NOT MEASUREMENT SENSITIVE

MIL-HDBK-3001(AS)
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DEPARTMENT OF DEFENSE HANDBOOK

GUIDE TO THE GENERAL STYLE AND FORMAT

OF

U.S. NAVY WORK PACKAGE TECHNICAL MANUALS

This handbook is for guidance only. Do not cite this document as a requirement.

AMSC N/A **AREA TMSS**

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FOREWORD

1. This military handbook is approved for use by the Department of the Navy and is available for use by all Departments and Agencies of the Department of Defense (DoD).

2. This handbook provides non-regulatory guidance for the preparation of technical manuals that are required to operate and maintain the various types of equipment and weapon systems within the Department of the Navy. It is for guidance only and cannot be cited as a requirement. If it is, the contractor does not have to comply.

3. This handbook expands and clarifies the requirements contained in MIL-STD-3001-1 through MIL-STD-3001-8, Preparation of Digital Technical Information for Multi-Output Presentation of Technical Manuals, and provides recommended writing style, comprehensibility, format, and graphics requirements used by the U.S. Navy for the preparation of technical manuals to the work package concept.

4. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, NAVAIRWARCENACDIV, Systems Requirements Department, ATTN: Code 4.1.11.1, Lakehurst, NJ 08733-5100 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this handbook or by letter.

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1. SCOPE.

1.1 Scope. This handbook provides non-regulatory guidance and information for the preparation of technical manuals (TM) required to operate and maintain the various types of equipment and weapon systems within the Department of the Navy. It provides preferred format and general writing style, graphics, revisions, comprehensibility, and security guidance for the preparation of digital data for the delivery of all types of work package TMs. Section 4 provides technical manual development guidance for the preparation of page-based TMs. Section 5 provides technical manual development guidance for the preparation and display of linear structured, scrollable, Electronic Technical Manuals and frame-based Interactive Electronic Technical Manuals. Linear, scrollable Electronic Technical Manuals (hereafter referred to as ETMs) and frame-based Interactive Electronic Technical Manuals (hereafter referred to as IETMs) are digital in form and designed for interactive display to maintenance technicians or system operator end users by means of a computer controlled Electronic Display System (EDS). Although this handbook encourages the delivery of digital files, the requirement for digital files, paper, or both will be specified by the requiring activity. This handbook provides guidance only. It cannot be cited as a requirement. If it is, the contractor does not have to comply.

1.2 Applicability. This handbook is applicable for use by the Department of the Navy and supporting contractors.

2. APPLICABLE DOCUMENTS.

2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are the ones that are needed in order to fully understand the information provided by this handbook.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the latest issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplemented thereto, and are referenced for guidance only.

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-PRF-28000	Digital Representation for Communication of Product Data: IGES Application Subsets and IGES Application Protocols.
MIL-PRF-28001	Markup Requirements and Generic Style Specification for Exchange of Text and Its Presentation.
MIL-PRF-28002	Raster Graphics Representation in Binary Format, Requirements for.
MIL-PRF-28003	Digital Representation for Communication of Illustration Data: CGM Application Profile.

MIL-PRF-87268	Manuals, Interactive Electronic Technical - General Content, Style, Format, and User-Interaction Requirements.
MIL-PRF-87269	Data Base, Revisable: Interactive Electronic Technical Manuals, for the Support of.

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-100	Engineering Drawing Practices.
MIL-STD-1309	Definition of Terms for Testing, Measurement, and Diagnostics.
MIL-STD-3001-1	Preparation of Digital Technical Information for Multi-output Presentation of Technical Manuals.
MIL-STD-3001-2	Description, Principles of Operation, and Operation Data.
MIL-STD-3001-3	Testing and Troubleshooting Procedures.
MIL-STD-3001-4	Maintenance Information with IPB.
MIL-STD-3001-5	Aircraft Wiring Information.
MIL-STD-3001-6	Structural Repair Information.
MIL-STD-3001-7	Periodic Maintenance Requirements.
MIL-STD-3001-8	Separate Illustrated Parts Breakdown (IPB).

HANDBOOKS

DEPARTMENT OF DEFENSE

MIL-HDBK-9660	Handbook for DoD-Produced CD-ROM Products.

(Copies of specifications, standards, and handbooks are available by request from Defense Automated Printing Service, Building 4D, DPM-DODSSP, 700 Robbins Ave., Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents and publications. The following other Government documents and publications form a part of this handbook to the extent specified herein.

DoD 5200.1R	Information Security Program Regulation.
DoD 5220.22M	Industrial Security Manual.
EO 12196	Occupational Safety and Health Program for Federal Employees.
EO 12958	Classified National Security Information.

H4/H8 Cataloging Handbook	Commercial and Government Entity (CAGE) Codes.
Joint Pub 1-02	Department of Defense Dictionary of Military and Associated Terms.
Library of Congress Catalog Number Z253.U58	U.S. Government Printing Office (GPO) Style Manual.
NAVAIR 00-25-701	Technical Guide for Organizational Level Aircraft Wiring Systems Repair Manuals.
OPNAVINST 4790.2	The Naval Aviation Maintenance Program.
OPNAVINST 5510.1	Department of the Navy Information and Personnel Security Program Regulation.
Public Law 91-596	Occupational Safety and Health Act, dated December 29, 1970 and Executive Order 11807.

(Copies of directives and instructions are available by request to Commander, Naval Inventory Control Point Philadelphia, Publications/Forms Branch, Code 03334, 700 Robbins Avenue, Philadelphia, PA 19111-5098.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified therein. Unless otherwise specified, the issues of the documents that are DoD-adopted are those listed in the latest issue of the DoDISS, and supplement thereto.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Y14.2	Line Conventions and Lettering.
ANSI Y14.15	Electrical and Electronic Diagrams.
ANSI Y14.17	Fluid Power Diagrams.
ISO 8879	Information Processing - Text and Office Systems - Standard Generalized Markup Language (SGML).

(Copies of the documents listed above are available from the American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036.)

INSTITUTE FOR ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 91-84	Graphic Symbols for Logic Functions.

(Copies of the document listed above are available from the IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of the referenced document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. **DEFINITIONS**.

3.1 Acronyms used in this handbook. The acronyms used in this handbook are defined as follows:

AAE	Airborne Armament Equipment.
ALSS	Aviation Life Support Systems.
AMCM	Airborne Mine Countermeasure.
ANSI	American National Standards Institute.
ASCII	American Standard Code for Information Interchange.
ATE	Automatic Test Equipment.
BITE	Built-in Test Equipment.
CAGEC	Commercial and Government Entity Code.
CALS	Continuous Acquisition and Life-cycle Support.
CD	Compact Disk.
CD-ROM	Compact Disk-Read Only Memory.
CGM	Computer Graphics Metafile.
CRT	Cathode Ray Tube.
DIC	Direct Image Copy.
DoD	Department of Defense.
DoDISS	Department of Defense Index of Specifications and Standards.
DTD	Document Type Definition.
EDS	Electronic Display System.
EO	Executive Order.
ESD	Electrostatic Discharge.
ETM	Electronic Technical Manual.
FOSI	Formatting Output Specification Instance.
GAPL	Group Assembly Parts List.
GPO	Government Printing Office.
HMWS	Hazardous Materials Warning Summary.
IETM	Interactive Electronic Technical Manual.
IGES	Initial Graphics Exchange Specification.
IPB	Illustrated Parts Breakdown.
ISO	International Organization for Standardization.
LMI	Logistics Management Information.
LORA	Level of Repair Analysis.
LSA	Logistics Support Analysis.
NDI	Nondestructive Inspection.
NHA	Next Higher Assembly.
NSA	National Security Agency.
NSN	National Stock Number.
OJCS	Organization of the Joint Chiefs of Staff.
OS	Output Specification.
OSD	Office of the Secretary of Defense.
OSHA	Occupational Safety and Health Act.
PAT	Powered Aerial Target.

PMRC	Phased Maintenance Requirements Card.
PMRM	Phased Maintenance Requirements Manual.
P/N	Part Number.
PST	Powered Surface Target.
QA	Quality Assurance.
QECA	Quick Engine Change Assembly.
SCC	Sequence Control Chart.
SE	Support Equipment.
SGML	Standard Generalized Markup Language.
SM&R	Source, Maintenance and Recoverability.
SRA	Shop Replaceable Assembly.
SS	Special Stores.
TM	Technical Manual.
TMSS	Technical Manuals Specifications and Standards.
TP	Test Point.
TPDR	Technical Publication Deficiency Report.
UAV	Unmanned Aerial Vehicle.
WP	Work Package.
WRA	Weapons Replaceable Assembly.
WYSIWYG	What You See Is What You Get.

3.2 Definitions of selected terms.

3.2.1 Adjust. To maintain or regulate within prescribed limits, by bringing into proper position, or by setting the operating characteristics to specified parameters.

3.2.2 Alert. An alert is any message, communication, notice, or output which requires manual acknowledgment from the user of the ETM/IETM.

3.2.3 Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

3.2.4 American National Standards Institute (ANSI). A private sector organization that plans, develops, establishes or coordinates standards, specifications, handbooks or related documents.

3.2.5 Assembly. Two or more parts or subassemblies joined together to perform a specific function and capable of disassembly (e.g., brake assembly, fan assembly, audio frequency amplifier).

NOTE

The distinction between an assembly and subassembly is determined by the individual application. An assembly in one instance may be a subassembly in another where it forms a portion of an assembly.

3.2.6 Block diagram. A modified schematic diagram in which each group of maintenance-significant components that together perform one or more functions is represented by a single symbol or block. The block or symbol representing the group of components shows simplified relevant input and output signals pertinent to the subject diagram.

3.2.7 Built-in Test Equipment (BITE). Any identifiable device that is part of the supported end item and is used for testing that supported end item.

3.2.8 Calibrate. To determine and cause corrections or adjustments to be made to instruments or test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

3.2.9 Callout. Anything placed on an illustration to aid in identifying the objects being illustrated, such as index numbers, nomenclature, leader lines, and arrows.

3.2.10 CALS (Continuous Acquisition Life-cycle Support) raster. Compressed scanned raster images (CCITT, Group 4) in accordance with MIL-PRF-28002.

3.2.11 Caution. A statement or some other notification about an operating or maintenance procedure, practice, or condition that, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

3.2.12 Commercial and Government Entity (CAGE) Code. A five-character code assigned to commercial activities that manufacture or supply items used by the Federal Government and to Government activities that control design or are responsible for the development of certain specifications, standards, or drawings which control the design of Government items. CAGE Code assignments are listed in the H4/H8 CAGE Publications.

3.2.13 Comprehensibility. The completeness with which a user in the target audience understands the information in the TM.

3.2.14 Computer Graphics Metafile (CGM). A standard digital form for vector graphics preparation as defined by MIL-PRF-28003.

3.2.15 Continuous Acquisition Life-cycle Support (CALS). A DoD initiative to transition from paper-intensive, nonintegrated weapon systems design, manufacturing, and support processes to a highly automated and integrated mode of operation. This transition will be facilitated by acquiring, managing, and using technical data in standardized digital form.

3.2.16 Continuous tone photographs or drawings. Continuous tone photographs or drawings have a continuous gradation of tonal values ranging from light (white) to dark (black), including gray. These tonal values are not created by lines or dots.

3.2.17 Department of Defense (DoD). The Office of the Secretary of Defense (OSD) (including all boards and councils), the Military Departments (Army, Navy, and Air Force), the Organization of the Joint Chiefs of Staff (OJCS), the Unified and Specified Commands, the National Security Agency (NSA), and the Defense Agencies.

3.2.18 Department of Defense Index of Specifications and Standards (DoDISS). The DoD publication that lists unclassified Federal and military specifications and standards, related standardization documents, and voluntary standards approved for use by DoD.

3.2.19 Depot-level maintenance. Maintenance that is beyond the capability of the organizational and intermediate support activities. Depot-level maintenance normally consists of overhaul, recondition, manufacture, repair, or modification and requires technical assistance beyond lower maintenance level capability.

3.2.20 Digital graphics forms. A standard graphics form acceptable for graphics preparation in accordance with graphic standards listed in 6.1. These forms include CGM, CALS raster, and Initial Graphics Exchange Specification (IGES).

3.2.21 Direct image copy (DIC). One-on-one reproducible without paste-overs or mortises, suitable for use on a copier or making direct image masters. Quality should be such that if a negative were to be prepared, only the imperfection due to the quality of photolithographic film would require touch up before making the offset plates.

3.2.22 Disassemble. The step-by-step taking apart (or breakdown) of an assembly or subassembly to the lowest level of its parts identification as maintenance-significant (i.e., assigned a Source, Maintenance and Recoverability (SM&R) code for the category of maintenance under consideration).

3.2.23 Document Type Definition (DTD). The definition of the markup rules for a given class of documents. A DTD or reference to one should be contained in any SGML-conforming document.

3.2.24 Electronic Display System (EDS). An electronic device on which display images can be represented; most often a CRT or a liquid-crystal device.

3.2.25 Electronic Technical Manual (ETM). For the purpose of this handbook, an **ETM** is a technical manual normally prepared from a linear SGML document file and not a hierarchically-based database as an IETM. The ETM is also displayed on an EDS as a scrollable, linear structured document and may employ a combination of an automated intelligent index, prompted dialog boxes, and content-driven logical "NEXT" functions.

3.2.26 Footer. One or more lines of text that appear at the bottom of each page (also called feet and running feet).

3.2.27 Formatting Output Specification Instance (FOSI). The FOSI interprets the style and formatting requirements of the Output Specification (OS). The FOSI can include font, leading, hyphenation characteristics, etc.

3.2.28 Frame-based Interactive Electronic Technical Manual (IETM). An **IETM** which has been designed to be displayed frame by frame.

3.2.29 Functional diagram. A type of illustration in which symbols are connected by lines to show relationships among the symbols. The symbols may be rectangles or other shapes, standard electronic symbols representing components or functions, or pictorials representing equipment or components. Where appropriate, voltage readings are shown. The lines may represent procedures or processes, such as signal or logic flow, and physical items, such as wires. Functional diagram includes schematics, wiring and piping diagrams, logic diagrams, flow charts, and block diagrams.

3.2.30 Graphic(s). Any type of presentation or representation which gives a clear visual impression.

3.2.31 Halftones. Halftones are the tonal values of gray and black created by lines or dots. A halftone is a conversion of a continuous tone print.

3.2.32 Header. One or more lines of standard text that appear at the top of each page (also called heads and running heads).

3.2.33 Horizontal (Landscape) TM format. Positioning of technical manual content so that the page horizontal (width) dimensions are greater than vertical (height) dimensions.

3.2.34 Hotspot. An area of the display which acts as a hidden button. Touching the hotspot selects designated information for display.

3.2.35 Icon. Pictorial representation; visual image to give immediate recognition of a hazard or to provide essential information.

3.2.36 Illustration. A general term meaning graphic presentations of all types. Illustrations include pictorials, functional diagrams, and line graphs. This term is used instead of such terms as figure, graphic, drawing, diagram, and artwork.

3.2.37 Index numbers and letters. A number or letter (on a figure or an illustration) usually attached to a line or an arrow which points to an object on the illustration. This number or letter corresponds to the same number or letter in a legend or text that defines or identifies the object in the illustration.

3.2.38 Initial Graphics Exchange Specification (IGES). A standard digital form for vector graphics preparation. Defined by MIL-PRF-28000.

3.2.39 Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

3.2.40 Institute of Electrical and Electronics Engineers (IEEE). Membership organization that includes engineers, scientists and students in electronics and allied fields. Founded in 1963, it has over 300,000 members and is involved with setting standards for computers and communications.

3.2.41 Interactive Electronic Technical Manual (IETM). An **IETM** is a technical manual, prepared (authored) by a contractor and delivered to the Government or prepared by a Government activity, in digital form on a suitable medium, by means of an automated authoring system; designed for electronic screen display to an end user; and possessing the following three characteristics: (1) The format and style of the presented information are optimized for screen presentation to assure maximum comprehension; that is, the information presented is frame-oriented, not page-oriented; (2) The elements of technical information constituting the IETM are so interrelated that a user's access to the information he/she requires is facilitated to the greatest extent possible, and is achievable by a variety of paths; (3) The computer-controlled IETM electronic display system (EDS) can function interactively (as a result of user request and information input) in providing procedural guidance, navigational directions, and supplemental information; and also in providing assistance in carrying out logistic support functions supplemental to maintenance.

3.2.42 Landscape mode. To print an image sideways on the page so that the longest edge of the form corresponds to the horizontal axis.

3.2.43 Legend. A tabular listing and explanation of the numbers or symbols on a figure or an illustration.

3.2.44 Logic text. Text that is composed of procedures and actions branching to a series of questions, resulting in a "yes" or "no" answer, leading to determination and resolution of a problem.

3.2.45 Logistics Management Information (LMI). The selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the systems engineering process, to assist in acquiring the required support; and providing the required support during the operational phase at minimum cost. Replaces Logistics Support Analysis (LSA).

3.2.46 Logistics Support Analysis (LSA). The selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the systems engineering process, to assist in acquiring the required support; and providing the required support during the operational phase at minimum cost.

3.2.47 Lubricant. Any solid, fluid, or semifluid material that performs a lubricating or related specialty function. Such materials include lubricating oils, greases, hydraulic fluids, damping fluids, dielectric coolants, anti-seize compounds, corrosion preventatives, and bonded or unbonded solid films.

3.2.48 Maintenance level. The separation of maintenance activities or functions in the U.S. Navy according to the required skills and available facilities.

3.2.49 Maintenance step. A single maintenance action, such as setting a switch to the OFF position. Usually, a step has one action, but in certain cases, there may be a series of identical actions, such as removing seven bolts.

3.2.50 Marginal copy. Copy (generally headers and footers) placed outside that portion of the page used for either text, full page tabular data, or full page illustrations, but within the printing area dimensions of the page.

3.2.51 National Stock Number (NSN). A 13-digit number assigned to a repair part to be used for requisitioning purposes.

3.2.52 Next Higher Assembly (NHA). Assembly or subassembly of which subject component(s) or subassembly are a subpart.

3.2.53 Nomenclature. The approved name or alphanumeric identifier assigned to an item, equipment, or component in agreement with an organized designation system.

3.2.54 Note. A statement or some other notification that adds, emphasizes, or clarifies essential information of special importance or interest.

3.2.55 Orphan. Last line of a paragraph pushed to a new page, stranded alone (orphaned) at the top of the page without the rest of its paragraph.

3.2.56 Overhaul. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications.

3.2.57 Part number (P/N). A primary number used to identify an item used by the manufacturer (individual, company, firm, corporation, or Government activity) that controls the design, characteristics, and production of the item by means of engineering drawings, specifications, and inspection requirements.

3.2.58 Phantom. Portraying an item (i.e., part, equipment, etc.) on an illustration with broken lines rather than solid lines to de-emphasize the item.

3.2.59 Pictorial. A type of illustration showing the physical appearance of equipment or component parts. This term is used instead of such general terms as illustration, drawing, and diagram.

3.2.60 Pre-screening. A process in which a clear material with a dot pattern or crossing opaque lines is used through which an image is photographed in making a halftone.

3.2.61 Preventive maintenance (scheduled maintenance). The performance of scheduled inspections and maintenance functions necessary to keep the equipment in serviceable condition and ready for its primary mission.

3.2.62 Readability. Text comprehensibility measured by such variables as number of syllables, words, and sentences.

3.2.63 Reference designator. Letters or numbers, or both, used to identify and locate discreet units, portions thereof, and basic parts of a specific equipment, assembly, or subassembly.

3.2.64 Remove/install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

3.2.65 Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, and/or replace), including fault location/troubleshooting, removal/installation, and disassembly/assembly procedures, and maintenance actions to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system. Repair is authorized by the LSA/LMI and the assigned maintenance level is shown as the fourth position code of the SM&R code.

3.2.66 Repair part. Those support items that are an integral part of the end item or weapons system which are coded as not repairable (i.e., consumable items).

3.2.67 Replace. To remove an unserviceable spare or repair part and install a serviceable counterpart in its place. Replace is authorized by the LSA/LMI and the assigned maintenance level is shown as the third position code of the SM&R code.

3.2.68 Requiring activity. The DoD component, activity, or organization of a using military service, or that organization delegated by a using service, that is responsible for the selection and determination of requirements for TMs.

3.2.69 Revision. A revision is comprised of corrected, updated or additional pages or work packages to the current edition of a manual. It consists of replacement work packages that contain new or updated technical information, or improves, clarifies or corrects existing information in the current edition of the manual.

3.2.70 Schematic diagram. A graphic representation showing the interrelationship of each component or group of components in the equipment. The essential characteristic of these diagrams is that every maintenance-significant functional component is separately represented. Also, where appropriate, voltage readings are shown.

3.2.71 Scrollable. Ability to move a text or graphics display up and down, or left and right, or both.

3.2.72 Sentence. A group of words conveying a complete thought and terminated by a semicolon, period, exclamation mark, or question mark. Headers, captions, and paragraph titles are not considered sentences.

3.2.73 Service. Operations required periodically to keep an item operating, i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

3.2.74 Source, maintenance, and recoverability (SM&R) code. The five-position code containing supply/requisitioning information, maintenance level authorization criteria, and disposition instruction. The first two positions of the SM&R code determine how to get an item. The third position represents who can install, replace, or use the item. The fourth position dictates who can do complete repair on the item. The fifth position represents who determines disposition action on unserviceable items.

3.2.75 Spare part. Those support items that are an integral part of the end item or weapons system that are coded as repairable (i.e., reparable items).

3.2.76 Standard Generalized Markup Language (SGML). A language for document representation that formalizes markup and frees it of system and processing dependencies as defined in MIL-PRF-28001.

3.2.77 "Sticky". In reference to electronic tables, "sticky" infers that the title and column heads will be continually displayed throughout the scrolling process of the entire table.

3.2.78 Subassembly. Two or more parts that form a portion of an assembly or a component replaceable as a whole, but having a part or parts that are individually replaceable.

3.2.79 Task dialog. A pop-up display window by which the computer solicits user input, such as a selection of choices.

3.2.80 Technical manuals (TMs). Documents that contain instructions for the installation, operation, maintenance, and support of weapon systems, weapon system components, and support equipment. TM information may be presented, according to prior agreement between the contractor and the Government, in any form or characteristic, including hard printed copy, audio and visual displays, disks, other electronic devices, or other media. They normally include operational and maintenance instructions, parts lists, and related technical information or procedures exclusive of administrative procedures.

3.2.81 Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, electrical, or electronic characteristics of an item and comparing those characteristics with prescribed standards.

3.2.82 Text. The written parts of the technical sections excluding labels, legends, and callouts in illustrations.

3.2.83 User. A person using the technical manual.

3.2.84 Verification. The final QA iteration by the Government for acceptance of the TM during which a TM is tested to determine its adequacy and operational suitability for operation and maintenance of equipment or systems using target audience personnel.

3.2.85 Vertical TM format. Positioning of technical manual so that the page horizontal (width) dimensions are less than vertical (height) dimensions.

3.2.86 Warning. A statement or some other notification about an operating or maintenance procedure, practice, or condition that, if not strictly observed, could result in long term health hazard, injury to, or death of personnel performing the task prescribed in the TM.

3.2.87 Widow. First line of a paragraph that is left alone (widowed) at the bottom of a page.

3.2.88 Wiring diagram. Diagram illustrating signal flow or wiring connections. Where appropriate, voltage readings should be shown.

3.2.89 Word. Any string of characters (including letters, numbers, symbols, and groups of letters) separated from other strings by one or more spaces. Hyphenated words and contractions count as one word. For example, each of the following count as one word: couldn't; GFE; i.e.; 32,008; 19-inch; +25^{o}F; left-hand. Thus a sentence like "The left-hand MLG door shouldn't open more than 25^{o}." consists of 9 words.

3.2.90 Work packages (WPs). Presentation of information functionally divided into individual task packages in the logical order of work sequence. These WPs should be stand-alone general information, descriptive, theory, operating, maintenance, troubleshooting, parts, and supporting information units containing all information required for directing task performance.

4. **PAGED-BASED TECHNICAL MANUAL DEVELOPMENT**.

4.1 General. This section is intended to provide guidance and further clarify the requirements contained in MIL-STD-3001-1 through MIL-STD-3001-8. The general style, format, and graphics guidance contained herein are applicable for the preparation of the following types of page-based, technical manuals developed to the work package (WP) concept.

a. Aircraft systems and equipment maintenance instruction manuals.

General aircraft information manual
Plane captain’s manual
Line maintenance manual
Principles of operation manual
Functional flow diagram manual
Testing and troubleshooting manual
Fault reporting manual
Fault isolation manual
Integrated weapon systems testing and troubleshooting manual
Maintenance instructions with illustrated parts breakdown (IPB) manual
Structural repair manual
Aircraft wiring diagram manual
Aircraft wire bundle manual
Aircraft wire connector repair manual
Power plant build-up manual
Periodic maintenance requirements card sets
Separate illustrated parts breakdown (IPB).

b. Aeronautical equipment, airborne weapons/equipment, and support equipment operation and maintenance manuals.

Operation instructions manuals
Operation and maintenance instructions with IPB manuals
Maintenance instructions with IPB manuals

c. Engine intermediate and depot maintenance manuals.

4.2 Selective application and tailoring. This section contains guidance that may not be applicable for the preparation of all TMs listed in 4.1. Selective application and tailoring of requirements are the responsibility of the requiring activity and are accomplished using MIL-STD-3001-1 through MIL-STD-3001-8. If an identifiable, written conflict exists between this section and the detailed content standard, the detailed content standard takes precedence.

4.3 Preparation of TMs in digital format. Technical manuals prepared in work package format and delivered digitally are Standard Generalized Markup Language (SGML) tagged and assembled using modular Document Type Definitions (DTDs). These DTDs have been developed in accordance with MIL-PRF-28001 and ISO 8879. The modular DTDs interpret the technical content and structure of the functional requirements explained in MIL-STD-3001-1 through MIL-STD-3001-8 and this handbook.

4.4 Style and format for printed page-oriented TMs. Mandatory style and format requirements are provided in MIL-STD-3001-1, Appendix B. The style and format guidance provided in this section is recommended for use when acquiring TMs for the U.S. Navy. Formatting Output Specification Instances (FOSIs), developed in accordance with MIL-PRF-28001, interpret the style and format requirements contained in MIL-STD-3001-1 and this handbook. Style sheets developed by the TM developer may be used in lieu of FOSIs for printing paper manuals.

4.5 Obtaining the modular DTDs/FOSIs. Information on using and obtaining the DTDs, FOSIs and associated tag and attribute descriptions, which are SGML constructs, can be obtained from the requiring activity.

4.6 Figures contained in this handbook. The work package examples (figures 1 through 44) show the style and format requirements and subject matter contained in various types of WPs for page-based TMs. In an attempt to minimize the size of this handbook, most of the technical content provided in the examples are in abbreviated form and some figures referenced in the text of the example WPs have purposely been omitted. The font size, leading and vertical spacing of the text for the examples have been intentionally compressed to allow the data to fit within the boxed image area on the page. Appendix A of this handbook provides examples of style and format requirements for the different types of specific graphics used in the development of TMs.

4.7 Development of work package technical manuals. The style and format guidance provided in this section has been established to facilitate the development of technical information for the page-based WP concept. The WP concept is defined as a logical combination of requirements and improved presentation techniques designed to enhance digital display of page-formatted pages. A WP technical manual is specifically designed to support individual functional information or maintenance work tasks for a weapon system or equipment. WP requirements are provided in MIL-STD-3001-1 through MIL-STD-3001-6. Periodic maintenance requirements card decks are prepared on reduced sized card stock because of their frequent use and for portability. Work package requirements are not used in the preparation of these card decks. Technical content, and style and format for all card decks are contained in MIL-STD-3001-7. MIL-STD-

3001-8 establishes the content requirements for separate printed, page-based IPBs.

4.7.1 Types of work packages. There are basically two types of work packages. The first type is an information-oriented work package. (Refer to figure 1.) It provides support information such as general information about the TM or weapon system/equipment, principles of operation, and operating instructions. The second type of WP is task-oriented. (Refer to figure 2.) Task-oriented WPs reflect all required maintenance tasks at the assigned level of maintenance, and environment, material, and support equipment required for each defined task. WPs are written to reflect the engineering design, Logistics Support Analysis (LSA), Logistics Information Management (LMI), approved maintenance plan, and the established repair concept (Source, Maintenance and Recoverability (SM&R) Codes).

4.7.2 Technical manuals developed in accordance with MIL-STD-3001 series standards. This section may be used in conjunction with the series of standards listed below to develop page-oriented WP technical manuals for aircraft weapon systems, engines, aeronautical equipment, airborne weapons/equipment, and support equipment. MIL-STD-3001-1 through MIL-STD-3001-8 contain the technical content and mandatory style and format requirements for the preparation of technical manuals at all maintenance levels through depot. Each of these Parts provides instructions on how to develop and structure the required technical information into individual work packages in a logical order of work sequence.

MIL-STD-3001-1	Preparation of Digital Technical Information for Multi-output Presentation of Technical Manuals.
MIL-STD-3001-2	Description, Principles of Operation, and Operation Data.
MIL-STD-3001-3	Testing and Troubleshooting Procedures.
MIL-STD-3001-4	Maintenance Information with IPB.
MIL-STD-3001-5	Aircraft Wiring Information.
MIL-STD-3001-6	Structural Repair Information.
MIL-STD-3001-7	Periodic Maintenance Requirements.
MIL-STD-3001-8	Illustrated Parts Breakdown (IPB).

4.7.3 Preparation of digital technical information for multi-output presentation of technical manuals (MIL-STD-3001-1). This Part establishes the requirements needed to prepare and assemble digital technical information for multi-output presentation of NAVAIR work package technical manuals (TMs). It contains the following requirements and data:

a. Applicable documents and definitions.

b. General requirements and types of technical manuals covered by the series of standards.

c. Matrixes that provide the technical content requirements for all technical manuals covered in the series of standards.

d. Mandatory style and format requirements.

e. Front matter and introductory information used to develop and assemble complete TMs.

Author's Note: Front matter consists of a title page, numerical index of effective work packages/pages, Technical Publication Deficiency Reports (TPDR) page, Hazardous Materials Warning Summary (HMWS) page, and an alphabetical index. Introductory information includes WPs for a numerical index of part numbers, numerical index of reference designations, and introductions for specific types of TMs and periodic maintenance requirements card decks. Also considered introductory information is a WP for consolidated lists of technical directives, support equipment, material, and references and an engine maintenance allocation WP.

4.7.4 Description, principles of operation, and operation data (MIL-STD-3001-2). This Part contains technical requirements necessary to develop description, principles of operation, and operation data for aircraft weapon systems, engines, aeronautical equipment, airborne weapons/equipment, and support equipment. The information is divided into the following specific types of work packages, as applicable to the weapon system/equipment:

a. Aircraft description WPs:

Aircraft general description
Aircraft arrangement
Aircraft systems description
Aircraft instrument panel location
Danger areas and precautionary measures
Aircraft stations
Aircraft dimensions
Aircraft access and inspection panels and provisions
Aircraft external power source connections.

Author's Note: The above work packages are required when preparing a General Aircraft Information manual, a Plane Captain's manual or a Line Maintenance manual for an aircraft weapons system.

Author's Note: Figures 3 through 5 provide examples of the technical content structure and preferred style and format for several of the different types of the aircraft description WPs listed above. The general structure, style and format provided in the examples can be used as an example to facilitate the development of all the WPs listed above.

b. Aircraft system, subsystem, and component description WPs (see figure 6).

c. Aeronautical equipment, airborne weapons/equipment, and support equipment description WPs.

Author's Note: Figure 7 provides an example of a combination description and principles of operation WP for support equipment. The general structure, style and format provided in the example can be used to facilitate the development of description WPs for all types of aeronautical equipment, airborne weapons/equipment and support equipment. All applicable supporting illustrations such as location of components controls and indicators, schematics, block diagrams, etc., should be included in the same WP. Separate WPs containing only the supporting illustrations are not recommended.

d. Engine and engine system description WPs (see figure 8).

e. Aircraft weapon system principles of operation WPs (see figure 9).

f. Aeronautical equipment, airborne weapons/equipment, and support equipment principles of operation WPs.

g. Engine and engine system principles of operation WPs.

Author's Note: Figure 10 provides an example of a principles of operation WP for an item of support equipment. The general structure, style and format provided in the example can be used to facilitate the development of description WPs for all types of aeronautical equipment, airborne weapons/equipment, engines and engine systems, and other types of support equipment.

Authors Note: All principles of operation WPs may include descriptive data for better clarity or to facilitate ease of use. When description and principles of operation are provided in the same WP, separate WPs for descriptive data (b. through d. above) are not required.

h. Operating instruction WPs (see figure 11).

i. Software loading WPs (see figure 12).

4.7.5 <u>Testing and troubleshooting procedures (MIL-STD-3001-3)</u>. This Part contains technical requirements necessary to develop testing and troubleshooting procedures for aircraft weapon systems, engines, aeronautical equipment, airborne weapons/equipment, and support equipment. The information is divided into the following specific types of work packages, as applicable to the weapon system/equipment:

a. Aircraft and aircraft system testing and troubleshooting WPs:

Maintenance code listing (for **Fault Reporting Manuals only**) (see figure 13).
Fault indications (for **Fault Reporting Manuals only**) (see figure 14) .
Fault descriptor (for **Fault Reporting Manuals only**) (see figure 15).
Symbology (for **Fault Reporting Manuals only**) (see figure 16).
Fault isolation troubleshooting procedures (for **Fault Isolation Manuals only**) (see figure 17).
Operational checkout (see figure 18).
Troubleshooting procedures.

Author's Note: Based on the complexity of the troubleshooting to be performed, troubleshooting procedures can be structured differently and, therefore, will contain different content elements. Troubleshooting procedures can be developed in either a text, text-logic, tabular, or logic flow diagram form. The troubleshooting procedures can be output in an all text-logic format (see figure 19), a tabular format (see figure 20), or a logic flow diagram format (see figure 21).

Combined operational checkout and troubleshooting procedures (see figure 21).
Functional flow diagram (see Appendix A).

b. Aeronautical equipment, airborne weapons/equipment and support equipment testing and troubleshooting WPs.

c. Engine testing and troubleshooting WPs.

Author's Note: The structure, style and format of testing and troubleshooting procedures provided in figures 18 through 21 can also be applied when developing test and troubleshooting procedures WPs for all types of aeronautical equipment, airborne weapons/equipment and support equipment.

4.7.6 Maintenance information with illustrated parts breakdown (MIL-STD-3001-4). This Part establishes the technical content requirements for the preparation of maintenance information with illustrated parts breakdown (IPB) for aircraft weapon systems, engines, aeronautical equipment, airborne weapons/equipment, and support equipment. The maintenance information is divided into the following specific types of work packages, as applicable to the weapon system/equipment:

a. Maintenance WPs.

Author's Note: These task-oriented maintenance work packages contain all authorized maintenance tasks, such as remove, inspect, service, test, install, replace, disassemble, assemble, repair, clean, adjust, align, etc., for the overall equipment and each maintainable system, subsystem, assembly, and component. An Illustrated Parts Breakdown (IPB) should be included for all maintenance tasks that require parts replacement. An example of a maintenance with IPB WP is shown in figure 2. This example can be used as a guide to develop maintenance WPs for aircraft weapon systems, engines, aeronautical equipment, airborne weapons/equipment, and support equipment.

b. General maintenance WPs (see figure 22).

c. Servicing WP (see figure 23).

d. Support equipment WP (see figure 24).

Author's Note: This support equipment WP is specifically used to provide maintenance procedures for support equipment that is not covered in separate support equipment maintenance manuals. Instructions for required fabrication of peculiar tools, when such fabrication is approved by the requiring activity, should be included.

e. Local manufacturing and assembly WP (see figure 25).

Author's Note: This local manufacturing and assembly WP is specifically used to provide fabrication procedures for items source coded as "Make From" or "Assemble From" items.

f. Power plant build-up WPs (**engines only**) (see figure 26).

g. Preinduction and mandatory inspection WP (**engines only**) (see MIL-STD-3001-4 for an example).

h. External tubing, cabling and clamping WPs (**engines only**) (see MIL-STD-3001-4 for an example):

Numerical index.
Bracket installation.
External components.
Tubing, cabling and clamping installation.
Critical clearances.

i. Engine sequence control chart (SCC) (see figure 27).

Author's Note: An engine SCC is only required when the requiring activity requests that it be developed. The content and format for an SCC is not covered by the modular DTD for Maintenance Information with IPB. See figure 27 for an example.

4.7.7 Aircraft wiring information (MIL-STD-3001-5). This Part establishes the technical content requirements for the preparation of wiring information for an aircraft and its systems, subsystems, and equipment. The wiring information is divided into the following specific types of work packages, as applicable to the weapon system/equipment:

Author's Note: An aircraft wiring diagram manual, an aircraft wire bundle manual, and an aircraft wiring connector repair manual should be developed for every aircraft weapon system. The WPs required for each of these TMs are listed below.

a. Aircraft wiring diagram WPs:

Wiring diagram identification and information (see MIL-STD-3001-5 for an example).
Wiring diagram (see Appendix A).
Wire list (see MIL-STD-3001-5 for an example).
Wire and connector component identification and location list (see MIL-STD-3001-5 for an example).

Author's Note: Title block, reference material lists, record of applicable technical directives, support equipment required lists, and materials required lists (refer to 4.7.3) are not required for individual wiring diagram work packages. A reference material list, record of applicable technical directives, support equipment required list, and materials required list should be included in the introductory information in the front of the aircraft wiring diagram manual.

b. Aircraft wire bundle WPs:

Wiring system bundle assembly identification and information (see MIL-STD-3001-5 for an example).
Access information (see MIL-STD-3001-5 for an example).
Wire bundle assembly routing and parts data (see MIL-STD-3001-5 for an example).

c. Aircraft wiring connector repair WPs:

Author's Note: Unless otherwise noted below, WP examples are provided in NAVAIR 00-25-701.

Wiring systems repair identification and information.
Wiring system component repair tool list.
Dedicated aircraft wiring systems repair kit.
Wire type list data (see MIL-STD-3001-5 for an example).
Wiring systems connector repair tools.
Wiring systems connector component repair.
Aircraft cable assembly parts data (see MIL-STD-3001-5 for an example).

4.7.7.1 Wiring information for engines, aeronautical equipment, airborne weapons/equipment, and support equipment. Required wiring information for engines, aeronautical equipment, airborne weapons/equipment, and support equipment is the same as for the aircraft wiring diagram WPs described in 4.7.7 a. When developing separate TMs for engines, aeronautical equipment, airborne weapons/equipment, and support equipment, this information, however, can be included as separate WPs or be included in other types of WPs as supporting data (e.g., as part of a testing or troubleshooting WP).

4.7.8 Structural repair information (MIL-STD-3001-6). This Part establishes the technical content requirements for the preparation of information for the repair, corrosion control, and nondestructive inspection (NDI) of aircraft structure and structural components at all levels of maintenance. An Illustrated Parts Breakdown (IPB) should be included for all maintenance tasks that require parts identification and replacement. The structural repair information is divided into the following specific types of work packages, as applicable to the weapon system/equipment.

a. Structural repair information WPs:

General aircraft structural information (see figure 28).
Typical repair data (see figure 29).
Specific repair data (see figure 30).
Visual structural repair indexes (see MIL-STD-3001-6 for an example).

b. Corrosion control repair information WPs:

Corrosion control materials requirements.
General information.
Typical corrosion control data.
Inspection for corrosion.
Cleaning.
Stripping.
Corrosion removal.
Chemical treatment of metal surfaces.
Corrosion control seals and sealants.
Paint systems.

Author's Note: An example of a typical corrosion control repair WP is shown in figure 31. Even though the content will vary based on the technical content requirements provided in MIL-STD-3001-6, the example is typical and can be used as a guide for the structure and format presentation of all the corrosion control WPs listed above.

c. Nondestructive inspection information WPs:

NDI general information (see figure 32).
NDI typical procedures (see figure 33).
Visual NDI repair index (see MIL-STD-3001-6 for an example).
NDI specific procedures (see figure 34).

Author's Note: An Illustrated Parts Breakdown (IPB) should be included for all maintenance tasks that require parts replacement.. An example of an IPB for structural, corrosion, and NDI repair procedures is provided in MIL-STD-3001-6.

4.7.9 Periodic maintenance requirements (MIL-STD-3001-7). This Part establishes the technical content requirements for the preparation of periodic maintenance inspection requirements for aircraft weapon systems, quick engine change assemblies, powered aerial targets (missiles), support equipment, automatic test equipment, airborne armament equipment or special stores, powered surface targets, and aviation life support systems.

