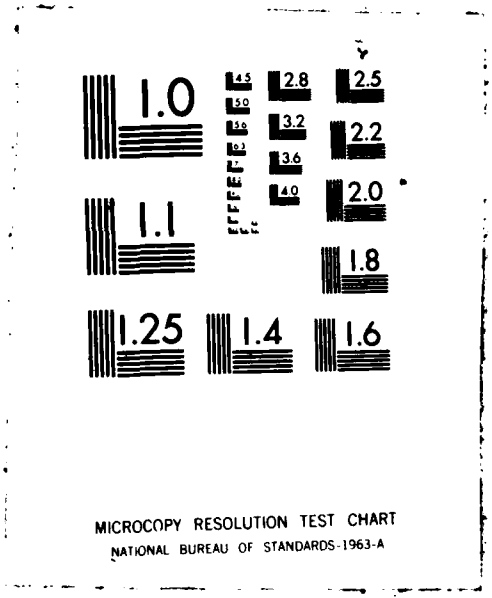
AD-A178 297 FUNCTIONAL CAPABILITIES SPECIFICATION COMMUNICATIONS ENGINEERING DESIGN S..(U) KANSAS UNIV CENTER FOR RESEARCH INC LAWRENCE TELECOMMUNICATIO.. JAN 87 1/1

UNCLASSIFIED NOSC-TD-1049 N66001-85-C-0315 F/G 17/2 NL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NOSC TD 1049

Technical Document 1049
January 1987

Functional Capabilities Specification Communications Engineering Design System (COEDS)

Telecommunications and
Information Sciences Laboratory
University of Kansas

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This document was prepared by Telecommunications and Information Sciences Laboratory for Code 822 of the Naval Ocean Systems Center.

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Under authority of
G.E. Ereckson, Head
Shipboard Systems Division

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S) NOSC TD 1049
6a NAME OF PERFORMING ORGANIZATION Telecommunications and Information Sciences Laboratory 6b OFFICE SYMBOL (If applicable)	7a NAME OF MONITORING ORGANIZATION Naval Ocean Systems Center
6c ADDRESS (City, State and ZIP Code) The University of Kansas Center for Research, Inc.. 2291 Irving Hill Drive Lawrence, Kansas 66045-6929	7b ADDRESS (City, State and ZIP Code) Code 822 San Diego, CA 92152-5100
8a NAME OF FUNDING/SPONSORING ORGANIZATION David W. Taylor Naval Ship Research and Development Center 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N66001-85-C-0315
8c ADDRESS (City, State and ZIP Code) Bethesda, MD 20084	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO: 62543N; PROJECT NO: CM41; TASK NO: RF45405; AGENCY ACCESSION NO: DN088 509

11 TITLE (Include Security Classification)

Functional Capabilities Specification Communications Engineering Design System (COEDS)

12 PERSONAL AUTHOR(S)

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Interim	FROM Jan 1986 TO Apr 1986	January 1987	22

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Communications Engineering Design System (COEDS) local area network (LAN)

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

Communications Engineering Design System (COEDS) is an integrated system to aid in the design and performance evaluation of shipboard exterior RF communication systems. COEDS may also aid in the design and performance evaluation of fixed, mobile, and aircraft communication systems. This functional capabilities specification for COEDS is a detailed statement of the particular system functions that will be designed and built in COEDS.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	UNCLASSIFIED
22a NAME OF RESPONSIBLE INDIVIDUAL S.T. Li	22b TELEPHONE (Include Area Code) (619) 225-2646
	22c OFFICE SYMBOL Code 822

DD FORM 1473, 84 JAN

83 APR EDITION MAY BE USED UNTIL EXHAUSTED
ALL OTHER EDITIONS ARE OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

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1 INTRODUCTION

This document is the Functional Capabilities Specification for COEDS (Communications Engineering Design System). The specifications are shown in the following sections:

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Section 3. Functional Subsystems
Section 3.1 Subsystem Definition
Section 3.2 User Interface Module
Section 3.3 Design and Modification Module
Section 3.4 Analysis Module
Section 3.5 Performance Evaluation Module
Section 3.6 Data Base Module

Section 4. User Oriented Features

1.1 System Definition

COEDS is an integrated system to aid in the design and performance evaluation of shipboard exterior RF communication systems. COEDS may also aid in the design and performance evaluation of fixed, mobile and aircraft communication systems. This functional capabilities specification for COEDS is a detailed statement of the particular system functions that will be designed and built into COEDS. These system functions are the particular and unique items that are necessary for COEDS to be used as an integrated design system. In addition to the system functions this specification also includes User oriented features that are provided by the system.

