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AD-A276 973

DTIC ACCESSION NUMBER

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INVENTORY

ASC-TR-94-5016

DOCUMENT IDENTIFICATION

Aug 93

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MODULAR SIMULATOR SYSTEM (MSS)

SYSTEM/SEGMENT SPECIFICATION FOR THE GENERIC
MSS - NAVIGATION/COMMUNICATION MODULE
VOLUME 6

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AUGUST 1993

FINAL REPORT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

SYSTEMS ENGINEERING DIVISION
AERONAUTICAL SYSTEMS CENTER
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This technical report has been reviewed and is approved for publication.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	13 Aug 93	FINAL

4. TITLE AND SUBTITLE
System/Segment Specification for the Generic Simulator System-Navigation/Communication Module Volume 6

5. FUNDING NUMBERS
F33657-86-C-0149
64227F

6. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NUMBER
S495-10400D

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Aeronautical Systems Center
Systems Engineering Division
Bldg 11 2240 B St Ste 7
Wright-Patterson AFB, OH 45433-7111

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
ASC-TR-94-5016

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release;
distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This is the Navigation/Communication portion of the generic Modular Simulator System (MSS) specification. It is designed to be tailored to specify the requirements for a specific aircraft training device or family of aircraft training devices. This specification contains specific tailoring instructions for each paragraph. When the tailoring process is complete, the italicized tailoring instructions should have been replaced by application specific text or deleted from the specification. It is suggested that the user read the "Modular Simulator Engineering Guide" and the "Modular Simulator Management Guide" prior to tailoring this volume.

14. SUBJECT TERMS
Modular Simulator System (MSS)

15. NUMBER OF PAGES
33

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

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PREFACE

This generic Modular Simulator System (MSS) segment specification has been developed in accordance with DI-CMAN-80008A, Data Item Description for System/Segment Specifications. This specification meets or exceeds the requirements for MIL-STD-490, Type A, specifications. This specification is designed to be tailored to specify the requirements for a specific aircraft training device or family of aircraft training devices. Training devices may consist of Weapon System Trainers (WST), Operational Flight Trainers (OFT), Cockpit Procedures Trainers (CPT), Part Task Trainers (PTT), etc.

Tailoring will be necessary to meet specific application requirements. The tailoring must be accomplished so as not to violate the goals and intent of the MSS concept. It is assumed that the user of this document has a familiarity with the MSS design concepts and architecture, the application aircraft training requirements, and general working knowledge of aircraft training systems. It is suggested that the user read the "Modular Simulator System Engineering Design Guide" (D495-10440-1) and the "Modular Simulator System Management Guide" (D495-10439-1) prior to tailoring this specification. These guides provide an overview of the MSS architecture, an in-depth discussion on its application, and lessons learned from previous applications.

Each segment in the MSS architecture provides a portion of the overall system functionality. Similar functions and operations were grouped in each segment based on past experience, areas of design expertise, and management of intersegment communication. To promote reuse of the segments and gain the maximum benefits of using the MSS approach, it is suggested that user adhere to the generic functional allocation. Interfaces between the segments should remain relatively constant from application to application. The application vehicle is considered to be an air vehicle (e.g. fixed wing, variable geometry, or rotary wing), although the MSS architecture and concepts may be applied to either ground or sea vehicles.

This specification contains specific tailoring instructions for each paragraph. The instructions are contained within the paragraphs, and are identified by blank spaces and/or italicized text. When the tailoring process is complete, the italicized tailoring instructions should have been replaced by the application specific text or deleted from the specification. Paragraphs which do not apply to a particular application should not be deleted. They should be identified as "Not Applicable" to maintain paragraph numbering consistency between volumes and various MSS applications.

1. SCOPE

1.1 Identification. This segment specification establishes the requirements for the Navigation/Communication (NAVCOM) segment of the _____ *(insert application aircraft type)* Modular Simulator System (MSS). This volume is one of ___ *(insert number of volumes for the application system/segment specification)* volumes which comprise the system/segment specification for the _____ *(insert application aircraft type)* MSS. Volume I of this specification contains system level requirements such as MSS structure, communication architecture, network interface performance, system level diagnostic and test requirements, Ada programming language applicability, adaptability and expandability, and other requirements which pertain to all volumes.

1.2 System Overview. The purpose of the NAVCOM segment is to simulate the navigation and communication system functions within the _____ *(insert application aircraft type)* MSS. The navigation functions receive occulting and/or range data to the student selected navigation aid station. This data is used in conjunction with inputs from the crew station to simulate navigational guidance, and provide data to other MSS segments. The communications functions provide simulation of the reception and transmission of voice and encoded communications for the ownship. The NAVCOM segment interfaces with other MSS segments as described in the _____ *(insert application aircraft type)* Interface Design Document (IDD), _____ *(insert IDD document number)*. Each of the navigation and communication functions identified in this specification are processed within the NAVCOM segment.

1.3 Document Overview. This segment specification defines NAVCOM segment unique requirements for the _____ *(insert application aircraft type)* MSS. It contains requirements for the functions performed within the segment including communication interface requirements, segment performance requirements, segment diagnostic and test requirements, and expandability and adaptability requirements as applicable to the NAVCOM segment.

2. APPLICABLE DOCUMENTS

2.1 Government Documents. The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

The Government documents, applicable to the _____ *(insert application aircraft type)* MSS, are listed in Volume I of this specification. The following Government documents are in addition to those documents, and are specifically applicable to the _____ *(insert application aircraft type)* MSS NAVCOM segment.

SPECIFICATIONS:

Federal - *(Identify applicable federal specifications)*
Military - *(Identify applicable military specifications)*
Other Government Agency - *(Identify applicable government specifications)*

STANDARDS:

Federal - *(Identify applicable federal standards)*
Military - *(Identify applicable military standards)*
Other Government Agency - *(Identify applicable government standards)*

DRAWINGS: *(Identify applicable government drawings)*

OTHER PUBLICATIONS:

Manuals - *(Identify applicable government manuals)*
Regulations - *(Identify applicable government regulations)*
Handbooks - *(Identify applicable government handbooks)*
Bulletins - *(Identify applicable government bulletins)*

Copies of specifications, standards, handbooks, drawings, publications and other Government documents required in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.

