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NATIONAL TRAINING CENTER

NTC ANALYSIS
FINAL TECHNICAL REPORT
MARCH 1981

DRESS REHEARSAL
FOR COMBAT

SAI SCIENCE APPLICATIONS, INC.

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NTC ANALYSIS

FINAL TECHNICAL REPORT

March 1981

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SAI

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SCIENCE APPLICATIONS, INC.

TO: DISTRIBUTION

29 May 1981

SUBJECT: National Training Center Analysis
Final Technical Report

This document is submitted in fulfillment of contract No. DAAK 40-78-C-0198. It is the final report on Phase 1-ALPHA in the development of the Army's National Training Center (NTC) at Fort Irwin, California.

The development of the NTC has been continuous, and many technical reports have been published previously. This report draws on these earlier reports and presents a comprehensive summary and overview of the SAI work to date supporting development of the NTC.

Sincerely,

SCIENCE APPLICATIONS, INC.

William B. DeGraf
Assistant Vice-President
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SAI NTC Program Manager

WBD/mgs

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1) The Defense Advanced Research Projects Agency (DARPA)

2) Headquarters, U. S. Army Training and Doctrine Command (TRADOC)

3) U. S. Army Combined Arms Training Development Agency (CATRADA)

4) The Electromagnetic Compatibility Analysis Center (ECAC)

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1) F Troop, 2nd Squadron, 3rd Armored Cavalry Regiment

2) L Troop, 3rd Squadron, 3rd Armored Cavalry Regiment

3) 2nd Battalion, 10th Cavalry

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EXECUTIVE SUMMARY

SECTION 1

EXECUTIVE SUMMARY

1.1 INTRODUCTION

This report addresses the tasks and accomplishments of Science Applications, Inc., in contractually assisting the U. S. Army's development of the National Training Center (NTC) at Fort Irwin, California, through NTC I-ALPHA and the Phase I transition periods. SAI's participation in this effort began in 1978 and is characterized by 1) the successful completion of a detailed baseline analysis of the NTC, which provided the program framework, and 2) the subsequent innovative design, application, and demonstration of the core instrumentation subsystem (CIS) to enhance battalion-level, combined-arms, tactical training. In terms of impact, the NTC technical accomplishments will enhance the field training environment to a point where near combat realism will be achieved in force-on-force simulated battles, one-sided live-fire exercises, and brigade-level command battle simulations. As a result, greatly expanded opportunities for experiential learning and for objective analysis of unit performance will become available.

Because of the scope and duration of SAI tasks, a detailed series of special technical reports has been submitted separately during the course of the NTC development process. A list of these detailed reports is provided at Appendix B. The primary purpose of this report, therefore, is to provide a comprehensive summary of SAI's approach to required tasks, accomplishments, and the major findings and conclusions resulting from this effort. A discussion of difficulties encountered and SAI's view of future NTC tasks is also provided.

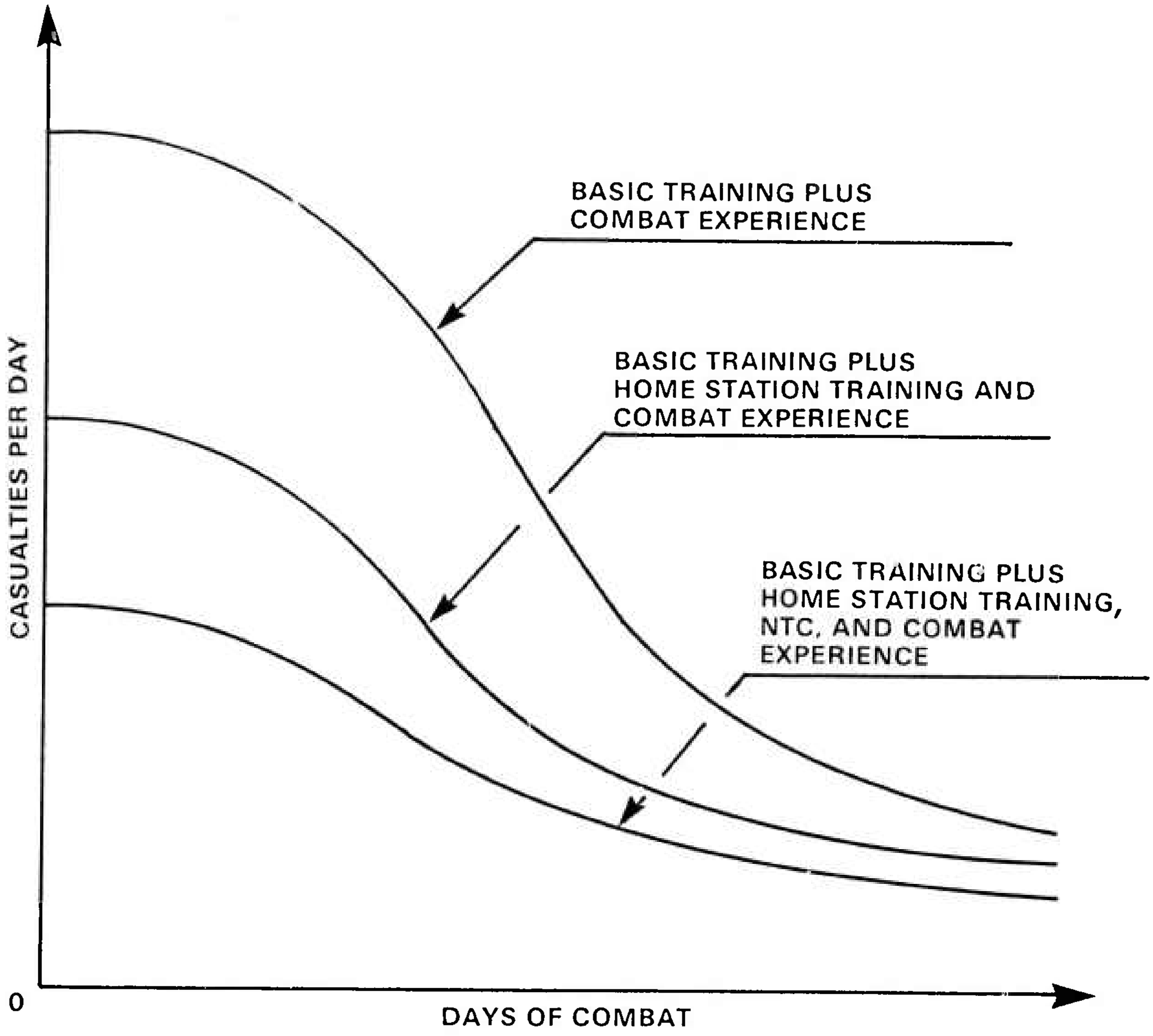
1.2 NTC BACKGROUND

1.2.1 The Training Need

U. S. Army readiness to carry out its foreseeable wartime missions is measured in terms of manpower, materiel, and training. Training is a critical factor because it is the process by which organized manpower and materiel resources are merged within the doctrinal framework to attain essential tactical capabilities: levels of effectiveness and performance that can spell out the difference between success or failure in battle. Figure 1-1 shows conceptually the payoff of realistic training.

1.2.1.1 The Training Challenge

The training challenge has become increasingly complex as advances in air and ground weapon technology change the tempo, lethality, and spread of the battle area. To prevail in combat, Army units must be trained in peacetime to operate effectively in an intense and dynamic battle environment; one that demands, more than ever, rapid tactical assessments, timely decisions, and the skillful employment of forces. Similarly, commanders must learn to deal confidently with an array of hostile air power; electronic, nuclear, biological, and chemical (NBC) warfare measures; and other sophisticated threats. In the course of such training, the Army must strive to eliminate the costly mistakes frequently made by inexperienced soldiers and leaders during their initial exposure to rigorous combat. The battlefield is unforgiving, and mistakes inevitably lead to loss of lives, equipment, and battles. As General Rogers, former Army Chief of Staff, has emphasized, "the worst thing that can happen is for a soldier and a unit to find themselves on a battlefield for the first time and never to have experienced anything like it before." For these reasons, realistic collective training is a central Army requirement; a requirement that, if neglected, threatens losses beyond any acceptable limits.



TOTAL CASUALTIES EQUALS THE AREA UNDER THE CURVE.
THE BETTER THE TRAINING, THE FEWER THE CASUALTIES IN COMBAT.

Figure 1-1. Combat Effectiveness Payoff Through Realistic Training

1.2.1.2 The Train-Evaluate-Train Model

In response to the increased training challenge, the Army instituted the comprehensive Army Training and Evaluation Program (ARTEP), a collective training program, described by the train-evaluate-train model. Since tactical experience is fundamental to sound combat decisions, field training under the ARTEP program is intended to elicit, as closely as possible, the same tactical planning and decision challenges as those expected in combat. Moreover, it is recognized that, unless this is accomplished with high fidelity, both what is learned and the evaluation process that directs future remedial training suffer. Similarly, there is a keen awareness that the means of evaluating unit performance and effectiveness must be credible and responsive.

1.2.1.3 Training Constraints

Nowhere is the need for realistic training and a credible evaluation process manifested more clearly than at the battalion level. As the basic combined-arms building block, the battalion task force is the pivotal echelon of tactical command in terms of its role in fighting the land battle. Battalion commanders and their operating staff must be trained to fit their forces to the ground and skillfully orchestrate the combat power of maneuver forces, artillery, Army aviation, and tactical aircraft to defeat the enemy, often a numerically superior force. Yet, virtually everywhere it is stationed, the Army has found itself severely constrained in providing the full range of resources necessary to support realistic battalion task force training. The most common of these constraints are:

- The lack of adequate maneuver area for two-sided armor and mechanized exercises
- The lack of modern live-fire ranges for unit tank gunnery and anti-tank missile training, often because the exceptionally large safety fans required exceed available acreage
- The proximity of civilian communities to training areas, which limits the ability of units to employ safely electronic warfare, close air support, laser designators, and other essential tactical systems

- The lack of dedicated resources to portray realistically an opposing force and to provide the means for controlling and evaluating task-force-level exercises.

Looking ahead into the 1980s, the Army has concluded that the impact of these local training constraints will increase in relation to the training need as newer air and ground weapon systems, now under development, are delivered to tactical units. Included in this category are the XM-1 tank, the advanced attack helicopter, the general support rocket system, the division air defense gun, and the infantry fighting vehicle; all will increase the squeeze of land and training resources at local installations.

Together, the growing inadequacy of current training facilities, and the urgent need for enhanced realism and improved means of evaluation, have triggered the development of a National Training Center concept, a concept that was formally set forth by the Secretary of the Army and the Chief of Staff in their 1978 joint-posture statement to Congress. In that statement, the Army indicated the need for "one or more National Training Centers, large military reservations which can support the kind of combined arms training needed to ready the total Army for battle in Europe."

1.2.2 Program Concept

The underlying concept of the NTC at Fort Irwin is to provide a learning environment that will allow the Army to bridge the gap between the level of tactical effectiveness that can be attained by units at their home stations and the level required to survive and win in combat. Figure 1-2 lists the key elements of the concept. More specifically, a facility where: 1) heavy battalion task forces, brigade headquarters, and supporting units can conduct realistic and intensified training that is not possible at their home stations because of increasing resource constraints or the prohibitive cost of upgrading local training areas; 2) objective information can be collected and analyzed to improve doctrine, tactical training systems, equipment, and tactical procedures; 3) detailed feedback

To train a battalion task force and its superior brigade and parallel battalion staffs in a realistic surrogate combat environment combining:

- Large-scale field maneuver and firing exercises against a realistic OPFOR including electronic warfare
- Direct fire simulation using advanced laser weapon engagement and weapon effects cue generation techniques
- Live-fire exercises against coordinated dynamic target arrays emulating realistic scenario situations
- Simulation of battle context using advanced real-time, two-sided, free-play command battle simulation techniques.

Figure 1-2. NATIONAL TRAINING CENTER CONCEPT

can be provided to participating units, as an extension of the ARTEP programs, for use in directing subsequent home-station training.

The NTC is conceived as a centralized training facility, modeled after the successful U. S. Air Force Red Flag Program at Nellis Air Base. The Fort Irwin facility will serve as a focal point of Army combined arms training, a place where all continental United States (CONUS) based armor and mechanized battalions will periodically deploy to "put it all together" against a highly skilled opposing force (OPFOR) in situations closely approximating actual combat and against a dynamic target array in live-fire exercises.

The concept further envisions the unique merging and application of modern instrumentation technology to create the near-combat environment and enhance the evaluation and feedback process.

U. S. Army, TRADOC, in its subsequent expansion of the NTC concept, identified seven significant elements to be stressed in the development program.

1) The Battalion Task Force (BTF) -- a combined arms team with a staff and a critical task of planning, coordinating, controlling, and supporting combat power on the battlefield.

2) The Opposing Force -- a dedicated unit, sized and equipped to operate against the BTF in realistic numbers, using Soviet tactics and signatures and operating as part of the control force to ensure proper balance in combat operations.

3) Electronic Warfare (EW) -- the use of jammers against U. S. communications and electromagnetic devices in a manner expected of the Soviets in Europe.

4) Close Air Support (CAS) -- the opportunity to plan and execute joint air-ground operations.

5) Live Fire (LF) -- an imaginative use of dynamic, instrumented targets to provide a realistic threat, both offensively and defensively, to the BTF under conditions that permit the BTF to coordinate and control live fires.

6) Weapon Engagement Simulation (WES) -- the use of lasers and computers to simulate fires on the battlefield, including a realistic and understandable assessment of casualties.

7) Instrumentation -- the use of sensors, computers, and data communications to tie together the whole NTC activity and to capture that activity in a manner which permits effective training feedback and assessment.

1.2.3 Mission Requirements

The NTC development program is both comprehensive and sophisticated in terms of its scope and the number of different technical disciplines required. The instrumentation systems in particular must address functional and performance requirements, spanning the full spectrum of operational situations. Accordingly, the critical NTC mission requirements are:

- Real-time monitoring and coordination of combined large-unit (BTF) field maneuver and command post brigade (BDE) exercises.

- A dynamic live-fire exercise with realistic portrayal of enemy target arrays and real-time scoring.

- Provision for combat realism while maintaining non-intrusive positive control to assure safety and adherence to the rules of engagement.

- Real-time interactive coordination and control of a realistic opposing force as a means to create the desired training stimulus and environment to assure that overall training objectives are met.

- Near real-time planning, synthesis, and execution of after-action reviews (AAR) at various command echelons using a multimedia presentation of training feedback data including audio, video, and digital displays.

- A 24-hour per day, 7-day per week training schedule capable of exercising BTFs during 2 weeks of intensive training.

- An ability to provide an effective test bed for the training developments and combat developments communities while not interfering with the primary training mission of the NTC.

- Management of NTC electromagnetic emissions to avoid interference with NASA Goldstone, U. S. Army, and U. S. Air Force operations.

- Provision of take-home training feedback packages to drive and enhance remedial training at home station to correct deficiencies noted at the NTC.

Each of these critical mission requirements are specified in detail in the NTC Development Plan published by HQ, U. S. Army TRADOC, 3 April 1979.

1.3 PROGRAM OBJECTIVE

The broad objective of the overall NTC program is to establish an early operational capability at Fort Irwin, California, for battalion task force training under conditions that minimize technical, schedule, and cost risks.

Based upon this objective, a phased development strategy has been established as discussed in the section which follows.

1.4 DEVELOPMENT STRATEGY AND CHRONOLOGY

1.4.1 Development Strategy

The NTC program is based on a phased development and implementation strategy shown in Figure 1-3. The strategy, discussed below, stems from the NTC Baseline Analysis conducted by SAI in 1978 and 1979 (see Appendix B). This comprehensive analysis established the conceptual framework to attain an early operational capability while also identifying the need for advanced technology development by the Defense Advanced Research Projects Agency. The analysis included:

- Synthesis of the NTC concept
- Detailed definition and analysis of NTC functions and functional interfaces
- Assessments of available technology and related risks
- Implementation concepts
- Program roadmaps.

From these, a two-phased approach was established. In general terms, Phase I focuses on attaining an initial operational capability in early FY 1982 using off-the-shelf instrumentation technologies. The Phase II plan is to build on the Phase I experience by introducing advanced technologies, particularly those that will permit a fully decentralized position location system and enhanced laser engagement simulators for all tactical weapon systems.

The key features of the development strategy for NTC instrumentation systems are:

- System flexibility to accommodate future growth and applications
- Minimum technical, schedule, and cost risks
- Modular design

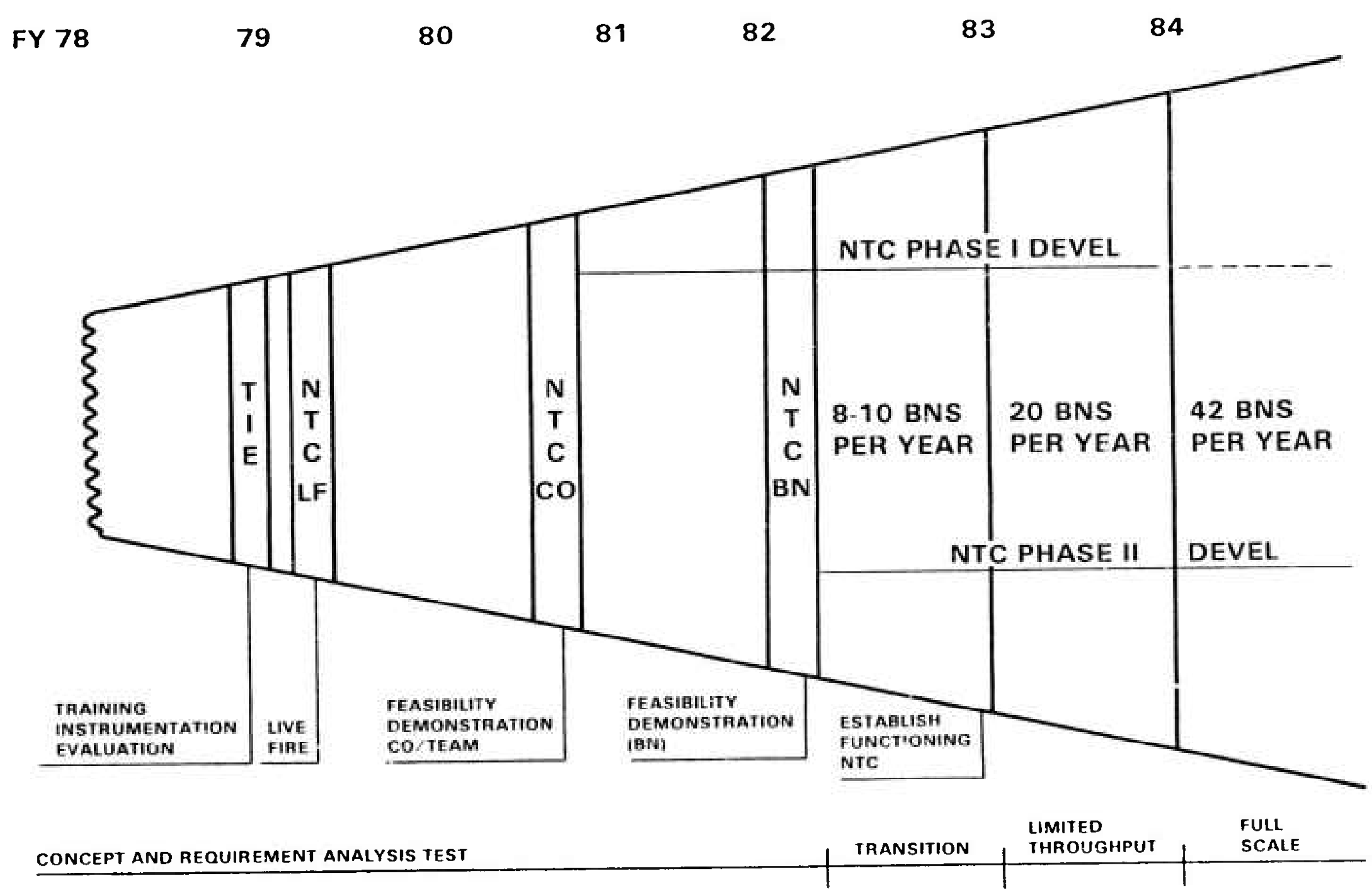


Figure 1-3. Development Implementation Strategy

- Parallel development of baseline capabilities
- System reliability, availability, and maintainability.

Within this development strategy, the key attributes that drove the NTC design are summarized as follows:

- Large unit (BTF) field maneuver and command post-exercise training (simultaneous coordination of ES and CBS)
- Combat realism while maintaining safety (non-intrusive positive control)
- Production training schedule (40+ BTFs per year)
- Near-real-time training and readiness feedback (after action review (AAR) 30 minutes after each exercise segment)
- Support force readiness assessment combat developments without interfering with "production" training operations
- Need to conduct training experimentation and to integrate new training concepts and equipment into NTC without significant impact on training schedule
- Management of EM spectrum to avoid interference with Goldstone
- Provide take-home remedial training package

The NTC I-ALPHA program was planned and conducted as one of a series of major developmental steps in the strategy to achieve an early operational capability. It provided the first opportunity to validate the instrumentation concept and to test and evaluate selected components of a prototype Phase I system under field conditions at Fort Irwin, California.

1.4.2 Development Chronology

The chronology of the NTC development process and related SAI tasks through the Phase I transition period is shown in Figure 1-4. A further summary of SAI's role and accomplishments in fulfilling these tasks is provided in the following paragraph.

MAY 1978	INITIAL PROPOSAL TO DARPA
JULY 1978	COMPETITIVE MICOM (DARPA) CONTRACT FOR $100K
SEPTEMBER 1978	NTC CONCEPT STUDY PRESENTATION TO DARPA/TRADOC
OCTOBER 1978	$100K ADD-ON FOR FURTHER NTC CONCEPT DEVELOPMENT
FEBRUARY 1979	SAI CONCEPT FOR I-ALPHA DEMONSTRATION
MARCH 1979	$450K ADD-ON FOR NTC AND I-ALPHA CONCEPT DEVELOPMENT
JULY 1979	DRAFT NTC FUNCTIONAL SPECIFICATIONS
SEPTEMBER 1979	PRELIMINARY CIS SOFTWARE DESIGN FOR I-ALPHA
SEPTEMBER 1979	$300K ADD-ON FOR I-ALPHA DEMONSTRATION DEVELOPMENT
NOVEMBER 1979	INITIAL CIS SOFTWARE DEMONSTRATION
DECEMBER 1979	$1.5M ADD-ON FOR I-ALPHA DEMONSTRATION CONDUCT
DECEMBER 1979	CIS HARDWARE AND SOFTWARE INTEGRATION AT SUNNYVALE
JANUARY 1980	CIS INTEGRATION AND TEST AT FT. IRWIN
FEBRUARY 1980	NTC I-ALPHA INSTRUMENTATION INTEGRATION AT FT. IRWIN
MARCH 1980	NTC I-ALPHA DEMONSTRATION TO ARMY
APRIL-SEPT. 1980	REVISION AND DOCUMENTATION FOR I-ALPHA
OCT.1980-MAY 1981	NTC PHASE I TRANSITION PLANNING

Figure 1-4. SAI NTC History

1.5 SAI ROLE AND ACCOMPLISHMENTS

The SAI role began in response to Army Technical Requirement Number N094, dated 20 June 1978, and continued contractually through the NTC I-ALPHA demonstration and the subsequent Phase I transition period. SAI, for nearly 3 years, has had a leading role working for and with DARPA and the U. S. Army to conceive, design, and develop the NTC. Because of the scope and duration of SAI tasks, the following outline of SAI's role and accomplishments is provided. Specific technical details are provided in the separate reports listed by title in Appendix B.

1.5.1 Support Functions

A. Baseline Support

1) Performed top-down functional analysis to define and validate functional requirements and to synthesize a functional design for the NTC

2) Synthesized the NTC operational system concept

   - Training concept
   - Operational concept

3) Performed system design tradeoffs to assess the utility and feasibility of using off-the-shelf software and hardware

4) Developed programmatic roadmaps for:

   - Phase I System: initial operational capability (IOC) -- FY 1982 (off-the-shelf)
   - Phase II System: IOC -- FY 1986 (advanced technology)

5) Supported specification of NTC hardware system requirements and design

B. NTC I-ALPHA Support

1) Designed prototype CIS system configuration

2) Designed and developed demonstration software

3) Defined measures of effectiveness (MOE), measures of performance (MOP), and essential elements of analysis (EEA), and test scenarios

4) Trained CIS operational personnel for company-level exercise

5) Modified digital map preprocessor for NTC application

6) Analyzed and developed AAR training and operational techniques

7) Provided on-site training and technical support for CIS operations

C. NTC I-ALPHA Analysis and Revision

1) Refined CIS design (hardware and software) based on NTC I-ALPHA experience

2) Designed software requirement traceability module for software development and management

3) Developed software configuration for test support driver

4) Recommended design of AAR process

5) Developed CIS manning recommendations and human factors considerations

D. Phase I Transition Program

1) Provided requirements analysis and definition needed to support Phase I CIS design and operational training plan

2) Developed detailed CIS transitional design including hardware, software, facilities, systems, and subsystem configurations

3) Provided software transitional design for program design review (PDR), including expanded interactive display and control systems

4) Prepared expanded design of test support driver

5) Analyzed requirements for software development facility

6) Prepared operational training plan and requirements analysis based on NTC I-ALPHA experience.

1.5.2 Factors Contributing to Success

The fact that SAI successfully completed all assigned tasks on or ahead of schedule and within costs can be attributed to a number of factors categorized below:

- Management
  - An in-depth understanding of all facets of the NTC mission
  - A dedicated and stable team of competent and innovative people
  - Assignment of team members to subsystems in a manner which grouped together functionally and technically compatible areas to minimize interface complexities
  - Corporate-wide interest and support for the NTC program
- Design concept
  - Explicitly accounting for risk as major criteria in hardware and software design tradeoff analysis
  - Building on a design concept which proved feasible and effective in the NTC I-ALPHA demonstration
  - Use of commercial off-the-shelf hardware and standard hardware interfaces exclusively
  - Built-in flexibility to accommodate future growth of CIS system
  - Use of state-of-the-art programming and documentation standards for operational software
- Training
  - Training program for CIS operators that was sufficiently flexible to accommodate anticipated evolutionary changes in systems operation
  - A highly qualified and dedicated team to conduct the training
  - Swift reaction to student feedback.

1.6 DIFFICULTIES ENCOUNTERED

Aside from the problems normally associated with a development program of the scope and complexity of the NTC, other significant difficulties were encountered, the most important of which related to funding:

- A "stop and start" effect threatened program continuity and momentum
- Key personnel were retained, at a considerable risk, until funding issues were resolved
- Another related difficulty was caused by the requirement to keep costs to a minimum.
- Coordination and management difficulties were encountered during the NTC I-ALPHA program because of the co-equal status of participating contractors, SAI, Ford Aerospace and Communications Corporation (FACC), and General Dynamics/Electronics (GDE).
- The remote location, austere environment, and climatology of Fort Irwin were a significant challenge to the ingenuity and capabilities of all concerned
- There was a degree of program risk and turbulence affecting operator training, since training was seriously affected by the schedule constraints
- The need for a definitive set of MOEs and MOPs has not been fully satisfied.

1.7 SUMMARY OF CONCLUSIONS

1.7.1 Conclusions

Realistic combined-arms training is a central Army requirement. The comprehensive NTC development program represents a major commitment by the Army to satisfy that requirement. Based on the NTC I-ALPHA experience, the NTC offers the potential to raise the level of unit tactical effectiveness to a point never before achieved in peacetime. Several unique attributes of the NTC support this conclusion and are presented as follows:

- Its size and location (away from civilian communities)
- Its application of advanced technology devices such as lasers, computers, position location systems, and munition simulators
- Its one-of-a-type nature also will permit the development of skillful and dedicated opposing forces
- Its computer systems will capture and retain data that can be used to:
  - Assess training effectiveness
  - Assist in reviewing doctrine and readiness
  - Aid in weapons analyses and modeling
  - Provide follow-on remedial training
  - Measure the degree of experiential learning

The paragraphs which follow summarize the major conclusions derived from the NTC baseline analyses, the NTC I-ALPHA program, and the Phase I transitional period.

1.7.2 NTC Baseline Analysis

The initial NTC baseline analysis conducted by SAI was an essential step in establishing a framework for an early operational capability of the NTC by TRADOC. SAI's detailed functional analysis, carried out to the fourth level of detail, defined for the first time NTC system functions and interfaces. Moreover, it provided the first comprehensive specification of functional requirements, which with only minor refinements, has proved valid in subsequent development stages.

An overview of this analysis is provided in Figure 1-5. In this figure, the top-level system functions are listed on the diagonal in the darkly outlined boxes and major subfunctions within each top-level function are listed within the coresponding diagonal box under the name of the top-level system function. Entries in off-diagonal boxes define the functional interactions between the corresponding two-system functions on the diagonal. Specifically, entries in off-diagonal boxes on any row (either

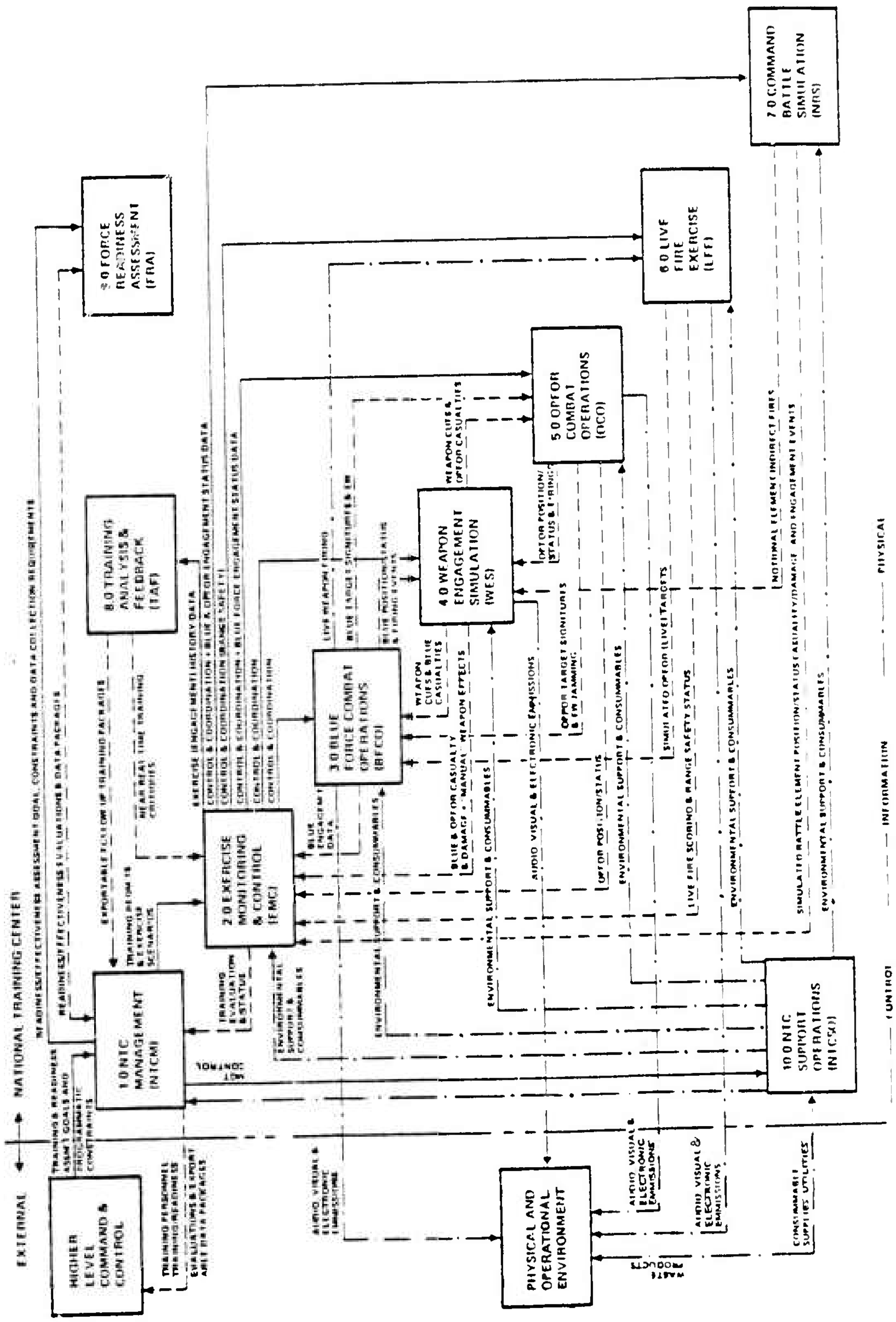


Figure 1-5. NTC System Level Functional Flow Diagram

right or left of the diagonal) are outputs from the corresponding system function on the diagonal. Entries in any column (either above or below the diagonal) are inputs to the corresponding system function on the diagonal. Therefore, entries in an off-diagonal box formed by the intersection of a row and column from functions on the diagonal define the functional input/output relationship between the corresponding two system functions.

The concept, developed during the baseline analyses, of using off-the-shelf technology for NTC I-ALPHA has proven sound and will allow the Army to attain an early operational capability with minimum risks.

1.7.3 NTC I-ALPHA

The NTC I-ALPHA program has validated SAI's design of the core instrumentation system. Specifically, the program successfully accomplished the following:

- Demonstrated a prototype SAI core instrumentation subsystem
- Demonstrated a distributed, direct-fire, real-time casualty assessment (RTCA), engagement simulation
- Demonstrated a method of indirect-fire casualty assessment
- Demonstrated the interface between the CIS and the range measurement system
- Demonstrated an SAI system for data collection that can be manipulated to display selected MOE/MOP for after-action reviews
- Provided valuable experience in exercise monitoring and control (EMC) and training analysis and feedback (TAF) functioning
- Provided valuable experience with the field controller structure and its interface with the core instrumentation.

1.7.4 Phase I Transition

The transitional concept of dividing the NTC instrumentation system into three major subsystems, range data measurement, core instrumentation, and range monitoring and control, will minimize the complexity of subsystems interfaces during Phase I development.

The Phase I transitional design provides for the recovery of the software developed for the Army during the NTC I-ALPHA program.

SAI's analysis and definition of requirements to support Phase I design and operator training incorporate the significant lessons learned from the NTC I-ALPHA program and provide for an orderly, evolutionary growth of NTC capabilities.

1.8 FUTURE TASKS

Looking ahead, the most salient feature of the NTC will be its evolutionary growth. The basic objective which the NTC must meet is to provide a realistic combat environment for training. This means that no single type of training nor any specific group of training programs will be used or practiced exclusively. To accomplish its purpose, NTC capabilities must evolve and change with doctrine and techniques of warfare. In this process, additional elements of combat must be incorporated to enhance the training environment. Refinements must be made also to existing instrumentation. Categorized in the following paragraphs are future tasks which SAI believes should be addressed on a priority basis.

1.8.1 Field Artillery

Indirect fires are already a part of NTC, but the speed, completeness, and flexibility of their implementation need to be improved. A system should be considered which will permit automated monitoring of the field artillery TACFIRE system. In addition, further research is required to develop a suitable method for marking fires.

1.8.2 Close Air Support

Use of tactical aircraft, both fixed wing and rotary wing, in a close support role is currently within the state of the art. It is not inexpensive to instrument aircraft, but the training benefit should more than offset the costs. Realism in offensive or defensive operations will be greatly affected by the presence or absence of close air support.

1.8.3 Electronic Warfare

Intelligence indicates that the Soviets have given major attention to electronic warfare and that U. S. forces in the field can expect to be attacked by electronic means. EW training, in both an offensive and defensive mode, will become an important aspect of training at Fort Irwin. The means of EW employment should be examined with an eye toward prompt application to the NTC program.

1.8.4 Nuclear, Biological, Chemical

Combat in the European theater must be considered to involve NBC. The Warsaw Pact forces train seriously in both offensive and defensive NBC measures. Inclusion of the nuclear and chemical facets of warfare should be introduced relatively early in the next phases of the NTC. The biological training requirement remains undefined.

1.8.5 Air Defense

Realistic air defense training should be introduced at the same time close air support is introduced into the NTC. This will require laser emitters and sensors (or other suitable means of realistic engagement simulation) on aircraft as well as on the divisional air defense weapons.

1.8.6 Mine Warfare

Emplacement and breaching of mine fields is planned to be a part of the NTC training. Such operations are currently within the state of the art and, depending on how training is tailored for each unit, should be incorporated into scenarios. Commanders should have a "menu" from which they will be able to designate the types of training needed by their units. Mine warfare should be included on this menu.

1.8.7 Post Processing Training Analysis

SAI has recommended a computer program that will construct a take-home instructional package. This package will be processed in an off-line mode following termination of the exercise and upon completion of the after-action review. The preparation of this take-home package will be linked to the after-action review through the exercise simulation history file. Specific MOE and MOP combinations that can be supported by data from the exercise simulation history file and that answer selected essential elements of analysis will be processed by an off-line program.

The product of this processing will be a take-home report that will be directly correlated with the after-action review and will provide a review package of salient instructional points which can be reviewed (without special equipment) by the unit at home station.

Examples of the formats used for displaying data that support the EEA are: 1) graphs and charts, 2) tables, 3) lists, 4) hard copy of graphic overlays for a particular map area, and 5) critical events that were controller identified. The indicated list is potentially much larger and can be added to as requirements increase and the configuration of the take-home package becomes clarified.

1.8.8 NTC Planning and Scheduling

Although hard requirements have not been specified for this area, the NTC I-ALPHA software design should provide significant latitude for implementation of exercise planning and scheduling functions. An engagement simulation (ES) scheduling function will have an equipment and vehicle maintenance data base. The format and record specifications lend themselves to personnel or additional equipment being added. Quantitative supplies (gas, oil, etc.) will also be maintained in an operational status data base.

The statistical displays and alphanumeric terminals will be provided to support maintenance and status menu processing. A resource management function will be fully supported by the initial suite of both hardware and support software (data base services, menu services, etc.) recommended as part of the IOC configuration.

1.8.9 Support Software

SAI developed a number of software development, maintenance, and testing tools to speed and simplify the program development process. A few of the software support modules developed by SAI are described as follows:

- Requirements Tracing Module

  A requirements tracing module has been designed by SAI to automatically map software requirements from high-level mission requirements through system- and software-level requirements to the actual code.

- Librarian

  SAI has developed an automated source code librarian for maintaining configuration control of software products. The librarian is able to track and maintain software products through various versions and configurations, allowing the reconstruction of any version or configuration of a program automatically.

- Automatic Test Analysis Tool

  SAI has prepared several automated analysis tools for the testing of software. One such tool provides metrics on a number of key software attributes (such as program complexity) to note areas requiring the most extensive testing.

1.8.10 Mobile Instrumentation

As a spin-off of the NTC development programs, SAI believes that it is feasible to develop a mobile, small-scale version of NTC instrumentation that could be used to enhance small-unit training. Such systems could be taken to locations where active and reserve units can conveniently train at the squad, platoon, and company levels. Other variations of this concept could be aimed at improving training for the rapid deployment force and for specialized training, such as combat in cities, air landings, and river crossings.

1.9 OVERVIEW OF REPORT

The following sections of this report provide a comprehensive review of SAI's role and accomplishments in support of the NTC development process, culminating with a detailed requirements analysis, transitional CIS design, and operational training plan to support Phase I development. The objective of SAI's tasks was to assist the Army achieve an early NTC operational capability with minimum technical, schedule, and cost risks. This objective has been achieved.

Section 2

CONCEPT DEVELOPMENT AND FUNCTIONAL ANALYSIS OF NTC

SECTION 2

CONCEPT DEVELOPMENT AND FUNCTIONAL ANALYSIS OF NTC

This section presents an overview of SAI's research effort conducted in response to Technical Requirement Number N094, dated 10 June 1978, and reported to DARPA and TRADOC in September of that year. Given the Army's urgent training requirements, this tasking document set in motion a comprehensive analysis of the NTC concept and functional framework as an essential first step in laying the foundations for all subsequent NTC development planning.

2.1 CONTRACT OBJECTIVE

The specified objective of this research effort was to provide a detailed functional analysis of the NTC to support both DARPA and TRADOC in their planning for the NTC. Further, the analysis was intended to provide a framework which would allow TRADOC to achieve an early operational capability while also identifying requirements for advanced development of needed technologies by DARPA.

2.2 SAI APPROACH

To accomplish the above objective, the analytical approach outlined below was followed.

CONCEPT SYNTHESIS	(Selection and definition of preferred concept)
FUNCTIONAL ANALYSIS	(Definition and specification of functional requirements)
TECHNOLOGY ASSESSMENT	(Assessment of training system technologies on near-, mid-, and long-term NTC capabilities)
SYSTEM DEFINITION	(Selection and definition of preferred systems for near-, mid-, and long-term NTC capabilities)
PROGRAM ROADMAPS	(Development of two time-phased program schedules)

2.2.1 Concept Formulation

SAI's initial effort was directed toward synthesizing and evaluating a number of NTC operational systems concepts. Each concept was evaluated in terms of training, operational, and technology issues. Both centralized and decentralized instrumentation concepts were examined, taking into account the various operational and training systems that were currently available or would be available in the 1981-1985 time frame. SAI's selection of a preferred NTC system concept, along with selection rationale, was approved by both DARPA and TRADOC in 1978 and has served as the basis for subsequent NTC program development.

Early in the examination of the NTC concept, SAI identified two key demands on the data collection systems which were not easily meshed. The first was the requirement to acquire and process the data needed to satisfy a wide variety of measures of effectiveness; measures which could be expected to change periodically as experience is gained in NTC operations. The second demand was for a data collection system that would have long-term utility and stability in terms of not requiring costly changes or modifications as the Army progresses through its developmental activities, and as the NTC was brought to full maturity.

Based on these demands, SAI proceeded to develop the conceptual framework within which the instrumentation and data collection systems could be built in a way that minimized changes over time and, at the same time, provided the dynamic MOE support needed by the training analyst. System flexibility, therefore, became the cornerstone of the SAI approach.

2.2.2 Top-Down Analysis

Using the missions and basic objectives of the NTC as a starting point for its analysis, SAI expanded the conceptual view of the NTC to its full potential and then performed a comprehensive top-down analysis of each functional component (Figures 2-1 through 2-12). The analysis synthesized

ARMY FUNCTIONS AFFECTI

Joint Activities • OSD Management • JCS Review • Theater Requirements • Advanced Concepts Dev • Joint Doctrine and Procedures Generation • Joint Developments • Joint Exercise Conduct	• Missions • Resource Allocation • Program Review and Constraints • Joint Doctrine and Procedures • Joint Plans • Adv. Concepts and Systems • Joint Exercises • General Direction			
• Resource Requirements • Program Status and Data • Army Status • Plans and Projections • Forces • Army Views	**Army Activities** • Management and Direction • Doctrine and Equipment Development • External Interface • Army Concept Dev • Training	• Goals and Objectives • Resource Allocation • Constraints • Regulations and Directives • Review and Assessment • Doctrine • Policy and Guidance	• Goals and Objectives • Resource Allocation • Constraints • Regulations and Directives • Review and Assessment • Doctrine • Policy and Guidance	• Goals and Obje • Resource Alloc • Constraints • Regulations an • Review and As • Doctrine • Policy and Gui • Joint Assets
	• Status Reports • Evaluations • Requirements	**Individual & Crew Training** • MOS Duty Training SQTS • Crew Training SQTS • Weapon Firing • On-the-Job Training • Schooling	• Trained Individuals	
	• Status Reports • Evaluations • Requirements		**Small Unit Training** • Squad, Section, Platoon & Company Training and Evaluation • ARTEP/Miles • Weapon Engagement Exercises • CPX and Map Exercises • Field Exercises • Battle Simulations	• Trained Units • Problem Areas
	• Proposed Changes in Equipment, Orgn and Doctrine • Status Reports • Requirements			**Combat Effe** • Combat Readi • Training and C • System Devel • Organization • Joint Training
	• Status Reports • Evaluations • Plans and Programs • Requirements • Data	• Problem Areas • Recommendations	• Problem Areas • Recommendations • Critique • Exportable Training Package	• Problem Ar • Recommend • Evaluations • Data
	• Readiness Evaluation • Data • Special Evaluation Reports		• Readiness Evaluations	• Data • Special Evalu

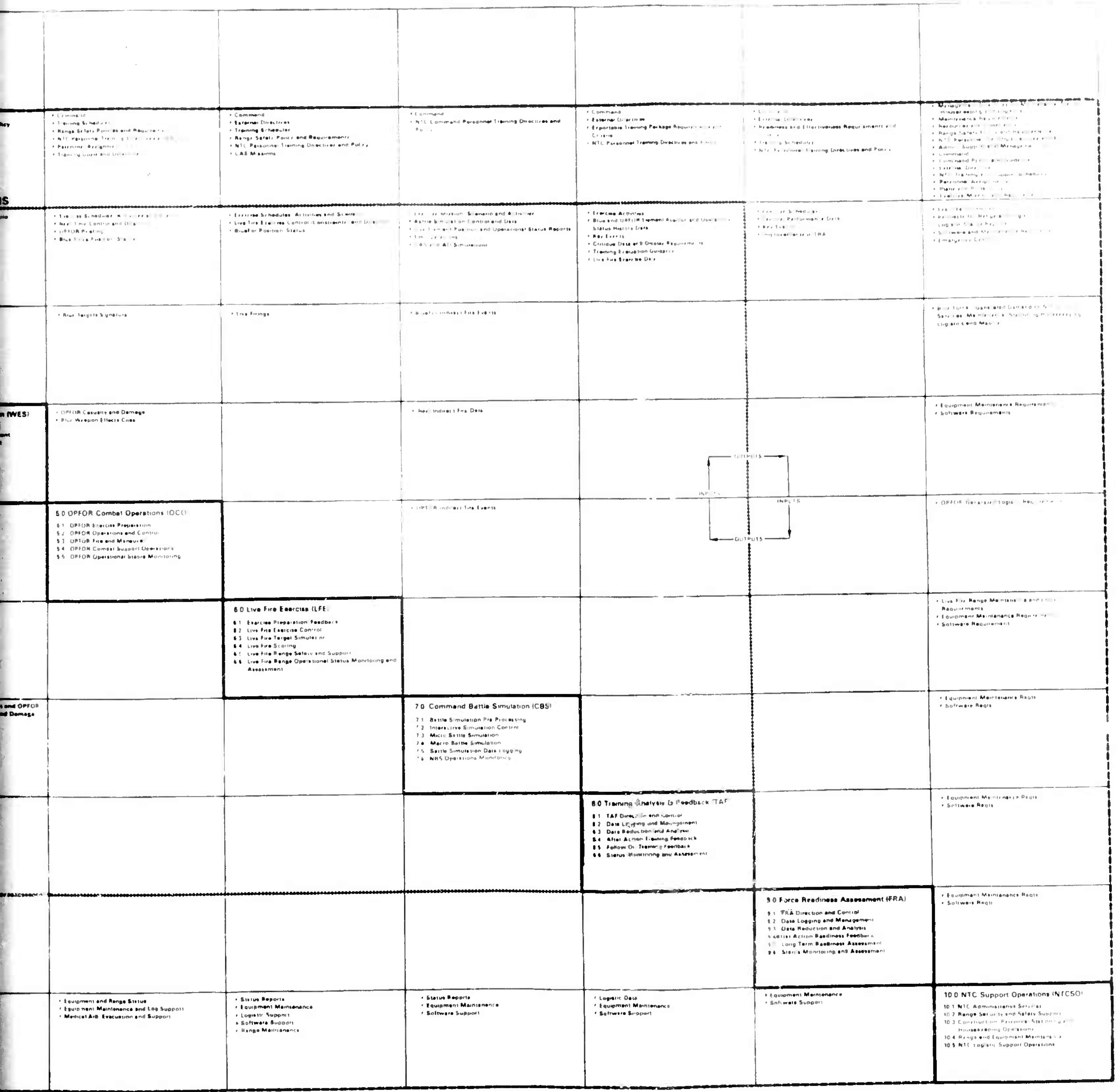
Figure 2-1. Top Level NTC Functions and Functional In

ARMY FUNCTIONS AFFECTING TRAINING

• Goals and Objectives • Resource Allocation • Constraints • Regulations and Directives • Review and Assessment • Doctrine • Policy and Guidance	• Goals and Objectives • Resource Allocation • Constraints • Regulations and Directives • Review and Assessment • Doctrine • Policy and Guidance • Joint Assets	• Goals and Objectives • Review and Assessments Resource Allocation • Evaluation Requirements • Constraints • Policy and Guidance • Training Needs • Data Requirements • Plans and Programs • Doctrine • Joint Assets • Regulations and Directives	• Goals and Objectives • Data Requirements • Special Evaluations • Policy and Guidance • Readiness Issues • Review and Assessment
• Trained Individuals			
Small Unit Training • Squad, Section, Platoon & Company Training and Evaluation • ARTEP, Miles • Weapon Engagement Exercises • CPX and Map Exercises • Field Exercises • Battle Simulations	• Trained Units • Problem Areas	• Trained Units • Deficiencies	• Trained Units
	Combat Effectiveness Enhancement • Combat Readiness Testing • Training and Combat Developments • System Development and Testing • Organization and Force Structure Review • Joint Training	• Requirements • Adv. Concepts	• Data Requirements • Special Evaluations
• Problem A • Recommendations • Critique Exportable Training Package	• Problem Areas • Recommendations • Evaluations • Data	**Large Unit Training** • NTC Management • Exercise OPNS • Data Collection and Analysis • Training Evaluations and Feedback • NTC Assessment	• Management and Direction • Data • Resource Allocation
• Readiness Evaluations	• Data • Special Evaluation Reports	• Status Reports • Requirements	**Force Readiness Assessment** • Data Base Analysis and Maintenance • Organizational Assessment • Doctrine Assessment • Weapons Assessment