1.2 Specification Reference

The basis for the COEDS Functional Capabilities Specifications is COEDS contract, Task I.2, Developing Functional Specifications for COEDS. Related specifications for other items which are necessary for COEDS system design, but not included in this document, are:

1. Software Structure Specifications: Task I.3. These are specifications for the software to be developed for the system and subsystem modules.

2. Hardware Specifications: subset of Task I.4. These are specifications for the hardware used in the design system. The specifications are part of the Design System Selection Recommendations Report.

3. Government Furnished Software: COSAM II WIDEBAND. COEDS will be developed and built around COSAM II WIDEBAND software as described in ECAC Report, THE COSAM II (DECAL/PECAL) WIDEBAND AND NARROWBAND RF ARCHITECTURE ANALYSIS PROGRAM USERS MANUAL, ECAC-CR-85-120, September 1985, Consulting Report, IIT Research Institute. This software and documentation to be updated and modified by NOSC per meeting notes item number 12; COEDS Project Meeting, San Diego, 6-10 Jan 86.

2 SYSTEM ARCHITECTURE

The general architecture of COEDS is shown in figure 1, COEDS Block Diagram. The block diagram shows all the major hardware items of COEDS, the COEDS interface to other systems and the peripheral equipment. Figure 1 also provides an overview of the COEDS computational environment.

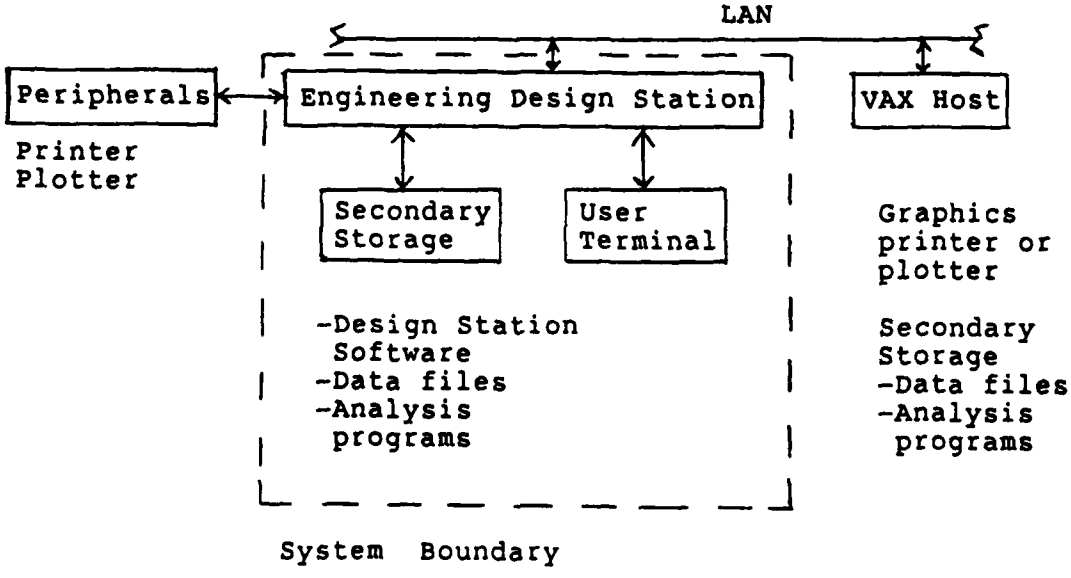


Figure 1. COEDS System Block Diagram

COEDS consists of the Engineering Design Station with Secondary Storage and a User Terminal. Peripherals, LAN and the VAX Host are part of the COEDS computational environment. This hardware is defined as follows:

- Engineering Design Station: The station block contains all the COEDS hardware except for the User terminal and the secondary storage.

- User Terminal: A high resolution, bit mapped display unit (VDU), a keyboard and a "mouse". This terminal is the User's primary interface to the Engineering Design Station for input, output, administration and control.

- Secondary Storage: Secondary storage is for nonvolatile storage of programs and data required by the Engineering Design Station. Secondary storage consists of on-line storage for quick access and back-up storage for archiving and protection. On-line storage is provided by a hard disk. Back-up is provided by a streaming tape system.