(In this paragraph, list only those documents which are explicitly referenced within this specification volume. If a requirement paragraph is tailored to a reference in a system/segment specification Volume I paragraph, and that paragraph contains a reference, the document should not be listed here. All requirements and references in system/segment specification Volume I are requirements of this specification unless specifically excluded in this volume.)

2.2 Non-Government Documents. The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents reference herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

The non-Government documents applicable to the _____ *(insert application aircraft type)* MSS are listed in Volume I of this specification. The following non-Government documents are in addition to those documents, and are specifically applicable to the _____ *(insert application aircraft type)* MSS NAVCOM segment.

SPECIFICATIONS: *(Identify applicable non-government specifications)*
STANDARDS: *(Identify applicable non-government standards)*
DRAWINGS: *(Identify applicable non-government drawings)*
OTHER PUBLICATIONS: *(Identify applicable non-government publications)*

Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal Agencies.

(In this paragraph list only those documents which are explicitly referenced within this specification volume. If a requirement paragraph is tailored to reference a system/segment specification Volume I paragraph, and that paragraph contains a reference, the secondary document should not be listed here. All requirements and references in system/segment specification Volume I are requirements of this specification unless specifically excluded in this volume.)

3. REQUIREMENTS

3.1 Segment Definition. The NAVCOM segment shall provide the capabilities to simulate _____ *(insert application aircraft type)* aircraft navigation and communication systems. The NAVCOM segment is one of _____ *(insert number of segments to be used in the application simulation)* unique segments which comprise the _____ *(insert application aircraft type)* MSS. The NAVCOM segment shall provide the modes, states, and functions as defined in this specification volume and Volume I.

The NAVCOM segment shall provide the real-time simulation of the _____ *(insert application aircraft type)* navigation and communication systems. This segment shall provide operation and control representative of both normal and degraded states. The NAVCOM segment shall provide simulation/stimulation for the aircraft radio systems, radio navigation systems, intercommunication systems, and navigation systems.

(This paragraph should be tailored to convey the exact top level functions required of the segment. If this segment is to be used/reused on several devices within a family of trainers, that should be stated here with any unique performance requirements.)

3.2 Characteristics

3.2.1 Performance Characteristics. Performance of the NAVCOM segment shall be as specified herein and in accordance with the _____ *(insert application aircraft type)* aircraft design criteria. The NAVCOM segment shall simulate functions associated with the _____ *(insert application aircraft type)* aircraft NAVCOM system. The fidelity of the NAVCOM segment shall be sufficient to provide the necessary level of training as specified in Volume I, paragraph 6.1 of this specification.

(Several considerations must be addressed in this paragraph:

a. Availability of specific and traceable NAVCOM system design and engineering data
b. Manufacture of specific NAVCOM systems.

Additional text should be added to this paragraph to identify the design criteria and specific NAVCOM equipment to be simulated. A general statement with respect to the fidelity of the simulation should be added.)

3.2.1.1 Segment Modes and States. The NAVCOM segment shall support the system modes and states as described in Volume I of this specification. Additional requirements, or operations, shall not cause degradation of the system nor violate the intent of the system mode or state.

(Introduction of new modes is prohibited. Functions should be accomplished within the established modes and states. This paragraph should be tailored to describe the segment's response to a given mode or state. Subparagraphs should be added to identify and define segment requirements for each mode and state.)

3.2.1.2 NAVCOM Segment Functions. Functions characterized as "Implemented" shall be implemented to the extent described by the paragraphs dedicated to those functions. Functions characterized as "Not Applicable" do not exist in the simulation of the _____ *(insert application aircraft type)*, and are not required to be implemented in any form within the NAVCOM segment.

a.	Navigation/Communication Support Function	Implemented
b.	Attitude Heading Reference System Function	*(Implemented, N/A)*
c.	Inertial Navigation System Function	*(Implemented, N/A)*
d.	Radar Altimeter Function	*(Implemented, N/A)*
e.	Radio Navigation Aid System Function	*(Implemented, N/A)*
f.	Communication Function	*(Implemented, N/A)*
g.	Star Tracker Function	*(Implemented, N/A)*
h.	Doppler Radar Function	*(Implemented, N/A)*
i.	Air Data System Function	*(Implemented, N/A)*
j.	Application Unique Avionics Function	*(Implemented, N/A)*
k.	Identification Friend or Foe (IFF) Function	*(Implemented, N/A)*

(Each function listed should be characterized as "Implemented" or "Not Applicable (N/A)")

3.2.1.2.1 NAVCOM Support Function. The NAVCOM support function shall provide segment unique support services required for operation of the NAVCOM segment in the MSS environment. The NAVCOM support function services shall include the functions listed below, and as described in the following paragraphs.

a. Executive Control
b. Initialization
c. MSS Virtual Network (VNET) Communication
d. Diagnostics and Test
e. Backdoor Interfacing
f. Malfunctions
g. Damage Assessment
h. Security Processing
i. Scoring
j. Other Support Function Services.

(Service functions are usually incidental to the simulation but no less critical. Examples are overhead and I/O functions. Additional services may be added as necessary to meet specific

application requirements. If so, corresponding subparagraphs need to be added below. Do not reuse paragraphs for support services that are not applicable.)

3.2.1.2.1.1 Executive Control. The executive control support service shall provide operational control for the NAVCOM segment. This control shall include: execution sequencing of all software segments, mode and state control, and communication between the simulation software and the VNET.

(For most applications this paragraph will require no tailoring. If additional or specific executive control functions are required, they should be identified in this paragraph.)