4.7.9.1 Periodic maintenance card sets. Periodic maintenance requirements consist of a series of scheduled maintenance requirements that provide a basis for planning, scheduling, and execution of scheduled maintenance. The requirements should be developed to provide general and specific instructions required to perform scheduled maintenance at the organizational and intermediate maintenance levels. Periodic maintenance requirements are contained and subdivided into a series of periodic maintenance card sets due to their frequency of use and to facilitate ease of use on the flight line and other maintenance environments. Periodic maintenance requirements card sets are divided into specific types of card decks for the weapon system and types of equipment/systems listed below.

Author's Note: Because periodic maintenance data are contained on 5-inch by 8-inch card stock, the work package concept required by this handbook does not apply. Refer to MIL-STD-3001-7 for additional content and format requirements for individual card sets.

a. Aircraft.

b. Quick engine change assembly (QECA).

c. Airborne armament equipment (AAE)/special stores (SS).

d. Support equipment (SE)/automatic test equipment (ATE).

e. Powered aerial target (PAT).

f. Powered surface target (PST).

g. Aviation life support systems (ALSS).

h. Airborne mine countermeasure (AMCM) equipment.

i. Unmanned aerial vehicle (UAV).

4.7.10 Illustrated parts breakdown (IPB) requirements (MIL-STD-3001-8). This Part establishes the technical content requirements for the preparation of separate page-based IPBs for printing paper TMs or for viewing page-based TMs on an EDS. This Part also provides the requirements needed to develop a complete IPB including the front matter, alphabetical index, and numerical indexes of part numbers and reference designations.

Author's Note: IPB requirements for the development of separate page-based IPBs for paper output have been included in MIL-STD-3001 to permit developers of revisions to legacy IPBs to use this standard. For all new TM programs, IPBs should be included as part of the maintenance WPs (see MIL-STD-3001-4). The requiring activity should be consulted before developing separate paged-based IPBs.

4.8 How to develop and assemble a work package TM. The following general process should be followed when requiring weapon system/equipment work package TMs.

a. Review contractual requirements and establish specific content requirements for each TM using the

TM content selection matrixes supplied in MIL-STD-3001-1, Appendix A. Refer to figure 35 for an example of a technical content selection matrix.

b. Develop a detailed TM outline (refer to 4.8.1) for each TM, using the filled-out TM content selection matrixes as a guide.

c. Access or obtain the required modular DTDs. Refer to MIL-STD-3001-1.

d. Develop an SGML-tagged source file (refer to figure 36) for each WP using the applicable modular DTD.

e. Using the assembly DTD (refer to MIL-STD-3001-1), develop the required front matter and applicable introductory information.

f. Using the assembly DTD, assemble the front, introductory, and all the technical content WP source files developed for the specific TM into a complete TM. The applicable TM content selection matrix or TM outline should be used as a guide.

4.8.1 Creating an outline. Basic outline development principles are controlled and identified in MIL-STD-3001-1 through MIL-STD-3001-8. These standards divide manuals by functional information. Work package manual information alignment must be specifically tailored to the maintenance requirements of the individual weapon system, related systems, and components within the system or related equipment. Source information such as engineering design, LSA/LMI, or the approved maintenance plan is used to define and organize each function and task in their appropriate order of sequence in the applicable TM. The review of all available source information should result in the identification of the following:

a. A complete, properly sequenced listing of every maintenance task required for product support.

b. Identification of testing and troubleshooting requirements, their points of observation, and their method of accomplishment.

c. Areas of system integration and the relationship between systems.

d. The relationship between similar tasks.

e. Tasks nominated for additional task analysis.

f. The levels of maintenance at which each task is authorized to be performed.

g. The rating requirements, skill levels and number of personnel required for task performance.

h. Facility and support equipment requirements.

The task identification phase of technical manual development constitutes the identification and recording of all descriptive data and operating and maintenance tasks necessary to accomplish maintenance on a given end item. Once the task identification phase is complete, the manual developer can begin to develop the required number of outlines for the weapon system, related systems, and components within the system or related equipment.

4.8.1.1 Outline development. The development of the outline begins by identifying the appropriate technical manual breakdown. This can be facilitated by using the technical manual content matrixes provided in MIL-STD-3001-1, Appendix A.

Author's Note: The technical manual breakdown list can be affected by system design complexity and the volume of information required for complete coverage. MIL-STD-3001-1, in the interest of usability, indicates a bulk restriction to printed manuals. This must be taken into consideration when preparing the proposed list of TMs.

Once all individual technical manuals are identified by type, name, and maintenance level, an outline is prepared for each TM identified. Outline development consists of breaking down the applicable system, equipment or component TM into its smallest repairable unit and as dictated by the LSA/LMI or approved maintenance plan. The required descriptive data, and operating and maintenance tasks are divided into WPs and assigned WP numbers. The final outline should reflect the proper depth and scope of each manual as defined.

4.8.1.2 Identifying work packages. The WP concept is based on simplified presentations by grouping descriptive information or work actions into individual task packages of 30-50 pages or less. However, one of the advantages to WP presentation is its flexibility. In some situations, too little information per unit could be as detrimental as excessive data.

a. For example, when covering a simple system or component, it may be more beneficial and informative to provide testing and troubleshooting as primary headings within a WP.

b. A similar situation may apply to related maintenance tasks. On occasion it would be more effective to present a series of similar or related tasks (remove/install) in a single WP rather than a number of redundant individual WPs.

c. For more complex coverage (greater volume), the philosophy could change to development of principles of operation, testing, troubleshooting, introduction and maintenance tasks (with IPB) into individual stand-alone WPs.

d. Note that the degree of flexibility has exceptional latitude. For example, troubleshooting coverage under the WP concept could appear as a series of paragraphs within a WP, as one or more individual WPs within a manual or, if necessary, as a separate troubleshooting manual.

4.8.2 How to develop work packages. The requiring activity must apply the requirement of weapon systems, equipment or component engineering design to the development of the technical manuals. The guidelines set forth in the approved LSA/LMI or maintenance plan dictate the technical content of the WP manuals. The TM developer working with the requiring activity and using the TM content selection matrixes provided in MIL-STD-3001-1, Appendix A, should develop TM outlines for each proposed TM. Using the filled out TM content selection matrixes as a guide, develop an outline (refer to 4.8.1) that will reflect the arrangement and alignment of the required technical information into the required volumes and WPs.

4.8.2.1 Development of individual work packages. Ideally, each WP in a manual will be an independent, stand-alone data unit. The author will be required to group some information or maintenance tasks in one work package and divide others into several WPs of suitable length. Division or selection of coverage will depend on various factors. These factors may include but are not limited to:

a. A specific work package that is required by MIL-STD-3001-1 through MIL-STD-3001-7.

b. A specific work package that is required by the TM content selection matrix or TM outline approved by the requiring activity.

Author's Note: An 'R' included for a specific WP requirement contained in the TM content selection matrix (refer to figure 35) denotes that a WP or a WP requirement is mandatory and must be included in the TM. An 'O' included for a specific WP requirement contained in the TM content selection matrix denotes that a WP or a WP requirement is optional and should be included if applicable to the subject weapon system or equipment.

c. A WP may be determined by the operational modes, complexity of the maintenance action, or level(s) of maintenance covered.

Author's Note: Separate maintenance WPs may be developed for the same equipment or component for different maintenance levels (e.g., a WP for organizational maintenance and a WP for intermediate maintenance for the same item of equipment).

d. Two or more WPs for an identical maintenance task may be required because the task is performed differently due to differences in configurations.

e. More than one WP may be required because the size of the work package will exceed 30-50 pages.

Author's Note: It is permissible to divide a set of maintenance tasks for a specific system, equipment or component into two or more WPs to comply with the page size limitation (e.g., removal and installation procedures could be placed in one WP and disassembly, cleaning, repair, and reassembly could be placed in a second WP).

f. Development of more than one WP because the reduction in the size of the work package would make it more useable.

g. Confining the information to one WP because dividing the information into several work packages would degrade the usability.

Author's Note: For example, splitting a disassembly procedure into two separate WPs would degrade the usability of the maintenance procedure.

h. The use of separate WPs for a series of maintenance tasks for a repairable component due to the use of different support equipment, materials required, etc.

Author's Note: If the support equipment, tools, or materials used to perform removal and installation are very different than the support equipment, tools, or materials used to perform disassembly and reassembly for the same system or component, it may be better to separate this information into two WPs.

4.8.3 Development of an SGML source file. Once an outline is prepared and all the work packages have been identified, an SGML source file (document instance) should be developed for each WP. (Refer to figure 36.) The SGML-tagged source file is composed of SGML-coded ASCII (American Standard Code for Information Interchange), marked up (tagged) in accordance with the applicable modular DTD, including the identification of the supporting graphics required. In order to tag WP text appropriately, the author inserting the tags must be familiar with the DTD or must provide the text file to a person who is experienced with the DTD and who understands the type of documentation being written, especially when content tags are used. A customized template modeled for the applicable DTD may be available or developed to assist the author in creating the document instance.

Author's Note: A template can be implemented in a text editor, a WYSIWYG (What You See Is What You Get) editor, a database input form, or an SGML authoring/composition system.

4.8.4 Printing the TM using the FOSI. The FOSI specifies the desired appearance of the content of the document instances. Document formatting requirements such as page layout and hyphenation rules are specified in the FOSI, as well as how document elements such as paragraph titles, tables, and lists are to be formatted. The FOSI provides the composition and imaging characteristics to be applied to the SGML tagging (including attributes) of an SGML-tagged text source file (document instance) to present the text material in paginated or screen presentation form. The use of a FOSI is not mandatory.

4.8.5 Printing the TM using a style sheet. A style sheet may be used in lieu of a FOSI to specify the desired appearance of the information content of the document instance. The style sheet provides the same formatting requirements to an authoring/composition system as does a FOSI.

4.9 Format.

4.9.1 General. The format contained in this section has been included to expand, emphasize, and clarify the requirements provided in MIL-STD-3001-1 through MIL-STD-3001-8. To avoid unnecessary repetition and to provide the user of this handbook with a more useable document, requirements contained in MIL-STD-3001-1 through MIL-STD-3001-8 that are self explanatory or can only be interpreted in one way have been omitted from this handbook.

4.9.2 Major divisions. The hierarchical breakdown of a TM is: volumes (if required) and work packages (WP). Each division used should have at least two occurrences (for example, where there is a Volume 1, there should be a Volume 2).

4.9.3 Work packages. Work packages (WPs) are used to logically divide all data required for a certain function (i.e., descriptive information, operator's instructions, maintenance with IPB, troubleshooting, etc.). Procedural maintenance tasks or descriptive information contained in a WP consists of a series of paragraphs and procedural steps. When it is necessary to divide a maintenance task into subtasks, for clarity subparagraph titles may be used. Refer to paragraph 4.9.4.

4.9.3.1 Work package numbering system. Each WP should be assigned a permanent number as required by MIL-STD-3001-1. The WP number should be considered permanent upon distribution of the basic issue of the manual and should not change until WPs are renumbered for a complete revision. The WP number should be placed on each page of the WP in the extreme upper right corner of the reproduction area.

4.9.3.1.1 WP number assignment. Each WP number should be a five-digit number, beginning with the number 001 00. There should be one blank space between the third and fourth digit. The basic WP number is identified by the first three digits of the WP number. The last two digits can be used to add work packages that reflect related coverage for the same basic descriptive information or operational or maintenance task when there is a permanent configuration difference, different support equipment, or preferred and alternate procedures required. Normally, "00" should be assigned as the last two digits of the WP, indicating all required coverage for the WP subject (task) has been included. If additional work packages are required to provide permanent configuration differences, different support equipment, or preferred and alternate procedures for the same subject contained in the "00" WP, the additional WPs should be assigned an "01," "02," "03," etc.

4.9.3.1.1.1 WP numbers for front and introductory matter. WP numbers 001 00 and WP 002 00 are always used for front and introductory information for the applicable technical manual. The last two digits are used for specific types of front and introductory information as described below.

a. Alphabetical Index WP. The alphabetical index WP should be the first WP in the manual and should be assigned WP number 001 00.

b. Numerical Index of Part Numbers WP. The Numerical Index of Part Numbers WP should be assigned WP number 001 01.

c. Numerical Index of Reference Designations WP. The Numerical Index of Reference Designations WP should be assigned WP number 001 02.

4.9.3.1.1.2 WP number for technical publication deficiency reports (TPDR) page. The TPDR page should be assigned WP number TPDR-1, TPDR-2, etc.

4.9.3.1.1.3 WP number for hazardous material warning sheets (HMWS). The HMWS should be assigned WP number HMWS-1, HMWS-2, etc.

4.9.3.1.1.4 WP numbers for introductory matter. The Introduction WP should be assigned WP number 002 00.

4.9.3.1.1.5 WP numbers for technical content. The technical content WPs should be assigned in numeral sequence starting with the WP number 003 00 and continue through the WP number 999 00.

4.9.3.1.1.6 Assignment of the last two digits (basic WP number suffix). The Index WPs are normally the only exceptions to the assignment of the last two digits of the WP number in the basic issue of the manual. However, when the basic issue of a manual requires two or more WPs for proper coverage of the same basic task, assignment of the last two digits is authorized (e.g., permanent configuration difference, different support equipment, or preferred and alternate procedures). The last two digits of the WP are also used to permit expansion of the manual to incorporate changed or new configuration data without affecting the WP numbers previously assigned.

4.9.3.1.1.7 Reserved WP numbers. WP numbers may be reserved for future use for expansion purposes, provided that the numbers reserved are not titled and are accounted for and marked "Reserved" in the numerical index of effective work packages. If a WP number has been assigned a title and technical content is not available at the time of distribution, the deficiency should be noted in the numerical index of effective work packages by the statement "To Be Provided."

4.9.3.1.1.8 Deleted WP numbers. WPs deleted by a pickup revision should be accounted for and marked "Deleted" in the numerical index of effective work packages. For complete revisions, WPs will be renumbered and assigned new WP sequence numbers in consecutive order.

4.9.3.1.1.9 Work package numbers - division into volumes. When an existing manual is divided into volumes, the previously assigned WP numbers should not be reassigned or renumbered. The first volume should contain the front matter, including a comprehensive index for all volumes, and as many WPs as appropriate beginning with WP 001 00. The second and subsequent volumes should contain a comprehensive alphabetical index for the volume and the WPs contained in the volume.

4.9.4 Paragraphs.

a. Paragraphs contained within a WP should be numbered consecutively in Arabic numerals beginning with the number 1-1,1-2, 1-3, 2-1, 2-2, etc.

b. Paragraphs and subparagraphs within a work package may have titles. If titled, the title should begin at the left margin.

(1) A first level paragraph title stands alone and is in all capital letters.

(2) A second level paragraph title is run-in and is in all capital letters.

(3) A third level paragraph title stands alone and has the first letter of the first word and of each principle word capitalized.

(4) A forth level paragraph title is run-in and has the first letter of the first word and of each principle word capitalized.

(5) Paragraph text after stand-alone paragraph titles begins flush left.

c. All titles are in boldface type.

Author's Note: If additional titles levels are necessary over and above the four levels, unbolded upper case stand-alone and unbolded upper case run-in capital letters should be used. No more than 6 levels should be used.

4.9.5 Procedural steps. Procedural steps present detailed, step-by-step instructions for performing an operational or maintenance task - such as turning on a test set; changing oil; replacing a part; repairing an assembly; or inspecting, cleaning, or removing an item of equipment, etc. Procedural steps are presented in a logical sequence and reflect the sequence in which the tasks are actually performed. Procedural steps and substeps are numbered consecutively with Arabic numerals or lower case letters. Procedural steps are placed immediately after paragraph or subparagraph titles, or, if applicable, after a small paragraph that introduces the procedural steps as shown by the examples below:

"1-1 **REMOVAL**

1-2 The procedure below is typical for the left or right MLG uplock switch (6, figure 1) except as noted.

1. Make sure electrical and hydraulic power is off (A1-F18AC-LMM-000).

2. Jack aircraft (A1-F18AC-LMM-000).

3. Open LG circuit breaker 12CBJ001 on RH Essential Circuit Breaker Panel.

4. Remove clamp (1) and attaching parts from switch (6) wires being removed.

5. In MLG wheelwell and access door 47, perform the substeps below:

    a. Remove electrical bushing (22).

b. Remove and retain switch (6) by removing screws (7)."

OR

"1-1 **REMOVAL**

1. Move SENSOR SELECT knob (5, figure 1) to NEUTRAL.

2. Loosen two setscrews (7).

3. Remove SENSOR SELECT knob (5) from SENSOR SELECT shaft (6)."

4.9.5.1 Procedural step levels. Procedural steps may be, when required, divided into no more than six levels.

Author's Note: The following demonstrates, by example, how procedural steps and substeps levels are formatted and numbered.

EXAMPLE

1. Primary procedural step numbers (1, 2, 3, etc.) are flush left. Text begins two spaces after the period following the numeral. The text is blocked.

   a. The first-level procedural substep step letters (a, b, c, etc.) are immediately below the text of the first-level procedural steps. Titles are not allowed. The text is blocked.

      (1) The second-level procedural substep step numbers ((1), (2), (3), etc.) are immediately below the text of first-level procedural substeps. Titles are not allowed. The text is blocked.

         (a) The third-level procedural substep step letters ((a), (b), (c), etc.) are immediately below the text of second-level procedural substeps. Titles are not allowed. The text is blocked.

            1 The fourth-level procedural substep step numbers (1, 2, 3, etc.) are immediately below the text of third-level procedural substeps. Titles are not allowed. The text is blocked.

               a. The fifth-level procedural substep step letters (a, b, c, etc.) are immediately below the text of fourth-level procedural substeps. Titles are not allowed. The text is blocked.

Author's Note: If additional substep letters are required, use aa, ab, etc., after z, or (aa), (ab), etc., after (z), or aa, ab, etc., after z.

4.9.6 Tables and lists.

4.9.6.1 Table locations.

a. Tables are inserted in the TM on the same page or as soon after the first reference in the text as possible.

b. Full-page tables using a horizontal (landscape) format are positioned so that the page must be rotated 90 degrees clockwise to be read. The table number and title are placed at the top of the table.

4.9.6.2 Table numbering. Tables are numbered consecutively within each WP in the order of their reference starting with Arabic number 1. If only one table is referenced in a WP, it is numbered. Tables that are not referenced except from an adjacent paragraph and are one column in width should not be numbered. Tables that are referenced in two or more paragraphs and tables that are full page width should be numbered.

4.9.6.3 Table titles. Each table has a title. The titles identify the contents or purpose of the table and distinguish that table from others in the TM.

a. The table title consists of the word "Table" followed by the table number, a period, two spaces, and the title. Capitalize the first letter of the first and each major word of the title.

b. Center table titles above the table. If the title is too long to fit on one line, align the second line with the first letter of the title.

c. Identify tables applicable to one Service only in a joint service TM. (For example, Table 3. Fuel Indicator Correction Factors (Navy Only).)

d. Identify tables applicable to more than one service in a joint service TM. (For example, Table 1. UHF Radio Controls (Navy and Air Force Only).)

4.9.6.4 Table format. Certain required tables in MIL-STD-3001-1 through MIL-STD-3001-8 are referred to as "standard tables." Tables designated as standard have no deviations to the number of columns and the titles in the column headings. The format and table headings are automatically generated by the applicable modular DTD and FOSI or style sheet used for the functional information. The following applies to all nonstandard tables developed for a TM.

a. Place a horizontal rule at the beginning (head) and at the end (foot) of a table. Title columns appropriately in boldface, upper case letters. Place a horizontal rule under the column titles. All tables have outside vertical rules and, if required for clarity, vertical rules between columns.

b. When a table is continued on more than one page, the table number and title is repeated followed by the notation "Cont" in parentheses. The closing rule is omitted at the foot of a continued table; the opening rule is continued at the head of the continued portion along with the heading title data.

c. Design tables so that related entries in different columns are aligned.

d. Align data within one column of a table by one method only, i.e., left justified, left justified with substeps indented, centered, etc. However, different columns within the same table may be presented differently, i.e., one column may have the data left justified while another column may have the data centered.

e. Tables may contain procedural steps and substeps, with a maximum of four levels (i.e., (a), (b), etc.). Number steps in accordance with 4.9.5.1. When space allows, indent the substeps two spaces.

f. Illustrations may be included within a table, if necessary.

4.9.6.5 Footnotes to tables. Footnotes in tables should not be used. Notes may be placed in tables, but not at the bottom of a page, deliberately separated from the applicable table to which they apply.

4.9.6.6 Table readability and use.

a. There should be a clear space between columns. Row entries in tables may also be arranged in groups separated with clear space.

b. Entries are aligned within columns as follows:

(1) For decimal data, decimal points are aligned.

(2) For scientific notation, multiplication signs are aligned.

(3) All other numeric data are aligned flush right.

(4) Alphabetic or alphanumeric data may be aligned flush left, flush right, or centered. Data may also be indented.

c. Units of measure are identified in appropriate row entries or as separate column headings.

d. The user will not be required to interpolate (estimate between tabled values). Avoid interpolation by expanding the table or by presenting the data in a graph.

4.9.7 Lists. Lists may be used in lieu of tables, when appropriate. Three types of lists are identified below. Lists may be unnumbered, numbered sequentially, or lettered alphabetically. They may have an optional title in all upper case bold letters. (Refer to figure 37.)

a. Definition list. The definition list consists of the term and the definition. It may have the headers, "**Term**" and "**Definition**" above the appropriate sections of the list. Refer to MIL-PRF-28001 for more information on the development of lists.

b. Random list. The random list consists of one or more items in a random order.

c. Sequential list. The sequential list consists of one or more items in a specified order, such as alphabetic, numeric, or alphanumeric.

4.9.7.1 Wire list. Two types of wire lists are used to support maintenance and on-aircraft troubleshooting of aircraft wiring systems. The first type is a wire run list. The second type is a wiring reference designation list. Detailed content requirements are provided in MIL-STD-3001-5. For aircraft systems wiring TMs, the lists are not used in lieu of wiring diagrams but are used to supplement the information provided on wiring diagrams. For aeronautical equipment, airborne weapons/equipment, and support equipment TMs, these lists may be used in lieu of preparing wiring diagrams, when authorized by the requiring activity.

4.9.7.1.1 Aircraft wire run list. The aircraft wire run list should contain the technical content information as required by MIL-STD-3001-5 and include a list of all wires for the aircraft systems, subsystems, and equipment (refer to figure 38). Wires should be listed in alphanumeric sequence by system wire number.

4.9.7.1.2 Wiring reference designation list. The wiring reference designation list work package should contain a list of all wiring component reference designations and pin numbers (refer to figure 39).

4.9.7.1.3 Wire run list for aeronautical equipment, airborne weapons/equipment, and support equipment. For these types of equipment manuals, wire run lists can be used in lieu of wiring diagrams when approved by the requiring activity. Wire run lists are usually computer generated and are being used more and more by contractors. Formats may vary; however, the content information shown in figure 40 should be included.

4.9.7.1.4 Placement of wire run lists. Wire lists should be contained in work packages. Aircraft wire run list work packages should be placed in a separate aircraft system wiring diagram manual immediately following the aircraft systems wiring diagrams. Aircraft reference designation list work packages should immediately follow the aircraft wire run lists. When wire run list work packages are developed for other types of equipment maintenance manuals, they should be placed where appropriate for maximum usability.

4.9.7.2 List format. Certain required lists in MIL-STD-3001-1 through MIL-STD-3001-7 are referred to as "standard lists." Lists designated as standard have no deviations to the number of columns and the titles in the column headings. The format and list headings are automatically generated by the applicable modular DTD and FOSI or style sheet used for the functional information.

4.9.8 Figures/illustrations.

4.9.8.1 Figure numbering. Figures, with the exception of foldouts, are numbered consecutively within each WP in the order of their reference starting with Arabic number 1. If only one figure is referenced in a WP, it is numbered. Foldouts are placed at the end of each work package; therefore, foldout figure numbers should start with the next number after the last standard size illustration figure number in the WP.

4.9.8.2 Figure titles.

a. Illustrations should be assigned a figure title. The figure title should follow the figure number. "Figure" is in upper and lower case, followed by the figure number, a period, two spaces, and the title. Capitalize the first letter of the first and each major word of the title. Center figure titles on the graphic image area below the graphic and begin the title on the same line with the figure number.

b. If the title of the figure is too long to fit on one line, align the second line with the first letter of the title.

c. Identify illustrations applicable to one Service in a joint service TM. (For example, Figure 3. Fuel Indicator (Navy Only).)

d. Identify illustrations applicable to more than one Service in a joint service TM. (For example, Figure 3. Fuel Indicator (Navy and Air Force Only).)

e. Each sheet of a multi-sheet illustration should be identified by a sheet number following the figure number and title (e.g., Sheet 1, Sheet 2, etc.).

4.9.8.3 Legends. Legends are part of figures and not part of the text. Nomenclature use should be identical in both the legend and in the supporting text.

4.9.9 Warnings, cautions, and notes. Warnings and cautions are short, concise, and used only to highlight operating or maintenance procedures, practices, conditions, or statements which are considered essential to protect personnel (Warnings) or equipment (Cautions). Notes are used to highlight procedures, practices, conditions, or statements that are not considered essential to protect personnel. Warnings, cautions, and notes do not contain procedural steps.

4.9.9.1 Format for warnings, cautions, and notes.

a. Standard warnings and cautions consist of four parts: a heading (WARNING, CAUTION), a statement of the hazard or precaution, minimum precautions to be taken, and a possible result if the warning or caution is disregarded. Warnings and cautions immediately precede the text to which they apply. Notes precede or follow applicable text, depending upon the material to be highlighted. When warnings, cautions, and notes occur for the same text, warnings will appear first, cautions second, and notes last.

b. The header **WARNING**, **CAUTION**, or **NOTE** is bold and centered above the appropriate text. Headers are not numbered. When a warning, caution, or note consists of two or more paragraphs, the header **WARNING**, **CAUTION**, or **NOTE** is not repeated above each paragraph. Warnings, cautions, and notes on unrelated topics may not be contained under one heading.

c. Indent all lines of warnings, cautions, or notes five spaces or characters from both left and right margins.

d. Bulleted lists are not allowed in warnings, cautions, or notes.

e. Warnings, cautions, or notes are not divided so that first lines or groups of icons appear on one page and remaining lines or group of icons appear on another page. Warnings, cautions, and notes are not separated from the text to which they apply.

4.9.9.2 Hazardous materials warnings with icons. Procedures prescribed for the operation and maintenance of equipment are consistent with the safety standards established by the Occupational Safety and Health Act (OSHA) Public Law 91-596 and Executive Order (EO) 12196. It is mandatory to use the hazardous material warnings with approved icons when preparing work package technical manuals. Refer to MIL-STD-3001-1 for style, format, and content requirements for the hazardous material warnings. Also refer to figure 34 for an example of placement of warning icons in a procedure.

4.9.10 Page sizes.

a. Table I lists approved TM page sizes. The maximum printing area includes all printed matter on the page (e.g., text, illustrations, revision bars, TM numbers, page numbers, etc.). (Refer to figure 41.) Other page sizes may be used when authorized by the requiring activity. Table I also provides the image area for the authorized page sizes. Image areas for other page sizes will be provided by the requiring activity.

b. Table II lists manual trim sizes, foldout maximum page trim sizes, and foldout maximum image area for foldout pages. The minimum margin is 1/2-inch top and bottom and 1/2-inch on the side opposite the binding edge. Binding edge margin should not be less than one inch. Foldouts will only appear in 8-1/2 by 11 manuals.

TABLE I. *TM page sizes (in inches).*

Style	Trim Size	Format	Maximum Printing Area
Standard	8-1/2 x 11	Vertical	7 x 10

	11 x 8-1/2	Horizontal	10 x 7
PMRCs (Phased Maintenance Requirements Cards)	5 x 8	Horizontal	4 x 6-1/4
Double	17 x 11	Horizontal Only	15-1/2 x 10

TABLE II. *Foldout page sizes (in inches).*

Maximum Trim Size	Foldout Maximum Page Trim Size (Including Apron)	Foldout Maximum Image Area
8-1/2 x 11	45 x 11	36 x 10

4.9.10.1 Authorized printed manual size by thickness. The thickness for an 8-1/2 x 11-inch manual should not exceed 3 inches (approximately 600 sheets of paper). For 17 x 11-inch manuals, the thickness should not exceed 1 inch (150 sheets of heavy stock paper). For PMRCs prepared on heavy stock, there are no thickness limitations.

4.9.11 Type sizes and styles. Table III lists preferred type sizes and styles. All type sizes may be plus or minus one point. Slight variations in spacing and leading are permitted. Except for pocket size TMs that may use 6-point type size, 8 point is the smallest permissible type size.

TABLE III. *Style, capitalization, leading, and spacing.*

Use	Preferred Type/Size	Capitalization	Leading	Vertical Spacing
Title Page: Security Classification	Same or larger than TM number	Upper case		
Title Page: TM Number	Sans serif bold 18-20	Upper case		
Title Page: Publication or Revision Number and Date	Sans serif bold 14	Initial caps		
Title Page: Words Technical Manual	Sans serif bold 14	Upper case		
Title Page: Type of Publication	Sans serif bold 18	Upper case		
Title Page: Maintenance Levels	Sans serif bold 18	Upper case		
Title Page: Nomenclature of Equipment	Sans serif bold 18-20	Upper case		
Title Page: Type, Model, Part Number, National Stock Number, or Subject	Sans serif bold 14-18	Upper case		
Title Page: Subtitle (Volume Title and Number)	Sans serif bold 14	Upper case		
Title Page: Supersedure Notice, Cross-reference Notice, Continuation Notice	Sans serif bold 10	Upper and lower case		
Title Page: Distribution Statement, Export Control Notice Warning, Destruction Notice	Sans serif bold 10 for header and sans serif 6 - 8 for text	Upper case for header and upper and lower case for text		
Title Page: Authority Notice (Service Nomenclature)	Sans serif bold 10	Upper and lower case		
"A" Page (Header Information): Publication Number	Sans serif bold 16	Upper case		
"A" Page (Header Information): Publication Date, Revision Number, and	Sans serif bold 10	Initial caps		

Use	Preferred Type/Size	Capitalization	Leading	Vertical Spacing
Page Identification				
"A" Page Title	Sans serif bold 10	Upper case		48 points below TM number; 18 points above text
TPDR and HMWS (Header Information): Publication Number, Security Classification	Sans serif bold 16	Upper case		
TPDR and HMWS (Header Information): Page Identification, Publication Date	Sans serif bold 10	Upper case. Date initial caps.		
TM Number	Sans serif bold 16	Upper case		30 points from top of page
Page Number	Sans serif bold 10			30 points centered from bottom of page
Revision Number	Sans serif bold 10	Upper case for first letter of revision		
Security Classification	Sans serif bold 16	Upper case		*30 points from top of page
Work Package Marginal: Publication Date or Revision Date, and Page Numbers	Sans serif bold 10	Initial caps		
Work Package: Title for Reference Material List, Record of Applicable Technical Directives, Support Equipment Required List, and Materials Required List	Sans serif bold 10	Initial caps		
Paragraph Titles	Sans serif bold 10	All upper case or upper case for first letter of each principal word (depending upon emphasis)	2	12 points below title block bottom rule; 12 points above/below text, table, or illustration; 12 points above/below warning, caution, and note headers/text
Text (including Group Assembly Parts List (GAPL))	Serif 10	Upper and lower case. GAPL text upper case.		18 points below TM number, WP or other header; 12 points above/below table or

Use	Preferred Type/Size	Capitalization	Leading	Vertical Spacing
				illustration; 6 points above page no.; 6 points above/below warning, caution, and note headers
Emphasis	Italic bold 10	Upper and lower case	1	
Formulas and Equations	Italic 10	Upper and lower case	1	12 points above/below text, table, or illustration
Figure Number and Title	Serif 10	Upper case for first letter of each principal word	2	18 points below illustration (within the figure area)
Legend on Illustrations	Sans serif 8	Upper case for first letter of first word	1	As required
Illustration Callouts	Sans serif 8	Upper case		As required
Illustration Captions	Sans serif bold 10	Upper case	2	18 points below illustration
Table Number and Title	Serif 10	Upper case for first letter of each principal word	2	6 points above title
Column Headers	Serif bold 10	Upper case	1	
Table Text	Serif 10	Upper and lower case	2	
List Headers	Sans serif bold 10	Upper case for first letter of each principal word	2	12 points above list

*NOTE: When a TM is classified, the TM number is 48 points from the top of the page and the page number 48 points from the bottom of the page. All other spacing is adjusted accordingly.

4.9.12 Placement of text and illustrations.

4.9.12.1 Text formatting requirements.

a. Preferred text format for 8-1/2 by 11-inch manuals is single column (page wide), although double column can be used. An exception is that double column text can be used to present principles of operation for better readability. Both single and double column formatted WPs can be included in a single TM if it would make the data more readable or comprehensible; however, both formats should not be used in the same work package. Text is single spaced (double spaces between procedural steps) with the left margin justified.

b. The first line of a paragraph should not be located at the bottom of the page or column. The last line of a paragraph should not be placed at the top of a new page. Do not place the title or header on the last line of a page or column. Widows and orphans are not allowed.

c. Text should be double-spaced between paragraphs, procedural steps, and before and after the headings "WARNING," "CAUTION," and "NOTE." IPB GAPL pages should be considered text. Layout should conserve space without lessening usability or clarity of material. Double spacing of text within a paragraph, or similar wastefulness, is unacceptable. Blank space on a page should be avoided whenever possible unless clarity or readability is sacrificed.

4.9.12.2 Placement of text and related illustrations.

a. Do not place procedural steps in illustrations.

b. Place text and illustrations in such a manner that will conserve space without crowding or degrading the usability or clarity of the material. Avoid blank spaces whenever possible. Whenever possible, place illustrations on the same or facing page of associated text. If this is not possible (for example, more than one full-page illustration), place the illustration as close to the related text as possible.

c. Foldout illustrations are placed at the end of the applicable work package.

4.9.12.3 Text wrapping. Always position text within the required image area. Do not wrap text around illustrations. (Refer to figure 42.)

4.9.12.4 Illustration placement options. Illustrations are placed either immediately above or below the supporting text or the procedural step or group of steps. Illustrations may float on a page to reduce the white space on a page. If there is not enough room on a page to place a supporting illustration, place the illustration on a facing page, if possible. An illustration should not be inserted between two-column text on a page. The illustration should be placed either above or below the text.

Author's Note: When developing an SGML document instance, use the following words to indicate placement options for digital illustrations: "Above," "Below," "Immediate (default)," "Facing," and "Float." Tag the appropriate position in the text with the correct option.

a. Use the "Above" reference to place the illustration above the referenced text or steps.

b. Use the "Below" reference to place the illustration below the referenced text or steps.

c. Use the "Intermediate (default)" reference to place the illustration immediately below the referenced text or steps.

d. Use the "Facing" reference to place the illustration on the page facing the referenced text or steps.

e. Use the "Float" reference to place the illustration anywhere on the page with the referenced text or steps.

4.9.12.5 Multiple tasks using same illustrations. When two separate tasks (e.g., Removal and Installation) appear on the same page, one illustration can be used to support both tasks if space permits.

4.9.12.6 Repeating illustrations. Illustrations are not repeated unless necessary to support multipage descriptions of tasks or to support a different requirement in another part of the TM.

4.9.13 National stock numbers. National stock numbers (NSNs) should not appear in NAVAIR WP technical manuals.

4.9.14 Part numbers and reference designations. Part numbers and reference designations (Ref Des) should not be used in the text or on illustrations except for the following:

a. Part numbers identifying specific support equipment or materials required are acceptable in text and on illustrations when more than one item has the same nomenclature; for example, "Position clamp P/N 2469-10 over retaining fixture."

b. Part numbers identifying items contained in support equipment tool kits should be used in text or illustrations. The tool kit part number should be included in the "Support Equipment Required" list.

c. Part numbers may be included in legends on, or adjacent to, the associated artwork as an aid in identification.

d. When necessary for clarity, the specification, standard, or part number of consumable materials (lockwire, adhesive, sealant, etc.) may be included in text and on maintenance WP illustrations but not on IPB illustrations.

e. Part numbers may be used in figure titles to further identify the assembly or component being illustrated. Part numbers will not be used when the Ref Des has been used.

f. Ref Des are encouraged to be used in text to couple the item or unit under discussion with the supporting schematic or marking on the equipment.

g. Ref Des will be included in figure titles to further identify the item, assembly or component illustrated.

h. Use of Ref Des on schematics is appropriate and encouraged.

4.9.15 Nomenclature. Nomenclature of identical systems, subsystems, equipment, support equipment, components, and parts of the end item should be consistent throughout a manual, volumes of a manual, and manuals that are a part of a set of manuals covering an end item. The preparing activity should develop official/approved nomenclature lists for associate preparing activities and sub-preparing activities to ensure such consistency. (Official nomenclature is the nomenclature used in the IPB GAPL.) Shortened versions of the approved nomenclature are not considered deviations. Approved nomenclature will be used wherever the use of a common name might be ambiguous. The correct nomenclature should be derived from one of the following sources (listed in the order of precedence):

a. "AN" nomenclature,

b. Nameplate nomenclature,

c. H-6 assigned nomenclature, or

d. Nomenclature on the drawing from which the item was manufactured.

4.9.15.1 Nomenclature consistency and applicability. Nomenclature, other terms, and names must be consistent within a manual and throughout other directly related manuals. Statements that explain applicability for individual items of equipment will use specific serial numbers, block designations, model designations, or similar identification. Such terms as "on later equipment" and "on early serial numbers" will not be used.

4.9.15.2 Noun modifiers. Noun modifiers should be added to the description of parts as required to assure positive identification, such as cotter pins/taper pins. These modifiers need not appear on the preparing activity's drawing. Noun modifiers, once added for clarity, should be used throughout the technical data.

a. Simple identifying modifiers provided for parts may be dropped after the first full identification of the item in the WP. For example, "Remove attaching bolt" is acceptable and preferred to "Remove cadmium plated steel bolt," unless specific identification of one bolt within a group of similar objects is required.

b. When an item is identified by a common name, both this name and the correct technical name should be clearly identified the first time the item appears in the text of a WP. The listing of common names in IPB GAPLs is not required.

4.9.15.3 Neutral terms. TMs will make no reference to age, sex, race, or national origin. Use sex neutral terms. Terms such as "airman" and "workman" are considered sex neutral. Terms such as male and female connectors, pins, etc., are acceptable.

4.9.15.4 Military terms. Military terms used will be in accordance with Joint Pub 1-02, or any approved dictionary or glossary of Navy military terms.

4.9.15.5 Automatic electronic test and checkout terminology. Terms used for automatic electronic test and checkout will be in accordance with MIL-STD-1309.

4.9.15.6 Placard data. If all or a portion of the name of a control or display appears as a label on the equipment, that portion should be written exactly as on the label, except that the placard should be written in all capital letters to distinguish it from surrounding text (e.g., "POWER switch" or "MAIN PWR circuit breaker"). It is also permissible to spell out the word for a symbol that cannot be reproduced by the machine used to prepare the manuscript or reproducible copy.

4.9.15.7 Designation of equipment. The official designation of aeronautical equipment should be expressed in specific terms such as model number, type, serial number range, or similar terms. Nomenclature corresponding to that appearing on the equipment in the form of nameplates, decals, engraved legends or other markings should be stated in text using the same wording that appears on the hardware.

4.10 General writing style.

4.10.1 Abbreviations and acronyms.

a. At the first use of abbreviations and acronyms in a WP, spell out words completely and place the abbreviation or acronym in parentheses immediately after the word(s). When a phrase is abbreviated as an acronym, capitalize the first letter of each word and do not separate letters in the acronym by periods (for example, "Illustrated Parts Breakdown (IPB)"). Abbreviations and acronyms accepted as words, such as radar, sonar, laser, etc., need not be spelled out.

b. Do not create new abbreviations or acronyms to duplicate those presently listed in OPNAVINST 4790.2. The use of abbreviations or acronyms not listed in OPNAVINST 4790.2 should be held to a minimum. Abbreviations and acronyms may be plural or possessive.

c. Spell out abbreviations and acronyms used in tables, but not found in the text or other portion of the TM, in a note to the applicable table. Spell out abbreviations and acronyms used in illustrations or figures, but not found in the text or other portion of the TM, in a note on the applicable illustration or figure.

d. When abbreviations or acronyms are used as markings on equipment (placarding), use the same abbreviation or acronym in the TM.

e. Abbreviations or acronyms should not be used in a publication or WP title.