- VAX Host: The COEDS interface to a VAX Host computer is via a local area network (LAN) provided by the user. The Engineering Design Station interface to the LAN is by a communications port on the station and controlled by DECNet software in the station. This connection allows the COEDS User to be connected to a VAX Host computer also connected to the LAN. The VAX Host could be used to access other computing resources, additional program and data files, and other peripherals connected to the VAX Host such as printers and plotters. The communications port hardware and DECNet software are provided as part of the station.

- Peripherals: Peripheral equipment can be connected to the Engineering Design Station for printing and plotting. Connection to the station is via an RS-232 type interface. These peripherals allow the COEDS output to be printed or plotted. Within COEDS the input, output and all commands are only displayed on the User Terminal VDU. Note: there are no printers nor plotters provided as part of COEDS contract N66001-85-C-0315. However the station's VMS operating system has routines and procedures for driving a printer.

3 FUNCTIONAL SUBSYSTEMS

COEDS is composed of five (5) functional subsystems (modules).

1. User Interface
2. Design and Modification
3. Performance Evaluation
4. Analysis
5. Data Base

Each functional module represents a unique subset of COEDS functions. The modules are integrated and operated by the COEDS system shown in figure 1 using existing software and new software specifically developed for COEDS.

Functional Organization

COEDS functional modules are connected in a hierarchal tree structure as shown below in figure 2, Functional Organization Diagram. This shows an outline of all modules, interrelationship between modules, and the overall organization of COEDS functions.

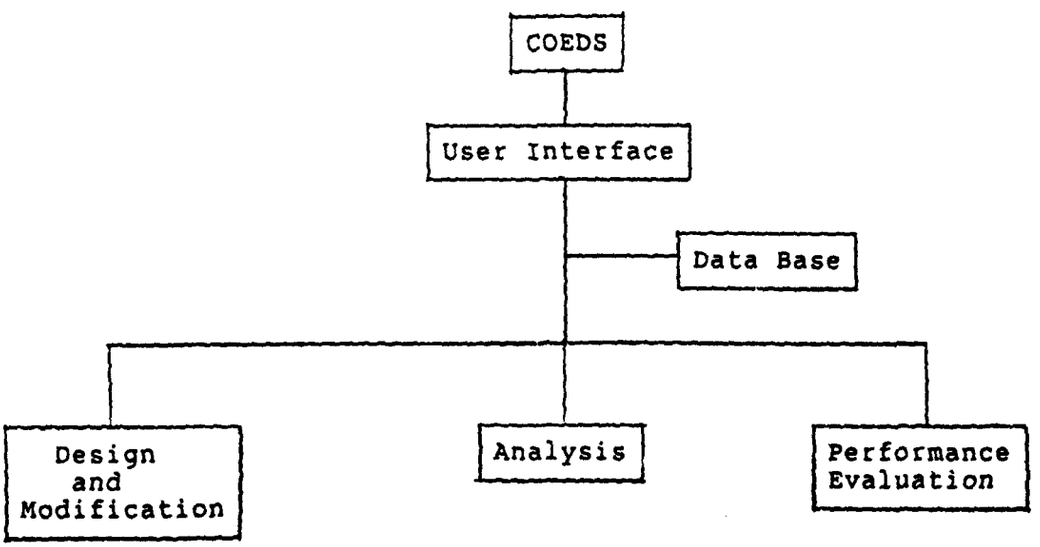


Figure 2. COEDS Functional Organization

The Organizational Diagram shows that the User Interface module controls COEDS functions. The Data Base module supports all other modules and can be accessed by all other modules. The Design and Modification, Analysis and Performance Evaluation modules are controlled and used through the User Interface. Data for these three modules is obtained from the Data Base.

In the next sections each module is defined and the features and functions of each module are described. Following in Section 4 is a description of specific User oriented features provided through integration of the functional modules.

3.1 Module Definition

The modules in figure 2 are defined in terms of their general functions within COEDS. The unique functions and specific details of each module is explained in Sections 3.2 - 3.6, following the module definitions below.

1. User Interface: facilitates use of COEDS by controlling all inputs, outputs, interactions and interfaces between all modules.

2. Design and Modification: permits User to "design" and configure the system to be analyzed; permits the User to modify the "design" and converge to a design goal; and allows the User to set up and specify the analysis which is desired.