3.2.1.2.1.2 Initialization. The initialization support service shall control initial hardware and software states for the NAVCOM segment. System initialization shall occur during power-up and system resets, as defined in Volume I of this specification. The initialization function shall access mission initialization data, and transfer the data to other segment functions for mission initialization.

(Initialization requirements unique to the application aircraft NAVCOM systems should be specified in this paragraph. Initialization refers to setting initial hardware and software states during power-up and system resets as defined in Volume I. Instrument scale factors and default instrument settings (usually powered off) are typically initialized by this function. A second initialization function is to access mission initialization data (for example from disc) to pass to other segment functions for mission initialization.)

3.2.1.2.1.3 MSS Virtual Network Communication. The MSS VNET communication support service shall provide the NAVCOM segment interface to the VNET. It shall allow communication with other segments in the _____ *(insert application aircraft type)* MSS. The NAVCOM segment shall communicate on the MSS VNET in accordance with the protocol requirements defined in the _____ *(insert application aircraft type)* MSS IDD, _____ *(insert MSS IDD document number)*.

3.2.1.2.1.4 Diagnostics and Test. The diagnostics and test support service shall provide control for the diagnostic and test functions incorporated into the NAVCOM segment. Diagnostic and test requirements, for the NAVCOM segment, shall be in accordance with the requirements specified herein.

(Based upon the specific simulator diagnostic requirements, all or part of the three types of diagnostic capabilities may be required. "Not applicable "should be inserted if the specific diagnostic type is not required for the application MSS. Specific diagnostics and their requirements should be listed in each paragraph when applicable.)

3.2.1.2.1.4.1 On-Line Diagnostics. On-line diagnostics shall be provided for the NAVCOM segment. These diagnostics shall be self initiating during startup, and/or they may be executed as a background function during training mode.

(On-line diagnostics are those diagnostics that execute while the training system is in the real-time training mode. These diagnostics may run as a background task. An example that would be used in an MSS might be a segment functional diagnostic. Each diagnostic would tell the IOS segment that it was still functioning on a periodic basis (say once a minute). If the IOS does not receive the message then it assumes the segment is not functioning properly and provides a message to the instructor.)

3.2.1.2.1.4.2 Off-Line Diagnostics. Off-line diagnostics shall be provided by the NAVCOM segment. Off-line diagnostics shall be executed when the _____ *(insert application aircraft type)* MSS is not engaged in a system mode.

(Off-line diagnostics are those diagnostics that are performed on a segment in the stand-alone or segment mode. Typical off-line diagnostics would include; hardware self tests, software tests, I/O debug programs, Daily Readiness at a segment level, etc.)

3.2.1.2.1.4.3 Remote Controlled Diagnostics. Remote controlled diagnostics shall be provided for the NAVCOM segment. These diagnostics shall be executable, from the Instructor Operator Station (IOS), when the MSS is in the Remote Controlled Diagnostic mode.

(Remote controlled diagnostics are those diagnostics that run in the special remote controlled Diagnostic mode. These diagnostics require the system to be up and running and the segments communicating. An example of a Remote Controlled Diagnostic would be a real-time debugger.)

3.2.1.2.1.5 Backdoor Interfacing. The Backdoor interface support service shall provide the means to support external interfaces to the NAVCOM segment. All ownship NAVCOM system Input/Output (I/O) not specifically identified in the _____ *(insert application aircraft type)* MSS IDD shall interface via the MSS VNET. Backdoor interfaces shall not be utilized for normal intersegment communication.

(Specific external interfaces should be discussed in this paragraph. Backdoor interfaces may include a 1553 bus to installed aircraft avionics or a specialized interface to drive a Head Up Display (HUD). A backdoor interface may not be utilized to transmit intersegment data.)

3.2.1.2.1.6 Malfunctions. The malfunctions support service shall provide control for the processing and execution of NAVCOM segment malfunctions. The system response shall be in accordance with aircraft design criteria.

(NAVCOM segment malfunction requirements should be defined in a program unique Malfunction Description Document)

3.2.1.2.1.7 Damage Assessment. The damage assessment support service shall provide for the processing and implementation of

any damage simulation for which the NAVCOM segment is responsible. This shall include the degradation of the appropriate systems within the NAVCOM segment based on an evaluation of the damage severity and location.

(Specific damage assessment and system degradation requirements should be specified in this paragraph which are consistent with the training requirements of the specific simulator.)

3.2.1.2.1.8 Security Processing. The NAVCOM segment security processing support service shall provide processing to meet the security requirements of the _____ *(insert application aircraft type)* MSS NAVCOM segment.

(This paragraph should be expanded to clearly specify which government directives apply and to what extent consistent with security considerations. Security processing would include Memory Erase Mode if required and any other security considerations, such as removable memory or special encoding devices.)

3.2.1.2.1.9 Scoring. The scoring support service shall provide the ability to assess NAVCOM performance. The NAVCOM segment scores shall be provided to the IOS segment via the MSS VNET.

(Application specific scoring data requirements for the NAVCOM segment shall be listed in this paragraph. If large amounts of data are required, it may be advisable to provide this as a non-real-time activity.)

3.2.1.2.1.10 Other Support Function Services. Not Applicable.

(If there are other support functions unique to this segment they should be listed here, otherwise identify this paragraph as "Not Applicable". An example is intra segment communication. Before defining new functions be sure the function cannot be incorporated as a variant of an existing function.)

3.2.1.2.2 Attitude Heading Reference System Function. The Attitude Heading Reference System (AHRS) function shall simulate the operations and functional characteristics of the standby attitude director indicator and compass onboard the _____ *(insert application aircraft type)* aircraft in accordance with design criteria data. The cockpit controls and indicators associated with the AHRS function shall be located within the Flight Station segment. The interface between the AHRS function and the cockpit controls and displays shall be as defined in _____ *(insert application aircraft type)* MSS IDD.

(This paragraph should be tailored to describe the types of AHRS cockpit controls and displays associated with the application aircraft. This paragraph should be tailored with training objectives in mind. The AHRS model number and manufacturer should be specified, if applicable.)