NTC FUNCTIONS

Level NTC Functions and Functional Interfaces



2-2. Second Level NTC Functions and Functional Interfaces

NTC Operational Environment • Higher Level Command and Control • Physical Environment (Weather and Terrain) • Non NTC Operations (Civilian, Military) • External EM Environment • Mission, Technology and Programmatic Constraints	No Functional Interactions	• R[illegible] and Administrative Activities • NTC [illegible] and Policy • Directives for Exercise [illegible] • Requests for [illegible] Readiness Data [illegible] • [illegible] Requests	• NTC Programmatic and Budgetary Constraints and Data • Plans and Programs	• BTF Personnel Requiring Training • Training Concepts, Approaches, Effectiveness Inquiries • CAS Support to NTC
No Functional Interactions	**External NTC System Funtions** 2 0 Exercise Monitoring and Control 3 0 Blue Force Combat Operations 4 0 Weapon Engagement Simulation 5 0 OPFOR Combat Operations 6 0 Live Fire Exercise 7 0 National Battle Simulation 8 0 Training Analysis Feedback 9 0 Tactical Readiness Assessment 10 0 NTC Support Operations	• Response to [illegible] Directives [illegible] • Operational Status [illegible]	• Funding Reports (10 1) • Personnel Data and Actions (10 1) • Financial Data (10 1) • Problem Areas and Shortfalls (10 1, 10 3) • MCA Requirements (10 3) • Procurement Contracting Needs (10 5)	• Exportable Training Packages (8 5) • Training Effectiveness Evaluations (8 1, 8 5) • Live CAS Requirements (2 2) • Exercise Assessment (2 6)
• Routine Administrative Activities • Request for NTC Resources • Exportable Training Packages • Training Development Recommendations to Correct Training Deficiencies • Tactical Readiness Assessment Reports, Final Approved Copy • Recommendations to Correct Observed Readiness Deficiencies • Public Relations Activities	• Command Air • Command Guidance and Policy (2 2, 10 1, 10 3) • External Directives (2 1, 6 1, 8 1, 9 1, 10 1, 10 2, 10 3, 10 4, 10 5) • Plans and Procedures (10 1, 10 2, 10 3, 10 4, 10 5) • Equipment Maintenance Req's (10 4) • Space and Bldg Req's (10 3)	**1 1 NTC Command & Coordination** • Direction of NTC Operations • Liaison with External [illegible] • Community Relations • NTC Effectiveness Evaluation • Long Range Planning • Operations Monitoring and Status Assessment	• Budget Fiscal Guidance • Resource Availability Projections • Funding Priorities Constraints • Personnel Priorities Constraints • Reqs for Special Management Reports	• Training Policy, Objectives, Priorities and Constraints • Special Training Requirements, Exercises, Demonstrations in Response to External Directives
• Supportive Budgetary and Fiscal Data • Personnel Needs Forecasts • NTC Contracts and Procurements	• Personnel Assignments (2 2, 5 3, 10 1) • Administrative Support (2 2, 10 1) • Management Information (2 2, 10 1) • Resource Allocation (10 1, 10 3, 10 4, 10 5) • Funding and Status (10 1) • Procurement and Contracting (10 1, 10 3, 10 5)	• NTC Resource Requirements Forecasts (Equipment, Supplies, Personnel) • NTC Budget Requests • NTC Personnel Requests • NTC Management Information • Management Reports	**1 2 NTC Resource Management** • Budgeting and Fiscal Management • Procurement and Contracting • Resource Allocation • Personnel Management • Management Information • Administrative Support	• Resource Allocations to Training • Administrative Support
• Exportable Training Packages for Home Station Follow up Training • Training Deficiencies and Corrective Recommendations • Coordination with Air Force for CAS Missions	• Training Schedule (2 1, 3 1, 5 1, 6 1, 9 1, 10 2, 10 3, 10 8, 10 5) • New Unit Training Reqm'ts and Supportive Analysis Data (2 1) • Training Goals, Objectives (2 1, 5 1, 5 2) • Exercise Mission and Req's (2 1, 10 4, 10 5) • Training Resource Constraints (2 1) • Exportable Training Package Evaluation (8 1) • CAS Missions (6 2)	• Training Exercise Schedules • Training Status Reporting • Summary Training Evaluation Reports, Trends	• Resource Requirements Forecasts (Equipment, Personnel) • Resource Utilization Data	**1 3 Training Operations Management** • Goal Objectives Synthesis • Training Macro Scheduling • Training Prioritization • New Unit Needs Assessment • Exercise Mission Reqm'ts Synthesis • Training Evaluation and Reports Review • Exportable Training Package Review • External Coordination
• Tactical Readiness Evaluations and Supportive Analysis Data • Tactical Readiness Shortfall and Corrective Recommendation	• Readiness Assessment Guidance Criteria (9 1) • TRA Product Req's Guidance (9 1)	• Readiness Assessment Status Reporting • Summary Tactical Readiness Reports	• Resource Requirements Forecasts (Equipment, Personnel) • Resource Utilization Data	• Readiness Assessment Data Collection Reqm'ts
• Range Safety Data to Support Special Investigations • Safety Device Requirements • Recommendations on Safety • Safety Reports	• Range Safety Policies, Procedures and Reqm'ts (2 8, 5 2, 8 5, 10 2) • Frequency Policy Constraints (2 6) • Spurious EM Signals (2 6)	• Range Safety Status Reporting • Recommendations to Improve Range Safety Policy Procedures • Response to Special Investigations	• Resource Requirements Forecasts (Equipment, Personnel) • Resource Utilization Data	• Special Safety [illegible]uirements
• Demands for Supplies and Services to Support NTC Operations	• Support Operations Schedule (10 2, 10 3, 10 8, 10 5) • Training Directives and Policy for NTC Personnel (2 1, 4 1, 5 1, 6 1, 7 1, 8 1, 9 1, 10 5) • Support Planning (10 3, 10 5)	• NTC Support Operations Status Reporting • NTC Personnel Training Status Reporting	• Resource Requirements Forecasts (Equipment, Supplies, Personnel) • Resource Utilization Data	• NTC Support Resource Availability Constraints

1 0 NTC MANAGEMENT (NTCM) FUNCTIONS

Figure 2-3. 1.0 NTC Management

NTC Programmatic and Budgetary Constraints and Data Plans and Programs	• BTF Personnel Requiring Training • Training Concepts, Approaches Effectiveness Inquiries • CAS Support to NTC	• Tactical Readiness Issues and Inquiries	• Range Safety Constraints • Frequency Spectrum and Constraints • Spurious EM Signal Problems	• [illegible]
unding Reports (10.1) ersonnel Data and Actions (10.1) inancial Data (10.1) roblem Areas and Shortfalls (10.1, 10.3) CA Requirements (10.3) ecurement Contracting Needs (10.5)	• Exportable Training Packages (8.5) • Training Effectiveness Evaluations (8.1, 8.5) • Live CAS Requirements (2.2) • Exercise Assessment (2.8)	• Tactical Readiness Assessments and Recommendations (9.4)	• Range Safety Reports (2.6, 10.2) • OPFOR Safety Status (5.2) • Safety Device Reqs (10.2) • Range Medical Reqs (10.2) • Incident Reports (10.5)	• NTC Support Operations and Status Reports (10.2, 10.4, 10.5) • Training Status of NTC Personnel [illegible] (10.5) • [illegible] Reqs for NTC (10.5) • Support Data (10.5)

1.0 NTC MANAGEMENT (NTCM) FUNCTIONS

dget Fiscal Guidance source Availability Projections nding Priorities Constraints rsonnel Priorities Constraints qs for Special Management Reports	• Training Policy, Objectives Priorities and Constraints • Special Training Requirements, Exercises Demonstrations in Response to External Directives	• Readiness Assessment Policy, Objectives, Priorities and Constraints • Special Analysis Requirements in Response to External Directives	• Range Safety Policy and Requirements • Exceptions and Special Considerations • Reqs. For Safety Data to Support Investigations	• NTC Operations Plans, Projections and Schedules • Policy and Guidance
NTC Resource Management dgeting and Fiscal Management curement and Contracting ource Allocation sonnel Management nagement Information ministrative Support	• Resource Allocations to Training • Administrative Support	• Resource Allocations to Readiness Assessment • Administrative Support	• Resource Allocations to Range Safety • Administrative Support	• Resource Allocations to NTC Support Operations • Administrative Support
urce Requirements Forecasts (8. Equipment onnel) urce Utilization Data	**1.3 Training Operations Management** • Goal Objectives Synthesis • Training Macro Scheduling • Training Prioritization • New Unit Needs Assessment • Exercise Mission Reqmts Synthesis • Training Evaluation and Reports Review • Exportable Training Package Review • External Coordination	• Training Exercise Schedules	• Training Exercise Schedules • Training Data Requirements Impacting Safety	• Training Exercise Schedules • Support Requirements Projections
urce Requirements Forecasts (8. Equipment nnel) urce Utilization Data	• Readiness Assessment Data Collection Reqmts	**1.4 Readiness Assessment Management** • Goals Objectives and Criteria Synthesis • Assessment Requirement Synthesis • Readiness Assessment Reports Review	• Readiness Assessment Activity Schedules • Data Collection Requirements Impacting Safety	• Readiness Assessment Schedules • Support Requirements Projections
rce Requirements Forecasts (8. Equipment nnel) ce Utilization Data	• Special Safety Requirements	• Special Safety Requirements	**1.5 Range Safety Management** • Range Safety Requirements and Procedures Synthesis • Range Safety Compliance Monitoring • Range Safety Reports • Frequency Control Management • Air Space Management • Special Investigations	• Support Requirements Projections
e Requirements Forecasts (8. Equipment, e. Personnel) e Utilization Data	• NTC Support Resource Availability Constraints	• NTC Support Resources Availability Constraints	• NTC Support Resource Availability Constraints	**1.6 NTC Support Operations Management** • Support Operations Planning and Scheduling (Stationing, Supplies, Medical, Fire Fighting, Security) • Support Operations Coordination and Control • Range Maintenance Management • NTC Personnel Training

Figure 2-3. 1.0 NTC Management

EXERCISE MONITORING AND CONT

External NTC System Functions 1 0 NTC Management 3 0 Blue Force Combat Operations 4 0 Weapon Engagement Simulation 5 0 OPFOR Combat Operations 6 0 Live Fire Exercise 7 0 Notional Battle Simulation 8 0 Training Analysis and Feedback 9 0 Tactical Readiness Assessment 10 0 NTC Support Operation	• Equipment Pre Exercise Test Checkout Results (3 1 4 1 5 1 6 1 7 1 8 1 9 1) • Training Goals Objectives Mission Scenario and Schedules (1 3) • New Unit Training Reqm ts (1 3) • Training Resource Constraints (1 3) • Training Policy and Directives for Control Personnel (1 6) • Exercise Mission and Requirements (1 3) • External Directives (1 1)	• Command Guidance and Policy (1 1) • Personnel Assignments Resource Allocations and Admin Support (1 2) • BLUEFOR Reports Plans Interaction with Higher Notional Units (3 2 3 3 3 4 5 4) • OPFOR Operational Plans Interactions (5 2 4 4 5 4) • Incident Reports (10 2) • Notional Element Position Operational Reporting and Displays (7 2) • Explosive Ord Disposal (10 4) • Indirect Fire Events Data (3 5 4 3 5 4) • Range Security and Fire Fighting Opns (10 2) • Management Information (1 2) • Notional Tactical Messages (7 2) • Cue Generation (4 3)	• Control of Fire and Maneuver (6 2) • Weapon Effects Cues (4 5) • Medical Aid and Evacuation (10 3) • Field Logistic OPNS (10 5)	• Casualty • Engagem • Key Ope • BLUEFO • OPFOR • OPFOR (• NHS Eve • Live Fir • Live Fir • Data Tre • Indirect Assessm • Weapon
• Training Status of Control Personnel (1 6) • Exercise Initiation Activities (4 1 5 1 6 1 7 1 8 1) • Exercise Termination Control (4 1 5 1 6 1 7 1 8 1) • Exercise Schedule (3 1 5 1 6 1 9 1 10 2 10 3 10 4 10 5) • Exercise Mission and Scenario (3 1 4 1 5 1 6 5 7 1) • Simulation Control Req s (7 1) • OPFOR Briefing (5 1)	**2 1 Exercise Preparation & Termination** 2 1 1 Exercise Initiation Control 2 1 2 Detailed Exercise Planning and Scheduling 2 1 3 Slice of Battle Definition Scenario Development and OPORD Preparation 2 1 4 Pre exercise Control Team and OPFOR Briefing Preparation 2 1 5 Exercise Termination and Debriefing 2 1 6 Training of Control Personnel	• Training Exercise Schedules • Training Exercise Scenarios (slice of battle definition) • Exercise or Operations Orders • White Team Command Briefing • Exercise Initiation Termination Enablements	• Cue Generation and Event Recording Equipment Draw and Checkout • White Team Operations Procedures and Plans Tailored to Specific Exercises	• Field Ins • Date Ac • Date Lin Simulat Checkou • Radio F
• Live CAS Req s (1 3 • Cease Fire Command (3 2) • Higher Notional Unit Interfaces (3 1 3 2 3 3 3 4 3 5) • EW Operations and Jamming (3 2) • Engagement and Control Interactions (3 4) • Real Time OPFOR Direction and Control (5 2 6 2) • Coordination and Control of Battle Simulation (7 2) • Emergency Control (10 2) • Indirect Fire Data (4 3)	• Exercise HALT Termination Notice and Exercise Reinitialization Reqm ts • Pre engagement Equipment Operational Checkout Results	**2 2 Conduct of Exercise** 2 2 1 Interface with NTC Management 2 2 2 Control (White) Team Operations Coordination and Control 2 2 3 OPFOR Operations Coordination and Control 2 2 4 Battle Simulation Coordination Control and Role Playing 2 2 5 Live Fire Exercise Coordination and Control 2 2 6 Real Time Training Assessments and Key Event Situation Tagging for Feedback 2 2 7 Indirect Fire Effects Management	• Control Team Deployment and Functional Assignment • Real Time Control Team Directives to Support Engagement Simulation and Live Fire Exercise • Manual Weapon Cue Generation Comm and and Supportive Data • Administrative HALTS • BLUEFOR Casualty and Loss Marking for Indirect Fires	• Indirect • Key Eng • Signific
• Manual Weapon Effect CUEs and Casualty Generation (3 2 3 4)	• Pre engagement Equipment Operational Checkout Results	• Rule on Engagement Violations • Weapon Engagement Hit-Kill Violation/Intervention Reports • Response Notifications of Receipt Execution of Control Directives • Notification of Range Safety Emergencies Intrusions • Real-Time Recommendations of Engagement Adjustments • Manual Event Recording	**2 3 Control Team Field Operations** 2 3 1 Application and Enforcement of Engagement Rules of Play 2 3 2 Weapon Engagement Hit/Kill Supervision Implementation 2 3 3 Weapon Effects Cue Generation and Placement 2 3 4 Key Tactical Engagement Event Recording Reporting 2 3 5 Range Safety Monitoring Intrusion 2 3 6 Training Critique Support 2 3 7 Control of Spurious EM Signals	• Key Eng Date
• BLUEFOR and OPFOR Unit Position Data (4 2 5 2 7 2 8 2 6 2) • Live Fire Exercise Data (8 2) • Battle Simulation Event History Data (8 2 • Engagement Simulation Event History Data (6 2) • Engagement Events by Weapons Types (4 2) • Tactical Performance Data (9 2) • Key Event Flags (8 4 3 4)	• Pre engagement Equipment Operational Checkout Results	• Real Time Tactical Situation (BLUEFOR and OPFOR) Data to Support Real Time Coordination and Control • Real Time Battle Simulation Data Feedback to Support Command Role Playing • Real Time Controller (White Team) Situation Data • Real Time Live Fire Data • Real Time Frequency Management Data		**2 4 Rea** 2 4 1 Enga Firm 2 4 2 BLU and 2 4 3 Key and V 2 4 4 Com Disp 2 4 5 Live 2 4 6 Freq Proc
• Critique Data Display and Reports Requirements (8 4) • Playback Requirements (8 4) • After action Review and Critique (3 1) • Improvements in TRA (9 1) • Training Evaluation Guidance (8 1)	• Pre engagement Equipment Operational Checkout Results	• Recommendations for Adjustment in Exercise Scenario Mission to Emphasize Training Deficiencies (for Subsequent Battle Slices) • Exercise Coordination and Control Effectiveness Problems Feedback	• Control Team Effectiveness Problems Feedback	• Data Bas Preparat
• Exercise Operational Status Updates and Reports (1 1 7 2) • Range Safety Reports (1 5) • Exercise Assessment (1 6) • Logistic Status Reports (10 5) • Requests for Logistic and Range Assistance (10 5) • Software Requirements (10 4) • Equipment Maintenance Requirements (10 4)	• Pre engagement Equipment Operational Checkout Results • Frequency Allocations	• Emergency Safety Alerts • Equipment Operational Status Updates • Equipment Failures Impacting Exercise Capabilities • Location of Spurious EM Signals	• Real Time Range Safety Update Intervention Directives • Location of Spurious EM Signals	

Figure 2-4. 2.0 Exercise Monitoring and Contr

Control of Fire and Maneuver (6 2) Weapon Effects Cues (4 5) Medical Aid and Evacuation (10 3) Field Logistic OPNS (10 5)	• Casualty and Loss Reports (5 2 4 3) • Engagement Events by Wpn Types (3 4 5 3) • Key Operational Events Data (5 4) • BLUEFOR Position Operational Status (3 2 3 4 3 5 3 6) • OPFOR Position Operational Status (5 5) • OPFOR Observations of BLUEFOR (5 2) • NBS Event History Data (7 5) • Live Fire Observations of BLUEFOR Proficiency (6 4) • Live Fire Scoring (6 4) • Data Transmission Requests (8 2 9 2) • Indirect Fire Impact Point and Damage Casualty Assessment Data (7 3) • Weapon Target Pairing (4 2)	• Training Critique Displays and Report (6 1 8 4 9 4) • Real Time Engagement Playback Data (8 4 9 4) • OPFOR Observations of BLUEFOR Performance (5 2)	• [illegible] • [illegible] • [illegible] • [illegible] • [illegible] • [illegible] • [illegible] 8 6 • Range Safety [illegible] 1 5

EXERCISE MONITORING AND CONTROL FUNCTIONS

Cue Generation and Event Recording Equipment Draw and Checkout White Team Operations Procedures and Plans Tailored to Specific Exercises	• Field Instrumentation Draw Alignment and Checkout • Data Acquisition and Storage Equipment Checkout • Data Links to Field Instrumentation (Engagement Simulation and Live Fire) and Battle Simulation Checkout • Radio Frequency Assignments	• Critique Schedules and Resource Designation • Critique Attendance Specification • Critique Presentation Equipment and Facilities Checkout	• Safety Procedures and Requirements for Specific Exercises • Initial Equipment Availability and Operational Status Summary
• Control Team Deployment and Functional Assignment • Real Time Control Team Directives to Support Engagement Simulation and Live Fire Exercise • Manual Weapon Cue Generation Command and Supportive Data • Administrative HALTS • BLUEFOR Casualty and Loss Marking for Indirect Fires	• Indirect Fire Data • Key Engagement Events Situations Tagging • Significant Control Events	• Real Time Adjustments to BLUEFOR Critique Plans and Schedules • Critique Guidance (Emphasis) Based on Real time Exercise Observation • Key Event Situation Tagged for Critique Replay • Weapon Engagement Hit Kill Violations and Corrective Actions	• Real Time Adjustments to Range Safety Requirements and Procedures • Special Safety Situations Alerts
2.3 Control Team Field Operations 2 3 1 Application and Enforcement of Engagement Rules of Play 2 3 2 Weapon Engagement Hit/Kill Supervision Implementation 2 3 3 Weapon Effects Cue Generation and Placement 2 3 4 Key Tactical Engagement Event Recording Reporting 2 3 5 Range Safety Monitoring Intrusion 2 3 6 Training Critique Support 2 3 7 Control of Spurious EM Signals	• Key Engagement Events Situations with Supportive Data	• Key Personnel and Field Data To Support BLUEFOR Critique	• Real Time Equipment Failure Notices • Safety Violation Notices • Safety Emergency Notices • Recommendations for Change — Safety Procedures (Non Real Time)
	2 4 Real Time Data Acquisition & Processing 2 4 1 Engagement Simulation (ES) Unit Position Combat Firing Events Data Acquisition 2 4 2 BLUEFOR OPFOR Controller Unit Position Status and RTCA Processing and Display 2 4 3 Key Engagement Event Manual Data Entry (Commo and Video Monitoring) 2 4 4 Command Battle Simulation Data Acquisition and Display 2 4 5 Live Fire Data Acquisition Processing and Display 2 4 6 Frequency Management Data Acquisition Processing and Display	• Tactical Situation Data to Support Critique Planning • Key Engagement Events Situations Tagged for Critique	• Exercise Status Data
• Control Team Effectiveness Problems Feedback	• Data Base Queries to Support Training Critique Preparation	**2 5 BLUEFOR Training Critique** 2 5 1 Critique Planning and Scheduling 2 5 2 Critique Objectives Goals and Feedback Reqmts Synthesis 2 5 3 Critique Preparation 2 5 4 Critique Presentation 2 5 5 Critique Evaluation and Improvement Assessment 2 5 6 Support Exportable Training Package Production	• BLUEFOR Safety Feedback
• Real Time Range Safety Update/Intervention Directives • Location of Spurious EM Signals		• Safety Requirements Procedures and Violations Review Reenforcement Recommendations	**2 6 Exercise Monitoring & Assessment** 2 6 1 Equipment Operational Status Monitoring and Assessment • Field Instrumentation • OPFOR Equipment • Live Fire Equipment • Battle Simulation Equipment • Exercise C[3] Equipment 2 6 2 Exercise Impact Assessment 2 6 3 Impact Mitigation Minimization Mgmt 2 6 4 Range Safety Monitoring and Assessment 2 6 5 Range Safety Management 2 6 6 Freq Control and Management 2 6 7 Spurious EM Signal Location 2 6 8 Control Software Reqts

2.0 Exercise Monitoring and Control

BLUE FORCE COMBAT OPERATIONS (BFCO) FUNCTIONS

External NTC System Functions 1.0 NTC Management 2.0 Exercise Monitoring and Control 4.0 Weapon Engagement Simulation 5.0 OPFOR Combat Operations 6.0 Live Fire Exercise 7.0 Notional Battle Simulation 8.0 Training Analysis and Feedback 9.0 Readiness/Effectiveness Assessment 10.0 NTC Support Operations	• Training Schedules (1.3, 2.1) • Exercise Mission (2.1) • Higher Notional Unit Interfaces (2.2) • After Action Review and Critique (2.6) • Exercise Safety Requirements and Procedures (2.7)	• Higher/Notional Unit Interfaces (2.2) • EW Operations and Jamming (2.2) • Initial OPORD (2.2) • Cease Fire Commands (2.2) • Manual Weapon Effects Cues and Casualty Generation (2.3)	• Higher/Notional Units Interface (2.2) • OPFOR Targets (6.3)	• Higher/N • "Manual" Generatio • Disableme • Engagem Teams (2. • "Automat Generatio • OPFOR T • Live Fire Simulatio • Simulated • OPFOR R
• Operational Status Reports (1.1)	**3.1 Combat Preparation & Termination** 3.1.1 Orientation Briefings • Administrative • Range Safety 3.1.2 POMCUS Equipment Draw and Checkout 3.1.3 OPS Orders Communication 3.1.4 Assembly Area Designation and Deployment Coordination 3.1.5 After-Action-Review and Performance Critique	• Pre Exercise Requirements	• OPFOR Order of Battle • Background Intelligence [illegible] on Battlefield Situation (OPFOR Disposition)	• Weapon • Operation • Maneuv • Coordina Positions
• Initial Unit Status (2.1) • Combat Reports/Plans Interactions with Higher Notional Units (2.2) • TOC Position/Status (2.4)	• Key Personnel for After-Action-Review and Critique • Pre-Exercise Activities	**3.2 Command, Control & Communications** 3.2.1 Operational Planning and Plan Adaptation 3.2.2 Operations Orders Generation • Force Tailoring • Fire Coordination • Maneuver Control • Reserve Employment 3.2.3 Combat Operations Control and Direction (Attack/Defense, Loss Management, Force Reconstitution) 3.2.4 Communication and OPSEC 3.2.5 TOC Location/Status Measurement	• Operations Orders	• Operation
• Intelligence Requirements and Priorities (2.2) • Intelligence Activities and Reports (2.2)	• Key Personnel for After-Action-Review and Critique	• Intelligence and Recon Plans and Operations	**3.3 Intelligence Operations** 3.3.1 EEI Development 3.3.2 Intelligence Collection, Analysis and Integration 3.3.3 Combat Intelligence and Information Development 3.3.4 Sensor Allocation, Target Acquisition Support 3.3.5 Reconnaissance 3.3.6 Enemy Deception Operation 3.3.7 PW/Documents Processing 3.3.8 Key Element Position/Status Measurement	• Intelligen • Intelligen
• Fire/Maneuver Element Position/Operational Status (2.4) • Direct Fire Events by Weapon Type Data (2.4) • Live Weapon Fire (6.2) • Target Signatures (5.3)	• Key Personnel for After-Action-Review and Critique	• Operational Reports and Activities	• Operational Reports and Activities	**3.4 Fire** 3.4.1 Man Utili 3.4.2 Dire 3.4.3 Fire/ 3.4.4 Ener 3.4.5 Secu 3.4.6 Resp 3.4.7 Situ 3.4.8 Posi
• BLUEFOR EW Plans (2.2) • CAS Requests (2.2) • Support Element Position/Status (2.4) • AO Plans (2.2) • Use of Indirect Fire (2.2)	• Key Personnel for After Action-Review and Critique	• CAS, ARTY Fire Support Requirements • SITREPS/Spot Reports	• Reports	• CAS, AR • SITREPS
• Log Element Position/Status (2.4) • Requirements for Higher Level Maint. (10.4) • Requests for Log Assistance (10.5)	• Key Personnel for After Action-Review and Critique	• Logistic Status Reporting • Casualty/Personnel Status Reporting • Logistic Reports	• Log Support	• Log Su

Figure 2-5. 3.0 Blue Force Combat Operation

AT OPERATIONS (BFCO) FUNCTIONS

	• Higher/Notional Units Interface (2.2) • OPFOR Targets (6.3)	• Higher/Notional Unit Interfaces (2.2) • "Manual" Weapon Effects Cues and Casualty Generation (2.3) • Disablement and Degradation (4.4) • Engagement and Control Interactions of Control Teams (2.3) • "Automated" Weapon Effects Cues and Casualty Generation (4.4) • OPFOR Targets and Signatures (6.3) • Live Fire Exercise Weapon Effects Cues and Casualty Simulation (6.3, 6.4) • Simulated OPFOR Target Signatures (6.3) • OPFOR Firing Signatures (4.5)	• Higher/Notional Unit Interfaces (2.2)	• Specialized Admin. Service (10.1) • Medical Aid and Evacuation (10.2) • Medical Support (10.3) • Log Support (10.3, 10.4, 10.5) • Higher Echelon Maint. (10.4)
	• OPFOR Order of Battle • Background Intelligence [illegible] on Battlefield Situation (OPFOR Disp[illegible]	• Weapon Safety Requirements • Operational Safety Constraints • Maneuver Lanes • Coordination in Moving from AA to Initial Operational Positions	• Operational Safety Constraints • EM Frequency Assignments • Initial Conditions on Friendly CAS • Obstacle Preparations • Chem-Nuc Device Preparations	• Irwin Peculiar Maintenance Instructions
...tions ...ion ...n ...rce	• Operations Orders	• Operational Orders	• OPORD	• Logistics Orders • Transportation Control and Movement Coordination • Resupply Priorities • Personnel Replacement Priorities
	3.3 Intelligence Operations 3.3.1 EEI Development 3.3.2 Intelligence Collection, Analysis and Integration 3.3.3 Combat Intelligence and Information Development 3.3.4 Sensor Allocation, Target Acquisition Support 3.3.5 Reconnaissance 3.3.6 Enemy Deception Operation 3.3.7 PW/Documents Processing 3.3.8 Key Element Position/Status Measurement	• Intelligence Requirements • Intelligence Support	• Intelligence Requirements • Intelligence Support	
	• Operational Reports and Activities	**3.4 Fire and Maneuver** 3.4.1 Maneuver Planning (Terrain Organization/Utilization) 3.4.2 Direct Fires Planning 3.4.3 Fire/Maneuver Coordination and Conduct 3.4.4 Enemy Force Detection and Engagement 3.4.5 Security Operations 3.4.6 Response to CW/NUC Environ 3.4.7 Situation Reporting 3.4.8 Position/Status Recording		• Log Reporting

	• Reports	• CAS ARTY Fires Plan and Coordination
		• SITREPS and Spot Reports
			3.5 Combat Support Operations
			3.5.1 Electronic Warfare
			  • ECM
			  • ECCM
			3.5.2 CAS Coordination and Control
			3.5.3 Indirect Fires Planning
			3.5.4 Air Defense Operations
			3.5.5 Engineer Operations
			  • Mine Field Placement/Removal
			  • CBR Decontamination
			  • Bridge/Road/Barrier Construction
			3.5.6 Position/Status Recording
				• Admin. and Logistic Requirements

	• Log Support	• Log Support	• Log Support	**3.6 Admin. & Logistics Operations** 3.6.1 Personnel Replacement 3.6.2 Medical Support Casualties Evacuation 3.6.3 Consumables Resupply (Food, Ammo, Pol, Equipment) 3.6.4 Damaged Equipment Evacuation, Repair, Replacement 3.6.5 Status Reporting 3.6.6 Key Element Position/Status Recording 3.6.7 Admin. Services

2-5. 3.0 Blue Force Combat Operations

WEAPON ENGAGEMENT SIMULATION (WES) FUNCTIONS

External NTC System Function 1.0 NTC Management 2.0 Exercise Monitoring and Control 3.0 Blue Force Combat Operations 5.0 OPFOR Combat Operations 6.0 Live Fire Exercise 7.0 Notional Battle Simulation 8.0 Training Analysis and Feedback 9.0 Tactical Readiness Assessment 10.0 NTC Support Operations	• Training Policy and Directives for WES Personnel (1.6) • Exercise Initiation Activities (2.1) • Exercise Scenario (2.1) • Exercise Termination and Shutdown Controls (2.1)	• Firing Events by Weapon Types (2.4) • BLUEFOR and OPFOR Unit Position Data (2.4)	• Real Unit Indirect Fire Message/Data (2.2) • Notional Indirect Fire Data (7.3, 7.4)	
• Training Status of WES Personnel (1.6) • Test/Checkout Results (2.1)	**4.1 Exercise Preparation & Termination** 4.1.1 Pre Exercise Operations Coordination and Control 4.1.2 Equipment Operational Test and Checkout 4.1.3 Equipment Initialization, Alignment and Calibration 4.1.4 Equipment Replacement/Repair (Rapid Response) 4.1.5 WES Termination and Shutdown 4.1.6 Training of WES Personnel	• Initialization and Test Data and Engagement • Termination/Shutdown Enablement • Casualty/Damage Assessment Criteria	• Initialization and Test Data and Enablements • Casualty/Damage Assessment Criteria • Termination/Shutdown Enablement	• Initialization an[d] • Termination/Sh[utdown]
• Weapon/Target Pairing (2.4)		**4.2 Direct Fire Casualty/Damage Assessment** 4.2.1 Weapon/Target Pairing 4.2.2 Personnel Casualty Assessment 4.2.3 Equipment Damage Assessment	• Weapon to Target Range • LOS Notice • Percent Target Obscuration • WPN Tgt Interactions	• Near Miss Rep[ort] • Hit Report • Weapon Effect[s] • Kill • Functional Ki[ll] • Degradation
• Casualty and Loss Calculations (2.4, 5.3) • Indirect Fire Weapon Effects Data (2.2, 7.3, 7.4) • Casualty Damage Data for Manual Weapon Effect Implementation & Cue Generation (2.2)			**4.3 Indirect Fire Casualty/Damage Assessment** 4.3.1 Indirect Fire Dynamics Computation 4.3.2 Personnel Casualty Assessment 4.3.3 Equipment Damage Assessment 4.3.4 Infrastructure Damage Assessment 4.3.5 Force Suppression 4.3.6 NBC Weapon Effects	
• Weapon Damage Impact on Opposing Elements (2.2, 3.4)				**4.4 Direct Fi[re]** 4.3.1 Target Ki[ll] – Hard or 4.3.2 Target Pe[...] 4.3.3 Target Su[...]
• OPFOR Weapon Effect Cues on BLUEFOR (2.3, 3.4) • BLUEFOR Weapon Effect Cues (5.3) • OPFOR Firing Signatures (3.4)				
• Operational Status Reports (2.8) • Software Requirements (10.4) • Equipment Maint. Req'ts (10.4)	• Fault Detection/Isolation	• Fault Detection/Isolation	• Fault Detection/Isolation	• Fault Detecti[on]

Figure 2-6. 4.0 Weapon Engagement Simulati[on]

...essage/Data (2.2) ...s (7.3, 7.4)			• Software Support (10.4) • Equipment Maint (10.4) • Status Reports (10.4)

...LATION (WES) FUNCTIONS

...s and Enablements ...ment Criteria ...nablement	• Initialization and Test Data and Enablements • Termination/Shutdown Enablement	• Initialization and Test Data and Enablements • Termination Shutdown Enablement	• Initialization and Test Data and Enablements • Pre Exercise Test Results • Termination Shutdown Enablement

...n	• Near Miss Reports
	• Hit Report
	• Weapon Effect Report
	  • Kill
	  • Functional Kill
	  • Degradation
		• Near Miss Reports
		• Hit Report
		• Damage Assessment Reports
		  • Kill
		  • Damage
			• Operational Status

.../Damage Assessment ...omputation ...ssment ...ssment ...ssessment			• Operational Status
	4.4 Direct Fire Weapon Effect Implementation 4.3.1 Target Kill Implementation – Hard or Functional 4.3.2 Target Performance Degradation Implementation 4.3.3 Target Suppression Effects Implementation		• Operational Status
		4.5 Direct Fire Weapon Effects Cue Generation 4.5.1 Weapon Firing Cue Generation 4.5.2 Target Near Miss Cue Generation 4.5.3 Target Hit Cue Generation 4.5.4 Weapon Effect (Target Response) Cue Generation	• Operational Status
	• Fault Detection/Isolation		**4.6 Status Monitoring & Assessment** 4.6.1 WES Equipment Operational Status Monitoring 4.6.2 Equipment Operational Status Recording Reporting 4.6.3 Fault Detection and Isolation 4.6.4 Graceful Performance Degradation Implementation 4.6.5 Software Requirements

...ngagement Simulation

5.0 OPFOR COMBAT OPERATIONS (OCO

External NTC System Functions 1.0 NTC Management (NTCM) 2.0 Exercise Monitoring and Control (EMC) 3.0 Blue Force Combat Operations (BFCo) 4.0 Weapon Engagement Simulation (WES) 6.0 Live Fire Exercise (LFE) 7.0 Notional Engagement Simulation (NES) 8.0 Training Analysis and Feedback (TAF) 9.0 Readiness and Effectiveness Assessment (REA) 10 NTC Support	• Exercise Scheduling (1.3, 2.1) • Exercise Scenario (2.1) • Training Goals and Objectives (1.3) • OPFOR Missions and Orders (2.1, 2.2) • OPFOR Briefing (2.1) • Log Support (10.3, 10.4, 10.6) • OPFOR Task Organization (2.1) • Equipment and Range Status (10.4) • Monitor Test/Checkout (2.1) • Training Policy and Directives for OPFOR Personnel (1.6)	• Blue Force Position/Status Data (2.4) • Training Goals and Objectives (1.3) • Range Safety Procedures and Requirements (1.5) • Real Time OPFOR Direction and Control (2.2) • Exercise Termination Control (2.1)	• Real Time Casualties and • Wpns Effects Cues (4.5) • OPFOR Personnel (1.2) • Log Support (10.3, 10.4, 1 • Medical Aid and Evacua • Medical Support (10.3) • Target Signatures (3.4)
• Test Checkout Results (2.1) • Training Status of OPFOR Personnel (1.6)	**5.1 OPFOR Excercise Preparation** 5.1.1 OPFOR Exercise Operations Planning 5.1.2 Detailed OPFOR Scenario Developm t 5.1.3 OPFOR Personnel Briefing on Exercise/Goals/Objectives 5.1.4 OPFOR Resource Allocation 5.1.5 Training of OPFOR Personnel	• OPFOR OPORD • Performance Criteria • Exercise Requirements • Exercise Scenario • Initial Allocations	• OPFOR OPORD
• Blue Force Performance Observations (2.5) • Key Engagement Events Data (2.4) • OPFOR Safety Status (1.5) • Casualty Reports (2.4) • Operational Interaction with Control (2.2)		**5.2 OPFOR Operations & Control** 5.2.1 OPFOR Administrative Oper'ts 5.2.2 OPFOR Safety Management 5.2.3 Coordination with Control (White) Team Operations 5.2.4 Real Time Direction of OPFOR Exercise Operations 5.2.5 Blue Force Performance Observation and Key Engagement Outcomes Evaluation 5.2.6 Casualty and Loss Control	• Control of Maneuver • Safety • Direction of Simulated Ac • Blue Information
• OPFOR Engagement Events and WPN Types (2.4) • OPFOR Targets (Movers, Shooters, Non Comm Emitters) and Signatures (Audio/Visual, EMI (3.3, 3.4) • OPFOR Key Operational Events Data (2.4)		• Time/Event Information • Tactical Reports • Problem Areas • Observations on Blue • Casualties and Losses • CW Simulations	**5.3 OPFOR Fire/Maneu** 5.3.1 OPFOR Maneuver Ta 5.3.2 OPFOR Direct Fires 5.3.3 OPFOR Mover, Shoo Target Signatures (A Generation 5.3.4 Indirect Fire Marking 5.3.5 Chemical Warfare Si 5.3.6 Casualty and Loss A
• Indirect Fires on Blue (2.2) • OPFOR EW Plan (2.2) • OPFOR CAS Requirements (2.2) • OPFOR AD Plans (2.2)		• Time/Event Information • Observations on Blue • Jamming Simulations • Air Defense Data • COMSEC Reports on Blue	• Time/Event Information
• OPFOR Position Location Data (2.4) • OPFOR Logistics Reqmts (10.4, 10.6) • OPFOR Status Reports (2.6, 2.4)		• Position/Location Data • Status Reports	• Position/Location Data

Figure 2-7. 5.0 OPFOR Combat Operatio

…/Status Data (2 4) … Objectives (1 3) …edures and Requirements (1 5) …Direction and Control (2 2) …on Control (2 1)	• Real Time Casualties and Losses (4 3) • Wpns Effects Cues (4 5) • OPFOR Personnel (1 2) • Log Support (10 3 10 4 10 5) • Medical Aid and Evacuation (10 2) • Medical Support (10 3) • Target Signatures (3 4)	• Log Support (10 3 10 4 10 5)	• Equip Maint (10 4)

…0 OPFOR COMBAT OPERATIONS (OCO) FUNCTIONS

…ia …ents	• OPFOR OPORD	• Blue EW O&D • Targets of Emphasis	• OPFOR Pre Exercise Readiness Status • Time/Event
…tions & Control …nistrative Oper'ts …y Management …with Control (White) Team …ection of OPFOR Exercise …rformance Observation and Key …Outcomes Evaluation …Loss Control	• Control of Maneuver • Safety • Direction of Simulated Activities • Blue Information	• Control of Operations • Safety • Blue Information • Support Needs	• Casualty and Loss Reporting • Equipment and Personnel Status Changes • Log Requirements
…tion …e …es	**5.3 OPFOR Fire/Maneuver** 5 3 1 OPFOR Maneuver Tactics/Simulation 5 3 2 OPFOR Direct Fires Generation (Firing Events) 5 3 3 OPFOR Mover, Shooter, Non-Comm Emitter Target Signatures (Audio, Visual and EM) Generation 5 3 4 Indirect Fire Marking on OPFOR 5 3 5 Chemical Warfare Simulation 5.3 6 Casualty and Loss Assessment	• Dispositions/Fires • Casualties and Losses	• Changes in Status • Log Needs • Casualties and Losses
…tion …e …es … Blue	• Time/Event Information	**5.4 OPFOR Combat Support Operations** 5 4 1 OPFOR EW • Intercept • Jamming 5 4 2 Coord and Control of OPFOR CAS against Blue 5 4 3 Indirect Fire Planning and Control 5 4 4 OPFOR Air Defense against Blue CAS 5 4 5 Engineer Support	• Location Reporting • Log Needs • Changes in Status
…ta	• Position/Location Data	• Position/Location Data	**5.5 OPFOR Operational Status Monitoring** 5 5 1 Pre Exercise Equipment Checkout 5 5 2 OPFOR Unit Real Time Position/Status Recording/Reporting 5 5 3 OPFOR Equipment Damage/Failure Detection On-Site Mitigation and Reporting 5 5 4 OPFOR Logistic Requirements Synthesis 5 5 5 Materiel/Supply Status

…e 2-7. 5.0 OPFOR Combat Operations

LIVE FIRE EXERCISE (LFE) FUNCTIONS

External NTC System Functions 1 0 NTC Management 2 0 Exercise Monitoring and Control 3 0 Blue Force Combat Operations 4 0 Weapon Engagement Simulation 5 0 OPFOR Combat Operations 7 0 Notional Battle Simulation 6 0 Training Analysis and Feedback 9 0 Tactical Readiness Assessment 10 0 NTC Support Operations	• Exercise Schedules (1 3, 2 1) • Training Policy and Directives for LFE Personnel (1 6) • Exercise Missions and Scenario (2 1) • Exercise Initiation and Termination (2 1) • External Directives (1 1)	• CAS Missions (1 3) • Live Fire Exercise Control and Coordination (2 2) • Blue Force Position and Status (2 4) • Range Safety Direction (2 7) • BLUEFOR Fires (3 4)		
• Training Status of LFE Personnel (1 6) • Pre Exercise Live Fire Range Operational Status (2 1) • Training Critique Displays and Reports (2 5)	**6 1 Exercise Preparation/Feedback** 6 1 1 Live Fire Exercise Planning 6 1 2 Live Fire Scenario Preparation 6 1 3 Mission Objectives Briefing to Control Team Personnel 6 1 4 Equipment Checkout Test 6 1 5 After Action Report and Critique Preparation Report • OPFOR/White Team Observations • Video Recording 6 1 6 Training LFE Personnel	• Live Fire Scenario • Direct Indirect Fire Restrictions (Constraints) • Initiation Enablement • Pre Exercise Checkout Test Enablement and Data • Exercise Termination Controls	• OPFOR Target Presentation Requirements for This Exercise • Pre Exercise Checkout Test Enablement and Data	• Pre Exercise
• Control of Fire Maneuver (2 3)	• Key Personnel to Support AAR and Critique • Pre Exercise Operational Status Check	**6.2 Live Fire Exercise Control** 6 2 1 Execution of Live Fire Scenario 6 2 2 Coordination and Control of Live Fire Targets 6 2 3 Coordination and Control of Support Fire Activities (CAS ARTY) 6 2 4 Enforcement of Live Fire Range Safety 6 2 5 Monitoring of Blue Operations – Position, Firings Status	• Detailed Enemy Target Employment and Fire Simulation Events • Start Up Termination Commands	• Blue Force Po • Scoring Crite
• Simulated OPFOR Target Signatures (3 4) • Simulated OPFOR Weapon Firing and Weapon Effect Cues (3 4) • Blue Weapon Effect Cues (On Simulated Targets) (3 4)	• Pre-Exercise Operational Status Check	• Real-Time Position Status of Enemy Targets	**6.3 Live Fire Target Simulation** 6 3 1 Enemy Target and Target Movement Effects Signatures Generation (Audio Visual, EM) 6 3 2 Real Time Coordination and Operation of Enemy Targets – Position, Movement, Operational Status 6 3 3 Enemy Target Hit Kill Cue Generation 6 3 4 Enemy Firing Cue Generation	• Target Positio Exposure
• Target Scoring Data (2 4) • Blue Force Live Fire Proficiency Observations (2 4) • Simulated OPFOR Casualties (3 4)	• Key Personnel to Support AAR and Critique • Video Recordings • Pre Exercise Operational Status Check	• Target Hit/Damage Reports • Blue Force Firing Observation (Real-Time) and Assessment	• Target Hit Damage Assessment for Degrading Disabling Enemy Targets and Generation of Weapon Hit/Kill Cues	**6.4 Live Fire** 6 4 1 Target H 6 4 2 Target D 6 4 3 Target S 6 4 4 Blue Fire 6 4 5 Overall
• Range Safety Reports (2 6) • Range Safety Briefing (3 1)	• Pre-Exercise Operational Status Check	• Emergency Cease Fire • Support Fire Missions • Safety Control by Control Teams	• Range Safety Firing Fans • Target Presentation Enablements/Inhibition	• Support Fire
• Real-Time Live Fire Range Operational Status (2 6) • Software Requirements (10 4) • Equipment Maintenance Req'ts (10 4) • Request for Log and Range Assistance (10 5)	• Pre-Exercise Equipment Repair/Replacement Reports	• Operational Status Reports • Rapid Response Equipment Repair/Replacement Support	• Rapid Response Equipment Repair/Replacement	• Rapid Respo

Figure 2-8. 6.0 Live Fire Exercise

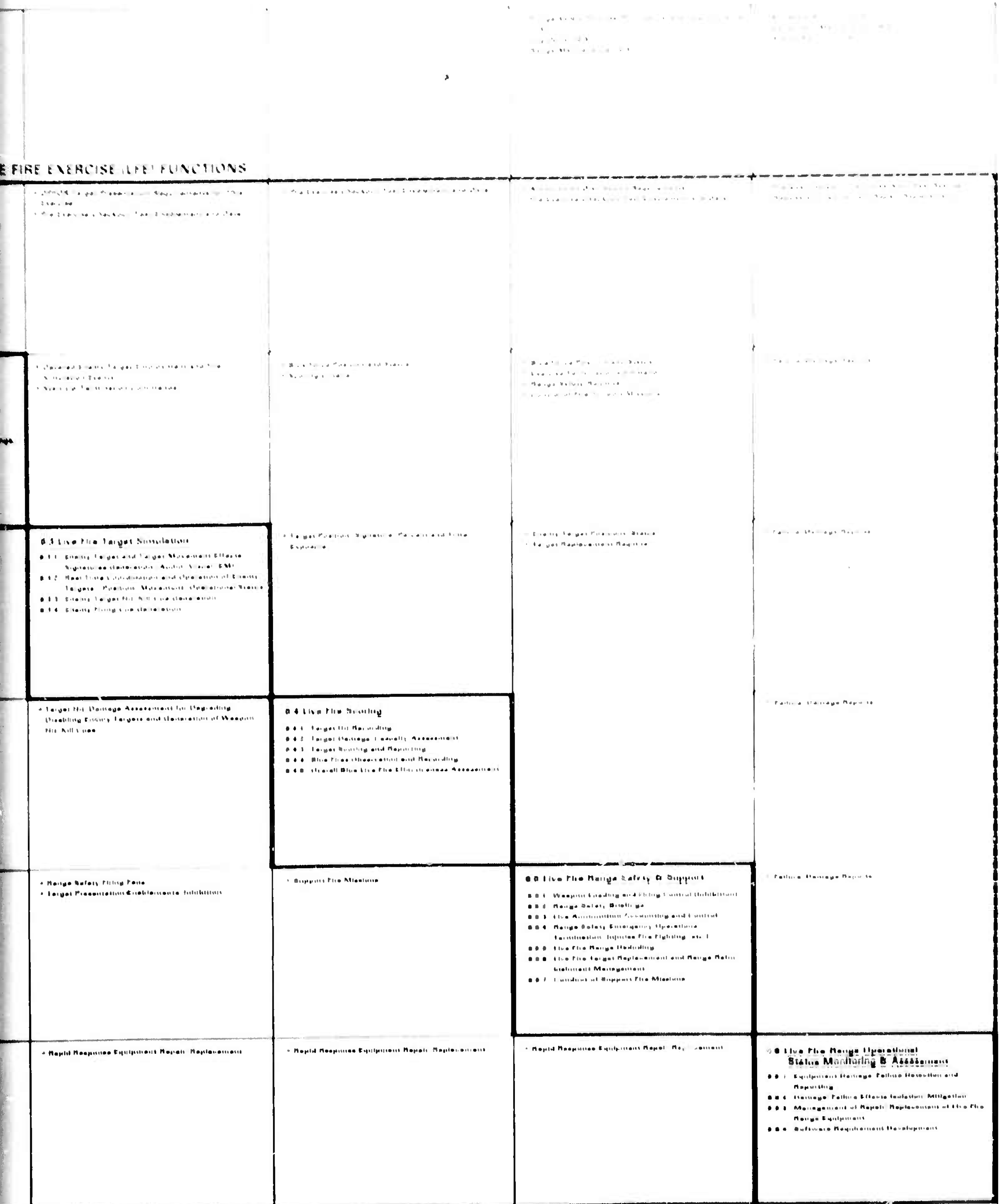


Figure 2.8 6.0 Live Fire Exercise

7.0 COMMAND BATTLE SIMUL

External NTC System Functions 1.0 NTC Management 2.0 Exercise Monitoring and Control (EMC) 3.0 Blue Force Combat Operations (BFCO) 4.0 Weapon Engagement Simulation (WES) 5.0 Dr OR Combat Operations (DCO) 6.0 Live Fire Exercise (LFE) 8.0 Training Analysis and Feedback (TAF) 9.0 Readiness/Effectiveness Assessment (REA) 10.0 NTC Support Operations (NTCSO)	• Exercise Mission and Scenario (2.1) • Simulation Control Requirements (2.4) • Exercise Initiation and Terminating Controls (2.1) • Training Policy and Directives for CBS Personnel (1.6)	• Coordination and Control of Battle Simulation (2.2) • Blue OPFOR Position Status Data (2.4, 2.8)	• Indirect Fire Weapons Effects Data (4.3)	• Indir
• Equipment Pre Exercise Test/Checkout Results (2.1) • Training Status of CBS Personnel (2.1)	**7.1 Battle Simulation Pre Processing** 7.1.1 Data Base Management 7.1.2 Scenario Data Base Preparation 7.1.3 Simulation Run Data Base Preparation 7.1.4 Simulation Control 7.1.5 CBS Role Player and Controller Training	• Interactive Control and Display Data Base • Scenario Data Base • Control Parameters • Controller Input Error Diagnostics • Database Preparation Prompt • Controller Trainee Prompts • Initiation/Termination Enablement	• Macro Battle Simulation Initial Conditions and Engagement/Run Parameters Data Base • Scenario Data Base • Exogenous Events • Initiation/Termination Enablement	• Macr Run • Scen • Exog • Initia
• Notional Element Position Operational Reports and Displays (2.2) • Tactical Messages (2.7)	• Scenario Data & Generation Commands • Simulation Run Data & Generation Commands • Controller Trainee Commands	**7.2 Interactive Simulation Control** 7.2.1 Terrain Features Display 7.2.2 Battle Situation Display 7.2.3 Key Event Notification 7.2.4 Control Menu Generation 7.2.5 Interactive Control Processing 7.2.6 Simulation Execution Control	• Macro Battle Simulation Commands • Live Blue OPFOR Unit Position/Status and Command Decisions (Real Time) • Displays	• Macro- • Display
• Real Unit Indirect F e Message/Data (4.3)		• Blue/OPFOR Notional Unit Position/Operational Status (Real-Time) • Engagement Events • EW Degradations • BN/BDE Command Decision Reports	**7.3 Micro Battle Simulation** 7.3.1 Small Unit Command and Control 7.3.2 Target Acquisition 7.3.3 Fire and Weapon Effects 7.3.4 Combat Unit Movement 7.3.5 Administration and Logistics 7.3.6 Micro Battle Environment	• BN/BDI Battlefi
• Real Unit Indirect Fire Message/Data (4.3)		• Macro Battlefield Unit Dispositions and Status • Macro Battlefield Key Engagement Events Reports • Combat Intelligence/Information from Div/Corps Collection Assets • Div/Corps Command/Decision Report	• Division/Corps Reenforcement Elements Movement into BN/BDE Area of Interest • Support Fires Impacting BN/BDE Area of Interest • Div/Corps Level EW Actions	**7.4 Mi** 7.4.1 Co 7.4.2 Int 7.4.3 Fir 7.4.4 Fo 7.4.5 Cu 7.4.6 Ma
• Command Battle Simulation Event History Data (2.4)		• Engagement History Data (Both Graphical and A/N) for Replay – Real, Slowdown, Accelerated Time	• Tactical Simulation Data Recording Control Parameters	• Macro Param
• Exercise Operational Status Reports (2.6) • Requirements for Equipment Maintenance and Software Support (10.4)	• System Start Up and Initialization Reports • System Operational Checkout Reports • System Shutdown Reports	• Fault Error Mitigation	• Fault/Error Mitigation	• Fault/Err

