens for almost all trainer control does not take into account the different control task requirements. For example, use of a light pen for control of malfunctions does not take into account the required visual tasks of the instructor or the need for positive rapid control. The concentrated perceptual motor behavior, essential for accurate light pen operation, conflicts directly with the visual monitoring required to identify the time for malfunction insertion or removal. While light pen operation may be compatible with data editing tasks, for example, it is not optimum where other perceptual motor requirements conflict with the intensive perceptual motor requirements of the light pen hooking operation. Similarly, multi-dimensional controls, such as the joysticks, should not exhibit coupling problems such as exist between the throttle control (knob rotation) and pitch and roll control (stick tilt) on the IP joystick. The use of a full computer terminal keyboard for alpha entry only introduces a complex control for that little used function (CDP-12,-13,-15,-16).

INSTRUCTOR DISPLAY REQUIREMENT PROBLEMS. The requirement that flight and tactics monitoring displays be usable by instructors with essentially no specific console operation training has arisen with the implementation of the MO billet. Most of the displays do not meet this requirement. For example, the status monitor, initial conditions, malfunctions, facilities, data link and target threat pages are not formatted in user terms. In addition, displays which are intended as analogs of cockpit displays are not complete representations either in terms of display content or in terms of arrangement. Both the flight and tactics stations repeaters exhibit this problem. In other cases, excessive data are displayed and often not in user meaningful terms. For example, threat data are displayed in simulation options, not in threat terms. The WAVS target monitor display has no meaning to the instructor. In short, much of the data displayed do not reflect instructor requirements, either in content or format (Problems CDP-17 through -34, CDP-36 through -39).

INSTRUCTIONAL CONTROL REQUIREMENTS. Again, the requirement that the instructor station be operable with essentially no training, presents many problems. The majority of these involve the extensive simulator operating functions designed into the tactics and flight stations. Most of these functions are now performed by the MO. The control requirements of the instructors is now primarily one of accessing displays required to monitor aircrew performance. However these data are intermixed with simulation control data. Thus the instructors cannot directly access the information needed. In addition, the control options create operability problems. For example, the function keyboard display options far exceed the instructor's needs and complicate display selection. Similarly, light pen control for most instructor monitor functions is not optimum since light pen operation conflicts with visual monitoring tasks.

MO DISPLAY AND CONTROL REQUIREMENTS. The MO requires two CRTs with integrated controls to effectively meet the requirement for simulator operation in support of the squadron instructors. The necessity of sharing a flight station CRT is neither compatible with IP or MO requirements.

Similarly, initialization and operation of the WAVS from the WAVS CRT display requires the use of the flight station or reaching across the flight instructor station. Since the WAVS is an integral part of the WST, initialization should be fully integrated with WST initialization and implemented at the MO station.

SUMMARY. Them majority of control and display problems or deficiencies which were identified are the result of either the creation of the MO billet or lack of human factors effort in the design of the console. Since the MO billet was necessitated by operability problems with the original console design, the prime causal factor is the apparent lack of human factors design effort. Many of the MO operating problems also reflect the fact that no changes were made to the console, particularly the SO station, when the billet was implemented. The console was designed for manning with a technician operator and instructors trained in operating the device; it is now manned by a professional operator and instructors untrained in simulator operation. This problem coupled with the deficiencies in basic control/ display design and layout has created a console with serious operability problems, especially for the operational instructors. In short, the instructors are in general, unable to effectively utilize the console for training. This is particularly true for the battle and war-at-sea training events. The inability to effectively operate the trainer in other than the formulated mode, severely constrains the effectiveness of the device in advanced tactics training.

TRAINING FUNCTION PROBLEMS. As designed, the trainer effectively supports only one training function, the Train function. It cannot be utilized for briefing or debriefing of the aircrew without expending simulator training time. In addition, since no space or displays or controls are provided, any briefing or debriefing would require the use of the instructor console. Although support to some other training functions could potentially be provided, such as instructor briefing, the following training functions which were analyzed must be accomplished manually and essentially independent of the 2F112 system:

a. Prepare,

b. Brief,

c. Evaluate,

d. Debrief,

e. Manage Data,

f. Instructor Training.

The programming of training events function is supported. However, the process is complex and cannot be utilized by the instructors, i.e., it is not "user friendly." Mission programming is not done in user terminology with the result that the instructors cannot readily relate to programmed threats. Mission variations to minimize student "learning" of the simulator targets and tactics are difficult to implement and can create problems in mission evolution.

The trainer does not support instructor training in using the device. The documentation available does not meet the needs of either the instructors or the MO in terms of operating guides, training manuals or reference manuals. The Instructor manual is over 560 pages in length and is not organized to support any of the functions for which it was designed.

The apparent emphasis on simulation parameter control resulted in a plethora of displays and controls which are either not training relevant or are so complex that they are not utilized. For example, the facilities data are not used in training although access to the data in the formulate mode is required to update facilities data. The target threat data pages, especially the countermeasures, radars and data link pages, are not utilized because of the complexity involved. Finally, some required displays are not meaningfully available. This is especially true of initial condition data and data required for performance monitoring such as procedures completions. The required use of the light pen for training control has proven unsatisfactory. While the technique might be acceptable if reliable for non-time critical data editing and control functions, the inherent requirement for displaying the CRT page which presents the control option and for concentrated visual and motor performance by the instructor makes the technique unsatisfactory during the training mission when the instructor is busy monitoring aircrew performance.