3.2.1.2.3 Inertial Navigation System Function. The Inertial Navigation System (INS) function shall simulate the operational and functional characteristics of the _____ *(insert application aircraft type)* aircraft INS, in accordance with design criteria data. This function shall model the functional performance of the INS platform, as well as, the combination of platform data improved by other aircraft sensors. The cockpit controls and displays, associated with the INS function, shall be located within the Flight Station segment. The aircraft state information shall be provided to the support function for output on the MSS VNET in accordance with the requirements of the _____ *(insert application aircraft type)* MSS IDD.

(If the application aircraft does not have an Inertial Navigation System (INS), then the requirements for an INS should be deleted. If the aircraft has a dual INS it should be specified. This paragraph should be tailored to provide a list of the INS cockpit controls and displays. The model number and manufacturer of the INS being simulated should be specified. This paragraph should be tailored with training objectives in mind. If a less than 100 percent solution is a program objective, the INS could be modeled to exclude error processing, elaborate gyro spinup models, and time consuming alignment processes. If a full simulation is required, any performance characteristics less than "as aircraft" should be identified. Timing and accuracy requirements should be addressed here.)

3.2.1.2.4 Radar Altimeter Function. The Radar Altimeter function shall simulate the operations and functional characteristics of the _____ *(insert application aircraft type)* aircraft radar altimeter in accordance with design criteria data. The radar altimeter controls and displays shall be located within the Flight Station segment. The interface between the radar altimeter function and the other segments shall be via the MSS VNET and shall be in accordance with the interface requirements of the _____ *(insert application aircraft type)* MSS IDD.

(The model number and manufacturer of the Radar Altimeter system being simulated should be specified. If the aircraft does not have a Radar Altimeter, or dual Radar Altimeters are utilized, it should be specified in this paragraph. This paragraph should be tailored to provide a list of the radar altimeter controls and displays. The source for the height above terrain should also be identified.)

3.2.1.2.5 Radio Navigation Aid Systems Function. The Radio Navigation Aid Systems Function shall simulate the operations and functional characteristics of the _____ *(insert application aircraft type)* aircraft navigation equipment listed below:

a. Global Positioning System (GPS)
b. Instrument Landing System (ILS)
c. Microwave Landing System (MLS)
d. Automatic Direction Finder (ADF)
e. Tactical Air Navigation (TACAN)

f. Very High Frequency Omni Range (VOR)
g. Distance Measuring Equipment (DME)
h. Long Range Navigation (LORAN)
i. Omega
j. Station Keeping Equipment (SKE).

The Radio Navigation Aid System controls and displays shall be located within the Flight Station segment. System indications shall be in accordance with _____ *(insert application aircraft type)* design criteria data. The interface between the radio navigation aid systems function and the controls and displays shall be via the MSS VNET in accordance with the requirements specified in the _____ *(insert application aircraft type)* MSS IDD.

(This paragraph should be tailored to describe the specific radio navigation aids included on the application aircraft. The types of radio navigation aids, part number, model number, etc. should be identified. Environmental effects may include twilight effects (function of altitude and frequency) and weather effects (due to electrical storms), if so then these should be specified.)

3.2.1.2.6 Communication Function. The Communication Function shall simulate communication equipment onboard the _____ *(insert application aircraft type)* aircraft. This function shall model the crew interfaces and functional responses for the communication systems listed below:

a. Very High Frequency (VHF) radio
b. Ultra High Frequency (UHF) radio
c. Intercommunication System (ICS)
d. Satellite Communications (SATCOM)
e. Joint Tactical Information Distribution System (JTIDS).

The Communication Function shall provide a simulation for voice and digital data link communications between the ownship and companion aircraft, ownship and ground, and intercommunication among crew members in autonomous training. During Multiple Simulator Environment (MSE) operations communication is provided with other simulation systems.

Communication system controls and displays shall be located within the Flight Station segment. The Communication Function shall produce outputs to their controls and displays in accordance with _____ *(insert application aircraft type)* aircraft design criteria data. The interface between the communication function and the controls and displays shall be in accordance with the interface requirements specified in the _____ *(insert application aircraft type)* MSS IDD.

(The communication system requirements should be tailored to represent the communication systems required by the specific aircraft being simulated. The communication system part numbers, model numbers, etc. should be identified.)

3.2.1.2.7 Star Tracker Function. The Star Tracker Function shall simulate the operations and functional characteristics of _____ *(insert application aircraft type)* aircraft star tracking equipment in accordance with design criteria data.

Star Tracker controls and displays shall be located within the Flight Station segment. The interface between the Star Tracker Function and the controls and indicators shall be via the MSS VNET in accordance with the interface requirements specified in the _____ *(insert application aircraft type)* MSS IDD.

(The type of star tracker system, part number, model number, etc. should be identified. Atmospheric effects on star brightness and apparent location should be modeled as additions to the noise and bias on the simulation outputs The effects of vehicle dynamics on tracking performance should be modeled. Star tracker requirements need not be included if the specific aircraft does not contain star tracker equipment.)

3.2.1.2.8 Doppler Radar Function. The Doppler Radar Function shall simulate the _____ *(insert application aircraft type)* aircraft Doppler Radar system operations and functional characteristics in accordance with design criteria data. Doppler radar controls and displays shall be located within the Flight Station segment. The interface between the Doppler radar function and the associated cockpit controls and displays shall be in accordance with the interface requirements specified in the _____ *(insert application aircraft type)* MSS IDD.

(Doppler radar system, part number, model number, etc. should be identified. If the application aircraft does not contain a Doppler radar system, then this function need not be modeled.)