Figure 2-9. 7.0 Command Battle Simulatio

• Indirect Fire Weapons Effects Data (4.3)	• Indirect Fire Weapons Effects Data (4.3)		• Equipment Maintenance 10.4 • Software Support 10.4 • Status Reports 10.4

7.0 COMMAND BATTLE SIMULATION (CBS) FUNCTIONS

• Macro Battle Simulation Initial Conditions and Engagement/Run Parameters Data Base • Scenario Data Base • Exogenous Events • Initiation/Termination Enablement	• Macro Battle Simulation Initial conditions and Run Data Base • Scenario Data Base • Exogenous Events • Initiation Termination Enablements	• Data Logging Parameters Commands • Initiation Termination Enablements	• System Start up, Initialization, and Termination Activities • Initiation Termination Enablement
• Macro Battle Simulation Commands • Live Blue/OPFOR Unit Position/Status and Command Decisions (Real Time) • Displays	• Macro Battlefield Simulation Commands • Displays	• Engagement Replay Commands • Interface Management Commands	• Fault Error Reporting • Initialization Test Reports
7.3 Micro Battle Simulation 7.3.1 Small Unit Command and Control 7.3.2 Target Acquisition 7.3.3 Fire and Weapon Effects 7.3.4 Combat Unit Movement 7.3.5 Administration and Logistics 7.3.6 Micro Battle Environment	• BN/BDE Tactical Fire, Maneuver Impacting Macro Battlefield	• Micro Battle Unit Position/Operation Status History Data • Tactical Engagement Command Decisions Blue OPFOR • Damage/Casualties/Location of Simulated Fires	• Fault Error Reporting • Initialization Test Reports
• Division/Corps Reinforcement Elements Movement into BN/BDE Area of Interest • Support Fires Impacting BN/BDE Area of Interest • Div/Corps Level EW Actions	**7.4 Macro Battle Simulation** 7.4.1 Command, Control and Communications 7.4.2 Intelligence and Target Acquisition 7.4.3 Fire and Weapon Effects 7.4.4 Force Movement 7.4.5 Combat Service Support 7.4.6 Macro Battle Environment	• Macro Battle Engagement Data History • Division/Corps Level Command Decisions • Combat Intelligence Information from Div Corps Collection Assets	• Fault Error Reporting • Initialization Test Reports
• Tactical Simulation Data Recording Control Parameters	• Macro Battle Simulation Data Recording Control Parameters	**7.5 Battle Simulation Data Logging** 7.5.1 Data Logging Management & Control 7.5.2 Micro Battle History Recording 7.5.3 Macro Battle History Recording 7.5.4 Commentary Logging 7.5.5 Analog Time Tagging 7.5.6 Simulation History DB Maintenance	• Fault Error Reporting • Initialization Test Reports
• Fault/Error Mitigation	• Fault/Error Mitigation	• Fault/Error Mitigation	**7.6 CBS Operations Monitoring** 7.6.1 Pre-Simulation Equipment Checkout 7.6.2 CBS Equipment Performance Monitoring and Maintenance 7.6.3 Fault Detection and Isolation 7.6.4 CBS System Diagnostics Support 7.6.5 CBS System Status Recording and Reporting 7.6.6 Software Requirements

2-9. 7.0 Command Battle Simulation

External NTC System Functions 1.0 NTC Management 2.0 Exercise Monitoring and Control 3.0 Blue Force Combat Operations 4.0 Weapon Engagement Simulation 5.0 OPFOR Combat Operations 6.0 Live Fire Exercise 7.0 Notional Battle Simulation 9.0 Tactical Readiness Assessment 10.0 NTC Support Operations	• Exportable Tng Package Evaluation (1.3) • Training Policy and Directives for TAF Personnel (1.6) • TAF Initialization Activities (2.1) • TAF Termination Control (2.1) • Training Evaluation Guidance (2.5) • External Directives (1.1)	• Engagement Simulation Event History Data (2.4) • Live Fire Exercise Data (2.4) • Battle Simulation Event History Data (Real Time) (2.4) • Unit Position Data (2.4) • Log Info and Data (10.5)	• Key Event Flags (2.4)	• Critiq • Playb
• Interim Training Effectiveness (1.3) • Training Status of TAF Personnel (1.6) • Equipment Test Results (2.1)	**8.1 TAF Direction & Control** 8.1.1 TAF System Test and Checkout Management 8.1.2 System Initializatin 8.1.3 TAF Operations Planning, Priorities and Scheduling 8.1.4 TAF Operations Direction 8.1.5 External Control Interactions 8.1.6 Training of TAF Personnel	• Coordination, Control and Direction • Initialization	• Coordination and Control	• Traini • Feedb • Critiq • Coord
• Data Transmission Requests (2.4)		**8.2 Data Logging & Management** 8.2.1 Data Communications Management 8.2.2 Data Verification, Filtering and Storage 8.2.3 Data Base Management - Retrieval, Merge, Sort, Add, Delete, Formatting, Editing 8.2.4 Data Base Maintenance 8.2.5 Data Base Security	• Engagement Data for Current Slice of Battle • Engagement History Data from Previous Battle Segments • Historical Baseline Comparison Data (Cumulative over Numerous Exercises)	
		• Data Base Queries	**8.3 Data Reduction & Analysis** 8.3.1 Input Data Reduction 8.3.2 Statistical Analysis 8.3.3 Hypothesis Testing 8.3.4 Summarization, Aggregation 8.3.5 Rapid Response Training Feedback Analysis 8.3.6 Long Term Training Evaluation and Trend Analysis	• Analys • Perfo • Train • Display • Engage
• Training Critique Displays and Reports (2.5) • Real Time Engagement Playback Data (2.5)	• Interim Evaluations		• Data Analysis Requirements • Results Presentation Formats • Analysis Control and Direction • Data Request for Flagged Events	**8.4 Aft** 8.4.1 Fe De 8.4.2 Pre 8.4.3 Sl 8.4.4 Illu Co 8.4.5 Le 8.4.6 En Ac 8.4.7 Re
• Exportable Training Packages for Home Station (1.3) • Training Effectiveness Evaluations (1.3)		• Updated Historic Baseline Data Base • Trends Data	• Data Analysis Requirements • Results Presentation Formats • Analysis Control and Direction	
• Exercise Operational Status Reports (2.6) • Software Req'ts (10.4) • Equipment Maint Reqts (10.4)	• System Test/Checkout Results • System Status	• Fault Mitigation	• Fault Mitigation	• Fault M

Figure 2-10. 8.0 Training Analysis and Fee

(2 4)	• Key Event Flags (2 4)	• Critique Data Display Report Requirements (2 5) • Playback Requirements (2 5)		• Software Support (10 4) • Equipment Maint (10 4)
	• Coordination and Control	• Training Evaluation Criteria • Feedback Priorities • Critique Evaluations and Recommendations • Coordination and Control	• Training Evaluation Criteria • Feedback Priorities • Follow On Training Package Evaluation and Recommendations • Coordination and Control	• Coordination and Control
Sort	• Engagement Data for Current Slice of Battle • Engagement History Data from Previous Battle Segments • Historical Baseline Comparison Data (Cumulative over Numerous Exercises)			• Operational Status
	8.3 Data Reduction & Analysis 8.3.1 Input Data Reduction 8.3.2 Statistical Analysis 8.3.3 Hypothesis Testing 8.3.4 Summarization Aggregation 8.3.5 Rapid Response Training Feedback Analysis 8.3.6 Long Term Training Evaluation and Trend Analysis	• Analysis Results – MOE s • Performance Evaluation • Training Diagnosis • Displays and Reports • Engagement History Tape for Playback	• Analysis Results MOE s • Performance Evaluation and Improvement Trends • Training Diagnosis and Corrective Prescription • Displays and Reports	• Operational Status
	• Data Analysis Requirements • Results Presentation Formats • Analysis Control and Direction • Data Request for Flagged Events	**8.4 After Action Training Feedback** 8.4.1 Feedback Needs, Priorities and MOE s Determination 8.4.2 Presentation Format Specification 8.4.3 Slice of Battle BLUEFOR Performance Diagnosis 8.4.4 Illustration of Deficiencies and Suggest Corrections 8.4.5 Lessons Learned Summary 8.4.6 Engagement Playback (Real Slowdown or Accelerated Time) 8.4.7 Real-Time Interactive Display	• Key Training Deficiencies and Suggested Training	• Operational Status
	• Data Analysis Requirements • Results Presentation Formats • Analysis Control and Direction		**8.5 Follow On Training Feedback** 8.5.1 Detailed Tactical Proficiency Evaluation Analysis 8.5.2 Performance Improvement Trends Analysis 8.5.3 Detailed Training Deficiencies Diagnosis 8.5.4 Follow On Training Prescription Synthesis 8.5.5 Exportable (to Home Station) Training Package Production	• Operational Status
	• Fault Mitigation	• Fault Mitigation	• Fault Mitigation	**8.6 Status Monitoring & Assessment** 8.6.1 System H W and S W Test 8.6.2 System Operation Performance Monitoring 8.6.3 Fault Detection Diagnosis and Isolation 8.6.4 System Status Recording and Reporting 8.6.5 Software Req ts

re 2-10. 8.0 Training Analysis and Feedback

TACTICAL READINESS ASSESSMENT (TRA) FUNCTIONS

External NTC System Functions 1 0 NTC Management 2 0 Exercise Monitoring and Control 3 0 Blue Force Combat Opertions 4 0 Weapon Engagement Simulation 5 0 OPFOR Combat Operations 6 0 Live Fire Exercise 7 0 Notional Battle Simulation 9 0 Training Analysis and Feedback 10 0 NTC Support Operations	• Training Schedules (1 3, 2 1) • Training Policy and Directives for TRA Personnel (1 9) • TRA Product Req ts Guidance (1 4) • Tactical Readiness Assessment Guidance Criteria (1 4) • Improvements in Tactical Readiness Assessment (2 6) • External Directives (1 1)	• Tactical Performance Data (2 4)		• Key Even
• Training Status of TRA Personnel (1 9) • TRA Equipment Test Results (2 1)	**9.1 TRA Direction & Control** 9 1 1 TRA System Test Management 9 1 2 TRA Start Up Initialization and Termination 9 1 3 Operations Planning and Activity Scheduling 9 1 4 Readiness Assessment Profile Development (MOE/MOI Synthesis) 9 1 5 TRA Effectiveness Evaluation 9 1 6 External Control Interactions 9 1 7 Training for TRA Personnel	• Coordination Control and Direction • Initialization	• Coordination and Control	• Coordinat • Near Term • Readiness • Schedules • MOE MOI
• Data Transmission Requests (2 4)		**9.2 Data Logging & Management** 9 2 1 Data Transmission Management 9 2 2 Data Verification Filtering and Storage 9 2 3 Data Base Management – Retrieval, Sort, Merge Add Delete Edit, Etc 9 2 3 Data Base Maintenance 9 2 4 Data Base Security	• BLUEFOR Tactical Performance Data for Current Slice of Battle • BLUEFOR Tactical Performance Data for Previous Slices of Battle (Individually and Cumulative) • Historical BLUEFOR Tactical Performance Data	
		• Data Base Queries	**9.3 Data Reduction & Analysis** 9 3 1 Input Data Reduction 9 3 2 Statistical Analysis 9 3 3 Hypothesis Testing 9 3 4 Readiness Assessment Research Analysis (Doctrine Organization, New Weapons)	• Analysis R • Tactical • Readines • BLUEFOR
• After Action Readiness Feedback Displays/Reports (2 5) • Real-Time Engagement Playback Data (2 5)	• AAR Reports	• Interim Tactical Readiness Assessment Results • Key Tactical Readiness Deficiencies for Long Term Readiness Assessment Emphasis	• Analysis Requirements and Requests • Analysis Feedback Data Formats • Analysis Control/Direction	**9.4 After-** 9 4 1 BLUEF Asses 9 4 2 Tactic Techn 9 4 3 Tactic Gener 9 4 4 Real-Ti
• Tactical Readiness Assessment and Recommendations (1 4)	• TRA Reports	• Updated Historic Baseline Data Base • Trend/Statistical Data	• Analysis Requirements and Request • Analysis Results Formats • Analysis Control/Direction	
• Operational Status Reports (2 9) • Software Req ts (10 4) • Equipment Maint Spt (10 4)	• System Test/Checkout Results • System Status	• Fault Mitigation	• Fault Mitigation	• Fault Mitig

Figure 2-11. 9.0 Tactical Rediness Assessme

	• Key Event Flags (2.4)		• Software Support (10.4) • Equipment Maint. (10.4)

...INESS ASSESSMENT (TRA) FUNCTIONS

...oordination and Control	• Coordination and Control • Near Term Feedback Priorities • Readiness Assessment Criteria • Schedules • MOE MOI	• Coordination and Control • Long Term Feedback Priorities • Readiness Assessment Criteria • Schedules • MOE MOI	• Coordination and Control • System Startup, Initialization and Termination Activities
...BLUEFOR Tactical Performance Data for Current Slice of Battle ...BLUEFOR Tactical Performance Data for Previous Slices of Battle (Individually and Cumulative) ...Historical BLUEFOR Tactical Performance Data			• Operational Status
...3 Data Reduction & Analysis ...1 Input Data Reduction ...2 Statistical Analysis ...3 Hypothesis Testing ...4 Readiness Assessment Research Analysis (Doctrine, Organization, New Weapons)	• Analysis Results • Tactical Performance • Readiness Diagnosis • BLUEFOR Engagement History Data for Playback	• Analysis Results • Tactical Performance Individually and Cumulative Over Entire Exercise • Readiness Diagnosis • Performance Trends	• Operational Status
...Analysis Requirements and Requests ...Analysis Feedback Data Formats ...Analysis Control/Direction	**9.4 After-Action Readiness Feedback** 9.4.1 BLUEFOR Tactical Readiness Deficiencies Assessment and Definition 9.4.2 Tactical Readiness Feedback Format and Technique Synthesis 9.4.3 Tactical Readiness Feedback Displays/Reports Generation 9.4.4 Real-Time Playback Support	• Interim Tactical Readiness Assessment Results	• Operational Status
...Analysis Requirements and Request ...Analysis Results Formats ...Analysis Control/Direction		**9.5 Long Term Readiness Assessment** 9.5.1 Detailed BLUEFOR Tactical Readiness Evaluation 9.5.2 Comparative and Trend Analysis 9.5.3 Evaluation of Specific New Doctrine, Organization and Weapon System Concepts 9.5.4 Synthesis of Tactical Readiness Shortfall and Corrective Action Recommendations	• Operational Status
...Fault Mitigation	• Fault Mitigation	• Fault Mitigation	**9.6 Status Monitoring & Assessment** 9.6.1 TRA System Test and Checkout 9.6.2 System Operational Status Monitoring 9.6.3 Fault Detection, Isolation 9.6.4 System Status Recording and Reporting 9.6.5 Software Req'ts Development

...1. 9.0 Tactical Rediness Assessment

SUPPORT OPERATIONS

External Environment 1 0 NTC Management 2 0 Exercise Monitoring and Control 3 0 Blue Force Combat Opns 4 0 Weapons Engagement Simulation 5 0 OPFOR Combat Opns 6 0 Live Fire Exercise 7 0 Notional Battle Simulation 8 0 Training Analysis and Feedback 9 0 Tactical Readiness/Analysis	• Command Guidance and Policy (1 1) • Management Information (1 2) • Plans and Projections (1 1) • Resource Allocations (1 2) • External Directives (1 1) • Procurement and Contracting Actions (1 2) • Funding and Status of Funds (1 2) • Administrative Support (1 2) • Personnel Assignments (1 2)	• External Directives (1 1) • Training Schedules (1 3, 2 1) • Support OPNs Schedules (1 6) • Safety Procedures (1 5) • Emergency Control (2 2)	• Plans and Projections (1 • Resource Allocations (1 • External Directives (1.1) • Command Guidance an • Training Schedules (1 3, • Support Schedules (1.6) • Procurement Contracti • Space and Building Req
• Problem Areas and Shortfalls (1.2) • Funding Reports (1 2) • Financial Data (1.2) • Personnel Data (1 2) • Specialized Services to Training Units (3 6) • Personnel Actions (1 2)	**10.1 NTC Administrative Services** 10 1 1 Financial, Accounting, and Disbursement 10 1 2 Civilian Personnel 10 1 3 Personnel Services		• Funds
• Safety Device Requirements (1.5) • Range Medical Requirements (1 5) • Incident Reports (1.5, 2.2) • Routine Reports (1.5) • Range Security and Fire Fighting Opns (2.2) • Status Reports (1.1, 1.6) • Medical Aid and Evacuation (2.3, 3 6, 5 3)		**10.2 Range Security & Safety Support** 10 2 1 Range Security OPNs 10 2 2 Fire Fighting Support 10 2 3 Range Medical Support	
• MCA Requirements (1 2) • Problem Areas and Shortfalls (1 2) • Medical Support to Units (3 6, 5 3) • Special Food Services (3.8, 5.1, 5 3, 5.4)			**10.3 Construction Pers Housekeeping Op** 10 3 1 Coordinate W/Post 10 3 2 Stationing, Plannin 10 3 3 NTC Building Provi 10 3 4 Medical Support 10 3 5 Food Services 10 3 6 MCA
• Equipment and Range Status (1.6, 2.6, 4 6, 5 1, 6 6, 7 6) • Software Support (2 6, 4.6, 6 6, 7.6, 8 6, 9 6) • Equipment and Range Maintenance (All) • Explosive Ordinance Disposal (2.2)		• Maintenance of Equipment	
• Support Data (1.6) • Log Requirements (1.6) • Field Logistics Operations (2.3, 3.6, 5.3, 6.5) • Log Status Reports (1 6, 2.6) • Procurement/Contracting Needs (1.2) • Information for Feedback (8 2) • Consumables (All) • Training Status of Support Personnel (1.8)		• Equipment and Material • Consumables • Range Needs	• Space and Warehouse Req • Material • Consumables

Figure 2-12. 10.0 Support Operatio

1.1) 1.3, 2.1) dules (1.6) .5) (2.2)	• Plans and Projections (1.1, 1.6) • Resource Allocations (1.2) • External Directives (1.1) • Command Guidance and Policy (1.1) • Training Schedules (1.3, 2.1) • Support Schedules (1.6) • Procurement/Contracting Actions (1.2) • Space and Building Requirements (1.1)	• Plan and Projections (1.1) • Resource Allocations (1.2) • External Directives (1.1) • Training Schedules (1.3, 2.1) • Exercise Mission and Reqts (1.3) • Support Schedules (1.6) • Equipment Maintenance Reqts (All) • Equipment Status Reports (2.6 • Software Rqmts (2.6, 4.6, 6.6, 7.6, 8.6, 9.6)	• Resource Allocations (1.2) • Procurement and Contracting Actions (1.2) • External Directives (1.1) • Training Unit Schedules (1.3, 2.1) • Plans and Projections (1.1, 1.6) • Exercise Missions and Reqts (1.3) • Requests for Log and Range Assistance (2.6, 3.6, 5.5, 6.6) • Support Schedules (1.6) • Log Status Reports (2.6) • Training Policy and Directives for Support Personnel (1.6)
SUPPORT OPERATIONS FUNCTIONS			
	• Funds	• Provision of Civilian Personnel	• Funds • Management Information
ty & Safety Support y OPNs upport l Support		• Maintenance Requirements	• Requirements
	10.3 Construction Personnel Stationing & Housekeeping Operations 10.3.1 Coordinate W/Post Functions 10.3.2 Stationing, Planning and Scheduling 10.3.3 NTC Building Provision 10.3.4 Medical Support 10.3.5 Food Services 10.3.6 MCA		• Requirements
pment		**10.4 Range & Equipment Maintenance** 10.4.1 Range Development and Maintenance 10.4.2 Blue and OPFOR Pre-positioned Equipment Maintenance 10.4.3 NTC Instrumentation Maintenance 10.4.4 Data Proc and Communications Equip Maintenance 10.4.5 Software Support	• Requirements
riel	• Space and Warehouse Requirements • Material • Consumables	• Material • Supplies and Spare Parts • Range and Equipment Needs	**10.5 NTC Logistics Support Operations** 10.5.1 Plan, Schedule, Order 10.5.2 NTC Consumables 10.5.3 NTC Supply Distribution Warehouse/Storage OPNs 10.5.4 Coordinate Routine Post Logistic Functions (Engr, etc.) 10.5.5 Range Support 10.5.6 Log Status 10.5.7 Training of NTC Support Personnel

Figure 2-12. 10.0 Support Operations

an NTC functional design concept, defined and validated functional requirements, and provided a structure and methodology to trade functional requirements upward to the overall NTC mission, goals, and objectives and also downward to instrumentation and training concept implementations of the requirements.

The top-down functional analysis was carried to the fourth level and allowed the Army to examine in close detail the major component parts of the overall NTC system. For example, out of this examination, it became apparent that:

- The exercise monitoring and control function plays the central role within the system.
- The interface between EMC and other major functions must be carefully defined to ensure essential operational capabilities.
- There must be a close coupling between EMC, the command battle simulation, and the training analysis and feedback functions to optimize their potential.
- There will be a large volume of data to receive, process, display, and analyze during the course of the NTC exercises.
- Instrumentation systems must be tailored to accommodate position location and event recording requirements.

The functional analysis also resulted in a systems approach to the NTC which took full advantage of such technical capabilities as automated position location, use of lasers for direct-fire interactions, audio and video recording of activities, computer assisted and augmented displays, and automated aids for training analysis. Finally, the need to focus the flow of data and to integrate key functional activities led to the core instrumentation concept which is now central to the development program and which is described in Section 3.

Under this concept, the CIS would consist of two major functional components: 1) exercise management and control, and 2) training analysis and feedback. EMC would perform the function of directing and controlling all field operating elements and also monitor and record key combat activities. TAF would be responsible for performing all analyses, display, and control functions necessary for the preparation of after-action reviews.

2.2.3 Tradeoff Analysis

Based on the above functional analysis, SAI performed technology tradeoffs to assess the utility and feasibility of using off-the-shelf hardware and software to implement the selected system concept. SAI conducted an industry-wide survey of candidate instrumentation solutions for all aspects of the NTC system. Each of these candidates were evaluated in terms of meeting NTC requirements, availability, maturity, flexibility (growth potential), and cost. Candidates which were judged acceptable were defined in detail. All technology shortfalls (i.e., indirect-fire simulations) were identified.

2.2.4 Development Roadmaps

Using the foregoing analyses, SAI developed multi-level programmatic roadmaps for both an initial NTC program, based on off-the-shelf technology, and an advanced NTC program, based on new technology. Each of these programmatic roadmaps provided detailed task schedules, milestones, decision points, and the resources required to meet programmatic timing and constraints. These programmatic roadmaps have served as the basis for the current NTC development plan.

Section 3

CORE INSTRUMENTATION SUBSYSTEM DEVELOPMENT

SECTION 3

CORE INSTRUMENTATION SUBSYSTEM DEVELOPMENT

3.1 DEVELOPMENT REVIEW

This section provides a description of SAI's core instrumentation development process under the auspices of DARPA and TRADOC. The focus is on the important developmental activities conducted by SAI, culminating with the successful completion of the NTC I-ALPHA program at Fort Irwin. A discussion of the refined CIS design, based on the NTC I-ALPHA experience, is provided in Section 8.

SAI's detailed functional analyses of the NTC and its objectives led to the identification of an initial set of seven real-time functions, which required an integrated technically sophisticated and highly automated instrumentation system. This broad requirement, in turn, led to the core instrumentation subsystem concepts discussed below. By grouping the key NTC functions together under the core concept, minicomputers, microcomputers, and storage capabilities could be grouped to tie all elements together. As a result, greater efficiency was achieved in meeting the data collection and computational needs of the various components than would have been possible by a decentralized approach. Moreover, the core concept allowed for higher system availability through redundancy and prioritization, and lower costs than having each functional subsystem use a dedicated computer or processor.

3.1.1 Core Instrumentation Subsystem Concept

The first-level set of real-time functions which followed from SAI's functional analysis of the NTC concept are shown graphically in Figure 3-1.

From a closer examination of these functions and their interrelationships, Figure 3-2, it became apparent that the activity and data flow within each area could be efficiently centralized by means of a highly

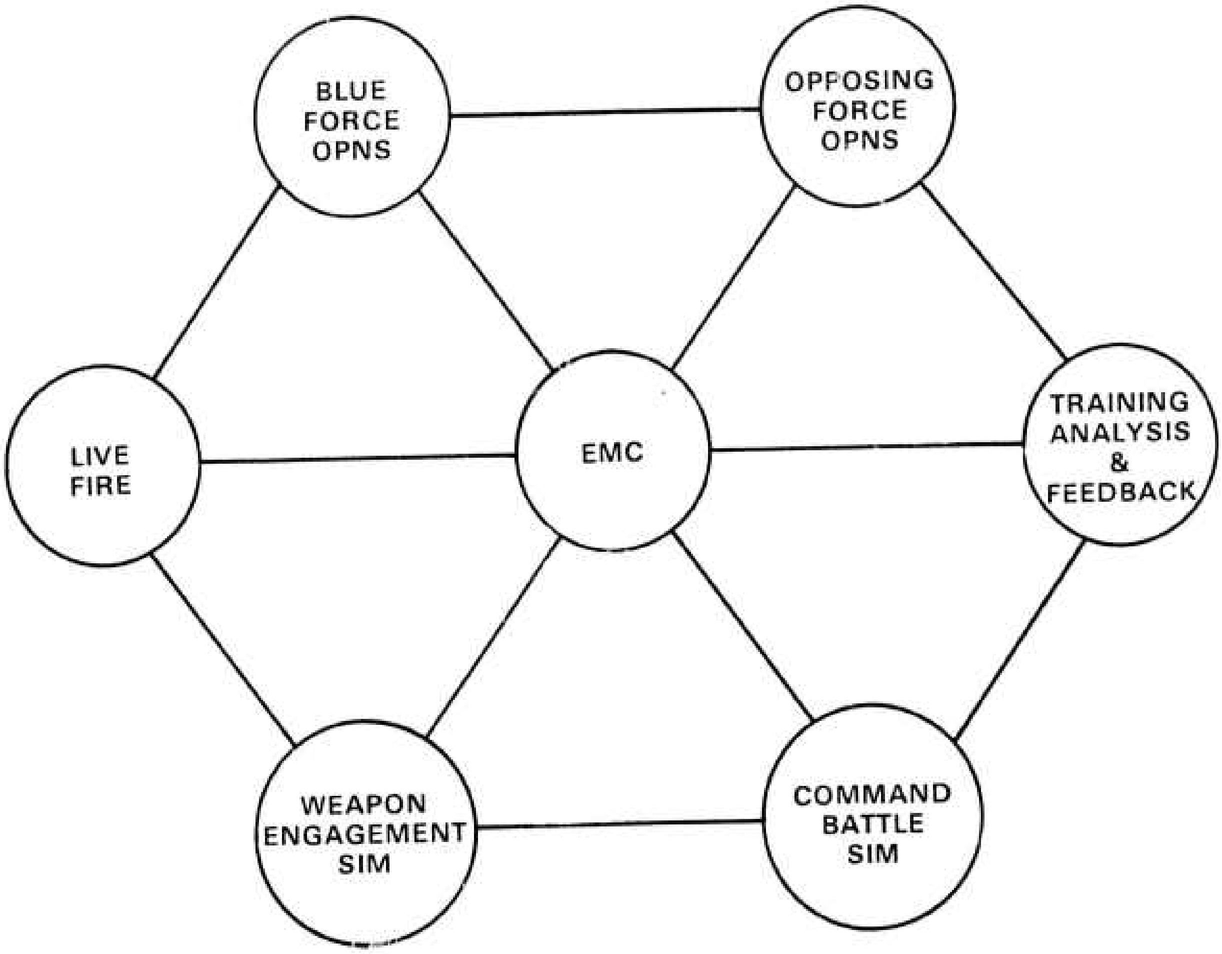


Figure 3-1. Concept of CIS

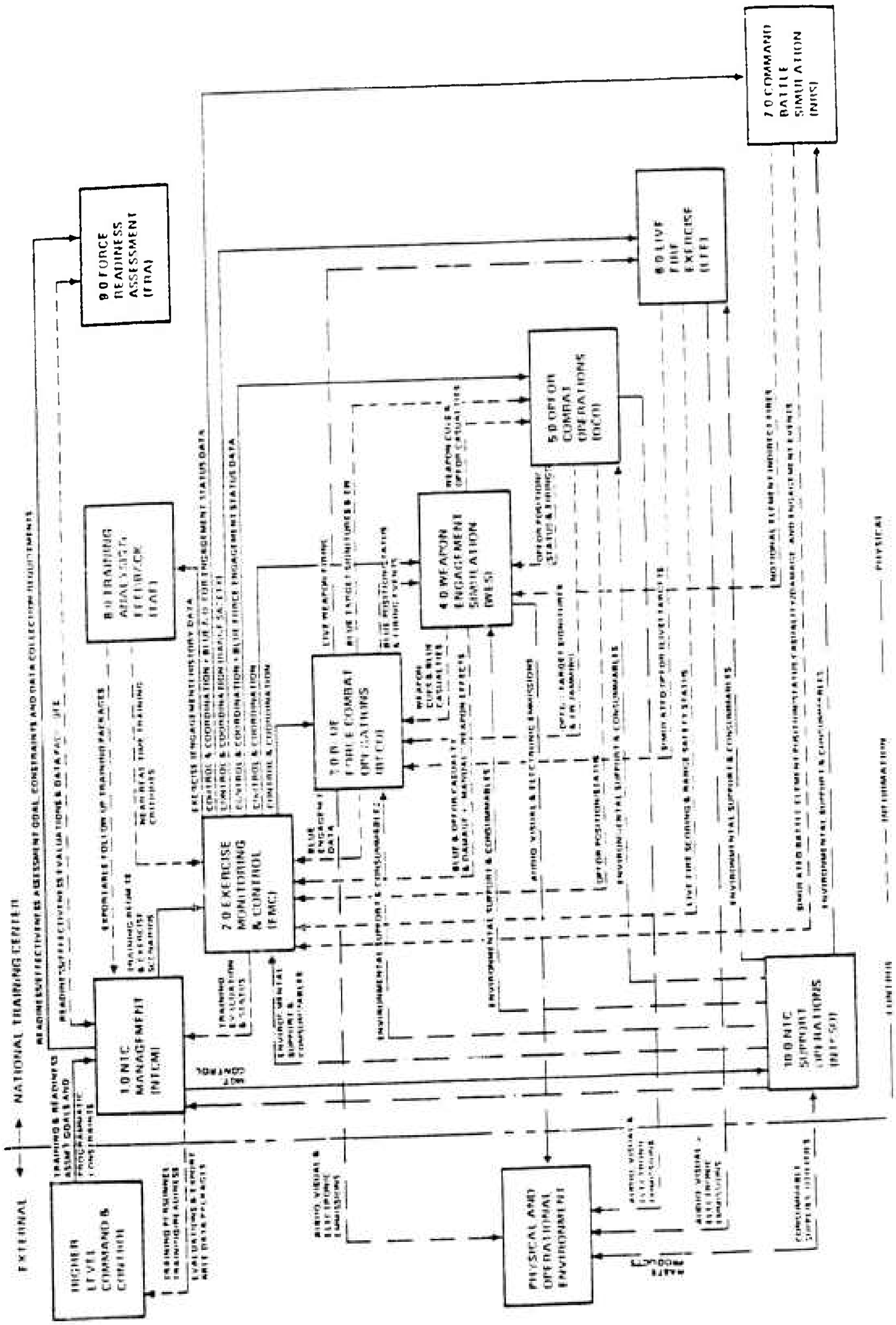


Figure 3-2. NTC System Level Functional Flow Diagram

automated instrumentation subsystem. The core instrumentation concept was adopted, therefore, to provide an integrated data collection, display, and computational capability for all functional activities. Under this concept, the subsystem would consist of a matrix of state-of-the-art minicomputers, graphic displays, and interactive software and would be organized to support four major functions:

1) Exercise Monitoring and Control
2) Training Analysis and Feedback
3) Command Battle Simulation
4) Force Readiness Assessment (Developmental Test Bed)

Each of the above functional sections within the CIS would have similar hardware and, should one section become inoperable, would have the capability to shift functions between sections. Computer-driven imagery and graphics would provide for real-time visualization of battlefield activities, unit performance evaluation, preparation of after-action reviews, and other essential analytical tasks.

The development of the required CIS capabilities was planned as a graduated and controllable series of design/develop/demonstrate/evaluate cycles leading to an early Phase I operational capability.

3.1.2 Development Objectives

The broad objectives of the CIS development effort was to support the NTC training and evaluations objectives by designing a system that:

1) Minimizes technical schedule and cost risk
2) Provides growth flexibility to allow evolutionary enhancements
3) Provides redundancy to assure required system availability and graceful performance degradation

4) Is tailored to user requirements to maximize operability

5) Provides for low-cost operation and maintenance over the entire system life cycle.

CIS functional and performance requirements are discussed in paragraph 3.3.3 below.

3.1.3 Technical Approach

In the course of this contract, SAI has followed an incremental CIS development strategy in close coordination with TRADOC to ensure that initial and refined Army requirements were met and that technical and programmatic risks were identified. Using this approach, the CIS design has evolved through a series of hardware configurations and software builds. Each build was tested, demonstrated, and evaluated to guide subsequent builds. In addition to providing rapid and meaningful design feedback, this approach assured an early limited operational capability for NTC I-ALPHA that could be expanded to meet subsequent program milestones leading to the Phase I IOC. In addition, this strategy allowed the Army to assess four basic issues related to NTC I-ALPHA:

1) What should be collected and measured?

2) What can be collected and measured and at what level?

3) What are the methods and frequency of feedback presentations?

4) What will the evaluation data be used for?

A detailed discussion of SAI's technical approach to the CIS design and development tasks is provided in the reports listed under CIS design in Appendix B.

3.1.4 Program Management

SAI's functional management structure for the NTC program is shown in Figure 3-3. As indicated, SAI assigned subsystems to team members in a manner that groups functionally and technically compatible areas together. As a result, interface complexities between subsystems were minimized. SAI has employed proven formal management techniques which assure a low-risk, high-quality, core instrumentation subsystem development while meeting budgetary and schedule constraints. Important features of this management approach include:

- A management team composed of experienced personnel with a proper balance of military operations, software, and a hardware systems development and training technology expertise.
- A project office reporting to senior SAI corporate management to assure high-level visibility and access to decision-making authority to ensure successful completion of the project.
- A carefully structured project plan with clearly defined objectives, goals, and responsibilities combined with comprehensive contract monitoring procedures.
- A detailed project organization with work package responsibilities which assure the required span of management and measurable management responsibility.
- Assignment of task management responsibilities to individuals with directly relevant past experience for all critical work packages.
- Frequent and in-depth reporting of work progress to the government to allow and encourage meaningful and timely technical interchanges.
- An incremental software development process based on an iterative build-test-demonstrate philosophy to allow hands-on experience as early as possible.
- An outside technical advisory group selected from the corporation to review all aspects of the project to assure that technical and programmatic (cost, schedule) requirements are being met.

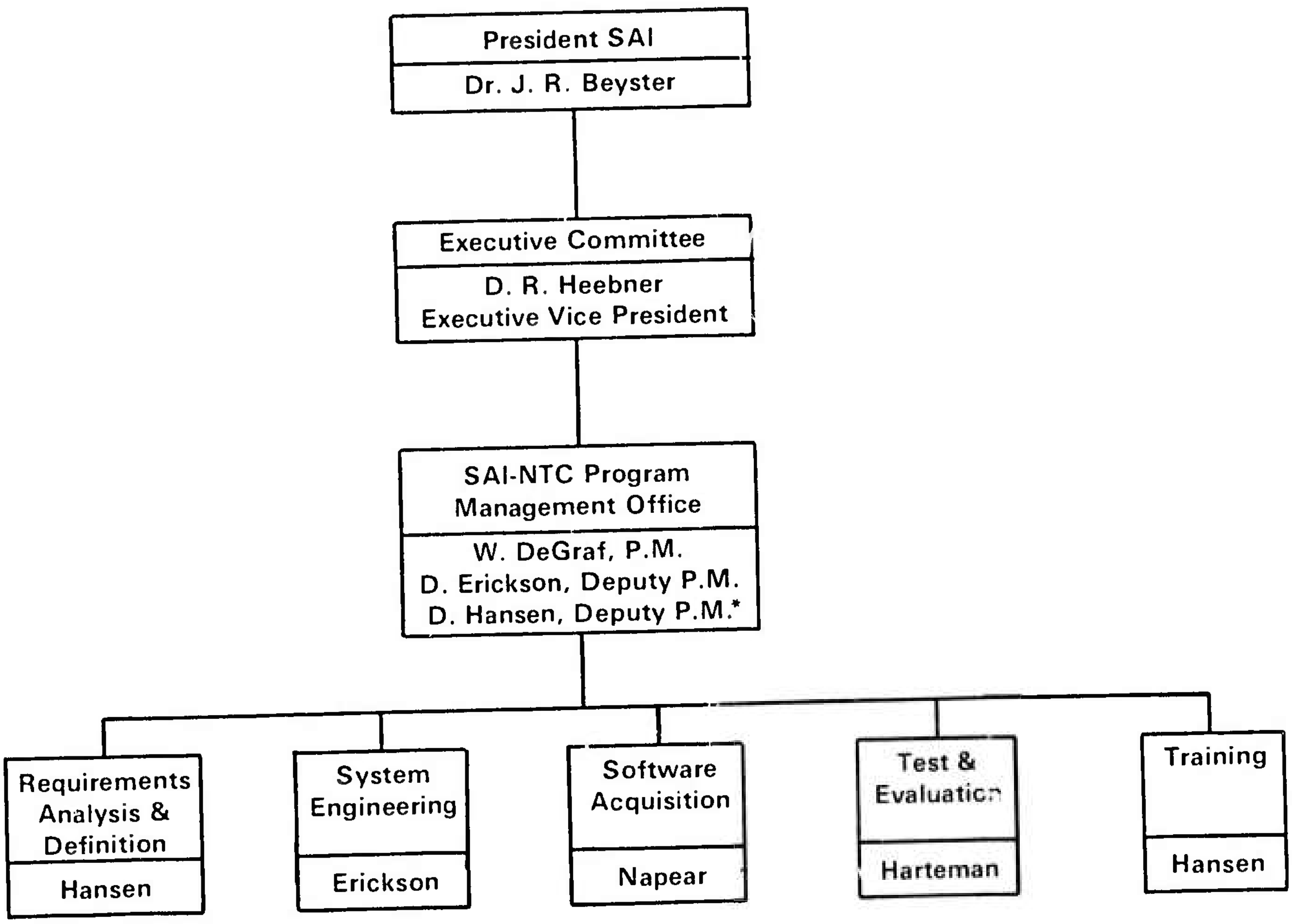


Figure 3-3. SAI NTC Management Structure

*Dr. Hansen resigned from SAI in Oct. 1980

- A dedicated NTC CIS software development facility with all development hardware and support software identical to the configuration proposed for the operational CIS.

- A close working relationship between the project manager and his senior technical staff with the government team to assure responsive support to NTC needs and changing requirements.

3.1.4.1 Configuration Management

SAI's configuraton management provided a tailored, time-phased approach, employing standard techniques for the identification, control, and status accounting associated with both hardware and software.

The importance of the configuration management function within SAI is illustrated by placement of the configuration manager in direct-line responsibility to the NTC configuration manager.

Change control was maintained by providing organizational responsibility for approving and incorporating changes as indicated in Figure 3-4.

The software configuration control function was implemented in conjunction with the software library function and maintained defined changes to operational code in an automated manner, using the SAI software librarian code. Changes to documentation were maintained, using a word processor and a document control program.

A typical SAI change control flow diagram is shown in Figure 3-5. The vehicle for initiating a change is the engineering change request (ECR).

3.1.4.2 Software Quality Assurance

The purpose of SAI's established software quality assurance program is to provide independent assurance that the NTC software meets high standards for quality. Assurance was achieved by audits and continual review of the software and supporting documentation.

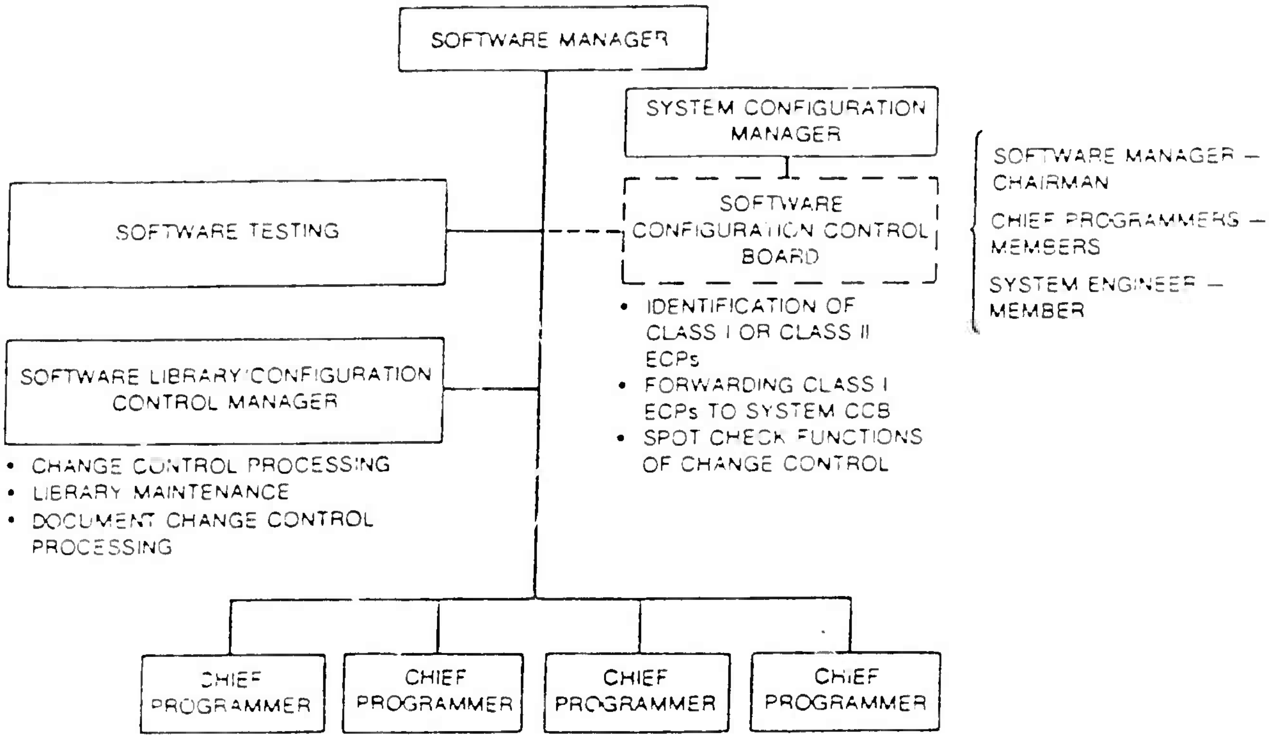


Figure 3-4. Change Control Organizational Responsibility

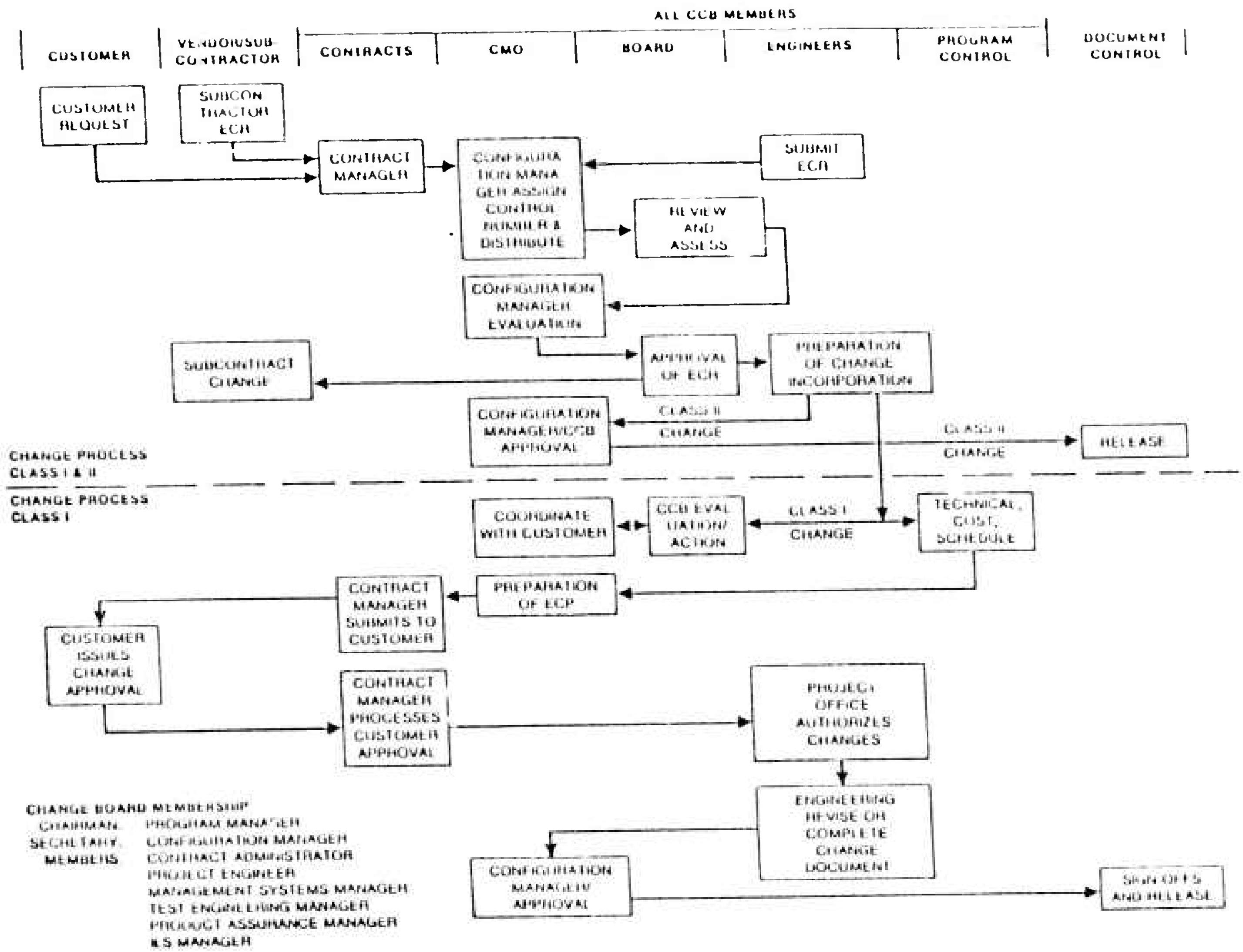


Figure 3-5. Change Control Information Flow/Events

Significant software quality assurance efforts were planned during development, including documentation and design reviews, and witnessing of formal tests. Specific functions for software quality assurance included the following:

- Support design reviews
- Design analysis
- Coding audits
- Witness testing
- Review documentation
- Spot checks.