3. Analysis: an integrated set of software subsystems to perform the analysis calculations.

4. Performance Evaluation: shows the results of the analysis, design, modification or other output in a "thought enhancing" format.

5. Data Base: a structure that incorporates the existing data, allows modification of existing data, and allows adding and deleting data. Data may consist of equipment parameters, ship's outlines, case histories, design rules and checks.

3.2 User Interface Module

The User Interface not only controls interaction between user and COEDS but also controls use of all the system modules, based on demands from the user. The primary physical interface between the User and COEDS and the User's activities is:

- Mouse: drawing the system diagram and system connections; placement of antennas on a graphical outline of a ship which has been provided from sources external to COEDS; and menu selection.

- Keyboard: text input; control statements; data; and menu selection.

- Video Display: echo all input and display all output.

The User Interface Module controls and manages the operation and use of the system. The User Interface Module uses programs and procedures built into the User Interface Module as well as programs and procedures which are part of the terminal's operating system. The control functions provided by the User Interface Module are for the following areas:

1. Physical Interface: the primary User interaction with the system through the keyboard, mouse, VDU, printer, and communication ports.

2. System Administration: for access and management of COEDS features and functions are: User accounts, sign on and sign off procedures, accounting information about use of the system as allocated to Users or projects, statistics summarizing use of the system, configuration of the system, and security of the data and programs in the system.

3. User Activities: functions which enable use of the system for particular problems. These are: menus, multiple windows, graphics and other functions to display input and output. User functions allow easy entry into the system, selection of procedures to structure the analysis to be done, control of the analysis, and control of the output.

4. Module Interface: provides the means to control the interface and interaction between all the system modules. Also the

interface and interaction to outside data sources and linking data sources within the system.

3.3 Design And Modification Module

The Design and Modification Module provides following functions: problem setup and system configuration; control of the analysis; design rules and guidelines; and changes in configuration and parameters. These functions are shown below.

1. Input Configuration: screen (VDU) layout and interconnection between all elements of equipment including antennas, and their location on a graphical outline of a ship (if outline is available from external sources). Also included is a User defined coupling matrix if known by the User.

2. Block Diagram: a communication system block diagram is generated including the interaction paths between all transmitters and the victim receiver(s). The block diagram will be shown on the User's screen with the same nomenclature and labels used in customer supplied layout. This will provide a 1:1 visual correlation between screen layout (block diagram) and the original system and equipment layout supplied by the customer.

   The nomenclature and the labels in the block diagram on screen will be used throughout the program to provide a consistent reference system for analysis, performance evaluation, reports, data and any other reference to the problem.

3. System Parameters: will be defined and generated during system layout and generation of the block diagram. These parameters will serve as input to other modules such as the analysis and performance evaluation modules.

4. Interaction Paths: will be generated from the block diagram according to system analysis rules and guidelines or from the User. Besides the interaction paths the interaction frequencies will be generated according to system analysis rules and guidelines or from the user.

5. Changes: handle changes to the system design and analysis so an iterative or "what if" type analysis may be accommodated.

6. Design Rules: used to check input to ensure system configuration specified has no logical inconsistencies and the analysis required is allowable based on input data. Also included will be some guidelines and rules displayed to User to aid in structuring and controlling the analysis.

7. Interface: to all other modules to index, locate and recall previous designs and other data necessary to layout the system and set up the analysis.

3.4 Analysis Module

The Analysis Module contains individual subsystems to perform computations required either directly from the User Interface or from the Design and Modification Module or the Performance Evaluation Module. The Analysis Module is the computation module for the system. Some particular functions and computation subsystems are as follows:

1. Computation Subsystems: main subsystems which will be used for analysis are:

   --COSAM WIDEBAND (which includes versions of DECAL and PECAL).

   --LINCAL

   --Interference Free Frequency Pairs

   --Antenna Matching

2. Model Subsystems: will be a channel model for phase interference fading. (The path loss models used with LINCAL will be incorporated with LINCAL.)

3. Path Analysis: may be done in two directions using LINCAL. The mean path loss will be calculated using loss models under LINCAL. The short term (Rayleigh) fading will be estimated using a channel model for phase interference fading.

4. Expansion: facility to incorporate additional models and computation subsystems in the future such as may be required for frequency hopping.