3.2.1.2.9 Air Data System Function. The Air Data System Function shall model the operations and functional characteristics of the _____ *(insert application aircraft type)* aircraft air data system. This function shall calculate angle of attack, stall warning, and air data parameters such as pressure altitude, static pressure ratio, airspeed, Mach number, and air density ratio using true atmospheric parameters. Functional and operational characteristics of the air data simulation shall be in accordance with design criteria data. Data shall be provided to other segments in accordance with the interface requirements specified in the _____ *(insert application aircraft type)* MSS IDD.

(This paragraph should be tailored to specify requirements which are unique to the application aircraft's air data system. The type of air data system, part number, model number, etc. should be identified.)

3.2.1.2.10 Application Unique Avionics Simulation Function. The Application Unique Avionics Simulation Function shall provide the capability to simulate _____ *(insert application aircraft type)* aircraft

avionics subsystems. This function shall produce outputs to controls and displays in accordance with design criteria.

(This paragraph should identify which avionics subsystems are to be simulated. This is particularly critical to a simulator which is employing embedded avionics software because avionics processor interfaces will have to be simulated. This paragraph may also be used to specify requirements for emerging technology sensors.)

3.2.1.2.11 Identification Friend or Foe Function. The Identification Friend or Foe (IFF) Function shall simulate the operations and functional characteristics of the _____ *(insert application aircraft type)* aircraft IFF equipment. This function shall emulate the IFF transceiver functions between ownship and companion aircraft or ground stations in accordance with design criteria data. The IFF controls and displays shall be located within the Flight Station segment. The interface between the IFF function and the controls and indicators shall be in accordance with the interface requirements contained in the _____ *(insert application aircraft type)* MSS IDD.

(The required IFF modes should be specified.)

3.2.2 System Capability Relationships. The NAVCOM segment shall support the system capability relationships defined in Volume I of this specification. NAVCOM segment functional relationships shall be as described in the following paragraphs.

(Define any NAVCOM segment unique capability relationships. In general, the capability relationships specified in Volume I will suffice for this segment.)

3.2.2.1 Segment Functional Relationships. The top level, typical, NAVCOM segment functional relationships are depicted in FIGURE 1. Each function shall operate in a manner which will allow the segment, as a system, to satisfy the timing requirements described in Volume I of this specification. Functions implemented within the NAVCOM shall operate in such a manner which will allow the segment to meet both segment and system level requirements without degradation.

(There are two approaches to describing inter-segment interfaces: all functions communicate through the support function, or all functions communicate directly with other functions. FIGURE 1 in all segments may have the same structure. For this segment, functions which are not implemented shouldbe shaded out. If desired, functions which are only partially implemented may be graphically represented with cross hatching. Note that the intent of this diagram should be to identify "required" internal relationships and not to specify the segment's internal design. The tailoring of this paragraph should be done very carefully.)

3.2.3 External Interface Requirements. The NAVCOM segment shall support the external interface requirements defined in Volume I