The quality assurance personnel performed reviews on such documents as program performance specifications, interface design specifications, program design specifications, data base design documentation, program description documents, user manuals, test plans, and test procedures. The purpose of these reviews was to ensure the following:

- Adequacy of Presentation -- Each document is evaluated to ensure that sufficient information is presented to serve the intended purpose and will identify areas which are not adequately covered.

- Correctness of Material -- The material presented in each document has been evaluated for correctness, both technical and in terms of up-to-date inclusion of design changes. The evaluation also identified omissions or suspected inadequacies.

- Reflection of Product Quality -- Many of the reviewed documents directly affect the quality of the software product, such as test specifications, design materials, etc. In these cases, an essential part of the quality assurance review was an evaluation of the quality implications of the document.

3.2 BASELINE CIS FUNCTIONAL DESCRIPTION AND PERFORMANCE REQUIREMENTS

The paragraphs which follow discuss the primary CIS functional and performance requirements identified by SAI, based on the key NTC mission requirements outlined below:

- Real-time monitoring and coordination of combined large unit (BTF) field maneuver and command post (BDE) exercises.
- A dynamic live-fire exercise with realistic portrayal of enemy target arrays and real-time scoring.
- Provisions for combat realism while maintaining non-intrusive positive control to assure safety and adherence to the rules of engagements.
- Real-time interactive coordination and control of a realistic opposing force as a means to create the desired training stimulus and environment to assure that overall training objectives are met.
- Near real-time planning, synthesis, and execution of after-action reviews at various command echelons, using a multimedia presentation of training feedback data, including audio, video, and digital displays.
- A 24-hour per day, 7-day per week training schedule capable of exercising over 40 BTFs annually (two BTFs at a time) with 2 weeks of intensive training allocated to each BTF.
- An ability to provide an effective test bed for the training developments and combat developments communities while not interfering with the essential training mission of the NTC.
- Management of NTC electromagnetic emissions to avoid interference with NASA Goldstone, U. S. Army, and U. S. Air Force operations.
- Provision of take-home training feedback packages to drive and enhance remedial training at home station, based on deficiencies uncovered at the NTC.

3.2.1 Core Instrumentation Subsystem Functional Description

The CIS provides all real-time data processing and interactive display capabilities needed to monitor, command, and control all NTC engagement simulation and live-fire exercise activities. The CIS also provides data processing, iterative display, and training material production capabilities needed to synthesize and present near-real-time after-action reviews, both in the field and in the theater, and to produce take-home training packages. Additionally, the CIS provides battle simulation and interactive display and control capabilities needed to realistically exercise BDE and BTF command staff functions. Finally, the CIS provides the data processing and interactive display capabilities required to support training developments and combat developments research at the NTC.

As shown in Figure 3-6, the CIS consists of five major components:

1) Digital interface component (DIC)
2) Computational component (CC)
3) Display and control component (DCC)
4) Voice/video control and editing component (VVCEC)
5) The facility component (FC).

The DCC is further subdivided into four major elements:

1) Exercise monitoring and control
2) Training analysis and feedback
3) Command battle simulation
4) Experimental test bed.

The digital interface component provides the single input/output interface for all digital data communications between the CIS and the range data measurement subsystem (RDMS) and range management and communication subsystem (RMCS), respectively. The DIC implements digital communications

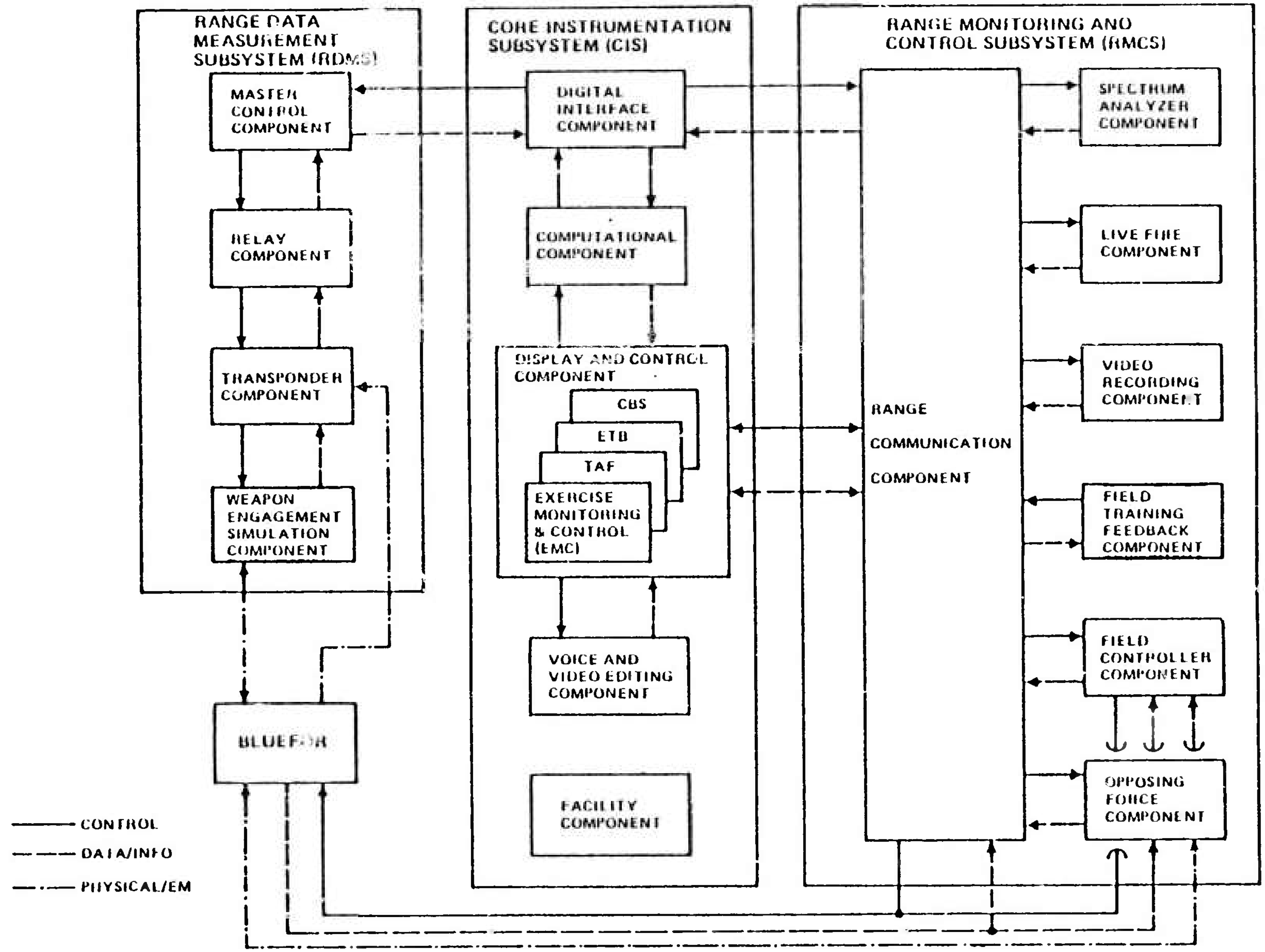


Figure 3-6. NTC Instrumentation System Interface Diagram

protocol between the CIS and external subsystems. It reformats and provides data buffering for all CIS digital input/output (I/O). In short, the DIC centralizes all digital I/O data communications for the CIS and preprocesses I/O data to transform it into the proper format required by the CIS.

The computational component performs the mainline computation in support of all CIS exercise monitoring, command control, battle simulation, and training feedback activities. Specific computational processing performed by CC includes:

1) State estimation (position and status) for all instrumented players

2) Real-time casualty assessment for all direct- and indirect-fire weapon engagements (those not performed or only partially performed by the WESC)

3) Real-time statistical analyses to provide training MOEs, MOPs, and EEAs

4) Battle simulation to support command staff exercise role playing.

The display and control component provides all real-time iterative data display and control facilities required for CIS controllers to direct all aspects of the NTC training experience. Specifically, the DCC provides a digital background map, selectable tactical symbology, engagement event data, statistical performance data, and function key, keyboard, and interactive menus to interactively control all aspects of the CIS subsystem. The DCC implements the CIS display and interactive control operations of exercise monitoring and control, training analysis and feedback, command battle simulation, and experimental test bed.

The voice/video control and editing component provides all facilities needed to record, archive, edit, and replay relevant voice and video data obtained by monitoring Blue Force (BLUEFOR) and OPFOR field operations. It also provides an interactive software system to assist tactical communications monitors to manually input key COMMO event data. Finally, the VVCEC provides similar recording, editing, and replay facilities for all video data collected in the field by fixed-video cameras and mobile cameras operated by the field video teams.

The facility component provides the operational environment for all CIS personnel and equipment. Specifically, the FC provides physical security, conditioned power, light, air conditioning, and personnel services.

Figure 3-7 provides an overview of the baseline CIS performance requirements.

3.3 NTC I-ALPHA CIS PROTOTYPE DESIGN AND DEVELOPMENT

3.3.1 Background

The NTC I-ALPHA test was the first in a sequence of operational tests leading up to the full NTC Phase I capability. The test provided the first opportunity to evaluate and demonstrate a number of the key operational features to be included in the full up NTC system. The test was conducted on a small maneuver range at Fort Irwin, California, during the second quarter of FY 1980, using a prototype of the core instrumentation subsystem, borrowed position location subsystem (PLS) equipment (DDR&E RMS II system), and the MILES to simulate direct-fire weapon engagements. Of the three major NTC Phase I training activities, engagement simulation, live-fire exercise, and command battle simulation, only engagement simulation was included in this test.

Engagement simulation exercises were conducted between the BLUEFOR tank heavy company-team and a limited OPFOR. Approximately forty players were instrumented between the BLUEFOR and the OPFOR.

SUBSYSTEM	FUNCTION	PARAMETERS	PHASE I	PHASE II
FIELD INSTRUMENTATION	Position Location System to provide player ID, location, and time for monitoring and playback.	Number and type of players	500, major vehicle weapon systems, ATGM, helicopter	1000+, major vehicle and weapon systems, AD systems, helicopter and FW-aircraft, ATGM and PGM designators
		Duration of exercises	24-36 hours	3-5 days
		X, Y, Z accuracy required	± 25 m Y ± 25 m Z ± 15 m	X ± 15 m Y ± [illegible] m Z ± [illegible] m
		Update (polling) rate by player type	Ground - 5 sec Air - 0.5 sec Air defense - 0.5 sec	Ground - 1 sec Air - 0.1 sec Air defense - 0.1 sec
		Transmission distances	15 x 15 km	50 x 50 km
		GFE	No	Yes
	Engagement Simulation System to simulate as closely as possible actual weapon signature and effect. Records occurence and outcome of event	Pairing/scoring at players or central facility	Player scoring central pairing record	At player - central record
		Range	To 3000 m	TOE weapon capability
		Type of weapons with direct interaction	105 Tk TOW DRAGON AD M16	All
		Ammunition status	Basic load, expended, remaining	Basic load, expended, remaining, selective interrogation
		Cueing	Manual-controllers	Automatic, all weapons
		GFE	No	?
	Exercise Command, Control and Display Systems communication, display and recording to permit exercise control. Also source of post-exercise critique data.	Real or near-real time	Near real	Near real
		Type of data desired	TBD by MOE/MOP development	TBD by MOE/MOP development
		Voice net recording	Yes Bn-Co Controller	Yes Bde-Bn-Co-Plat Admin/Log Controller Air UHF
		Type of displays	Larger screen CRT Graphic printout Event history Video coverage Store-recall Raster and stroke	Large screen CRT's remote location Graphic printout Event history Video Coverage Store-recall Raster and stroke
		GFE	No	No
CORE INSTRUMENTATION	Live Fire Command and Control System to permit independent operation to live fire range.	Number and type of targets	?	?
		Scoring method	Automatic	Automatic
		Target maintenance requirement	Minimum	Minimum
		Friendly casualty assessment	No	Yes
		GFE	?	?
	Notional Unit Representation System to function together with actual training exercise, generating and accepting inputs to simulate Brigade-level tactical plan.	Type of displays	Raster and stroke	Raster and stroke large screen-terrain board
		Exercise interfaces	TBD	TBD
		Inputs/outputs	TBD	TBD
		GFE	No	No
	Evaluation Training analysis function to assess unit readiness and eventually to measure command and staff effectiveness against proven criteria.	MOEs	TBD - Evolutionary	TBD - Evolutionary
		MOPs	TBD - Evolutionary	TBD - Evolutionary
		Form and content of critique package	TBD - Evolutionary	TBD - Evolutionary

Figure 3-7. NTC Instrumentation Parameters

SUBSYSTEM	FUNCTION	PARAMETERS	PHASE I	PHASE II
FIELD INSTRUMENTATION	<u>Position Location</u> System to provide player ID, location, and time for monitoring and playback	Number and type of players	500, major vehicle weapon systems, ATGM, helicopter	1000+, major vehicle and weapon systems, AD systems, helicopter and FW aircraft, ATGM and PGM designators
		Duration of exercises	24-36 hours	3-5 days
		X, Y, Z accuracy required	X : 25 m Y : 25 m Z : 15 m	X : 15 m Y : [illegible] m Z : [illegible] m
		Update (polling) rate by player type	Ground - 5 sec Air - 0.[illegible] sec Air defense - 0.5 sec	Ground - 1 sec Air - 0.1 sec Air defense - 0.[illegible] sec
		Transmission distances	15 x 15 km	50 x 50 km
		GFE	No	Yes
	<u>Engagement Simulation</u> System to simulate as closely as possible actual weapon signature and effect. Records occurence and outcome of event	Pairing/scoring at players or central facility	Player scoring central pairing record	At player - central record
		Range	To 3000 m	TOE weapon capability
		Type of weapons with direct interaction	105 Tk TOW DRAGON AD M16	All
		Ammunition status	Basic load, expended, remaining	Basic load, expended, remaining, selective interrogation
		Cueing	Manual-controllers	Automatic, all weapons
		GFE	No	?
CORE INSTRUMENTATION	<u>Exercise Command, Control and Display</u> Systems communication, display and recording to permit exercise control. Also source of post-exercise critique data.	Real or near-real time	Near real	Near real
		Type of data desired	TBD by MOE/MOP development	TBD by MOE/MOP development
		Voice net recording	Yes Bn-Co Controller	Yes Bde-Bn-Co-Plat Admin/Log Controller Air UHF
		Type of displays	Larger screen CRT Graphic printout Event history Video coverage Store-recall Raster and stroke	Large screen CRT's remote location Graphic printout Event history Video Coverage Store-recall Raster and stroke
		GFE	No	No
	<u>Live Fire Command and Control</u> System to permit independent operation to live fire range.	Number and type of targets	?	?
		Scoring method	Automatic	Automatic
		Target maintenance requirement	Minimum	Minimum
		Friendly casualty assessment	No	Yes
		GFE	?	?
	<u>Notional Unit Representation</u> System to function together with actual training exercise, generating and accepting inputs to simulate Brigade-level tactical plan.	Type of displays	Raster and stroke	Raster and stroke large screen-terrain board
		Exercise interfaces	TBD	TBD
		Inputs/outputs	TBD	TBD
		GFE	No	No
	<u>Evaluation</u> Training analysis function to assess unit readiness and eventually to measure command and staff effectiveness against proven criteria.	MOEs	TBD - Evolutionary	TBD - Evolutionary
		MOPs	TBD - Evolutionary	TBD - Evolutionary
		Form and content of critique package	TBD - Evolutionary	TBD - Evolutionary

Figure 3-7. NTC Instrumentation Parameters

The primary objectives of the NTC I-ALPHA test were as follows:

- Test, evaluate, and demonstrate a number of key exercise monitoring and control and training analysis and feedback functions.
- Demonstrate the ability to conduct and control a real-time engagement simulation at the company team level on Fort Irwin terrain.
- Gain valuable insight into the operations of all key NTC I-ALPHA subsystems to guide the future development of the NTC instrumentation system.
- Test, evaluate, demonstrate, and validate the NTC I-ALPHA software as a means to formally accept the first software "build" in a series of four planned builds in the NTC I-ALPHA software development process.

EMC functions specified for demonstration were as follows:

- Coordination and control of a company team-level, free-play, engagement simulation against a real OPFOR.
- The ability to control and direct controller teams on the ground (white team) in real time to enforce rules of engagement and range safety.
- Direction of OPFOR operations to create the desired training environment and to assure that training objectives are met.
- Manual input of key engagement events into the real-time data base that were obtained from monitoring tactical BLUEFOR components and from observations reported by the white team and OPFOR.
- Identification of key training situations to guide the preparations of AAR within TAF.

TAF functions specified for demonstration were:

- Real-time training data logging and management,
- Real-time data analysis to generate selected MOEs and MOPs,
- Near real-time AAR synthesis in parallel with ongoing field exercise, and
- Preparation of interactive after-action reviews.

3.3.2 NTC I-ALPHA Program Schedule

The NTC I-ALPHA program was planned and conducted in five stages as shown in Figure 3-8. It should be noted that this phased schedule is characterized by several unique features:

1) It was based on a concept of modular hardware and software development in parallel with subsystem integration activities.

2) Because of schedule constraints and the remoteness of Fort Irwin, initial prototype development and testing of CIS components were conducted at the FACC laboratory in Sunnyvale, California. Use of this facility provided the opportunity to rapidly install and check out subsystems in a controlled environment before shipment and integration at Fort Irwin.

3.3.3 EMC and TAF Functional Requirements

The prototype core instrumentation subsystem developed by SAI for the NTC I-ALPHA program consisted of two major components: 1) EMC and 2) TAF. The design of CIS was driven by the functional requirements outlined in Figure 3-9. The ability of the CIS to meet these requirements was the basis of the evaluations conducted throughout the NTC I-ALPHA program.

3.3.4 Constraints

The NTC I-ALPHA CIS development schedule was extraordinarily ambitious in terms of the time allotted to the following critical activities:

- Software Development
- Hardware Procurements
- Systems Integration and Testing
- Software Application and Testing
- Operator Training.

As a result, all these activities were conducted essentially in parallel, with the attendent technical and schedule risks. Operator training, in

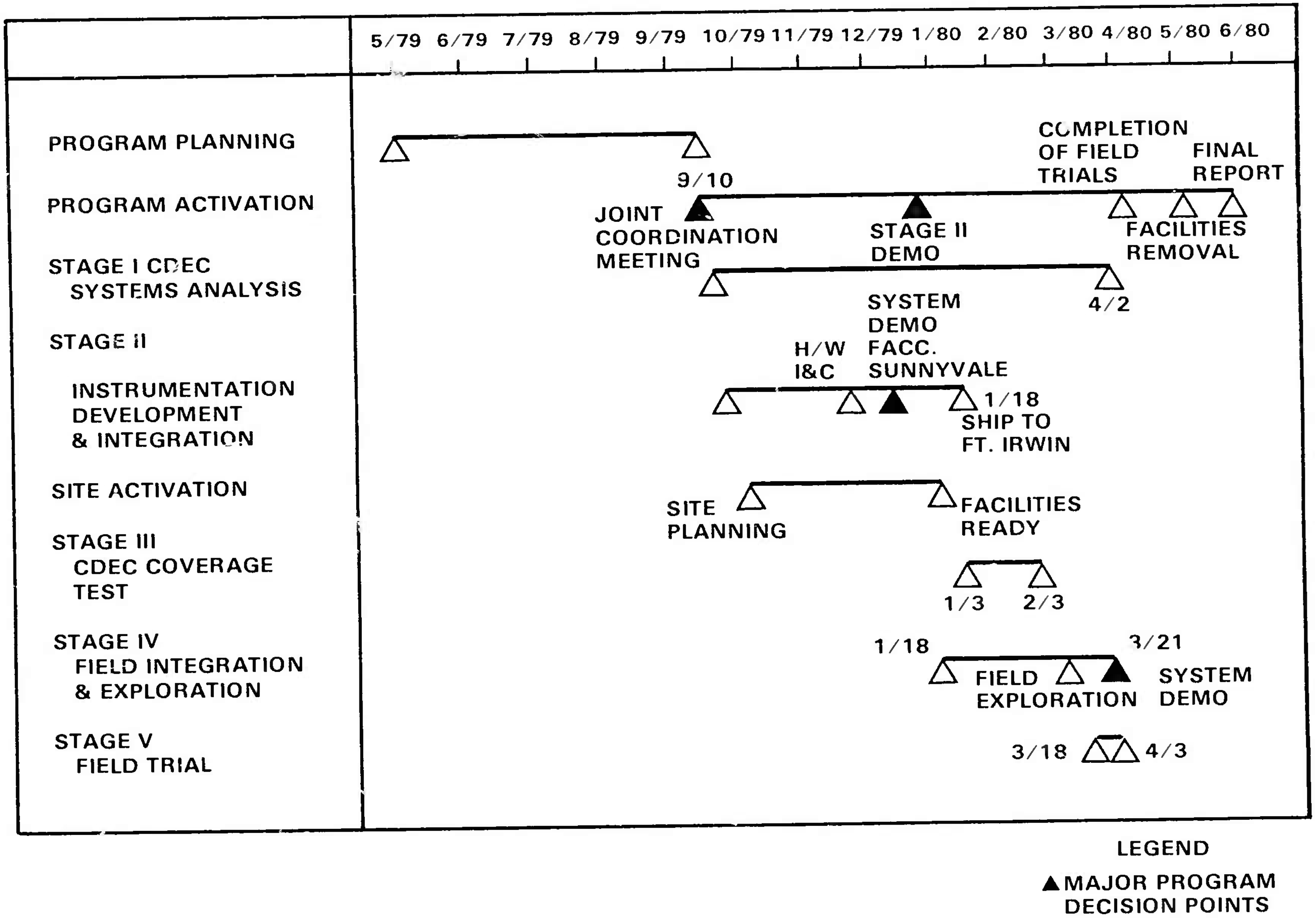


Figure 3-8. NTC I-ALPHA Program Schedule

(1) TEST, EVALUATE AND DEMONSTRATE A NUMBER OF PROTOTYPE IMPLEMENTATIONS OF KEY EMC AND TAF FUNCTIONS.

EXERCISE MONITORING AND CONTROL (EMC):

- COORDINATE AND CONTROL COMPANY LEVEL FREE-PLAY ENGAGEMENT SIMULATION AGAINST A REAL OPFOR
- APPLY NON-INTRUSIVE, YET EFFECTIVE, CONTROL BY DIRECTING A CONTROLLER TEAM ON THE GROUND (WHITE TEAM) IN REAL-TIME (RULES OF ENGAGEMENT/SAFETY)
- DIRECT REAL-TIME OPERATIONS OF OPFOR TO CREATE DESIRED TRAINING ENVIRONMENT AND MEET TRAINING OBJECTIVES (OPFOR AS ELEMENT OF CONTROL)
- ON-LINE MANUAL INPUT OF KEY ENGAGEMENT EVENTS INTO REAL-TIME DATA BASE OBTAINED BY MONITORING TACTICAL COMMO NETS AND OBSERVATIONS REPORTED BY WHITE TEAM AND OPFOR
- REAL-TIME KEY TRAINING SITUATION IDENTIFICATION AND TAGGING

Figure 3-9. I-ALPHA Prototype CIS Objectives

TRAINING ANALYSIS AND FEEDBACK (TAF):

- REAL-TIME DATA LOGGING AND MANAGEMENT
- NEAR-REAL-TIME DATA ANALYSIS TO GENERATE SELECTED MOE/MOPs
- NEAR-REAL-TIME AAR SYNTHESIS — IN PARALLEL WITH ONGOING EXERCISE
- AAR PRESENTATION (DISPLAY, TECHNIQUES AND PROCEDURES) BOTH IN FIELD AND IN PROTOTYPE THEATER

(2) TEST, EVALUATE AND DEMONSTRATE THE ABILITY OF THE CIS TO SUPPORT THE CONDUCT AND CONTROL A COMPANY-TEAM LEVEL EXERCISE IN REAL-TIME ON THE FORT IRWIN TERRAIN.

(3) GAIN VALUABLE INSIGHTS INTO CIS OPERATIONS TO GUIDE THE DEVELOPMENT OF THE NTC PHASE I CIS OPERATIONAL CONCEPT:

- HUMAN FACTORS (HARDWARE I/O, CONSOLE, SOFTWARE DATA AND DISPLAYS)
- CIS RELIABILITY, AVAILABILITY, MAINTAINABILITY (RAM)
- CIS LOGISTICS SUPPORT
- CIS OPERATIONAL PERSONNEL TRAINING

(4) TEST, EVALUATE AND DEMONSTRATE CIS SOFTWARE CAPABILITY TO ASSESS THE APPLICABILITY AND RECOVERABILITY OF THIS SOFTWARE TO MEET PHASE I CIS REQUIREMENTS

(5) REASSESS THE ADEQUACY AND REASONABLENESS OF NTC PHASE-I CIS PROGRAMMATIC, (SCHEDULE RESOURCES) ESTIMATES

Figure 3-9. I-ALPHA Prototype CIS Objectives (Cont'd.)

particular, was seriously constrained. To be meaningful, such training should be conducted only after the other critical activities are completed.

In addition, the remote location, austere facilities, and climatology of Fort Irwin presented a significant challenge to the successful completion of the NTC I-ALPHA schedule of activities. The impacts of these factors are discussed further in the NTC I-ALPHA Final Report dated 20 May 1980.

3.4 NTC I-ALPHA SOFTWARE DESIGN AND DEVELOPMENT

This paragraph contains a summary of the salient features of SAI's software design and development effort to support the NTC I-ALPHA program. A complete technical description of the design and specifications was provided in our Technical Report entitled NTC I-ALPHA Software Design, dated July 1979.

The software product consisted of over 40,000 lines of source code, with approximately 90 percent in FORTRAN IV. Application was made to a real-time data acquisition, interactive graphic, multi-computer system consisting of 12 user stations and a large screen display supported by two PDP 11/60 computers and two LSI 11/2 computers.

3.4.1 Software Configuration

The basic NTC I-ALPHA software configuration is outlined below.

NTC I-ALPHA SOFTWARE CONFIGURATION

- System Control Software
  - PLS Interface Communications
  - EMC and TAF Control

- EMC Display and Control Software
  - Digital Background Map of Operational Area
  - Symbology
  - A/N Messages
  - Manual Data Entry (COMMO only)
- TAF Display and Control
  - Data Logging
  - MOE/MOP Computation (NTC I-ALPHA Subset)
  - Training Feedback, AAR Synthesis, and Display
- Test Support Software
  - PLS Simulator to Support NTC I-ALPHA
  - System Integration, Testing, and Operator Training

3.4.2 Software Development Stages

To meet the constrained NTC I-ALPHA schedule, software development progressed through a series of the following five stages:

1) Stage I (post-functional design) consisted of a detailed system and software design culminating with the publication of an NTC I-ALPHA software requirements/design document. This effort was completed in approximately one month.

2) Stage II included actual task design and coding leading to the first release product. This effort commenced on 1 September 1980, and the product was accepted on 17 November 1980.

3) Stage III consisted of supporting hardware and operational testing followed by initial operator training.

4) Stage IV was the development of additional software necessary for CIS and RMS interface. In addition, periodic software changes were made to accommodate changes in Army requirements.

5) Stage V was devoted to modification and enhancement of statistical display functions based on new requirements generated by early operation field tests. Throughout this process, SAI's average productivity for documented, debugged,

and delivered code was 38 lines per day per programmer compared to the industry standard for real-time software of 5 lines per day per programmer.

3.4.3 Design Overview

An overview of SAI's software design is depicted in Figure 3-10.

3.4.4 Design Philosophy

- Top-down development
- Maximum use of software technology to automate exercise management control and training analysis and feedback tasks
- Emphasis on subsystem reliability and flexibility; all operator stations functionally and physically identical
- Modular software development to minimize technical and schedule risks
- Maximum software recovery for subsequent use in Phase I
- Support the incremental time-phased NTC developmental concept, whereby systems are gradually brought on-line and integrated into a fully operational system.

3.5 NTC I-ALPHA HARDWARE DESIGN AND INTEGRATION

3.5.1 Concept

The hardware design for the NTC I-ALPHA prototype CIS was based on the concept of using a matrix of off-the-shelf minicomputers, microprocessors, graphic displays, and storage capabilities to provide essential EMC and TAF capabilities. Moreover, hardware developed for the CIS was designed to be recoverable as part of future instrumentation systems. Selection of hardware components and vendors was based upon maintainability and record of performance.

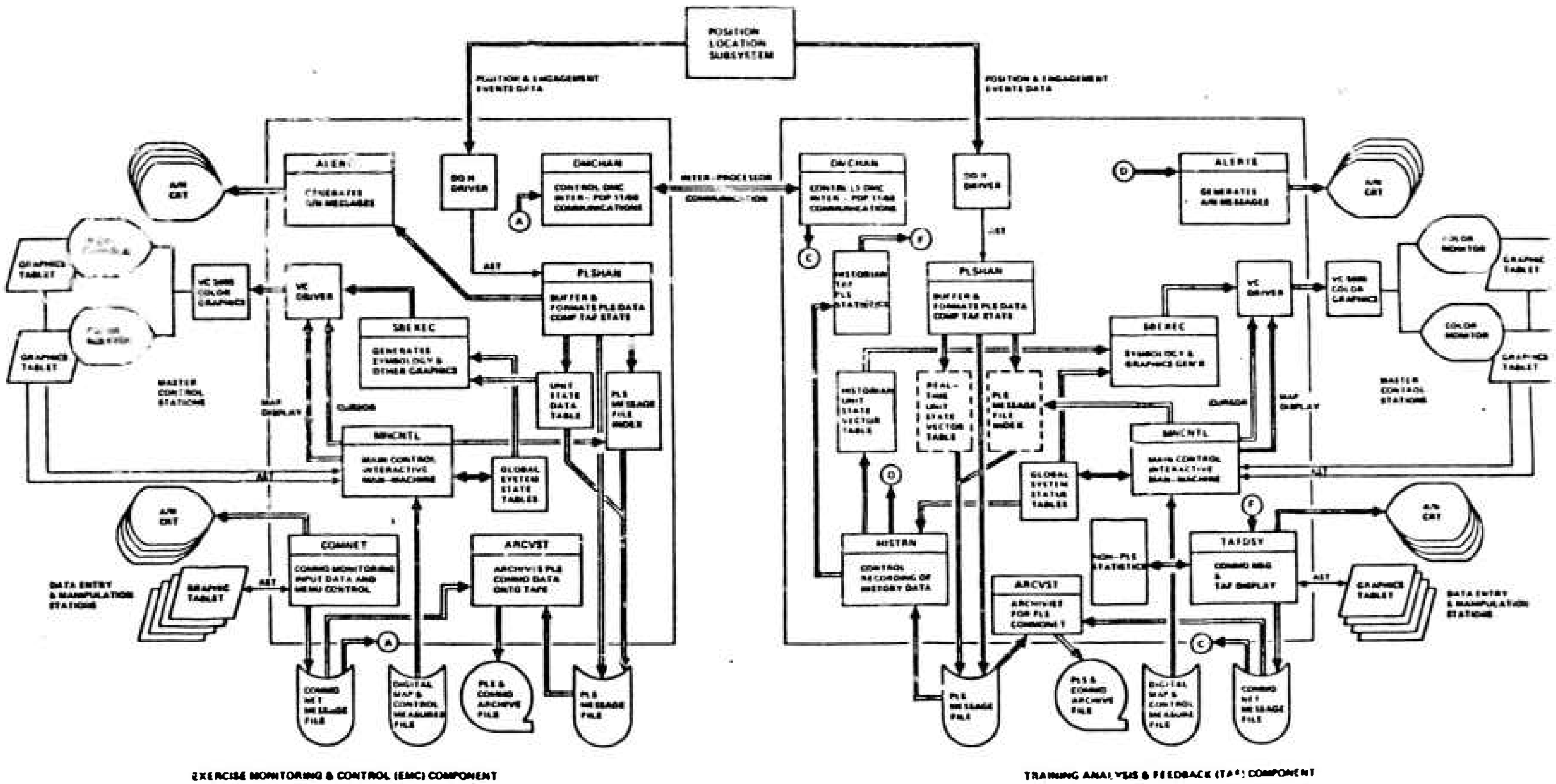


Figure 3-10. NTC 1-ALPHA Software Design Overview

3.5.2 CIS Hardware Configuration

As shown in Figure 3-11, the EMC and TAF components of the CIS had essentially identical hardware. This configuration provided the necessary redundancy to allow the TAF components hardware to pick up EMC functions if the EMC hardware failed, given a time gap for start up.

In this configuration, the CIS operated in a passive mode with respect to the PLS subsystem. That is, there was a one-way data interface between the PLS and the CIS in which data were shipped from the PLS to each of the mini-computers in the CIS. This interface was implemented by a black box interface device designed by SAI, which allowed the CIS to tap into the data stream within the RMS II Display Subsystem just behind the modem. The interface with each of the PDP 11/60 mini-computers was implemented by means of the standard DEC interface. This interface allowed a data transfer rate of up to a 50 kiloband. As shown, each of the PDP 11/60s were interfaced by means of a relatively low data rate link implemented by a standard DEC DMC interface. This intercomputer link allowed transfer of data between the EMC and TAF components to maintain the currency of selected data bases in each of these components.

As shown, there were six interactive displays and control stations in both EMC and TAF. Only two of the six stations were capable of interactively controlling the background map and display, and the selection of military symbology characterizing the engagement situation displayed on the color monitor or large screen. All other stations were provided with an interactive capability to control the display of alphanumeric CRT and input data using a graphics tablet and menus on the CRT. Within EMC, the master control and display stations were allocated to the exercise director and the training situation analyst. Within TAF, these stations were allocated to the training director and the AAR synthesis supervisor.

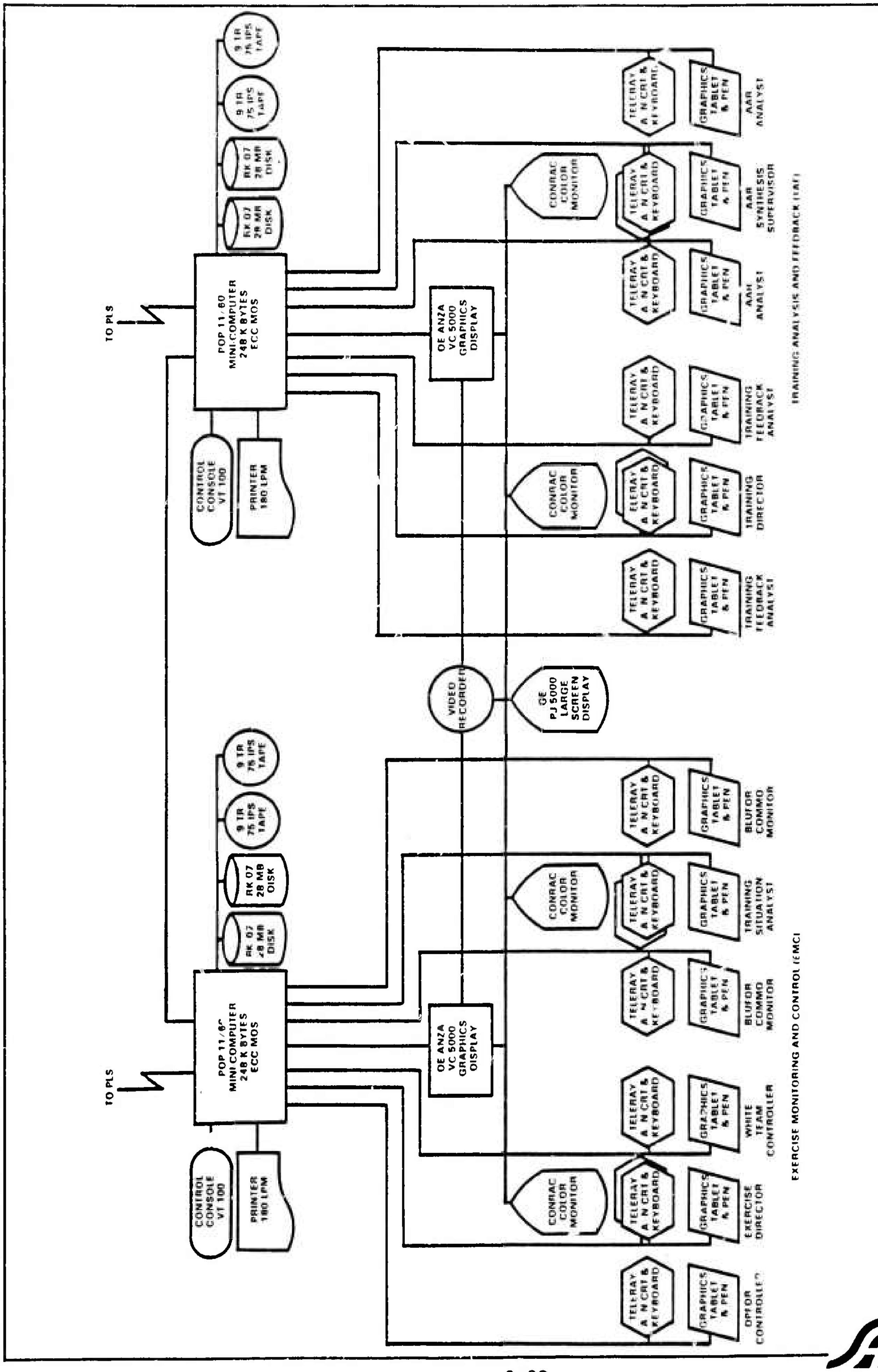


Figure 3-11. NTC I-ALPHA CIS Hardware Configuration

3.5.3 CIS Facility Layout

A layout of the NTC I-ALPHA CIS facility is shown in Figure 3-12. At Fort Irwin the CIS facility was installed in a specially designed triple wide transportable building, equipped with power conditioning and environmental controls. Space was provided for the computer elements, EMC and TAF elements, and an after-action review theater area. A diagram of a standardized operator station with associated hardware elements is shown in Figure 3-13.

3.5.4 Integration and Testing

Based upon the SAI CIS design, hardware components of the CIS were procured, installed, and maintained by the NTC I-ALPHA systems integration contractor (see paragraph 3.8 below). This contractor was also responsible for hardware and software integration, and testing with SAI assistance. An overview of system integration activities and stages is provided in Figure 3-14. (A complete description of these activities and the results achieved are contained in the NTC I-ALPHA Final Report, dated 20 May 1980 (FACC).) During Stage II, the prototype CIS was installed and integrated in the FACC Design Engineering Laboratory at Sunnyvale, California. This effort began on 1 November 1979 and was completed on 19 December 1979 when a formal demonstration of a fully functioning CIS was conducted. The demonstration successfully verified all performance objectives of the Stage II effort and resulted in a major milestone decision in favor of deploying the system to Fort Irwin.

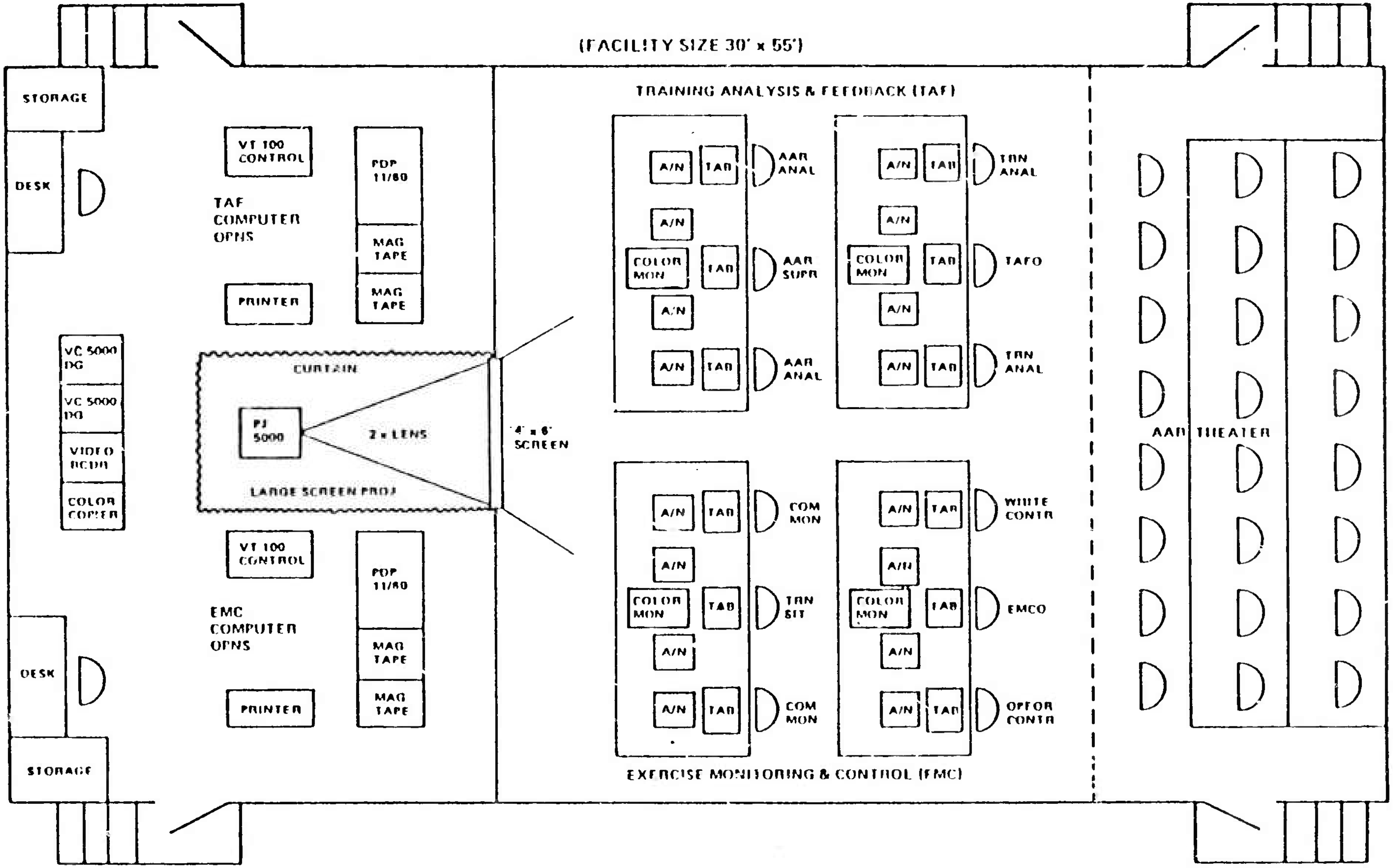


Figure 3-12. Prototype CIS Facility Layout Designed by SAI

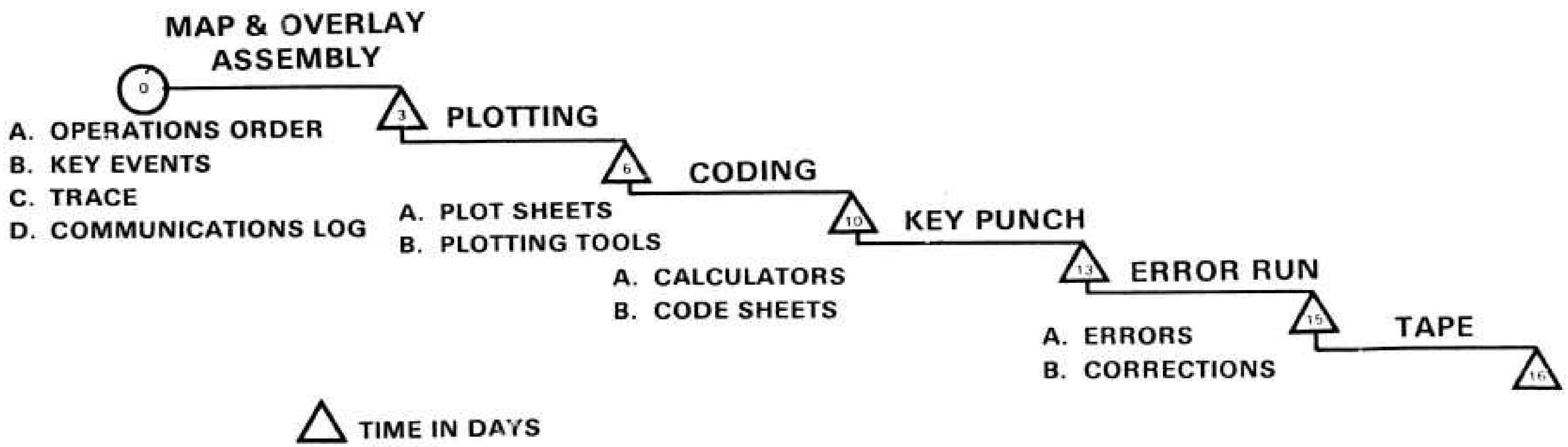


Figure 3-13. Scenario Process

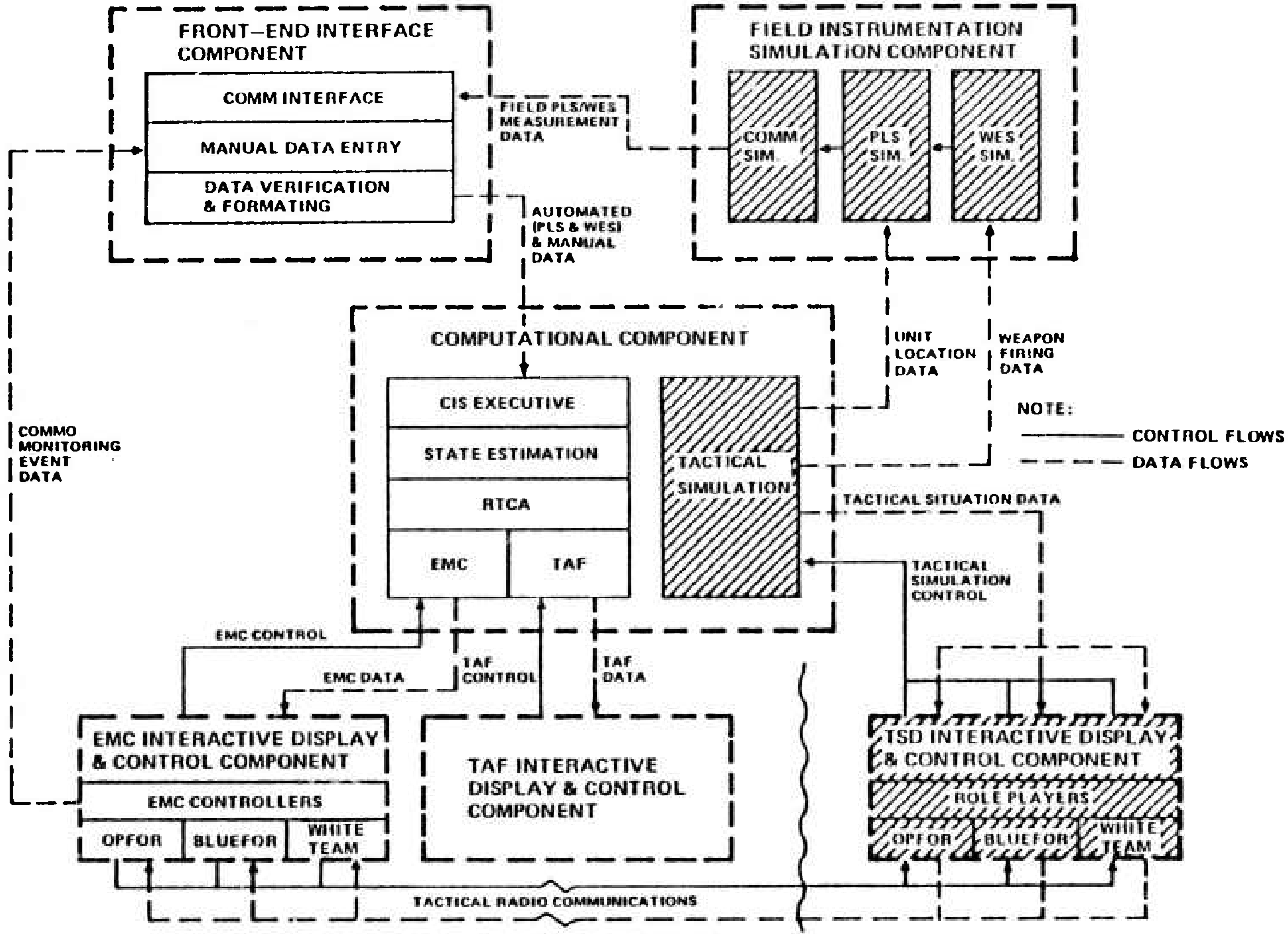


Figure 3-14. Overview of Test Support Driver (TSD) Concept

3.6 SCENARIO DEVELOPMENT

One of the critical SAI tasks in the early stages of CIS development was the design and development of six automated scenarios to represent typical company-level tactical operations against a representative opposing force. The objectives of the six scenarios were to:

- Test CIS operability and effectiveness
- Test functional assignment of EMC and TAF operators
- Provide capability to perform system integration testing for each CIS built
- Provide means for realistic operator training prior to field exercises.