5. Interface: to other modules for analysis, data and other programs.

3.5 Performance Evaluation Module

The Performance Evaluation Module shows the analysis results in a "thought enhancing" display. The major functions are handling stored text, and generation of tables and graphs to display the results of the analysis. These are outlined below.

1. Graphical display of results of analysis: Display to be in User selected, standard formats from a menu. Text and labels to be inserted in graphs based on menu selection and response from User.

2. Tabular display of results of analysis: Tables to be in standard row-column format. Text and labels to be inserted in tables based on menu selection and response from User.

3. Report Generation: To assist the User in preparing a report about a design problem and analysis, the system will be capable of storing text which may be integrated into COEDS output (graphs and tables) by the User. The stored text will be input by the User and maintained and updated by the User in respnse to his analysis requirements and customer's requirements.

3.6 Data Base Module

The Data Base Module may contain equipment parameter files (EPF), measurement data, two dimensional ship's outlines, case histories, design rules and checks. This data base will incorporate existing data, permit adding new data, permit deleting and modifying existing data and allow access to COEDS by an expert system in future versions of COEDS.

In addition to storing data, the module also contains programs and procedures to manage and maintain the data, similar to the COSMAIN file maintenance program in COSAM II. The file maintenance and management program for COEDS provides the following functions:

1. Editing: allows the User to add, change, delete, view, substitute and link files. These editing functions vary depending on the read-write permission attached to all data in the data base.

2. Directory: allows the User to group data in to Directory categories, maintain a Directory for the data base, and allow a means of searching and checking for existence of data.

3. List: allows the User to list (print) data from the data base.

4. Access Control: provides control over all data in the data base. The control is for read-write permission on all data and accessing the module. Control over a particular segment of data will be by the User or System Administrator (controls the COEDS system).

5. Error Checking: provides error checking on User input data to ensure that the data entered is according to the required syntax and predefined formats.

4 USER ORIENTED FEATURES

The functions described above for the five COEDS modules provide specific operational features for the User. The operational features that will be provided (as a minimum) are listed below. The purpose of the list is to describe the particular features which will be included as a minimum in COEDS. The list is not all inclusive in that it does not show the set of all possible features available from COEDS. The set of all possible features is not listed as the set of all possible features depends on the particular use of the system for a particular problem. The minimum set of specific user oriented features are as follows.

1. Block Oriented Functional Format (BOFF): The emphasis in COEDS is on a block oriented layout (presentation) of both the equipment and the analysis. A block oriented equipment layout shows the equipment modules and their connections to form a system. A block oriented analysis shows the association of parameters, signals and data with individual items of equipment which are being analyzed. Using BOFF, the parameters, data and signals are represented in a block format along with the equipment. BOFF provides the means to link the equipment modules and to create the necessary files to run the analysis. It also provides the means to duplicate customer supplied labels and descriptions throughout the analysis and to maintain consistency with labeling and descriptions.

2. Quick Analysis: A screen block diagrams and necessary files may generated on the basis of customer suppplied block diagrams and default conditions when it is desired to do a quick estimate and analysis. Particular types of files generated are those necessary for PECAL, DECAL and LINCAL type analysis.

3. Interaction Format: The interactions between transmitters and victim receiver(s) will be generated on the basis of the screen block diagram or (optionally) by the User. The features available will be:

   - Highlighting of interaction paths on screen block diagram.

   - Consistent labeling so that screen block diagram and customer supplied diagrams are the same.

- Incorporation of Case Western Reserve University frequency analysis program to generate list of interference free frequencies.

- Generation of data files for interaction paths to link to other programs.

In addition the User could specify the type of interactions from among the six COSAM types available for the interference analysis.

4. Design Guidelines: Built-in rules and checks will guide the User through the analysis. The features available will be:

- ability to determine the maximum allowable transmitter power given frequency separation, antenna coupling and desired level of interference.

- ability to show changes in performance with changes in equipment parameters; such as changes in power or bandwidth and the effect on S/N.

- to show confidence intervals on results of calculations given confidence intervals on the input data and parameters.

- to allow interpolation between integer frequency values so analysis can be done using frequencies other than those for which there is data on coupling.

- incorporate data from previous designs.

- ability to develope a frequency plan given a configuration, and maximum interference levels which can be tolerated or other performance criteria.