# SECTION V

# CONCLUSIONS

## GENERAL

As pointed out throughout the report, the original console design of the 2F112 instructor operating console proved to be inoperable by squadron instructors without both extensive training in its operation and frequent use to maintain that proficiency. Neither of these requirements could be met by either fleet squadrons or the readiness squadron. The establishment of the professional Mission Operators, while solving the simulator operating problem, has not solved the instructor station operability problems. The controls and displays required by the MO are not readily available since no changes were made to the operator station. As a result, the MO is required to operate from two stations (generally flight and operator) to access the control and displays required for simulator control. Since the complexity of the instructor station remains, the instructors are dependent on the MO to assist in the CRT display operation. The CRT displays and simulator controls are essentially common to all stations. Thus, in effect, they do not meet either the operating requirements of the MO or the monitoring requirements of the instructor.

These problems, coupled with many basic display and control design deficiencies, result in the trainer being operated primarily in the programmed or formulated mode with very little instructor interaction.

The threats are not simulated in user meaningful/friendly characteristics which further constrains instructor interfacing with the simulated tactical environment. Security restrictions may dictate special handling such a separate disc pack for threat data. However, for fleet squadrons in particular, training with realistic and meaningful threats should be provided. Threat generation should be retained in the formulate mode.

Many of the operating modes and techniques of operation evolved by the MO to achieve trainer usefulness are not documented and mask many of the trainer's operating problems. They will resurface should the MOs be replaced if the problems are not corrected or the "make-it-work" techniques documented.

The 2F112 was designed to support all training from pre-flight cockpit procedures to ACM, carrier landing and shutdown procedures training. Many of the training objectives are not implemented by the squadrons, either because the training requirements have changed or because of trainer limitations. Thus, data link tactics and air-to-ground weapons delivery training features, for example, are not utilized. Carrier landing training has not been implemented because the WAVS visual environment does not provide the display resolution required. Other features are marginally used either because of the complexity of the design, such malfunctions and countermeasures implementation, or because of display and control limitations, such as in the manual flying of the visual target threat. Some new training events such as the multiple event battle problem, create instructor station requirements which are not supported by the trainer.

SPECIFIC CONCLUSIONS

The following specific conclusions are grouped by major design headings.

CONSOLE STATION LAYOUT

a. The operator station does not provide the M the displays and controls required to perform the simula - operating function.

b. The battle problem instructor does not have .ation or position from which he can effectively manage the sc .io and evaluate crew performance.

DISPLAYS

a. The CRT display modes and pages common to all stations meet neither the MO simulator operating requirements nor the instructor monitoring requirements.

b. The cockpit repeater displays are deficient in that not all required information is available nor do the displays parallel the cockpit configuration. This minimizes their effectiveness for monitoring aircrew performance, especially if fleet pilots and RIOs with little experience in 2F112 characteristics are to be involved. Training of intermittent users in the use of unique equipment is not cost effective, especially where such training could potentially transfer negatively to the operational system.

c. The TSD display is difficult to use both because of the many sub-pages of data included and because of the shortcomings in the map display. For example, target range and heading information are difficult to abstract from the TSD or from the data displays. The map display contains no geographical reference data other than display center coordinates. The data pages require target hook with the light pen or entry of target number via the NKB. Both are difficult with any target raid density. Scale expansion or target search disrupts tactical situation monitoring. The nine data summary pages are primarily target characteristics oriented which is an MO function.

d. The MAP displays are complex in that they contain multiple flight summary sub-pages. They should be consolidated for instructor use. Most of the data on the pages are redundant or control (MO) oriented. Some essential data such as approach plate data are not provided. The polar and grid maps are not utilized.

e. Indicator lights are confusing since the color coding is inconsistent and not in accordance with aviation practice. The indicators are also collocated with switches of similar shape and color.

f. Time of day and mission identification are redundant on most displays.

g. Malfunction options far exceed requirements which complicates selection and control. No data on malfunction simulation characteristics are readily available at the console.

h. No display of procedural steps and status is provided. The Time Event Monitor does not provide data in a readily usable form.

i. Display and control labeling is inadequate and does not conform to standard aviation practices.

CONTROLS

a. A light pen is not acceptable as the primary and in most cases, only, simulator control device, both because of operating difficulties (low probability of initial hook) and because of the the concentrated visual-motor activity required. It is unacceptable for real-time simulation control which requires a positive "hook" in a limited time frame.

b. Subsystem controls are not grouped for effective error-free control. The hard copy controls, reset/replay control and WAVS controls for example, are scattered not only across stations, but also across panels. Some are unlabeled and most labels are confusing and often redundant.

c. Simulation controls are not functionally grouped or allocated to stations.

d. WAVS controls are inaccessible from the operator station.

e. The joystick controls as implemented in the 2F112 are unusable for target or for display symbol control because of poor display-control dynamics.

FUNCTIONS

a. Training mission/event descriptive data are difficult to access and summaries are inadequate for instructor needs.

b. Briefing/debriefing support is essentially nonexistent for aircrew or training staff. Video recording of the WAVS display is inadequate and is not used. Simulator replay cannot be utilized for debriefing because of the lack of space, displays, controls and instructor editing options.

c. Performance measurement is not available except for weapons launch "snap-shots" and a GCA approach performance summary. The snap shots contain data which are not readily decoded. The GCA data are not described. No instructor input options are provided.

d. Mission programming or formulation is not in user terminology. While the MOs will be capable of "coding" or programming operational user generated scenarios for system input, a user oriented formatting capability would simplify the translation and reduce errors of interpretation.

e. Crewstation configuration mismatch resolution (IC and cockpit configuration) is complex and time consuming.

f. Communications simulation does not exist. Instructors are required to manually simulate, record and "replay" all communication for mission simulation. The resulting instructor/student ratio is unacceptable.

MISCELLANEOUS. Instructor related console documentation is inadequate and meets none of the functional requiremnts including training or console operation.