Each scenario was structured to accommodate the following sequential activities:

1) Exercise initialization
2) Operational phases -- planning, movement to LD, movement to contact, attack, and consolidation
3) Post-exercise reassembly
4) AAR preparation
5) AAR presentation

Considering the time constraints, scenario development was an exceptionally demanding task since each scenario was manually developed from large terrain map boards (see Figure 3-13). Individual player positions and movements, together with firing events, were plotted by map coordinates and then transcribed to a sequence listing, coded and key punched onto cards. Data were subsequently placed on magnetic tapes to drive the CIS systems. In addition, up to nine tactical radio-net scripts were written and recorded on audio tapes to match tactical events realistically.

The successful use of these scenarios in the NTC I-ALPHA program led to the development of the test support driver concept discussed in paragraph 3.9 below.

3.7 FORT IRWIN OPERATIONS 22 JANUARY 1980-4 APRIL 1980

Following its successful demonstration at Sunnyvale, the CIS was moved and installed at Fort Irwin in accordance with Stage IV planning. Following installation, the hardware and software were again integrated and tested to include the CIS interface with the PLS subsystem. Stage IV also included the exploratory testing of system components to ensure that each component was operating as specified. This was followed by graduated force-on-force exercises to increasingly stress the entire system, starting with one-on-one field actions and progressing to a free-play scenario between multiple units. At the conclusion of Stage IV, the fully integrated CIS hardware and software had been tested and was ready to begin the full-scale company-level field trials planned for Stage V. This final stage of activity consisted of daily free-play operational trials and subsequent after-action reviews to fully stress the CIS functional subsystems and to evaluate their reliability, availability, maintainability, and operability from the human factors standpoint. The major lessons learned from this stage are provided in Section 7.

3.8 ROLE OF OTHER CONTRACTORS

Aside from SAI, other contractor support for the NTC I-ALPHA program was provided by:

1) Ford Aerospace and Communications Corporation

   Systems Integration, including site engineering, facilities preparation, hardware procurement, hardware installation/checkout, CIS hardware maintenance, voice recording subsystem/video recording subsystem operations/maintenance, facilities maintenance, and project evaluation.

2) General Dynamics/Electronics

Position location subsystem, including installation, software/hardware modifications, coverage analysis, and maintenance/operation of the PLS.

3) Xerox Electro-optical Systems

Multiple Integrated Laser Engagement System support, including codevelopment of the MILES/RMS interface with GDE, preparation and maintenance of the MILES units.

3.9 NTC I-ALPHA COLLATERAL DEVELOPMENTS

Three collateral development activities conducted by SAI under this contract are discussed below. Despite the ancillary nature of these activities, each has served important objectives, the most important of which is to attain an early IOC with minimum technical and programmatic risks.

3.9.1 Test Support Driver

To support the incremental developmental concept, there is a need to exercise (or drive) the evolving instrumentation system in a realistic operational mode. This capability is required to: 1) perform system integration and test for each incremental build, 2) train operation personnel in the use of the system prior to field exercises, 3) support system exercises without troops to build the experiential background needed for subsequent builds, and 4) provide a means to demonstrate the evolving CIS operational capability early in the NTC I-ALPHA acquisition cycle.

The test support software designed by SAI will fulfill the above requirements. In effect, the TSD is a cost-effective surrogate for activities which would normally be conducted in the field to provide the CIS with all necessary real-time control and training data. In this role, the test support driver (TSD) simulates all field exercise operations and the field instrumentation input needed to measure and record these operations. TSD also provides interactive display and control capabilities to allow role playing of all human interfaces with the CIS and to implement CIS control measures in the simulated exercise. Thus, the TSD models the automated as well as the manual (human) data interfaces between the CIS and its operational environment.

An overview of the TSD concept is presented in Figure 3-14. TSD elements are shaded while NTC CIS elements are not. All data interfaces between the TSD and the CIS are shown as directed line segments between the shaded and unshaded areas.

Further technical details pertaining to the TSD are contained in the TSD technical report listed in Appendix C.

3.9.2 Terrain Data Base Conversion

A second important collateral development accomplished by SAI was the preparation of a Terrain Data Base Conversion Manual. This manual explains in detail the process of converting Defense Mapping Agency (DMA) supplied terrain data into the CCM and vegetation files of the digital terrain image display (DTID) system data base required by the NTC software system. The four steps involved in converting the raw DMA data to an 8-bit image format are detailed in the User's Manual DMA Data Conversion Process for the NTC Terrain Data Base, dated July 1980.

3.9.3 Support Software

The complexity of the large-scale software systems required for the CIS necessitates intensive management and quality control of the software development process. To provide the degree of management and control required, SAI is adopting a variety of software engineering tools as a collateral program effort. These tools, along with their purpose, are listed below. Figure 3-15 indicates the role which each tool plays in CIS software development processes.

SOFTWARE ENGINEERING TOOL	REQMT ANAL. & DEFIN.	DESIGN	CODE & CHECKOUT	INTEG. & TESTING	MAINT.
Requirements Tracing Tool (RTT)	P	S		S	S
Software Design and Development Language (SDDL)		P	S		
E-Metric Computer Code			P	S	S
Test Management Tool (TMT)				P	S
Librarian				S	P
P = Primary Application					
S = Supporting Application					

Figure 3-15. Role of SAI Software Engineering Tools

Software Tools	Purpose
Requirements Tracing Tool (RTT)	Automated requirements, data base maintenance, and tracing
Software Design and Development Language (SDDL)	Automated software design and documentation system: a processor and a language
E-Metric Computer Code	Computes subroutine complexity metrics (quantitative measures) -- Halstead
Test Management Tool (TMT)	Creates and maintains central testing data base and generates test reports
Librarian	Automated source code configuration management: maintains configuration and versions within configurations

Section 4

NTC I-ALPHA CIS OPERATOR TRAININC

SECTION 4

NTC I-ALPHA CIS OPERATOR TRAINING

This section provides a summary of the NTC I-ALPHA CIS operator training program designed and conducted by SAI. Our approach generally followed the Army instructional systems development (ISD) methodology, namely:

- Analysis of Requirements
- Design
- Implementation
- Evaluation.

Appropriate adaptations of this methodology were incorporated in the team training area. A complete discussion of this program is contained in the "Program of Instruction for NTC I-ALPHA EMC/TAF Operations Personnel Training" document submitted by SAI to CATRADA on 1 December 1979. Also included in this section is a brief review of SAI's Special Technical Reports pertaining to training which were submitted as part of the NTC I-ALPHA, Phase I transition planning effort.

4.1 TRAINING CONCEPT

Training of officer personnel, selected by CATRADA, in the operation of the CIS, was initially planned in two phases using the mix of instructional strategies outlined below:

- Orientation -- lectures, workbook, demonstration
- Terminal Operations -- tutorial hands-on
- Exercise Operations -- on-the-job training, procedural manual, team training
- Evaluation and Feedback -- operator functional duties, stress tests, criterion performance standards

Phase I initial training was planned as a 2-week program conducted during the period of 10 to 21 December 1979 at the FACC Design Engineering Laboratory, Sunnyvale, California, using the prototype CIS installed at that facility. Phase II advanced training was planned for Fort Irwin following installation and integration of the full prototype system in January 1979. The initial in-plant training phase was subsequently cancelled because of schedule constraints and all training was reprogrammed for Fort Irwin.

It is important to note also that, under this concept, NTC I-ALPHA operator training was designed to be responsive to an environment of flux. By necessity, training at Fort Irwin was dovetailed into the installation and checkout of CIS components which were progressively integrated into a full prototype system.

4.2 CIS TRAINING ANALYSIS

SAI's training development effort began with a detailed analysis of CIS operator functions and tasks to determine the parameters and requirements of the training mission. Operator functional responsibilities were broken out as shown in Figure 4-1. Based on these functions, specific operational tasks were identified in keeping with CIS system capabilities and design specifications. A sample of results of this analysis is shown in Figure 4-2. A full discussion of these tasks is contained in the document cited in the introduction to Section 4.

4.3 PROGRAM OF INSTRUCTION

Training of CIS operators at Fort Irwin was based upon an 80-hour program of instruction prepared by SAI and approved by CATRADA. However, in effect, training was a continuous process throughout the entire Fort Irwin period as experience was gained on the system. Trainees were twelve Army officers from selected branch specialties.

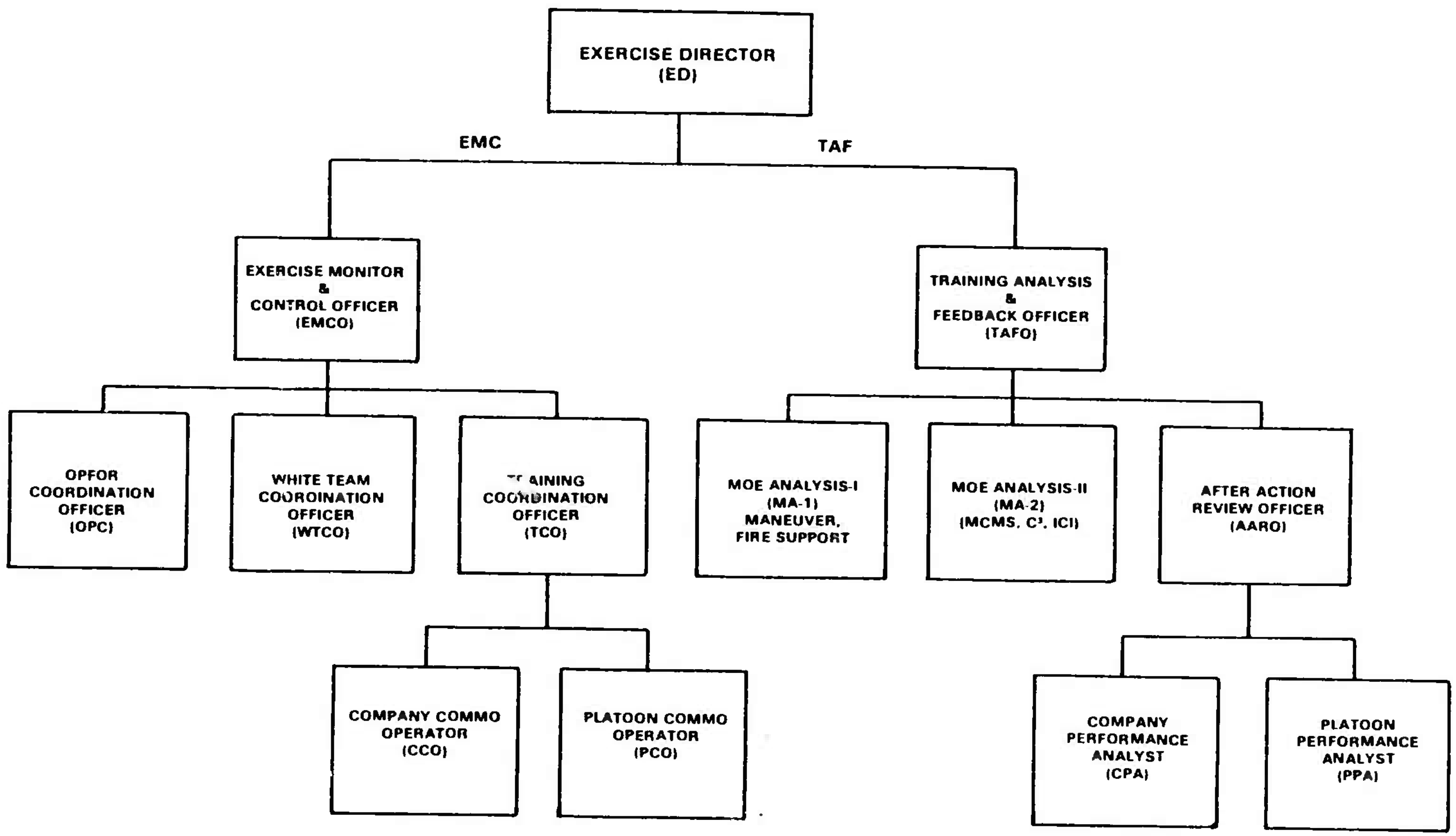


Figure 4-1. Tactical Operations Center

Job: Officer in Charge of the Training Analysis and Feedback

Tasks:

- Monitor A terminal and direct NTC tactical analysis and feedback operations
- Supervise and synchronize all AAR preparations and presentations based upon information from EMCO
- Supervise all readiness, resource, doctrine, tactics, analysis, and reports
- Make decisions on real-time MOE analysis
- Supervise integration of core, field video, and VRS inputs
- Direct up-grades in TAF system
- Coordinate TAF communications

Figure 4-2. TRAINING ANALYSIS AND FEEDBACK OFFICER

The training program consisted of the following elements:

- Introduction to the NTC I-ALPHA
  - Orientation
  - Overview of NTC Concept
  - AAR Purpose and Objectives
  - Field Trip for Terrain Orientation and Demonstration of PLS/WES Equipment.

- EMC and TAF Team Assignment (initial)
  - Functions, responsibilities, tasks
  - Operational team concept
- Familiarization with CIS Equipment
  - Component purpose and use
  - Tablet operations
  - Console operat ons
- Hands-on Equipment Training
  - Data and CRT formats
  - Hand and eye coordination
  - Use of intercom, radio, and audio recording equipment
- AAR Familiarization
  - Preparation
  - Player roles
  - Hardware/software capabilities
  - Structure and organization
  - Presentation
- Scenario Exercises (simulated field trials)
  - Skill development
  - Application of responsibilities during increasingly complex scenarios
  - Practical AAR development experience

4.4 TRAINING APPROACH

CIS training was conducted on an individual and group basis at appropriate operator stations. A guided practice approach was taken to enhance skill levels. System components were introduced incrementally and operator tasks described. Operators then practiced with individual and collective components, assisted by SAI instructors.

4.5 TRAINING ACTIVITY SCHEDULE

CIS operator training began the first week of February 1980 and was initially conducted in afternoon sessions to allow the morning period for system integration and testing. As mentioned earlier, training was essentially dovetailed with other development activities. As such activities reached completion, more and more time became available for advanced operator training. Fortunately, the introduction of practice scenarios early in the training cycle raised the level of operator proficiency to a point that allowed a timely transition from a training mode to an operational mode in support of scheduled field exercises.

4.6 TRAINING EVALUATION

A detailed evaluation of CIS operator training effectiveness and future requirements was made during and at the conclusion of the NTC I-ALPHA program. Input was received from instructors, officer trainees, on-site CATRADA representatives, and selected contractor personnel from FACC. Detailed findings and recommendations based on this evaluation are contained in SAI's Special Technical Report, CIS Operations, Training, and Manning, dated June 1980, and in the NTC I-ALPHA Final Report (FACC) dated 20 May 1980. One specific lesson learned which affected the entire training effort was that training should not begin until system integration and testing are completed. The circumstances of the NTC I-ALPHA schedule resulted in a parallel development approach, and, predictably, training continuity was seriously disrupted and impeded.

4.7 POST NTC I-ALPHA TRAINING DEVELOPMENTS

4.7.1 NTC Operational Training Plan Outline

In January 1981, SAI submitted a special technical report that outlined recommended Phase I in-plant and on-site training courses for Army personnel based on the results of NTC I-ALPHA, and analyses of known transitional requirements. This operational training plan addresses instruction for NTC components and describes in general terms course prerequisites, resource requirements, and supporting information. One in-plant and four on-site courses are described in detail.

4.7.2 Requirements Analysis for In-Plant Training Course

This special technical report describes the results of SAI's requirements analysis of an 88-hour in-plant course to train selected Army personnel in EMC/TAF duties and to serve the needs of instructors and other key Army personnel involved in NTC support functions.

4.7.3 NTC Technical Orientation Course

This report presents an analysis of the need and requirements for an informal technical orientation course for Army planners to familiarize them with NTC instrumentation systems, ancillary equipment, and design features.

4.7.4 CIS and Voice/Video Control and Editing Component, Man-Man Interface Requirements Analysis

A detailed analysis of CIS-VVCEC interface requirements was also submitted in January 1980 as a special technical report. This effort established the need for a well prepared plan of operation to permit an efficient CIS-VVCEC team effort. Team functions, duties, and responsibilities were clearly established. The task of selecting appropriate VVCEC information for inclusion in AARs was also analyzed.

4.7.5 Post-Processing Training Analysis

The post-processing training analysis to be undertaken for Phase I will involve the creation of programs capable of constructing a take-home training package. The take-home training package will be processed in an off-line mode following the termination of the NTC training cycle and upon completion of the final after-action review. The information contained in the take-home package will be available from the exercise data files contained within the storage area of the core instrumentation subsystem. Files will be maintained on each exercise, thus giving the capability to compile data from multiple exercises, and generate reports that will allow a comparative analysis of a battalion task force at different times during the NTC cycle or to other task forces. The SAI special report submitted in January 1981 provides a description of the post-processing training analysis requirements, a phased implementation schedule, multiple exercise processing, and a work breakdown layout for NTC Phase I.

4.7.6 Computer-Based Instruction and Test Support Driver

This topic was the subject of a special SAI technical report submitted on 17 February 1981 and is linked to the need to thoroughly train CIS operations personnel within the TSD functional area. The primary focus is on the development of a program of computer-based instruction (CBI) for the training of role players, instructors, facilitators, scorers, and other key individuals in the TSD operations. As described in this report, CBI will provide also a manually scored test of individual operator proficiency and group proficiency.

Section 5

NTC I-ALPHA MOE/MOP DEVELOPMENT

SECTION 5

NTC I-ALPHA MOE/MOP DEVELOPMENT

This section provides an overview of SAI's contribution to the NTC I-ALPHA MOE/MOP development process. Primary responsibility for MOE/MOP requirements analysis and specification remained with CATRADA.

5.1 CONCEPT

The NTC evaluation concept specifies that the evaluation function will concentrate on five levels of activity by the combined arms task force: execution, control, coordination, support, and planning. Moreover, the evaluation process is designed to provide a comprehensive objective evaluation of unit effectiveness to serve as a basis for subsequent home-station training.

The underlying concept of the MOE/MOP development process was to serve this evaluation function by means of quantitative and, to a lesser degree, qualitative measures and standards of performance.

5.2 OBJECTIVES

The primary objectives in the development of MOE/MOP were to provide objective diagnostic feedback to player units, assist in identifying training weaknesses, and provide the basis for remedial home-station training.

5.3 METHODOLOGY

The methodology used in the development of the MOE and MOP data set consisted of assembling appropriate data sources to identify, in the broadest context, the evaluation functions of each essential element of analysis and its substructures (MOE and MOP). This approach allowed for progressively lower subdivisions until quantitative and qualitative measures could be specified. A technical report was produced by SAI, in conjunction with CATRADA, to address the requirement for EEA development. This report was entitled U. S. ARMY NATIONAL TRAINING CENTER COMBAT EVALUATION PROGRAM (-EEA, MOE, MOP), originated by CATRADA, 15 August 1980. This report served as the basis for the development of evaluation measures for NTC I-ALPHA.

5.4 STRUCTURE OF THE ASSESSMENT PROCESS

The major categories of the NTC evaluation program consist of essential elements of analysis, measures of effectiveness, and measures of performance. The major categories of EEAs are those combat domains primarily exercised in the BN Task Force (execution, control, coordination, support, and planning).

Measures of effectiveness were developed to provide statistical indicators of the success of the task force in mission accomplishment. Measures of performance were developed to explain performance or lack of performance, quantitatively or qualitatively, in an MOE area. However, this structure was somewhat cumbersome for a smooth transition from MOP to MOE and subsequently to EEAs. To overcome this limitation, SAI developed the NTC COMBAT EVALUATON (EEA, MOE, MOP) INTERPRETIVE GUIDE, 30 November 1979. The interpretive guide provided a substructure to the MOEs, entitled "Headings." Headings serve to aggregate MOPs into topic areas and to provide an interface structure between the MOEs and MOPs.

As a result of this procedure, a chain or linkage was established consisting of data inputs at the lowest level; MOPs at the next level; headings, providing aggregation of MOPs, and, in turn, headings aggregated to MOEs; MOEs answering statistically the degrees of success in mission accomplishment; and EEAs addressing the major combat domains exercised by the task force.

5.5 SOURCE DESCRIPTION

The sources for the input and analysis of MOE and MOP data during NTC I-ALPHA were as follows:

1) ARCVST

The ARCVST compiled data from the position location system, communication system, and integrated laser system (MILES) input to computer disk by the CIS system hardware and EMC/TAF personnel. The ARCVST was interrelated to other data source systems for the purpose of AAR presentation.

2) Field Input

Field input data was derived from forms filled in by white team controller personnel to facilitate the AAR process.

3) Voice Recording System (VRS)

The VRS system provided input data via the various communications networks, the White Team, BLUEFOR, and OPFOR.

4) Indirect Fire Casualty Assessment (IFCAS)

Indirect fire casualty assessment provided data from artillery. Because of the nature of the IFCAS system, data collection was controlled by standards and parameters pre-set to collection specifications.

5) Core Instrumentation System/Decision

To assist the above-mentioned resource collection agencies, the personnel from EMC/TAF (the CIS personnel) provided a decision-making entity which assisted in the enhancement of the data collection and reduction functions for preparation of AAR and input of key data for specific exercise-keyed events.

5.6 EVALUATION

Further refinement of the NTC MOE/MOP data base is required to realize the full potential of this evaluation tool and its proper application to the NTC AAR and post-exercise data analysis process (PEDAP). Recently, SAI completed initial research on the development of a cross index of measures of combat effectiveness. An SAI technical report entitled: A Cross Indexing Structure for DARPA, USA NTC, USA ARTEP, and MCCRES Measures of Combat Effectiveness (Volume I and Volume II), 18 September 1980, provides a functional index structure. The report develops the EEA, MOE, MOP concept structure further to increase the ability to perform functional analysis and evaluation of the BN Task Force during the NTC training cycle and general applications for inter-service users.

Section 6

AAR DEVELOPMENT

SECTION 6

AAR DEVELOPMENT

One of the major objectives of the NTC I-ALPHA program was to demonstrate and evaluate the training analysis and feedback functions within the CIS. The preparation and presentation of after-action reviews required collecting, analyzing, and displaying appropriate multi-media information and data in order to provide timely diagnostic feedback to participating units. This section discusses SAI's contribution in the AAR development effort during and after the NTC I-ALPHA program. A complete discussion of SAI's contributions is contained in the following documents:

1) NTC I-ALPHA Final Report (FACC), 10 May 1980

2) NTC I-ALPHA Special Technical Report, CIS Operations, Training, and Manning, June 1980

3) NTC I-ALPHA Special Technical Report, After-Action Review Process and Upgraded Design, January 1981

4) NTC I-ALPHA Special Technical Report, Field Training Feedback Component/Theater After-Action Review, January 1981

6.1 CONCEPT

The effectiveness of the CIS system rests primarily in the ability of the various subsystems to provide training analysts with the automated capability to collect, analyze, and present timely, objective feedback to player units. To improve combat effectiveness, multiple forms of feedback must be used during the after-action review process to reconstruct tactical events with high fidelity. The concept of the AAR process is to use the technology provided by the NTC instrumentation systems to provide a learning environment and setting in which leaders and soldiers can see, understand, and learn from the effects of their battlefield actions and decisions.

In coordination with CATRADA, SAI conducted a detailed AAR requirements analysis, based upon the above concept, which led to the AAR training and operation methodology followed in NTC I-ALPHA and subsequently refined during the Phase I transition period.

6.2 APPROACH

The development of the after-action review procedures has been fundamentally a conceptual process beginning with analysis of what data should be collected, how it should be analyzed and at what level, how it should be presented, who should present the review, and who should attend the AAR from the player units. As a result, an evolutionary approach was followed, culminating with the methodology applied and demonstrated during operational field trial at Fort Irwin.

Based on the SAI course of instruction for TAF operators and later refined by officer trainee input, effective AARs were successfully conducted during the last five exercises. In general, presentation techniques varied as the player audience was varied. Initially, AARs were briefed to the unit commander and selected members of the command. The commander was then allowed access to the TAF displays for discussion of details with his subordinates. Another method employed was to brief the commander, and then he conducted the AAR for his unit. (A full description of these techniques is contained in SAI Technical Report on CIS Operations, Training, and Manning, June 1980.)

6.3 TRAINING METHODOLOGY

The methodology used for CIS operator AAR training is provided in Appendix D.

Section 7

NTC I-ALPHA LESSONS LEARNED

SECTION 7

NTC I-ALPHA LESSONS LEARNED

A full discussion of lessons learned during the NTC I-ALPHA program is contained in the following reports submitted earlier:

1) NTC I-ALPHA Final Report, 20 May 1981 (FACC),

2) SAI NTC I-ALPHA Special Technical Report, CIS Operations, Training, and Manning, June 1980, and

3) SAI NTC I-ALPHA Special Technical Report, NTC CIS Design and Upgrade Based on the NTC I-ALPHA Test Results, November 1980.

Lessons learned from NTC I-ALPHA have been incorporated in all SAI reports submitted during the Phase I transition period. Attention is invited also to Chapter 11 of this report, Conclusions.

These reports are available and provide detailed information concerning lessons learned. However, a summary of the lessons learned, as described in reference (2) above, is provided to facilitate familiarization with the observations made concerning CIS operations during NTC I-ALPHA. These are:

- The operators did not consider the graphics tablet to be suitable, and a replacement device would be useful. A keyboard entry device that includes function keys, alphanumerics, a digital pad, and a "joystick" cursor control would simplify the method for input of data manually.

- The alphanumeric alert display of fixing events was very useful, but the size of the CRT screen was a limiting factor. Because larger-scale operations will further complicate the problem, a capability of producing hard-copy printouts is recommended.

- The means by which data entries are selected must be related to the source content. Furthermore, the manual input of data was dependent on operator memory and note-taking. Changes to eliminate this problem will not be difficult. In addition, measures can be taken to reduce data input to significant details only.

- The personnel job loads varied substantively; some became overloaded at times while others were only partially occupied. This problem can be corrected by adjusting the tasks at each CIS station. This will increase flexibility in assigning work and adjusting loads.

- The EMC operators are required to perform tasks beyond just monitoring and controlling exercises. It became clear that the input of analyst data could be facilitated by an independent graphic display and control for analysis, which could monitor and control demands so that each analyst could concentrate on that portion of the exercise, data, and activity for which he is responsible. This can be accomplished by providing each operator with independent terminals, which include input devices, alphanumeric displays, and graphic monitors.

- Statistical information was presented on each graphics monitor in the side margins, thus limiting the size of the graphics display. This will not work well as units and activity increase. The problem can be resolved by removing most statistical information from the graphics display CRT.

- CIS initialization was time consuming, tedious, and required a high degree of accuracy. This difficulty can be overcome by providing a single point of entry for data initialization, with transfer to other stations on demand.

- The limitations on the numbers and types of displays, the need for manual data for display and the lack of a full real-time display capability indicate that there may be a problem when substantially increased requirements must be met. To overcome this limitation, the system capabilities and data display requirements must be re-examined.

- AARs were developed and presented initially by the TAFO with input from other TAF operators. They were based on "canned" scenarios and presented to EMC personnel.

As VRS and "canned" field video became available, the AARs became more complex in composition and presentation. The resultant video/audio recording, which was played to the AAR audience, was somewhat unrealistic. As live players and field controllers were introduced, additional problems arose. These can be resolved by providing additional statistical analysis capabilities, a more flexible display, and improved format. In addition, the post-exercise analysis will have to maximize use of automated data sources.

Section 8

REFINED CIS DESIGN BASED UPON NTC I-ALPHA EXPERIENCE

SECTION 8

REFINED CIS DESIGN BASED UPON NTC I-ALPHA EXPERIENCE

The refined CIS design* for NTC I-ALPHA is based upon the experience gained from the company-level exercises conducted during NTC I-ALPHA. A complete description of the expanded design for battalion-level exercises is contained in SAI's Special Technical Report entitled "NTC Core Instrumentation Subsystem Design Modification and Upgrade Based Upon NTC I-ALPHA Test Results," dated November 1980.

8.1 DESIGN OVERVIEW

The overriding feature of the upgraded NTC I-ALPHA CIS design is flexibility. This flexibility permeates the entire CIS hardware and software design structure. It provides the required operational flexibility to reassign personnel and functions among CIS controller stations as well as to reconfigure the CIS in order to mitigate the impact of equipment failures or damage. The inherent flexibility built into the design also provides the means to accommodate growth and changes dictated by evolving requirements.

The upgraded CIS design is fully responsive to NTC I-ALPHA CIS functional performance requirements to the degree they were known and defined. The design is a direct- or follow-on to the NTC I-ALPHA CIS design and incorporates all significant lessons learned from the NTC I-ALPHA test. To minimize technical, schedule, and cost risks, the design recovers as much of the NTC I-ALPHA software as possible as well as other off-the-shelf software which has been developed under government contract and proven as part of U. S. Army training or test operations.

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* This design is based on the NTC I-ALPHA test experience. The final Phase I design is the responsibility of SAI under the new Phase I support contract.

Finally, the CIS design employs state-of-the-art hardware and software development techniques and standard off-the-shelf hardware interfaces exclusively. This design philosophy minimizes design risks and assures easy low-cost enhancement and maintenance of the operational CIS.

8.1.1 Hardware Design

All hardware components for the proposed NTC I-ALPHA CIS design, Figures 8-1 and 8-2, for both the initial and full-up configuration were selected based on the following criteria:

- The ability to meet or exceed all known NTC I-ALPHA CIS functional and performance requirements
- Overall costs and cost performance (including the impact of software costs)
- Technical, schedule, and cost risk minimization
- Proven vendor performance record based upon firsthand experience or extensive scrutiny and reference checks
- High confidence in product quality, reliability, and maintainability over the total life cycle of the NTC I-ALPHA system
- The potential of the vendor and his hardware to support future growth without causing significant redesign and recoding of CIS software.

Key hardware design features are highlighted in detail in Section 3.2 of the cited technical report.

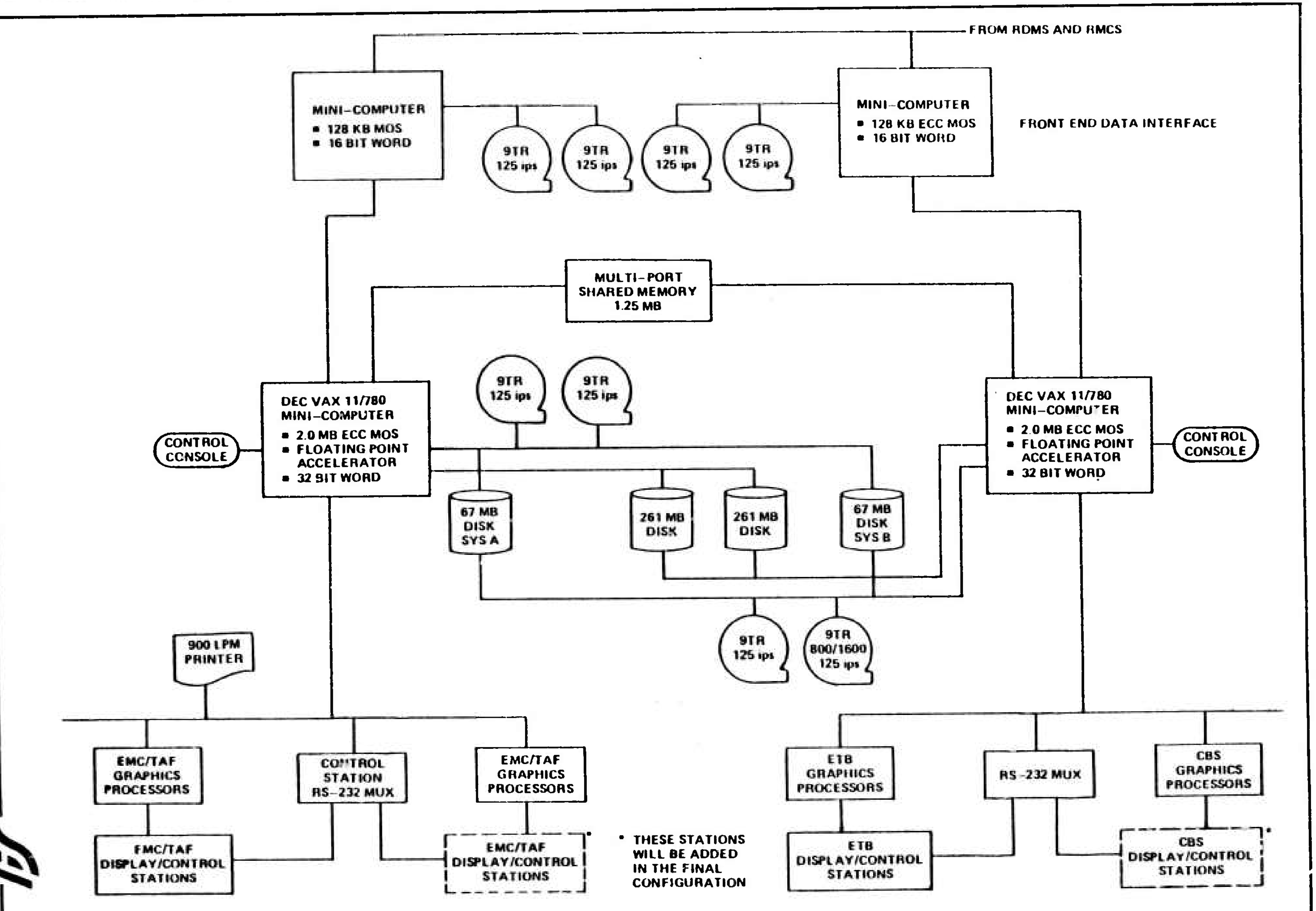


Figure 8-1. Initial CIS Hardware Configuration

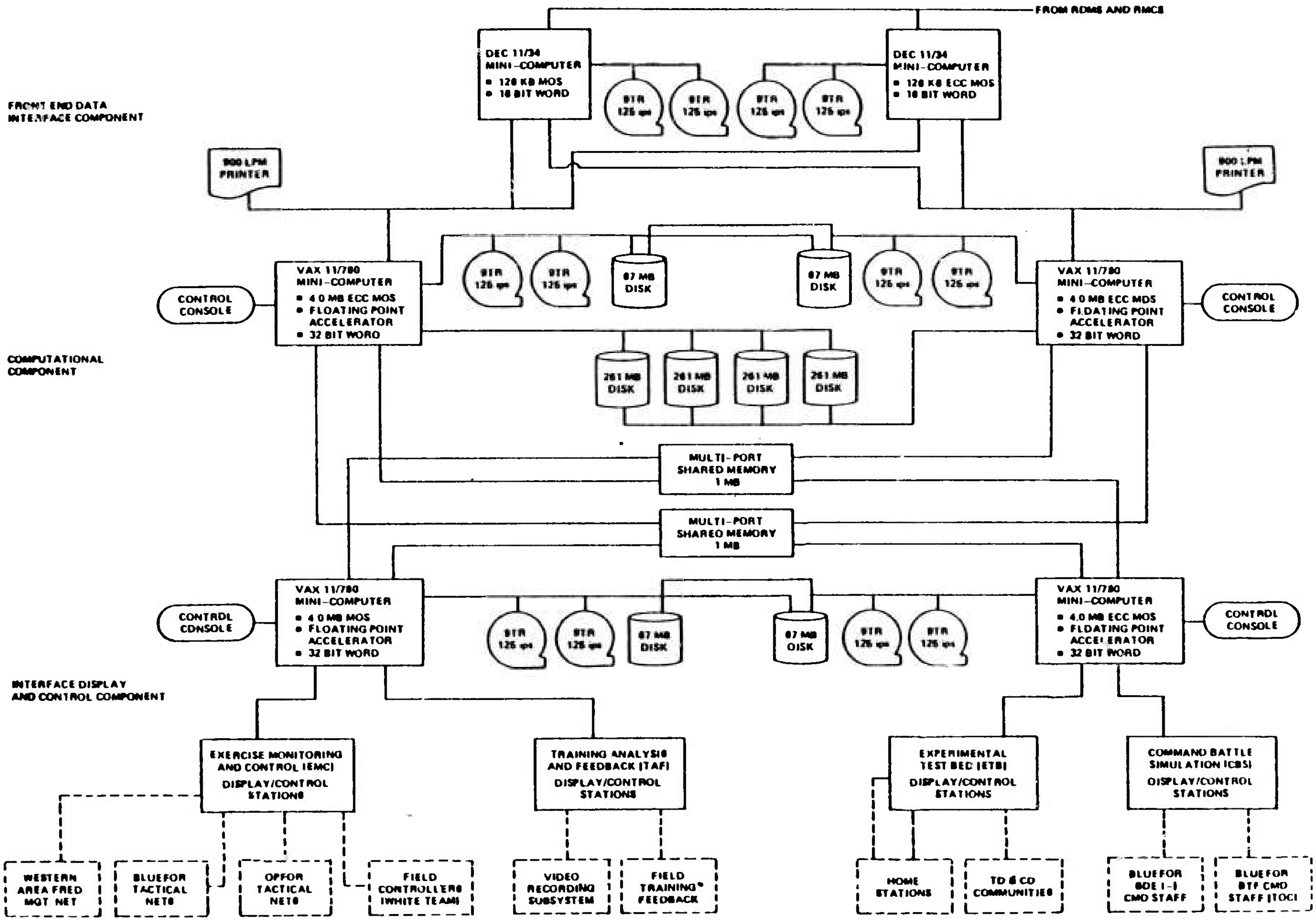


Figure 8-2. Full-up CIS Hardware Configuration

8.1.2 Software Design

The upgraded software design is a direct extension of the NTC I-ALPHA software. It is based on a comprehensive top-down design to assure that all requirements have been met and there is sufficient flexibility to accommodate growth. Some of the key features of the software design are:

- Recovery of most of the NTC I-ALPHA software code, executive and data base structure, and design philosophy
- Identical software functional capabilities at each controller station, thereby allowing any CIS function to be performed at any station
- Input/ouput capabilities with flexibility to employ a graphic tablet for graphic and interactive menus or an A/N terminal and keyboard for free-format data entries or interactive A/N menus using function keys to drive these menus
- A simple and responsive interactive display and control software design which fully exploits DEC operating system software intra- and inter-task coordination mechanisms
- A balanced software design which distributes processing loads across the mainline computers and the graphics display processors associated with each station
- A highly flexible background terrain map display with all the features provided at NTC I-ALPHA as a minimum
- A range measurement pre-filter for ground players which significantly reduces state estimation processing load while assuring that all ground players position accuracy requirements are met
- A means to compute all kernel statistics in real-time to support EMC and TAF functions
- Automated NTC system initialization and status monitoring software
- NTC range management (exercise scheduling and resource allocation) support software
- Take-home training package synthesis and production software.

The top-level CIS data flow is diagrammed in Figure 8-3.

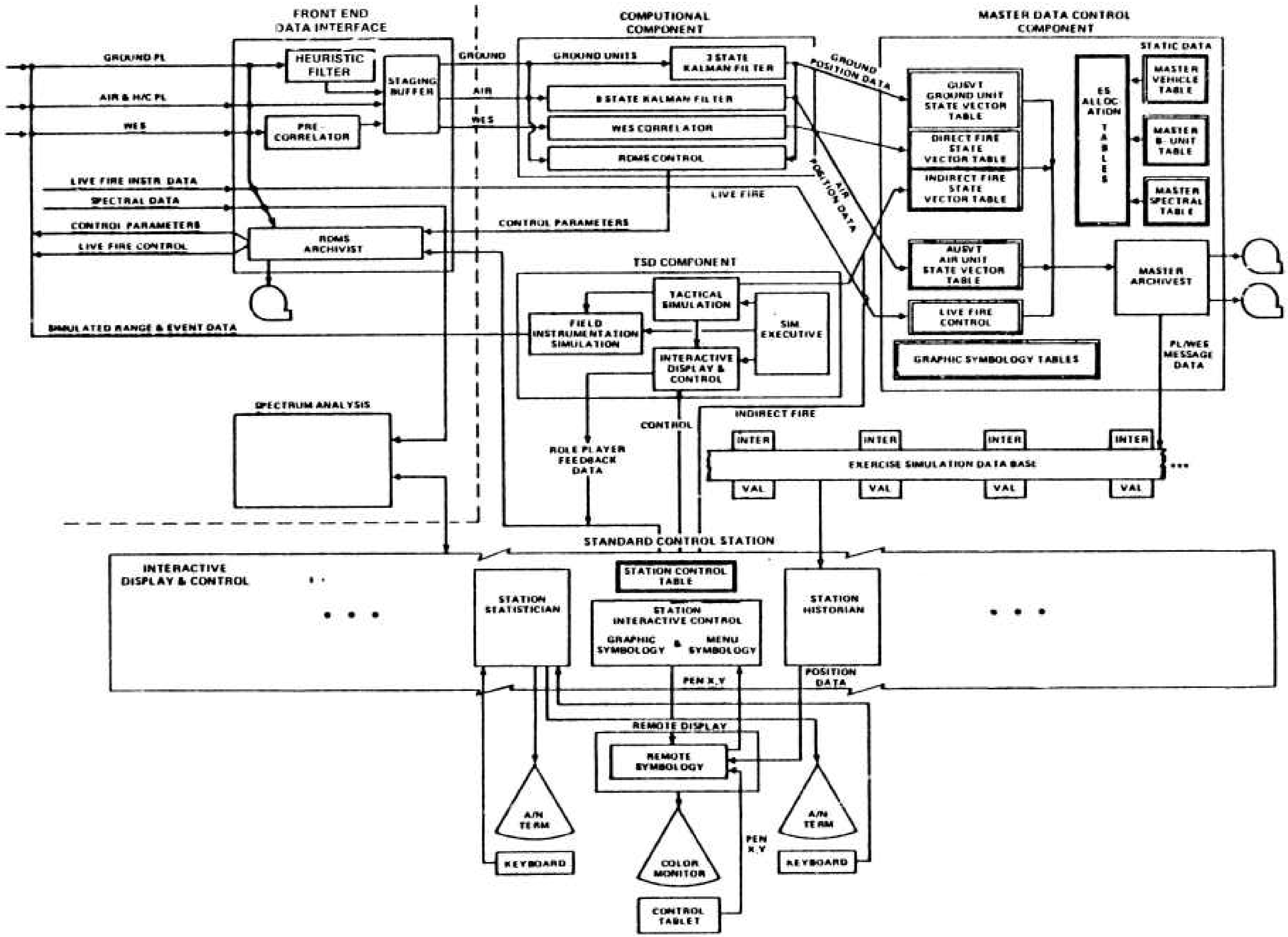


Figure 8-3. NTC Phase Top Level CIS Software Data Flow Diagram

8.2 SIZING AND TIMING REQUIREMENTS

One of the most significant SAI accomplishments under this task was a detailed technical analysis to establish timing (throughput) requirements for the Phase I computer hardware. In the IOC configuration, one of the two computational computers will be allocated the following EMC/TAF functions:

- Player state estimation
- Real-time casualty assessment
- Real-time statistical analyses
- Interactive display and control for EMC/TAF

The other computer will perform all computations and interactive display and control functions required by the test support driver. Timing analyses for each of these computers are detailed in Section 3 of the special technical report cited earlier in the introduction to Section 8.

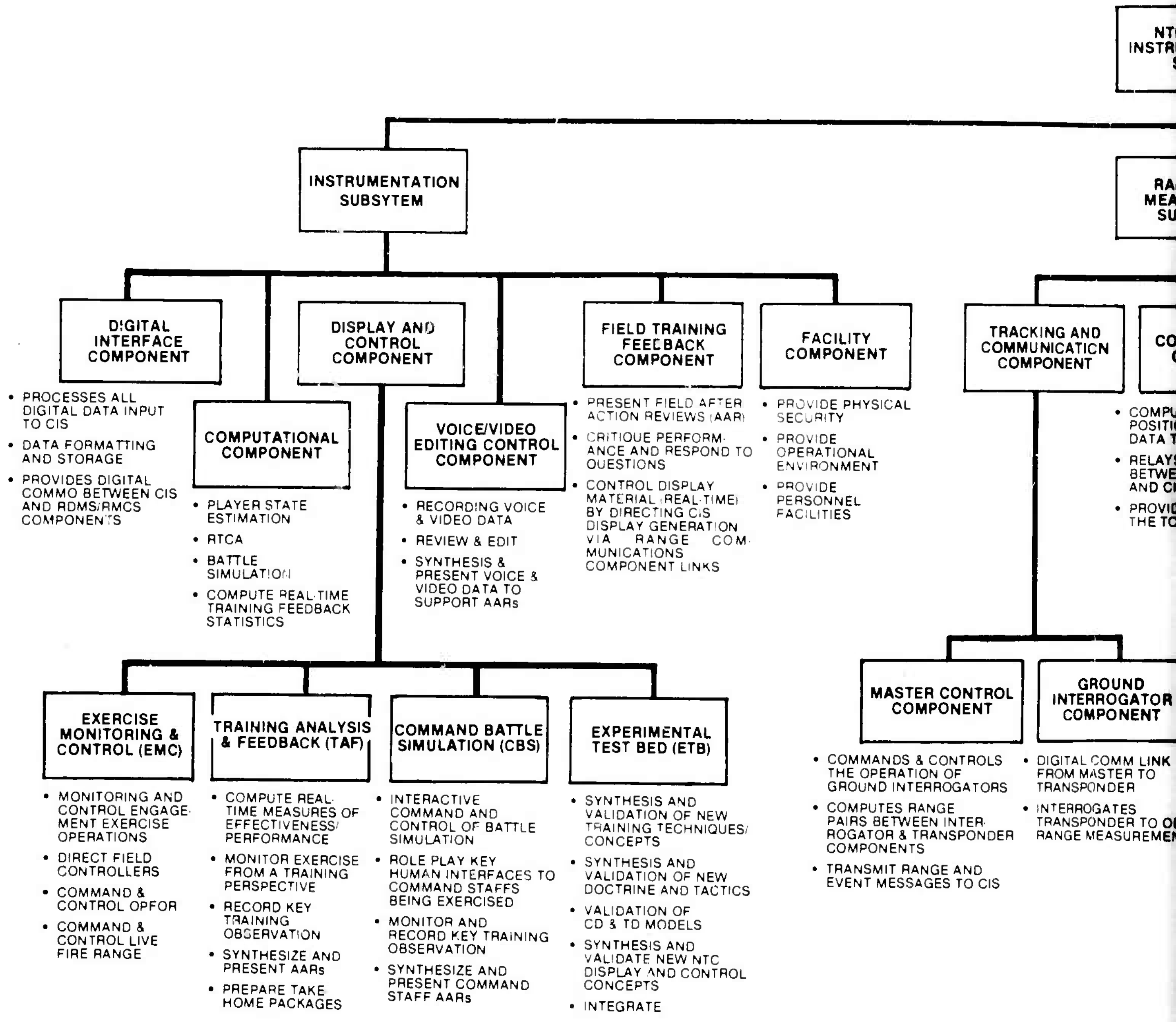
In a related action, SAI has developed and tested at NTC I-ALPHA a filter designed to pass only meaningful ground-player range change measurements (in terms of the required accuracy needed for ground-players positions of +25 m) into the state estimation functions. Simply stated, this filter will screen out all range measurements coming from the RDMS which result in less than a 16m change in range from the estimated current position. This screening filter significantly reduces the state estimation processing load associated with ground players since a large percentage of the range measurements are insignificant and, therefore, do not need to be processed (i.e., they will not contribute a large enough change in range to justify updating the player's position estimate).

8.3 PROPOSED SYSTEM CONFIGURATION

The proposed Phase I instrumentation system architecture is shown in Figure 8-4. The system has been grouped into three major subsystems (RDMS, CIS, and RMCS). Separate functions have been allocated to each subsystem to the extent that functional and physical interfaces between subsystems are simple and straightforward (Figure 8-5). The digital interface between the RDMS and CIS was successfully demonstrated during NTC I-ALPHA. For NTC I-ALPHA, this interface may change in that range pair data will be transmitted across this interface instead of position data as in the case of the NTC I-ALPHA test (i.e., no computational component is anticipated in the NTC I-ALPHA RDMS configuration). This change will not materially alter the RDMS-CIS interface, since data formats can be defined based on well known RDMS capabilities, and the physical interface can be implemented using standard off-the-shelf inter-computer communications equipment.

In summary, the following key attributes were incorporated into the refined CIS design:

- Meets NTC I-ALPHA cost and schedule targets
- Provides essential capability levels in all functional areas
- Provides high system availability and graceful performance degradation
- Incorporates low-risk and cost-position location system
- Provides integrated software/data base design concept
- Provides distributed state-of-the-art mini-computer graphics and input/output control hierarchy
- Provides capability for multi-media and near-real-time training feedback
- Incorporates developmental test bed design to support combat development needs without interfering with essential training mission
- Allows for growth flexibility and evolutionary enhancements; nearly all Phase I investments in hardware and software are recoverable for NTC Phase II.