5. Permissible Exposure Levels (PEL): interface to NEEDS to allow the User to obtain a safe distance from a transmit antenna beyond which there would be no hazard to personnel or to equipment and munitions, given the transmitter power level and location of transmit antenna. These computations to follow Navy guidelines for PEL. The electromagnetic field calculations necessary to establish the field intensity at a given point will be done external to COEDS using NEC analysis. The output of the NEC analysis will serve as an input to the PEL computation subsystem.

6. Baseline Performance Report: A particular type of report for a customer will be the Baseline Performance Report. This report will provide details of the general capabilities, limitations and link performance for all the equipment in a particular system configuration. The purpose of this report would be to provide, typically, a ship's Captain with a summary of the capability of the communications installed on his ship.

7. File Maintenance: routines, procedures and subprograms to edit and maintain the data base. The features available will be:

   - check format of data and check data being within an expected range.

   - capability to add alternate pieces of equipment when data for desired equipment is missing.

   - capability to add to EPF's.

   - capability to add measurement data.

   - check for existence of required EPF's when beginning an analysis and alert the User if required EPF's are not available.

   - provide interface for reading foreign data files.

   - provide data translation for files external to the Data Base Module.

8. Equipment Substitution: routines, procedures and subprograms to search the EPF's to assist the User in substituting equipment types for the following cases:

   - equipment chosen for a design analysis is not suitable because the equipment operating parameters do not match the operating parameters required for the design.

   - equipment chosen for a design analysis is desired to be substituted for reasons other than obtaining a change in equipment operating parameters (example: equipment chosen is not available or not in inventory any longer and a newer version is desired and which has approximately the same operating parameters as the original chosen.).

9. Link Analysis: using LINCAL to predict mean path loss and a channel model to determine short term (Rayleigh) fading. A conventional link analysis may be performed in both directions of the link. The analysis parameters will be from the block oriented system input for both ends of the link. The output will be selected from a menu to show (typically) received signal distribution, S/N distribution or availability for specified S/N or received signal levels.

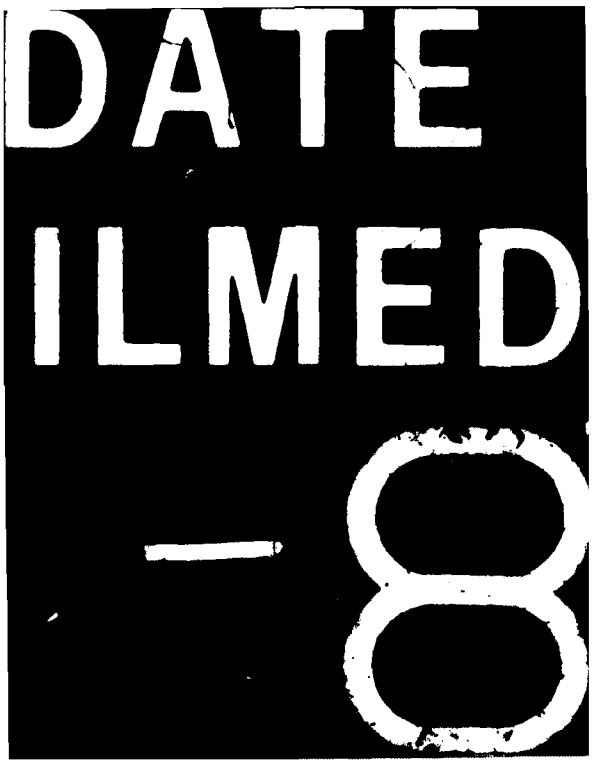
10. Coupling Values: will be shown in a block oriented format in the system diagram. User will be able to check and display coupling values and edit as desired.

11. Antenna Matching: routines, procedures and subprograms to allow the User to calculate and evaluate changes in system performance as a result of changes in the antenna impedance and matching to radio equipment (VSWR). The antenna impedance and changes in antenna impedance will be calculated external to COEDS, typically in a NEC calculation.

12. Drawing Files: of graphical ship's outlines may be stored in COEDS data base by the User. The format for input of graphical outlines into the data base will be according to one standard format such as the present one used by the Navy; Interactive Graphics Exchange System Version II (IGES II). The graphical ship's outlines will be available to the User for display on the terminal, printing, and for placing antennas and including (the outline) in the system design.

13. Noise Model: Various noise models will be included in the data base for use in the Analysis module. This will allow the User to specify the external noise levels he wishes to use for a particular analysis. The noise models will account for differences in atmospheric radio noise levels and man-made noise levels.