4.10.2 Equations. The use of equations should be held to the minimum use required by the needs of the TM user. For some examples of the use of symbols and punctuation in equations and equation alignment and placement, refer to figure 43.

4.10.3 Connecting words. Place connecting words of explanation, such as "therefore" and "similarly," flush left either on the same line with the equation or on a separate line.

4.10.4 Spacing. Use clear space above and below equations as needed. Center and indent any complex or hard-to-read expressions in a clear space between the lines of text. Start a series of such expressions at the left margin or indent in any consistent manner. Center and indent any important expression, regardless of complexity, to introduce or emphasize it.

4.10.5 Numbering and referencing to equations. When it is necessary to reference equations in the text, give the equation a reference number. The reference number consists of EQ, followed by an Arabic numeral beginning with 1 within each WP (for example, EQ 1, EQ 2, etc.). (Refer also to figure 44.)

5. SCROLLABLE AND FRAME-BASED TECHNICAL MANUAL DEVELOPMENT.

5.1 General. This section is intended to provide guidance and further clarify the requirements contained in MIL-STD-3001-1 through MIL-STD-3001-7 for ETMs/IETMs developed to the work package (WP) concept. The general style, format, and graphics guidance contained herein is applicable for the preparation of the following types of technical information for aircraft weapon systems, engines, aeronautical equipment, airborne weapons/equipment, and support equipment at all levels of maintenance.

- Supporting information.
- Descriptive information, principles of operation, and operation data.
- Testing and troubleshooting information.
- Maintenance and procedural information, including:
  - Structural repair information.
  - Wiring diagram information.
  - Aircraft wire bundle information.
  - Aircraft wire connector repair information.
  - Power plant build-up information.
- Parts information.

Author's Note: MIL-STD-3001-8 is not applicable for the development of ETMs/IETMs. MIL-STD-3001-8 is to be used only for the development of separate IPBs for paper output or screen display of page-based IPBs.

5.2 Selective application and tailoring. This section contains some guidance that may not be applicable for the preparation of all ETMs/IETMs. Selective application and tailoring of requirements are the responsibility of the requiring activity and are accomplished using MIL-STD-3001-1 through MIL-STD-3001-7. If an identifiable, written conflict exists between this section and the detailed content standard, the detailed content standard takes precedence.

5.3 Development of work package ETMs/IETMs. A work package ETM/IETM is specifically designed to support individual functional information or maintenance work tasks for a weapon system or equipment. Technical manual data developed for scrollable or frame-based display in work package format should be prepared in accordance with the requirements of MIL-STD-3001-1 through MIL-STD-3001-7. Technical manual data should be tagged using Standard Generalized Markup Language (SGML). This is accomplished by applying the applicable Document Type Definitions (DTDs) and style sheets. The DTDs interpret the technical content and structure of the functional requirements explained in MIL-STD-3001-1 through MIL-STD-3001-7 and are mandatory for use. The use of a specific style sheet will dictate the style and format as it appears on the display device. Style sheets should be developed using the style and format requirements contained in MIL-STD-3001-1 and in this handbook. Development of ETMs/IETMs is accomplished through the use of the DTDs combined with the requirements contained in MIL-PRF-87268 and MIL-PRF-87269. The requirements contained in MIL-PRF-87268 and MIL-PRF-87269 apply unless they conflict with the requirements in MIL-STD-3001. The requirements in MIL-STD-3001 take precedence over the requirements contained in MIL-PRF-87268 and MIL-PRF-87269.

Author's Note: The term "work package" is used throughout this section and the MIL-STD-3001 series to denote specific increments of technical content needed to ensure that the technical information presented in support of a given task or process is complete, comprehensible, and effective. The term "work package" has been retained because it was used extensively in the development of most paper, page-based, NAVAIR technical manuals and is recognized as standard terminology for an independent, stand alone data unit containing specific descriptive information or maintenance task.

5.4 Obtaining the modular DTDs. Information on using and obtaining the DTDs and associated tag and attribute descriptions, which are SGML constructs, can be obtained from the requiring activity.

5.5 Figures contained in this handbook. Figures 45 through 87 provide examples of preferred style and format for the scrollable and frame-based display of ETM/IETM technical content work package data. In an attempt to minimize the size of this handbook, most of the technical content provided in the examples are in abbreviated form. Appendix A of this handbook provides examples of style and format requirements for the different types of specific graphics used in the development of TMs.

Author's Note: ETMs and IETMs for the U.S. Navy have been developed using a variety of authoring and presentation systems. The "look and feel" of technical content differs greatly between ETMs/IETMs depending on the authoring and presentation used. The examples provided in figures 45 through 87 have been selected from various weapon system/equipment ETMs/IETMs and are the preferred style and presentation formats for the display of technical content information.

5.6 Types of work packages. There are basically two types of work packages. The first type is an information-oriented work package. It provides information such as general information about the

ETM/IETM or weapon system/equipment, principles of operation, and operating instructions. The second type of WP is task-oriented. Task-oriented WPs reflect all required maintenance tasks, including testing and troubleshooting, at the assigned level of maintenance, and environment, materials, and support equipment required for each defined task. WPs are written to reflect the engineering design, Logistics Support Analysis (LSA) or Logistics Management Information (LMI), Level of Repair Analysis (LORA), approved maintenance plan, and the established repair concept (SM&R codes).

5.7 ETMs/IETMs developed in accordance with MIL-STD-3001 series standards. This section should be used in conjunction with MIL-STD-3001-1 through MIL-STD-3001-7 to develop work package ETMs/IETMs for aircraft weapon systems, engines, aeronautical equipment, airborne weapons/equipment, and support equipment. MIL-STD-3001-1 through MIL-STD-3001-7 contain the technical content and mandatory style and format requirements for the preparation of technical manuals at all maintenance levels through depot.

5.8 How to develop and assemble a work package ETM/IETM.

5.8.1 Technical manual outline. If required by the requiring activity, an outline should be developed prior to the start of ETM/IETM development. Outlines need not be maintained current following the initial delivery of the ETM/IETM.

5.8.1.1 Initial outline development. The first step in the development of an ETM/IETM outline is to determine if all descriptive and maintenance information about the weapon system will be provided in a single ETM/IETM. It may be more logical or effective to provide some aircraft specific maintenance information in a separate ETM/IETM. For instance, structural repair, corrosion control, and nondestructive inspection (NDI) repair data is unique, voluminous, requires frequent updating, and is used at specific areas and sites. Therefore, it may be better to provide this data in a separate ETM/IETM. Similarly, Phased Maintenance Requirements Manual (PMRM) card sets have the same characteristics and may also be better suited to be in a separate ETM/IETM. Once a determination is made as to how many ETMs/IETMs should be developed for an aircraft weapon system, a detailed outline can be generated for each using the specific types of functional requirements listed in 5.8.1.2.

Author's Note: The requiring activity should provide guidance on how many separate ETMs/IETMs are required for a specific weapon system or equipment. ETM/IETM packaging can be based on various factors, including weapon system site location; number, types, and availability of electronic display devices; specialized maintenance facilities; and the need for only specific maintenance information at a particular maintenance site. In addition, the frequency of change to certain types of maintenance information may preclude it from being packaged or grouped with other information (i.e., structural repair data may be better isolated from other nonscheduled aircraft system maintenance because of the nature and detail of the repairs and replacement parts required and the constant changes required to keep this type of information current).

5.8.1.2 Outline content and arrangement. An outline should be a detailed breakdown of system data. The outline should also indicate recommended information that should remain in paper. An outline should be developed for each system, subsystem, equipment, and major component, as applicable. For each system, subsystem, equipment, and major component, the following types of data to be developed should be noted.

Supporting information.
Types of descriptive data (i.e., description, theory of operation, use of controls and indicators, etc.).
Procedural tasks necessary to operate the system.
Procedural tasks necessary to perform complete maintenance.
Test and troubleshooting data.
Schematics and wiring information required.

5.8.2 Development of individual work packages. Ideally, each WP in a manual will be an independent, stand alone data unit. The author will be required to group some information or maintenance tasks in one work package and divide others into several WPs. Division or selection of coverage will depend on various factors. These factors may include, but are not limited to:

a. A specific work package that is required by MIL-STD-3001-1 through MIL-STD-3001-7.

b. A specific work package that is required by the TM content selection matrix or TM outline approved by the requiring activity.

c. A WP may be determined by the operational modes, complexity of the troubleshooting or maintenance action, or level(s) of troubleshooting or maintenance covered. (Separate maintenance WPs may be developed for the same equipment or component for different maintenance levels (e.g., a WP for organizational maintenance and a WP for intermediate maintenance for the same item of equipment).)

d. Two or more WPs for an identical troubleshooting or maintenance task may be required because the task is performed differently due to differences in configurations.

e. Confining the information to one WP because dividing the information into several work packages would degrade the usability (e.g., splitting a disassembly procedure into two separate WPs would degrade the usability of the maintenance procedure).

f. The use of separate WPs for a series of maintenance tasks for a repairable component due to the use of different support equipment, materials required, etc. (For example, if the support equipment, tools, or materials used to perform removal and installation are very different from the support equipment, tools, or materials used to perform disassembly and reassembly for the same system or component, it may be better to separate this information into two WPs.)

5.8.3 Development of an SGML source file. Once all the work packages have been identified, an SGML source file (document instance) should be developed for each WP. The SGML-tagged source file is composed of SGML-coded ASCII, marked up (tagged) in accordance with the applicable modular DTD, including the identification of the supporting graphics required. In order to tag WP text appropriately, the author inserting the tags must be familiar with the DTD or must provide the text file to a person who is experienced with the DTD and who understands the type of documentation being written, especially when content tags are used. A customized template modeled for the applicable DTD may be available or developed to assist the author in creating the document instance. (A template can be implemented in a text editor, a WYSIWYG editor, a database input form, or an SGML authoring/composition system.)

5.8.4 Use of a style sheet. The style sheet specifies the desired screen presentation of the information content of the document instances. Document formatting requirements such as layout and hyphenation rules are specified in the style sheet, as well as how document elements such as paragraph titles, tables, and lists are to be displayed. The style sheet provides the composition and imaging characteristics to be applied to the SGML tagging (including attributes) of an SGML-tagged text source file (document instance) to present the text material in screen presentation form.

5.9 Navigational, access, and other commands. The user should be provided with a comprehensive set of commands to navigate and sequence through the information. The recommended minimum set of navigation and control functions which should be available to the user and common to all ETMs/IETMs are provided in MIL-STD-3001-1, Appendix C. Additional functions may be specified by the requiring activity.

5.10 ETM/IETM divisions. The hierarchy of an ETM/IETM consists of front matter and a series of work packages that include the types of data listed below.

a. Supporting information - Supporting information includes information such as the Numerical Index of Part Numbers; Numerical Index of Reference Designations; Introduction; Consolidated Lists of Technical Directives, Support Equipment, Materials, and References; and Maintenance Allocation (engines intermediate maintenance only). Supporting information is divided into the support-oriented WPs that are required to supplement or complement the technical information and task-oriented WPs developed in accordance with MIL-STD-3001 series.

b. Descriptive information - Descriptive information provides information on how system, subsystem, and components function or operate and is intended to provide the user with an understanding of the system process. This information may consist of physical arrangement, functions, processing, theory of operation, modes of operation, built-in test (BIT), controls, indicators, and displays.

c. Testing and troubleshooting information - Testing and troubleshooting (fault isolation information) is the data necessary to isolate faults found in a system, equipment, or component. Fault data basically contains outcomes, faults, and corrective actions.

d. Procedural information (operator and maintenance tasks) - Procedural information is primarily corrective or scheduled maintenance procedures, such as adjustment, servicing, inspection, removal, installation, and repair.

e. Parts information - Parts information is the necessary information required to identify and order a new part, generally called IPBs (illustrated parts breakdowns) in a conventional TM.

Author's Note: Refer to MIL-STD-3001-2 through MIL-STD-3001-6 for detailed requirements for the preparation of specific work packages for the technical content data described above.

5.10.1 Front matter. The following ETM/IETM front matter is necessary to supplement the technical content WPs.

a. ETM/IETM installation data (see figure 45).

b. CD (Compact Disk) label and flyleaf data (if applicable) (see figure 45).

Author's Note: This ETM/IETM installation and CD and flyleaf data is not contained within the ETM/IETM. It is the data that must be developed when the ETMs/IETMs are shipped or transmitted to a user's site. The applicable DTD used in the development of front matter does not contain the requirements to generate this data.

c. Preface information (see figure 46).

d. Content data (see figure 47).

e. Title data (see figure 48).

f. Log on information (see figure 49).

g. Revision summary data (see figure 50).

Author's Note: Revision summary data is used in ETMs/IETMs to replace the numerical index of effective work packages/pages (A page) used in traditional page-based TMs.

h. List of Contents (see figures 51 through 53).

i. "How To Use This ETM" information or "How To Use This IETM" information (see figure 54).

j. Acronyms and abbreviation list.

k. Configuration identification list.

Author's Note: Refer to MIL-STD-3001-1, Appendix C for detailed requirements for front matter preparation.

5.11 <u>Work packages</u>. Work packages (WPs) are used to logically divide all data required for a certain function (i.e., descriptive information, operator's instructions, maintenance with IPB, troubleshooting, etc.). These data types can be further divided into tasks, subtasks (procedures), paragraphs; procedural steps; tables; lists; warnings, cautions, and notes; and supporting graphics, etc. Parts information should be accessible in any of the data types, as necessary.

5.11.1 <u>Work package content</u>. Each work package should consist of a title, work package initial setup information, and the specific data necessary to develop the types of technical content work packages described in 5.10.

Author's Note: Refer to MIL-STD-3001-1, Appendix C for detailed requirements for work package content preparation.

5.11.1.1 <u>Work package title</u>. Each WP should have a title that identifies the general subject or maintenance or troubleshooting task contained in the WP. The title should be displayed in the title bar area of the user's EDS in all capital letters. (See figure 55.)

5.11.1.2 <u>Work package initial setup information</u>. Work package initial setup information should be included for each work package, as required by MIL-STD-3001-2 through MIL-STD-3001-7. The following types of information should be included, as applicable:

a. Maintenance level.

b. Effectivity.

c. Materials required.

d. Support equipment required.

e. Facilities required.

f. Personnel required.

g. Required conditions/system preparation checklist.

h. Special environmental conditions.

i. General safety instructions.

j. Reference materials.

k. Record of applicable technical directives.

5.11.1.2.1 Display of work package initial setup information. This information may be displayed full screen or split screen on one or multiple frames, or scrollable. (See figures 55 through 58 for examples.) The maintenance level and effectivity data need not be displayed.

5.11.1.2.2 Effectivities. Effectivities (including tail numbers, BuNos, model numbers, serial numbers, part numbers, etc.) are used to show limited applicability of information and instructions for different configurations of equipment. Configuration differences may be the result of engineering changes made during production or of service changes incorporated in the field. Effectivities should clearly show limited applicability of affected portions of the data. The following guidelines should be followed.

a. Use specific and recognizable identification. This includes (but is not limited to) model, series, type, block, software configuration, part, and/or serial numbers as required to adequately define the applicability. Indefinite phraseology such as "on earlier models" or "on later aircraft" is not acceptable.

b. The manner in which the effectivity is presented will be consistent throughout the data for a given item such as an aircraft.

c. Effectivities should not be displayed in the work packages. The effectivity should be selected by the user when logging on.

5.11.1.2.2.1 Task effectivities. Show effectivities for tasks in the List of Contents.

5.11.1.2.2.2 Procedural step effectivities. When a procedural step must have an effectivity, use the following guidelines.

a. When the effectivity affects a single step in a procedure, attach the effectivity to the step.

b. When two or more steps are affected by the same applicability restrictions, place the effectivity on the first step and move the second and subsequent affected steps to substeps below the first step (create substeps).

c. Do not attach more than one effectivity to a single step. If more than one effectivity affects the step, create an alternate step and attach the applicable effectivities to the steps.

Author's Note: Maintenance level and effectivity data should be included for every WP but need not be displayed. The data is needed to permit users to automatically access all technical information by maintenance level and tail or model number or both.

5.11.2 Supporting information work packages. Supporting information should be logically subdivided into the support-oriented work packages that are required to supplement or complement the technical information and task-oriented work packages developed in accordance with the MIL-STD-3001 series. Detailed technical content requirements for the following supporting information are provided in MIL-STD-3001-1, Appendix C. Supporting information includes:

Warnings and hazardous materials summary,

Consolidated lists of facilities, support equipment, materials, and references,

Consolidated numerical index of part numbers and reference designations

Maintenance allocation, as applicable (engines intermediate maintenance only).

This information may be developed and displayed in one or both of the following methods:

a. The information may be displayed in "traditional" tables and lists. (See figure 59.)

Author's Note: A "traditional" table or list will not include hotspotted information, but will be scrollable through the entire table or list.

b. The information may be displayed in interactive database format. (Refer to 5.12.7.1.2.)

Author's Note: A hotspot from a descriptive, maintenance, or troubleshooting task would link to the specific row(s) in the table or item(s) in a list instead of displaying the entire table or list.

5.11.3 Descriptive information work packages. Descriptive information work packages provide information such as general information about the weapon system/equipment and principles of operation. Text developed for descriptive information type work packages, such as description or principles of operation, will, as a default, be displayed across the entire frame and in multiple frames or scrollable. When it is illustrated, the illustrations may be full screen, or the text and illustration may be displayed in a split screen with the text on the left and the illustration on the right. (Refer to MIL-PRF-87268.) (See figures 60 through 63 for examples.)

Author's Note: Refer to MIL-STD-3001-2, for detailed technical content requirements for the preparation of description, operation, and principles of operation data.

5.11.4 Testing and troubleshooting information work packages. Testing and troubleshooting data should be developed to the extent required to maintain the aircraft weapon system, aircraft engines, aeronautical equipment, airborne weapons/equipment or support equipment at the authorized maintenance level. This testing and troubleshooting information should guide the technician, in as practical a manner as possible, to the system, subsystem, weapons replaceable assembly (WRA), shop replaceable assembly (SRA) or further to the replaceable part, interconnecting wire, or mechanical linkage which caused the malfunction or failure. See figures 64 through 67 for examples of screen display for testing and troubleshooting procedures.

5.11.4.1 Wiring and schematic graphic information. See figures 68 and 69 for examples of tabular and illustrated wiring information. When possible, schematics and wiring diagrams should be simplified to contain only the information referenced by the text for which they are displayed. However, the ETM/IETM should provide the user access to the entire schematic or wiring diagram. If the schematic or wiring diagram cannot be displayed in its entirety and in full detail, it should be displayed using interactive graphic display techniques such as those described in MIL-STD-3001-1, Appendix C.

Author's Note: All information required to perform the tests and evaluate probable malfunctions of the assembled systems or equipment should be provided in accordance with the technical content requirements of MIL-STD-3001-3.

5.11.5 Procedural information work packages. Task-oriented WPs reflect all maintenance tasks at the assigned level of maintenance, and the applicable initial setup information (refer to 5.11.1.2) for each defined task (see figures 70 through 74). The hierarchical organization for dividing procedural information is into tasks, subtasks (procedures), and steps (substeps, if required). Additional requirements for displaying procedural data are provided in MIL-STD-3001-1.

Authors Note: The requiring activity should provide guidance and recommendations on the method used to display procedural steps prior to the actual development of the IETM.

5.11.5.1 Procedures with locator graphics. Complex graphics can sometimes be broken into several less complex graphics. Figure 75 shows a context drawing (the aircraft) with an enlargement (detail) of the interior of a wheel well. The detail and legibility of the enlargement are sufficient to support the accompanying steps. Subsequent steps relate to the enlargement, but require more detail. Therefore, figure 76 uses a second graphic, a further enlargement of figure 75's enlargement. Again, the detail and legibility are sufficient for the relevant steps. The locator view need not be displayed on subsequent frames of the procedure, but should be linkable at any step or from any detail graphic.

5.11.5.2 Maintenance procedure leading to IPB information. Individual parts referenced in maintenance steps should be called out on graphics using hotspot index numbers or nomenclature that link the user to the applicable IPB information. (See figures 77 and 78.)

5.11.6 Parts data information. Parts information should be available at the point of the presentation in any work package to which the specific system and equipment replaceable and repairable part is identified. See figures 79 through 81 for typical examples of the display of parts data. Inclusion of parts information should be used to:

a. Identify a part or parts by part number and name.

b. Provide any additional parts data required to order the part.

c. Show the relationship of a part to other parts of the system or equipment.

d. Enhance or clarify the supporting operator, descriptive, or theory of operation data.

Authors Note: Refer to MIL-STD-3001-4 for detailed requirements for ETMs/IETMs parts data information.

5.12 Style and format for display of work package text and graphics. In general the style and format for the display of text and graphics should be in accordance with MIL-PRF-87268 and the information below.

5.12.1 Descriptive text. Work packages of descriptive text are generally formatted in paragraphs.

5.12.1.1 Paragraphs. Paragraphs within a WP for ETM/IETM display should be unnumbered. Paragraphs may have titles. When used, paragraph titles should be in bold capital letters. Ensure that the style of paragraph presentation is consistent throughout the entire ETM/IETM.

5.12.2 Procedural text. Procedural text is generally divided into tasks, subtasks (procedures), and steps (and substeps, if required).

5.12.2.1 Tasks. A task is a sequential list of steps to be performed by a technician or a collection of subtasks (procedures) directed toward accomplishment of a specific objective. Research has proven that long series of actions constituting a task should be broken up into sequential increments with the use of new subtask titles, even if the sets have to be arbitrary. For IETMs, each new task should begin on a new frame display.

5.12.2.2 Subtasks (procedures). Each subtask should include all steps required to achieve a specific objective. Each new subtask should begin on a new frame display. Subtasks are generally done sequentially, and their specific objectives differ. Usually, the subtasks have to be broken up into steps.

5.12.2.3 Steps. A step is a unit of a procedural sequence which consists of a single technician action. Steps compose subtasks (procedures). Procedural steps should be used to present detailed step-by-step instructions for performing an operational or maintenance task. In each set of steps, individual steps should be perceptually separated from each other. (Refer to 5.11.5.)

5.12.2.3.1 Step numbering. Unless specified by the requiring activity, procedural steps should be numbered consecutively with Arabic numerals. Substeps should be numbered consecutively with lower case letters.

Author's Note: Numbering/lettering of steps is the function of the style sheet.

5.12.3 Task dialog displays. Task dialogs should be developed, as required, and formulated as prompting questions to the user. Dialogs should be developed so that they require a user to respond (enter data) before any subsequent processing occurs. Task dialogs may appear as pop-up windows in the maintenance work packages to allow the user to indicate the results of the current maintenance activity. Examples of the types of task dialog displays that may be used are:

a. Fill in the blank. See figures 82 and 83.

b. Single/multiple choice. See figures 84 through 86.

c. Composite. See figure 87.

Author's Note: The content and the style and format of task dialog displays can vary widely, depending on the specific type of dialog required to perform and complete the maintenance or troubleshooting task. Implementation and presentation of these dialog displays are a function of the presentation system, DTD, and style sheet used to generate this data.

5.12.4 Titles.

5.12.4.1 Assignment of titles. Easy access to technical data contained in the ETM/IETM is key to a successful search for specific data. Titles should be assigned with full consideration of the importance they have in finding information quickly.

a. Titles should be assigned to all systems, subsystems, and components, as applicable, and to all tasks and descriptive information for each system, subsystem, and component.

b. The titles provided in the List of Contents should be identical to those assigned to systems, subsystems, components, and individual tasks.

c. Each title should be exclusive within the system of which the data is a part. A complete title should be definitive and descriptive of the content of the data.

5.12.5 Alerts.

5.12.5.1 Use of alerts. An alert is any message, communication, notice, or output which requires manual acknowledgment from the user of the ETM/IETM. Alert messages are mandatory for use in ETMs/IETMs and should be displayed within a border. Warnings (including hazardous material warnings), cautions, and notes should be treated as alerts. Detailed requirements for development and display of all types of alerts are provided in MIL-STD-3001-1.

5.12.6 Quality assurance (QA) requirements.

5.12.6.1 Quality assurance procedures. Procedures that are essential to equipment performance or to safety of personnel are considered to be "Quality Assurance Procedures." It is necessary to ensure that all required tasks, including final testing of the end item (verification of repair), are accomplished prior to completion of work.

5.12.6.2 Highlighting in-process quality assurance procedures and steps. Procedures considered to be "Quality Assurance Procedures" should be highlighted by the addition of the abbreviation "(QA)" preceding the procedure. It is necessary to ensure that all required tasks, including final testing of the end item (verification of repair), are accomplished prior to completion of work. In some cases, only certain steps of a procedure are considered to be "Quality Assurance Steps." These steps should also be highlighted by the addition of the abbreviation "(QA)" preceding the individual step or steps. Alternate ways of highlighting QA procedures and steps may be used when approved by the requiring activity. An explanation of the requirements and highlighting should be given in the introduction to the data. These QA procedures and steps may be summarized. Refer to 5.12.6.3.

5.12.6.3 Quality assurance procedure summary for procedural maintenance data. A summary of QA procedures or QA steps(s) may be provided for each maintenance task containing a procedure or step(s) designated for QA. This QA summary should be able to be user-invoked at any time during the performance of the entire maintenance task.

5.12.7 Tables and lists.

5.12.7.1 Tables.

5.12.7.1.1 Table locations. Placement of tables should be in accordance with MIL-PRF-87268.

5.12.7.1.2 Display of rows. Certain tables provide data that may be required to supplement or complement the descriptive information or maintenance or troubleshooting tasks contained in many of the work packages within the ETM/IETM. Therefore, it may be more efficient to link the data to the specific row(s) in the table where the applicable information is located instead of displaying the entire table (e.g., the consolidated list of materials required table, which is used in almost all maintenance WPs). When it is determined that only a specific row(s) of a complete table is required to support the associated procedural task or informational data, the information contained in the entire row(s) should be displayed.

5.12.7.1.3 Table numbering. Tables for ETM/IETM display should not be numbered.

5.12.7.1.4 Table titles. In general, tables should have a title. Each title should be descriptive and unique. The guidelines listed below should be followed:

a. Table titles should appear above the table. The table title should also appear in the display title bar.

b. If the table is scrollable, the table should have a "sticky" table title and all column heads.

Author's Note: "Sticky" infers that the title and column heads will be continually displayed throughout the scrolling process of the entire table. (See figure 68 for an example of a wire list in tabular format for frame-based display.)

5.12.7.1.5 Footnotes to tables. There should be no footnotes in tables. Notes should be used. Refer to 5.12.5. There should be an identifiable indication, such as an icon, to indicate the presence of a note.

5.12.7.2 Lists. Lists may be used in lieu of tables, when appropriate. Three types of lists are identified below. Lists may be unnumbered, numbered sequentially, or lettered alphabetically. They may have an optional title in all upper case bold letters.

a. Definition list. The definition list consists of the term and the definition. It may have the headers "**Term**" and "**Definition**" above the appropriate sections of the list.

b. Random list. The random list consists of one or more items in a random order.

c. Sequential list. The sequential list consists of one or more items in a specified order, such as alphabetic, numeric, or alphanumeric.

Author's Note: Numbering/lettering of items in a list is the function of the style sheet.

5.12.8 Figures/illustrations. (Refer also to MIL-PRF-87268.)

5.12.8.1 Figure numbering. Figure numbers for illustrations contained in work packages for ETMs/IETMs may be used.

5.12.8.2 Figure titles. Figure titles for illustrations should not be used.

5.12.8.3 Illustration identification numbers. Each illustration should be assigned a unique identification number. These identification numbers should not be displayed on the user's EDS.

5.12.9 Abbreviations and acronyms. Abbreviations, acronyms, and unusual terms may be used in any WP text, when applicable. It is not necessary to spell out the words completely after the first use of an acronym or abbreviation. A work package containing a consolidated list of abbreviations, acronyms, and uncommon terms should be developed explaining all abbreviations, acronyms, and unusual terms used in the ETM/IETM. It is not necessary to make the abbreviations, acronyms, and uncommon terms work package automatically accessible when an abbreviation, acronym, or uncommon term is used in a WP. Hotspots should be used to link all abbreviations, acronyms, and uncommon terms to the WP containing the complete explanation and listing of abbreviations, acronyms, and uncommon terms.

5.12.10 References. The use of references in text can create undue hardship and/or confusion for the user of the technical data. References should be kept to a minimum. A high amount of referencing in text frequently indicates improper task analysis or LSA/LMI. As a practical consideration, linking should be used and encouraged. Hotspots should be used to link cross-referenced material.

Author's Note: For ETMs/IETMs the words "cross-referencing" mean linking to another source of instruction or information. The primary goal of an ETM/IETM is preparation of self-contained task- or descriptive-oriented data. Each WP is intended to be an independent data package for performing a specific task.

6. GRAPHICS REQUIREMENTS.

6.1 Illustration preparation. Illustrations should be prepared in accordance with the requirements provided in MIL-STD-3001-1, Appendix B for page-based TMs and MIL-STD-3001-1, Appendix C for ETMs/IETMs.

6.1.1 Types of illustrations. As applicable, the following types of graphics should be used in the preparation of ETMs/IETMs. Preferred format requirements of these graphics and typical examples are provided in Appendix A.

a. Line drawings.

b. Photographs.

c. Engineering drawings.

d. Diagrams.

e. Charts and graphs.

7. REVISIONS AND UPDATES.

7.1 Revisions for page-based TMs. There are two types of revisions that can be prepared for a page-based NAVAIR TM: a pickup revision and a complete revision. The requiring activity will determine the type of revision required. Detailed requirements for the preparation of revision data are provided in MIL-STD-3001-1, Appendix B.

7.1.1 Pickup revisions. A pickup revision incorporates the basic issue or latest revision of a manual, all previous change pages, and the new change pages that would require the issuance of an additional revision. Only those updated or added change pages will have the current change number and date. Those pages not affected by the current change should retain the previous change symbols and change number/date.

7.1.2 Complete revisions. A complete revision requires rewrite and reorganization of the technical content of the data. All pages, paragraphs, illustrations and tables should be renumbered to establish correct sequence. WPs will be renumbered and assigned new WP sequence numbers in consecutive order. All existing change numbers, change bars, dates and change symbols will be removed. Change symbols will be inserted only on those pages incorporating new or changed data during the preparation of the complete revision. The revision date will be assigned by the requiring activity.

7.1.3 Change symbols. Change symbols should be inserted to identify technical changes in text, illustrations, and tables.

a. Text and tabular data. The text and tabular data affected by a change should be indicated by the letter "R" or a change bar in the outer margin of double column format material and in the outer margin (opposite binding edge) of single column format material.

b. Illustrations. Change symbols for illustrations should be as follows:

(1) Miniature pointing hand. A miniature pointing hand should be used to highlight the area containing the changed material.

(2) Change bar. When several changes are made in one area, or the area is congested, a change bar may be used to indicate a general area. The change bar should be placed in such a manner as to clearly indicate the changed area without confusing the user. If an illustration has been extensively changed, a change bar may be placed along the outer margin of the illustration (full page illustration) or in the applicable margin (partial page illustration).

(3) Alternate method. An acceptable alternate method for use with an extensively changed full page illustration is the use of the words "MAJOR CHANGE" enclosed in a box. The enclosed words should be placed in a clear space of the illustration image area.

7.1.4 Renumbering in a work package during a pickup revision. Paragraphs, illustrations, tables, pages, and index numbers on illustrations added between existing ones should be assigned the preceding number plus consecutive capital letter suffixes; for examples 3A and 3B might be added between existing numerals 3 and 4. Suffix letters I and O should not be used. Other than the addition of suffix letters, existing identification numbers and suffixes should not be renumbered.

7.1.5 Added or deleted material in a work package during a pickup revision.

a. Added material should be placed in proper sequential order within the WP. If this causes an overrun, the material that will not fit on the existing page should be placed on an added page. If blank space is available on either the preceding or following page of the one affected, this space may be used for overrun material; however, correct sequential order of material must be maintained. Pages should not be added between a right-hand (odd numbered) and a left-hand (even numbered) page. If additional copy is added to a right-hand page, the overrun should be carried to the next left-hand page and the overrun from this page should be placed on an added page. Therefore, such added pages should always be assigned even numbers; for example: "2A, 2B, 4A, or 4B."

b. Deleted paragraphs, procedural steps, or callouts following index numbers on illustrations should be indicated by placing the word "Deleted" after the affected item; for example: "r. Deleted." or "2 Deleted."

c. Deleted pages should be accounted for by placement of a note at the bottom of the preceding page or at the top of the succeeding page; for example: "Page 7 Deleted." The note should be placed within the required image area (with marginal copy).

7.2 Revisions and updates for ETMs/IETMs. When changes to ETMs/IETMs are ordered, the deliverable product should be either an update or a complete revision. The requiring activity will determine the type and frequency of the change required. Detailed requirements for the preparation of revision data are provided in MIL-STD-3001-1, Appendix C.

7.2.1 Revisions. A complete ETM/IETM revision requires rewrite of the technical content of the data to ensure that all new data and past updates are included. When applicable, all existing change numbers, change bars, dates, and change symbols will be removed. When required by the requiring activity, a revision summary should be provided. (Refer to 5.10.1.) Revisions will be incremental and the frequency of revisions will be defined in the contract. Each revision to an ETM/IETM should be identified by a revision date.

7.2.2 Updates. Updates are changes to the initial version of the ETM/IETM or to the latest complete revision of an ETM/IETM. Updates are issued incrementally as necessary, or as required by the contract. When authorized by the requiring activity, updates should include change symbols and change dates to inform the user what has changed and where the changes or additional information is located. When required by the requiring activity, a revision summary should be provided. (Refer to 5.10.1.)

7.2.3 Change symbols. When authorized by the requiring activity, change symbols should be inserted to identify technical changes in text, illustrations, and tables.

a. Text and tabular data. The text and tabular data affected by a change should be indicated by the letter "R" or a change bar in the outer margin.

b. Illustrations. Change symbols for illustrations should be as follows:

(1) Miniature pointing hand. A miniature pointing hand should be used to highlight the area containing the changed material.

(2) Change bar. When several changes are made in one area, or the area is congested, a change bar may be used to indicate a general area. The change bar should be placed in such a manner as to clearly indicate the changed area without confusing the user. If an illustration has been extensively changed, a change bar may be placed along the outer margin of the illustration.

(3) Alternate method. An acceptable alternate method for use with an extensively changed illustration is the use of the words "MAJOR CHANGE" enclosed in a box. The enclosed words should be placed in a clear space of the illustration image area.

8. **COMPREHENSIBILITY**.

8.1 Comprehensibility for page-based TMs.

8.1.1 Standard English grammar. The U.S. Government Printing Office Style Manual will be used as a general guide for standard American English usage, i.e., capitalization, punctuation, compounding of words, numerals in the text, spelling of nontechnical words, etc. Colloquial and slang expressions will not be used.

8.1.2 Narrative, nonprocedural text.

a. Word order. Narrative text (nonprocedural) will be written using simple word order (subject, verb, object) to the extent possible. Modifiers, including prepositional phrases, will be as close as possible to the word modified. Simple word order will ordinarily be used for description and discussion statements such as warnings, cautions, and notes.

b. Topical sentence. When necessary, for greater clarity, the first sentence of each paragraph will be the topical sentence. The topical sentence describes or summarizes the content of the paragraph. All information in the paragraph relates to the topical sentence.

c. Limitations for nonprocedural text. Explanatory, descriptive, or theoretical text will not contain procedures.

8.1.3 Procedural text. Detailed task steps will be identified and then properly worded for the target audience. Task steps will be organized in a logical order. They will be presented so that they sequentially show what action the user will be performing or what the user sees or detects on the equipment at each step of the procedure. Procedural steps will be worded and arranged in the order that will provide the most effective and efficient results. Emphasis will be placed on the specific steps to be followed, the results that may be expected or desired, and the corrective measures required when the expected results are not obtained.

8.1.3.1 Lead-in. Procedural steps will not be prefaced by a lead-in that merely duplicates the title as in the following example: "Disassembly of a sensing unit. The sensing unit is disassembled according to the following procedure:"

8.1.3.2 Form and content of procedures. A procedural step will be limited to a single operation or to repetitions of a single operation with the following exceptions:

a. If simultaneous operations are required, they will be listed together in the same step.

b. If the step represents a detailed procedure, so basic that the details should rarely be needed by the intended users, or if the procedure is very frequently repeated, such as a turn on, turn off, or calibrate procedures, the written procedure for that step will use a single verb and cite a reference to the detailed steps (e.g., "Turn equipment ON. [See WP 056 00 for details.]").

c. If needed, text will show verification of the result of a procedure performed in the step (e.g., "Press pushbutton A and be sure indicator A is lit.").

8.1.3.3 Limitations for procedural text. Procedures should not contain explanatory, descriptive, or theoretical material (except in notes, etc.).

8.1.3.4 Sentences in procedures. Sentences directing the actions of the user will begin with the verb (e.g., "Remove four screws (1) and cover (2)."). If more than one person is involved, the directions will be in the active voice, for example, "Technician 1 should... while Technician 2…".

8.1.3.5 Positive form. Procedural steps will be in positive form (i.e., "Close container." rather than "Do not leave container open.") unless the meaning demands the negative form.

8.2 Comprehensibility for ETMs/IETMs. ETMs/IETMs comprehensibility requirements are provided in MIL-PRF-87268.

9. **SECURITY CLASSIFICATION MARKINGS**.

9.1 Security classification markings for page-based TMs.

9.1.1 General. When preparation of a classified technical manual (TM) is specified by the requiring activity, the security classification markings will be identified in accordance with DoD 5200.1R, DoD 5220.22M, OPNAVINST 5510.1 and Executive Order 12958. Specific markings for classified manuals, pages, work packages, paragraphs, tables and illustrations are as prescribed herein. For guidance on security classification and handling restrictive markings on Compact Disk-Read Only Memory (CD-ROM), refer to MIL-HDBK-9660.

9.1.2 Overall classification. (Refer to figure 88). The overall classification assigned to all TMs agrees with the highest classification assigned to any page therein. Place the overall classification assigned to a TM at the top and bottom of the title page. When this results in a title page being marked with a higher classification than that assigned to the contents of that page, provide an explanation of the higher classification on that page under the bottom classification marking. For example:

CONFIDENTIAL (This page is UNCLASSIFIED)	or	SECRET (This page is CONFIDENTIAL)

9.1.3 Classification of alphabetical index. (Refer to figure 89.) Every effort should be made to use unclassified captions/titles in the alphabetical index. When classified captions/titles are used, place the security classification of the caption/title between the paragraph number and the caption/title. The classification marking is for the caption/title only and does not indicate classification of the content of work packages, tables, or illustrations. Do not mark unclassified titles.

9.1.4 Classification of work packages. (Refer to figure 90.) Each work package is considered a stand alone unit and for classification purposes is equivalent to a portion of the publication. Mark each page of the work package with the highest classification required for any element of the work package. When any page is marked with a higher classification than that assigned to its contents, provide an explanation on that page beneath the bottom classification marking. For example:

CONFIDENTIAL (This page is UNCLASSIFIED)	or	SECRET (This page is CONFIDENTIAL)

9.1.5 Classification of pages. (Refer to figure 91.) Mark each page (other than title page and work package pages) according to its highest content. When classification of two pages of one sheet (two pages back to back) differ, use the higher classification on both pages. When two pages of one sheet are unclassified, mark each page unclassified. When any page is marked with a higher classification than that assigned to its contents, explain the higher classification on that page beneath the bottom classification marking. For example:

CONFIDENTIAL (This page is UNCLASSIFIED)	or	SECRET (This page is CONFIDENTIAL)

If a blank page backs up a classified page, show the classification of the classified page on the blank page and explain the higher classification as described above. Blank pages backing up unclassified pages need not be marked. If the classification shown on the last page of a publication is not the same as that shown on the title page, then add a blank sheet to the back of the publication showing the same classification as the title page. The last page, if blank, of the publication reflects the same classification as the title page (i.e., the highest classification of the publication).

9.1.6 Paragraph and table markings. (Refer to figures 92 and 93.) Mark all paragraphs, subparagraphs, steps and tables to show the level of classification contained in or revealed by it, or that it is unclassified. Classification levels are shown by the appropriate classification symbols between the paragraph number, procedural step number or letter and the start of the text and between a table number and title. Use the following parenthetical symbols: (TS) for Top Secret, (S) for Secret, (C) for Confidential, and (U) for Unclassified. In marking warnings, cautions, or notes, place the appropriate marking immediately preceding and to the left of the warnings, cautions, or notes involved. The abbreviated classification markings are for internal content use only, not for overall marking of pages. These instructions apply to all new and revised publications.