# SECTION VI

# RECOMMENDATIONS

## GENERAL

A wide variety of enhancements to the instructor operating console of Device 2F112 are feasible and needed. The change to the console manning, in terms of the MO, has resulted in a requirement for major changes to console station design to achieve effective operability. The existing design which was based on manning with a technician operator and instructors trained in simulator operation, does not meet the requirements for manning with professional mission operators and instructors not trained in simulator operation. Expansion of the operator station to meet MO functional requirements and simplification of the instructor stations is needed. In addition, a redesign of the software to meet basic training functions is needed.

Since all feasible solutions involve a reallocation of control functions, as well as redesign of displays to meet instructor/MO needs, a systematic approach rather than component modification or change is essential. The interaction between MO, instructors, syllabi, simulation program and the console does not permit simple display or control fixes, although in some areas, especially in simulation control, even such improvements would be beneficial.

## SPECIFIC RECOMMENDATIONS

The following specific recommendations are made in relative order of priority, recognizing that a detailed analysis of console requirements should be be completed prior to making modifications. Such an analysis is necessary to establish the performance required and verify priorities. The following primary recommendations are made:

Recommendation 1. Console Enhancement Analysis. A detailed analysis of functions and display/control requirements for the instructor operating console based on the Mission Operator manning concept is required. The study must identify display and control requirements for both the highly trained MO and for instructors with minimal training in 2F112 operation. The analysis must include consideration of the fleet squadron, the readiness squadron and the NAVFITWEPSCOL syllabi including the unique requirements of battle problems as well as squadron instructor characteristics. The impact of feasible console enhancements must be considered. Therefore the analysis must be iterative in nature.

Recommendation 2. MO Station. Modification of the operator station to meet basic MO requirements for two CRTs and integrated simulation control is needed. The exchange of the operator and

TRIO/tactics CRT station appears feasible and could provide the MO with the required two CRTs. Integrated operation with appropriate controls and single light pen operation is required. The WAVS control panels including the initialization capability should be incorporated at the station.

Recommendation 3. Instructor Station. Modification of instructor stations display options and controls is essential. The display options should be accessible from the FKB with no (or very limited) paging required. CRT light pen operations should be eliminated, except as an option for CRT target symbol hooking. Ball-cursor or other alternative symbol designation techniques should be considered. Flight and tactics summary data pages should be reduced to the minimum, preferable only a single data summary page which integrates with the data available on the cockpit repeater displays.

Recommendation 4. Battle Problem Instructor Station. A console arrangement which provides the battle problem instructor a console station is essential. The station should include access to CRT tactical displays and threat characteristics data as well as crew performance data. Enhancements which permit preview of the unfolding scenarios are indicated. A solution to the communications simulation problem is vital.

Recommendation 5. Device Operating Software. The software operating system should be changed to permit simultaneous use of system data for briefing and debriefing as well as training. Briefing and debriefing requirements are minimally met with display replay. Rapid access to points of interest through flags or fast forward and reverse, for example, are essential for efficient and acceptable use. A briefing room with CRTs and other displays and controls is required. Hard copy and audio replay are required. The display area should provide for viewing by up to seven or eight personnel who could be involved in the battle problem.

Recommendation 6. Threat Simulation. Threats should be identified in operational terms and data displayed accordingly. Performance of threats should be similarly programmed. This would provide the instructor and the MO access to threats and all related characteristics by a simple description such as "MIG-23."

Recommendation 7. Performance Measurement. Performance measurement models should be developed and implemented to facilitate crew member, crew and unit readiness evaluation. Instructor interaction is essential. Performance measures should be summary in nature to minimize instructor processing requirements. Commonly used measures such as errors, response time, elapsed time, parameter averaging, time-on-target and offsets, for example, should be available for implementation.

Recommendation 8. Simulation Options. Simulation options in the areas of malfunctions and target characteristics should be reduced to a manageable and meaningful set. Thus, about 30 well defined malfunctions and 15 designated air threats, 10 ASM and five AAA types might suffice. All should be capable of being implemented in user terms. This does not rule out a large set of targets (and malfunctions) from being available for mission programming.

Recommendation 9. Communication Simulation. Enhancements to permit efficient simulation of communications including background is needed. Pre-recorded background communications linked to mission events are feasible. Programmed prompts are feasible. Reduction of instructor staff to support this function is essential to reduce instructor/student ratios.

Recommendation 10. Operating Procedures. Simplification of operating procedures such as initialization and formulation is required and can significantly enhance training operations.

Recommendation 11. Display/Control Design Changes. The human engineering design deficiencies in display and controls should be corrected, preferable in accordance with the results of the analysis recommended (Recommendation 1).

Recommendation 12. Documentation. New specifications for documentation relevant to the instructor console are required. Standard updating procedures must be established. At least three types of documents are required. These are:

a. Instructor/Operator IOS Training Manuals,

b. IOS Systems Manual,

c. IOS Procedures Manual.

The latter two manuals should utilize the NATOPS format, the System Manual resembling the "-1" manual and the Procedures Manual resembling the "-B" or Pocket Checklist Manual. The procedures manual should have ready access stowage at each instructor station.

Recommendation 13. Procurement Procedure Requirements. An analysis of the console procurement procedure should be undertaken to identify shortcomings and loopholes, especially in the human factors area. It is clear that existing procedures do not provide for adequate human factors engineering efforts. Some of the organizations and agencies involved may not have the required access to human factors expertise. The analysis should include an in-depth look at how human factor requirements can be addressed and monitored at all levels.

Recommendation 14. Design Guide Data. Generalizable design guide data based on the problems identified is contained in Appendix C. This information should be utilized in future trainer procurements to preclude the reoccurrence of these problems.

Recommendation 15. MO Billet. The Mission Operator has proven effective in the operation of the trainer in support of the instructors. Since modification of the IOS to permit "novice" user operation is probably not feasible, the MO manning approach should be retained. However, improvements to the IOS to facilitate MO operation as well as IP and IRIO utilization should be incorporated if training effectiveness is to be achieved.