14. Engineering Design Station: COEDS station will not be intimidating to the casual user nor require a large investment in time and study to use the station. Use of the station should not require any knowledge of computer functions, operation nor theory except the basics of using a computer keyboard, a mouse, and knowing the COEDS station commands. [It is assumed that the User has a working knowledge of the theory, methods and procedures of communication system design and analysis as it is used in COEDS.]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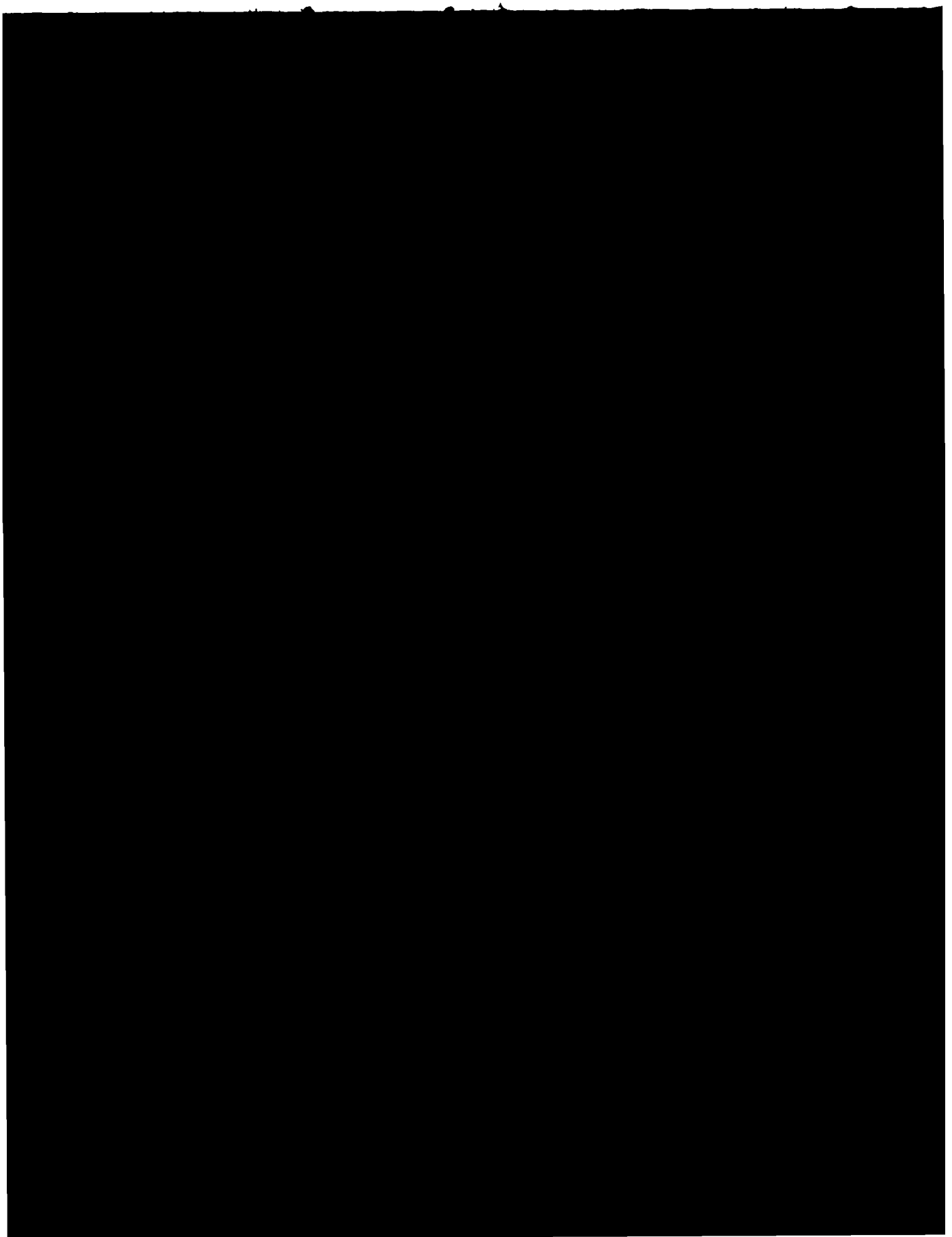

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