9.1.7 Illustration markings. (Refer to figure 94.) Mark illustrations, photographs, figures, graphs, drawings, charts and similar portions of classified documents to show their classification or unclassified status. Ensure that markings stand out and are placed within the illustration. Mark captions, if used, on the basis of their content alone by placing the symbol "(TS)," "(S)," "(C)," or "(U)" immediately before the caption.

9.1.8 Downgrading/Declassification. The downgrading/declassification notice on the title page and downgrading/declassification actions will be in accordance with DoD 5200.1R, DoD 5220.22M and OPNAVINST 5510.1.

9.2 Security classification markings for ETMs/IETMs.

9.2.1 Security classification markings. When preparation of a classified ETM/IETM is specified by the requiring activity, the security classification markings will be identified in accordance with DoD 5200.1R, DoD 5220.22M, OPNAVINST 5510.1, and Executive Order 12958. For guidance on security classification and handling restrictive markings on Compact Disk-Read Only Memory (CD-ROM), refer to MIL-HDBK-9660.

9.2.2 Display of security classification markings. Whenever classified information is displayed, the classification level should be indicated in the left-hand corner of the footer area. The indication should be the upper case spelling of the words corresponding to the classification level (e.g., CONFIDENTIAL or SECRET). When color is used, these indications should be displayed with a consistent color. The classification indication should be clearly distinguishable from the function indicators in the same area. If any classified information is contained in the ETM/IETM, the classification of the entire ETM/IETM is that of the highest classification level used, e.g., SECRET. In an IETM, if a given frame is unclassified, the label UNCLASSIFIED should appear in the footer bar.

10. **NOTES**.

10.1 Intended use. Technical manuals prepared in accordance with the information and guidance contained in this handbook are used to support operation and maintenance of various types of equipment and weapons systems within the Department of the Navy.

10.2 Subject term (key word) listing. The following terms are to be used to identify the MIL-HDBK-3001 document during retrieval searches.

Document type definition
Graphics
Hazardous materials warnings
Icons
Illustrated parts breakdown (IPB)
Illustrations
Maintenance instructions
Principles of operation
Revisions
Security classification
Troubleshooting information
Work package

A1-F18AC-130-100 **003 00**
1 May 1995

ORGANIZATIONAL MAINTENANCE

PRINCIPLES OF OPERATION

DESCRIPTION AND OPERATION

LANDING GEAR SYSTEM

Reference Material

Component Locator	WP 003 01
Landing Gear Control Simplified Schematic	WP 004 00
Landing Gear Warning and Position Indicating Simplified Schematic	WP 005 00
Landing Gear Controlled Relays Simplified Schematic	WP 006 00
Landing Gear BIT Simplified Schematic	WP 007 00
Catapult System Simplified Schematic	WP 011 02

Record of Applicable Technical Directives

TD Type/ Number	TD Date	Title and ECP/RAMEC No.	Date Inc.	Remarks
F/A-18 AFC 40	1 Feb 84	Landing Gear System, Main Landing Gear (MLG) Downlock Actuator Final Restrictor Assembly; Addition of (ECP MDA-F/A-18-00142R2)	15 Jun 95	
F/A-18 AFC 110		Relay Panel No. 2 Circuit Configuration Change (ECP RAMEC NORIS-10-87)	1 Jul 87	
F/A-18 AFC 155		Main Landing Gear Retract/ Extension System Timing, Improvement of (ECP MDA-F/A-18-00375)	1 Jul 92	

1-1 **DESCRIPTION**

1-2 **SYSTEM DESCRIPTION**. The landing gear system is made up of components listed in figure 1, and provides:

1. Normal retraction
2. Normal extension
3. Emergency extension
4. Warning and position indicating
5. Interface relays
6. Built-in test (BIT)

1

FIGURE 1. Example of an information-oriented work package.

1-4 Normal retraction is hydraulically powered and electrically controlled through the pilot controlled LDG GEAR control handle. Normal retraction pressure is supplied by hydraulic system no. 2A pressure.

1-5 Normal Extension

1-6 Normal extension is hydraulically powered and electrically controlled through the pilot controlled LDG GEAR control handle. Normal extension pressure is supplied by hydraulic system no. 2A pressure.

1-7 Emergency Extension

1-8 Emergency extension is primarily free fall aided by stored energy in the MLG shock absorber and hydraulic system no. 2B pressure. Hydraulic system no. 2B pressure is supplied by the Auxiliary Power Unit (APU) and emergency brake accumulators and serves to unlock the landing gear uplock mechanisms and aid in landing gear down lock. Emergency extension is controlled by the LDG GEAR control or the EMER LDG GEAR control.

1-9 Warning and Position Indicating

1-10 Warning and position indicating is controlled by the landing gear control unit (LGCU) and provides visual (lights) and audio (warning tone) indications to the crew of landing gear position and safety.

1-11 Interface Relays

1-12 Interface relay control is provided by the LGCU which computes input data combinations and provides outputs to control the state of the landing gear system relays which in turn control various other aircraft systems.

1-13 Built-In Test (BIT)

1-14 The BIT system electrically tests the initiated BIT provided by the LGCU. Periodic BIT runs landing gear system through a periodic BIT and an continuously from electrical power application to removal and tests internal LGCU circuitry. If a failure is detected by the LGCU BIT circuitry on F/A-18A and F/A-18B, the LGCU send applicable BIT fail signals to the maintenance status display and recording system. If a failure is detected by the LGCU BIT circuitry on F/A-18 and F/A-18D, the LGCU sends applicable BIT fail signals to the flight incident recording and monitoring system. Initiated BIT runs approximately 250 milliseconds and is activated 8.5 + 1.5 seconds after power application to test internal LGCU circuitry. Initiated BIT is also activated to test internal LGCU circuitry:

1. 30.0 + 1.0 seconds after aircraft touchdown with LGCU P/N 8-347-01 installed.

2. 60.0 +5.0 seconds after airdraft touchdown with LCU P/N 8-347-03 installed.

1-15 COMPONENT DESCRIPTION

1-16 Emergency Landing Gear Manual Control Valve Assembly

1-17 The emergency landing gear manual control valve assembly is a two-position manually activated valve which controls hydraulic systems no. 2B pressure (emergency) and no. 2A return to and from the landing gear system.

1-18 Emerg Ldg Gear and Emerg Brk Coupler Assembly

1-19 On F/A-18B and F/A-18D, the emergency landing gear and emergency brake coupler assembly provides a means of connecting forward and aft cockpit push-pull control assemblies to a single output push pull control to operate the emergency landing gear manual control valve assembly.

2

FIGURE 1. Example of an information-oriented work package - continued.

A1-F18AC-742-300 **012 00**

1 April 1995

ORGANIZATIONAL MAINTENANCE

SYSTEM MAINTENANCE WITH IPB

RADAR SET AN/APG-65 TRANSMITTER TO FLOOD ANTENNA

WAVEGUIDE ASSEMBLY (60W-A518)

Reference Material

Extension and stowage of Radar Set AN/APG-65	WP 003 00
Electrical Equipment Rack MT-4955/APG-65	WP 014 00
Avionic Cleaning and Corrosion Prevention/Control	NAVAIR 16-1-540
Line Maintenance Procedures	A1-F18AC-LMM-000

Materials Required

Nomenclature	Specification/Part Number	HMWS Index Number
Epoxy Primer Coating	MIL-P-2337 TY2	21

1-1 **REMOVAL**

1. Make sure electrical power is off (A1-F18AC-LMM-000).

2. Extend radar set (WP 003 00).

3. On 16395 and up, perform EMI shields removal procedure (WP 014 00).

CAUTION

To avoid damage to equipment, make sure waveguide coupling latch mechanism is disengaged before applying release pressure to the handle.

4. Unlatch waveguide coupling mating waveguide assembly (3, figure 1) to Radar Transmitter T-1377/APG-65.

5. While supporting waveguide assembly (3), loosen four bolts (2).

6. Remove waveguide assembly (3) from forward bulkhead.

7. Inspect waveguide assembly (3) for external corrosion and clean as required (NAVAIR 16-1-540). If internal corrosion or evidence of arcing exists, replace waveguide assembly.

2-1 **INSTALLATION**

1. Make sure electrical power is off (A1-F18AC-LMM-000).

2. Make sure two seals (1 and 4, figure 1) are installed in waveguide flanges.

1

FIGURE 2. Example of a task-oriented maintenance with IPB work package.

A1-F18AC-742-300 **012 00**

Epoxy Primer Coating, MIL-P-23377TY2 **21**

3. Apply a small amount of primer on threads of bolts (2).
4. Position waveguide assembly (3) and tighten four bolts (2).
5. Latch waveguide coupling mating waveguide assembly (3) to Radar Transmitter T-1377/APG-65. Make sure scribe line on latch is completely visible and parallel to top surface of clamp.
6. Perform waveguide pressure test (WP 018 00).
7. Stow radar set (WP 003 00).

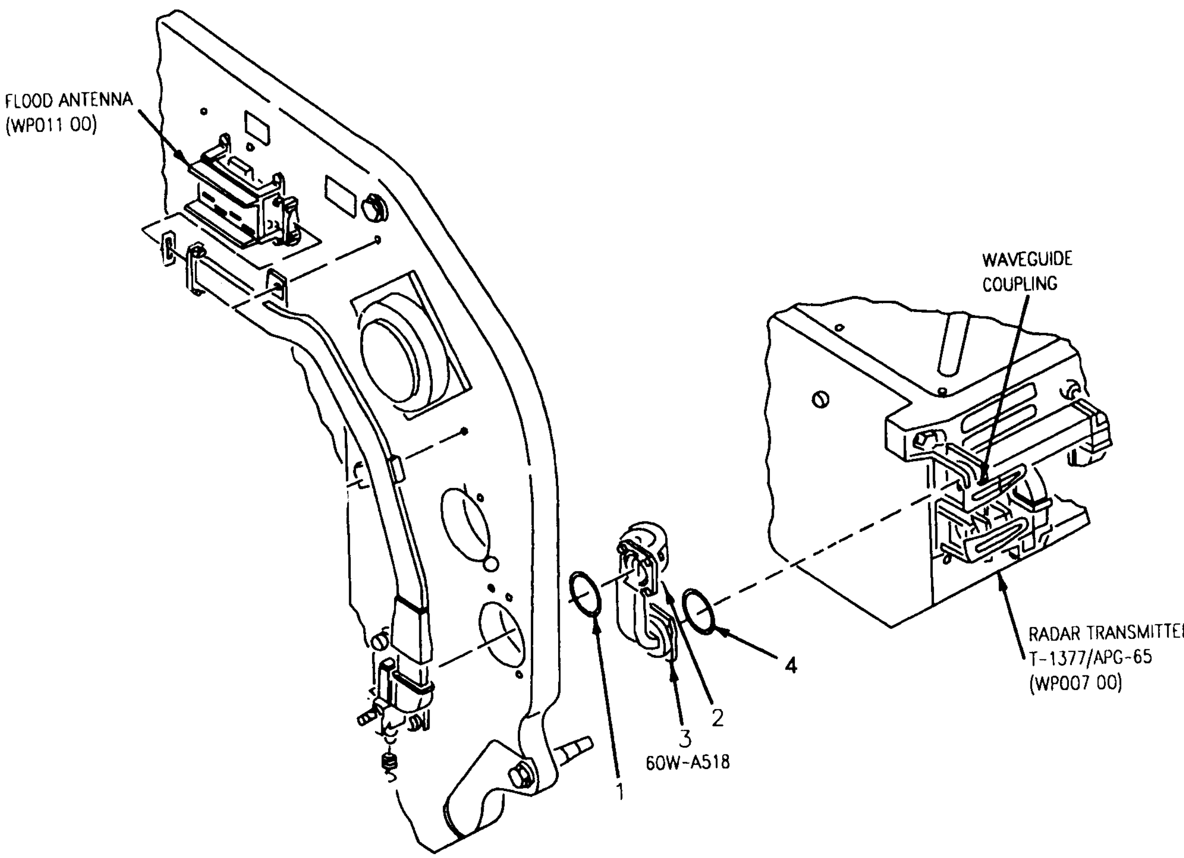

Figure 1. Transmitter and Antenna Waveguide Assembly.

2

FIGURE 2. Example of a task-oriented maintenance with IPB work package - continued.

A1-F18AC-742-300 **012 00**

3-1 **ILLUSTRATED PARTS BREAKDOWN**

3-2 This illustrated parts breakdown has data required for identifying and ordering parts. The manual introduction has more information on IPB data.

INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USE ON CODE	SM & R CODE
		RADAR SET AN/APG-65 WAVEGUIDE .... ASSEMBLIES			
1	19-12-4322-1221	• SHIELDING GASKET, ELECTRONIC.......... .... (SEAL) (18565) (HUGHES SPEC 929236-1C) (NHPA 3542156, 3542156-1; SM & R CODE PAOZZ	1		PAOZZ
2	AIC485-1	• BOLT, INTERNAL WRENCHING........................ (06725) (HUGHES SPEC 965834-1) (NHPA 3542156, 3542156-1; SM &R CODE PAOZZ)	4	*	PAOZZ
	D791184-8-14	• SEE ABOVE (97928)..	4	*	PAOZZ
	74886-12	• SEE ABOVE (56878)..	4	*	PAOZZ
	M-20884	• SEE ABOVE (20019)..	4	*	PAOZZ
	FIT7076-1	• SEE ABOVE (58998)..	4	*	PAOZZ
	MS35338-137	• WASHER (USE WITH INDEX 2)..........................	4	*	PAOZZ
3	3542156-2	• WAVEGUIDE ASSEMBLY TRANSMITTER...... TO FLOOD ANTENNA (82577) (60W-A518) (NHPA 5100044; SM & R CODE PAOOD)	1	I	PAOZZ
	3542156-1	• SEE ABOVE .... (NHPA 3578099-1, 5015456, 5015456-1, 5015656-2, 5015456-3, 5100044; SM & R CODE PAOOD)	1	*	PAOZZ
	3542156	• SEE ABOVE	1	*	PAOZZ

3

FIGURE 2. Example of a task-oriented maintenance with IPB work package - continued.

A1-F18AC-GAI-000 **004 00**
1 August 1995

ORGANIZATIONAL MAINTENANCE

AIRCRAFT ARRANGEMENT

Record of Applicable Technical Directives

TD Type/ No.	TD Date	Title and ECP/RAMEC No.	Date Inc.	Remarks
F/A-18 AFC-49	20 FEB 90	Sealed Lead Acid Battery, Addition of (ECP MDA-F/A-18-00074)	1 Feb 87	
FA-18 AFC-54	1 Aug 92	Video Recording System Incorporation (ECP MDA-F/A-18-00027)	1 Feb 87	

1-1 **GENERAL ARRANGEMENT**

1. Radome
2. Forward fuselage
3. Center fuselage
4. Aft fuselage
5. Wings

1-2 **RADOME.** The radome (figure 1) spans from Y coordinate 60.50 to Y coordinate 128.50. It is a filament wound fiberglass/epoxy shell mounted on an articulated hinge to allow easy access to the radar set. It provides an electrically transparent window for transmission and receiving of radar signals.

1-3 **FORWARD FUSELAGE.** The forward fuselage (figure 1) spans from Y coordinate 128.50 to Y coordinate 383.00. The forward fuselage includes the following:

1. Windshield
2. Canopy
3. Cockpit
4. Leading edge extension
5. Nose landing gear

1-4 **Windshield**

1-5 The windshield is the aerodynamic fairing for the cockpit and allows forward visibility for the pilot. The one-piece windshield is stretched acrylic attached to an aluminum frame. The frame is hinged to allow the windshield to rotate forward for instrument panel servicing.

1

FIGURE 3. Example of an aircraft arrangement work package.

A1-F18AC-GAI-000 **004 00**

1-6 **Canopy**

1-7 The one-piece clamshell canopy is stretched acrylic attached to an aluminum frame. The F/A-18B and F/A-18D canopy is 54 inches longer and 125 pounds heavier than the F/A-18A and F/A-18C canopy. The canopy may be opened and closed either manually or electrically operating the canopy actuator. When closed, the F/A-18A and F/A-18C canopy is secured by three latches and a forward latch pin on each side. The F/A-18B and F/A-18D canopy is secured by four latches and a forward latch pin on each side.

1-8 **Cockpit**

1-9 The F/A-18A and F/A-18C (figures 2, 3 and 4) have a single place cockpit. The F/A-18B and F/A-19D (figure 5) have a front and rear cockpit. These views are for familiarization purposes only.

1-10 **Leading Edge Extension**

1-11 The leading edge extension (LEX) is a highly swept and cambered extension of the wing leading edge and provides added lift at high angles of attack. The boarding ladder is mounted in the left LEX (figure 1).

1-13 **CENTER FUSELAGE.** The center fuselage (figure 1) spans from y coordinate 383.00 to Y coordinate 557.50. The center fuselage includes the following:

1. Main landing gear
2. Air intake ducts
3. External stores stations
4. Fuselage fuel tanks
5. Airframe mounted accessory drive

1-14 **MAIN LANDING GEAR**

1-15 The main landing gear is a lever design with an oleo shock absorber. The lever design provides a stable platform for aircraft carrier and shore based operations. The shock absorbs the energy from ground loads during landing and taxi operations.

2-1 **WALK AREAS**

2-2 Maintenance personnel should walk only on designated areas shown. Protective shoe coverings should always be worn when walking on aircraft is necessary. Protective covers should be placed on walk areas during periods of high volume traffic. Portions of the flap and horizontal stabilator area may be used for walks, provided the applicable locks are installed. For ground protective devices (A1-F18AC-PCM-000).

3-1 **MINIMUM STRUCTURAL ACCESS DOORS**

3-2 Some access doors are in an integral part of the aircraft structure. Any time the aircraft is subject to stress, these doors must be installed and/or closed. Procedures in A1-F18AC-LMM-000 that apply these requirements, reference the A1-F18AC-LMM-010.

2

FIGURE 3. Example of an aircraft arrangement work package - continued.

A1-F18AC-GAI-000 **004 00**

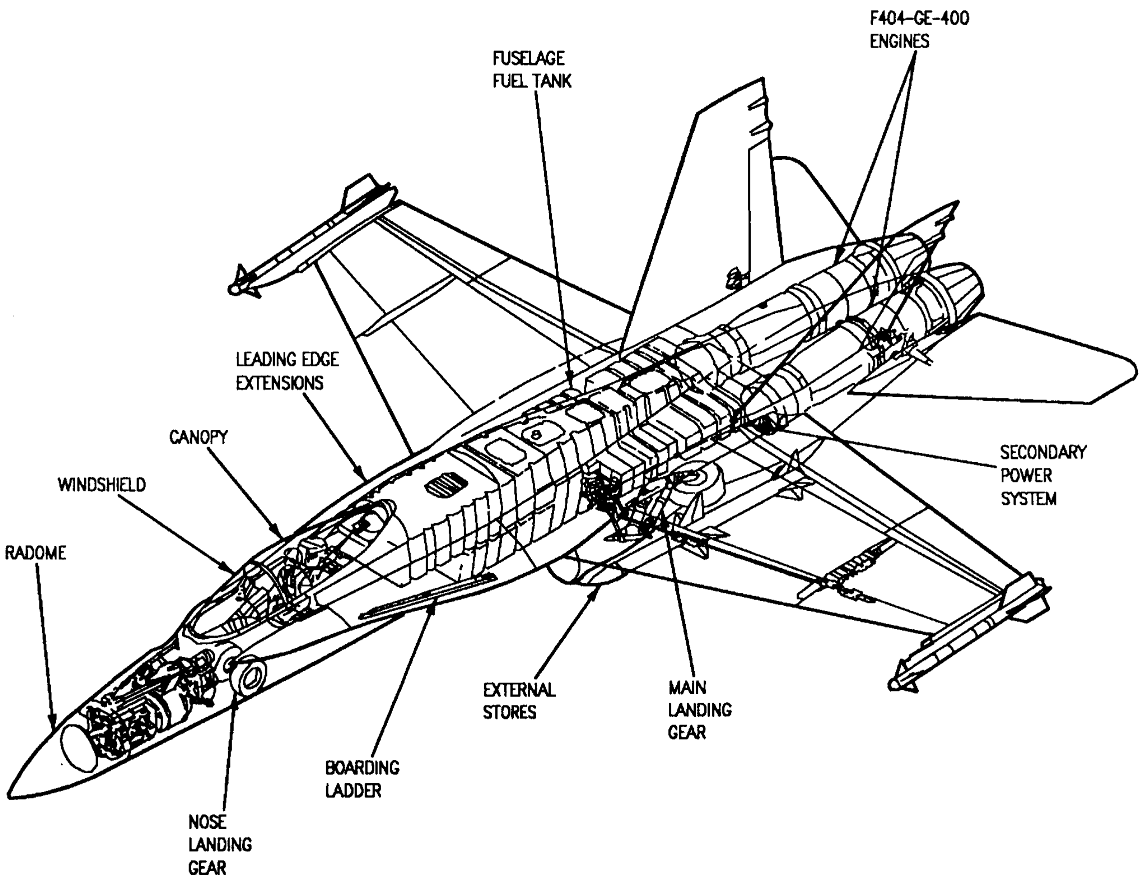

Figure 1. Aircraft General Arrangement (Sheet 1).

3

FIGURE 3. Example of an aircraft arrangement work package - continued.

A1-F18AC-GAI-000 **005 00**

1 August 1995

ORGANIZATIONAL MAINTENANCE

AIRCRAFT ARRANGEMENT

Record of Applicable Technical Directives

TD Type/ No.	TD Date	Title and ECP/RAMEC No.	Date Inc.	Remarks
F/A-18 AFC-27	1 Aug 90	Lead Edge Flap/Control Stick Changes, Incorporation of (ECP MDA-F/A-0044)	1 Feb 87	
FA-18 AFC-54	1 Aug 92	Incorporation of a Video Recording Set (ECP MDA-F/A-18-00027)	1 Feb 87	

1-1 **SEAT, CANOPY, SURVIVAL EQUIPMENT, WINDSHIELD AND BOARDING LADDER**

1-2 **EJECTION SEAT AND CANOPY EMERGENCY ESCAPE SEQUENCING**. On F/A-18A and F/A-18C, seat ejection and canopy jettison sequencing is started by pulling the ejection control handle on the front of the ejection seat bucket, firing the ejection seat initiators. Ballistic gas pressure produced by the right seat initiator does the following:

1. Acutates the pin puller
2. Fires the gas to SMDC initiator which fires the IFF switch and the canopy jettison system by way of the one-way transfer valve.
3. Fires the inertia reel cartridge.
4. Fires the 0.30-second delay initiator.
5. Ballistic gas pressure from either delay initiator operates the catapult primary cartridge which starts seat ejection.

1-3 On F/A-18B and F/A-18D, the emergency escape sequencing system provices for canopy jettison and ejection of seats in correct sequence. The selection of sequencing is made on the ejection selector in the rear cockpit. There are three selections:

1. Normal – When sequence is initiated from the cockpit, both seats are ejected with the rear seat first. When sequence is started from the rear cockpit, only the rear seat is ejected.
2. Solo – Selection is used when the rear cockpit is not occupied; only the cockpit or rear cockpit.
3. Aft Initiated – Both seats are ejected with the rear seat first when started from cockpit or rear cockpit.

1-4 On F/A-18C and F/A-18D aircraft, the ejection seat(s) are equipped with a SAFE/ARM indicator switch which indicates the ejection seat(s) not being armed under certain conditions. On F/A-18D the rear cockpit is equipped with a seat caution mode switch which overrides the rear cockpit SAFE/ARM indicator switch for solo flight.

1-5 **Internal Canopy Jettison**

1-6 Canopy jettison is started with the internal canopy jettison lever. On F/A-18A and F/A-18C, the internal canopy jettison lever is mounted inboard and below the canopy sill found in the left side of the cockpit. The lever is operated

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FIGURE 4. Example of an aircraft systems description work package.

A1-F18AC-GAI-000 **005 00**

by pushing down on the safety button and rotating lever aft. Aft rotation of the lever fires the canopy jettison initiator which in turn jettisons the canopy.

1-7 On F/A-18B and F/A-18D, canopy jettison is started with either the internal canopy jettison lever or the rear internal canopy jettison lever.

1-8 Cockpit internal canopy jettison:

1. Same as F/A-18A and F/A-18C.

2. Rear cockpit canopy jettison is located in the center of the left console.

1-9 The lever is operated by pushing in on safety button and pulling up. Pulling up on rear internal canopy jettison lever fires the rear canopy jettison initiator which in turn jettisons the canopy.

1-10 **External Canopy Jettison – 161353 THRU 162477.** Ground emergency jettison of the canopy is started by external canopy jettison handles which are in back of doors 5L and 5R. Each handle is attached to approximately eight feet of cable. The cables are joined to a common cable that connects to the internal canopy jettison lever. When either handle is pulled and the cable extended as far as possible, the canopy jettison initiator fires which in turn jettisons the canopy.

1-11 **EJECTION SEAT SYSTEM.** On 161353 thru 164068, the SJU-5/A ejection seat is fitted to the F/A-18A, F/A-18C and in the rear cockpit of the F/A-18B and F/A-18D aircraft. The SJU-6/A ejection seat is fitted to the cockpit of the F/A-18B and F/A-18D.

1-12 On 164196 and up, the SJU-17(V)1/A ejection seat is fitted to the F/A-18C and the rear cockpit of the F/A-18D aircraft. The SJU-17(V)2/A ejection seat is fitted to the cockpit of the F/A-18D.

1-13 The ejection seat provides support for the crewmember during normal flight conditions and a method of escape from the aircraft during emergency conditions. The ejection seat is automatic, cartridge operated and rocket assisted.

2-1 **LANDING GEAR AND RELATED SYSTEMS**

2-2 **LANDING GEAR.** The landing gear is electrically controlled and hydraulically operated. Before the gear can be raised normally, weight must be off the wheels and the launch bar must be retraced. The main gear is retracted aft and inboard into the fuselage and the nose gear is retracted forward. When the gear is extended, all gear doors remain open.

2-3 **LDG Gear Control Handle**

2-4 The landing gear is controlled by a two-position, wheel-shaped LDG GEAR control handle, located above LH vertical console control panel. Moving the LDG GEAR control handle up (with hydraulic and electrical power applied) raises the gear. Moving the LDG GEAR control handle down lowers the gear. On the ground (weight on wheels), movement of the LDG GEAR control handle from DN to UP is prevented by a solenoid in the LDG GEAR control panel. However, a down lock override button next to the LDG GEAR control handle makes it possible to override the weight on the wheels switch and retract the MLG, if a failure has occurred in the lock down solenoid circuit. In this case, the override button allows the LDG GEAR control handle to be raised. During maintenance with electrical power applied, the LDG GEAR control handle can be raised without pressing the override button with aircraft on jacks (weight off wheels) and proximity switch control not connected.

2

FIGURE 4. <u>Example of an aircraft systems description work package</u> - continued.

A1-F18AC-GAI-000 **006 00**

1 August 1995

ORGANIZATIONAL MAINTENANCE

DANGER AREAS AND PRECAUTIONARY MEASURES

Record of Applicable Technical Directives

TD Type/ No.	TD Date	Title and ECP/RAMEC No.	Date Inc.	Remarks
F/A-18 AFC-126	1 Oct 94	Addition of (DFIRS) Deployable Flight Incident Record Set (ECP 321R1C1)	1 Dec 92	
ACC 446 REV A	9 Jan 85	Parachute Harness Sensing Release Unit; Installation of (ECP CHINA LAKE-93)	1 Dec 86	

1-1 **FLAMMABLE LIQUIDS, COMPRESSED GASES AND EXPLOSIVE DEVICES**

1-2 Areas including reservoirs of flammable liquids, gases under pressure, and explosive devices are shown in figure 1. Rescue and maintenance personnel should be aware of the hazards related to these areas.

2-1 **CANOPY, SEAT AND DFIRS EXPLOSIVE DEVICES**

2-2 Many explosive devices (figure 2) are located in and around the crew station. The ejection seat(s) have rocket motors, initiators, and controls that require special handling during ground operations. The canopy has rocket motors, initiators, thrusters, and controls that also require special handling. Safety procedures are covered in A1-F18AC-PCM-000.

2-3 On 164725 and up; also 164627 thru 164724 after F/A-18 AFC 126, the DFIRS impact initiator, underwater initiator and the severable door (63L) are explosive devices. They do not require special handling during ground operations.

3-1 **AIRFRAME AND EXTERNAL STORES**

3-2 External fuel tanks, vertical ejection racks, missile launchers and conventional/nuclear weapons (figure 3), loaded on wing or fuselage centerline pylons, may be ejected by explosive cartridges. The area near these devices must be considered hazardous for maintenance personnel when aircraft electrical power is on.

3-3 Missile exhaust area and path of trajectory are hazardous for personnel. An inadvertently fired missile can cause death or injury from either end.

3-4 The M61A1 or M61A2 gun projectile trajectory path is hazardous to personnel. Gun fire can cause death or injury.

3-5 Aircraft carrying munitions must be loaded, unloaded, and parked in designated explosives parking areas.

4-1 **ENGINE**

4-2 Danger areas resulting from engine operation are related to exhaust velocity and temperature, air intake, and noise.

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FIGURE 5. Example of a danger areas and precautionary measures work package.

A1-F18AC-GAI-000 **006 00**

4-3 **AIR INTAKE AND EXHAUST.** During ground operation of the engines, the forward and aft ends of the aircraft are danger areas (figure 4). Inrushing air can pull a person into or against the intake ducts. Engine exhaust air can cause death or serious burns. The area immediately aft of the tail pipes is hazardous for 15 minutes after engine shutdown.

4-4 **ENGINE NOISE HAZARD.** The noise level of operating jet engines can cause hearing loss. Figure 5 shows relative noise levels at various distances from aircraft. Ear protectors must be worn when working near operating engines.

5-1 **RADAR ANTENNA**

5-2 When the radome is open and the radar system is operating (figure 6), personnel should be aware that the radar antenna can make sudden position changes and should stay 3 feet away from the antenna.

6-1 **RADIATION**

6-2 Radar operations are the main source of radiation injury to personnel. All radio, countermeasures set, and radar transmitters (figure 6) are sources of rf energy. Radiation hazards are listed below.

1. Long exposure to rf energy at close range will cause personnel injury. High rf energy areas should be posted with warning signs.

2. Accidental firing of electroexplosive devices (EED) can result from rf energy radiated through an opening in the EED, or conducted through the firing leads.

3. Radiation may cause photoflash bulbs to go off, resulting in injury to personnel.

4. Radiation may cause sparking between metal surfaces such as a fuel hose nozzle and aircraft structure. The sparks may ignite fuel vapor.

6-3 **PRECAUTIONARY MEASURES.** Personnel should not work in radiation fields of operating radar antennas.

6-4 All transmitting equipment should be turned off before bringing EED into the area.

6-5 Transmitters should not be operated within 500 feet of uninstalled EED.

7-1 **AUXILIARY POWER UNIT (APU)**

7-2 **AIR INTAKE AND EXHAUST.** Danger areas resulting from APU operations are shown in figure 7. The APU intake duct is in door 52. The APU exhaust duct is in door 66.

7-3 **NOISE HAZARD**. Noise levels near APU intake and exhaust ports during operation may cause hearing loss. Ear protection must be worn when working near an operating APU.

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FIGURE 5. Example of a danger areas and precautionary measures work package - continued.

A1-F18AC-GAI-000 **006 00**

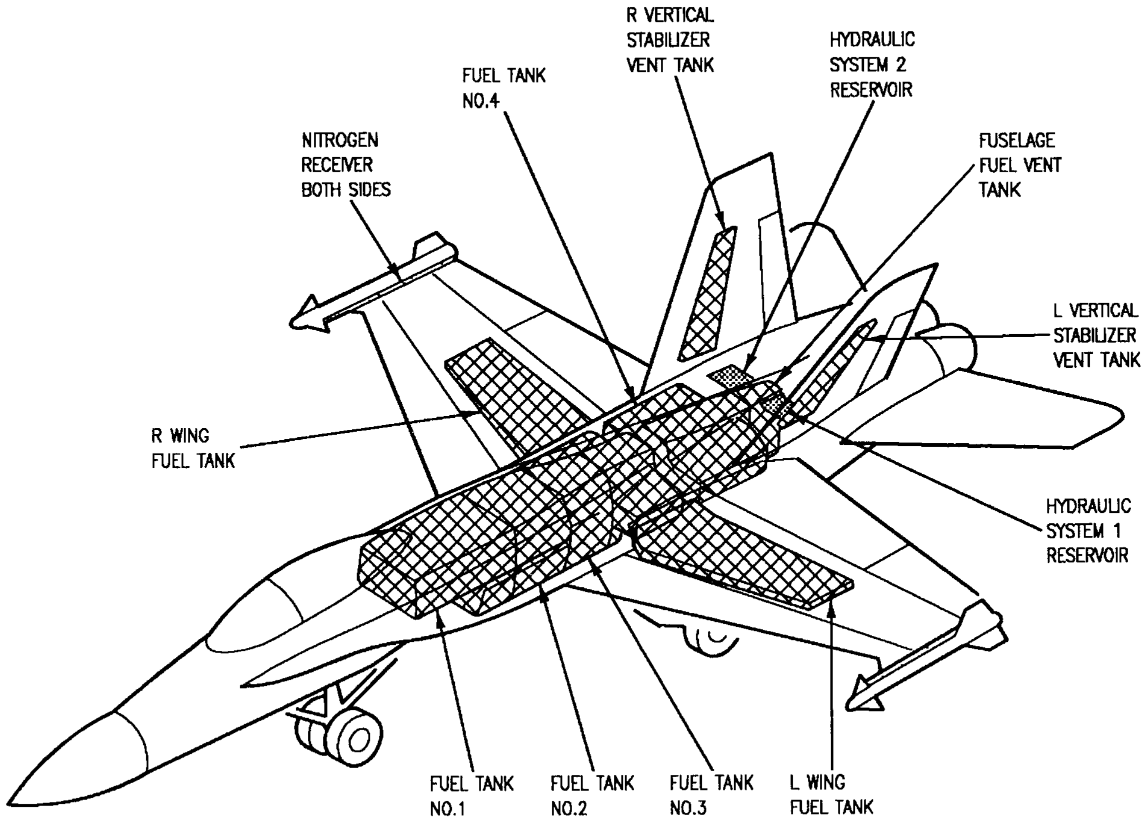

Figure 1. Flammable Liquids, Compressed Gases and Explosive Devices (Sheet 1).

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FIGURE 5. Example of a danger areas and precautionary measures work package - continued.

A1-F18AC-600-100 **011 01**
1 May 1997

ORGANIZATIONAL MAINTENANCE

DESCRIPTION

ADF SYSTEM

EFFECTIVITY: 161353 THRU 163782; ALSO 163985 THRU 164912 BEFORE F/A-18 AFC 185

This WP supersedes WP 011 01, dated 1 September 1993.

Reference Material

ADF System Locator	WP 012 00
ADF System Operation – Simplified Schematic	WP 013 00

1-1 **DESCRIPTION**

1-2 The description of the adf system is divided as listed below:

a. System Description
b. System Component
c. Related Systems
d. System Controls and Indicators

2-1 **SYSTEM DESCRIPTION**

2-2 The Direction Finder Set OA-8690()/ARD controls and indicators make up the automatic direction finder (adf) system. The adf system provides bearing to a station. The station is selected on vhf/uhf receiver-transmitter. The adf system sends bearing information to the mission computer system. The mission computer system uses adf information to position an adf bearing symbol on the HIS display. The bearing symbol position on the HIS display shows the bearing of the selected station in relation to aircraft position. The location of all system components is shown in figure 1.

3-1 **SYSTEM COMPONENT**

3-2 **DIRECTION FINDER SET OA-8697()/ARD.**

3-3 The direction finder operates in the 100 to 400 MHz frequency range. It has two sections. The antenna section receives and modulates rf signals. The audio processing section resolves the bearing of the adf audio received from vhf/uhf receiver-transmitter.

4-1 **RELATED SYSTEMS**

4-2 Related systems which interface with the adf system are:

1. VHF/UHF communication system
2. Mission computer systems

4-3 **VHF/UHF COMMUNICATION SYSTEM.** VHF/UHF receiver-transmitter receives the rf from the adf system. The detected adf audio is returned to the adf system to determine adf bearing. The antenna selector is an rf switching unit that connects the adf system to either one of the vhf/uhf receiver-transmitters. The antenna selector automatically switches the vhf/uhf receiver-transmitter to the comm system antennas when keyed for transmission.

4-4 **MISSION COMPUTER SYSTEM.** The mission computer system uses adf information to position the adf bearing symbol on the HIS display. The HIS display shows bearing of the selected station in relation to aircraft position.

5-1 **SYSTEM CONTROLS AND INDICATORS**

5-2 Operating controls and indicators are described in table 1. Cockpit displays are shown in table 2.

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FIGURE 6. Example of an aircraft system, subsystem, and component description work package.

A1-F18AC-600-100 **011 01**

Table 1. System Controls and Indicators

CONTROL/INDICATOR	FUNCTION
1. Electronic Equipment Control.	
a. ADF switch	
1	1. Connects direction finder to vhf/uhf receiver-transmitter no. 1. 2. When squelch is selected on electronic equipment control (equipment control) for vhf/uhf receiver-transmitter no. 1, automatically disables squelch. 3. Enables bandwidth control circuit in vhf/uhf receiver-transmitter no. 1. 4. Turns on power to direction finder when GND PWR control panel assembly 2 switch is set to B ON.
2	1. Connects direction finder to vhf/uhf receiver-transmitter no. 2. 2. When squelch is selected on equipment control for vhf/uhf receiver-transmitter no. 2, automatically disables squelch. 3. Enables bandwidth control circuit in vhf/uhf receiver-transmitter no. 2 4. Turns on power to direction finder when GND PWR control panel assembly 2 switch is set to B ON.
OFF	Turns off power to direction finder.
NOTE On F/A-18B 161354 thru 161360, COMM 1 or COMM 2 VOL controls on the equipment control and rear equipment control must be turned on in order for vhf/uhf receiver-transmitter equipment control comm option displays to appear.	
b. COMM 1 VOL control	Controls adf audio volume when direction finder interfaces vhf/uhf receiver-transmitter no. 1.
c. COMM 2 VOL control	Controls adf audio volume when direction finder interfaces vhf/uhf receiver-transmitter no. 2.
d. COMM 1 channel selector	Selects channel of station to which adf bearing is required when direction finder interfaces vhf/uhf receiver-transmitter no. 1.
e. COMM 2 channel selector	Selects channel of station to which adf bearing is required when direction finder interfaces vhf/uhf receiver-transmitter no. 2.

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FIGURE 6. Example of an aircraft system, subsystem, and component description work package - continued.