* FUTURE GROWTH OPTION

NTC PHASE I INSTRUM

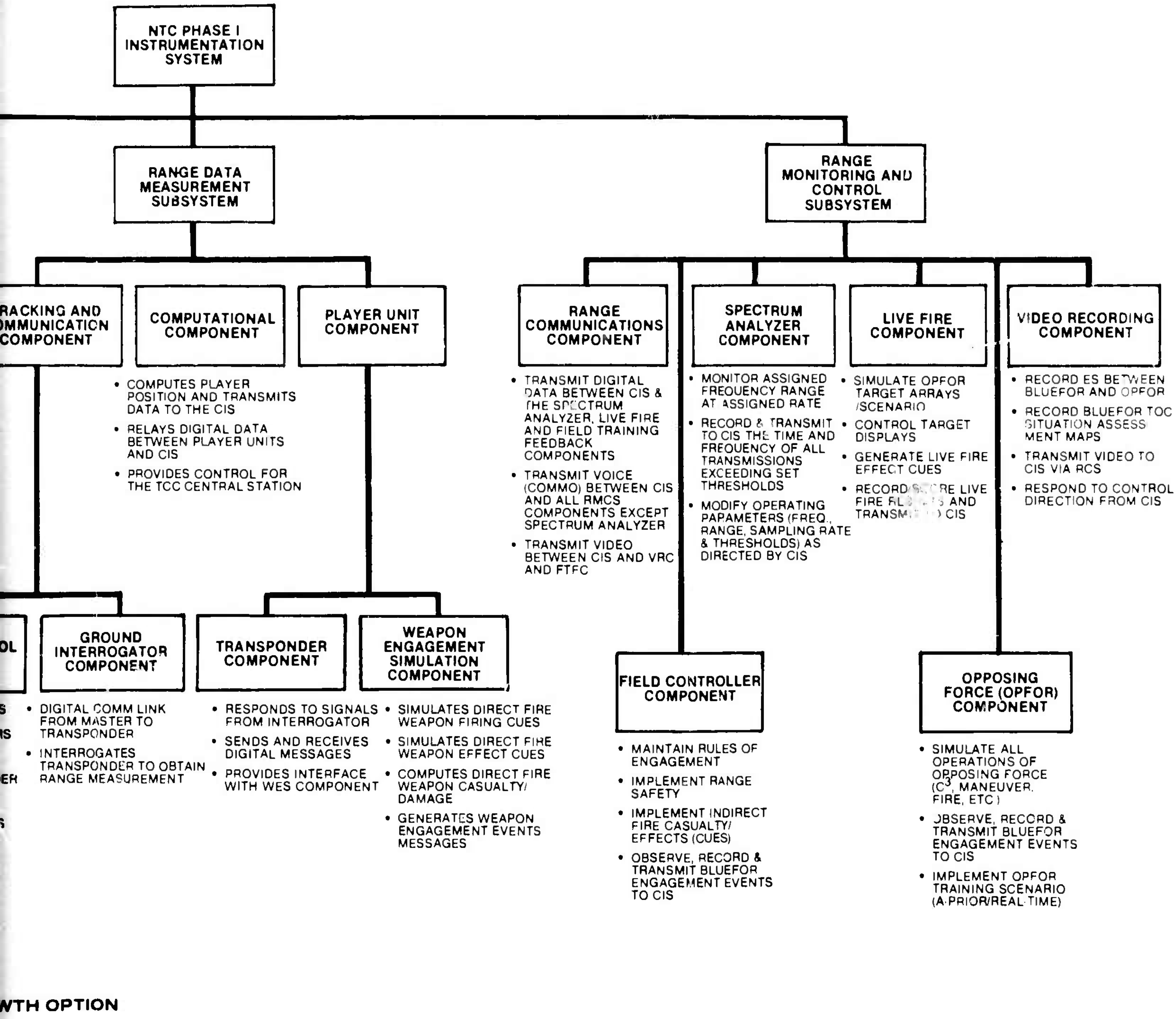


Figure 8-4.
HASE I INSTRUMENTATION SYSTEM ARCHITECTURE

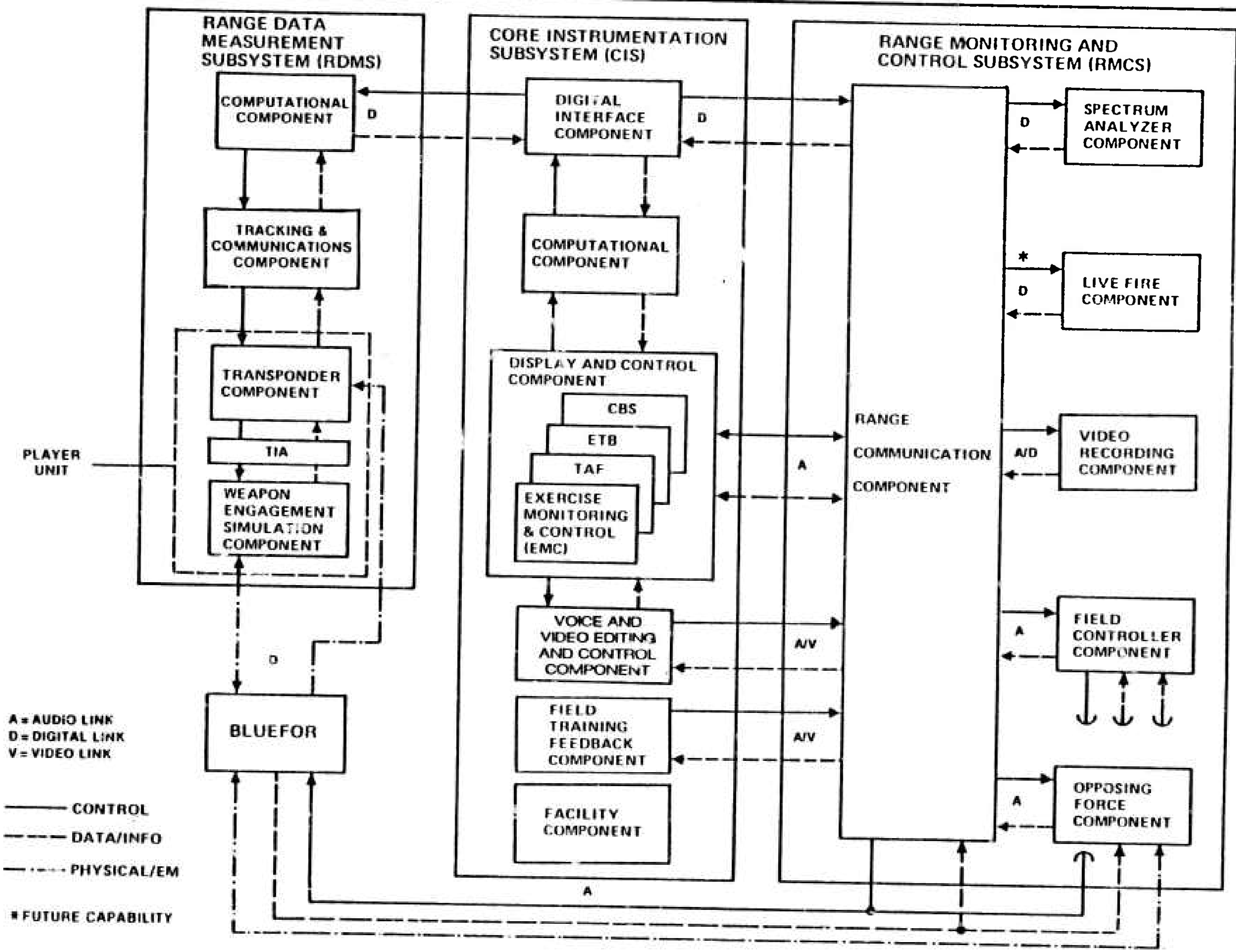


Figure 8-5. NTC Instrumentation System Interfaces

8.4 HUMAN FACTORS CONSIDERATIONS

Concurrent with the NTC I-ALPHA in-plant and on-site training programs at Fort Irwin, SAI conducted an informal evaluation of operator task and performance time requirements to determine it the physical and functional design of the CIS control and display systems met required human factor standards. This evaluation was conducted in coordination with FACC personnel and incorporated feedback from training instructors and Army student operators. The major areas of evaluation included:

- Ease of system operation
- Operator task loading
- Operator skill level requirements
- Functional efficiency and compatibility of systems from human factors perspective.

Detailed findings from this effort were provided in the NTC I-ALPHA Final Report dated 20 May 1980. Additional observations also were provided in the SAI NTC I-ALPHA Special Technical Report, CIS Operations, Training and Manning, dated June 1980. More importantly, all human factors findings and observations contained in these reports were carefully examined and considered in the revised CIS design.

8.5 RELIABILITY, AVAILABILITY, AND MAINTAINABILITY ASSESSMENT (RAM)

Another significant task in developing a refined CIS design based on the NTC I-ALPHA experience was a detailed RAM assessment of both the IOC and subsequent full-up CIS hardware configurations. The analysis conducted by SAI (presented in section 3.2.3 of the Special Technical Report) computed the mean time before failure (MTBF) for each of the major components making up the CIS hardware configuration. MTBF values for each hardware element were provided, along with the source of the estimates. In addition, aggregate MTBF were provided for various IOC CIS configuration assumptions. The bottom line of our RAM analysis is that the proposed IOC and full-up CIS configurations are highly reliable. Moreover, both configurations meet the required availability if one assumes that only fully redundant elements of the system may fail before impacting real-time operations.

8.6 CIS FACILITY DESIGN

Figure 8-6 presents SAI's candidate NTC I-ALPHA CIS facility design which has been adapted by the Army.

The proposed facility has five operations centers: two combined EMC/TAF operations centers (one each for each BTF), an ETB operations center, a VRS/VDRS operations center, and a CBS operations center. Also included is an AAR theater with seating capacity for approximately fifty people and a VIP observation gallery, seating fifteen. After-action reviews may be controlled from either of the EMC/TAF operations centers, where windows are provided so the controllers can see both the large-screen display as well as the briefer. Finally, the facility provides office and other personnel support facilities.

Figure 8-7 shows the proposed configuration and layout for the EMC/TAF operations centers. This layout is based on feedback from our NTC I-ALPHA experience, combined with subsequent timeline and operational analyses. It should be noted that our design provides for identical, independent controller stations with identical functional capabilities. Because of this design flexibility, stations and personnel may be reallocated in real time in order to meet the particular operational demands of the moment.

As shown, eight functionally identical stations are provided to cover both EMC and TAF functions for a single BTF (there will be two such centers in the full-up CIS facility). The four stations on the left-hand side are nominally allocated to EMC functions whereas the four right-hand stations cover TAF functions. EMC functions are those associated with creating and maintaining the BLUEFOR training environment while TAF functions are responsible for observing the performance of the BLUEFOR with the intent of

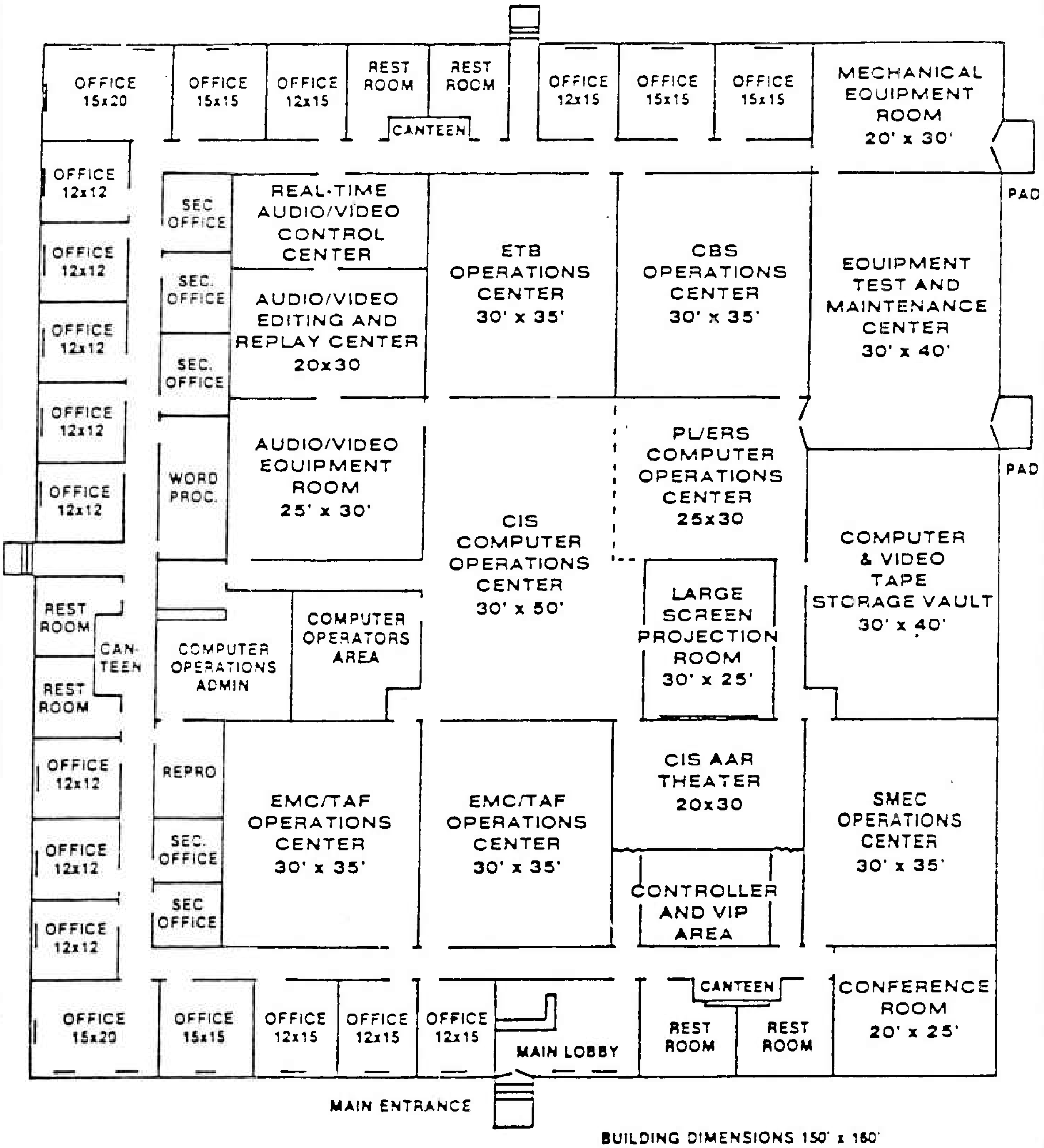


Figure 8-6. CIS Facility Floor Plan

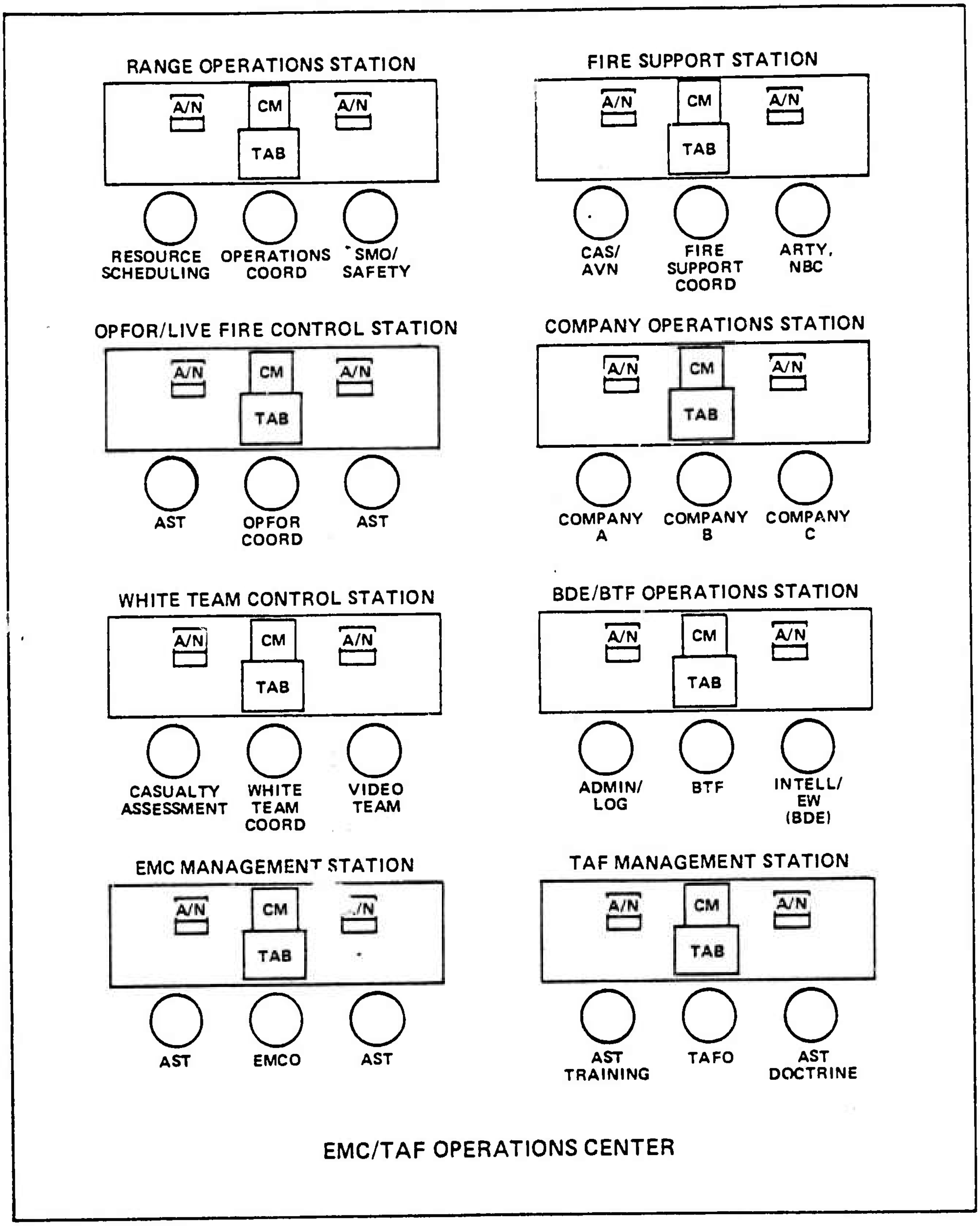


Figure 8-7. EMC/TAF Operations Center Layout and Operational Personnel Allocations

identifying, defining, and presenting key training points to the BLUEFOR in a timely and effective manner.

Figure 8-8 presents a candidate layout for the ETB operations center. The allocation of personnel and functions is tentative at this time since ETB requirements have not been fully defined. In general, the left-hand stations are allocated to training developments while the right-hand stations perform combat develoments functions.

Figure 8-9 presents SAI's recommended layout of the CBS operations center. As shown, there are four maneuver control stations (two for each notional BTFs). The remaining four stations are allocated to fire support, administration log, division operations, and OPFOR operations. The division operations stations will be directed by the command battle simulation officer (CBSO), who will be responsible for all real-time CBS operations.

Figure 8-10 presents the layout and configuration of the recommended standard CIS controller station. All stations are functionally identical in terms of hardware as well as software capabilities. As a result, any station in the CIS facility may be assigned any display and control function.

The main theater area provides seating for approximately fifty people. At the rear of the theater, a VIP observation gallery which will seat fifteen is also proposed. Three color monitors, mounted overhead, are provided in this area to augment the large-screen display.

8.7 SYSTEM INITIALIZATION AND STATUS ASSESSMENT

Based on the experience from NTC I-ALPHA, it is clear that system initialization for the NTC I-ALPHA environment has significant performance implications to the overall cost effectiveness of the National Training Center. Accordingly, SAI has undertaken to automate system and subsystem startup and status procedures consistent with the NTC I-ALPHA effort.

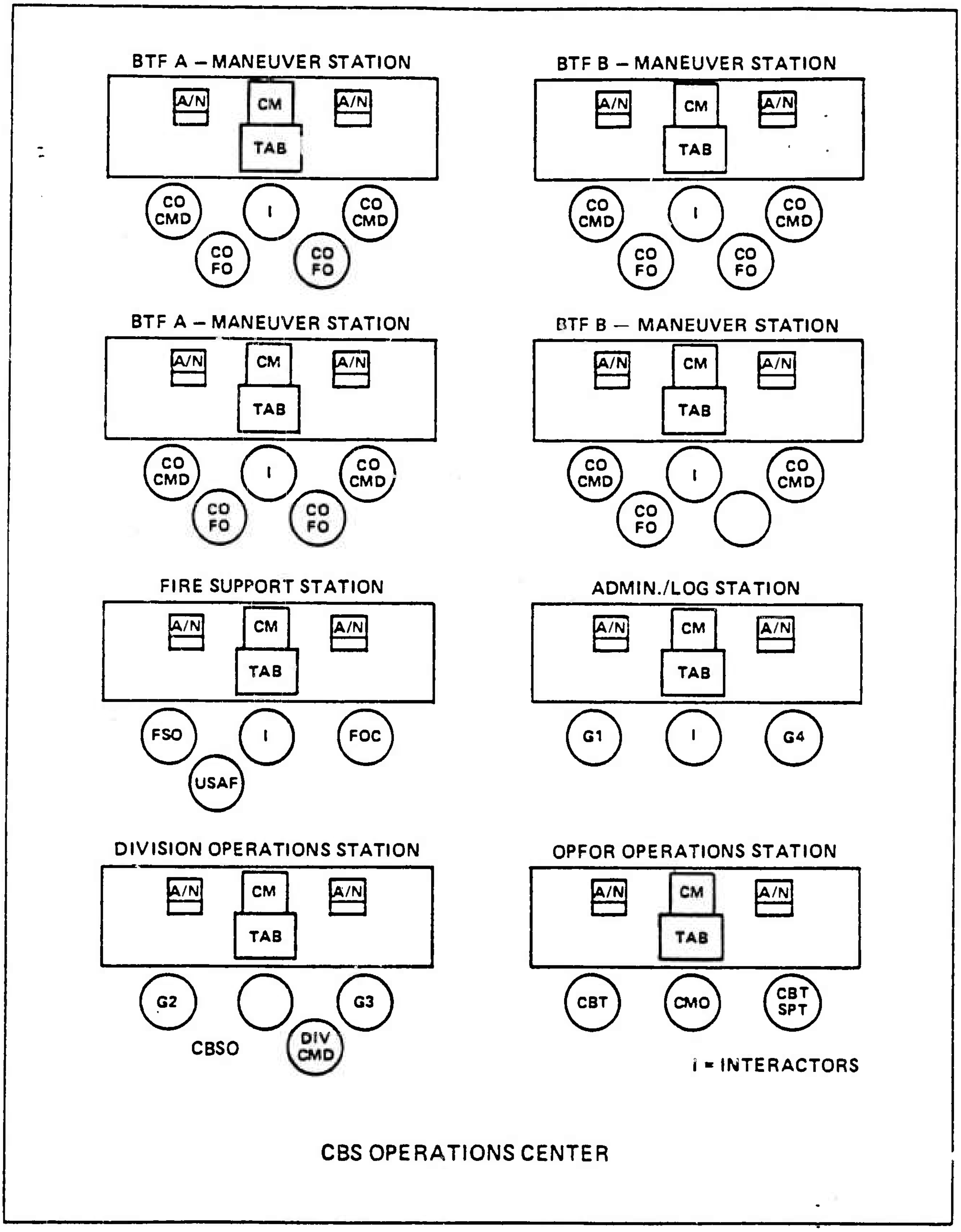


Figure 8-8. CBS Operations Center Layout & Operational Personnel Allocations

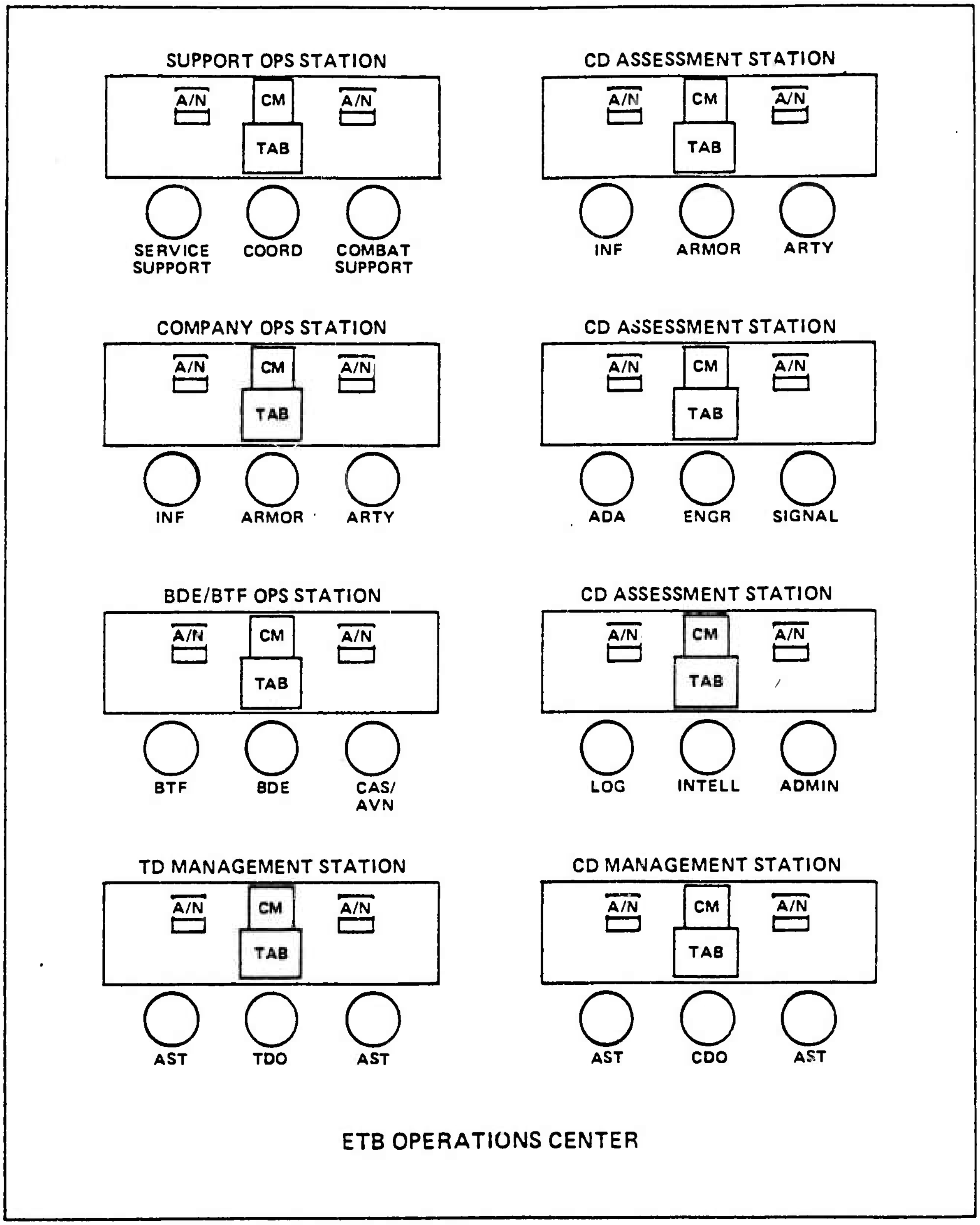


Figure 8-9. ETB Opertions Center Layout and Operational Personnel Allocations

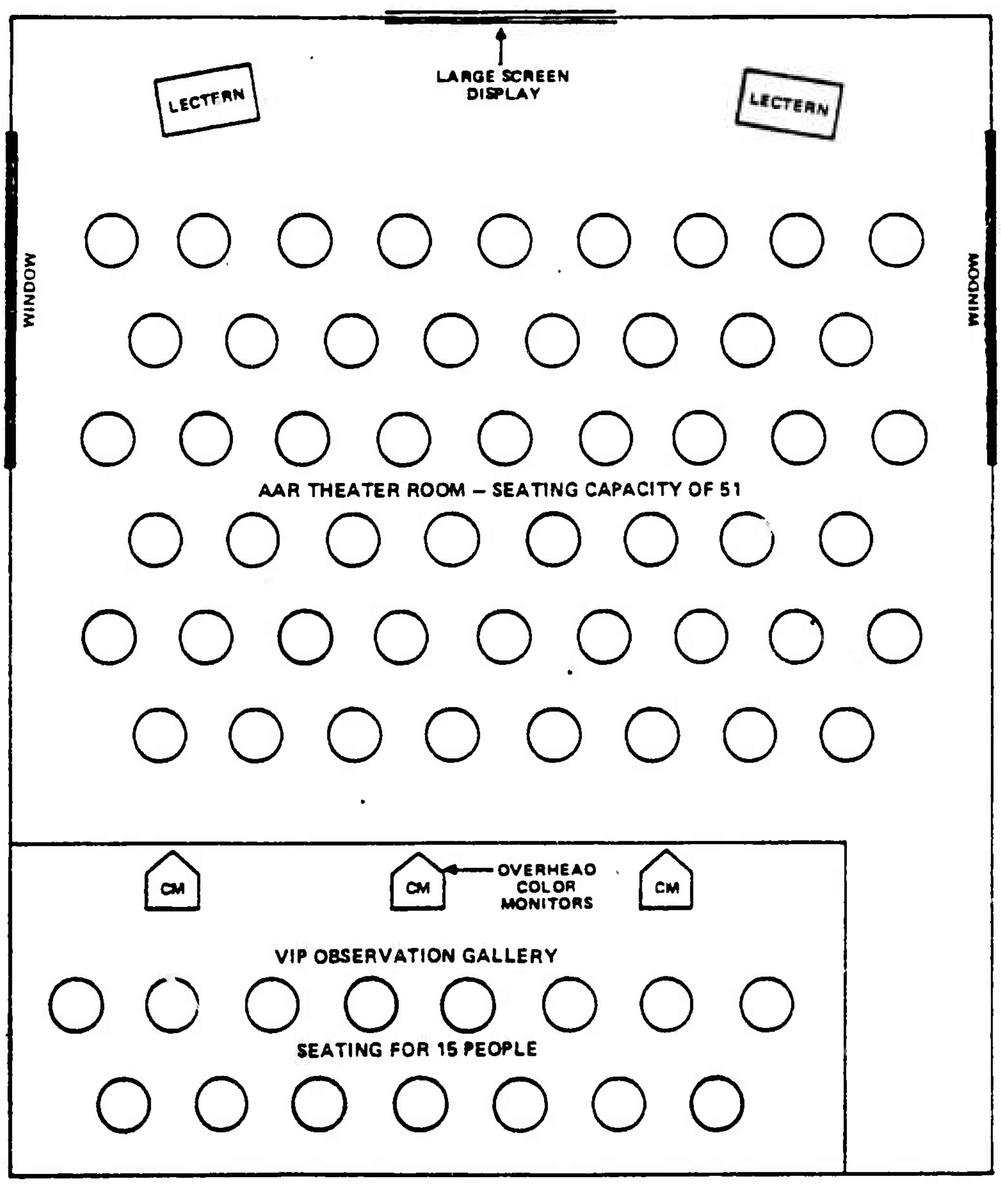


Figure 8-10. CIS AAR Theater Area

Included in this effort are design considerations for the following subsystems: CIS core initialization and status, PLS WES initialization and status, spectrum analysis initialization and status, and player equipment initialization and status. Live-fire support can be added in subsequent efforts as determined by the Army.

8.7.1 CIS Initialization Concept

Prior to each engagement simulation, an initialization phase will occur in the CIS internal system. One or more CIS operators will modify or create, as appropriate, a new unit organization and enter control measure graphics for the exercise scenario. The operator, via an interactive menu, enters the appropriate echelon organization, including battalion, assigned companies, and platoons, and, if applicable, selected squads. In addition to setting up this hierarchical organizational structure, task forces and company teams may be entered. The implication for organizational entries manifests itself in the statistical and graphical presentations during real-time operations. The battle can be viewed as a set of organizational elements, displayed by echelon symbols (FM101-5-1), and particular selected units (Company A, Platoons 2 and 3) can be presented by individual vehicle symbols. Statistical displays will present data organized by the hierarchy set up during initialization.

8.7.2 PLS WES Initialization Concept

Concurrent to internal CIS initialization, the position location subsystem and the weapon engagement subsystem initialization will be supported via an interactive menu system. The PLS B-units can be quickly checked out with automated support. All B units not responding or with anomalous results can be identified for repair or replacement. Similarly, the WES systems will be checklisted through a standard startup procedure with automated support provided by the CIS system. All inoperable weapons can be readily identified. Sensor testing also will be supported by having each sensor checklisted against controller guns or operational WES weapons.

The statistical displays at each station within the CIS will support this phase of initialization by providing a current list of equipment status.

All PL stations will be polled for operational status. As A stations fail to respond during normal operations, an alert will be sent to all statistical terminals. A status assessment menu will be provided for detailed PLS A station verification.

8.7.3 Spectrum Analysis Initialization Concept

The major initialization tasks for spectrum analysis include identification of individual emitters, their associated frequency signatures and a specification of high risk or critical frequencies. Once these data are entered for each emitter, it remains static. However, the assignments of emitters to PL instrumented player is more dynamic. As assignments are changed (i.e., because of radio replacement), the CIS data base must be updated. An interactive menu will be provided for emitter identification, associated signatures, and vehicle or player assignment.

Section 9

REFINED TRAINING REQUIREMENTS

SECTION 9

REFINED TRAINING REQUIREMENTS

The NTC I-ALPHA to Phase I Transitional Operational Training Plan (OTP) examines all NTC training requirements. However, it was determined early within the interim contract that a more in-depth look at non-core instrumentation subsystem and voice/video control and editing component personnel was warranted.

Accordingly, SAI has prepared an analysis of non-CIS/VVCEC personnel training requirements which discusses: 1) job, personnel staffing, and training requirements; 2) logical source suppliers of training; 3) course description and objectives; 4) instructor requirements; 5) number of personnel to be trained; and (6) estimated course lengths and hours of course development required for the following non-CIS/VVCEC areas:

- Field Controller (Non-CIS and Role Player) Field Training
- Field Controller CIS and Role Player Training
- Field Video Team Component Personnel Training
- Field Training and Feedback Component (FTFC Personnel Training)
- Spectrum Management, Evaluation, and Control Subsystem Personnel Training
- Range Data Measurement Subsystem Personnel Training
- Range Management and Communications Subsystem Personnel Training
- Opposing Force CIS Interface Training

Further details on this analysis are contained in the special technical report submitted in January 1981.

Section 10

COMMAND BATTLE SIMULATION

SECTION 10

COMMAND BATTLE SIMULATION

One objective of the NTC is to create command, control, and communications (C^3) realism for the BTF and BDE command groups (commanders and their staff) being exercised at the NTC. In real combat, the commander and his staff interact with subordinate commanders in the field, adjacent command groups, and superior command groups as well as a variety of combat and combat service support elements. The proficiency of these command interactions can play a major, if not dominant, role in determining the overall combat effectiveness of the combined arms team.

Recognizing the importance of C^3, the Army plans to expand the NTC system to provide the means to train BTF and BDE command groups in a realistic combat mode. This capability will be provided within the CBS function by means of role players interacting through controllers with a real-time, freeplay, two-sided battle simulation. The battle simulator models all combat operations to a level of detail needed accurately to reflect the consequences of decisions made within the BDE and BTF command groups. In addition, the CBS function will provide the means to control a simulated OPFOR independently in a real-time action-response manner (i.e., BLUEFOR command groups are opposed by trained and responsive OPFOR).

As currently conceived, the CBS will encompass all battle simulation functions as well as the means to initialize CBS data bases, interactively control the simulation, feedback the battle situation to role players, and record battle simulation history data for after-action reviews.

To facilitate early integration of the CBS function into the NTC, SAI has analyzed and identified CBS functional requirements to the fifth level of detail. Our special technical report, submitted in November 1980, significantly expands on the CBS component that was originally discussed in the Report of Findings on the NTC, published by SAI in December 1978. In that report, CBS was called notional battle simulation component. The latest report provides the basis for the detailed CBS software design when that task is activated.

Section 11

FINDINGS AND CONCLUSIONS

SECTION 11

FINDINGS AND CONCLUSIONS

11.1 SUMMARY OF FINDINGS AND CONCLUSIONS

Realistic combined-arms training is a central Army requirement; one that, if neglected, threatens losses beyond acceptable limits. The comprehensive NTC development program represents a major commitment by the Army to satisfy that requirement for its armored and mechanized forces. The objective of SAI's tasks was to assist the Army in achieving an early NTC operational capability with minimum technical, schedule, and cost risks. This objective has been achieved. When fully operational, the experiential learning and evaluation environment which the NTC will provide has the potential to raise the level of unit tactical effectiveness to a point never before achieved in peacetime. Several unique attributes of the NTC support this conclusion:

- Its size and location (away from civilian communities) will permit the unrestricted exercise of battalion task forces and a wide array of supporting tactical systems.
- Its application of advanced technology devices such as lasers, computers, position location systems, and munition simulators will create a near-combat environment for experiential learning.
- Its one-of-a-type nature also will permit the development of skillful and dedicated opposing force, the stationing of heavy equipment modified to meet NTC needs, the deployment of special communications, and the employment of highly selected controllers and training personnel.
- Its carefully designed computer systems will capture and retain data that can be used to:
  - Assess training effectiveness,
  - Assist in reviewing doctrine and readiness,
  - Aid in weapons analyses and modeling,
  - Provide follow-on remedial training, and
  - Measure the degree of experiential learning.

The paragraphs which follow summarize the major conclusions derived from the NTC Baseline Analyses, the NTC I-ALPHA program, and the Phase I transitional period. In addition, findings are provided related to program difficulties that SAI encountered.

11.2 NTC BASELINE ANALYSIS

The initial NTC baseline analysis conducted by SAI was an essential step in establishing a framework for an early operational capability of the NTC by TRADOC. SAI's detailed functional analysis, carried out to the fourth level of detail, defined for the first time NTC system functions and interfaces. Moreover, it provided the first comprehensive specification of functional requirements, which with only minor refinements, have proven valid in subsequent development stages.

The concept, developed during the baseline analyses, of using off-the-shelf technology for NTC I-ALPHA has proven sound and will allow the Army to attain an early operational capability with minimum risks.

11.3 NTC I-ALPHA

The NTC I-ALPHA program has validated SAI's design of the core instrumentation system. Specifically, the program successfully accomplished the following:

- Demonstrated a prototype SAI core instrumentation subsystem, including exercise management and control and trainiing analysis and feedback functions, and displays in an interactive mode with troops. Selected video and voice recording hardware also were integrated.

- Demonstrated a distributed, direct-fire, real-time casualty assessment, engagement-simulation system using the multiple integrated laser engagement system engagement simulation system, interfaced with position locating and event recording.

- Demonstrated a basic method of indirect fire casualty assessment that combined computer-stored location data and field controller/fire markers.

- Demonstrated the feasibility of SAI's interface between the CIS and RMS 2, a representative multilateration position locating system for ground tactical vehicles.

- Demonstrated a flexible SAI system for data collection that can be manipulated to display selected MOE/MOP for after-action reviews.

- Provided valuable experience in EMC and TAF functioning and insights for future operator training requirements.

- Provided valuable experience with the field controller structure and its interface with the core instrumentation.

11.4 PHASE I TRANSITION

The transitional concept of dividing the NTC instrumentation system into three major subsystems, range data measurement, core instrumentation, and range monitoring and control, will minimize the complexity of subsystems interfaces during Phase I development.

The Phase I transitional design provides for the recovery of the software developed for the Army during the NTC I-ALPHA program. This consists of over 40,000 lines of source code, approximately 90% FORTRAN IV.

SAI's detailed analysis and definition of requirements to support Phase I design and operator training incorporate the significant lessons learned from the NTC I-ALPHA program and provide for an orderly, evolutionary growth of NTC capabilities.

11.5 DIFFICULTIES ENCOUNTERED

Aside from the problems normally associated with a development program of the scope and complexity of the NTC, other significant difficulties were encountered, the most important of which related to funding.

From the SAI perspective, the difficulties frequently experienced in identifying and obligating funds to support NTC development resulted in a "stop and start" effect that threatened program continuity and momentum.

On several occasions, for example, SAI was faced with the prospect of diverting its NTC technical and management staff to other projects because of funding uncertainties. However, most key personnel were retained, at a considerable risk, until funding issues were resolved.

Another related difficulty was caused by the reiterated requirement to keep costs at a minimum. This resulted in employing fewer people to work on solving problems, restrictions on the types of expertise routinely available, and limited hardware options. While the NTC will reach IOC very close to schedule, SAI believes that an initial higher level of funding could have avoided many of the constraints encountered in the development and would in the long-run have reduced costs.

In another vein, several coordination and management difficulties were encountered during the NTC I-ALPHA program because of the co-equal status of participating contractors, SAI, FACC, and GDE. While every effort was made to minimize such difficulties, a prime-subcontractor relationship would have been more effective and would have reduced the burden on the Army program manager.

The remote location, austere environment, and climatology of Fort Irwin can be a significant challenge to the ingenuity and capabilities of all concerned. The impact of these factors on Phase I planning must be thoroughly addressed (see NTC I-ALPHA Final Report dated 20 May 1980).

The NTC I-ALPHA program was extraordinarily ambitious in terms of the time allotted to the following critical activities:

- Software Development,
- Hardware Procurement,
- Systems Integration and Testing,
- Software Application and Testing, and
- Operator Training.

As a result, all these activities were conducted essentially in parallel. The net effect was unnecessary program risk and turbulence. Operator training, in particular, was seriously affected by the schedule constraints. To be meaningful, such training should be conducted only after the other critical activities are completed.

The need for a definitive set of measures of effectiveness and measures of performance has not been fully satisfied. As a result, SAI related software and display tasks remain undefined. This situation will create further difficulties in the Phase I development process unless a concensus is reached in the near future.

11.6 FUTURE TASKS

Looking ahead, the most salient feature of the NTC will be its evolutionary growth. The basic objective which the NTC must meet is to provide a realistic combat environment for training. To accomplish its purpose, NTC capabilities must evolve and change with doctrine and techniques of warfare. In this process additional elements of combat must be incorporated to enhance the training environment. Refinements must be made also to existing instrumentation. Categorized below are future tasks which SAI believes should be addressed on a priority basis.

11.6.1 Field Artillery

Indirect fires are already a part of NTC, but the speed, completeness, and flexibility of their implementation needs to be improved. A system should be considered which will permit automated monitoring of the field artillery TACFIRE system. In addition, further research is required to develop a suitable method for marking fires.

11.6.2 Close Air Support

Use of tactical aircraft, both fixed wing and rotary wing, in a support role, is currently within the state of the art. It is not inexpensive to instrument aircraft, but the training benefit should more than offset the costs. Realism in offensive or defensive operations will be greatly affected by the presence or absence of U. S. Army and U. S. Air Force air support.

11.6.3 Electronic Warfare

Intelligence indicates that the Soviets have given major attention to electronic warfare, and U. S. forces in the field can expect to be attacked by electronic means. EW training, in both an offensive and defensive mode, will become an important aspect of training at Fort Irwin. A feasible means of EW employment should be examined with an eye toward prompt application to the NTC program.

11.6.4 Nuclear, Biological, Chemical

Combat in the European theater must be considered to involve NBC. The Warsaw Pact forces train seriously in both offensive and defensive NBC measures. Inclusion of the nuclear and chemical facets of warfare should be introduced relatively early in the next phases of the NTC. The biological training requirement remains undefined.

11.6.5 Air Defense

Realistic air defense training should be introduced at the same time close air support is introduced into the NTC. This will require laser emitters and sensors (or other suitable means of realistic engagement simulation) on aircraft as well as on the divisional air defense weapons.

11.6.6 Mine Warfare

Emplacement and a breaching of mine fields is planned to be a part of the NTC training. Such operations are currently within the state of the art and, depending on how training is tailored for each unit, should be incorporated into scenarios. Commanders should have a "menu" from which they will be able to designate the types of training needed by their units. Mine warfare should be included on this menu.

11.6.7 Post-Processing Training Analysis

SAI has recommended a computer program that will construct a take-home instructional package. This package will be processed in an off-line mode following termination of the exercise and upon completion of the after-action review. The preparation of this take-home package will be linked to the after-action review through the exercise simulation history file. Specific MOE and MOP combinations that can be supported by data from the exercise simulation history file and that answer selected essential elements of analysis can be processed by an off-line program.

The product of this processing will be a take-home report that will be directly correlated with the after-action review and will provide a package of salient instructional points which can be reviewed (without special equipment) by the unit at home station.

Examples of the formats used for displaying data that support the EEA are: 1) graphs and charts, 2) tables, 3) lists, 4) hard copy of graphic overlays for a particular map area, and 5) critical events that were controller identified. The list is potentially much larger and can be expanded as requirements increase and the configuration of the take-home package becomes clarified.

11.6.8 NTC Planning and Scheduling

Although hard requirements have not been specified, the NTC Phase I software design should provide significant latitude for support of exercise planning and scheduling functions. For example, equipment and a vehicle maintenance status and available quantities of supplies (gas, oil, ammunition) can be stored in an operational data base.

Such a resource management function can be fully supported by the initial set of both hardware and software (data base services, menu services, etc.) recommended as part of the IOC configuration.

11.6.9 Support Software

SAI developed a number of software development, maintenance, and testing tools to speed and simplify the program development process. They should be provided as part of the Phase I CIS configuration.

- Requirements Tracing Module -- A requirements tracing module has been designed by SAI automatically to map software requirements from high-level mission requirements through system and software level requirements to the actual code. This requirements data base will provide extensive enhanced requirements analysis capabilities and provide significant management support for trade-off analysis and cost operational-effectiveness analysis.

- Librarian -- SAI has developed an automated source code librarian for maintaining configuration control of software products. The librarian is able to track and maintain software products through various versions and configurations, allowing the reconstruction of any version or configuration of a program automatically. The librarian was designed to force a rigid configuration control system so that a software product may easily evolve to various levels of capability without the loss of integrity of previous versions.

- Automatic Test Analysis Tool -- SAI has prepared several automated analysis tools for the testing of software. One such tool provides metrics on a number of key software attributes (such as program complexity) to note areas requiring the most extensive testing. Using such a tool avoids the redundant (and costly) testing of all areas of the program to the same level of detail by focusing the attention of system integrators on those areas of the program in need of critical review.

11.6.10 Mobile Instrumentation

As a spinoff of the NTC development programs, SAI believes that it is feasible to develop mobile, small-scale versions of NTC instrumentation that could be used to enhance small-unit training. Such systems could be taken to locations where active- and reserve-component units can train at the squad, platoon, and company level. Other variations of this concept could be aimed at improving training for the rapid deployment force and for specialized training, such as combat in cities, air landings, and river crossings.