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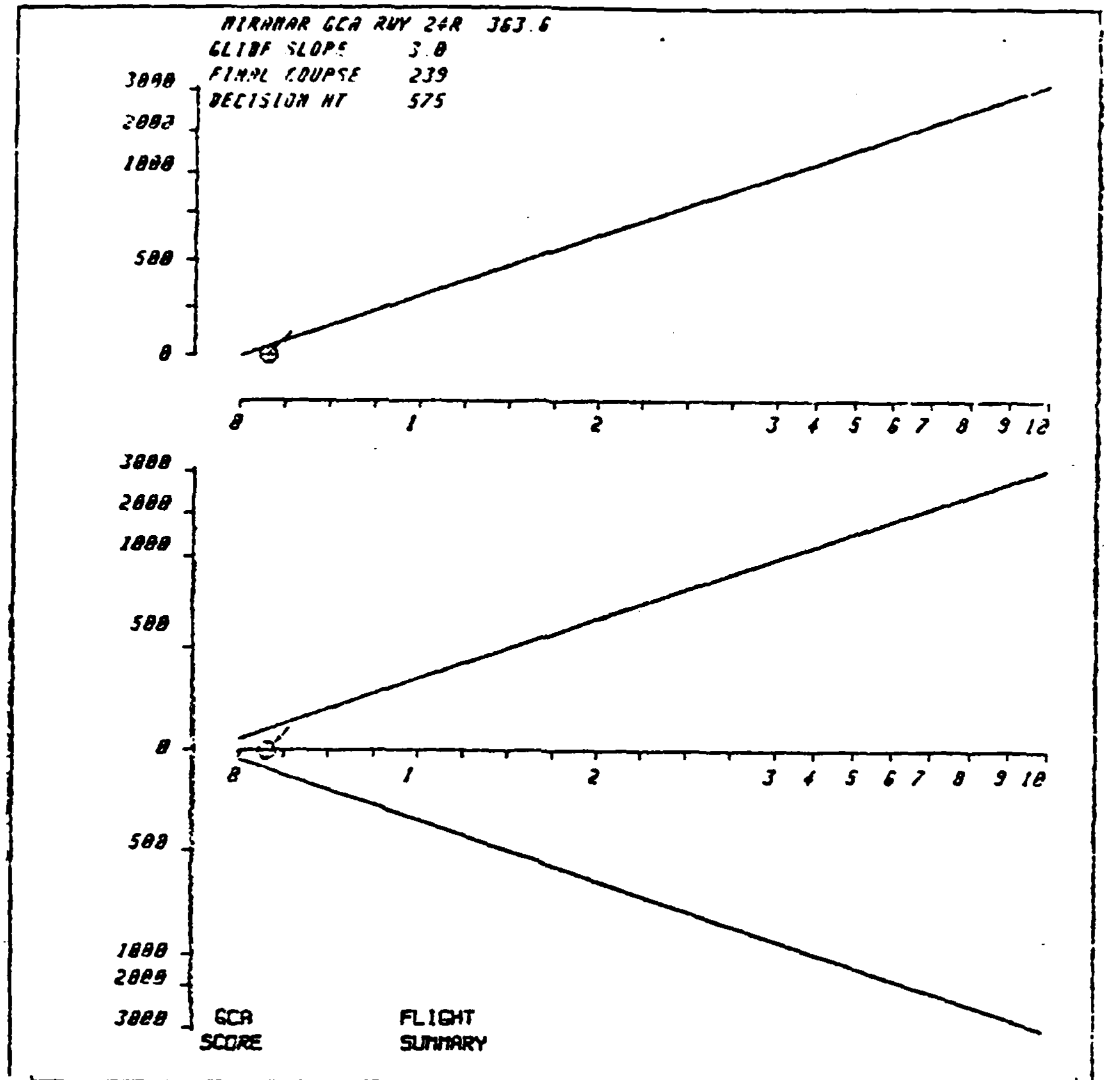
F-14A Instructor Handbook (Preliminary) Weapon System Trainer (Device 2F112). Techncial Manual NAVTRAEQUIPCEN 75-C-0098-F009, Naval Training Equipment Center, Orlando, FL, April 1980.

# APPENDIX A

## Device 2F112
## Selected Console Displays




| | | | | | |
|---|---|---|---|---|---|
| PILOT JOHN DOE | | DATE 10/11/78 | | RUN 0 | |
| WIND 360/ 0 | TURB 0 | ACTIVE MALFUNCTIONS 1 | | GR WT 45253 | |
| GLIDE PATH | % TIME | COURSE | % TIME | ANGLE OF ATTACK | % TIME |
| WELL ABOVE | 0.0 | WELL LEFT | 0.0 | VERY FAST | 0.0 |
| ABOVE | 0.0 | LEFT | 0.0 | FAST | 0.0 |
| SLIGHTLY ABV | 0.0 | SLIGHTLY LFT | 0.0 | ON | 0.0 |
| ON | 0.0 | ON | 0.0 | SLOW | 0.0 |
| SLIGHTLY BLW | 0.0 | SLIGHTLY RHT | 0.0 | VERY SLOW | 0.0 |
| BELOW | 0.0 | RIGHT | 0.0 | | |
| WELL BELOW | 0.0 | WELL RIGHT | 0.0 | | |
| RUN TIME | 0 SEC | % PATH COMPLETED | 0.0% | | |
| SUMMARY | TOTAL SCORE 0.0 | GATE SCORE | 0.0 | PATH SCORE | 0.0 |