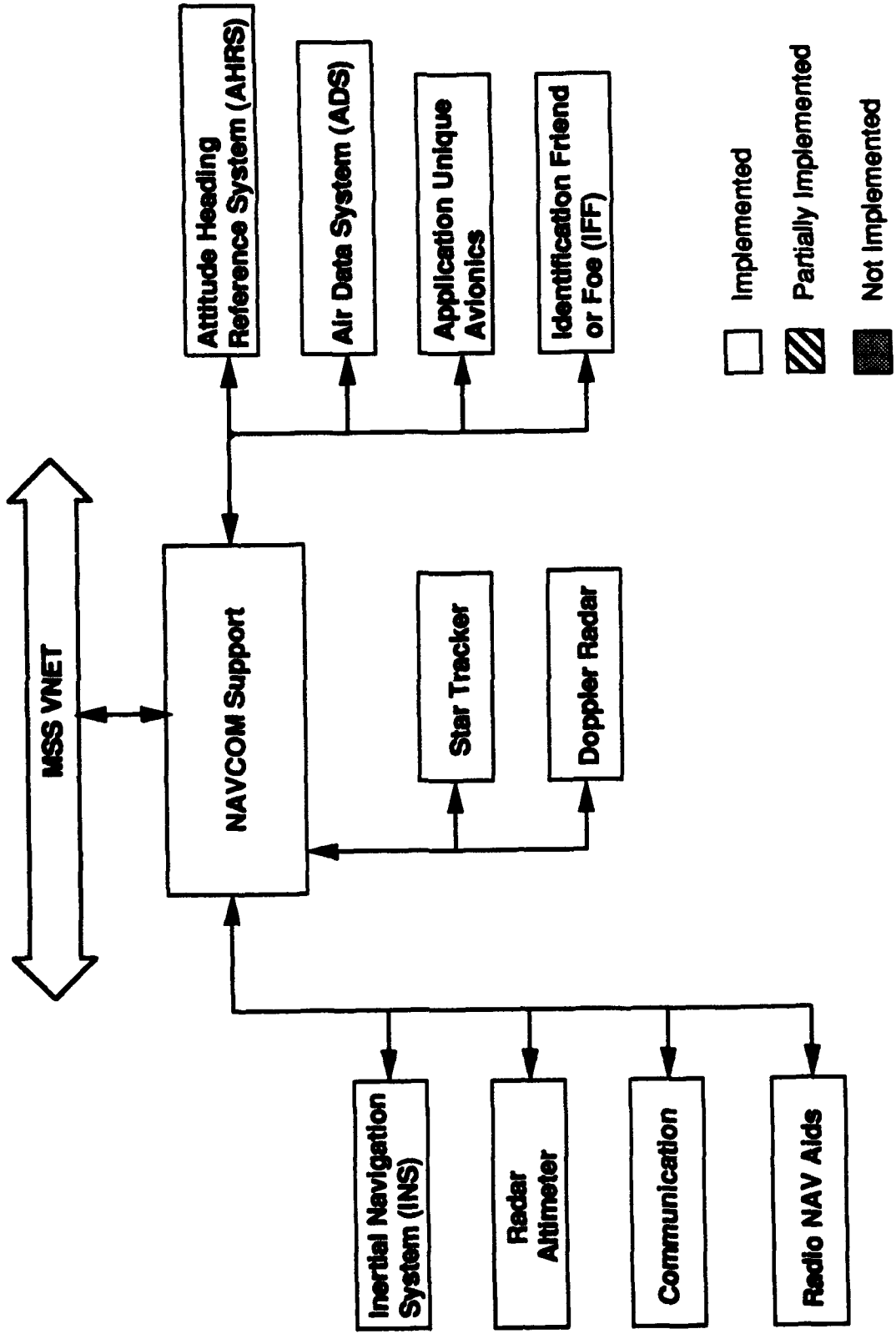

FIGURE 1 NAVCOM SEGMENT FUNCTIONAL RELATIONSHIPS

of this specification and the _____ *(insert application aircraft)* MSS Interface Requirements Specification (IRS), _____ *(insert IRS document number)*. External interfaces comprise data passed between functions contained in the NAVCOM segment and functions contained in the other MSS segments. With the exception of the dedicated interfaces for the cockpit, all other external interfaces which shall be used for the NAVCOM segment are specified in the _____ *(insert application aircraft type)* IRS.

(Define NAVCOM segment unique external interface requirements. Communications functions may interface with external systems which contain electronics equipment, such as amplifiers, noise or static generators, or digital signal processors. If such equipment is required it should be identified in this paragraph.)

3.2.4 Physical Characteristics. The physical characteristics of the NAVCOM segment shall meet the requirements as specified in Volume I of this specification. The NAVCOM segment physical characteristics shall be of such design as to interface with the other MSS segments via the MSS VNET.

(Physical characteristic requirements for the NAVCOM segment, other than those provided by the NAVCOM segment computational system and its interface to the MSS VNET shall be defined in this paragraph. Physical characteristic requirements may include backdoor interface hardware to connect NAVCOM segment Input/Output (I/O) to the NAVCOM equipment in the application aircraft cockpit; in particular, backdoor hardware interfaces may be required for the fire control and weapon stores panels in the Flight Station cockpit. In addition, any weight or size considerations applicable to the NAVCOM segment should be considered.)

3.2.4.1 Protective Coatings. NAVCOM segment protective coatings shall be as defined in Volume I of this specification.

(Additional protective coating requirements which are required for the NAVCOM segment may be defined in this paragraph. In general, the requirements of Volume I should suffice for the entire system.)

3.2.5 NAVCOM Segment Quality Factors

3.2.5.1 Reliability. The system level reliability requirements applicable to all segments in the MSS are defined in Volume I of this specification. The NAVCOM segment reliability must be ___ % to satisfy the system level reliability requirements. The Mean Time Between Critical Failure (MTBCF) shall be not less than ___ hrs.

(A specific allocation of reliability (e.g. MTBF) for this segment should be specified in this paragraph. Reliability should be allocated to each segment in such a way that system level reliability requirements will be met. Normally, this means that segment relability will be higher than system reliability.)

3.2.5.2 Maintainability. The system level maintainability requirements applicable to all segments in the MSS are defined in Volume I of this specification. The NAVCOM segment shall have a mean corrective maintenance time, μ_c, of ___ minutes, and a 90th percentile maximum corrective maintenance time of ___ minutes to satisfy the system level maintainability requirements.

(Maintainability requirements such as MTTR should be allocated to each segment in such a way that system level maintainability requirements will be met. Normally, this means that segment MTTR will be higher than system MTTR. System level requirements will include isolation to a faulty segment.)

3.2.5.3 Availability. The system level availability requirements applicable to all segments in the MSS are defined in Volume I of this specification.

(Usually availability applies only to the system level. Reliability and Maintainability (MTBF and MTTR) are allocated to each segment in such a way that system availability requirements will be met. It would be unusual to impose an availability requirement at the segment level.)

3.2.5.4 Additional Quality Factors. The additional quality factors, as defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Additional NAVCOM segment unique quality factors may be defined in this paragraph. In general, the system level additional quality factors will suffice for the NAVCOM segment.)

3.2.6 Environmental Conditions. The environmental condition requirements, as defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique environmental requirements. In general, the system level environmental conditions will suffice for the NAVCOM segment.)

3.2.7 Transportability. The transportability requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique transportation requirements. There may exist unique transportation requirements to ship the segment from the segment contractors facility to the prime contractors facility. In general, the system level transportability requirements will suffice for the NAVCOM segment.)

3.2.8 Flexibility and Expansion. The flexibility and expansion requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Unique requirements for this segment may include spare memory, spare time, spare mass storage, I/O channels by type, chassis expansion slots, etc. Expansion requirements should

consider the likelihood this segment will need to change as well as the cost of including capability now versus cost to change later. Reuse of the segment in future applications should also be considered.)

3.2.9 Portability. The portability requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Except for field transportable trainers portability of hardware is usually not a requirement. Portability of software may be a concern of future changes which may include upgrading the Computer Hardware Configuration Item (HWCI) are considered likely. Use of a standard higher order language such as Ada is usually adequate to assure software portability.)

3.3 Design and Construction. The design and construction requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique design and construction requirements. In general, the system level design and construction requirements will suffice for the NAVCOM segment.)

3.3.1 Materials. The materials requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique material requirements. In general, the system level material requirements will suffice for the NAVCOM segment.)

3.3.1.1 Toxic Materials. The toxic materials requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique toxic materials requirements. In general, the system level toxic materials requirements will be applicable to all segments.)

3.3.2 Electromagnetic Radiation. The electromagnetic requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique electromagnetic radiation requirements. In general, the system level electromagnetic radiation requirements will suffice for the NAVCOM segment.)

3.3.3 Nameplates and Product Marking. The nameplate and product marking requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique nameplate and product marking requirements. In general, the system level nameplate and product marking requirements will suffice for the NAVCOM segment.)

3.3.4 Workmanship. The workmanship requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique workmanship requirements. In general, the system level workmanship requirements will suffice for the NAVCOM segment.)