A1-F18AC-600-100 **011 01**

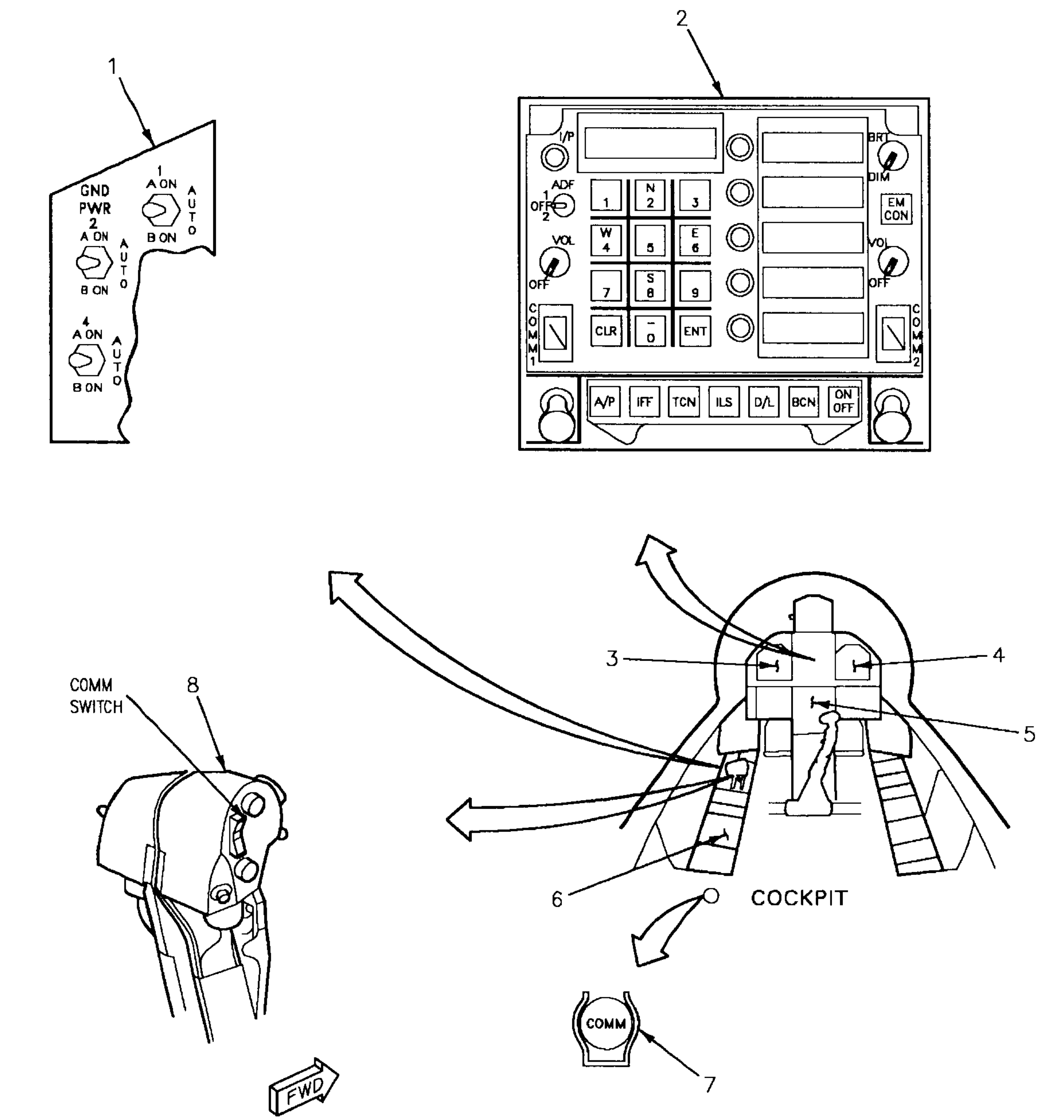

Figure 1. ADF System Locator (Sheet 1).

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FIGURE 6. Example of an aircraft system, subsystem, and component description work package - continued.

A1-F18AC-600-100 **011 01**

INDEX NO.	NOMENCLATURE	REF DES
1	GND PWR CONTROL PANEL ASSEMBLY	1A-H004
2	ELECTRIC EQUIPMENT CONTROL	79A-J006
3	LEFT DIGITAL DISPLAY INDICATOR	80A-H001
4	RIGHT DIGITAL DISPLAY INDICATOR	80A-J002
6	INTERCOMMUNICATION AMPLIFIER-CONTROL	76A-H009
7	COMM RECEPTACLE	76J-H016
8	RIGHT THROTTLE GRIP	52A-H048

Figure 1. ADF System Locator (Sheet 2).

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FIGURE 6. Example of an aircraft system, subsystem, and component description work package - continued.

NAVAIR 16-30USM449-5-50 **003 00**
1 July 1996

INTERMEDIATE MAINTENANCE

DESCRIPTION AND PRINCIPLES OF OPERATION

REFERENCE POWER SUPPLIES A2B4, A2B5

PART NUMBER 59822-40850-20

Reference Material

BIT 488-B Digital Programming Card Instruction Manual	NAVAIR 16-45-6126-16
IEEE-488 Standard Digital Interface for Programmable Instruction	IEEE-STD-488-1978
Model BOP 20-10M Bipolar Power Supply Instruction Manual	NAVAIR 16-45-6162-15

1-1 **INTRODUCTION**

1-2 This work package provides information necessary for proper maintenance of Reference Power Supplies A2B4 and A2B5. This information includes a description and principles of operation.

2-1 **DESCRIPTION**

2-2 Reference Power Supplies A2B4 and A2B5 are both located in Equipment Cabinet A2B. Reference Power Supply A2B4 provides the reference A high and low voltages, and Reference Power Supply A2B5 provides the reference B high and low voltages.

2-3 Each reference power supply consists of two identical bipolar operational (BOP) power supplies equipped with auxiliary digital programming cards and two identical switching power supplies mounted on a panel assembly.

2-4 Two BOP power supplies (PS1 and PS2) within each assembly provide the voltages that are used by the stimulus circuits within the Digital Test Station (DTS) to drive the unit under test (UUT). The BOP power supplies are programmable to provide a reference voltage between –20 and +20 vdc with a maximum voltage difference of 20 vdc.

2-5 Two switching power supplies (PS3 and PS4) within each reference power supply are used to provide a 5-volt signal in addition to the reference voltages produced by BOP power supplies PS1 and PS2.

2-6 Resistors R1 through R6 provide local sensing in the event that remote sensing is lost.

3-1 **PRINCIPLES OF OPERATION**

3-2 **BIPOLAR OPERATIONAL POWER SUPPLIES.** Figure 1 is a schematic diagram of Reference Power Supplies A2B4 and A2B5, and figure 2 is a block diagram of BOP power supplies PS1 and PS2 that are located within each assembly. Each BOP power supply consists of six internal power supplies: the –20 to +20 vdc programmable main dc power supply, +15-volt power supply, ±15-volt power supply, ±10-volt reference power supply, ±12-volt power supply, and a driver collector power supply.

3-3 AC power is supplied to the BOP power supplies through a three-conductor line cord connected to input power connector P201. The center contact of this connector is connected to the BOP power supply chassis to provide a safety ground. AC power applied to the BOP power supplies energizes the primary windings of the main and auxiliary transformers, which then produce dc source voltage on the secondary windings of the main auxiliary transformers.

3-4 The dual dc source voltages for the main dc power supply are obtained from the center-tapped secondary windings of the main transformer. They are then bridge-rectified and smoothed by capacitor filters before being applied to two groups of series/parallel connected NPN/PNP power transistors at the output power stage and made available at terminal block TB201 on the rear of the supply chassis.

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FIGURE 7. Example of a combination description and principles of operation work package.

The output power is driven by PNP/NPN power transistors with their base series resistors mounted onto a common heat sink. The secondary windings on the auxiliary transformer produce the dual dc voltages for the driver collector power supply. The driver collector power supply bridge-rectifies and filters the dc source voltages for the power transistor collectors.

3-5 BOP power supply PS1 and PS2 output power is interfaced to the DTS through connector J2; the sense lines for these power supplies interface through connector J5.

3-6 The BOP power supply front panel light emitting diode (LED) indicators and the digital integrated circuits for the voltage/current limiting circuitry are powered by the +15-volt supply. This is a single positive dc source originating from the secondary windings of the auxiliary transformer. The dc source is bridge-rectified and filtered through a capacitor to remove noise. The filtered voltage is then stabilized by a voltage regulator and filter capacitor before being applied to the digital components.

3-7 The linear integrated circuits within the BOP power supplies are powered by the +15-volt power supply, which is a dual dc source originating from the secondary windings of the auxiliary transformer. The dc source is bridge-rectified and filtered through capacitors to remove noise. The filtered voltages are then stabilized by a voltage regulator and filter capacitor before being applied to the linear components.

4-1 **SWITCHING POWER SUPPLY.** AC power is applied to the switching power supply (figure 3) via wires connected to ac input power connector J1. AC power is applied to a bridge rectifier via two suppression chokes. After the power is rectified and filtered, it is applied to a regulator, which is part of a pulse width modulation circuit that transmits on and off pulses to a transformer. These pulses energize the transformer, which, in turn, supplies power through several filters to a filter choke and two diodes (a series diode and a flyback diode) at the output. During the on time, power is supplied to the outputs through the series diode while the filter choke stores up energy. During the off time, the series diode turns off and the flyback diode conducts to supply power to the output from the filter choke.

4-2 Output power from power supplies PS3 and PS4 is interfaced to the DTS through connectors J3 and J4. The sense lines for these power supplies interface through connector J5

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FIGURE 7. Example of a combination description and principles of operation work package - continued.

A1-F404A-MMI-200 **004 00**

1 March 1993

INTERMEDIATE MAINTENANCE

GENERAL INFORMATION

OIL SYSTEM AND COMPONENTS DESCRIPTION

This WP supersedes WP 004 00, dated 1 March 1991.

1-1 INTRODUCTION

1-2 This work package (WP) contains a general description of the oil system components.

2-1 OIL SYSTEM

2-2 The engine oil system is self-contained and requires no external aircraft connections or inputs. The oil system consists of the following components:

1. Pressured Oil Tank
2. 10-Micron Nominal Filter
3. Oil Cooler (fuel/oil heat exchanger)
4. Lube and Scavenge Oil Pump
5. Three Main Sumps
6. Accessory Gearbox Sump
7. Magnetic Chip Detectors and Scavenge Screens (for each main sump and for the scavenge system)
8. Connecting Hoses and Tubing
9. Lube Oil Pressure Transmitter

2-3 Oil is circulated from the supply side of the pump through the accessory gearbox and oil cooler to a tee.

2-4 Flow from one side of the tee goes to the C-sump where it lubricates the No. 4 and No. 5 bearings. From the C-sump, part of the oil goes back to the gearbox sump by gravity and then returns to the tank. The balance of the oil from the C-sump returns to the tank through the scavenge side of the pump.

2-5 Flow from the other side of the tee goes to the A-sump, B-sump, and gearbox. The oil in the A-sump lubricates the No. 1 bearing and returns to the tank through the scavenge side of the pump.

2-6 The oil in the B-sump lubricates the No. 2 and No. 3 bearings and returns to the gearbox sump where it is combined with oil from the C-sump and is scavenged by the pump and returned to the tank. The oil in the gearbox lubricates all the gearbox bearings, gear teeth, and all splined couplings at the gearbox pads.

2-7 The oil tank is vented to the B-sump. The C-sump is vented to the B-sump between the high-pressure turbine shaft and fan drive shaft. The B-sump is vented overboard and the A-sump is not vented.

2-8 The oil system contains a pressure transmitter for monitoring the pressure differential between the filter inlet and the B-sump. Resulting pressure is transmitted to the cockpit for monitoring.

3-1 OIL TANK

3-2 The oil tank (figure 1) is an elongated spherical enclosure containing a fill tube, a vortex separator, and a pick-up chamber.

3-3 It also contains ports for system oil supply and scavenge return from the lube and scavenge oil pump, a vent connection to the B-sump, an oil level sight gage indicator, an oil level switch, an oil sampling valve, and a drain with magnetic chip detector plug.

3-4 Excessive air is removed by a deaerator inside the tank as scavenged oil is returned to the tank.

3-5 Deaerated oil enters an inner chamber of the tank which is connected to the inlet of the oil pump. The inner chamber is maintained full of oil by the scavenged oil plus required additional oil from the tank surrounding the inner chamber. The additional oil, if required, enters the inner chamber by scavenge oil driven eductors.

4-1 OIL FILTER

4-2 The oil system has a disposable 10-micron (nominal) filter. The filter assembly, a part of the lube and scavenge oil pump, has a pressure relief bypass valve which operates when pressure across the filter reaches 41-49 psid. The filter is designed to prevent discharge of filter contaminant through the bypass valve.

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FIGURE 8. Example of an engine system description work package.

A1-F404A-MMI-200 **004 00**

4-3 The filter housing has an automatic shutoff to prevent oil drainage when the bowl is removed. The filter housing is equipped with a differential pressure activated pop-out device.

4-4 The device provides visual warning of impending bypass with an extended red indicator when the pressure differential across the filter element reaches 22-35 psid. However, when engine oil is below 100°F (37.8°C), a lockout function prevents indicator pop-out. Once activated, the red indicator remains extended until manually reset with filter bowl inverted.

5-1 **OIL COOLER**

5-2 The oil cooler (figure 2) located on the outer bypass duct, consists of an aluminum shell and a cross-counterflow fuel-to-oil heat exchanger.

5-3 The cooler is a full-flow type with no provisions for temperature regulation. Engine fuel is warmed as it passes through the tubes, cooling the lubricating oil which flows around the tubes.

5-4 The variable exhaust nozzle (VEN) oil cooker is an integral part mechanically, although lubrication and VEN oil are separated functionally. Fuel flows in series, first through the lube oil cooler, and then through the VEN oil cooler.

6-1 **LUBE AND SCAVENGE OIL PUMP**

6-2 The lube and scavenge oil pump (figure 3) is a multi-element vane pump. The pump has one pressure element and five scavenge elements.

6-3 The pressure element supplies oil under pressure to the oil pressure transmitter and to the oil nozzles in the A-, B-, and C-sumps to lubricate the bearings. It also supplies oil to the gearbox to lubricate the gear train. The pump has a scavenge element for each sump and two scavenge elements for the gearbox sump area.

6-4 The pump also provides filtered oil to lubricate the drive spline located between the pump and the VEN power unit.

6-5 The pump is mounted on the forward left-hand pad of the accessory gearbox, and provides a mounting pad and drive for the VEN power unit.

6-6 A 10-micron nominal filter is contained in the pump, as is a relief valve set to crack at 200-240 psid and be fully open at 285 psid.

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FIGURE 8. Example of an engine system description work package - continued.

A1-F404A-MMI-200 **004 00**

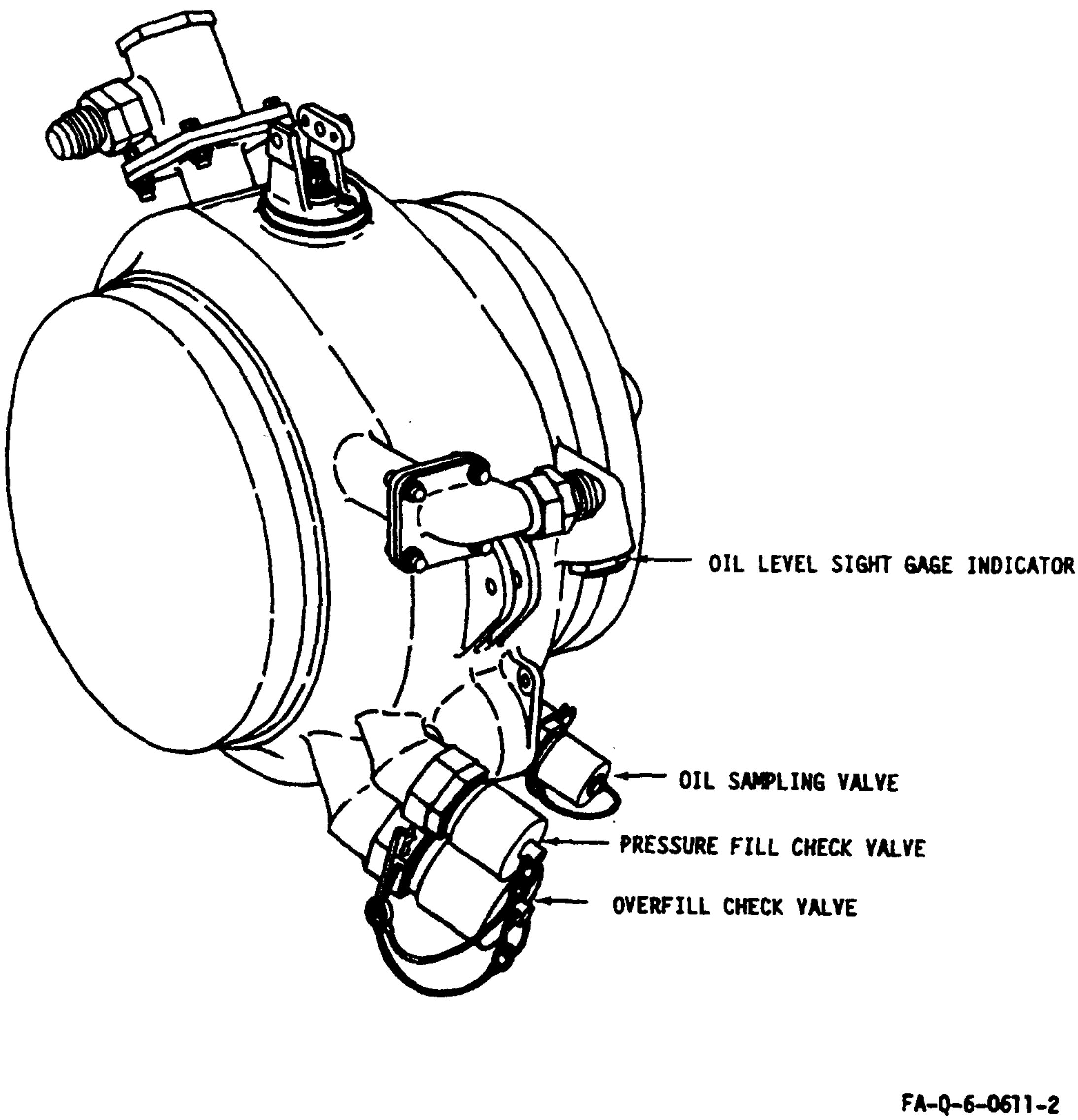

Figure 2. Oil Tank Description.

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FIGURE 8. Example of an engine system description work package - continued.

A1-F18AC-600-100 **011 01**

15 May 1997

ORGANIZATIONAL MAINTENANCE

PRINCIPLES OF OPERATION

EFFECTIVITY: 161353 THRU 163782; ALSO 163985 THRU 164912 BEFORE F/A-18 AFC 185

This WP supersedes WP 011 01, dated 1 September 1993.

Reference Material

ADF System Locator .... WP 012 00
ADF System Operation – Simplified Schematic .... WP 013 00

1-1 **OPERATION**

1-2 The operation of the adf system is divided as listed below:

1. Sequence of Operation
2. Functional Operation

2-1 **SEQUENCE OF OPERATION**

To start adf operation, apply aircraft electrical power. See table 1, GND PWR control panel assembly. On electronic equipment control (equipment control), set ADF switch 1 or 2 depending on which vhf/uhf receiver-transmitter is desired for adf operation. When adf 1 or 2 is selected, squelch is automatically deselected. Set the COMM 1 or COMM 2 VOL control to midposition and set the COMM 1 or COMM 2 channel selector to a channel for adf bearing. New adf frequencies can be entered using the equipment control. Refer to vhf/uhf communication system, sequence of operation, WP 003 00. On F/A-18B 161354 thru 161360, the COMM 1 or COMM 2 VOL controls on the equipment control and rear equipment control must be turned on for vhf/uhf receiver-transmitter equipment control comm option displays. To display the adf bearing marker (figure 1), turn on the Multipurpose Color Display IP-1535/A or Horizontal Indicator IP-1350/A. The adf bearing marker appears on the HSI display when the direction finder receives a signal.

3-1 **FUNCTIONAL OPERATION**

For simplified schematic, refer to figure 1. The adf system functional operation is divided into six functions:

1. Power
2. System Activation
3. ADF RF Signal Reception
4. Audio Signal Processing
5. Bearing Processing
6. Bearing Hold Processing

3-2 **POWER.** A synchro reference voltage (26vac, C) from no. 2 circuit breaker panel assembly is sent to the direction finder and to the control-converter. On 161353 thru 161359, the direction finder also receives 28vdc from no. 2 circuit breaker panel assembly. On 161360 and up, the direction finder also receives 28vdc from no. 4 circuit breaker panel assembly. This voltage is routed through the contacts of ground power relay no. 5, 1K-F057, to the direction finder. When 26vac, phase C and 28vdc voltage exist, the direction finder is ready for activation.

3-3 **SYSTEM ACTIVATION.** The adf system is activated by the adf on signal (ground). The ground is provided by setting the ADF switch to 1 or 2 on equipment control. Setting the ADF switch to 1 or 2 enables the 28vdc to the direction finder power supply and enables bandwidth control circuits in the vhf/uhf receiver-transmitter. It also provides adf select signals to the mission computer system and antenna selector and disables the squelch on the selected vhf/uhf receiver-transmitter.

3-4 The adf select signal to the antenna selector connects the direction finder to vhf/uhf receiver-transmitter no. 1 when adf switch is set to 1. Setting the adf switch to 2 connects the direction finder to vhf/uhf receiver-transmitter no. 2. The mission computer system uses the adf select signal to compute the adf bearing marker on the HSI display.

3-5 **ADF RF SIGNAL RECEPTION.** ADF system activation enables reception of rf signals by the adf antenna section of the direction finder. The rf is modulated at the rotation frequency of the antenna and sent to the antenna selector. From the antenna selector the rf is routed to the

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FIGURE 9. Example of an aircraft weapon system principles of operation work package.

vhf/uhf receiver-transmitter. The vhf/uhf receiver-transmitter, tuned to a station, detects the modulated rf and sends unattenuated audio and adf audio to the intercommunication amplifier-control.

3-6 **AUDIO SIGNAL PROCESSING.** The intercommunication amplifier-control processes the audio received from the vhf/uhf receiver-transmitter. The unattenuated audio is routed to the headsets (pilot, instructor, or ground crew) for an audio indication of adf signal reception. The adf audio is amplified and routed to the direction finder for resolving bearing information contained in the signal.

3-7 **BEARING PROCESSING.** Bearing information in the adf audio is resolved by the direction finder. The resolved adf bearing signal (bearing X, Y and Z) is sent to the control-converter for processing. The control-converter tests adf bearing validity and provides adf valid and adf bearing signals to the digital data computer no. 1

3-8 The digital computer receives the adf information from the control-converter and does the computation required to put the adf bearing marker on the HSI display. The adf bearing marker (figure 1) position on the display shows the bearing of the adf signal source in relation to the aircraft position.

3-9 **BEARING HOLD PROCESSING**. If during adf operation the pilot or instructor keys either vhf/uhf receiver-transmitter, a bearing hold signal is produced by the amplifier-control. The bearing hold signal is sent to the digital computer through the control-converter. The bearing hold signal is used by the digital computer and the control-converter to hold the previous (before keying) adf bearing symbol position on the HSI display. Unkeying of the vhf/uhf receiver-transmitter causes adf operation to revert to normal bearing processing.

FIGURE 9. Example of an aircraft weapon system principles of operation work package - continued.

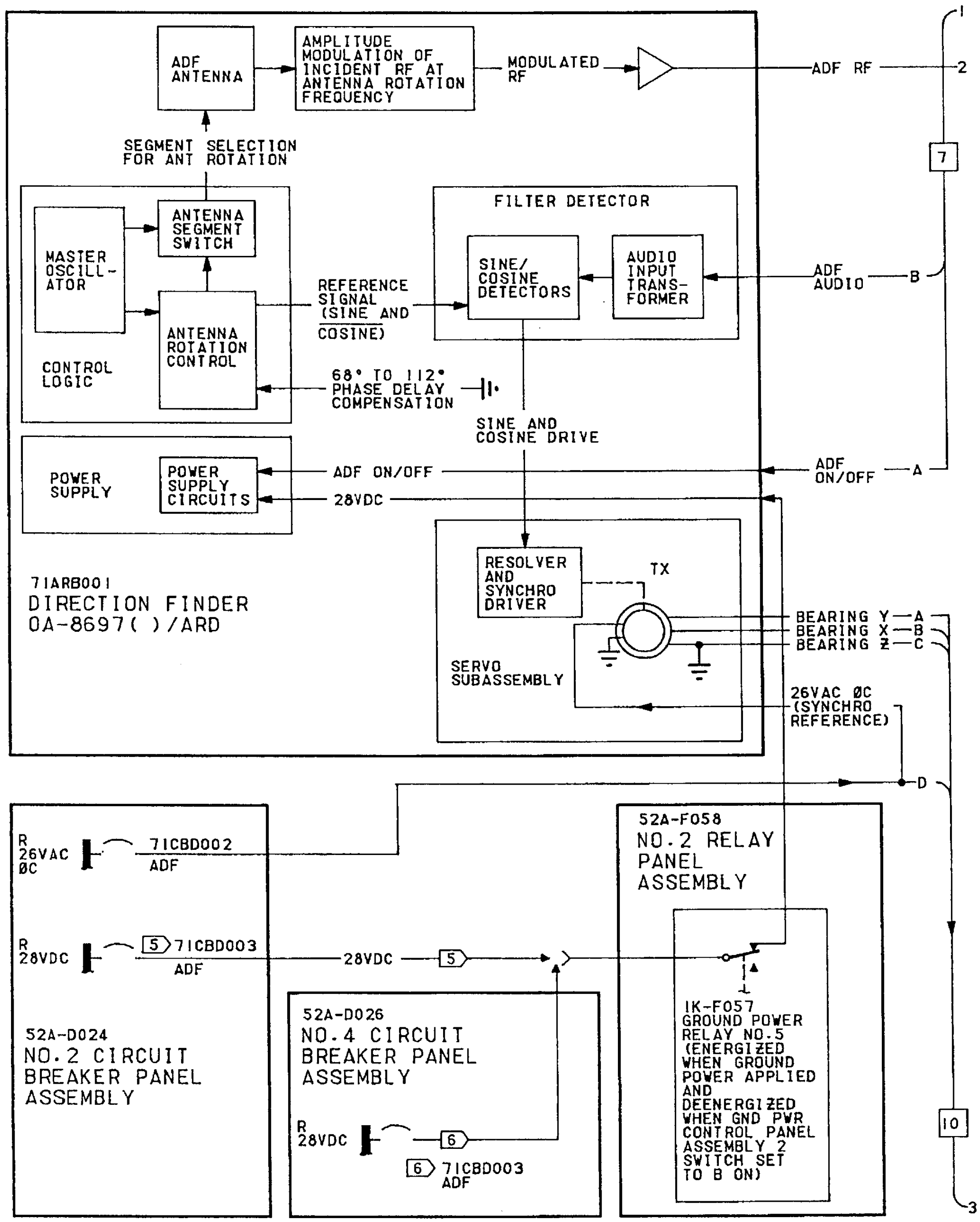


Figure 1. ADF System Simplified Schematic (Sheet 1)

3

FIGURE 9. Example of an aircraft weapon system principles of operation work package - continued.

NAVAIR 16-3OUSM449-7-2 **013 00**
1 July 1994

INTERMEDIATE MAINTENANCE

DIGITAL TEST STATION PRINCIPLES OF OPERATION

PART NUMBER 63603-43200-10

Reference Material

Digital Test Station Operation Instructions	WP 011 00
Digital Test Station Testing and Troubleshooting Procedures	WP 015 00
Programming manual, DETOL, AN/USM-449 (V) and AN/USM-449A (V) Automatic Test System (ATS), Volume I	NAVAIR 16-30USM449-3-1

1-1 **INTRODUCTION**

1-2 This work package contains the principles of operation for the Digital Test Station of the AN/USM-449A (V) 2 Automatic Test System (ATS). Equipment Cabinets A2A and A2B house the Digital Test Station (DTS). The information provided in this work package includes an overview and description of the Digital Test Station, basic DTS channel theory, a description of DTS hardware and software interactions, DTS built-in test, and block diagram descriptions of each DTS function.

2-1 **SYSTEM OVERVIEW**

2-2 The DTS is a digital stimulus and measurement device used to test digital units under test (UUTs). The DTS, housed in Equipment Cabinets A2A and A2B, contains 240 measurement or stimulus channels in non-expanded subsystem. The DTS is expandable to 480 channels by the addition of a second subsystem (B). NAVAIR 16-30USM449-7-3 contains a cable diagram that illustrates the cable assemblies comprising the DTS. The DTS is capable of automatic and manual testing of UUTs when interfaced to Rear Bay Assembly A2B2A1. This interface is accomplished by connecting a patchcard to a separate adapter by a series of cables. The UUT may contain shop replaceable assemblies (SRAs) or weapons replaceable assemblies (WRAs), which contain printed circuit assemblies, discrete logic circuits, or integrated circuits. The UUT test adapter design may be interface wiring or the UUT itself.

2-3 The DTS UUT interface consists of four fundamental building block elements. These building blocks are described in WP 011 00 and consist of UUT power supplies, output (data and clock stimulus), and input (measurement). The complexity of each of these fundamental building blocks varies with the user's testing requirements. One user requirement is that the power supply, clock, input, and output building blocks are manually controllable by the user. This, however, makes the basic DTs cumbersome, slow, and unmanageable in testing UUTs due to the variety of devices and specifications of UUTs. A more effective technique in testing utilizes a user-defined device that automatically controls the DTS as a function of the type of device being tested. This user-defined device is more commonly called a UUT test program. The test program is usually part of a test program set (TPS), which contains a test program instruction booklet, interface device, and a floppy disk of the test program.

2-4 The UUT test program is generally written in Abbreviated Test Language for All Systems (ATLAS) or Directly Executable Test Oriented Language (DETOL) by a programmer, compiled by a programmer, and executed by the operator. Each type of UUT has a test program that tests the UUT to specifications determined by the programmer rather than by an operator. The operator may then test the UUTs by utilizing the associated UUT test programs stored on the system computer hard disk drive. The level of complexity in the DTS increases with the addition of a system computer capable of generating, storing, and executing UUT programs. The system computer contains a software package (i.e., executive program) that enables communications with peripherals, interprets UUT program instructions, and communicates with the DTS during execution of UUT test program instructions. In addition, the level of hardware complexity within the DTS must increase to accommodate computer transfers to each programmable device.

1

FIGURE 10. Example of a support equipment principles of operation work package.

NAVAIR 16-3OUSM449-7-2 **013 00**

2-5 The DTS utilizes System Computer A1M6, which is part of the overall AN-USM-449A (V) ATS. The DTS communicates with the system computer via an IEEE-488 bus that is part of the input/output (I/O) function of the DTS. The elements of the basic DTS (i.e., power supplies, output, and input) are now automatically controlled over a range limited only by the internal hardware of the DTS. The UUT test requirements determine the quantity and complexity of the remaining hardware in the DTS. The following paragraphs summarize these requirements by providing a description of DTS capabilities required in testing UUTs. A summary of DTS capabilities is contained in Work Package 011 00. A description of the DTS built-in test (BIT) is contained in WP 015 00, and a more detailed description is contained in NAVAIR 16-45-6162-20.

2-6 **POWER SUPPLIES.** The DTS contains three UUT power supplies: one that provides a fixed 5-vdc supply and two that supply from 0 to 36 vdc for application to the UUT. These voltages are present on the center row (voltage pins) of the rear bay assembly. The four voltage pins labeled D20 (Power Supply Module A2A1PS1) are the voltage and sense lines for the fixed 5-vdc supply; the four voltage pins labeled D18 (Power Supply Module A2A2PS2) are for the programmable power supplies. The programmable power supplies are programmable from 0 to 36 vdc with a 10-bit digital word at a resolution of 0.1 vdc per bit.

3-1 **CHANNEL THEORY**

3-2 **STIMULUS AND MEASUREMENT CHANNELS.** The DTS has 240 input/output channels, each of which can be either a stimulus and/or measurement path. Function selection is the responsibility of the programmer. After the channels have been designated as either stimulus or measurement, the programmer assembles a test pattern for each channel. The resulting bit patterns of each channel are combined to form a set of test patterns called test vectors, which are used to stimulate and measure a digital UUT. The test vector has three main divisions: the stimulus pattern, the expected response pattern, and the mask pattern. These three patterns must be constructed in relation to one another on a vector-by-vector basis. For example, if a programmer is checking a simple two-input AND gate, the test vectors and channel designation may be shown on figure 3.

3-3 On figure 1, the mask pattern is not required because each set of stimuli results in only one possible UUT response unless the UUT is malfunctioning. The mask pattern is utilized in applications where several UUT outputs exist, the state of which is insignificant to certain sets of input stimulus vectors. When only one UUT response exists, the programmer applies a stimulus of logic 0 to channel 0 and logic 1 to channel 1. The response from the AND gate should be logic 0. The programmer selects channel 2 as the measurement return and establishes logic 0 as the correct response. Based on this programmed measured response, the DTS decides if the test is a go or no go.

2

FIGURE 10. Example of a support equipment principles of operation work package - continued.

AT-820FT-S78-010 **005 00**

15 January 1995

INTERMEDIATE MAINTENANCE

OPERATION INSTRUCTIONS

INTERMEDIATE AVIONICS TEST SET
PART NUMBERS 74D050000-1001, -1003, -1005, -1009, AND -1027

Reference Material

Intermediate Avionics Test Set AN/ASM-686 Aircraft Simulator AT-820FT-S78-030
Intermediate Avionics Test Set AN/ASM-686 Avionics Fault Tree Analyzer AT-820FT-S78-020

1-1 **OPERATING INSTRUCTIONS**

1-2 **INITIAL CONTROL SETTING**. Set controls in accordance with table 1.

Table 1. Initial Control Position

CONTROL	POSITION
INPUT POWER DRAWER	
115VAC 600 Hz MAIN POWER circuit breaker	OFF
115VAC 400 Hz AFTA POWER circuit breaker	OFF (74D053000-1001, -1003, -1005, AND -1009)
115VAC 400 Hz WRA POWER circuit breaker	OFF
28VDC WRA POWER circuit breaker	OFF
COCKPIT SIMLUATION DRAWER	
SYSTEM POWER switch	STANDBY
WRA POWER switch	OFF
WRA COOLING switch	OFF

1-3 **START-UP PROCEDURE**. To begin operation of IATS AIRISM, do the substeps below:

1. Lift switch cover and turn on the 115VAC 60 Hz MAIN POWER circuit breaker, located on the Input Power Drawer Assembly, to apply power to the system. The cooling fans should turn on.

NOTE

If testing does not require the use of AFTA, proceed to step 3.

2. On 74D053000-1001, -1003, -1005, and -1009, lift switch cover and turn on the 115VAC 400 Hz 3 Phase AFTA POWER circuit breaker, located on the Input Power Drawer Assembly, to apply power to the AFTA.

3. Lift switch cover on the 115VAC 400 Hz 3 Phase WRA POWER circuit breaker, located on the Input Power Drawer Assembly, to apply power to the UUT Interface Drawer for distribution to the WRA under test.

4. Lift switch cover and turn on the 28VDC WRA POWER circuit breaker, located on the Input Power Drawer Assembly, to apply power to the UUT Interface Drawer for distribution to the WRA under test.

5. On 74D053000-1001, wait for the 115VAC 400 Hz, and 28VDC WRA POWER MONITOR lamps to illuminate indicating power tolerance.

1

FIGURE 11. Example of an operating instructions work package.

AT-820FT-S78-010 **005 00**

6. On 74D053000-1003, -1005, -1009 and -1027 wait for the 115VAC 400 Hz, and 28VDC WRA POWER MONITOR lamps, located on both the AIRSIM and HALF RACK, to illuminate, indicating proper tolerance.

7. Apply system power by pressing the SYSTEM POWER switch, located on the Cockpit Simulation Drawer, until the switch illuminates OPERATE.

8. Apply WRA power by pressing the WRA POWER switch, located on the Cockpit Simulation Drawer, until the switch illuminates ON.

9. If required, apply WRA cooling power by pressing the WRA COOLING switch, located on the Cockpit Simulation Drawer, until the switch illuminates ON.

10. On 74D053000-1001, after system power is applied, the operating system retrieves the proper program and the main menu appears indicating that the AIRSIM is ready for use. Refer to tables 2 thru 4 for startup, tables 7 and 8 for EBIT and operating menu readouts.

11. On 74D053000-1003, -1005, -1009 and -1027 after system power is applied, the operating system retrieves the proper program and asks the user if the Half Rack is required.

    a. If the Half Rack is required, or the operator does not answer the question within a specified period of time, the operating system will initialize the Half Rack and load the appropriate programs into the Half Rack computer.

    b. If the user answers no, then the main menu appears indicating that the AIRSIM is ready for use. Refer to tables 2 thru 8 for startup and operating menu readouts.

1-4 **BUILT-IN TEST**

NOTE

Any text which is underlined on the plasma display may be selected and indicates that further instructions will follow.

1. Select the first page (PG 1) from the main menu.

2. Select EBIT from the page 1 menu.

NOTE

The UTILITIES menu can also be selected to run certain disk and setup programs prior to WRA testing.

3. Select the desired EBIT test on the page 2 menu. Messages and results will be displayed while the test is in progress. Refer to tables 6, 7 and 8 for screen layout.

1-5 **SHUTDOWN PROCEDURE**. After testing is complete or prior to disconnecting IATS AIRSIM from facility power, do the following:

1. Turn off WRA power by pressing WRA POWER switch, located on the Cockpit Simulation Drawer, until the switch illuminates OFF.

2. If operating, turn off WRA cooling by pressing WRA COOLING switch, located on the Cockpit Simulation Drawer, until the switch illuminates OFF.

2

FIGURE 11. Example of an operating instructions work package - continued.

AT-820FT-S78-010 **005 00**

3. Turn off system power by pressing SYSTEM POWER switch, located on the Cockpit Simulation Drawer, until the switch illuminates STANDBY.

4. Turn off the 28VDC WRA POWER circuit breaker, located on the Input Power Drawer, by lowering the switch guard.

5. Turn off the 115VAC 400 Hz 3 Phase WRA POWER circuit breaker, located on the Input Power Drawer, by lowering the switch guard.

6. On 74D053000-1001, -1003, -1005, and -1009 if AFTA power is on, turn off the 115VAC 400 Hz 3 Phase AFTA POWER circuit breaker, located on the Input Power Drawer, by lowering the switch guard.

7. Turn off the 115VAC 60 Hz MAIN POWER circuit breaker, located on the Input Power Drawer, to remove all power from the IATS AIRSIM.

1-6 EMERGENCY SHUTDOWN PROCEDURE

1. On 74D053000-1001, -1003, -1005, and -1009, if the IATS must be shut down during normal operation to prevent damage to equipment or personnel, the 115VAC MAIN POWER circuit breaker and the 115VAC AFTA POWER circuit breaker, located on the Input Power Drawer, may be shut off by lowering the switch guard. Turn off all other circuit breakers before reapplying 115VA MAIN POWER.

2. On 74D053000-1027, if the IATS must be shut down during normal operation to prevent damage to equipment or personnel, the EMERGENCY STOP button on the Cockpit Simulation I drawer may be pressed. The circuit breakers will automatically trip to the off position.

Table 2. Spin Up Menu

	AIRSIM BOOT PROM Vx.xx 2	
	COPYRIGHT <C> xxxx 3	
	MCDONNEL DOUGLAS CORP.	
	ALL RIGHTS RESERVED	
(TIME) (DATE)	<WAITING FOR DISK TO SPIN UP>	ABORT

3

FIGURE 11. Example of an operating instructions work package - continued.

NAVAIR 01-S3AAA-2-6-3 **007 00**
30 June 1988

ORGANIZATIONAL MAINTENANCE

OPERATION DATA

SOFTWARE LOADING

S-3A

Reference Material

General Aircraft Information .... NAVAIR 01-S3AAA-2-1
Electrical Power Application .... WP 007 00

1-1 **INTRODUCTION**

1-2 This WP provides the maintenance technician with the necessary information to initialize, load, and execute the System Test Program. Included in this work package is the PRE-POWER check list, avionics circuit breakers by system, TP load fault procedures, and pertinent safety precautions. Also tables and figures are provided where applicable.

2-1 **POWER INITIALIZATION**

2-2 Perform PRE-POWER check outlined in table 1-1 upon entering aircraft.

WARNING

Do not connect external power before ensuring that sonobuoy safety switch is in open position, or during fueling, defueling, on-loading, or off-loading weapons. Before turning on electrical power, ensure that all electrical access panels are closed and personnel have been alerted that electrical power will be turned on.

CAUTION

Ground air conditioning must be applied (NAVAIR 01-S3AAA-2-1) if internal avionics is operated for longer than:

5 Min:	75 degrees without direct sun 71 degrees with
1 Min:	78 degrees without direct sun 74 degrees with
Continuous:	68 degrees without direct sun 64 degrees with

If temperature can be measured in area between ADP and GPDC, the permissible temperature is 80 degrees (68 degrees ambient + 12 degrees rise in internal bay = 80 degrees).

1. Turn on electrical power (NAVAIR 01-S3AAA-2-1).
2. Ensure that appropriate circuit breakers on left and right circuit breaker panels are closed for tests to be run. Table 2 lists circuit breakers by system. Figures 1 through 4 show location of the circuit breakers.
3. On POWER CONTROL PANEL verify COMPUTER GROUP switch is OFF.
4. Insert a TTC into DMTU and perform Avionics Initialization (table 3) for tests to be run.

1

FIGURE 12. Example of a software loading work package.

NAVAIR 01-S3AAA-2-6-3 **007 00**

3-1 **STP PROGRAM LOAD PROCEDURES**

3-2 At TACCO station POWER CONTROL PANEL, momentarily operate COMPUTER RESTART switch to ON. When "SELECTION LOAD" is displayed, the following options are available:

SEL PROGRAM
1. OPERATIONAL
2. OPERATIONAL CONT
3. IFSTP
4. SYSTEM TEST
5. GPDC DIAG RECYCLE
6. TAPE COPY

NOTE

To ensure GPDC has attempted all possible load paths, wait 5 minutes after initiating RESTART for SELECTION LOAD cue before reinitiating RESTART switch. If SELECTION LOAD is not displayed within 5 minutes, refer to Paragraph 6-8 (NO SELECTION LOAD).