Figure A-1. Sample GCA display and data page

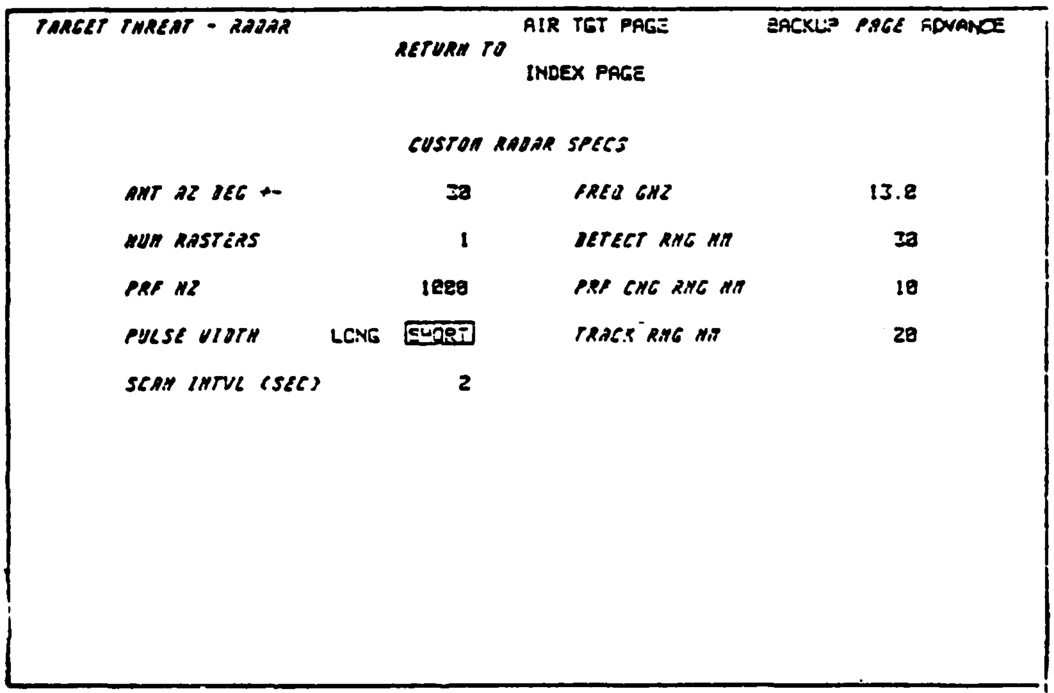



Figure A-2. Sample target threat-radar page

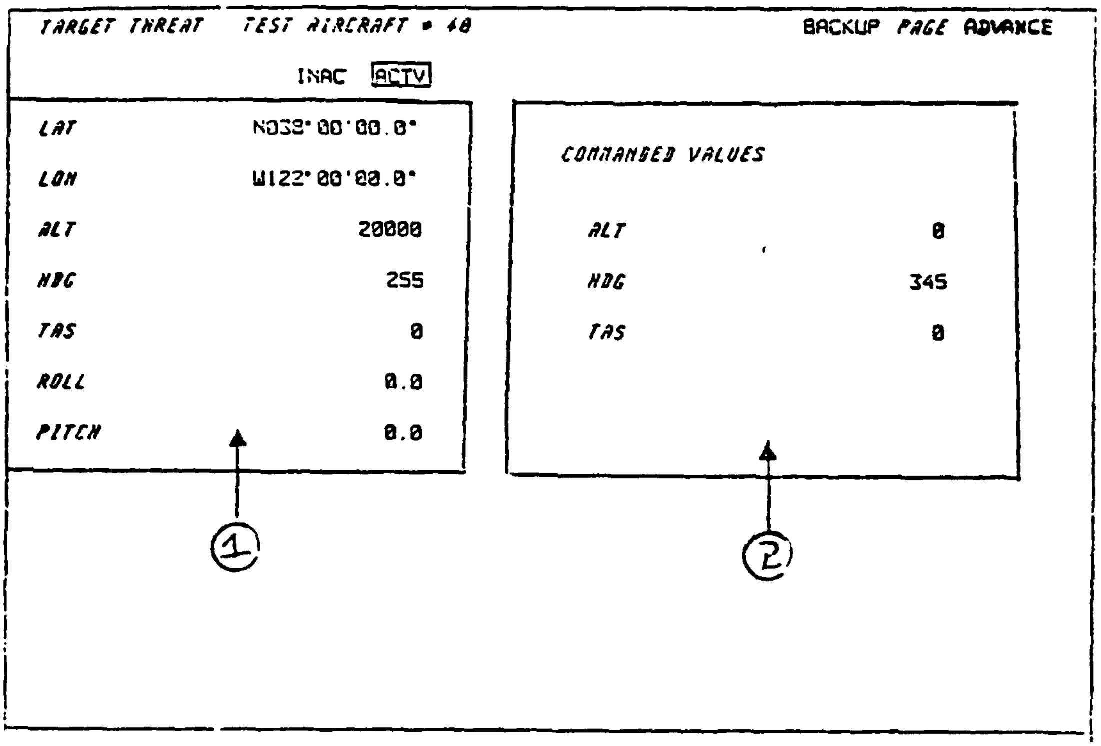



Figure A-3. Sample target threat - test aircraft page

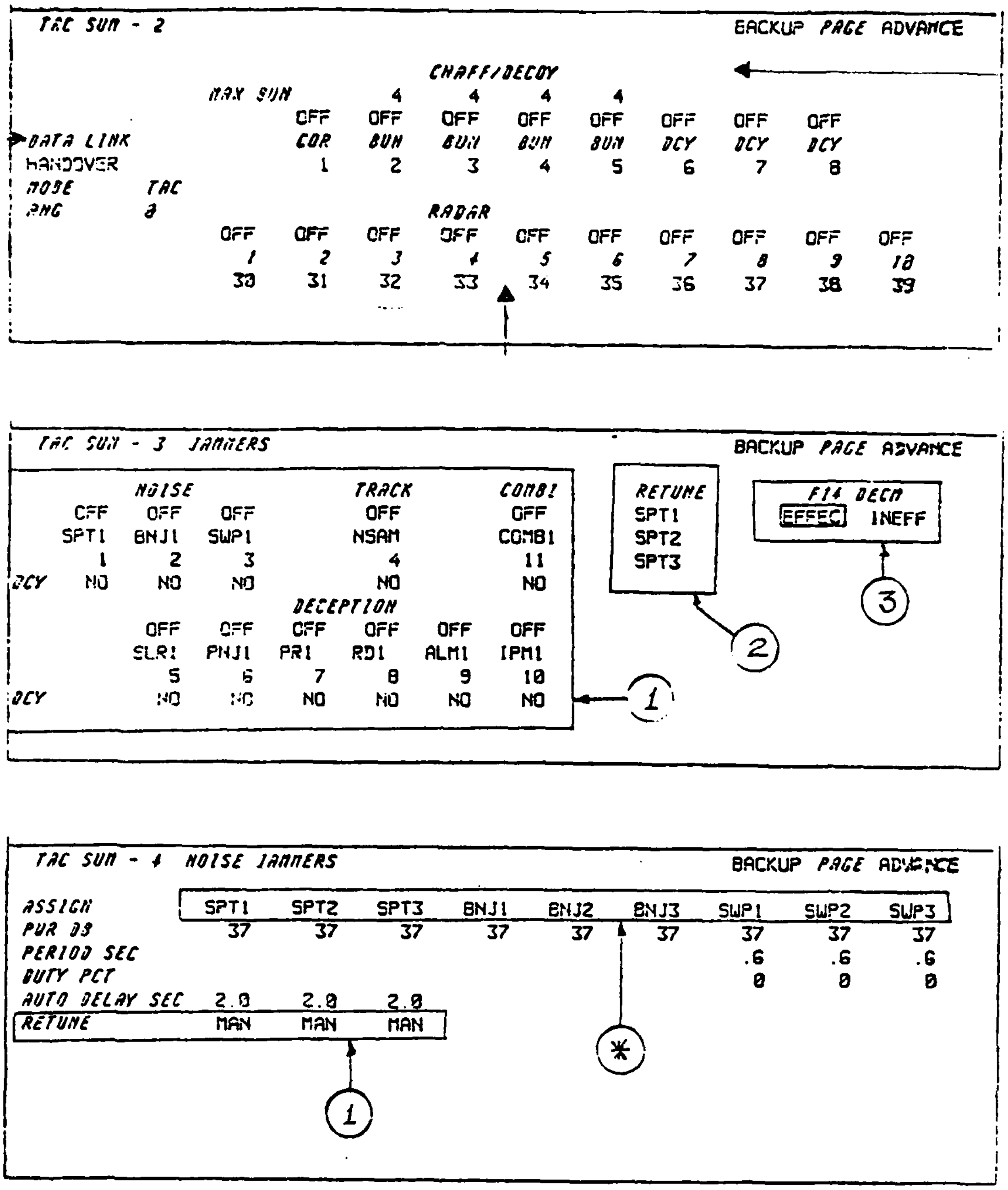



Figure A-4. Sample TAC SUM jammer pages

TAC SUM - 5 TRACK DECEPTION JAMMERS — BACKUP PAGE ADVANCE

| ASSIGN | NSAM | RSAM | SMR | IGN | CPR | CE | DFT | IFT | RGS |
|---|---|---|---|---|---|---|---|---|---|
| PWR DB | 37 | | | | | | | | |
| GAIN DB | | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 100 |
| PERIOD SEC | 5.0 | 2.0 | 2.0 | | | | 2.0 | | |
| DUTY PCT | | 0 | 0 | | | | 0 | | |
| ACCEL FPS2 | | | | | | | | | 32 |
| MAX SEP NM | | | | | | | | | 1.0 |
| MIN SEP FT | | | | | | | | | (2) → 50 |

TAC SUM - 6 DECEPTION JAMMERS 1 OF 2 — BACKUP PAGE ADVANCE

| ASSIGN | FNJ1 | PNJ2 | PNJ3 | PR1 | PR2 | PR3 | RD1 | RD2 | RD3 |
|---|---|---|---|---|---|---|---|---|---|
| PWR DB | 37 | 37 | 37 | | | | | | |