Appendix A

LIST OF ACRONYMS

APPENDIX A

LIST OF ACRONYMS

AAR	After Action Review
ARTEP	Army Training Evaluation Program
BDE	Brigade
BLUEFOR	Blue Force
BTF	Battalion Task Force
C^3	Command, Control, and Communications
CAS	Close Air Support
CATRADA	U. S. Army Combined Arms Training Development Agency
CBI	Computer Based Instruction
CBS	Command Battle Simulation
CBSO	Command Battle Simulation Officer
CC	Computational Component
CCM	Cross Country Mobility
CIS	Core Instrumentation Subsystem
CONUS	Continental United States
DARPA	Defense Advanced Research Projects Agency
DCC	Display and Control Component
DIC	Digital Interface Component
DMA	Defense Mapping Agency
DTID	Digital Terrain Image Display
ECAC	Electromagnetic Compatibility Analysis Center
ECR	Engineering Change Request
EEA	Essential Elements of Analysis
EMC	Exercise Monitoring and Control
ES	Engagement Simulation
ETB	Experimental Test Bed
EW	Electronic Warfare
FACC	Ford Aerospace and Communications Corporation
FC	Facility Component
FORSCOM	U. S. Army Forces Command
GDE	General Dynamics/Electronics
I/O	Input/Output
IFCAS	Indirect Fire Casualty Assessment
IOC	Initial Operational Capability
ISD	Instructional Systems Development
LF	Live Fire
MOE	Measures of Effectiveness
MOP	Measures of Performance
MTBF	Mean-Time Before Failure

APPENDIX A

LIST OF ACRONYMS (Cont'd)

NBC	Nuclear, Biological, Chemical
NTC	National Training Center
OPFOR	Opposing Force
OTP	Operational Training Plan
PDR	Program Design Review
PEDAP	Post-Exercise Data Analysis Process
PLS	Position Location Subsystem
RAM	Reliability, Availability, and Maintainability Assessment
RDMS	Range Data Measurement Subsystem
RMCS	Range Management and Communications Subsystem
RMS	Range Management System
RTCA	Real-Time Casualty Assessment
RTT	Requirements Tracing Tool
SAI	Science Applications, Inc.
SDDL	Software Design and Development Language
SMECS	Spectrum Management, Evaluation, and Control Subsystem
TAF	Training Analysis and Feedback
TMT	Test Management Tool
TRADOC	Hq., U. S. Army Training and Doctrine Command
TSD	Test Support Driver
USACDEC	U. S. Army Combat Developments Experimentation Command
VRS	Voice Recording System
VVCEC	Voice/Video Control and Editing Component
WES	Weapon Engagement Simulation

Appendix B

TECHNICAL REQUIREMENTS, SAI REPORTS, MAPPING

NTC PROJECT

REQUIREMENT	DELIVERABLE
NTC BASELINE ANALYSIS • Concept Synthesis • Functional Analysis • Technology Assessment • Implementation Concepts • Program Roadmaps • System Specification	(1) Report of Preliminary Findings on National Training Center, September 1978 (2) Supplement to Report of Preliminary Findings: Functions and Functional Interactions, September 1978 (3) Report of Findings on National Training Center, December 1978 (4) Supplement to Report of Findings; Functions and Functional Interactions, July 1979 (5) NTC System Specification with Associated Development Specification, July 1979
CIS DESIGN • Performance Requirements • Key Software Algorithms and Data Bases • Interface Requirements • Sizing, Accuracy and Timing Requirements • Availability Requirements	(6) National Training Center I-ALPHA Build; Software Design Document (Preliminary Version), September 1979 (7) National Training Center I-ALPHA Build; Software Design Document, May 1980 (8) "HIPO" Charts (Delivered Informally to Systems Planning Corporation at Govt. Request), Aug. 1979

REQUIREMENT	DELIVERABLE
SUPPORT OF NTC I-A ● Define and Specify Hardware ● Develop the Software ● Integrate and Test Software ● Develop Test Scenarios ● Modify Digital Map Preprocessor for NTC Application ● Train Army Personnel for CIS Operation ● Develop ARR Techniques ● Provide On-site Support for CIS Operation	(9) Tape of Release 2.1 (provided to Maj. Kaufman, 12 June 1980) (10) Revised Scenario Tapes (6) (11) User's Manual, DMA Data Conversion Process for NTC Terrain Data Base, July 1980 ● Training Covered in Report (14) ● AAR Techniques Covered in Report (14) ● CIS Design and Specifications Covered in Reports (6, 13) **SAI INTERNAL STAFF PAPERS** ● EEA, MOE and MOP Processing in Post Exercise Period, Oct. 79 ● NTC Combat Evaluation EEA, MOE, MOP Interpretive Guide, Nov. 79 ● Analysis of AAR Processing in Post Exercise Period, Dec. 79 ● NTC-1A Orientation Handbook for CIS Operators, Dec. 79 ● POI for NTC-1A EMC/TAF Operations Personnel Training, Dec. 79 ● NTC AAR Process: An Upgraded Design, Oct. 80

REQUIREMENT	DELIVERABLE
NTC I-A ANALYSIS AND REVISION • Refine CIS Design (hardware & software) Based Upon I-A Experience • Design a Software Requirements Traceability Module • Revise NTC Functional Interface Diagrams • Develop Software Configuration for a Test Support Driver • Recommend Design of AAR • Develop a Preliminary CIS Operation Training Program • Develop CIS Manning Recommendations • Explore Human Factors Considerations	(12) Preliminary Design, NTC Test Support Driver, February 1980 (13) NTC CORE Instrumentation Subsystem (CIS) Design Modification and Upgrade Based Upon NTC I-A Test Results (Preliminary Version), June 1980 (14) CIS Operations, Training and Manning, June 1980 (15) National Training Center Test Support Driver Detailed Design, June 1980 (16) Software Requirements Traceability Module for the NTC CIS, August 1980 (17) NTC CIS Design Modification and Upgrade Based Upon NTC I-A Test Results (Final Version) Nov. 80 (18) Functional Requirements for the Command Battle Simulation (CBS) Function Nov. 80 (19) Post-Processing Training Analysis (PEDAS/MEDAS), Jan. 81 (20) NTC After Action Review Process: An Upgraded Design, Jan. 81

REQUIREMENT	DELIVERABLE

I-A TO I TRANSITIONAL DESIGN
• Requirements Analysis
• CIS Transitional Design
    • Hardware
    • Facilities
    • Configurations
    • Software
• Software Development
    • Expanded Interactive Display and Control
• Expanded Design of TSD
• Develop Requirements for SDF
• Training Plan Outline
• Staff Planning Orientations
• In-Plant Technical Courses
• OJT Courses
• Continuing Training
	(21) Field Training Feedback Component/Theater After Action Review, Jan. 81
	(22) Voice/Video Control and Editing Component Transitional Design, Jan. 81
	(23) Core Instrumentation Subsystem and Voice/Video Control and Editing Component Man-Man Interface, Jan. 81
	(24) NTC Operational Training Plan Outline, Jan. 81
	(25) Requirements Analysis for NTC In-Plant Technical Training Courses, Jan. 81
	(26) Training Support for Non-CIS/VVEC Personnel, Jan. 81
	(27) Technical Orientation Courses, Jan. 81
	(28) Computer Based Instruction and Test Support Driver, Feb. 81

REQUIREMENT	DELIVERABLE
PROGRAM PLANNING AND ANALYSIS ● Assist TRADOC and DARPA in Planning and Developing NTC Activities	FOLLOWING "WHITE PAPERS" WERE PROVIDED TO TRADOC DURING PERIOD JAN. 79 - AUG. 79 ● Command Battle Simulation in NTC Phase I ● Fidelity and Accuracy on NTC Exercises ● Firer-Target Time Pairing Coincidence ● National Training Center Requirements ● Handling of NBC in NTC CORE ● NTC Central CORE Control of Live Fire Range ● NTC Live Fire Range Instrumentation ● NTC Air Defense Functions ● NTC Core Implementation at I-ALPHA Test: A Developmental Concept ● NTC Radio Spectrum Management

Appendix C

PROJECT FUNDING

SAI NTC PROJECT FUNDING

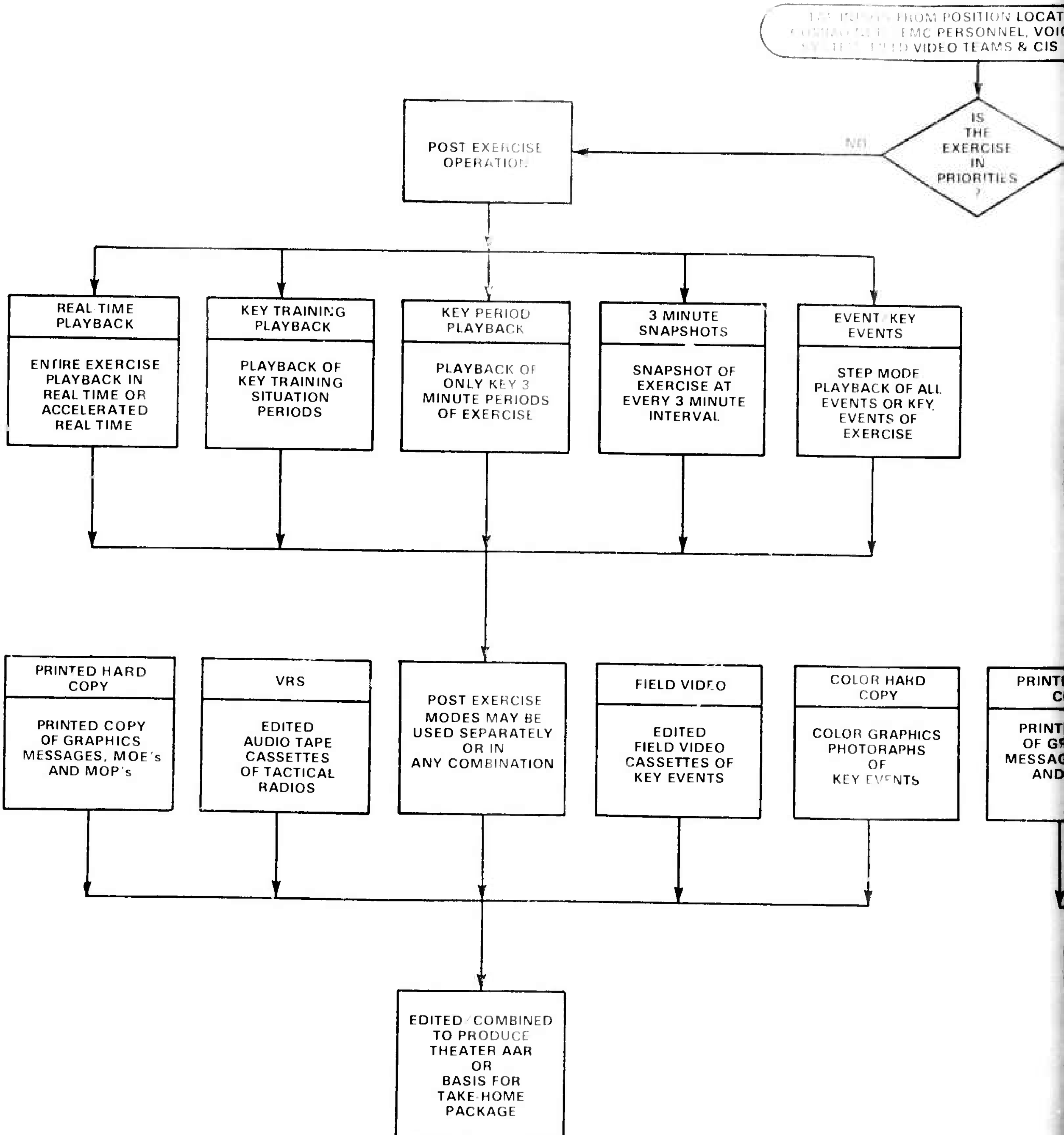
CONTRACT NO: DAAK40-78-C-0198

WORK EFFORT	TECH. REQUIREMENT NO.	CONTRACT MOD. NO.	AMOUNT FUNDED
NTC Baseline Analysis	N094 26 Jun 78	PZ0001	101,493
CIS Design	N094, Amend. #1 24 Jun 79	P00003	99,791
Support NTC I-A Development	N094, Amend #2 9 Jul 79	P00004	449,857
	N094, Amend #3 17 Sep 79	P00005 PZ0007	294,100
Support NTC I-A Exercise	N 157-80 31 Jan 80	P00010 PZ0011	1,489,243
IA to I Transition Design and Training Plan Outline	N 157-80, Amend #1 5 Sep 80	P00013 PZ0016	855,886
		TOTAL	3,290,370

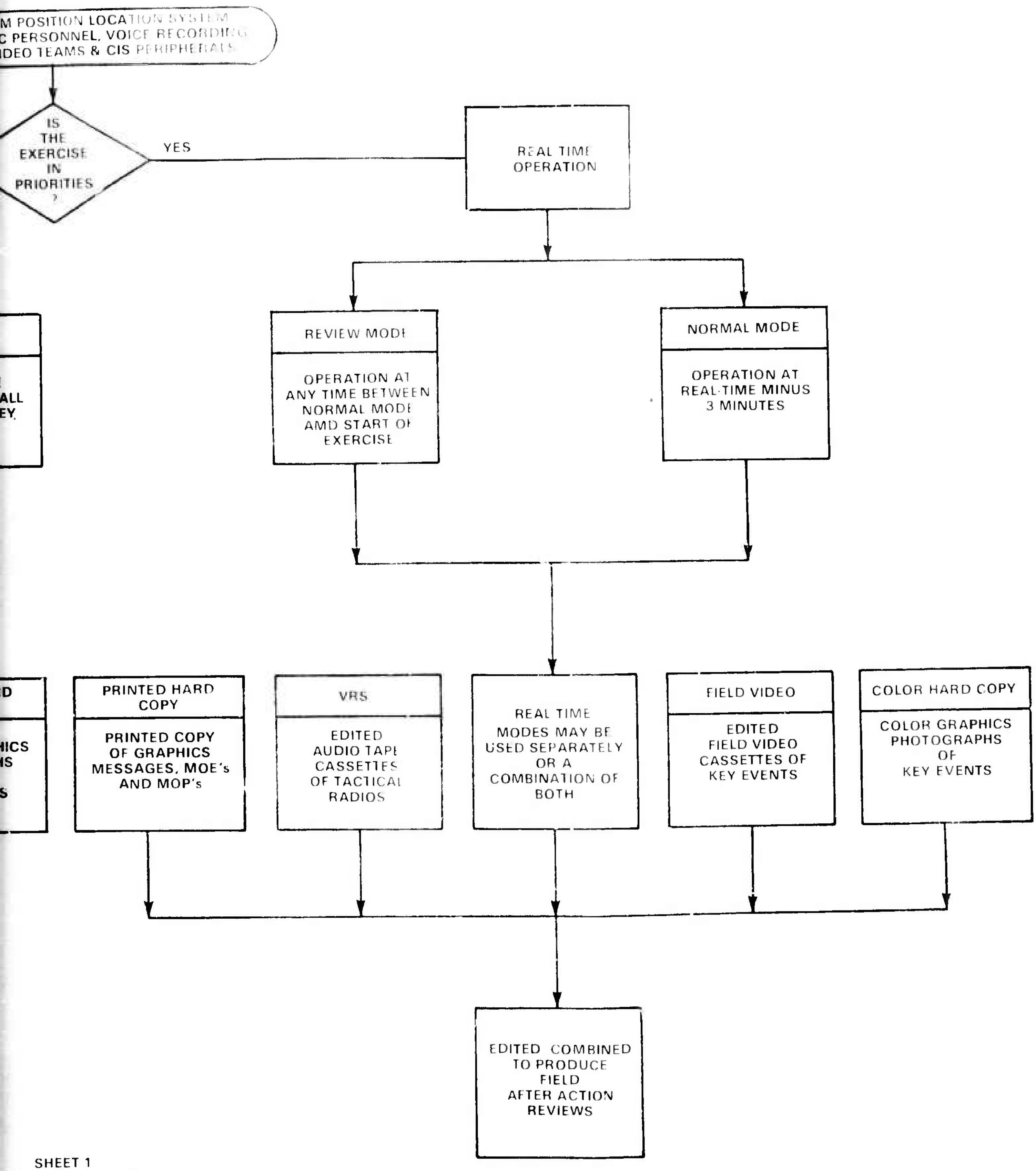
Contract Mods 2,6,8,9,12,14,15 were administrative modifications

Appendix D

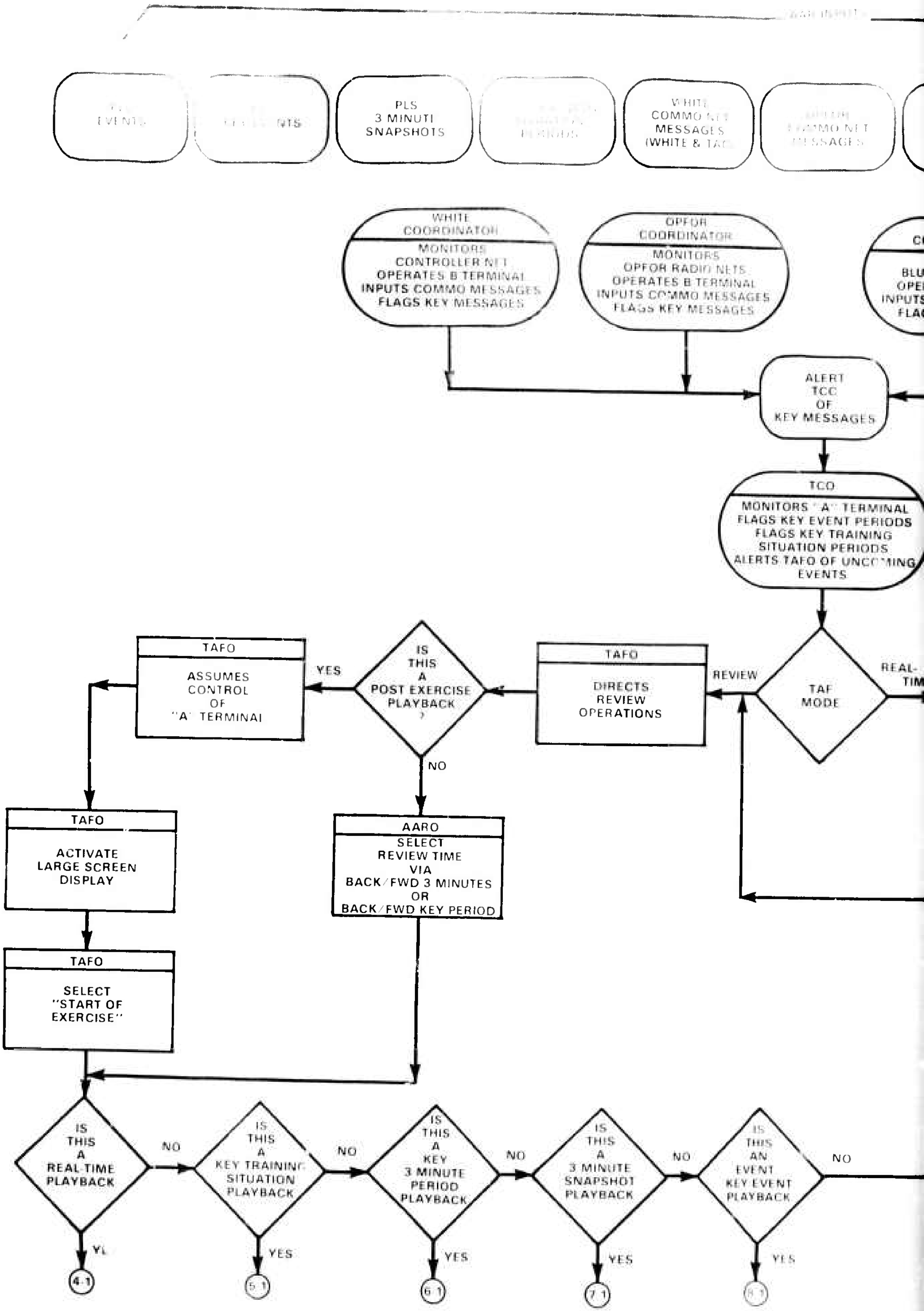
LOGIC FLOW FOR AAR PREPARATION



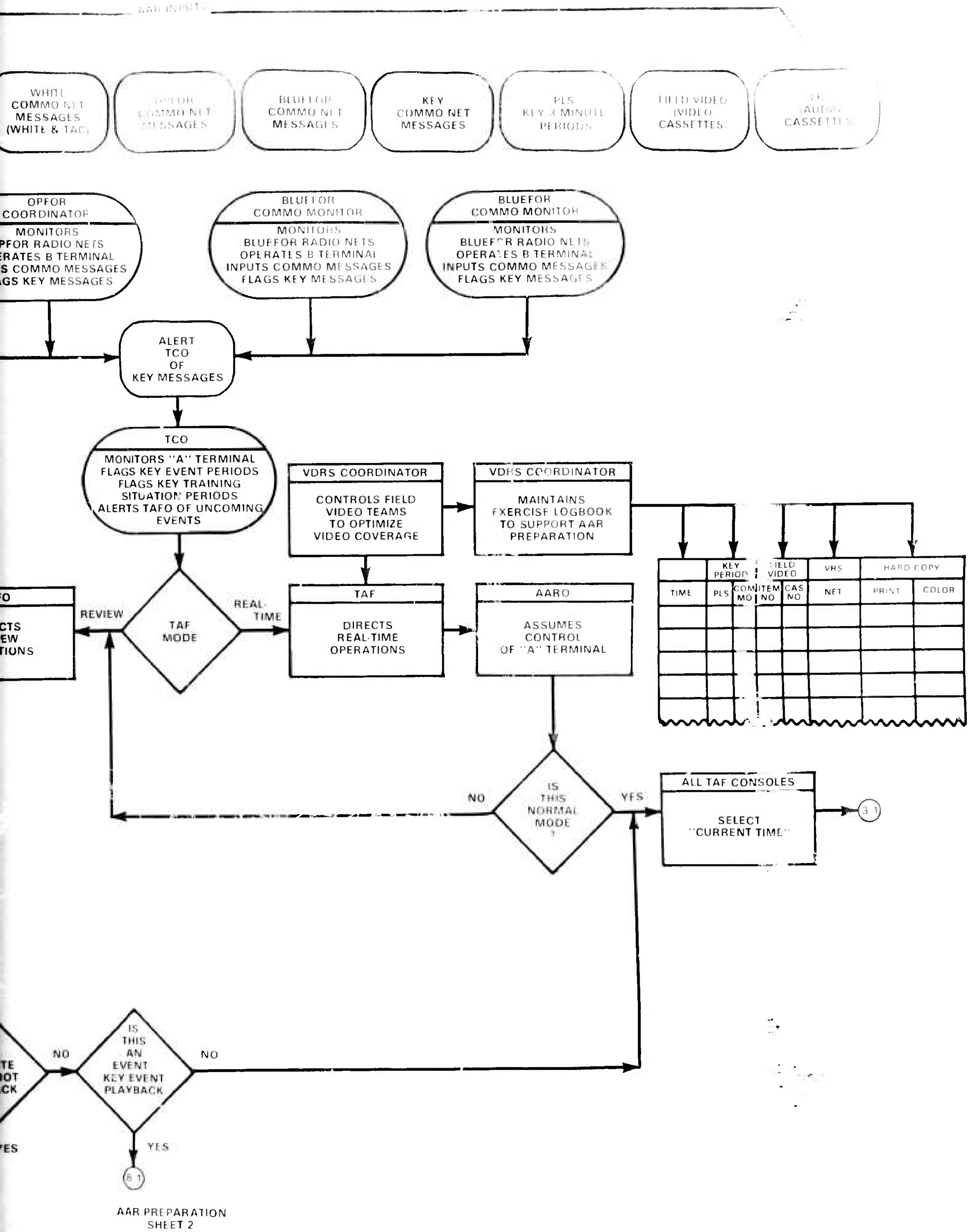
SHEET 1
TAF OPERATION MODES
AAR PREPARATION

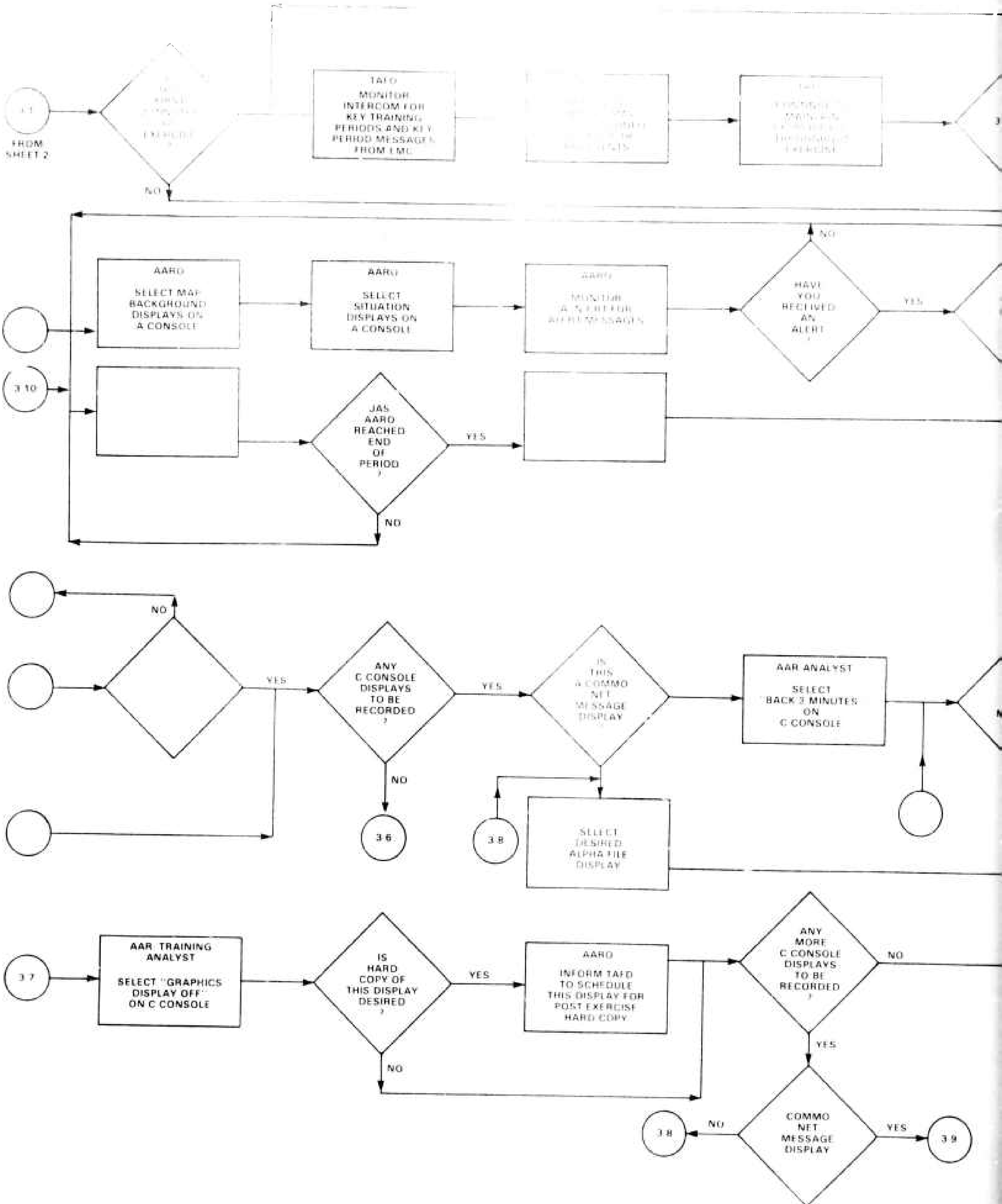


SHEET 1
F OPERATION MODES
AAR PREPARATION

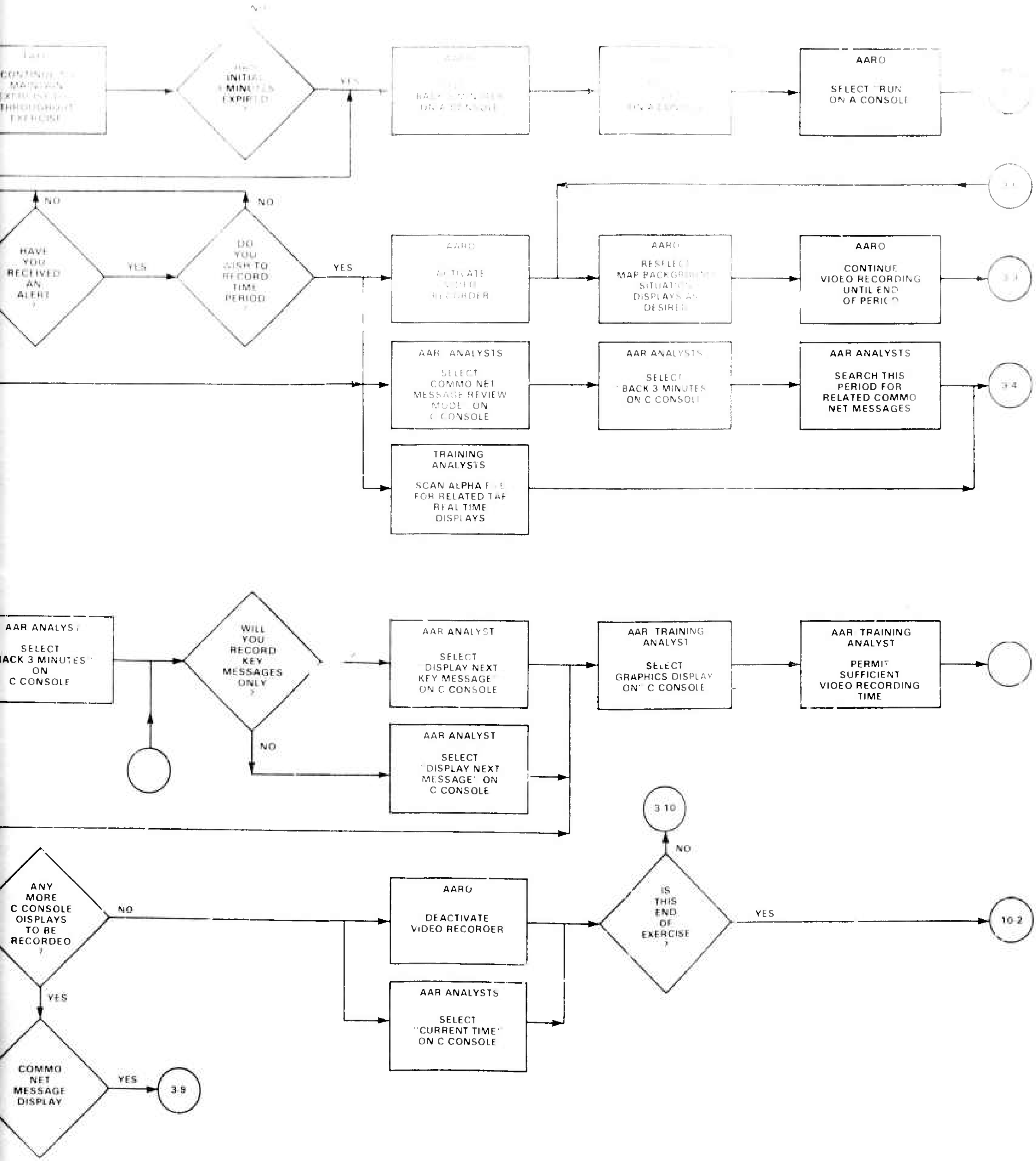


AAR PREPARATION
SHEET 2

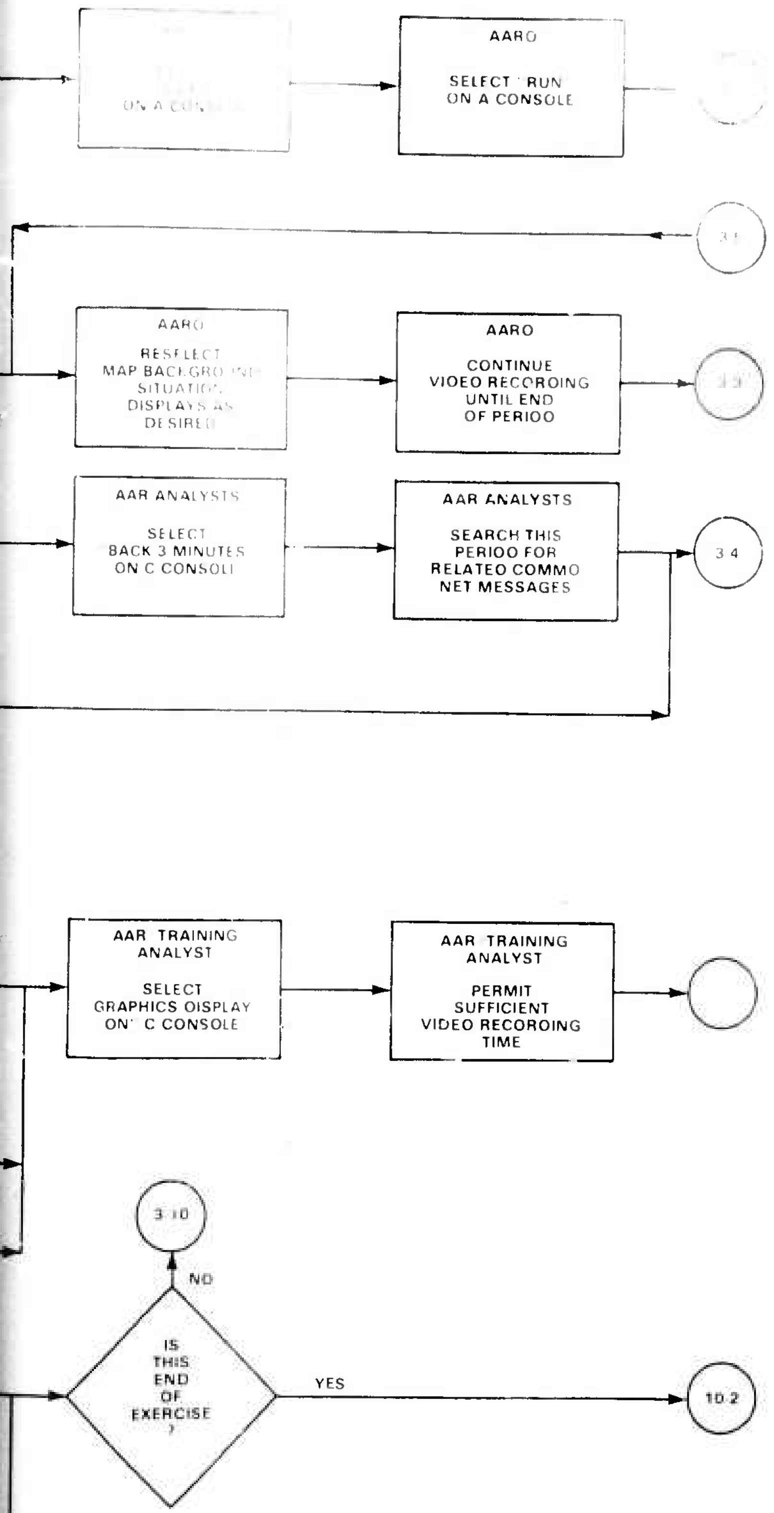

WHITE COMMO NET MESSAGES (WHITE & TAC)
BLUEFOR COMMO NET MESSAGES
KEY COMMO NET MESSAGES
PLS KEY 3 MINUTE PERIODS
FIELD VIDEO (VIDEO CASSETTES)
CASSETTES
OPFOR COORDINATOR
MONITORS
PFOR RADIO NETS
ERATES B TERMINAL
S COMMO MESSAGES
AGS KEY MESSAGES
BLUEFOR COMMO MONITOR
MONITORS
BLUEFOR RADIO NETS
OPERATES B TERMINAL
INPUTS COMMO MESSAGES
FLAGS KEY MESSAGES
BLUEFOR COMMO MONITOR
MONITORS
BLUEFOR RADIO NETS
OPERATES B TERMINAL
INPUTS COMMO MESSAGES
FLAGS KEY MESSAGES
ALERT TCO OF KEY MESSAGES
TCO
MONITORS "A" TERMINAL
FLAGS KEY EVENT PERIODS
FLAGS KEY TRAINING SITUATION PERIODS
ALERTS TAFO OF UNCOMING EVENTS
VDRS COORDINATOR
CONTROLS FIELD VIDEO TEAMS TO OPTIMIZE VIDEO COVERAGE
VDRS COORDINATOR
MAINTAINS EXERCISE LOGBOOK TO SUPPORT AAR PREPARATION
TIME
KEY PERIOD
PLS
COMMO
FIELD VIDEO
ITEM NO
CAS NO
VRS
NET
HARD COPY
PRINT
COLOR
FO
CTS
EW
TIONS
REVIEW
TAF MODE
REAL-TIME
TAF
DIRECTS REAL-TIME OPERATIONS
AARO
ASSUMES CONTROL OF "A" TERMINAL
NO
IS THIS NORMAL MODE ?
YES
ALL TAF CONSOLES
SELECT "CURRENT TIME"
3.1
TE
IOT
CK
NO
IS THIS AN EVENT KEY EVENT PLAYBACK
NO
YES
YES
8.1
AAR PREPARATION
SHEET 2

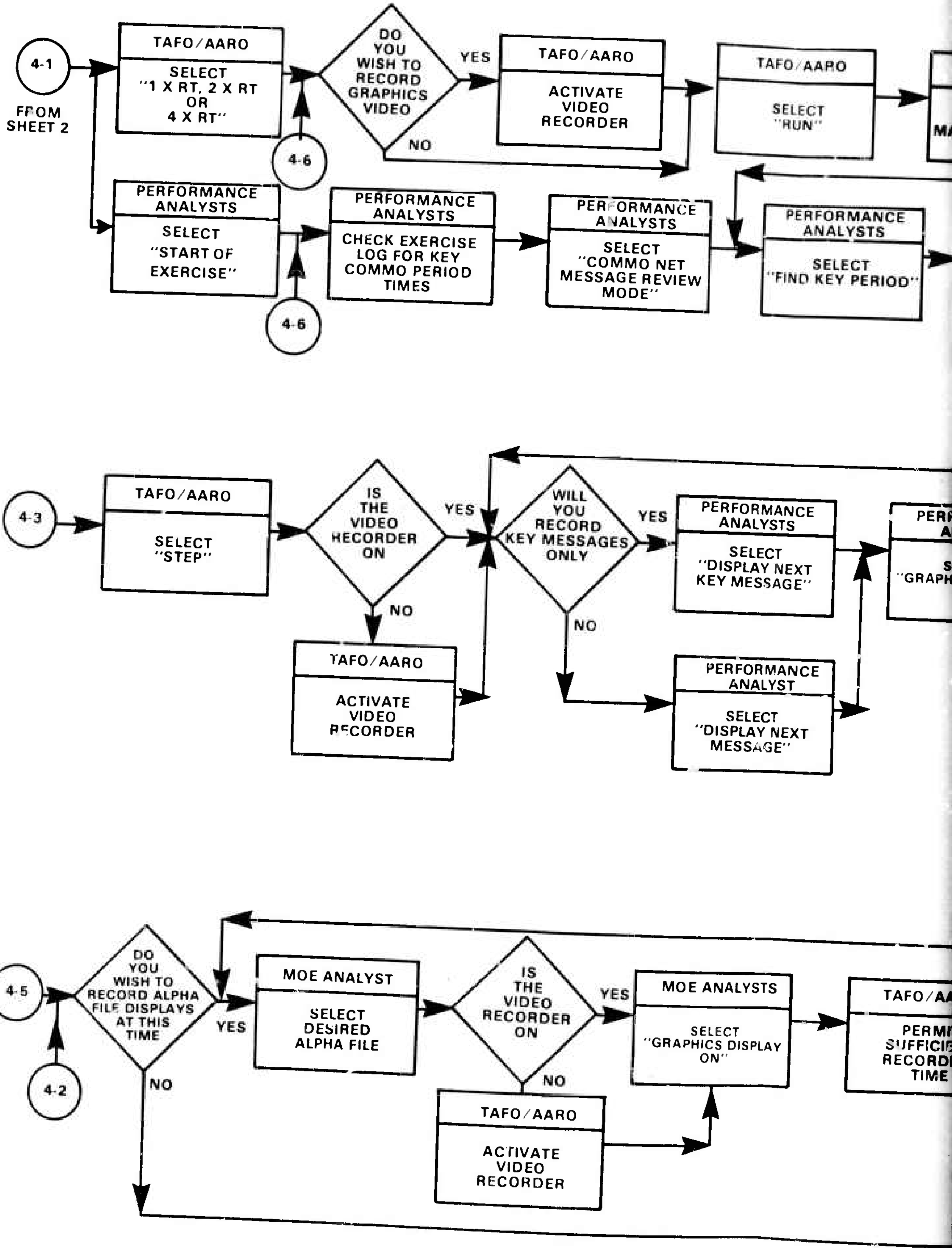


SHE
TAF NORMAL OPERATION
AAR PREP

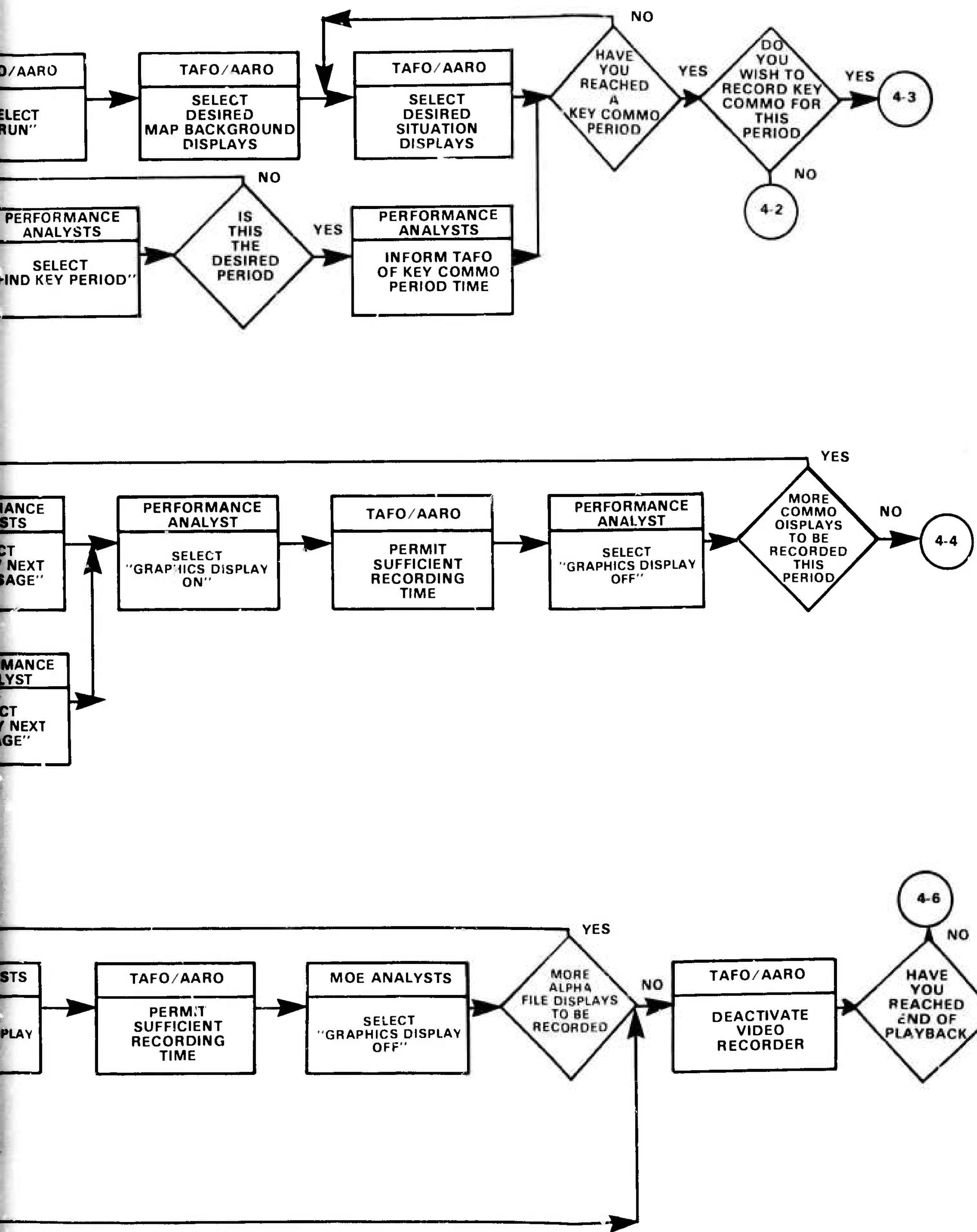


SHEET 3
TAF NORMAL OPERATION MODE (RT 3 MINUTES)
AAR PREPARATION

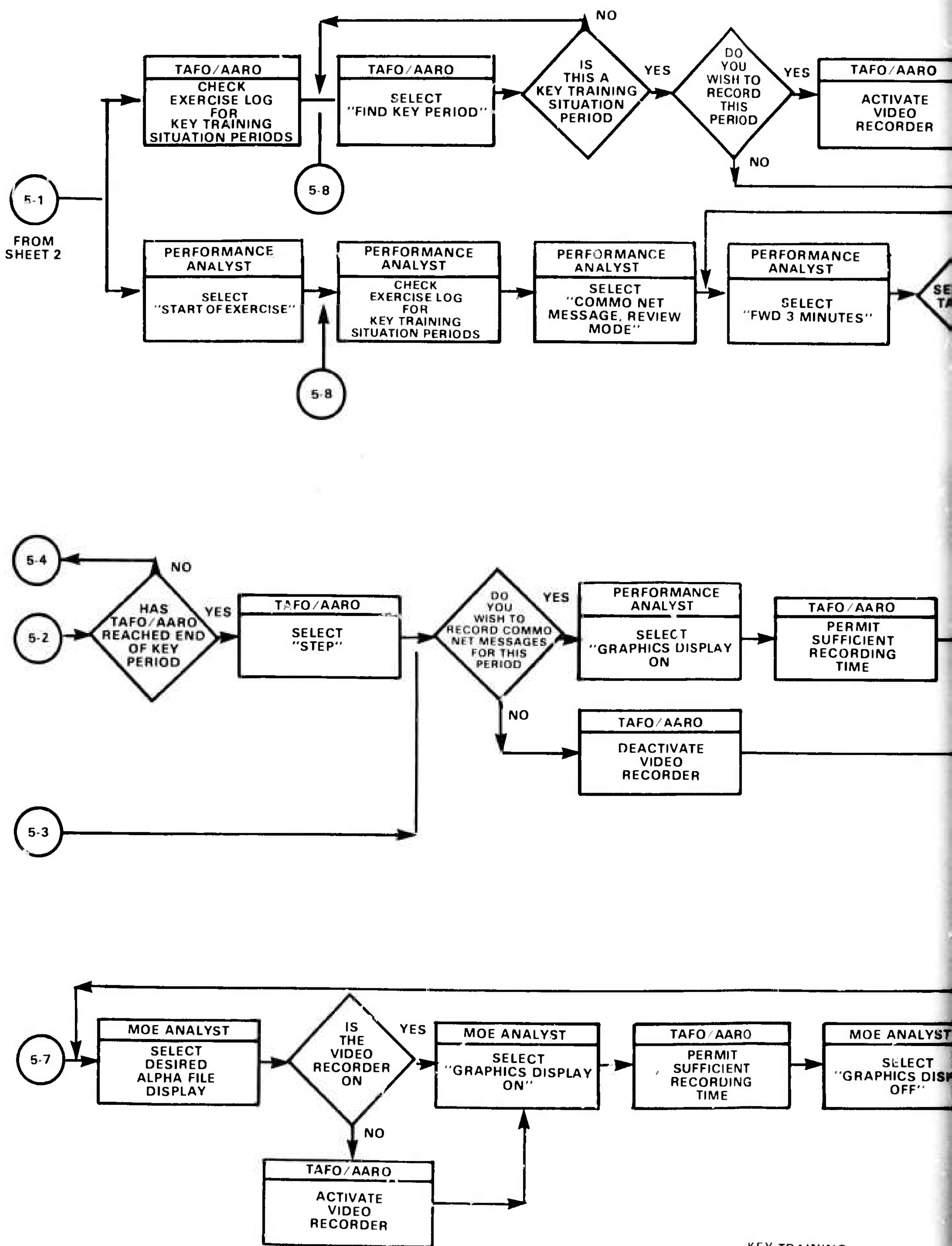

AARO
SELECT RUN ON A CONSOLE
AARO
CONTINUE VIDEO RECOROING UNTIL END OF PERIOO
AAR ANALYSTS
SELECT BACK 3 MINUTES ON C CONSOLE
AAR ANALYSTS
SEARCH THIS PERIOO FOR RELATEO COMMO NET MESSAGES
3 4
AAR TRAINING ANALYST
SELECT GRAPHICS OISPLAY ON C CONSOLE
AAR TRAINING ANALYST
PERMIT SUFFICIENT VIDEO RECOROING TIME
3 10
NO
IS THIS END OF EXERCISE ?
YES
10 2



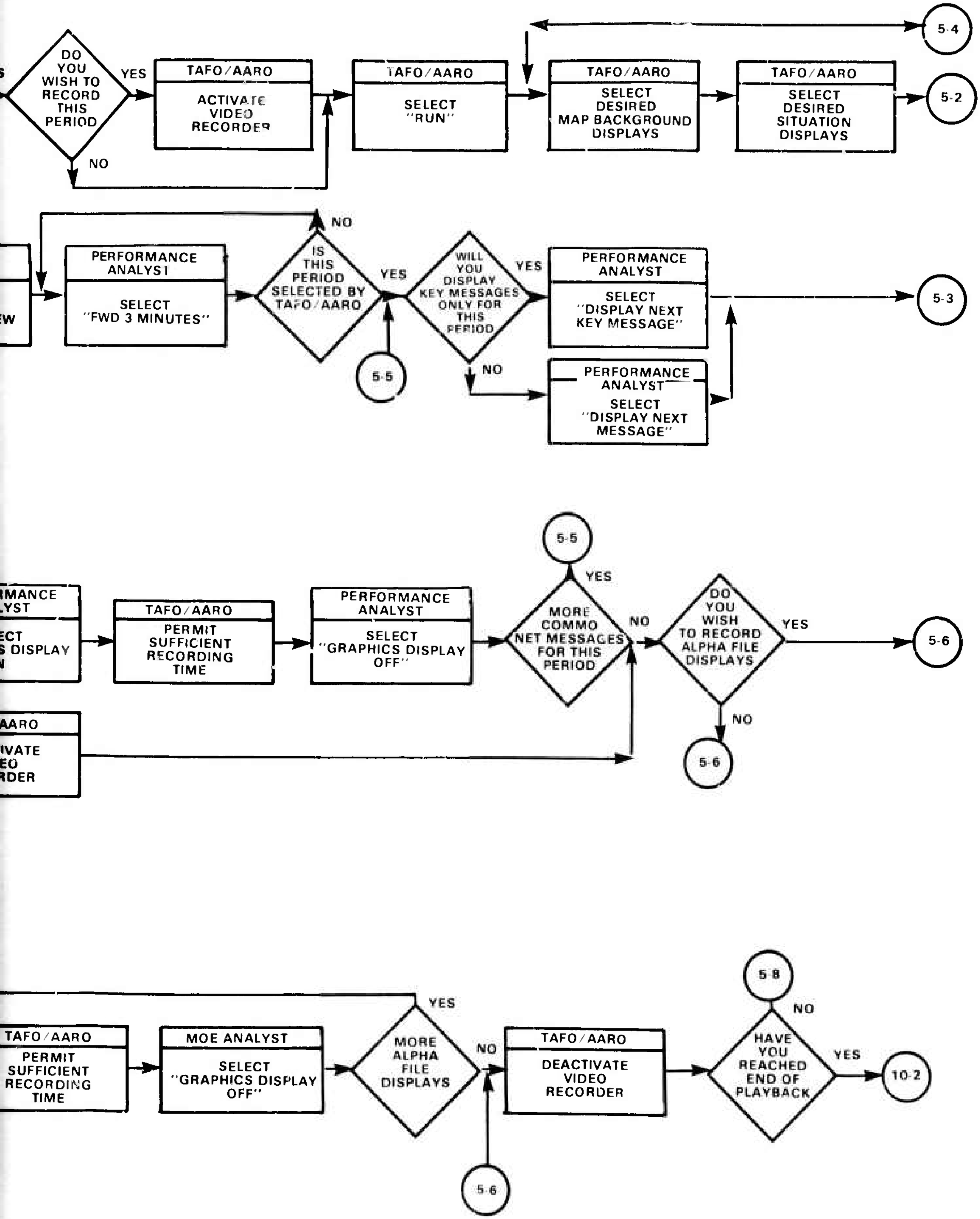
REAL-TIME PLAYBACK
AAR PREPARATION
SHEET 4