3.3.5 Interchangeability. The interchangeability requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique interchangeability requirements. In general, the system level interchangeability requirements will suffice for the NAVCOM segment.)

3.3.6 Safety. The safety requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique safety requirements. In general, the system level safety requirements will suffice for the NAVCOM segment.)

3.3.7 Human Engineering. The human engineering requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique human engineering requirements. In general, the system human engineering requirements will suffice for the NAVCOM segment.)

3.3.8 Nuclear Control. The nuclear control requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique nuclear control requirements. In general, the system level nuclear control requirements will suffice for the NAVCOM segment.)

3.3.9 Segment Security. The system security requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique security requirements. The NAVCOM segment may have additional requirements to ensure declassification of an embedded NAVCOM system. In general, the system level security requirements will suffice for the NAVCOM segment.)

3.3.10 Government Furnished Property. Government Furnished Property (GFP) shall be as identified in Volume I of this specification.

(Identify any NAVCOM segment unique GFP requirements. In general, the system level GFP requirements will suffice for the NAVCOM segment.)

3.3.11 Computer Resource Reserve Capacity. The system level processing resource requirements applicable to all segments in the MSS are defined in Volume I of this specification.

(In addition to the computer resource reserve capacity identified in Volume I, the specific reserve capacity for the NAVCOM segment may include the computational system hardware and software required to design, develop, and test the NAVCOM segment. System considerations such as spare (time, memory, storage, I/O channels) for growth unique to this segment should be imposed here. If this paragraph requires subparagraphs they should follow the numbering and topics used in Volume I.)

3.4 Documentation. The documentation requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique documentation requirements. Documentation requirements for the NAVCOM segment may include interface specifications and design data for interfacing to an embedded NAVCOM system. In general, the system level documentation requirements will suffice for the NAVCOM segment.)

3.5 Logistics. The system level logistics requirements applicable to the NAVCOM segment shall be as specified in Volume I of this specification, paragraph 3.5, and all subparagraphs of paragraph 3.5.

(Unique support requirements for this segment should be described here. These may include special tools and jigs for installation, alignment and calibration; special environmental conditions for operation and repair such as a clean-room for component repairs; levels and types of spares required.)

3.6 Personnel and Training. The system level personnel and training requirements, defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Identify any NAVCOM segment unique personnel and training requirements. In general, the system level personnel and training requirements (number, skills and training for maintenance personnel) will suffice for the NAVCOM segment.)

3.7 Subordinate Element Characteristics. Not applicable.

(This volume defines requirements for a subordinate element of the MSS. In general, there will be no subordinate elements of a segment.)

3.8 Precedence. The precedence requirements for the NAVCOM segment shall be as specified in Volume I of this specification.

4. QUALIFICATION REQUIREMENTS

4.1 Responsibility For Test and Inspection. The _____ *(insert application aircraft type)* MSS Responsibility For Test and Inspection requirements are defined in Volume I of this specification. The requirements defined in Volume I shall apply to the NAVCOM segment.

(This paragraph may be tailored to identify additional test or inspection requirements which are specific to the NAVCOM segment.)

4.2 Special Tests and Examinations. The system level general qualification events, levels, and methods of testing for the NAVCOM segment are defined in Volume I of this specification. The requirements defined in Volume I shall apply to the NAVCOM segment.

(Clearly identify which test events defined in Volume I apply to this segment. Be particularly explicit about the segment builder's responsibility during system integration and test. To the extent possible, segment verification should be accomplished as a stand alone segment test. In some cases verification can only be achieved in the integrated mode. A clear definition of the Segment supplier's responsibility during systems integration should be contained in the SOW.)

4.3 Requirements Cross Reference. A requirements compliance cross reference matrix shall be developed to ensure requirement verification traceability. The requirements cross reference matrix shall be included as part of the NAVCOM segment Prime Item Development Specification (PIDS).

5. PREPARATION FOR DELIVERY

The _____ *(insert application aircraft type)* MSS preparation for delivery requirements, as defined in Volume I of this specification, shall apply to the NAVCOM segment.

(Segment unique requirements may include packaging the segment for shipment to the integration location which could be different than packaging the system for shipment to the installation site. If requirements are imposed here, there may be test requirements for verification which must be added to Section 4.)

6. NOTES

6.1 Intended Use. The _____ *(insert application aircraft type)* MSS shall be used as an integral part of the _____ *(insert application aircraft type)* aircraft training system.

6.1.1 Missions. The NAVCOM segment shall support the mission requirements defined in Volume I of this specification. The NAVCOM segment shall provide simulation and training in cockpit familiarization, NAVCOM operating procedures, and mission procedures for the _____ *(insert application aircraft type)* aircraft NAVCOM systems. The NAVCOM simulation shall provide familiarization with the cockpit configuration and operation of the _____ *(insert application aircraft type)* NAVCOM systems. The simulation shall provide an environment to gain proficiency in executing normal procedures, recognize malfunctions/abnormal indications and executing the corresponding emergency procedures, and in executing mission procedures.

(The NAVCOM segment mission is to support the trainer mission, as described in Volume I. Any mission specific information should be described in this section. An example might be a segment intended to support a family of trainers, such as, a procedures trainer, part task trainer, flight trainer, or NAVCOM system trainer.)

6.1.2 Threat. Not applicable.

(This paragraph shall describe the threat which the NAVCOM system is intended to neutralize. In this context, this paragraph is not applicable to most simulators, and will generally remain "Not applicable".)

6.2 NAVCOM Segment Acronyms. The acronyms contained in this paragraph are unique to the NAVCOM segment and are in addition to the MSS acronyms contained in Volume I of this specification.

(Considerations may be given to including conversion factors or unique coordinate system definition.)