1. Select SYSTEM TEST by depressing numeric key 4 and ENTER on TACCO, SENSO, or Copilot INCOS. The following cue will be displayed:

SELECTION LOAD
GPDC DIAG LOAD
DISPLAYS GOING BLANK
FOR UP TO 250 SEC

NOTE

If an STP Load failure occurs or the GPDC Diagnostic fails, record the fault isolation data and refer to paragraph 6-10 or 6-12 for verification and possible work around.

2. After completion of GPDC Diagnostics, the Acoustic Data Processor (ADP) Program Load and Verification (PL+V) subtest initiated. The following cue is displayed:

ADP PROGRAM LOAD AND
VERIFICATION IN PROGRESS

6-1 **TRANSMISSION ERRORS**

6-2 A transmission error occurs when the GPDC receives an illegal response from a peripheral. The total count of transmission errors is displayed at completion of a SAT. An excessive number is indicative of an impending inability to communicate properly with the General Purpose Digital Computer (GPDC).

2

FIGURE 12. Example of a software loading work package - continued.

A1-F18AE-FRM-000 **003 00**
1 May 1997

ORGANIZATIONAL MAINTENANCE

FAULT REPORTING MANUAL

NOSE WHEELWELL DDI MAINTENANCE CODE LISTING

Record of Applicable Technical Directives

TD Type/ No.	TD Date	Title and ECP/RAMEC No.	Date Inc.	Remarks
F/A-18 AFC-126		Addition of (DFIRS) Deployable Flight Incident Recorder Set (ECP 321R1C1)	1 Jun 92	ECP Coverage Only
FA-18 AFC-185		Incorporation of Havequick Singars (ECP MDA-F/A18-0292R1A3R2)	15 Sep 94	ECP Coverage Only

1-1 **INTRODUCTION**

1-2 All built-in test (BIT) maintenance codes are identified in this work package (table 1). A description, the related system, and the recommended maintenance action are provided for each maintenance code.

1-3 When flag note and/or hexagonal box instructions are associated with a maintenance code, the instructions are to be done before the recommended maintenance action.

1-4 Letters in the code column identify unique requirements for setting some codes:

1. M – Maintenance BIT
2. I – Initiated BIT
3. P – Periodic BIT
4. A – Weight Off Wheels
5. G – Weight On Wheels
6. F – Fluids Test

1-5 Some maintenance codes have entries in the Possible Related Indications column. These can be fault indications provided by BIT or operator observations, depending on the type of failure. The possible related indications are considered corrected when the maintenance codes are cleared. Clearing of maintenance codes is done after corrective action or when corrective action is to ignore the maintenance code.

1-6 All caution line indications occur with LH advisory and threat warning indicator panel MASTER CAUTION light on and master caution audio. See descriptions of cautions (WP 004 00).

2-1 **MULTIPLE AVIONIC MUX BUS FAIL TROUBLESHOOTING**

NOTE

Before troubleshooting any Digital Data Computer 1 and/or 2 cautions, make sure Electrical Equipment Rack (on 163427 thru 164279); also 164627 thru 164897 before F/A-18 AFC 11; MT-4955/APG-65 (A1-F18AC-742-300); on 164898 and up; also 164627 thru 164897 after F/A-18 AFC 211; MT-6809/APG-73 (A1-F18AH-742-300) is not disconnected or removed from the aircraft.

1

FIGURE 13. Example of a maintenance code listing work package.

Avionic Mux Bus fail code set with no built-in test MUX FAIL displayed indicates that the mission computer is able to communicate with the system terminal on only one avionic mux bus (X or Y). Normal system operation may continue, but mux communication has lost one-half of its redundancy. Loss of the remaining mux bus may result in MUX FAIL and the operational failure or degradation of the system.

2-2 When multiple avionic mux bus fail maintenance codes (001 thru 030, and 062) exist, malfunction can be caused by defective avionic mux bus wiring. Using combinations of maintenance codes, tables 2 and 3 provide maintenance actions for isolation of defective avionic mux bus 1x/1y or 2x/2y wiring. Multiple failures on mux bus 4x/4y, 5x/5y, or 6x/6y should be fault isolated by analysis of the failure pattern/order using mux bus schematics of the A1-F18A ()-WDM-000 or A1-F18AE-741-500.

2-3 **AVIONIC MUX BUS 1 FAILS.** Table 2 lists the avionic mux bus fail maintenance codes for the components listed below:

1. Air Data Computer CP-1334A/A (001)
2. On 163427 thru 164980, Left Digital Display Indicator (002)
3. Control-Converter C-10382/A (004)
4. Armament Computer CP-1342/AVQ-9(V) (006)
5. Roll-Pitch Yaw Computer CP-1330/ASW-44 (FCCA) (014)
6. Roll-Pitch-Yaw Computer
7. Command Launch Computer CP-1001A/AWG (017)
8. VHF/UHF Receiver-Transmitter No. 1 (018)
9. Digital Data Computer No. 1 (028)
10. Signal Data Computer CP-1726/ASQ-194 (030).

NOTE

Avionics mux terminals must be installed and turned on to be tested for mux bux failure. When using tables to analyze mux failures, terminals not installed or not turned on should be considered in determining multiple failure pattern.

2-4 When more than one avionic mux bus 1 fail maintenance code exists, do the maintenance action in table 2 for that combination of codes. When an avionic mux bus fail maintenance code combination exists that is not listed in table 2, do the maintenance action prescribed in table 1 for each maintenance code.

2

FIGURE 13. Example of a maintenance code listing work package - continued.

A1-F18AE-FRM-000 **003 00**

Table 1. Maintenance Codes

CODE	MALFUNCTION (SYSTEM) MAINTENANCE ACTION	POSSIBLE RELATED INDICATIONS
000	Test value.	

NOTE

Avionic Mux Bus fail code set with no built-in test MUX FAIL displayed indicates that the mission computer is able to communicate with the system terminal on only one avionic mux bus (X or Y). Normal system operation may continue, but mux communication has lost one half of its redundancy and loss of the remaining mux bus will result in MUX FAIL and the operational failure or degradation of the system.

CODE	MALFUNCTION (SYSTEM) MAINTENANCE ACTION	POSSIBLE RELATED INDICATIONS
001	[2] Air Data Computer Avionic Mux Bus lx/ly fail (Air Data Computer System) Replace Air Data Computer CP – 1334A/A, (A1-F18AC-560-300)	Digital Display Indicator ADV-BIT ADC BIT status message – MUX FAIL

NOTE

Avionic Mux Bus fail code set with no built-in test MUX FAIL displayed indicates that the mission computer is able to communicate with the system terminal on only one avionic mux bus (X or Y). Normal system operation may continue, but mux communication has lost one-half of its redundancy and loss of the remaining mux bus will result in MUX FAIL and the operational failure or degradation of the system.

CODE	MALFUNCTION (SYSTEM) MAINTENANCE ACTION	POSSIBLE RELATED INDICATIONS
002	[2] [21] Left Digital Display Indicator Avionic Mux Bus 1x/1y fail (multipurpose Display Group) [7] Replace left Digital Display Indicator IP-1317 ( ). (A1-F18AC-745-300) [8] Replace left Digital Indicator IP-1556 ( ). If left Digital Display Indicator previously replaced, [7] do table 3, A1-F18AC-745-200 [8] do table 3, A1-F18AG-745-200.	Digital Display Indicator ADV-BIT LDDI BIT status message – MUX FAIL Left Digital Display Indicator STANDBY flashing
	[19] [22] Left Digital Display Indicator Avionic Mux Bus 6x/6y fail (Multipurpose Display Group) Replace left Digital Display Indicator IP-1556 ( ) If left Digital Display previously replaced, do table 3, A1-F18AG-745-200.	Digital Display Indicator ADV – BIT LDDI BIT status message – MUX FAIL Left Digital Display Indicator STANDBY flashing

3

FIGURE 13. Example of a maintenance code listing work package - continued.

A1-F18AC-FRM-000 **004 00**

ORGANIZATIONAL MAINTENANCE

FAULT REPORTING MANUAL

WARNING, CAUTION, ADVISORY, AND FAULT INDICATIONS

1-1 **INTRODUCTION**

1-2 This work package contains warning, caution, advisory, fault indicator locations, and voice alert messages. It also lists failure indications and describes the logic which causes the indication.

1-3 Table 1 describes voice alert messages sent to the pilot's headset for critical aircraft cautions and warnings. In addition to the voice alert messages, references are provided to other caution/warning indications related to the voice alerts.

1-4 Figures 1 and 2 are master locators.

1-5 Tables 2 through 16 and figures 29 and 30 describe fault indicators, list the related Digital Display Indicator ID-2150/ASM-612 maintenance (maint) codes, and provide the maintenance actions for the fault indicators. When a fault indicator and the related maintenance code exist, do the maintenance action prescribed. When a fault indicator exists and the related maintenance code does not exist, reset and ignore the fault indicator.

1-6 Tables 17 to 27 and figure 29 describe indicator panel indications and miscellaneous cockpit indications and provide schematic references for troubleshooting aid.

1-7 Figure 27 describes cautions and advisories which appear on the cockpit digital display indicators. In addition to the descriptions, reference codes, schematic references, and troubleshooting references, maintenance actions are provided. Reference codes are provided with each caution and advisory for entry points to operational flight program logic diagrams (A1-F18AC-OLD-000). The schematic references are listed to provide the maintenance technician with a troubleshooting aid. Troubleshooting references or specific maintenance actions are listed to aid in repairing the malfunction.

Table 1. Voice Alert Messages

VOICE ALERT MESSAGE	DESCRIPTION
NOTE Intercommunication and Audio System Functional Schematic (A1-F18AC-600-500) may be used as an aid in troubleshooting if required.	
<u>WARNINGS</u> "Altitude, Altitude"	Indicates aircraft radar altitude below index setting (index 1, fig 21) on Height Indicator ID-2163/A (fig 21) or aircraft barometric altitude is below setting entered by way of Electronic Equipment Control C-10380/ASQ (UFC). Voice alert set when low altitude warning light (index 3, fig 21) on for radar altitude or when aircraft is below barometric altitude setting (WARN ALT, WP 009 00), fig. 1).
"Engine Fire Left, Engine Fire Left"	Indicates fire in left engine/AMAD bay. Voice alert set when FIRE (index 1, fig 17) indicator on.

1

FIGURE 14. <u>Example of a fault indications work package</u>.

A1-F18AC-FRM-000 **004 00**

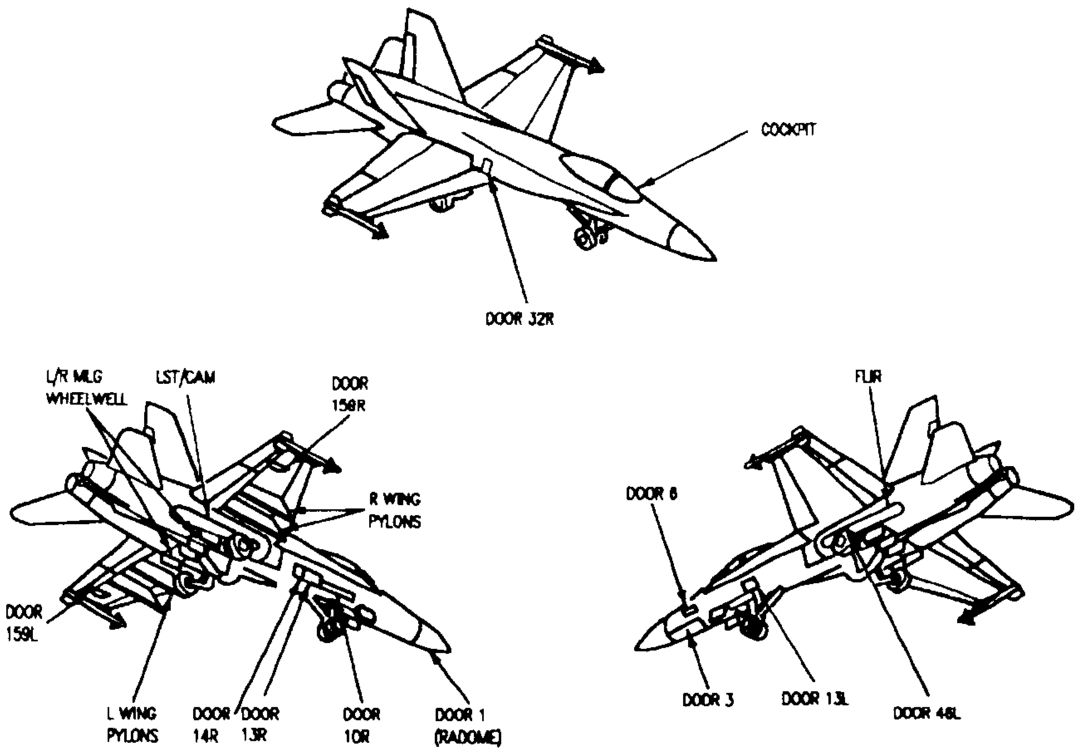
Table 2. Cockpit WRA Fault Indicators

INDEX	MALFUNCTION	RELATED MAINT. CODE	MAINTENANCE ACTION
1	Head-Up Display AN/AVQ-28 fault indicator latched (black and white)	098	Replace Head-Up Display Unit AN/AVQ-28 (A1-F18AC-745-300)
2	Right Digital Display Indicator fault indicator latched (black and white)	096	Replace Right Digital Display Indicator IP-1317/A (A1-F18AC-745-300).
3	Horizontal Indicator IP-1350/A fault indicator latched (black and white)	097	Replace Horizontal Indicator IP-1350/A (A1-F18AC-745-300).
4	Left Digital Display Indicator fault indicator latched (black and white)	095	Replace Left Digital Display Indicator (A1-F19AC-745-300).
5	FUEL QTY Indicator, ID fault indicator latched (yellow)	-	Normal indication with electrical power off Do table 2 (A1-F18AC-460-).
6	Left DCDR on	-	Replace Left Outboard Wing Pylon Encoder-Decoder Power Supply KY-842/AWB-3(V) (A1-F18AC-740,300)
	Right DCDR on	-	Replace Right Outboard Wing Pylon Encodes Decoder Power Supply KY-842/AWB-3(V) (A1-F18AC-740-300)
	Left or right CONTR on	-	Replace Control-Monitor C-10295/AWB-3(V).
7	Intercommunication Amplifier-Control AM-6979/A fault indicator latched (black and white).	146	Replace Intercommunication Amplifier-Control AM-6979/A (A1-F18AC-600-300).
8	Rear Left Digital Display Indicator IP-1318() fault indicator latched (black and white)	099	Replace Rear Left Digital Display Indicator IP-1318 ( ) (A1-F18AC-745-300).
9	Rear Right Digital Display Indicator IP-1318 ( ) fault indicator latched (black and white)	100	Replace Rear Right Digital Display Indicator IP-1318 ( ) (A1-F18AC-745-300).
10	Rear Center Digital Display Indicator IP-1318 () fault indicator latched (black and white)	101	Replace Rear Center Digital Display Indicator IP-1318 ( ) (A1-F18AC-745-300).

2

FIGURE 14. Example of a fault indications work package - continued.

A1-F18AC-FRM-000 **004 00**



	FAULT INDICATORS LOCATIONS	FIGURE NO.
	COCKPIT	2
	DOOR 1	3
	DOOR 3	4
	DOOR 6	5
	DOOR 1 DR	6
	DOOR 13L	7
	DOOR 13R	8
	DOOR 14R	9
	DOOR 32N	10
	DOOR 46L	11
1	DOOR 159L/R	12
	NOSE WHEELWELL	13
1	L/R MLG WHEELWELL	14
1	L/R WING PYLONS	15
	REAR COCKPIT	2
	LST/CAM	27

LEGEND

1 161353 THRU 161987

Figure 1. Fault Indicators Location.

3

FIGURE 14. Example of a fault indications work package - continued.

A1-F18AC-FRM-000 **004 00**

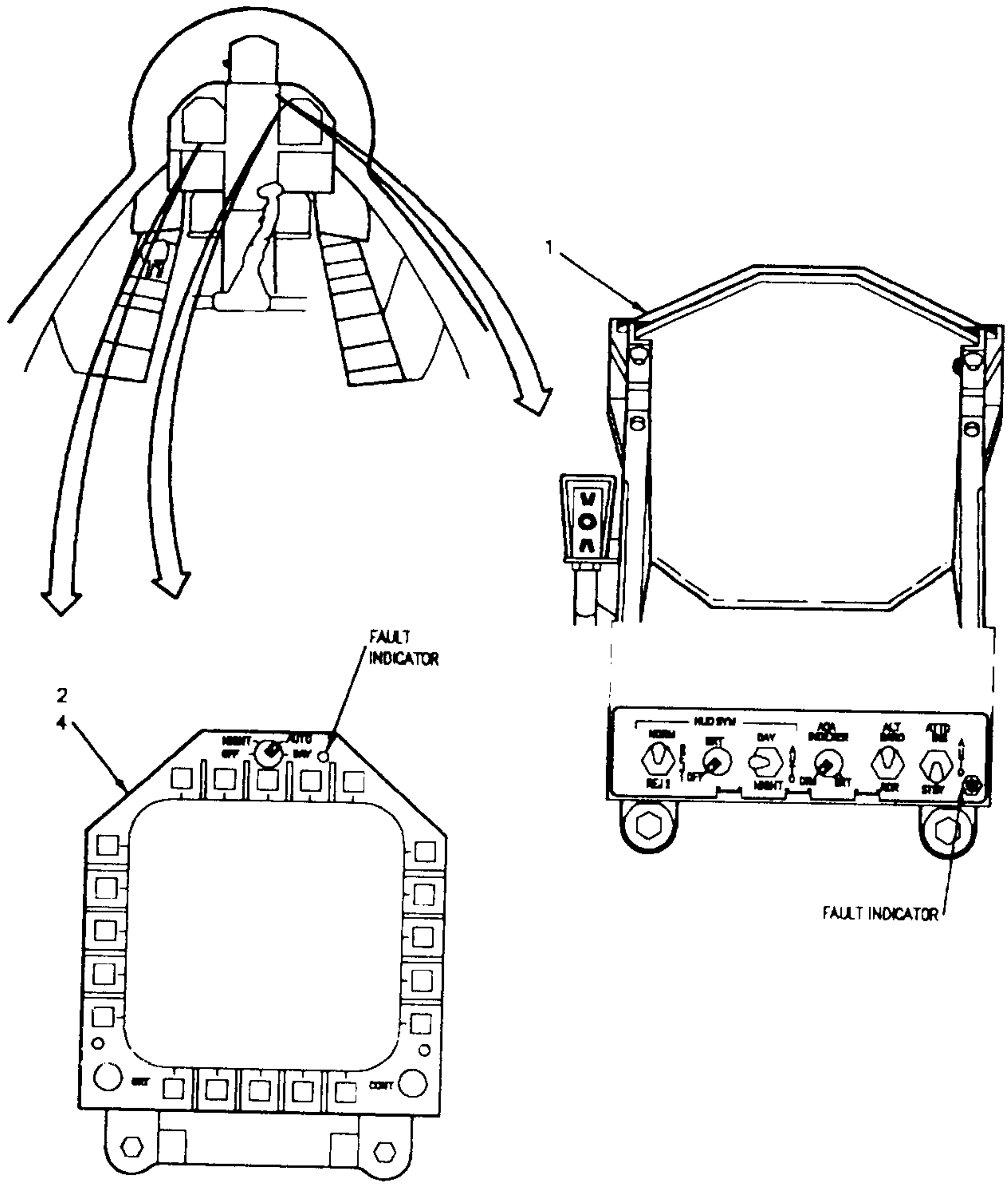


Figure 3. Cockpit WRA Fault Indicators (Sheet 1)

4

FIGURE 14. Example of a fault indications work package - continued.

A1-F18AE-FRM-000 **005 00**
1 May 1997

ORGANIZATIONAL MAINTENANCE

FAULT REPORTING MANUAL

FAULT DESCRIPTOR

Record of Applicable Technical Directives

TD Type/ No.	TD Date	Title and ECP/ RAMEC No.	Date Inc.	Remarks
F/A-18 AFC-126		Addition of (DFIRS) Deployable Flight Incident Recorder Set (ECP 321R1C1)	1 Jun 92	ECP Coverage Only
F/A-18 AFC-185		Incorporation of Have Quick Singars (ECP MDA-F/A18-0292R1A3R2)	15 Sep 94	ECP Coverage Only
F/A-18 AFC-211		AN/APG-65, Replacement with AN/APG -73 (ECP MDA-F/A-18-00508)	1 Dec 95	ECP Coverage Only

1-1 **INTRODUCTION**

1-2 This work package contains descriptions of reported malfunctions and related maintenance codes listed by system. The action to take for each fault descriptor is listed along with other data pertinent to that descriptor. Faults are listed only when no correlating maintenance codes exist. The maintenance codes listed by system may be used as an aid in relating reported malfunctions to maintenance codes. When a maintenance code and reported malfunction exist for a system or subsystem, perform the maintenance action for the maintenance code(s) (WP 003 00) first.

1-3 When a fault descriptor does not exist or the Maintenance Action column directs the user back to a functional test, do Beyond BIT Troubleshooting (WP 002 01).

Table 1. Lighting System

FAULT DESCRIPTION	MAINTENANCE ACTION
Cockpit instrument lights failure	Do Cockpit Instrument Lights Test (A-1F18AC-440-200).
Cockpit console lights failure	Do cockpit Console Lights Test (A1-F18AC-400-200).
Cockpit utility and floodlights failure	Do cockpit Utility and Floodlights Test (A1-F18AC-240-200).
Engine instrument floodlight failure	Do APU Performance Test (A1-F18AC-240-200).
Cockpit warning/caution advisory lights failure	Do cockpit Warning/Caution/Advisory Lighting System Test (A1-F18AC-440-200).
Position lights failure	Do Position Lights Test (A1-F18AC-440-200).
Formation lights failure	Do Formation Lights Test (A1-F18AC-440-200).

1

FIGURE 15. Example of a fault descriptor work package.

A1-F18AE-FRM-000 **005 00**

Table 1. Lighting System (Cont)

FAULT DESCRIPTION	MAINTENANCE ACTION
Anti-collision (strobe) lights failure	Do Anti-Collision (Strobe) Lights Test (A1-F18AC-440-200).
Landing/taxi light assembly failure	Do Landing/Taxi Light Assembly Test (A1-F18AC-440-200).
On F/A-18D, rear cockpit instrument lights failure	Do Rear Cockpit Instrument Lights Test (A1-F19AC-440-200).
On F/A-18D, rear cockpit console lights failure	Do Rear Cockpit Console Lights Test (A1-F18AC-440-200).
On F/A-18D, rear cockpit utility and floodlights failure	Do Rear Cockpit Utility and Floodlights Test (A1-F18AC-440.200).

2

FIGURE 15. Example of a fault descriptor work package - continued.

A1-F18AE-FRM-000 **007 00**

1 May 1997

ORGANIZATIONAL MAINTENANCE

FAULT REPORTING MANUAL

HUD DISPLAY SYMBOLOGY

Reference Material

Fault Reporting Manual (Confidential) .... A1-F18AC-FRM-101/(C)

Record of Applicable Technical Directives

TD Type/ No.	TD Date	Title and ECP/ RAMEC No.	Date Inc.	Remarks
F/A-18 AFC-211		AN/APG-65, Replacement with AN/ APG-73 (ECP MDA –F/A-18-00508)	1 Dec 95	ECP Coverage Only

1-1 **INTRODUCTION**

1-2 This work package contains illustrations and descriptions (table 1) of the display elements common to HUD displays. The illustrations are not meant to represent typical displays, but to provide general appearance and positioning of the elements which make up HUD displays. The descriptions may contain schematic references which show the development of the display elements.

Table 1. HUD Display Symbology Descriptions

INDEX NO.	DISPLAY ELEMENT (REF CODE)	DESCRIPTION
1	Heading	Magnetic heading displayed when valid and indicated on moving 30° scale. Moving scale provides trend information during turns. Not displayed when HUD REJ 2 selected. (Navigation Attitude and Heading Functional Schematic, A1-F18AC-730-500).
2	Data Link/WYPT/ Oap Command Heading	1. The DL command heading symbol is displayed in vector mode when vector data is valid, command heading is valid, and heading is displayed. (Vector Mode Coupled Heading Functional Schematic, A1-F18AC-630-510/(C). 2. The waypoint/offset aimpoint command heading is displayed when WYPT or OAP steering is selected. Provides steering to the selected WYPT/OAP. When a target or OAP has been designated, symbol is replaced by diamond (Bombing/navigation Functional Schematic, A1-F18AC-730-500).
3	Altitude	1. With ALT switch in BARO, barometric altitude is displayed in a box when valid (Air Date Computer System Functional Schematic, A1-F18AC-560-500). 2. With ALT switch in RDR, radar altitude is displayed in a box and identified by an R next to the box. When RDR selected but not valid, barometric altitude is displayed with a flashing B replacing the R.

1

FIGURE 16. Example of a symbology work package.

A1-F18AE-FRM-000 **007 00**

Table 1. HUD Display Symbology Descriptions (Cont)

INDEX NO.	DISPLAY ELEMENT (REF CODE)	DESCRIPTION
		If barometric altitude also not valid, only flashing B is displayed. 1 If the barometric altitude source error correction is invalid, an X will be displayed next to the uncorrected barometric altitude. The thousand and ten thousand digits are larger than the tens, hundreds, and units (XX,xxx). When altitude less than 1000 feet, all digits are the same size (XXX). Box is removed when HUD REJ 1 selected (Electronic Altimeter System Functional Schematic, A1-F18AC-600-500).
4	Barometric Setting	The barometric setting displays the value set in the Standby Pressure Altimeter AAU-39A. When the setting is changed, the new value is displayed for 5 seconds. It is also displayed and flashed for 5 seconds when aircraft altitude is below 10,000 feet and airspeed below 300 knots, after having been above both values (Air Data Computer System Functional Schematic, A1-F18AC-560-500).
5	Data Link Discretes/ Advisories	DL message discretes which appear in this area in vector mode are DATA, TILT, ad DISENGAGE (Vector Mode Command Data Functional Schematic,A1-F18AC-630-510/(C).
6	Data Link Discretes/ Advisories	CPL HDG displayed when FCS is coupled to data link vector mode heading command. Flashed for 10 seconds, then removed when couple unsuccessful or uncouple occurs when not commanded (Vector Mode Couple Heading Functional Schematic, A1-F18AC-630-510/(C).
7	Nosewheel Steering Case	NWS is displayed when nosewheel steering is engaged and weight on wheels. When high gain mode selected, NWS HI is displayed (Nosewheel Steering Functional Schematic, A1-F-18AC-570-500).
	DISPENSE 4	Displayed to indicate that a threat has been detected and operator action is required to dispense countermeasures.
	DISP I/P 4	Indicates countermeasures dispensing is in progress.
8	Destination Range	Steering destination range numerics, destination type, and destination number are displayed in NAV and A/G modes. When waypoint steering is selected and the current waypoint has offsets, the range to the OAP, the letter O, and the OAP number are displayed. When waypoint steering is selected and the current waypoint or mark does not have offsets, range numerics, W (waypoint) or M (mark) and the waypoint or mark number are displayed. When a target is designated, target range and TGT are displayed. TACAN steering is indicated by displaying TACAN range and TACAN station identification. Display removed when HUD REJ 2 selected (Navigation Velocity and Position Keeping Functional Schematic, A1-F18AC-730-500).

2

FIGURE 16. Example of a symbology work package - continued.

A1-F18AE-FRM-000 **007 00**

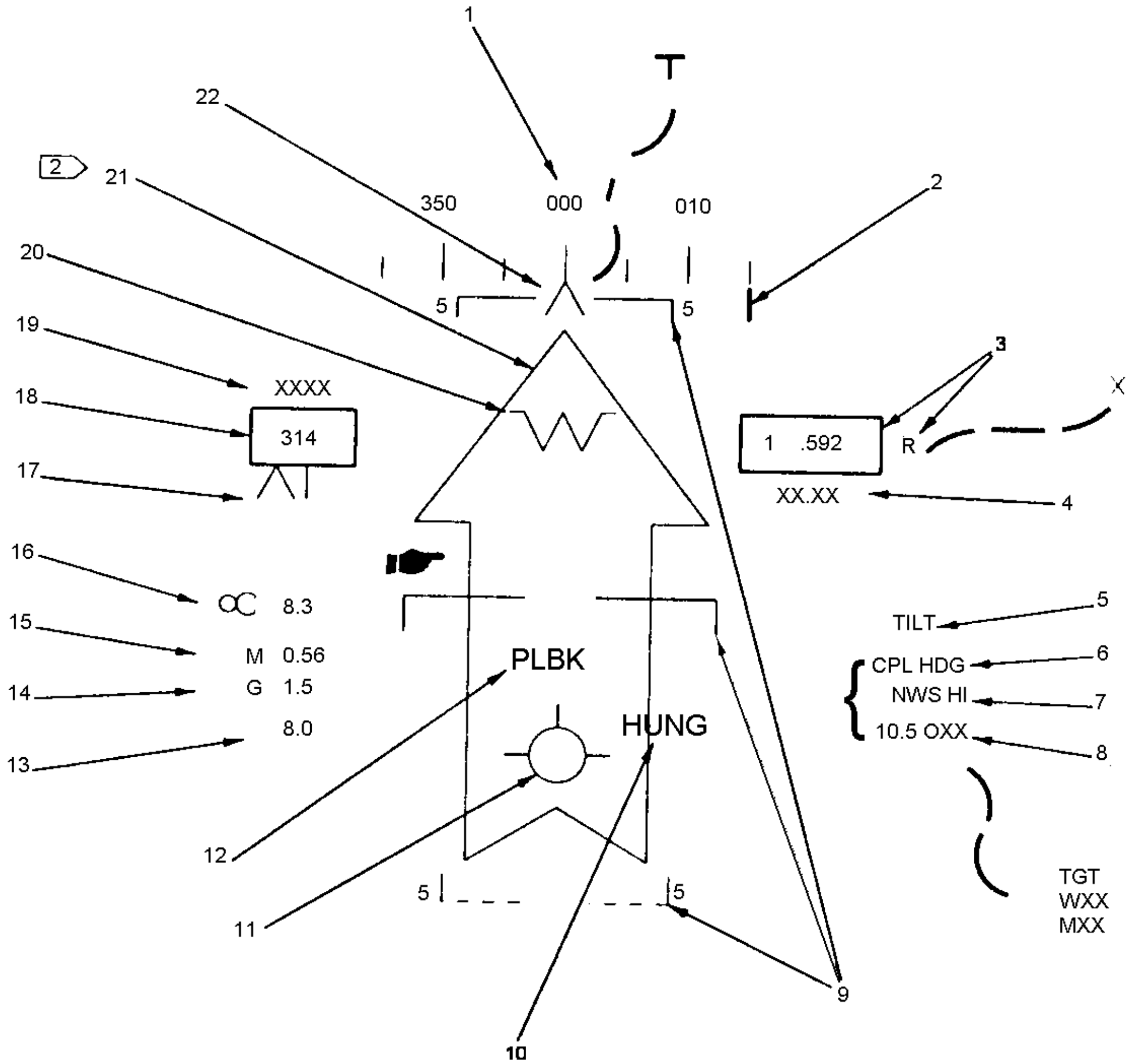


Figure 1. Mode Independent HUD Symbology (Sheet 1).

3

FIGURE 16. Example of a symbology work package - continued.

A1-F18AC-FIM-000 **084 00**

15 December 1997

ORGANIZATIONAL MAINTENANCE

FAULT ISOLATION MANUAL

Code 833 OR CODE 832 AND 833

TROUBLESHOOTING PROCEDURE

Reference Material

Line Maintenance Access Doors	A1-F18AC-LMM-010
Line Maintenance Procedures	A1-F18AC-LMM-000
Environmental Control Systems	A1-F18AC-410-500
Bleed Air System	WP 005 00

Support Equipment Required

Nomenclature	Part Number	CAGE Code
Multimeter	AN/USM-311	

Table 1. Code 833 or Codes 832 and 833

PROCEDURE	NO	YES
NOTE Bleed Air System Schematic (A1-F18AC-410-500) may be used as an aid when doing this procedure. For component locator, refer to A1-F18AC-410-500. **NOTE** Malfunction is caused by one of the items below: Aircraft Wiring Engine Bleed Air Secondary Pressure Regulating and Shutoff Valve Left Engine Bleed Air Pressure Regulating Shutoff Valve No. 4 Relay Panel Assembly Right Engine Bleed Air Pressure Regulating and Shutoff Valve Secondary Bleed Air Overpressure Switch		

1

FIGURE 17. Example of a fault isolation troubleshooting procedure work package.

A1-F18AC-FIM-000 **084 00**

Table 1. Code 833 or Codes 832 and 833 (Cont)

PROCEDURE	NO	YES
CAUTION		
To prevent damage to low level devices (switches/relay contacts), do not test for continuity with multimeter on the RX1 scale. Pin to pin tests that do not go through switches/relay contacts may use RX1 scale.		
NOTE		
The question used in logic tree "Does continuity exist" means to test for the items listed below:		
1. Pin to pin test per procedural step		
2. Shorts to ground		
3. Shorts between surrounding pins on connectors		
4. Shorts between shield and conductors		
5. Shield continuity		
1. Do substeps below:		
a. Do nose wheelwell digital display indicator built-in test/reset procedure (A1-F18AC-LMM-000).		
b. Apply electrical power (A1-F18AC-LMM-000).		
c. On GND PWR control panel assembly, set and hold 1 switch to A ON for three seconds.		
d Does code 833 exist?	7	2
2. Do substeps below:		
a. Turn off electrical power (A1-F18AC-LMM-000).		
b. Open door 68L (A1-F18AC-LMM-000).		
c. Disconnect 22P-S018 from secondary bleed air overpressure switch (switch).		
d. Does continuity exist from 22S-S018 switch receptacle pin 2 to pin 3?........................	4	5
3. Replace secondary bleed air overpressure switch (A1-F18AC-410-300) and do step 11.	-	-
4. Do substeps below:		
a. Remove door 32R (A1-F18AC-LMM-010).		
b. Disconnect 52P-N118B from no. 4 relay panel assembly.		
c. On F/A-18A and F/A-18B, disconnect 85P-N002C from Signal Data Converter CV 3493/ASM-612.		
d. On F/A-18C and F/A-18D, open door 14R (A1-F18C-LMM-010).		
e. On F/A-18C and F/A-18D, disconnect 85P-F042D from Signal Data Computer CP-1726/ASQ-194.		
f. On F/A-18A and F/A-18B, does continuity exist from:		
52P-N118B pin 51 to 22P-S018 pin 2 52P-N118B pin 34 to 85P-N002C pin 33?	5	6
g. On F/A-18C and F/A-18D, does continuity exist from:		

2

FIGURE 17. Example of a fault isolation troubleshooting procedure work package - continued.

A1-F18AC-FIM-000 **084 00**

Table 1. Code 833 or Codes 832 and 833 (Cont)

PROCEDURE	NO	YES
52P-N118B pin 51 to 22P-S018 pin 2 52P-N118B pin 34 to 85P-F042D pin 111?...	5	6
5. Isolate defective aircraft wiring (A1-F18A( )-WDM-000) and do step 11.	-	-
6. Isolate between no. 4 replay panel assembly wiring and relay 22K-N046 (A1-F18AC-420-300) and do step 11.	-	-
7. Do substeps below:		
a. Start engine and run at 80 percent (A1-F18AC-LMM-000). b. On ECS panel assembly, set BLEED AIR switch to R OFF. c. Do nose wheelwell digital display indicator built-in test/reset procedure (A1-F18AC-LMM-000). d. Does code 833 exist?...	8	9
8. Replace right engine bleed air pressure regulating and shutoff valve (A1-18AC-410-300) and engine bleed air secondary pressure regulating and shutoff valve (A1-F18AC-410-300) and do step 11.		
9. Do substeps below:		
a. On ECS panel assembly, set BLEED AIR switch to L OFF.		
b. Do nose wheelwell digital display indicator built-in test/reset procedure (A1-F18AC-LMM-000). c. Does code 833 exist?	10	3
10. Replace left engine bleed air pressure regulating and shutoff valve (A1-F18AC-410-300, F18AC-410-300) and do step 11.	-	-
11. If disconnected, removed, or opened during this procedure, make sure the items listed below are connected, installed, or closed:	-	-
a. Shut down engine b. Remove electrical power c. 22P-S018 d. 52P-N118B e. 85P-F042D f. 85P-N002C g. Door 68L h. Door 14R i. Door 32R		

3

FIGURE 17. Example of a fault isolation troubleshooting procedure work package - continued.

A1-F18AC-130-200 **010 00**

15 August 1995

ORGANIZATIONAL MAINTENANCE

TESTING AND TROUBLESHOOTING

OPERATIONAL CHECKOUT

ARRESTING GEAR SYSTEM

Reference Material

Line Maintenance Access Doors A1-F18AC-LMM-010
Line Maintenance Procedures A1-F18AC-LMM-000
Plane Captain Manual A1-F18AC-PCM-000

Support Equipment Required

Nomenclature	Part Number	CAGE Code
External Electrical Power Source		
External Hydraulic Power Source		
Gage, Push-Pull	DPPH-50	46221

1-1 **ARRESTING GEAR SYSTEM OPERATIONAL TEST (QA)**

1-2 Arresting gear operational test (table 1) is used to verify correct operation of arresting gear system and that the cockpit indicating light above the arresting HOOK manual control lever is functioning correctly with respect to hook position. For component locator, refer to figure 1. The test must be completed in sequence given and any abnormal indication must be corrected before going to the next step. The following prerequisite conditions must be followed:

Table 1. Arresting Gear System Operational Test

PROCEDURE	NORMAL INDICATION	REMEDY FOR ABNORMAL INDICATION

1. All arresting gear systems must be installed.
2. The following related systems must be installed and operational:
   a. Electrical System
   b. Hydraulic System
   c. Intercommunication and Audio System
   d. Maintenance Status Display and Recording System – F/A-18A AND F/A-18B
   e. Mission Computer System
   f. Multipurpose Display Group
   g. Flight Incident Recording and Monitoring System – F/A-18C AND F/A-18D

WARNING

To prevent loss of or damage to aircraft, precise arresting hook servicing is mandatory for correct system operation.

CAUTION

To prevent damage to aircraft, door 103 must be installed before arresting hook is extended or retracted.

1

FIGURE 18. Example of an operational checkout work package.

A1-F18AC-130-200 **010 00**

Table 1. Arresting Gear System Operational Test (Cont)

PROCEDURE	NORMAL INDICATION	REMEDY FOR ABNORMAL INDICATION
1. Make sure door 103 is installed (A1-F18AC-LMM-010).		
2. Make sure electrical and hydraulic power are off (A1-F-18AC-LMM-010).		
3. Jack aircraft to gain ground clearance for arresting hook assembly (A1-F18AC-LMM-010)		
4. Make sure arresting hook actuator is serviced correctly (A1-F18AC-LMM-000).		
5. Make sure arresting HOOK manual control lever is set to up.		
6. Read, record and reset nose wheelwell DDI (A1-F18AC-LMM-000).	No maintenance code exists.	Do procedures specified in table 2.
7. If arresting hook is not up, manually raise and latch arresting hook.	Arresting hook latches in up position.	Do arresting hook push-pull control assembly rigging or replace push-pull control assembly (A1-F18AC-130-000).
8. Do ground intercommunications hookup using external electrical power (A1-F18AC-LMM-000).	Arresting HOOK control advisory light off.	Arresting HOOK control advisory light on with arresting HOOK manual control lever l and arresting hook up. Refer to table 1 (WP 010 01).
9. On INTR LT control box panel assembly, set LT TEST switch to TEST.	Arresting HOOK control advisory light comes on.	Arresting Hook control advisory light does not come on when LT TEST switch on INTR LT control box panel assembly is set to TEST. Refer to table 2 (WP 010 01).
10. Remove arresting hook aircraft ground safety pin (A1-F18AC-PCM-000).		

2

FIGURE 18. Example of an operational checkout work package - continued.