| GAIN DB | | | | 90 | 90 | 90 | 90 | 90 | 90 |
| FRQ HZ | 720.0 | 700.0 | 700.0 | 50.0 | 50.0 | 50.0 | | | |
| FRQ DEV KHZ | | | | | | | 50 | 50 | 50. |
| DUTY PCT | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| ASSIGN | ALM1 | ALM2 | ALM3 | IFM1 | IPM2 | IPM3 | SLR1 | SLR2 | SLR3 |
| GAIN DB | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| SWP RTE KHZ/S | | | | 500 | 500 | 500 | | | |

TAC SUM - 7 DECEPTION JAMMERS 2 OF 2 — BACKUP PAGE ADVANCE

| ASSIGN | MFR1 | MFR2 | MFR3 | ASSIGN | FTG1 | FTG2 | FTG3 |
|---|---|---|---|---|---|---|---|
| GAIN DB | 90 | 90 | 90 | GAIN DB | 100 | 100 | 00 |
| PRF HZ (3) | 300 | 300 | 300 | # TGTS | 10 | 10 | 10 |
| DUTY PCT | 0 | 0 | 0 | | | | |
| ASSIGN | VGS1 | VGS2 | VGS3 | ASSIGN | NBRN1 | NBRN2 | NBRN3 |
| GAIN DB | 90 | 90 | 90 | GAIN DB | 90 | 90 | 90 |
| PERIOD SEC | 5.0 | 5.0 | 5.0 | BW KHZ | 0 | 0 | 0 |
| SWP DIR (1) | DN | DN | DN | | | | |
| ASSIGN | NGN1 | NGN2 | NGN3 | | | | |
| PWR DB | 37 | 37 | 37 | | | | |