ADF	Automatic Direction Finder
ADS	Air Data System
AHRS	Attitude Heading Reference System
DOD	Department of Defense
DME	Distance Measuring Equipment
GFP	Government Furnished Property
GPS	Global Positioning System
H/W	Hardware
HF	High Frequency

IDD	Interface Design Document
IFF	Identification Friend or Foe
ILS	Instrument Landing System
INS	Inertial Navigation System
I/O	Input/Output
IOS	Instructor/Operator Station
IRS	Interface Requirements Specification
JTIDS	Joint Tactical Information Distribution System
LORAN	Long Range Navigation
MLS	Microwave Landing System
MSE	Multiple Simulator Environment
MSS	Modular Simulator System
MTBCF	Mean Time Between Critical Failure
NAVCOM	Navigation Communication
SATCOM	Satellite Communications
SKE	Station Keeping Equipment
TACAN	Tactical Air Navigation
TNE	Tactical and Natural Environments
UHF	Ultra High Frequency
VHF	Very High Frequency
VNET	Virual Network
VOR	Very High Frequency Omnidirectional Range

6.3 Glossary of NAVCOM Segment Terms. The terms contained in this paragraph are unique to the NAVCOM segment and are in addition to the MSS terms contained in Volume I of this specification.

AIR DATA SYSTEM (ADS) - System which senses static and dynamic air pressures to determine aircraft airspeed, altitude, and attitude.

ATTITUDE HEADING REFERENCE SYSTEM (AHRS) - System consisting of a magnetic compass and gyroscope which jointly provide indications of aircraft heading and attitude.

AZIMUTH - The horizontal direction of a celestial point from a terrestrial point, expressed as the angular distance from a reference direction.

DISTANCE MEASURING EQUIPMENT (DME) - An electronic navigational aid that determines distance of an airborne interrogator from a transponder beacon.

GLIDEPATH - That portion of the approach path lying along the glideslope.

GLIDESLOPE - An inclined surface extending upward at an angle to the horizontal from the point of desired ground contact of an aircraft coming in for a landing.

GLOBAL POSITIONING SYSTEM (GPS) - A precision satellite based navigation system.

IDENTIFICATION FRIEND OR FOE (IFF) - Radio frequency interrogation system. System consists of an interrogator to transmit a signal, a transponder in the receiving vehicle, and a responder which produces data for display.

INERTIAL NAVIGATION SYSTEM (INS) - A system which measures vehicle accelerations, and integrates t n to determine ground speed and position. System also includes a gyroscope which measures vehicle heading and attitude.

INSTRUMENT LANDING SYSTEM (ILS) - A radio navigation system which provides vertical and horizontal guidance to a landing site.

JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS) - An airborne system for distributing tactical information between various participants in a combat scenario.

LONG RANGE NAVIGATION (LORAN) - A navigation system consisting of a series of synchronized radio stations which transmit at low frequencies allowing solution of navigation equations. LORAN signals can be received at considerable distances, up to 800 nautical miles.

OMEGA - A navigation system consisting of eight radio stations transmitting at ultra low frequencies allowing solution of navigation equations. Omega signals can be received at distances up to 1000 nautical miles.

RADAR ALTIMETER - An airborne low altitude terrain tracking and altitude system to determine height above terrain.

SATELLITE COMMUNICATION (SATCOM) - Line of sight UHF communication system utilizing satellites to transmit and receive messages.

STATION KEEPING EQUIPMENT (SKE) - Navigation system which provides relative range and bearing to a companion aircraft, as well as, steering commands to maintain formation flight.

TACTICAL AIR NAVIGATION (TACAN) - Navigation system which provides relative bearing and range to transmitting site.

ULTRA-HIGH FREQUENCY (UHF) - Radio frequency of 300 to 3000 megacycles per second.

VHF OMNIDIRECTIONAL RADIO (VOR) - VHF based navigation system utilizing ground based transmitters to provide relative bearing to each ground station.

VERY HIGH FREQUENCY (VHF) - Radio frequency of 30 to 300 megacycles per second.

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REVISIONS

LTR	DESCRIPTION	DATE	APPROVAL
A	BMAC-STS-86-303-1 Total revision required to incorporate changes required by testing/validation efforts and Government comments.	90/01/11	A. Clem Prepared By
		91/01/11	Sm Hawkins Checked By
		91/01/14	J Bua Dwg. Qual.
		90/01/11	Sm Hawkins Supervised By
		91/01/15	W V Tucker Approved By
B	CCP HSV-H91-008 Total revision required to incorporate changes resulting from addition of two new specifications and new functional allocation. Damage Assessment and Scoring were added to the module support function. The Navigation Environment and Height Above Terrain functions were deleted from the module.	91/06/26	B. Frazier Prepared By
		91/06/26	L. Stuckey Checked By
		91/06/26	J Bua Dwg. Qual.
		91/06/27	Sm Hawkins Supervised By
		91/06/27	W V Tucker Approved By

DO-6000-4530 ORIG. 12/87

REVISIONS

LTR	DESCRIPTION	DATE	APPROVAL
C	CCP HSV-H91-008 Total revision required to incorporate Government comments on document.	91-09-26 91-09-26 91/09/26 91-09-26 91-10-08	Prepared By Checked By Dsg. Qual. Supervised By Approved By
D	CCP HSV-H91-017 This specification volume has been totally revised to: 1. Change the format to comply with DI-CMAN-80008A. 2. Incorporate the tailoring instructions into the body of the text. The incorporation of tailoring instructions into each specification volume has caused a change in the number of specification volumes from fourteen to thirteen. Prior to this change, all tailoring instructions were provided in Volume XIII and Volume XIV contained the Tactical and Natural Environment segment specification. The content of Volume XIII has been integrated into the other specification volumes. The change is summarized as follows: **Volume** — **IS** — **WAS** I through XII — Titles for these volumes are unchanged XIII — Environment — Tailoring Instructions XIV — "Deleted" — Tactical and Natural Environment	93-09-23 93-08-23 93-08-23 93/08/24	PREPARED CHECKED SUPERVISED APPROVED

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