A1-F18AC-130-200 **010 00**

Table 1. Arresting Gear System Operational Test (Cont)

PROCEDURE	NORMAL INDICATION	REMEDY FOR ABNORMAL INDICATION
WARNING To prevent death or injury to personnel or damage to equipment, arresting hook assembly must be clear of personnel and obstructions		
11. Apply external hydraulic power (A1-F18AC-LMM-000).		
12. Using stop watch, measure time required to lower arresting hook assembly. Set arresting HOOK manual control to down.	1. Arresting hook assembly releases and lowers in 2.5 seconds maximum.	1. Arresting HOOK manual control lever will not move to down position. Refer to table 3 (WP 010 01). 2. Arresting hook will not extend. Refer to table 4 (WP 010 01). 3. Arresting hook extension time is greater than 2.5 seconds, replace arresting hook selector valve (A1-F18AC-130-300) or arresting hook selector valve return check valve (A1-F19AC-130-300), or arresting hook actuator (A1-F18AC-130-300).
	2. Arresting HOOK control advisory light comes on as arresting hook assembly starts to extend and goes out when the arresting hook assembly is within 12° of full down.	1. Arresting HOOK control advisory light does not come on as arresting hook is extending. Refer to table 1 (WP 010 02). 2. Arresting HOOK control advisory light does not go out when arresting hook is fully extended. Refer to table 2 (WP 010 02).

3

FIGURE 18. Example of an operational checkout work package - continued.

A1-F18AC-130-200 **010 05**
1 June 1997

ORGANIZATIONAL MAINTENANCE

TESTING AND TROUBLESHOOTING

TROUBLESHOOTING

ARRESTING GEAR SYSTEM

EFFECTIVITY: F/A-18C AND F/A-18D

Reference Material

Arresting Gear System	WP 010 00
Line Maintenance Access Doors	A1-F18AC-LMM-010
Line Maintenance Procedures	A1-F18AC-PCM-000

Support Equipment Required

Nomenclature	Part Number	CAGE Code
Multimeter	77AN	82468

NOTE

Arresting Gear Schematic (A1-F18AC-130-500) may be used as an aid when doing this procedure.

For component locator, refer to WP 010 00.

NOTE

Malfunction is caused by one of the items below:

Aircraft Wiring
Arresting Hook Up Switch
Arresting Hook Up Switch Rigging
Signal Data Computer CP-1726/ASQ-194
Temperature Compensated Pressure Switch

1

FIGURE 19. Example of a troubleshooting procedures text-logic format work package.

A1-F18AC-130-200 **010 05**

Table 1. 916 Code Displayed With Arresting Hook Actuator Properly Serviced

PROCEDURE	NO	YES
CAUTION To prevent damage to low level devices (switches/relay contacts), do not test for continuity with multimeter on the RX1 scale. Pin to pin tests that do not go through switches/relay contacts may use the RX1 scale. **NOTE** The question used in logic tree "Does continuity exist" means to test for the items listed below: 1. Pin to pin test per procedural step 2. Shorts to ground 3. Shorts between surrounding pins on connectors 4. Shorts between shield and conductors 5. Shield continuity		
1. Do substeps below:		
a. Make sure arresting hook is up and latched.		
b. Open door 14R (A1-F18AC-LMM-010).		
c. Disconnect 85P-F042D from Signal Data Computer CP-1726/ASQ-194.		
d. Does continuity exist between 85P-F042D pin 41 and aircraft ground?	2	5
2. Do steps below:		
a. Manually raise speed brake and install speed brake aircraft ground safety lock (A1-F18AC-PCM-000).		
b. Remove door 103 (AL-F18AC-LMM-010).		
c. Disconnect 19P-T012 from temperature compensated pressure switch.		
d. Does continuity exist between 19J-T012 pins 3 and 4?	7	3
3. Does continuity exist between 19P-T012 pin 4 and aircraft ground?	8	4
4. Does continuity exist between 85P-F042D pin 41 and 19P-T012 pin 3?	9	12
5. Does an open circuit exist between 85P-F042D pin 46 and aircraft ground?	10	6

2

FIGURE 19. Example of a troubleshooting procedures text-logic format work package - continued.

A1-F18AC-130-200 **010 00**

Table 1. 916 Code Displayed With Arresting Hook Actuator Properly Serviced (Cont)

PROCEDURE	NO	YES
6. Do steps below: **CAUTION** To prevent damage to aircraft, door 103 must be installed before arresting hook is extended or retracted. a. Make sure door 103 is installed (A1-F19AC-LMM-010). b. Set arresting HOOK manual control lever to down. c. Does continuity exist between 85P-F042D pin 46 and aircraft ground?	11	12

3

FIGURE 19. Example of a troubleshooting procedures text-logic format work package - continued.

AT-820YA-LTS-000 **010 00**

1 July 1997

INTERMEDIATE MAINTENANCE INSTRUCTIONS

CHECKOUT PROCEDURES AND TROUBLESHOOTING

LASER TARGET SIMULATOR SMU-127/E

PART NUMBER 3384307-1

Reference Material

Introduction .... WP 002 00
Laser Target Simulator Maintenance .... WP 008 00

Support Equipment Required

Nomenclature	**Part Number**	**CAGE Code**
Digital Multimeter	John Fluke 8840A	42021

1-1 **INTRODUCTION**

1-2 This work package (WP) provides the instructions for troubleshooting the Laser Target Simulator SMU-127/E (LTS).

2-1 **TROUBLESHOOTING**

2-2 Troubleshooting on the LTS is based on fault isolation. Refer to table 1 and figures 3 and 4 for general LTS system faults. The following paragraphs deal with problems specific to the cables and power supplies. For removal/installation of any faulty components, refer to WP 008 00.

2-3 **VERIFICATION OF CABLE CONTINUITY**

WARNING

Prior to checking cable continuity, remove power from the LTS.

1. Set POWER ON/OFF switch S1 to OFF position and remove power cable W1 from facility power.

2. Cable continuity is checked through the use of a digital multimeter. Verify the wiring connections illustrated in figures 5 through 7 for cables W1-W3 and figure 8 for the power supply cable. Repair as needed (WP 008 00).

Table 1. Laser Target Simulator Troubleshooting Procedures

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
POWER ON/OFF Indicator DS1 will not light.	1. Indicator lamp DSI burnt out.	Replace indicator lamp DSI.
	2. Lamp socket damaged or connections separated.	Repair/replace lamp socket.
	3. Faulty POWER ON/OFF switch S1.	Repair/replace POWER ON/OFF switch S1.

1

FIGURE 20. Example of a troubleshooting procedures tabular format work package.

AT-820YA-LTS-000 **010 00**

Table 1. Laser Target Simulator Troubleshooting Procedures (Cont)

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
	4. Faulty resistor A1R1/A1R2.	Replace resistor.
	5. Faulty filter A1FL1.	Replace filter.
	6. Faulty connector A1J1.	Repair/replace connector A1JI.
	7. Faulty power cable W1.	Perform VERIFICATION OF CABLE CONTINUITY, this WP. Repair/replace cable.
Fuseholder A1F1 indicator is lit.	1. Fuse F1 is blown.	Replace fuse F1.
	2. Fuseholder damaged or improperly connected.	Repair/replace fuseholder.
BACKGROUND LIGHTING indicator DS2 will not light.	1. Fuse F1 is blown.	Replace fuse F1.
	2. Indicator lamp DS2 burnt out.	Replace indicator lamp DS2.
	3. Lamp socket damaged or connections separated.	Repair/replace lamp socket.
	4. Faulty BACKGROUND LIGHTING ON/OFF switch S2.	Repair/replace BACKGROUND LIGHTING ON/OFF SWITCH S2.
	5. Faulty standoff insulator or separated connections.	Repair connections/replace standoff insulator.
	6. Faulty +28 VDC power supply.	Perform VERIFICATION OF POWER SUPPLY VOLTAGES, this WP.
	7. Faulty connector A1J4/A1P1.	Repair/replace connector A1J4/A1P1.
	8. Faulty power supply cable.	Perform VERIFICATION OF CABLE CONTINUITY, this WP. Repair/replace power supply cable.

2

FIGURE 20. Example of a troubleshooting procedures tabular format work package - continued.

A1-216PA-120-000 **005 00**
31 October 1996

INTERMEDIATE MAINTENANCE INSTRUCTIONS

TESTING AND TROUBLESHOOTING PROCEDURES

PILOT'S MISCELLANEOUS SWITCH CONTROL PANEL

PART NUMBER 41837-1

Record of Applicable Technical Directives

TD Type/ No.	TD Date	Title and ECP/ RAMEC No.	Date Inc.	Remarks
AFC 429 Revision B	1 May 1995	Electrical, Night Vision Goggle Compatible Cockpit Installation (ECP PN37R1)	28 Jun 1996	

Support Equipment Required

Nomenclature	Part Number	CAGE Code
Digital Multimeter (DMM)	77BN	26404
Power Supply (0-40 vdc)	JQE36-3M	85604
Variable Transformer (0-130 vac)	W10MT3A	24655

1-1 **TESTING AND TROUBLESHOOTING**

1-2 Testing and troubleshooting includes pretest setup, operational checkout, and troubleshooting procedures. Circled uppercase letters key the malfunction symptoms to appropriate troubleshooting procedures provided in figure 1. Troubleshooting procedures assume there is but one malfunction at a time. After all repairs are made, the operational checkout should be restarted to make sure that the replacement did not introduce a new malfunction. Successful completion of the operational checkout verifies proper operation of the equipment.

2-1 **PRETEST SETUP**

1. Make sure variable transformer is set to zero.

2. Connect variable transformer to control panel P94-b and P94-a.

3. Connect variable transformer to 115 vac 400 Hz utility receptacle.

4. Turn ON variable transformer.

1

FIGURE 21. Example of a combined operational checkout and troubleshooting procedures logic flow diagram format work package.

A1-216PA-120-000 **005 00**

3-1 OPERATIONAL CHECKOUT

CAUTION

Do not go over 5 vac to control panel, as damage to panel lamps may result.

1. Increase variable transformer output from 0 to 5 vac. Check that information plate assembly lamps increase uniformly to full brilliance.

   - If result is not as specified
     ___________ Figure 1 _______________ A

2. Turn OFF and disconnect variable transformer from control panel.

WARNING

Make sure power supply is off before connecting and disconnecting leads from control panel as injury to personnel or damage to equipment may occur.

3. With power supply adjusted for 28 vdc output, connect negative lead to P94-a and positive lead to P94-A. Check that TURN RATE, NORM or ALT indicator lamps go on.

   - If result is not as specified,
     _____________ Figure 1 _______________ B

4. Press TURN RATE switch. Check that opposite indicator lamps go on.

   - If result is not as specified,
     _____________ Figure 1 _______________ B

5. Press TURN RATE switch so that NORM indicator lamps are on.

6. Turn OFF and disconnect power supply from control panel.

4-1 TROUBLESHOOTING PROCEDURES

4-2 Troubleshooting procedures are provided in figure 1 and are keyed to the operational checkout results contained in paragraph 3-1.

2

FIGURE 21. Example of a combined operational checkout and troubleshooting procedures logic flow diagram format work package - continued.

A1-216PA-120-000 **005 00**

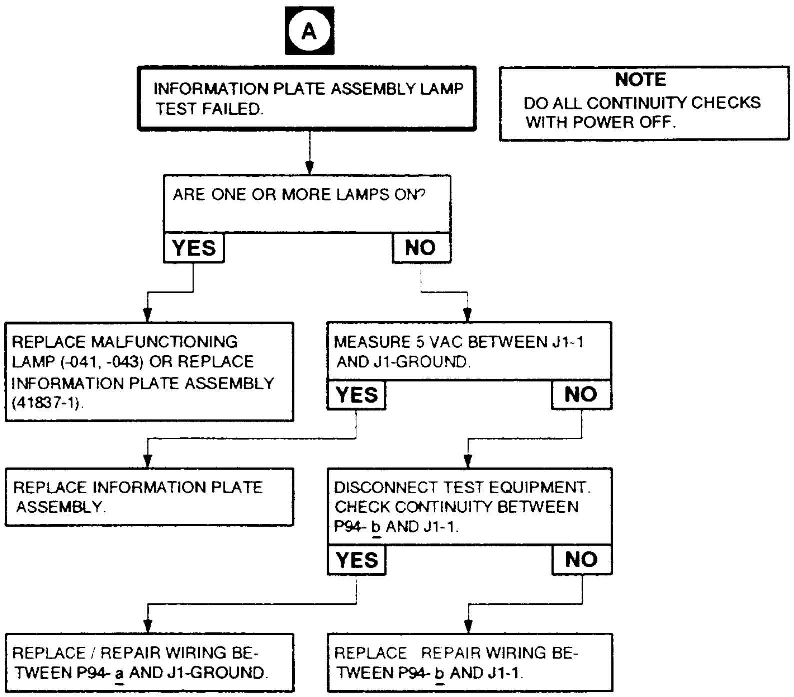


Figure 1. Troubleshooting Pilot's Miscellaneous Switch Control Panel (Sheet 1).

3

FIGURE 21. Example of a combined operational checkout and troubleshooting procedures logic flow diagram format work package - continued.

A1-216PA-120-000 **005 00**

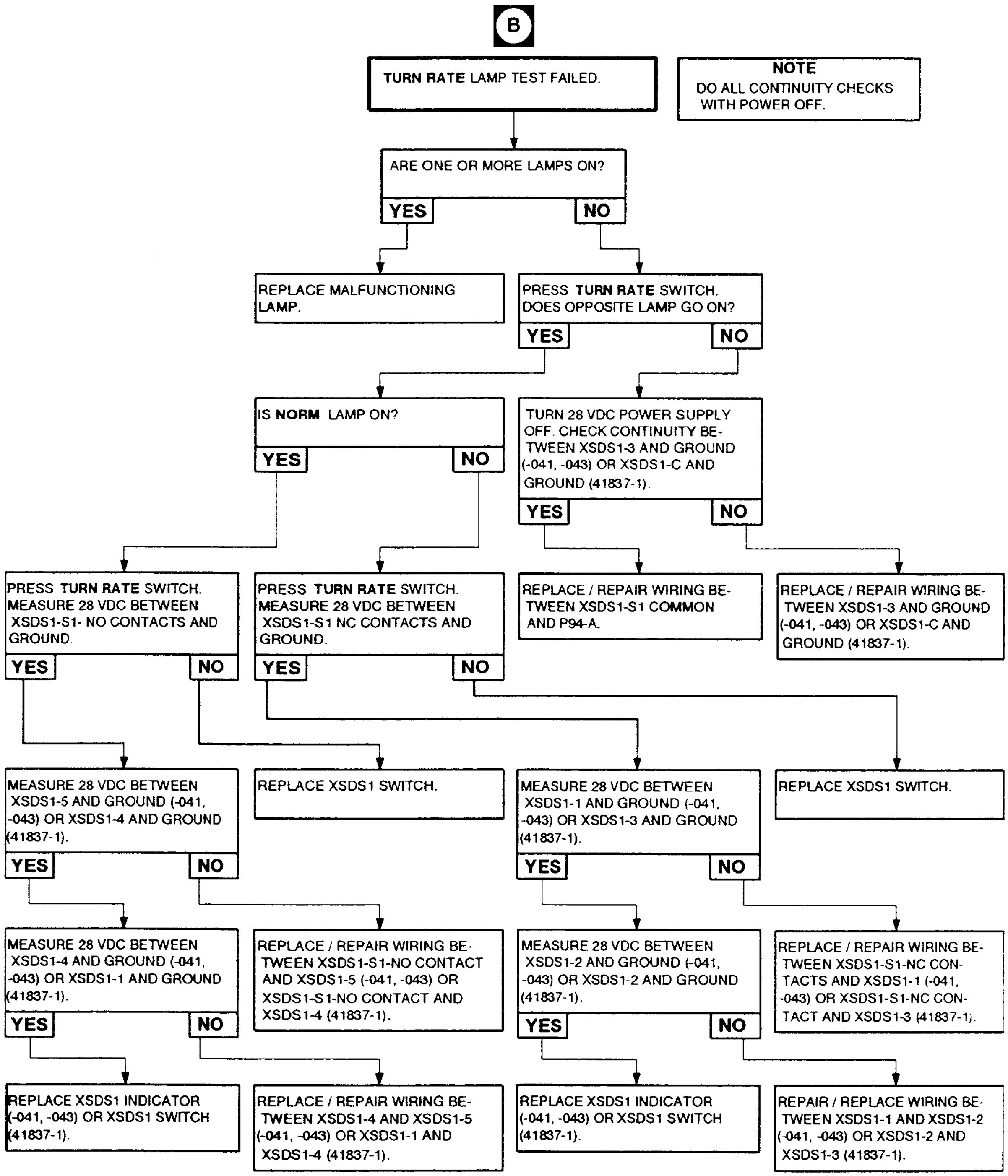


Figure 1. Troubleshooting Pilot's Miscellaneous Switch Control Panel (Sheet 2).

4

FIGURE 21. Example of a combined operational checkout and troubleshooting procedures logic flow diagram format work package - continued.

A1-T700A-MMI-200 **005 00**

1 July 1995

INTERMEDIATE MAINTENANCE

GENERAL MAINTENANCE PROCEDURES

Reference Material

Illustrated Parts Breakdown A1-T700A-IPB-400
Standard Maintenance Practices Manual .... NAVAIR 02-1-20

Materials Required

Nomenclature	Specification/Part Number	HMWS Index Number
Gloves, Protective	--	--
Gloves, Rubber	ZZ-G-381, Type I	--
Gloves, Thermally Insulated	9123T12	--
Goggles	--	--
Machinery Towels	DDD-T-541	--
Solvent, Dry Cleaning	P-D-680 (81348)	--

1-1 **INTRODUCTION**

1-2 This work package contains standard general maintenance procedures, miscellaneous inspections, and servicing information.

2-1 **REMOVAL/DISASSEMBLY PRACTICES**

1. To prevent damage to parts and injury to personnel, always use a hoist and recommended special lifting slings and adapters to lift heavy parts and assemblies. Use proper tools and procedures at all times.

2. Use only the special tools and fixtures specified in this manual to remove/disassemble the engine. Careless handling or improper use of tools or procedures can cause damage to engine parts, resulting in rejection of costly parts at inspection or serious engine malfunctions.

3. Do not leave tools on any part of an assembly during disassembly operations. After using each tool, return it to its proper storage place.

4. Avoid the use of makeshift tools. Special tools are identified by name and part number when they are required.

5. Visually inspect all tooling for damage or contamination before using the tool. Wipe tools with machinery towels DDD-R-541, as required.

6. Do not use force to remove parts. If difficulty is encountered, remove tooling and determine cause of trouble before proceeding.

7. When using a hydraulic pump to remove parts, stop the pumping operation if the needle on the gage enters the danger area.

8. Do not use metal-head hammers on any part of the engine. Plastic, nylon, or rawhide-head hammers should be used on parts.

1

FIGURE 22. Example of a general maintenance work package.

A1-T700A-MMI-200 **005 00**

3-1 **CLEANING PRACTICES**

NOTE

Cleaning of engine parts is necessary to permit adequate detailed inspection and subsequent repair of material defects. The cleaner the parts, the more reliable will be the inspection.

1. Cap all openings and tube ends before and after cleaning a part to prevent contaminations from entering internal passages.

2. Use only lint-free gloves and wipers when handling parts.

3. To avoid corrosion, do not handle parts with bare hands if protective coatings have been removed.

4. Be sure that cleaning facilities provide for safety of operating personnel. The cleaning area should be clean and well-ventilated.

5. Process each part only as long as necessary to clean the part adequately. The processing times specified in the cleaning procedures are not absolutes and should be used only as guides.

4-1 **ELECTRICAL CONNECTORS**

4-2 **PRELIMINARY INSTRUCTIONS.** Before connecting electrical connectors, inspect for the following:

WARNING

Heating Parts in Oven

Heat from oven or from hot parts can cause reddening and blistering of skin (or third degree burns) if hands are not protected.
If skin is burned, immerse contacted area in cold water for 10 minutes If pain or blistering persists, immediately get medical attention.
Use approved protective gloves when putting parts in or taking parts out of hot oven.

1. Inspect connectors (plugs and receptacles) to be sure they are free of moisture. If moisture is found, remove harness or component and bake dry at 250^{o}F for 2 hours. Using thermally insulated gloves, remove harness or component from oven.

2. Inspect connectors to be sure they are clean and free of fuel and oil. If not, clean and dry them (WP 015 00).

3. Inspect all connectors for bent pins. If bent pins are found, refer to applicable inspection table for repair limits.

4. All electrical connectors should be installed dry. Do not lubricate seals or threads.

2

FIGURE 22. Example of a general maintenance work package - continued.

A1-F18AC-LMM-000 **025 00**
15 April 1996

ORGANIZATIONAL MAINTENANCE

LINE MAINTENANCE PROCEDURES

SERVICING - MLG TIRE

Reference Material

Aircraft Tires and Tubes.. NAVAIR 04-10-506

1-1 **SERVICING**

WARNING

To prevent death or injury to personnel, always go toward MLG tire from forward or aft direction, never from the side. Never go near MLG tire if suspected to be overheated because of long taxi or continued brake application.

1. Approach MLG tire from forward or aft direction (figure 1).

2. Service MLG tire (NAVAIR 04-10-506) to correct inflation pressure per substeps below:

   a. If mission is to start, stop over or end on an aircraft carrier, inflate MLG tires to 345 to 355 psig.

   b. If mission includes only ashore operations on semiprepared fields, inflate MLG tires to 245 to 255 psig.

   c. If mission includes only ashore operations on prepared fields, inflate MLG tires to 245 to 255 psig.

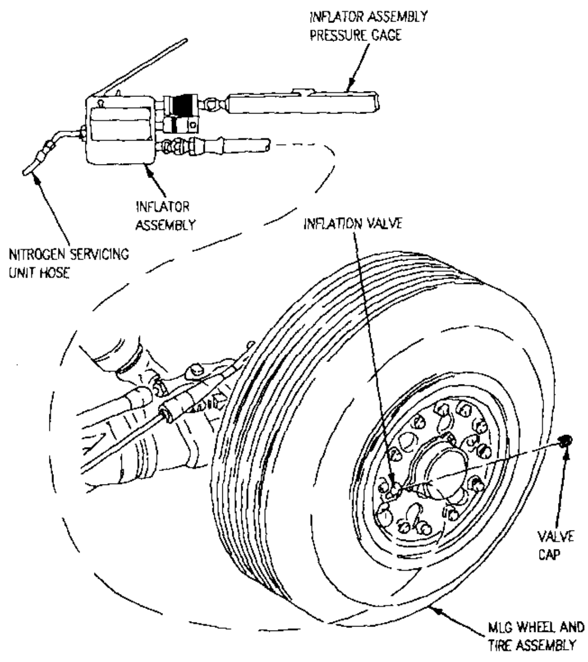


Figure 1. MLG Tire Servicing.

1

FIGURE 23. Example of a servicing work package.

A1-F404A-MMD-300 **007 00**

1 October 1991

DEPOT MAINTENANCE

MAINTENANCE

SUPPORT EQUIPMENT

Materials Required

Nomenclature	Specification/Part Number	HMWS Index Number
Bag, Plastic (General Purpose)	PPP-B-26	--
Compound, Corrosion Preventive	MIL-C-81309	320
Desiccant	MIL-D-3464	--
Oil, Lubricating	MIL-L-23699	66
Oil, Lubricating	MIL-L-7808	66
Wipes, Lint-Free	--	--

1-1 **INTRODUCTION**

1-2 This work package (WP) contains information for the proper care and maintenance of the support equipment (tools) provisioned for depot maintenance of the F404 engine. Because most of the tools are precision-made, they should be carefully handled, properly maintained, and periodically inspected.

2-1 **CARE OF TOOLS WHILE IN USE**

1. Use plastic or rawhide (never metal) hammer heads when driving on any of the pushers. Apply force evenly to all bearing pushers or pullers.

2. Tighten jackscrews, bolts, and nuts in small increments on opposite planes. This is called cross-torquing.

3. Wipe tools clean before using them on the engine. Always use lint-free (Kim-Wipes) wipers for this purpose.

4. Always use the correct size wrench (or socket) to turn or tighten a tool, locknut, or bolt.

5. Never leave tools or gages on benches, engines, etc., where they could fall and be damaged.

3-1 **CARE OF TOOLS WHILE IN STORAGE (PREVENTIVE MAINTENANCE)**

1. Clean and lubricate all tools before returning them to the storage box or container.

2. Always store tools in their respective storage box or container (if provided). Otherwise, store in a clean, dry area.

4-1 **CALIBRATION AND ADJUSTMENT OF TOOLS**

1. Use only calibrated tools.

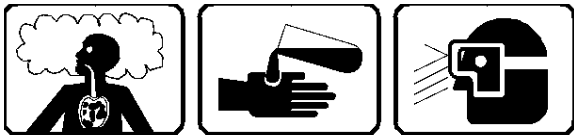
2. Measuring type tools, such as torque wrenches and dial indicators that have been dropped, should be calibrated before they are used again.

1

FIGURE 24. Example of a support equipment work package.

A1-F404A-MMD-300 **007 00**

5-1 SHIPMENT OF TOOLS



Lubricating Oil, MIL-L-23699/MIL-L-7808 66

1. Wipe tools with a cloth treated with lubricating oil MIL-L-23699 or MIL-L-7808 before shipment.

2. Ship tools in their storage box or container (if provided). Package tools securely before shipment to prevent damage.

3. To protect tools against corrosion, ship tools in rigid, air-tight containers, or in air-tight, plastic (general purpose) bags. Include desiccant MIL-D-3464.

6-1 SERVICING OF TOOLS

6-2 Knowing when to service tools is as important as knowing how to service them. It is important that these tools be removed from service when lubrication is required and when it is known, or there is reason to believe, they:

1. Are worn beyond usable limits.

2. Were dropped or misused.

3. Do not work properly.

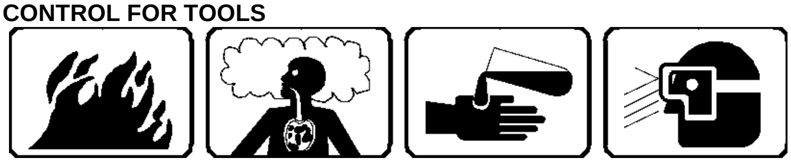
4. Were severely stressed during use.

7-1 INSPECTION REQUIREMENTS FOR TOOLS

1. Inspect tools periodically to determine if they are in usable condition.

2. Inspect tools for high metal, cracks, or other visible defects which might keep them from working properly. Tools having defects should either be repaired or replaced before using to avoid damaging engine parts.

8-1 CORROSION CONTROL FOR TOOLS



Corrosion Preventive Compound, MIL-C-81309 (ALOX 2028) 320

8-2 Support equipment used for maintenance is protected against corrosion by use of paint, electroless nickel plate, or anodize. These finishes will adequately protect the exposed surfaces against the formation of rust under normal conditions. However, prolonged exposure to salt-laden or high-humidity air may corrode the parent metal (including certain stainless steels) if preventive action is not taken. Therefore, in areas where corrosion may be a problem, a semi-annual spray application of corrosion preventive compound, MIL-C-81309, is recommended. No special procedures have to be followed to prepare equipment before spraying or after spraying. However, unexposed surface of equipment designed to come apart should also be sprayed.

2

FIGURE 24. Example of a support equipment work package - continued.

NAVAIR 02B-105AHE-6-1 **014 00**
1 August 1996

INTERMEDIATE MAINTENANCE

MAINTENANCE

LOCAL MANUFACTURING AND ASSEMBLY

EFFECTIVITY: Engine Serial No. 216001 and Subsequent

Reference Material

Alphanumerical Listing of Support Equipment .... WP 013 00
Standard Maintenance Practices Manual .... NAVAIR 02-1-20

1-1 **INTRODUCTION**

1-2 This Work Package (WP) contains instructions for the local manufacture of Support Equipment used at the intermediate levels of maintenance of the T58-GE-16 engines. A complete list of Support Equipment is available in WP 013 00.

2-1 **CARE AND MAINTENANCE**

2-2 For instructions on the calibration, care and maintenance of Support Equipment, refer to NAVAIR 02-1-20.

3-1 **LOCALLY MANUFACTURED TOOLS**

3-2 The following tools should be fabricated locally:

1. No. 2 bearing rear stationary seal support guiding pin (figure 1).

2. Static fuel filter bowl removal and installation tool (figure 2).

1

FIGURE 25. Example of a local manufacturing and assembly work package.

NAVAIR 02B-105AHE-6-1 **014 00**

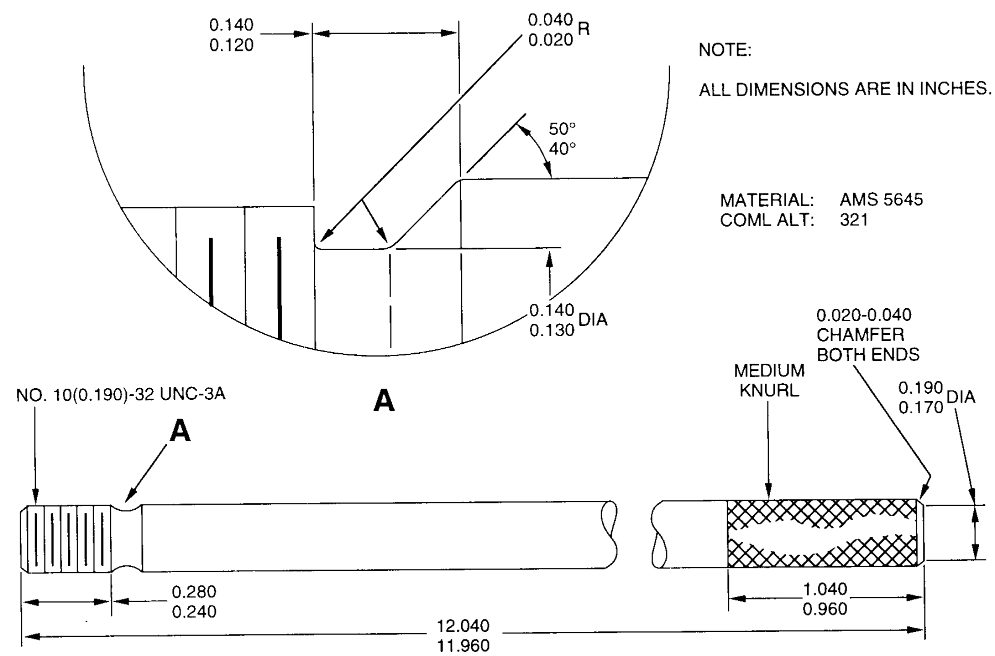


Figure 1. Seal Support Guiding Pin

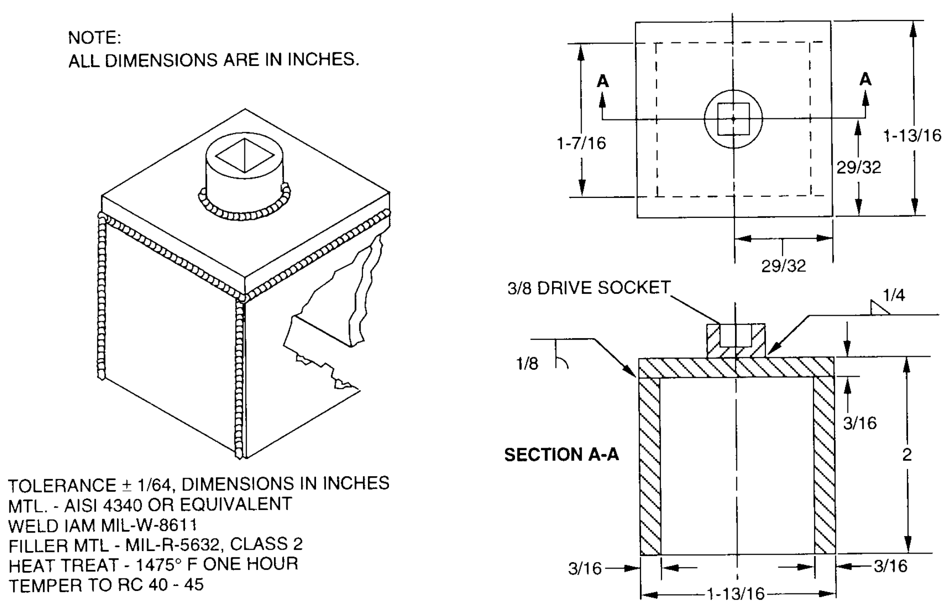


Figure 2. Static Fuel Filter Bowl Removal and Installation Tool.

2

FIGURE 25. Example of a local manufacturing and assembly work package - continued.

A1-E2C2A-QEC-000 **006 00**
15 June 1988

INTERMEDIATE MAINTENANCE

MAINTENANCE

E-2C (T56-A-425)

QUICK ENGINE CHANGE UNIT (QECU)

REDUCTION GEAR - BUILDUP

Reference Material

Record of Applicable Technical Directives

TD Type/ No.	TD Date	Title and ECP/ RAMEC No.	Date Inc.	Remarks
AFC 352	2/1/86	Deactivation of Propeller Gearbox Vibration Monitoring System (RAMEC 17-85)	6/15/88	-

Support Equipment Required

Nomenclature	Part Number	CAGE Code
Torque Wrench	0 to 100 inch-pounds (0 to 20 N-m)	-
Torque Wrench	0 to 250 inch-pounds (0 to 30 N-m)	-

Materials Required

Nomenclature	Specification/Part Number	HMWS Index No.
Lockwire	MS20995NC32	-

1-1 **INTRODUCTION**

1-2 This work package (WP) provides buildup procedures for the reduction gearbox. The reduction gearbox is part of the E-2C (T56-A-425) turboprop engine. Refer to WP 002 00 for sequence of engine buildup. Refer to WP 003 00 for general information.

1

FIGURE 26. Example of a power plant build-up work package.

A1-E2C2A-QEC-000 **006 00**

2-1 **REDUCTION GEAR FRONT HOUSING-COMPONENT INSTALLATION**

2-2 **NEGATIVE TORQUE BRACKET ASSEMBLY**

Buildup Components Required

Figure/ Index No.	Nomenclature	Part Number	Qty
2/1	Negative Torque Bracket Assembly	753790-1	1
2/2	Screw	*	3
2/3	Washer	*	3

*Supplied with negative torque bracket assembly.

1. Position negative torque bracket assembly (31, figure 1) on negative torque bracket assembly mounting pad (6) on reduction gear front housing. Insert three screws (2, figure 2) and washers (3) through negative torque bracket assembly and into reduction gear front housing. Torque screws to 40 to 50 inch-pounds (4.5 to 5.6 N•m) and lockwire. (QA)

2. Adjust adjusting screw (4) to obtain 0.006 to 0.015 inch (0.152 to 0.381 mm), 0.008 inch (0.203 mm) optimum clearance between reduction gear plunger (5) and adjusting screw (4). (QA)

2-3 **TORQUE RETAINER (ANTI-ROTATION BRACKET)**

Buildup Components Required

Figure/ Index No.	Nomenclature	Part Number	Qty
1/12	Bolt	*	2
1/30	Torque Retainer (Anti-Rotation Bracket)	543641	1

*Supplied with torque retainer.

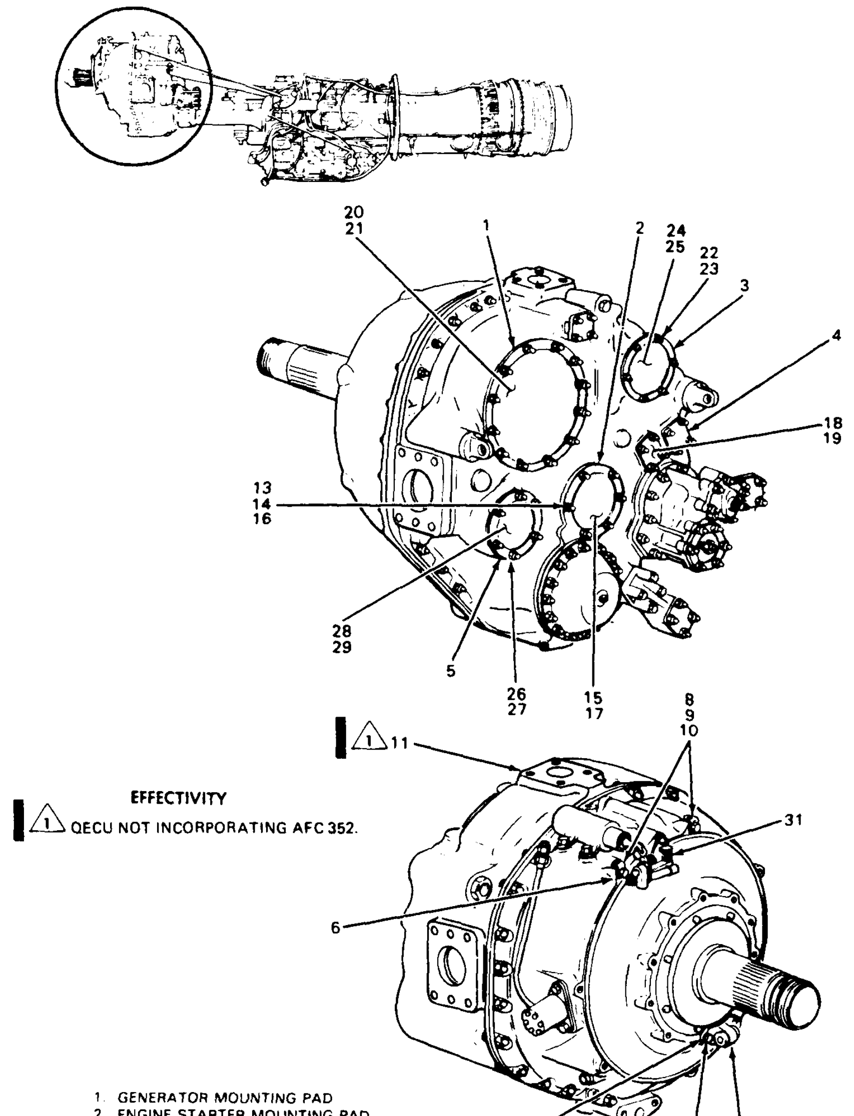
1. Position torque retainer (anti-rotation bracket) (30, figure 1) on torque retainer (anti-rotation bracket) mounting pad (7).

2. Secure torque retainer (anti-rotation bracket) (30) to torque retainer (anti-rotation bracket) mounting pad (7) with two bolts (12). Torque bolts to 155 to 165 inch-pounds (17.5 to 18.6 N•m) and lockwire bolts. (QA)

2

FIGURE 26. Example of a power plant build-up work package - continued.

A1-E2C2A-QEC-000 **006 00**

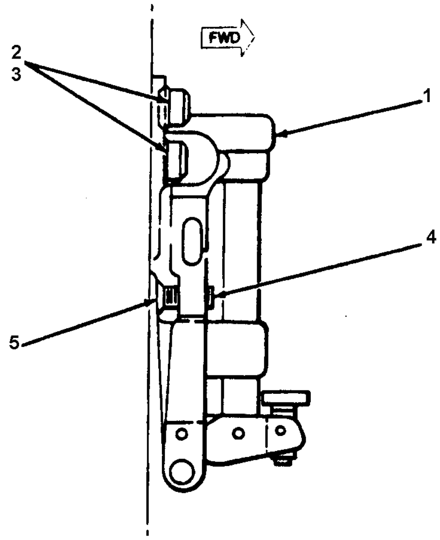


1. GENERATOR MOUNTING PAD
2. ENGINE STARTER MOUNTING PAD
3. COMBINED HYDRAULIC PUMP MOUNTING PAD
4. TACHOMETER GENERATOR MOUNTING PAD
5. FLIGHT HYDRAULIC PUMP MOUNTING PAD
6. NEGATIVE TORQUE BRACKET ASSEMBLY MOUNTING PAD
7. TORQUE RETAINER (ANTI-ROTATION BRACKET) MOUNTING PAD
8. BRACKET (2)
9. BOLT (2)
10. WASHER (2)
11. VIBRATION ACCELEROMETER MOUNTING PAD
12. BOLT (2)
13. NUT (6)
14. WASHER (6)
15. SHIPPING COVER
16. STUD (6)
17. GASKET
18. SHIPPING COVER
19. GASKET
20. SHIPPING COVER
21. GASKET
22. NUT (6)
23. WASHER (6)
24. SHIPPING COVER
25. GASKET
26. NUT (6)
27. WASHER (6)
28. SHIPPING COVER
29. GASKET
30. TORQUE RETAINER (ANTI-ROTATION BRACKET)
31. NEGATIVE TORQUE BRACKET ASSEMBLY

Figure 1. Reduction Gear – Component Mounting Locations.

3

FIGURE 26. Example of a power plant build-up work package - continued.



1. NEGATIVE TORQUE BRACKET ASSEMBLY
2. SCREW (3)
3. WASHER (3)
4. ADJUSTING SCREW
5. REDUCTION GEAR PLUNGER

Figure 2. Negative Torque Bracket Assembly.