Figure A-5. Sample TAC SUM jammer Pages

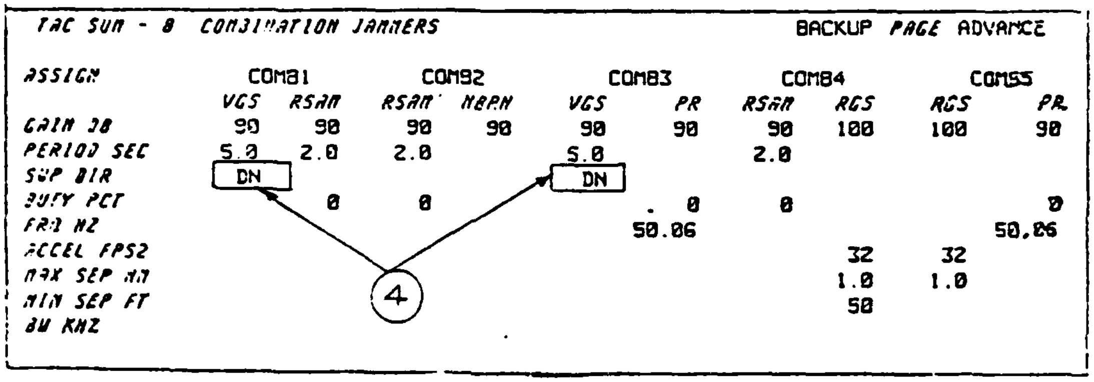



Figure A-6. Sample TAC SUM jammer pages

# APPENDIX B

## Simulator Trainer Functions (1)

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(1) From, Charles, John P., "Instructor Pilot's Role in Simulation Training (Phase II) NAVTRA-EQUIPCEN 76-C-0034-1, Naval Training Equipment Center, Orlando, FL, August 1977.

1 PREPARE FUNCTION

1.1 Identify Session

- student
- time
- simulator
- syllabus hop
- simulator status

1.2 Assemble Materials

- student file
- syllabus hop description
- scripts
- scenarios
- check lists/guides
- initalization data
- data recording sheets
- grade sheets
- simulator utilization sheets
- flight plans, etc.

1.3 Review Data

- student history - performance problems/weakness
  - missing training elements
- syllabus hop - objectives
  - performance criteria
  - priorities
  - implementation procedures
- simulator status

1.4 Develop Training Session

- individualize syllabus to students' needs
- modify initial conditions as required
- schedule and program malfunctions/emergencies
- structure controller functions
- develop tactical scenarios
- format demonstrations
- structure performance measurement
- structure display and control
- contingency plans
  - performance failures
    - crash
    - missed procedures
    - unacceptable accuracy/quality
  - simulator reset strategy
  - simulator emergency
    - fire
    - hydraulic malfunctions

- loss of communications
- area safety

- outline briefing sessions
  - student(s)
    - objectives
    - criteria
    - procedures/approach
    - simulator problems
  - simulator staff
    - responsibilities
    - evolution strategy

## II BRIEF FUNCTION

### 2.1 Brief Student(s)

- planned evolution
- learning objectives
- performance criteria
- simulator emergency procedures
- simulator discrepancies and characteristics
- planned use of training controls - Freeze, Reset, Replay, Demonstration, etc.
- communication procedures
- flight plan data

### 2.2 Brief Simulator Crew

- planned evolution
- support responsibilities
- emergency procedures

## III INITIALIZE FUNCTION

### 3.1 Configure Simulator

- configure simulation system
- configure crew station
- configure IP console

### 3.2 Initialize Simulator

- enter or verify initial conditions
  - airfield and runway locations, altitudes and arrangement
  - carrier types, positions, speeds, headings, sea state
  - radio/navigation aids locations and characteristics
  - target locations, characteristics and behavior
  - environment - ceilings, visibilities,

temperatures, winds, magnetic variation
- aircraft configuration
- aircraft position and heading (if airborne, altitude, heading, speed, attitude and power)
- malfunctions/failures
- preprogrammed malfunctions/emergencies
- data monitor/record settings

- enter preprogrammed data
- initialize crew station

3.3 Establish Readiness

- student(s) strapped in cockpit
- area secure and safe
- scripts, scenarios, data sheet, etc., available
- make communications check with student and crew

IV TRAIN FUNCTION

4.1 Control Simulator

- activate simulation
- provide interacting man-system simulations per scripts/guides/scenarios
  - controller functions
  - ground crew functions
  - other aircrew functions
  - other vehicles and targets, air, ground, sea, submarine, missiles
  - Radar and early warning system
- activate/deactivate emergencies/malfunctions
- select and activate demonstrations
- set and select replay
- freeze
- initialize and reset
- monitor safety of operations
- deactivate trainer at end of session

4.2 Monitor Performance

- procedures
- technique
- skill level
- simulator performance

4.3 Instruct

- provide feedback

- critique
- correct procedures
- provide technique advice

4.4 Record

- data for feedback
- data for simulator control, i.e., reset, replay
- data for debrief
- data for records

V EVALUATE FUNCTION

5.1 Monitor relevant parameter for segment/phase/task
5.2 Establish if performance within training performance envelope
5.3 If performance beyond envelope, diagnose problem
5.4 Select instruction technique to train
5.5 Develop plan and data to implement technique
5.6 Brief simulator crew and student as required

VI DEBRIEF FUNCTION

6.1 Debrief Student

- organize data collected
- assemble debriefing materials
- review performance problems (replay if available)
- review correct procedures, etc. (demo if available)
- review file data
- outline corrective actions to take