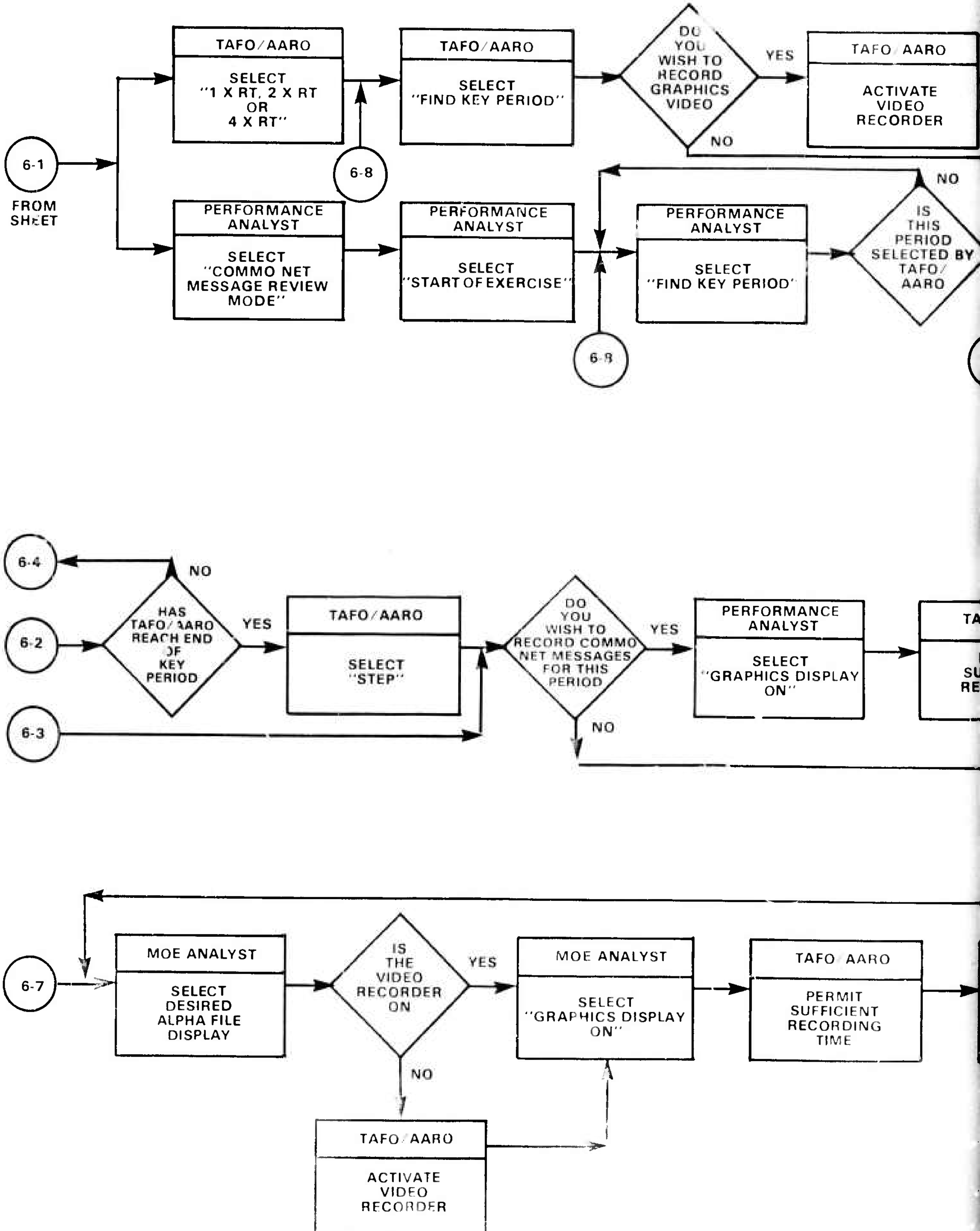
REAL-TIME PLAYBACK
AAR PREPARATION
SHEET 4



KEY TRAINING
SITUATION PLAYBACK
AAR PREPARATION
SHEET 5

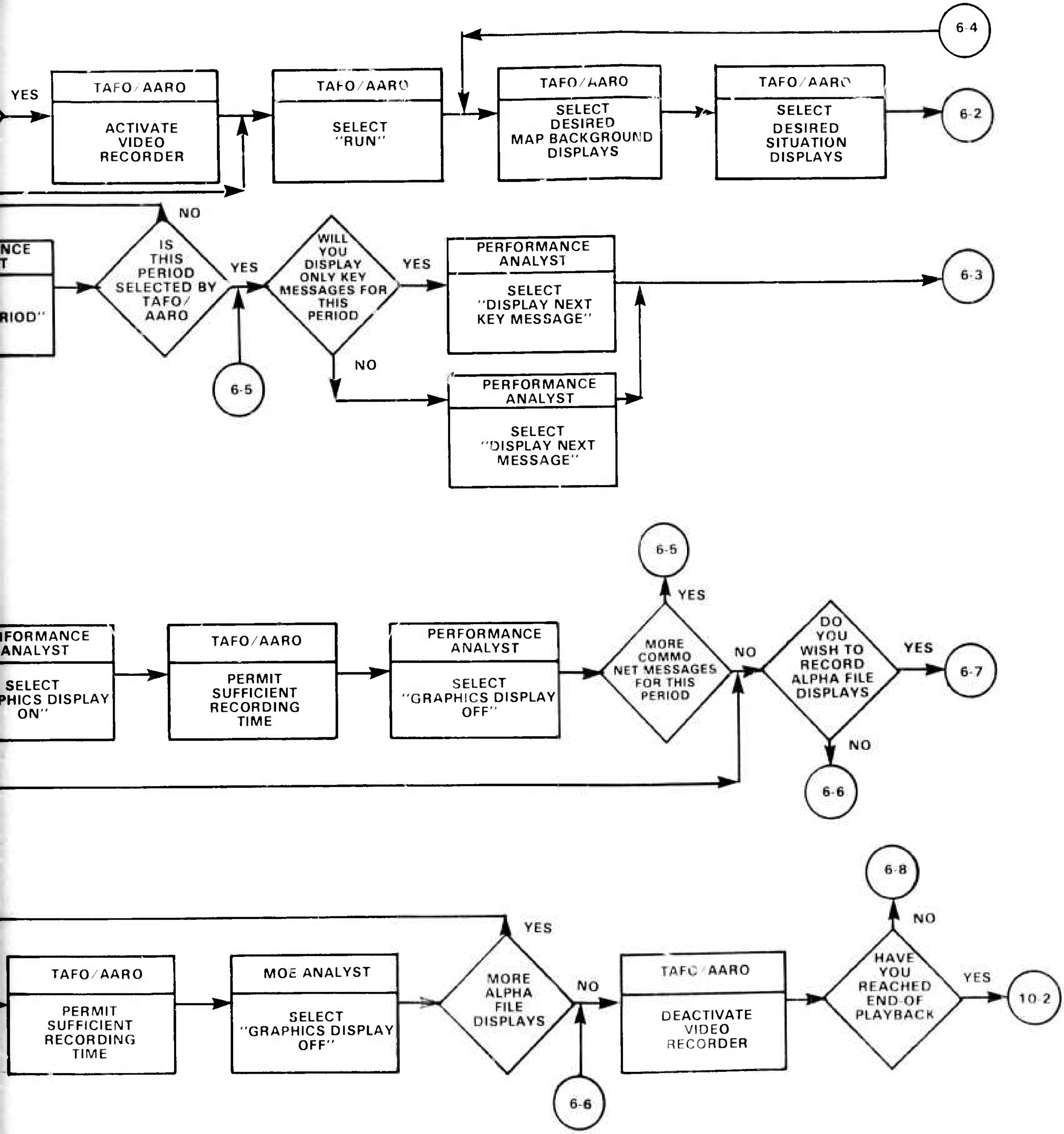


KEY TRAINING
SITUATION PLAYBACK
AAR PREPARATION
SHEET 5



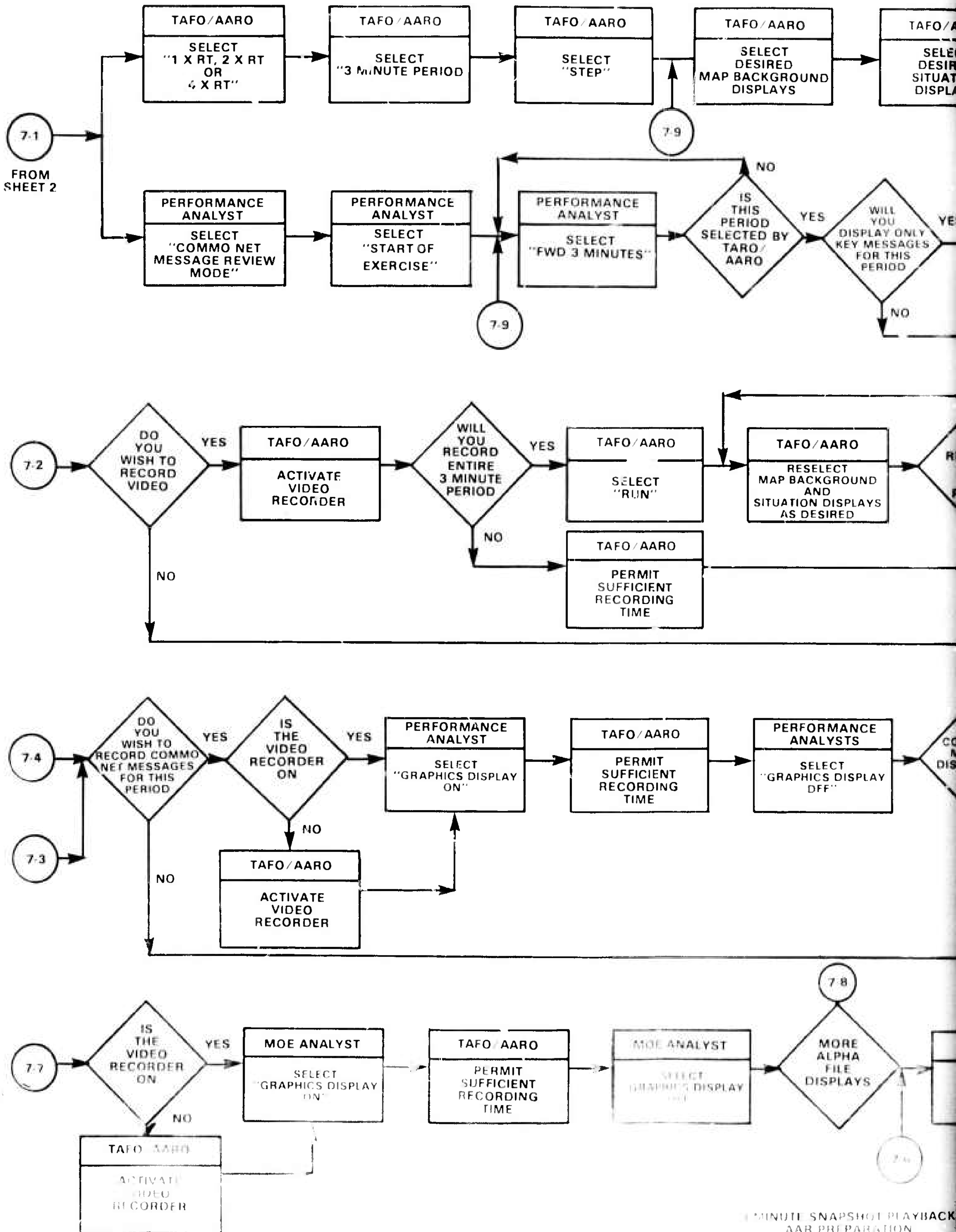
KEY PERIOD PLAYBACK
AAR PREPARATION

SHEET 6

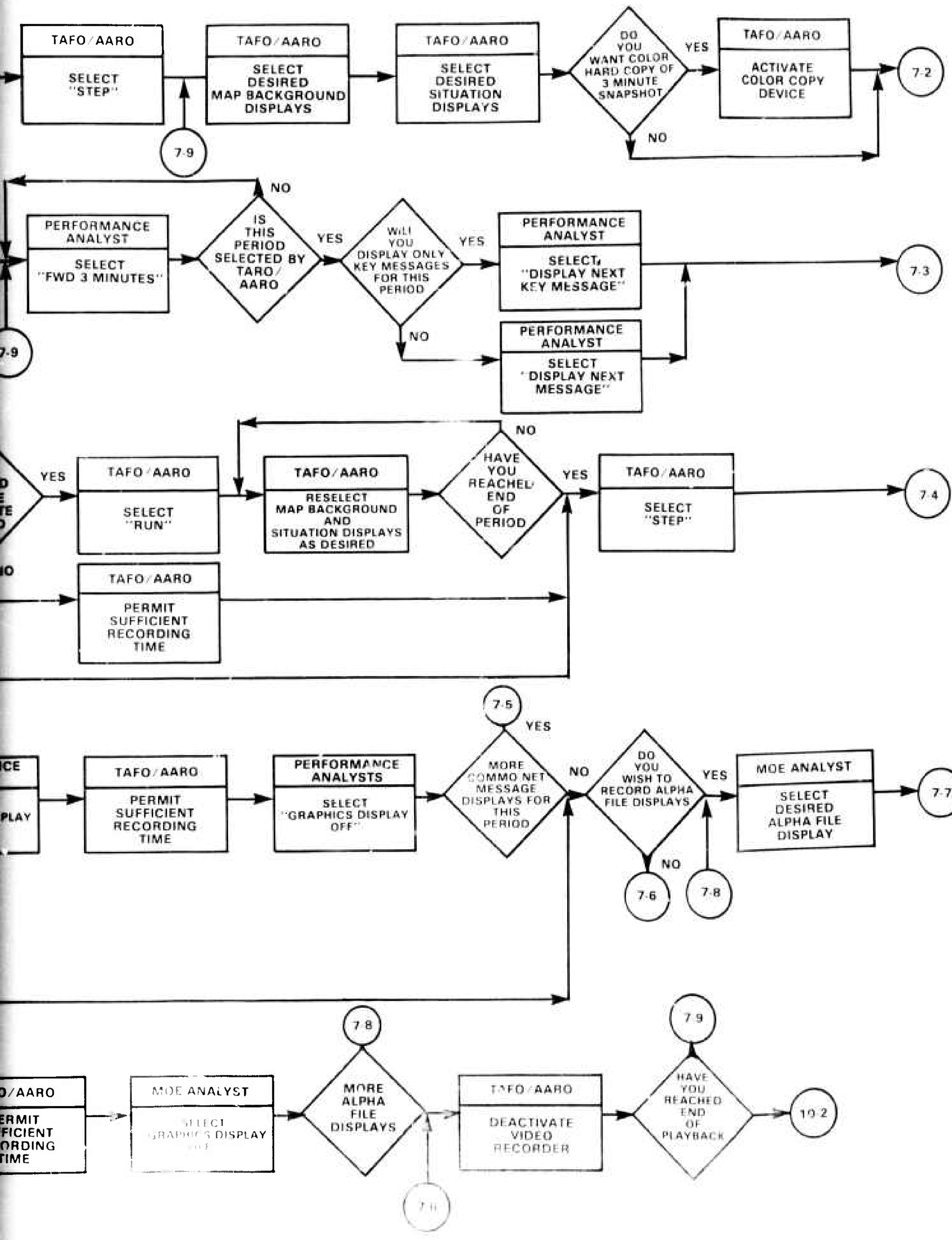


EY PERIOD PLAYBACK
AAR PREPARATION

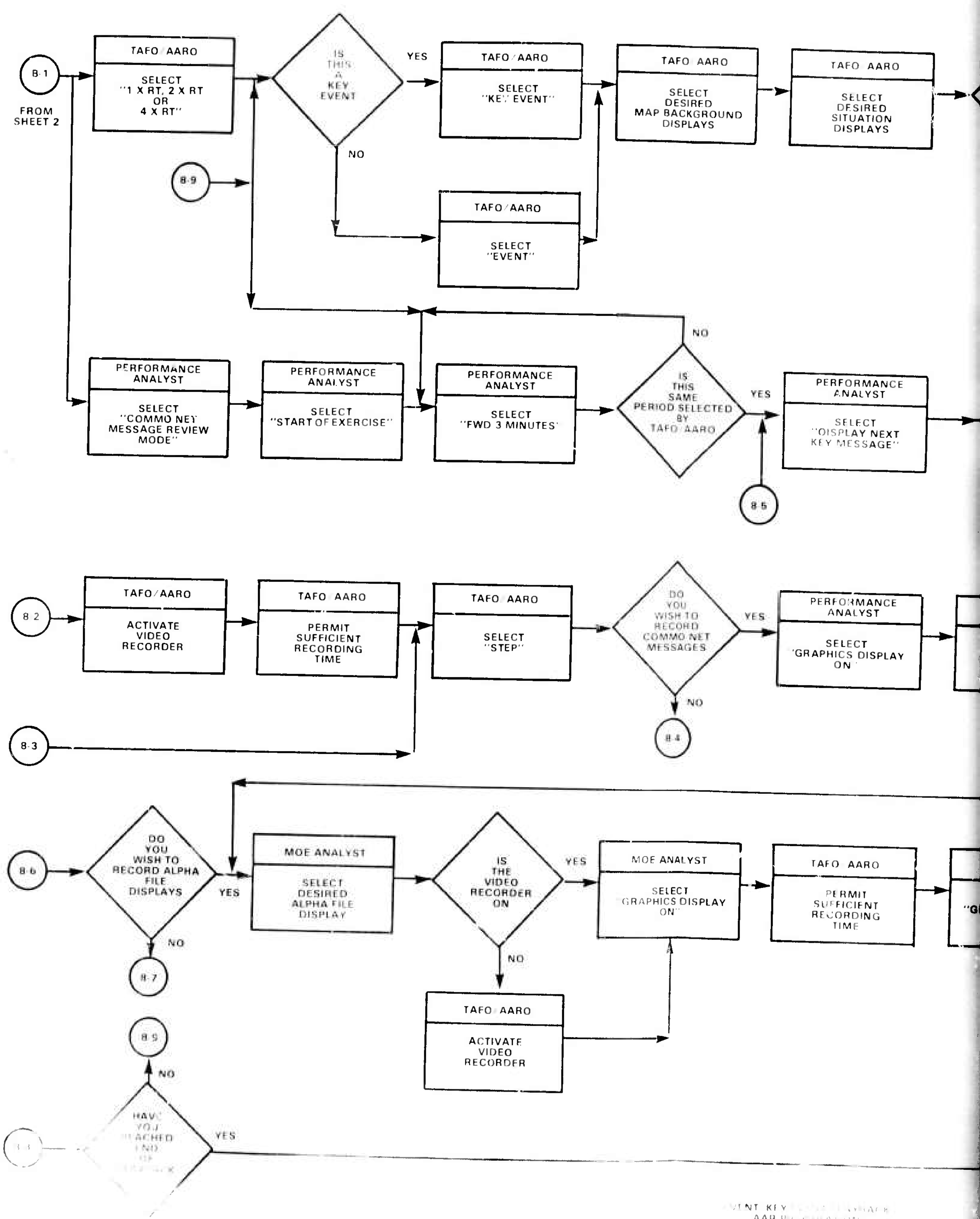
SHEET 6



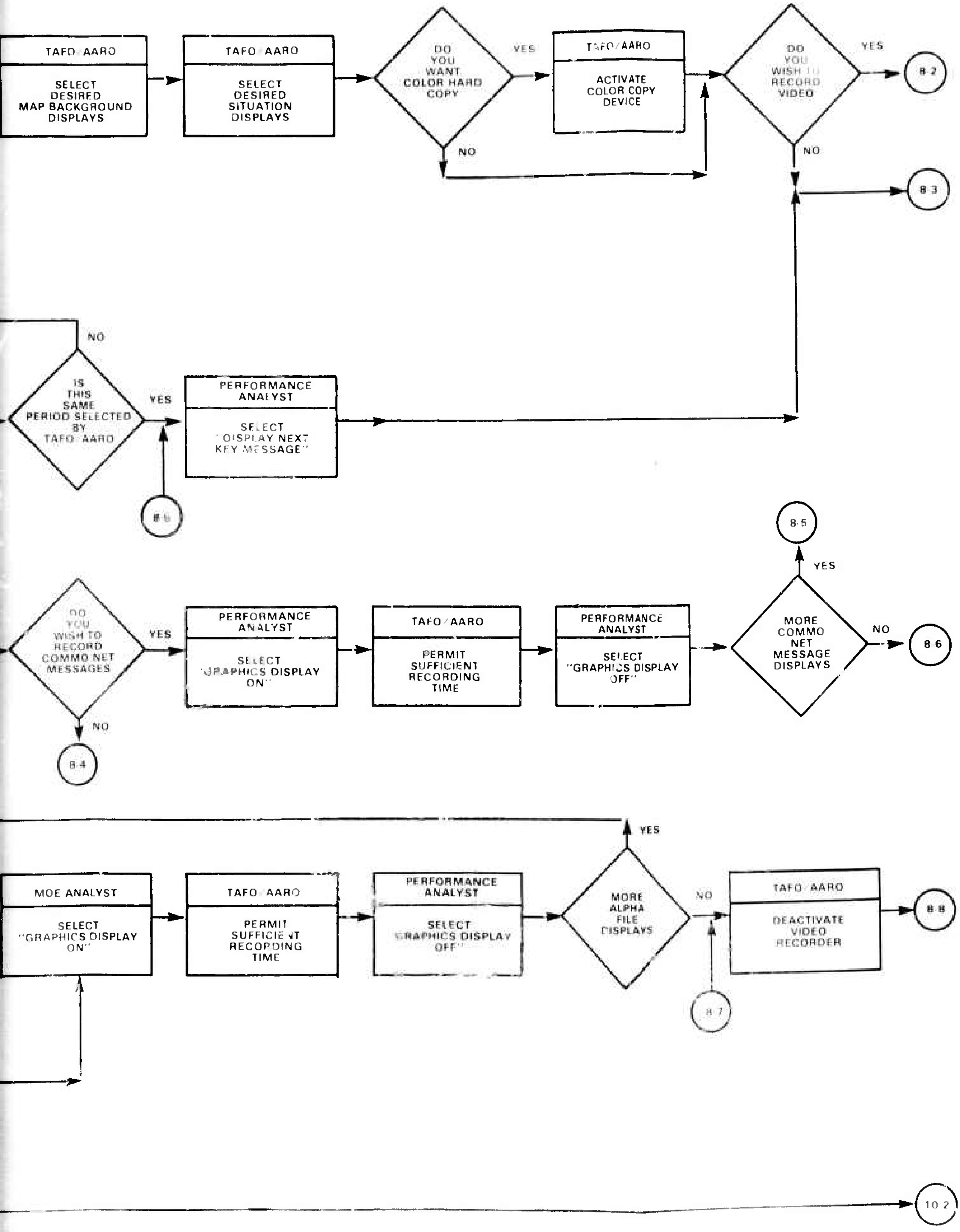
MINUTE SNAPSHOT PLAYBACK
AAR PREPARATION
SHEET 7



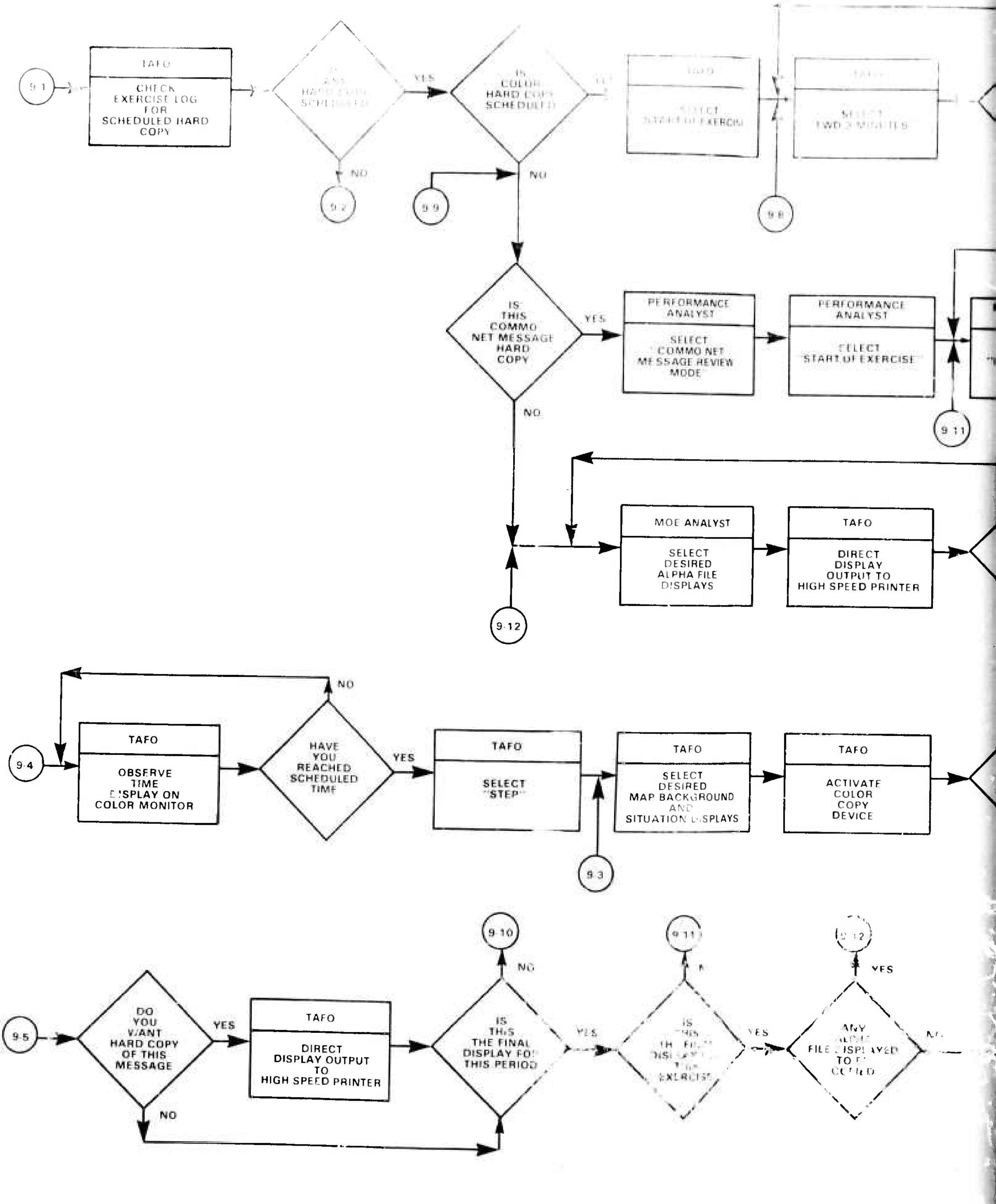
MINUTE SNAPSHOT PLAYBACK
AAR PREPARATION
SHEET 7



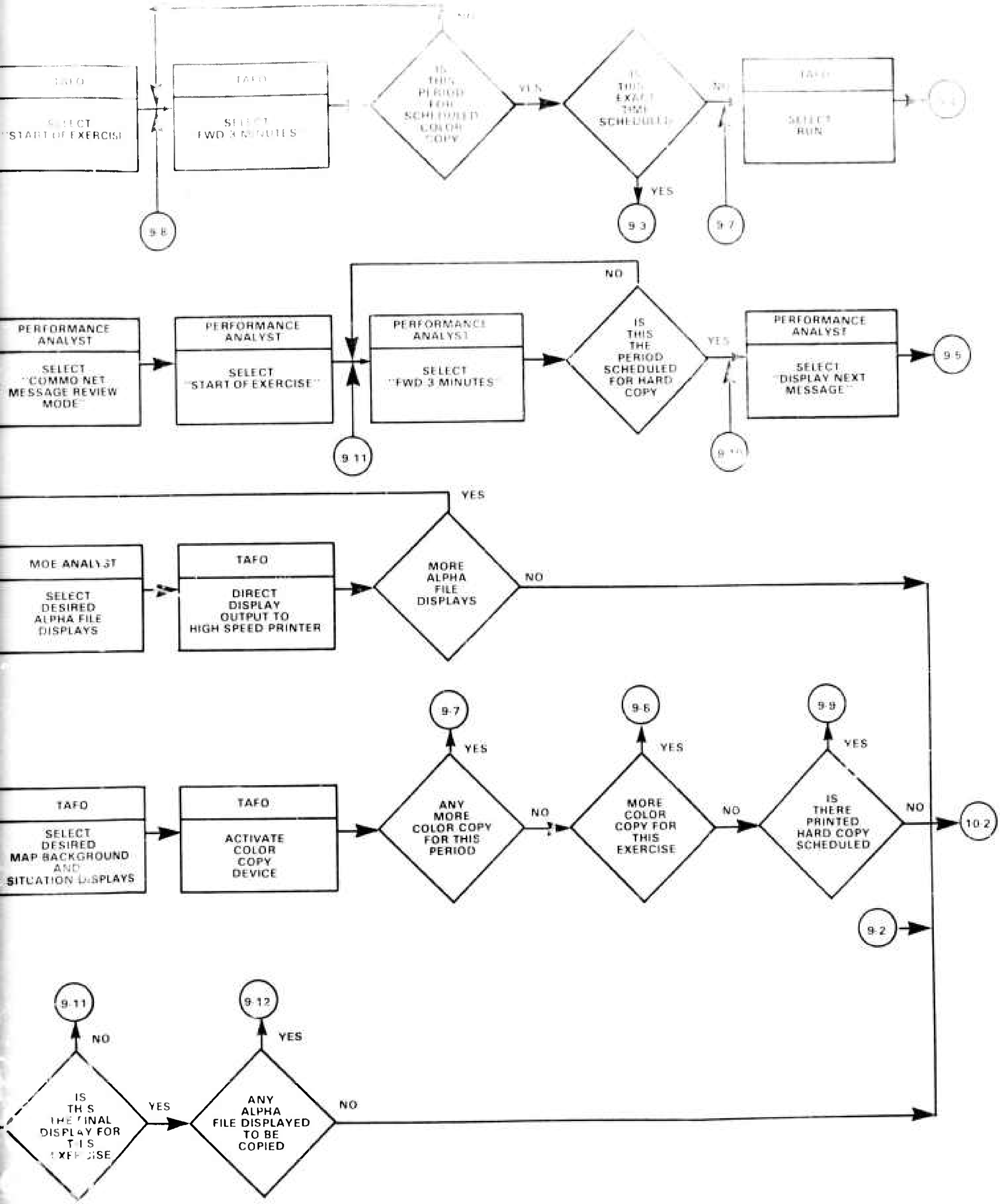
8-1
FROM SHEET 2
TAFO/AARO
SELECT "1 X RT, 2 X RT OR 4 X RT"
IS THIS A KEY EVENT
YES
NO
TAFO/AARO
SELECT "KEY EVENT"
TAFO AARO
SELECT DESIRED MAP BACKGROUND DISPLAYS
TAFO AARO
SELECT DESIRED SITUATION DISPLAYS
8-9
TAFO/AARO
SELECT "EVENT"
PERFORMANCE ANALYST
SELECT "COMMO NET MESSAGE REVIEW MODE"
PERFORMANCE ANALYST
SELECT "START OF EXERCISE"
PERFORMANCE ANALYST
SELECT "FWD 3 MINUTES"
IS THIS SAME PERIOD SELECTED BY TAFO AARO
YES
NO
PERFORMANCE ANALYST
SELECT "DISPLAY NEXT KEY MESSAGE"
8-5
8-2
TAFO/AARO
ACTIVATE VIDEO RECORDER
TAFO AARO
PERMIT SUFFICIENT RECORDING TIME
TAFO AARO
SELECT "STEP"
DO YOU WISH TO RECORD COMMO NET MESSAGES
YES
NO
8-4
PERFORMANCE ANALYST
SELECT "GRAPHICS DISPLAY ON"
8-3
8-6
DO YOU WISH TO RECORD ALPHA FILE DISPLAYS
YES
NO
8-7
MOE ANALYST
SELECT DESIRED ALPHA FILE DISPLAY
IS THE VIDEO RECORDER ON
YES
NO
MOE ANALYST
SELECT "GRAPHICS DISPLAY ON"
TAFO AARO
PERMIT SUFFICIENT RECORDING TIME
TAFO AARO
ACTIVATE VIDEO RECORDER
8-9
NO
YES



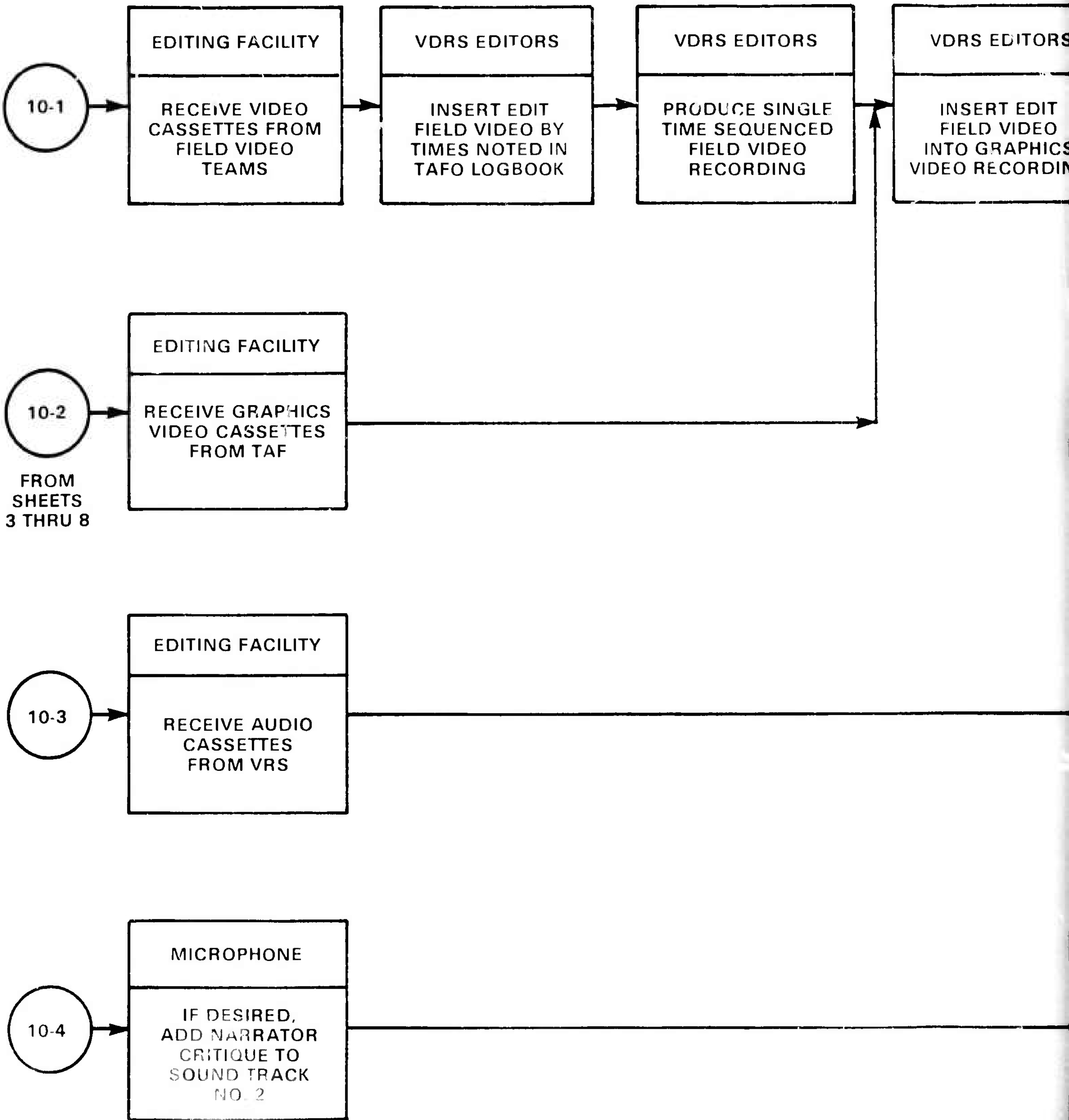
VENT KEY ... PLAYBACK
AAR PREPARATION



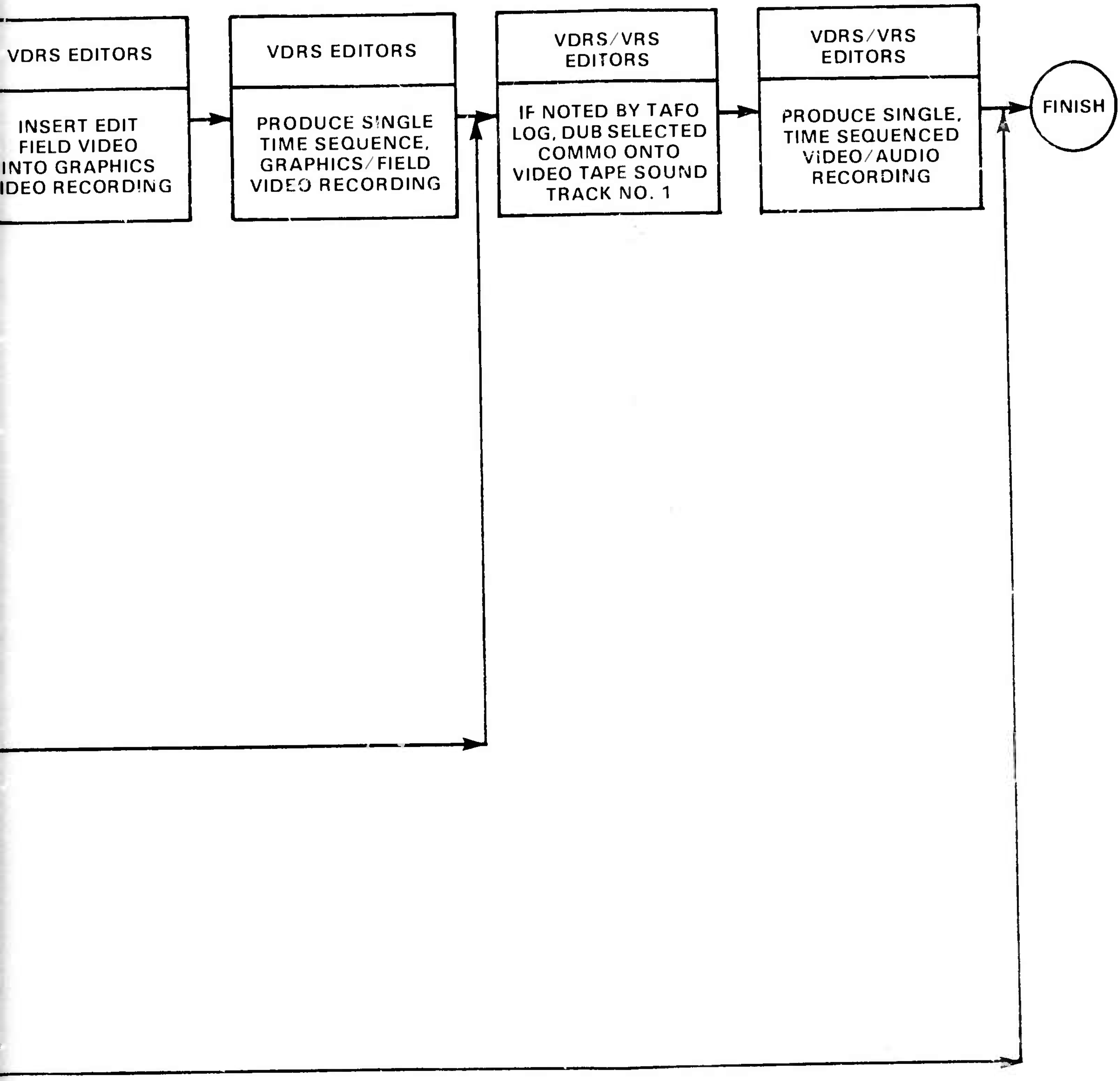
HARD COPY PROCESSING (POST EXERCISE)
AAR PREPARATION
SHEET 9



HARD COPY PROCESSING (POST EXERCISE)
AAR PREPARATION
SHEET 9



SHEET 10
FINAL EDITING/PRO
AAR PREPARAT



SHEET 10
AL EDITING/PROCESSING
AAR PREPARATION

END

SUPPLEMENTARY

INFORMATION

SCIENCE APPLICATIONS, INC.

AD-B058803L

11 June 1981

TO: Distribution - See Attached Sheet

SUBJECT: National Training Center Analysis
Final Technical Report

The attached flow diagram, Sheet 3, should be substituted for the corresponding sheet in subject report, dated 29 May 1981. The original Sheet 3 contained several omissions that have been completed in the revised Sheet 3.

DAAK40-78-C-0198

Sincerely,

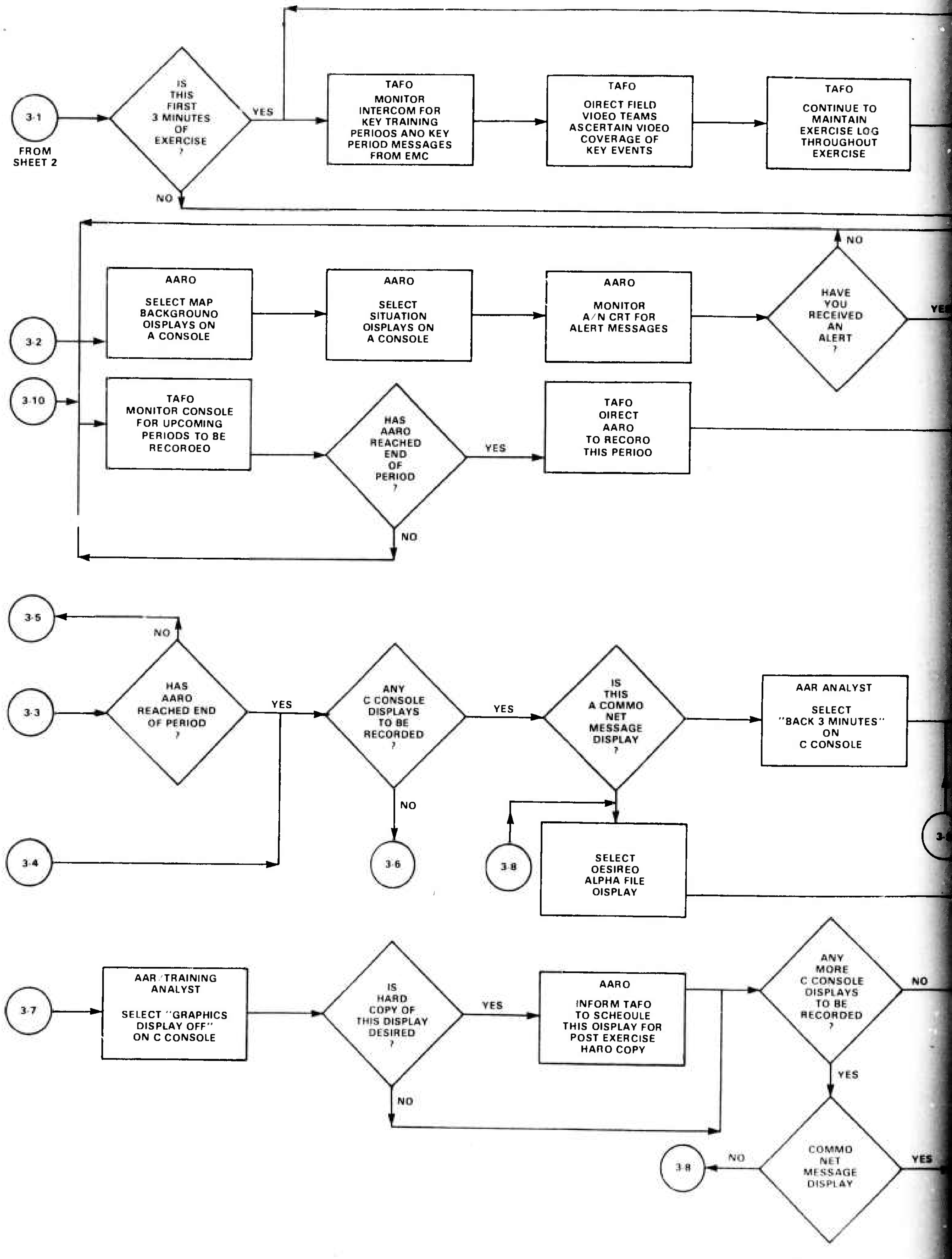
SCIENCE APPLICATIONS, INC.

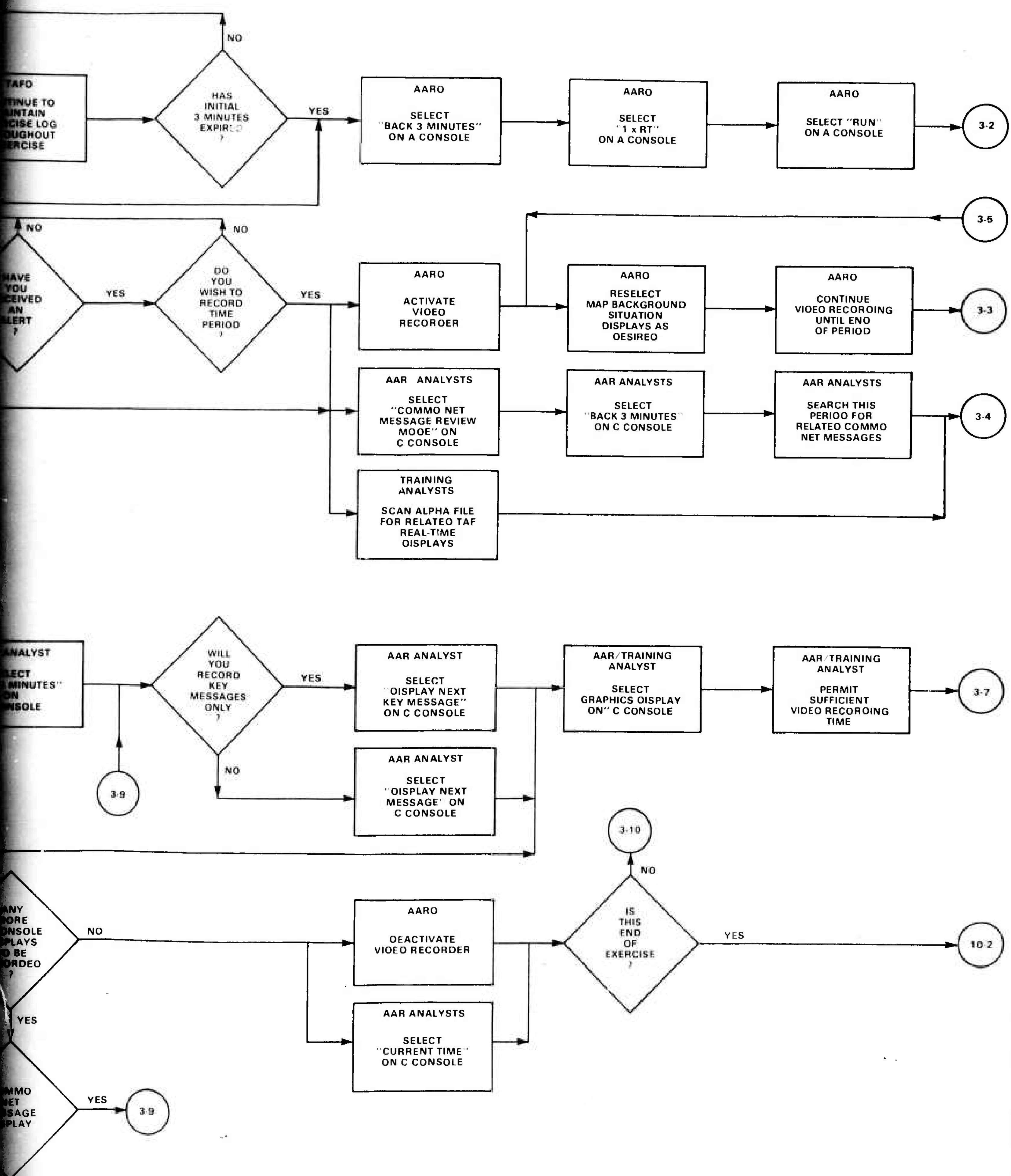
William B. DeGraf

WILLIAM B. DeGRAF
Assistant Vice-President
Training Systems and Analysis

SAI NTC Program Manager

WBD/mgs


3-1
FROM SHEET 2
IS THIS FIRST 3 MINUTES OF EXERCISE ?
YES
NO
TAFO
MONITOR INTERCOM FOR KEY TRAINING PERIODS AND KEY PERIOD MESSAGES FROM EMC
TAFO
DIRECT FIELD VIDEO TEAMS ASCERTAIN VIDEO COVERAGE OF KEY EVENTS
TAFO
CONTINUE TO MAINTAIN EXERCISE LOG THROUGHOUT EXERCISE
3-2
AARO
SELECT MAP BACKGROUND DISPLAYS ON A CONSOLE
AARO
SELECT SITUATION DISPLAYS ON A CONSOLE
AARO
MONITOR A/N CRT FOR ALERT MESSAGES
HAVE YOU RECEIVED AN ALERT ?
NO
YES
3-10
TAFO
MONITOR CONSOLE FOR UPCOMING PERIODS TO BE RECORDED
HAS AARO REACHED END OF PERIOD ?
YES
NO
TAFO
DIRECT AARO TO RECORD THIS PERIOD
3-5
NO
3-3
HAS AARO REACHED END OF PERIOD ?
YES
ANY C CONSOLE DISPLAYS TO BE RECORDED ?
YES
NO
3-6
IS THIS A COMMO NET MESSAGE DISPLAY ?
AAR ANALYST
SELECT "BACK 3 MINUTES" ON C CONSOLE
3-4
3-8
SELECT DESIRED ALPHA FILE DISPLAY
3-7
AAR/TRAINING ANALYST
SELECT "GRAPHICS DISPLAY OFF" ON C CONSOLE
IS HARD COPY OF THIS DISPLAY DESIRED ?
YES
NO
AARO
INFORM TAFO TO SCHEDULE THIS DISPLAY FOR POST EXERCISE HARD COPY
ANY MORE C CONSOLE DISPLAYS TO BE RECORDED ?
NO
YES
COMMO NET MESSAGE DISPLAY
NO
YES
3-8



REVISED

SHEET 3
TAF NORMAL OPERATION MOOE (RT 3 MINUTES)
AAR PREPARATION

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