6.2 Debrief Simulator Crew

- review problems
- review overall performance
- discuss simulator discrepancies

VII MANAGE DATA FUNCTION

7.1 Student Data

- student grade sheets, training sheets
- simulator training data sheets

7.2 Simulation System Data

- utilization data
- discrepancy data

7.3 Training Data

- problems
- changes tried/proposed
- instruction techniques

VIII DEVELOP SYLLABUS FUNCTION

8.1 Identify Changes
8.2 Format Changes
8.3 Implement Changes
8.4 Validate Changes

IX TRAIN IP FUNCTION

9.1 Simulator Operation

- console familiarization
- console operation
- operating procedures
- syllabus implementation

9.2 *Simulator Training*

- training functions
- training techniques
- evaluation
- simulator instructing

9.3 Simulator Syllabus Development
9.4 Standardization Training

X SELF/PEER TRAIN FUNCTION

10.1 Basic Simulator IP Function
10.2 Syllabus Lockouts

- preclude "getting ahead of instructor"
- preclude student data file access or change

10.3 Performance Lockouts

- stop training if performance bad or not improving
- stop training if skill overlearned

# APPENDIX C

## Training Device Design Guide Data

# APPENDIX C

## Training Device Design Guide Data

### GENERAL

Design problems and feasible solutions identified in the study of the instructor console of Device 2F112 which are generalized to other devices were summarized. They are presented under the headings of:

a. Console Layout

b. Panel Layout

c. Controls

d. Displays

e. Miscellaneous

f. Functional Requirements

The material presented do not duplicate the data presented in the earlier report on the Survey of Device 2F119, (Report NAVTRAEQUIPCEN 81-M-1083-1).

### CONSOLE LAYOUT GUIDES

a. Stations shall be designed to meet the functional requirements of the station operator.

b. Stations shall be provided for all operators/instructors required to conduct training events.

### PANEL LAYOUT GUIDES

a. Panels shall be designated to cluster all subsystem or functionally related controls and displays. Unrelated controls and displays shall not be interspersed on a panel.

b. Controls and displays shall be different in size, shape and color to preclude confusion as to function.

c. Inoperable or non-functional switches or displays should be removed or covered.

d. Controls shall be arranged in normal order or sequence of use beginning at the top left corner and proceeding across to the right corner. Additional rows may be added as necessary.

e. Repeater displays for instructor stations shall realistically repeat the mockup display in terms of layout and content.

CONTROLS

a. The control/display dynamics, especially for cursor/target control on CRTs shall provide positive control with positive feedback and damping to minimize any overshoot.

DISPLAYS

a. Repeater displays shall realistically duplicate the display in the cockpit in content and layout. If not duplicated, the display shall be made clearly different - not a repeater.

b. Display content shall be functionally relevant to the station at which displayed.

c. Alpha-numerics should not be utilized to "read-out" control panel switch positions.

d. Decoding data for any coded display shall either be common knowledge or displayed simultaneously with the display or on another display which is not required at the same time.

FUNCTION

a. Hard copy output shall be rapid (less than 15 seconds and shall not interfere with normal operation and update).

MISCELLANEOUS

a. Trainer documentation shall be designed to meet the user's requirements. At least three types of documents are required, a training manual, an operating manual, and a technical manual.

# GLOSSARY

| | |
|---|---|
| AAA | Anti-Aircraft Artillery |
| ACM | Air Combat Maneuvering |
| ADV | Advance |
| ANKB | Alpha Numeric Keyboard |
| EL | Elevation |
| CCA | Carrier Controlled Approach |
| CDP-"n" | Control Display Problem "n" |
| COMFITAEWWINGPAC | Commander Fighter Airborne Early Warning Wing Pacific |
| CRT | Cathode Ray Tube |
| CV | Carrier |
| DDD | Detailed Data Display |
| ECM | Electronic Countermeasures |
| EW | Electronic Warfare |
| FASOTRAGRUPAC | Fleet Aviation Specialized Operational Training Group Pacific |
| FAST | Fleet Airborne Superiority Training |
| FF | Fluel Flow |
| FKB | Function Key Board |
| FLOLS | Fresnel Lens Optical Landing System |
| FP-"n" | Functional Problem "n" |
| FPT | Fleet Project Team |
| FRS | Fleet Readiness Squadron |
| GCA | Ground Controlled Approach |
| GCI | Ground Controlled Intercept |
| HI PRI | High Priority |
| HSI | Horizontal Situation Indicator |
| HUD | Heads-Up Display |
| IC | Initial Condition |
| ICS | Intercommunciation System |
| IFF | Identification Friend or For |
| INIT | Initialize |
| IOS | Instructor Operator Station |
| IP | Instructor Pilot |
| IRIO | Instructor Radar Intercept Officer |
| L | Left |
| LPH | Light Pen Hook |
| LP-"n" | Layout Problem |
| LSO | Landing Signal Officer |
| MAN | Manual |
| MAS | Maritime Air Superiority |
| MAX | Maximum |
| MET | Mission Elapsed Time |
| MO | Mission Operator |
| MT | Mission Trainer |
| NAS | Naval Air Station |
| NATOPS | Naval Air Training and Operating Procedures Standardization |
| NAVTRAEQUIPCEN | Naval Training Equipment Center |
| NAVFITWEPSCOL | Navy Fighter Weapons School |
| NKB | Numeric Keyboard |
| OFT | Operational Flight Trainer |

| | |
|---|---|
| OP-"n" | Operating Problem |
| ORT | Orientation |
| PTT | Part Task Trainer |
| R | Right |
| RIO | Radar Intercept Officer |
| RP | Replacement Pilot |
| SAM | Surface-to-Air Missile |
| SIF | Selective Identification Feature |
| SO | Simulator Operator |
| STAT | Status |
| SUM | Summary |
| TAC | Tactical |
| TID | Tactical Information Display |
| TSD | Tactical Situation Display |
| VDI | Vertical Display Indicator |
| VF | Fighter Squadron |
| WAVS | Wide Angle Visual System |
| WST | Weapon System Trainer |

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