FIGURE 26. Example of a power plant build-up work package - continued.

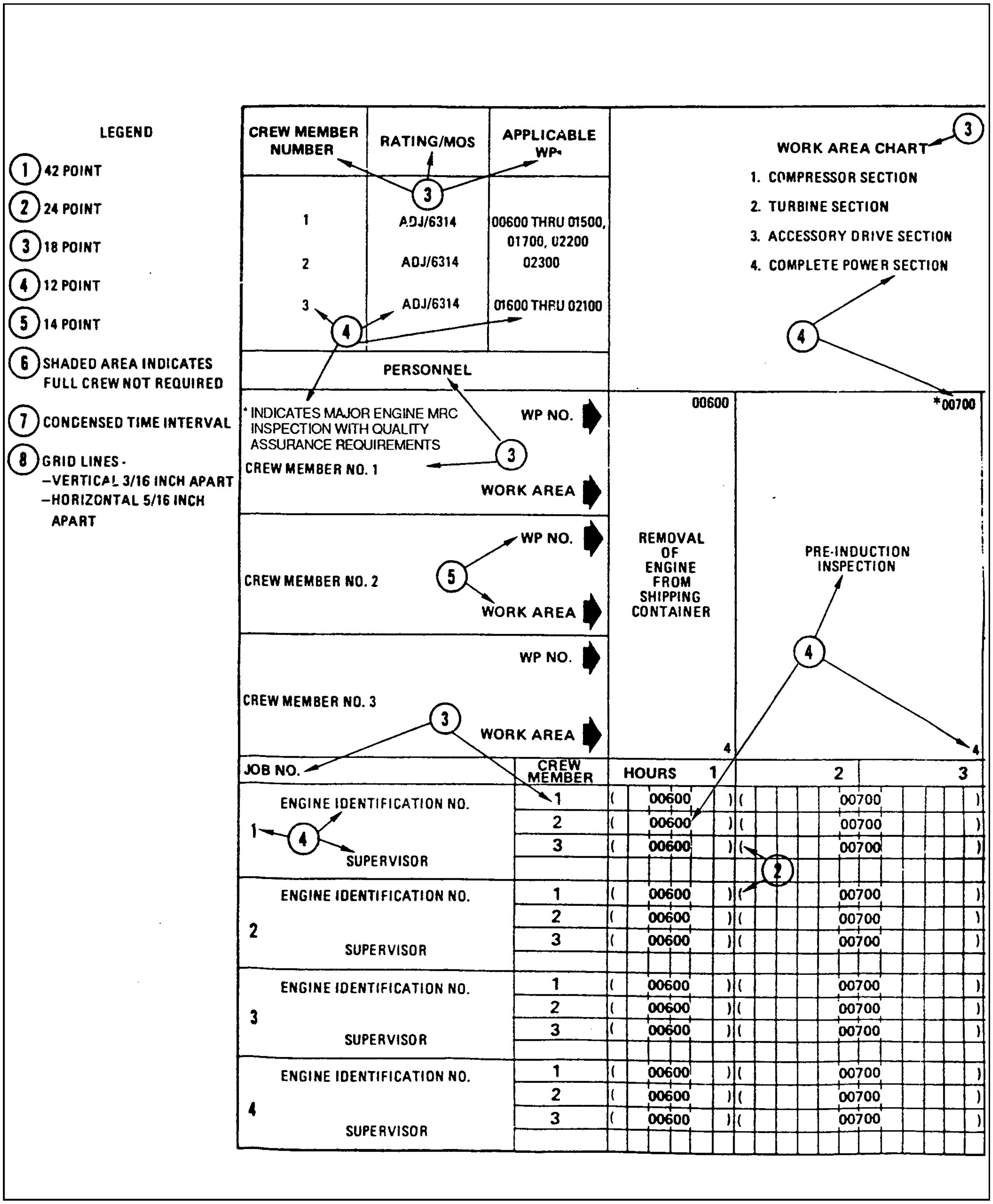


FIGURE 27. Example of a Sequence Control Chart.

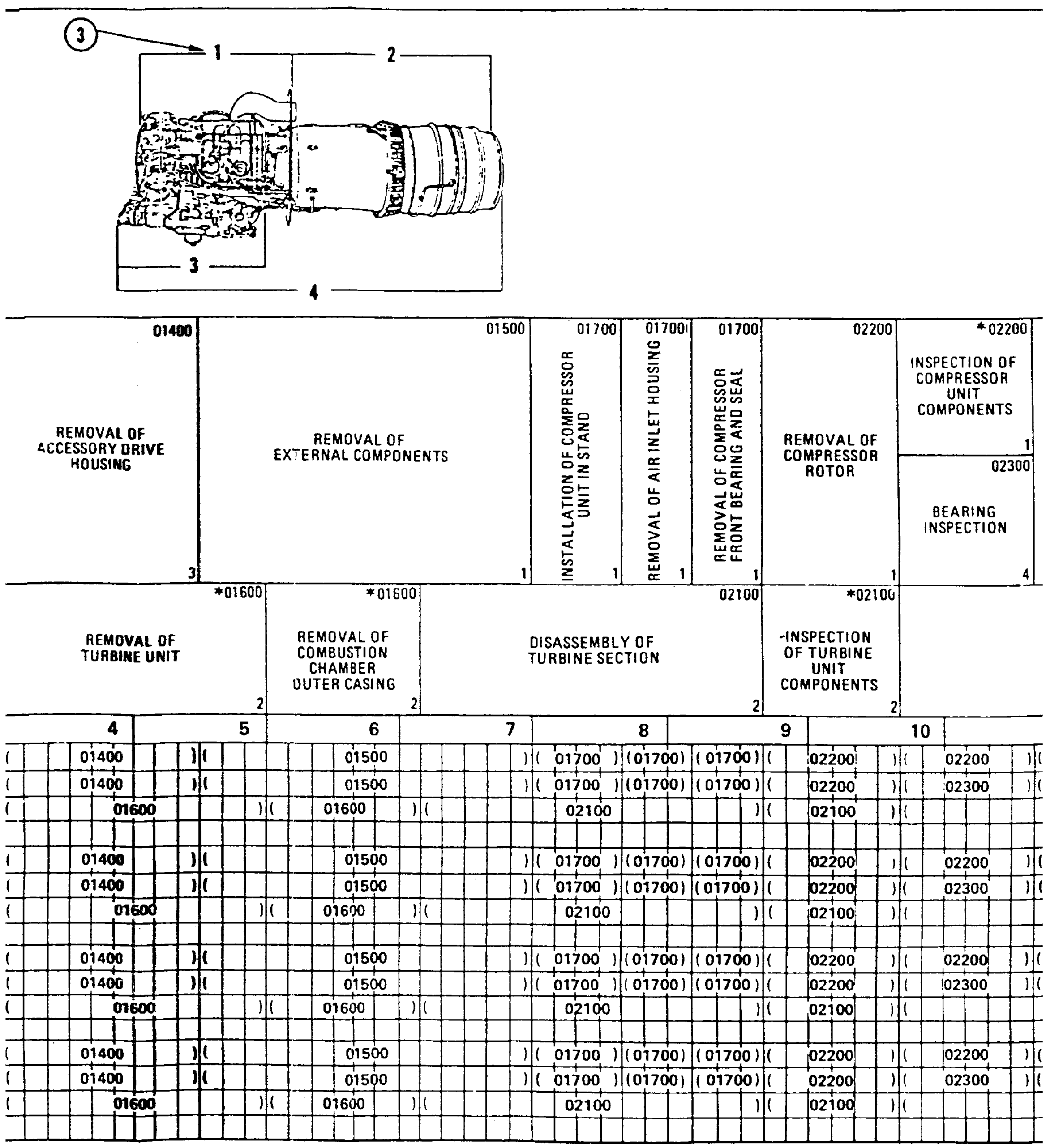
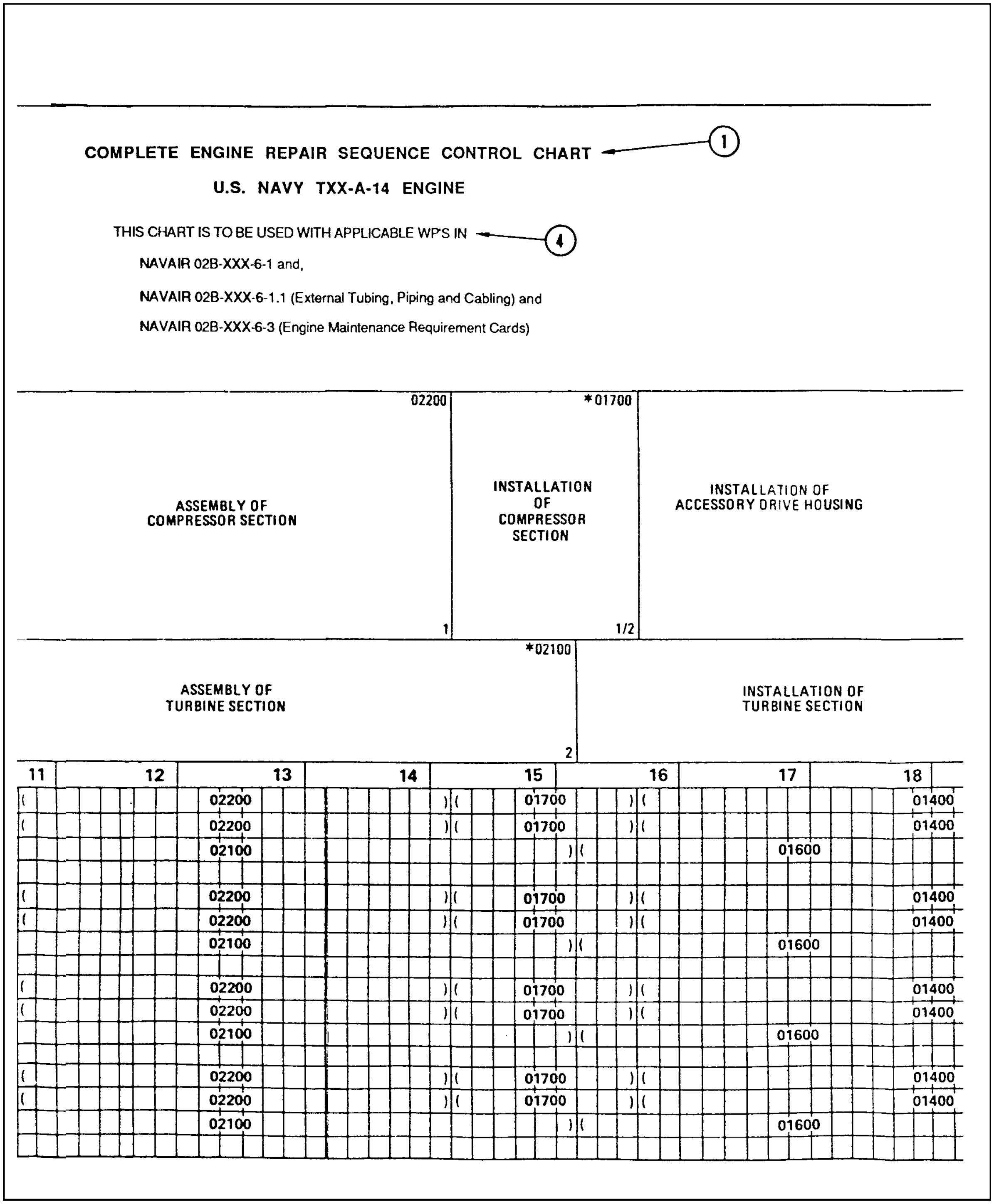


FIGURE 27. Example of a Sequence Control Chart - continued.


COMPLETE ENGINE REPAIR SEQUENCE CONTROL CHART
1
U.S. NAVY TXX-A-14 ENGINE
THIS CHART IS TO BE USED WITH APPLICABLE WP'S IN
4
NAVAIR 02B-XXX-6-1 and,
NAVAIR 02B-XXX-6-1.1 (External Tubing, Piping and Cabling) and
NAVAIR 02B-XXX-6-3 (Engine Maintenance Requirement Cards)

02200
ASSEMBLY OF COMPRESSOR SECTION
1
*01700
INSTALLATION OF COMPRESSOR SECTION
1/2
INSTALLATION OF ACCESSORY DRIVE HOUSING
*02100
ASSEMBLY OF TURBINE SECTION
2
INSTALLATION OF TURBINE SECTION

11 12 13 14 15 16 17 18
02200 01700 01400
02200 01700 01400
02100 01600
02200 01700 01400
02200 01700 01400
02100 01600
02200 01700 01400
02200 01700 01400
02100 01600
02200 01700 01400
02200 01700 01400
02100 01600

FIGURE 27. Example of a Sequence Control Chart - continued.

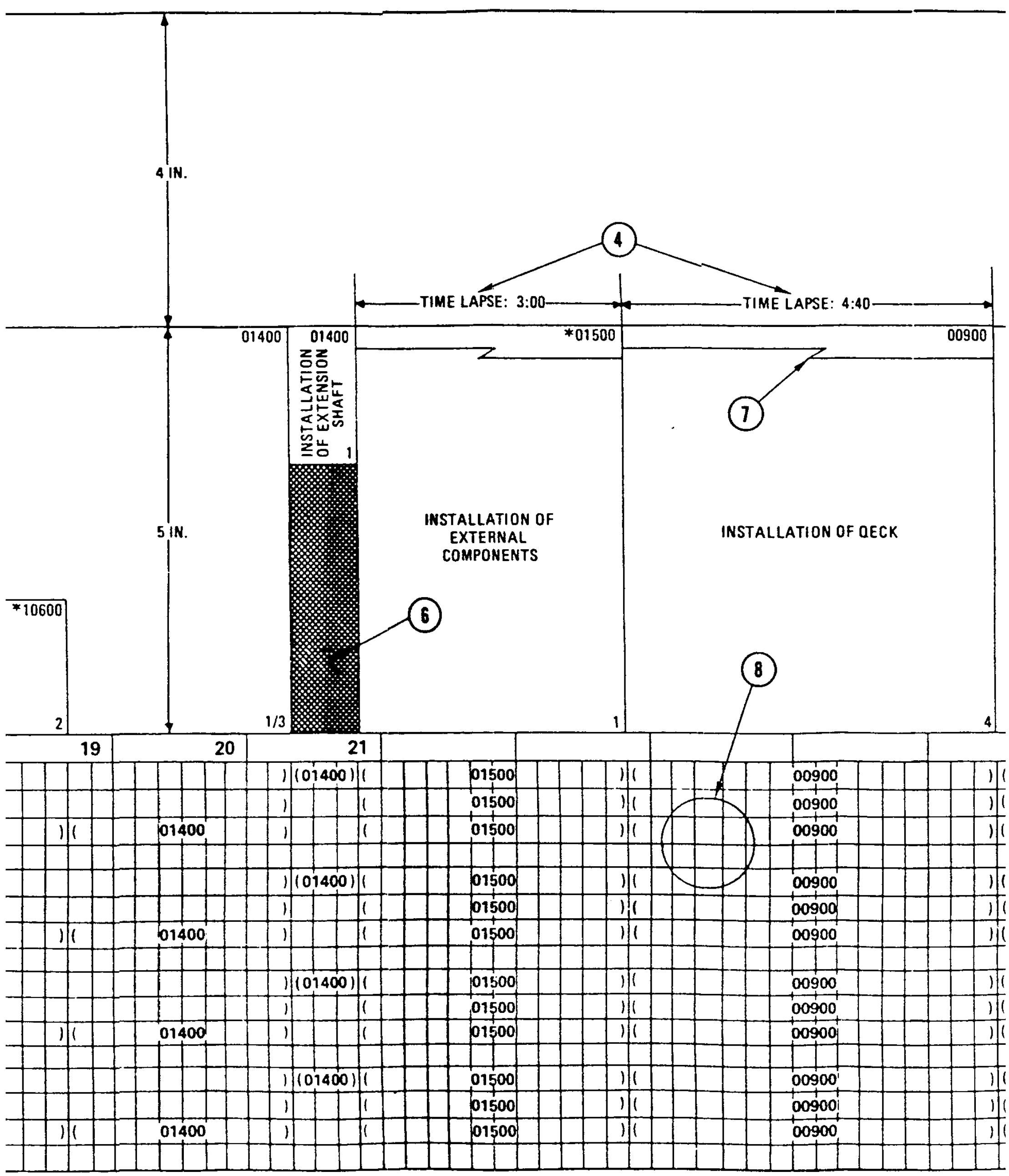


FIGURE 27. Example of a Sequence Control Chart - continued.

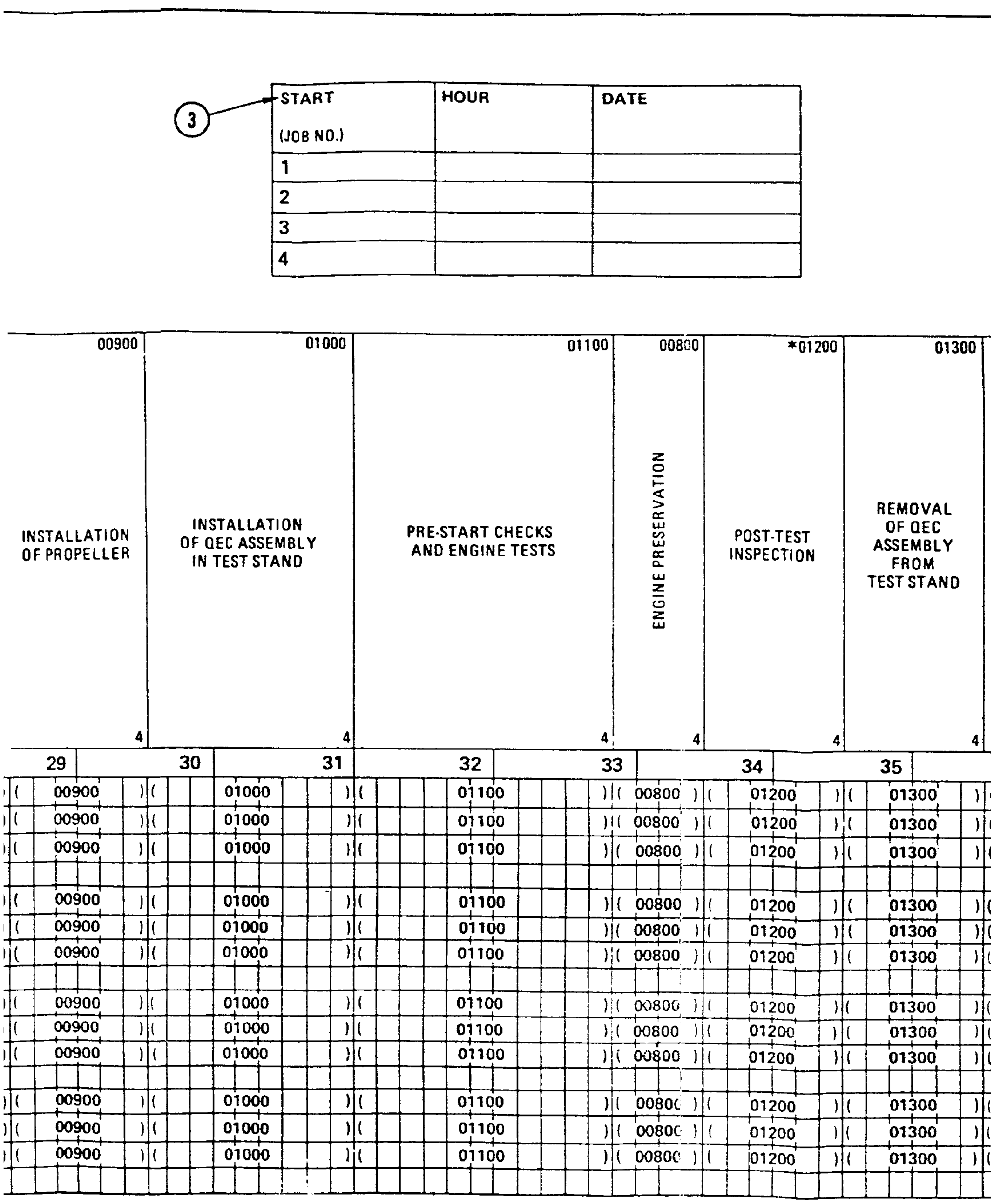


FIGURE 27. Example of a Sequence Control Chart - continued.

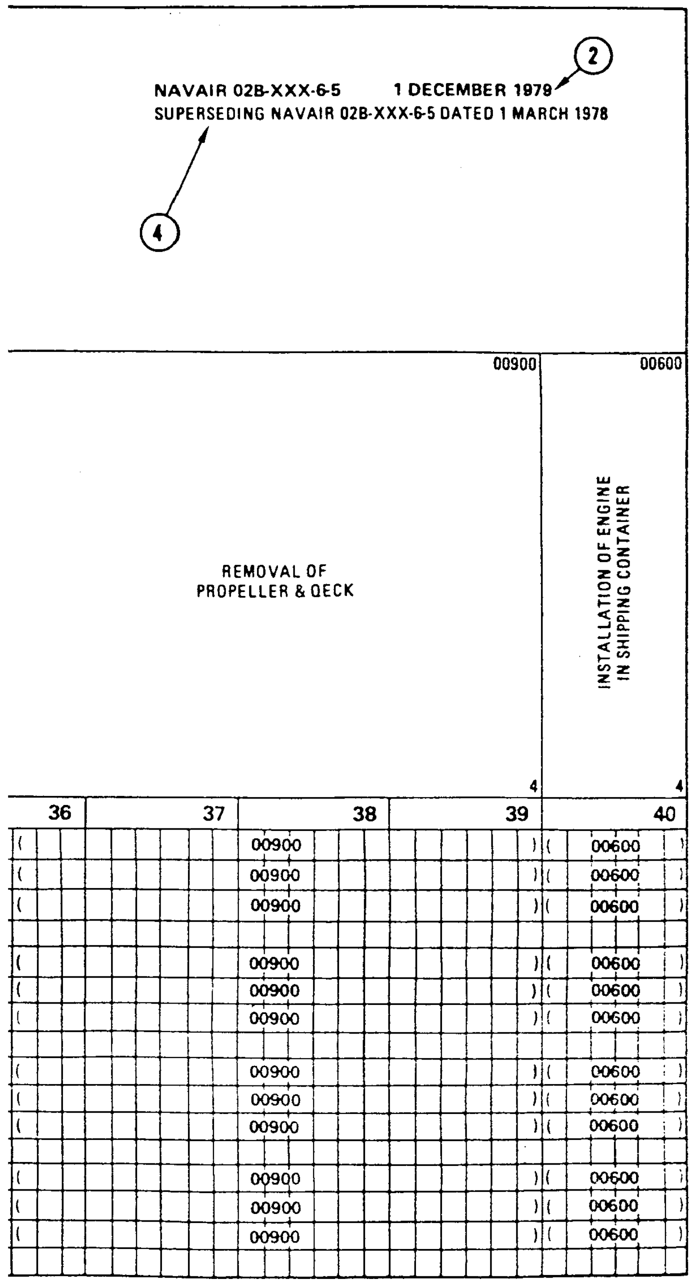


FIGURE 27. Example of a Sequence Control Chart - continued.

A1-AV8BB-SRM-200 **026 00**

1 October 1988

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

GENERAL INFORMATION

CRASH HANDLING

Reference Material

Airborne Weapons/Stores Loading Manual	A1-AV8BB-LWS-000
Line Maintenance Access Doors	A1-AV8BB-GAI-200
Alphabetical Index	WP 001 00
Line Maintenance Emergency Procedures	A1-AV8BB-GAI-300
Crew Removal	WP 003 00
Line Maintenance Procedures	A1-AV8BB-GAI-100
Electrical Power Application and Removal	WP 003 00
Hydraulic Power Application and Removal	WP 008 00
Aircraft Jacking	WP 024 00
Plane Captain Manual	A1-AV8BB-GAI-500
Safety Devices Required During All Ground Operations	WP 004 00

Support Equipment Required

Nomenclature	Part Number	CAGE Code
Aircraft Multiple Leg Hoisting Sling	75D110000-1001	42651
Airplane Crane Truck-Ashore	MB-1A	64580
Crane-Afloat	NS-60	82460
Salvage Trolley	-	-
Torque Wrench, 150 to 750 Inch Pounds	-	-
Wing Steadying Strap	-	-

1-1 **INTRODUCTION**

1-2 This work package contains information for recovery of a crash damaged aircraft.

2-1 **DESCRIPTION**

2-2 Every crash damaged aircraft will be evaluated on an individual basis and moved depending on surrounding terrain and aircraft condition. It may have to be raised, leveled or supported before being towed to a suitable location for further evaluation. The following paragraphs contain typical methods for moving crash damaged aircraft.

3-1 **SAFETY PRECAUTIONS**

CAUTION

Every attempt must be made to keep crash damaged aircraft from additional damage.

1. Emergency procedures for crew removal (A1-AV8BB-GAI-300).

2. Make sure hydraulic power is removed from aircraft (A1-AV8BB-GAI-100).

1

FIGURE 28. Example of a general aircraft structural information work package.

A1-F18AC-LMM-000 **026 00**

3. Make sure electrical power is removed from aircraft (A1-AV8BB-GAI-100).

4. Install ground safety devices (A1-AV8BB-GAI-500).

5. Make sure wing stores or external fuel tanks are removed (A1-AV8BB-LWS-000).

4-1 **CRASH DAMAGE INDEX**

4-2 A crashed aircraft may be in one or more of the following conditions. The determining factors will be location, amount of time to recover, and availability of equipment. Select method that is applicable.

5-1 **COMPLETE LANDING GEAR COLLAPSED**

5-2 This paragraph contains procedures, support equipment required and materials required for recovery of an aircraft with all landing gear collapsed.

1. Make aircraft safe (paragraph 3-1).

2. Move aircraft per applicable method listed below:

   a. Drag off (paragraph 9-1).

   b. Lifting

      (1) Lift aircraft by hoisting (paragraph 8-1) or jacking (paragraph 12-1).

      (2) Position salvage trolley under aircraft at CG location.

      (3) Tow aircraft to suitable location for further evaluation.

6-1 **NOSE LANDING GEAR COLLAPSED**

6-2 This paragraph contains procedures, support equipment required and materials required for recovery of an aircraft with the nose landing gear collapsed.

1. Make aircraft safe (paragraph 3-1).

2. Lift nose of aircraft per applicable method.

   a. Hoisting (paragraph 8-1).

   b. Jacking (paragraph 12-1).

3. Lower NLG or position salvage trolley under nose of aircraft.

4. Tow aircraft to suitable location for further evaluation.

2

FIGURE 28. Example of a general aircraft structural information work package - continued.

A1-F18AC-SRM-250 **003 00**
1 January 1995

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

TYPICAL REPAIR

MATERIAL PREPARATION

Support Equipment Required

Nomenclature	Part Number	CAGE Code
Scale, Balance, Trip, 0.10 Gram Graduations	-	-

Materials Required

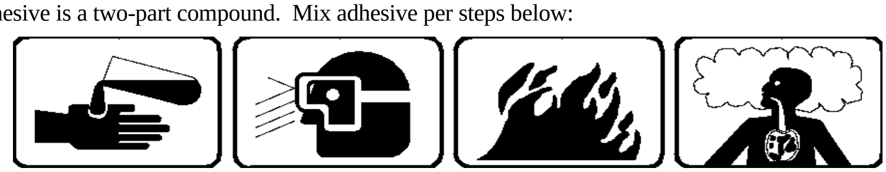
Nomenclature	Specification/Part Number	HMWS Index Number
Adhesive	EA956 A/B	9
Adhesive	EA9321 A/B	6
Adhesive	EA9396 A/B	8
Glass Fibers	-	-
Glass Floc, 0.070 + 0.040 Inch	-	-
Metal Spatula	GG-D-223	-
Paper Cup	UU-C-806, STYLE A, CLASS 1, TYPE 1 or 2	-
Rubber Gloves	ZZ-G-381	-

1-1 **INTRODUCTION**

1-2 This work package contains the materials and mixing procedures for making typical repairs.

2-1 **EA956 A/B ADHESIVE**

2-2 This adhesive is a two-part compound. Mix adhesive per steps below:



Adhesive, EA956 A/B **9**

NOTE

Mix only amount of materials that will be used in 40 minutes. Ambient temperatures in excess of 90°F, mix only amount of materials that will be used in 20 minutes. To avoid exotherm, mix no more than 5 cubic inches (approximately 100 grams) of this material at one time.

1. Combine 100 parts by weight of part A with 58 parts by weight of part B.

1

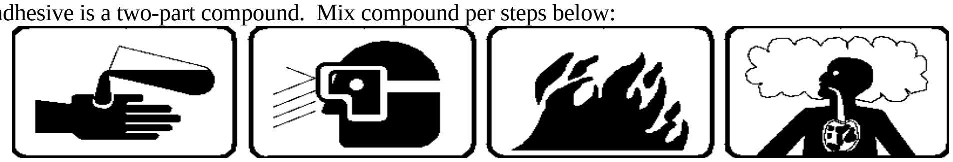
FIGURE 29. Example of a typical repair data work package.

2. Mix the two components thoroughly until a uniform color appears.

3. Allow adhesive to set for 5 minutes for air bubble removal before application.

3-1 **EA9321 A/B ADHESIVE**

3-2 This adhesive is a two-part compound. Mix compound per steps below:



Adhesive, EA9321 A/B **6**

NOTE

Mix only amount of materials that will be used in 40 minutes. Ambient temperatures in excess of 90°F, mix only amount of materials that will be used in 20 minutes. To avoid exotherm, mix no more than 5 cubic inches (approximately 180 grams) of this material at one time.

1. Combine 100 parts by weight of part A with 50 parts by weight of part B.

2. Mix the two components thoroughly until a uniform color appears.

NOTE

If repair procedure requires glass floc mixed with adhesive, do step 3.

3. Add 14 parts (by weight) chopped glass floc to mixed adhesive. Thoroughly mix chopped glass floc with adhesive.

4. Allow adhesive to set for 5 minutes for air bubble removal before application.

4-1 **EA9396 A/B ADHESIVE**

4-2 This adhesive is a two-part compound. Mix adhesive per steps below:

Adhesive, EA9396 A/B **8**

NOTE

Mix only the amount of material that will be used in 75 minutes. To avoid exotherm, mix no more than 250 grams of this material at one time.

1. Combine 100 parts by weight of part A with 30 parts by weight of part B.

2. Mix the two components thoroughly until a uniform color appears.

3. Allow adhesive to set for 5 minutes for air bubble removal before application.

FIGURE 29. Example of a typical repair data work package - continued.

A1-AV8BB -SRM-230 **029 00**

1 January 1996

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

STRUCTURE REPAIR

DAMAGE EVALUATION AND IPB

EXTERNAL HEAT SHIELD ASSEMBLY

This WP supersedes WP029 00, dated 1 October 1995.

Reference Material

Nondestructive Inspection Methods	NAVAIR 01-1A-16
Structure Repair – Repairs and Replacement	A1-AV8BB-SRM-250
Fastener and Fastener Hole Repairs	WP 005 00
Fire Shield and Heat Shield Repairs and Replacements Index	WP 021 00

1-1 **INTRODUCTION**

1-2 This work package contains damage evaluation, damage limits, repair index and parts and material index on the aft center fuselage external heat shields. The external heat shields are interchangeable assemblies.

2-1 **ILLUSTRATED PARTS BREAKDOWN (IPB)**

2-2 Figure 1 lists and identifies parts and materials used on the heat shield bracket assembly.

3-1 **DAMAGE EVALUATION**

3-2 For damage evaluation of the aft center fuselage external heat shields, see the paragraphs below.

3-3 **ORGANIZATIONAL**. Visual inspection of dents, gouges, cracks, loose or missing fasteners, and wear at heat shield attachments.

3-4 **INTERMEDIATE**. Nondestructive inspection of visible damage using ultrasonic inspection (NAVAIR 01-1A-16). Damage evaluation past this level of maintenance will not be necessary until the structural integrity values of the heat shield are in question.

3-5 **DEPOT**. Damage at this level will be determined on an individual basis.

4-1 **DAMAGE LIMITS**

4-2 For damage limits on the aft center fuselage external heat shields, see the paragraphs below. The limits for specified damage will be as follows, provided the structural integrity values of the part in question are not decreased.

4-3 **ORGANZATIONAL**. Loose or missing fasteners will be replaced as needed. Cracks are limited to 4 inches in length anywhere on the aft portion of the heat shield. Maximum freeplay of heat shield is 0.025, measured at aft end of each portion. Wear that exceeds 0.025 will require repair or replacement of worn parts. Worn links/brackets/angles will be reamed to next applicable sizes or replaced. Any worn bolts/pins/collars on the aft portion of the heat shield that are below minimum limits will be replaced (A1-AV8BB-SRM-250).

4-4 **INTERMEDIATE**. Damage limits at this level of maintenance will be determined on an individual basis according to the size and extent of repair required past the organizational level of maintenance.

1

FIGURE 30. Example of a specific repair data work package.

A1-AV8BB -SRM-230 **029 00**

4-5 **DEPOT**. Damage limits at this level of maintenance will be determined on an individual basis according to the size and extent of repair required past the organizational and intermediate levels of maintenance.

5-1 **REPAIR INDEX**

5-2 All repairs to the external heat shields that are approved are listed below. The repairs are listed under each maintenance level to show where the repair can be done.

5-3 **ORGANIZATIONAL**. Maintenance of this level will include the repairs listed below.

5-4 **Loose Or Missing Fastener Replacement**

5-5 For fastener repairs (A1-AV8BB-SRM-250).

5-6 **Aft External Heat Shield Repair**

5-7 For heat shield repair (A1-AV8BB-SRM-250).

5-8 **Aft External Heat Shield Links/Pins Repair**

5-9 This repair is good on ships up to 163853. There are two types of repairs approved. One repair uses bolts and nuts, the other uses manufactured repair pins. Both repairs can be used in any and all situations. The wear limits for links/brackets are given in Table 1 (A1-AV8BB-SRM-250). The maximum wear limit is given in each case. Any measurement that exceeds that limit will require the link/bracket to be reamed to the next applicable size hole, or replaced. Disconnect links at position 6, 10, 11, 14 and 15. The wear limits of the bolts/pins are given in Table 2. The minimum wear limit is given in each case. Any measurement that drops below that limit will require replacement of the bolt/pin. For repair (A1-AV8BB-SRM-250).

5-10 **Support Link Bracket No. 9 Replacement**

5-11 Bracket No. 9 should be replaced only if the fasteners become loose. This replacement occurs only on ships 161573 thru 162973. For repairs (A1-AV8BB-SRM-250).

5-12 **Extension of Heat Access Panel**

5-13 For extension procedures (A1-AV8BB-SRM-250).

5-14 **Forward External Heat Shield Attachment Angle Repair**

5-15 If attach angles on forward heat shield become worn at pin locations, the attach angle slots for pins and collars should be oversized and fitted with nuts and bolts or replaced. For repairs (A1-AV8BB-SRM-250).

5-16 **INTERMEDIATE**. Maintenance at this level will include all the repairs at the organizational level. At this time there are no specific repairs approved for this level. Repairs will be based on an individual basis.

5-17 **DEPOT**. Maintenance at this level will include all the repairs at the organizational and intermediate level. At this time, there are no specific repairs approved for this level. Repairs will be based on an individual basis.

2

FIGURE 30. Example of a specific repair data work package - continued.

A1-AV8BB -SRM-230 **029 00**

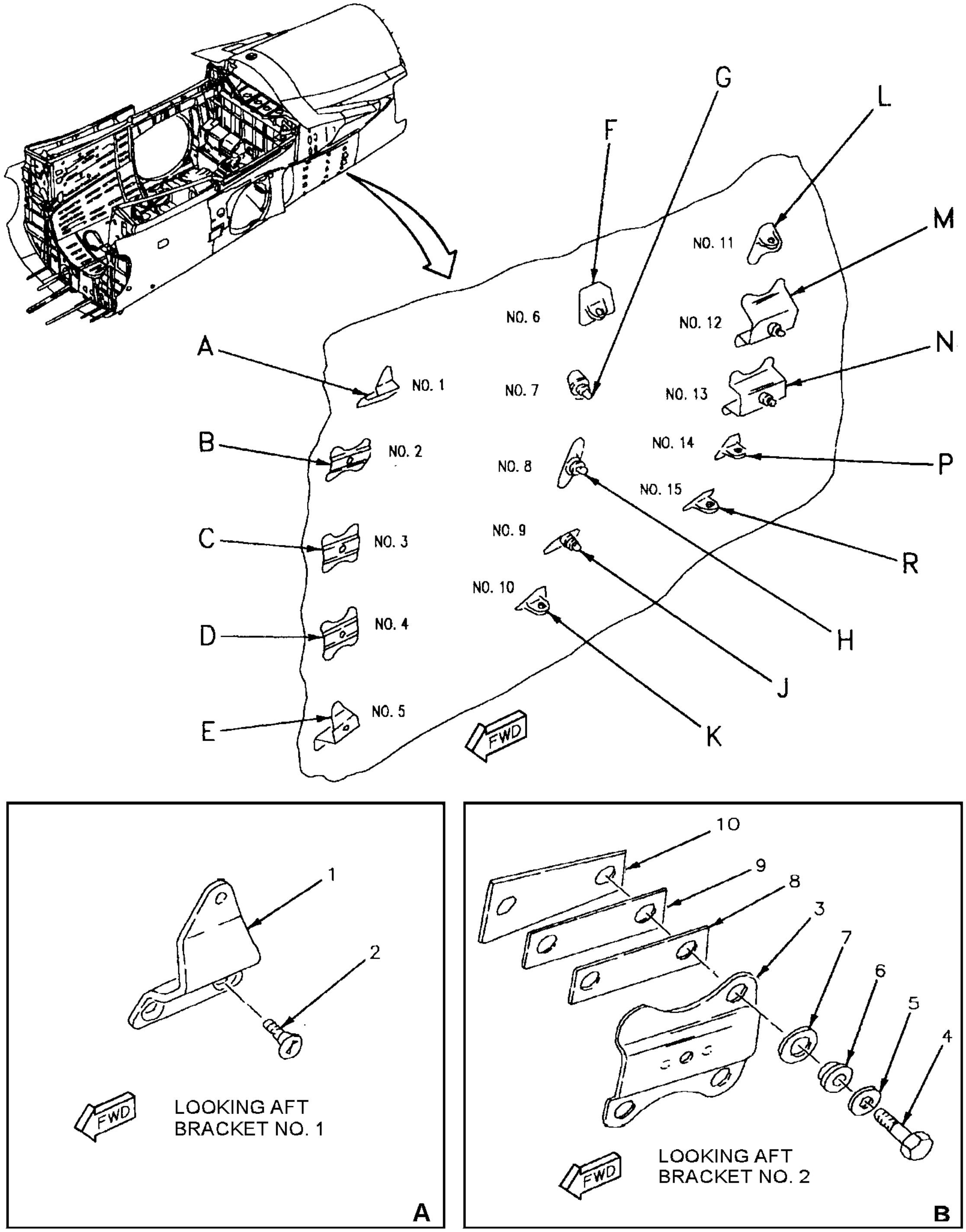


Figure 1. Heatshield Bracket Assembly, AV-8B-161573 thru 164547, TAV-8B-162747 and up (Sheet 1).

3

FIGURE 30. Example of a specific repair data work package - continued.

A1-AV8BB -SRM-230 **029 00**

INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	MAT	STOCK SIZE	UNITS PER ASSY	USE ON CODE	SM&R CODE
	75A327108-1003	HEATSHIELD BRACKETS-ASSY OF					
		LH (K0289) (NHA, WP028 00, FIG 3)....			REF	A	XCOZZ
	75A327108-1005	SEE ABOVE LH...			REF	B	XCOZZ
	75A327108-1007	SEE ABOVE LH...			REF	C	XCOZZ
	75A327108-1009	SEE ABOVE LH...			REF	K	XCOZZ
	75A327108-1004	SEE ABOVE RH			REF	A	XCOZZ
	75A327108-1006	SEE ABOVE RH			REF	B	XCOZZ
	75A327108-1008	SEE ABOVE RH			REF	C	XCOZZ
	75A327108-1010	SEE ABOVE RH			REF	K	XCOZZ
	75A327108-1003	• BRACKET NO. 1 LH (K0289)			1		PAOZZ
	75A327108-1004	• •SEE ABOVE RH.....................................			1		PAOZZ
	75A327108-2005	• •BRACKET LH (K0289)..........................			1		XBOZZ
1	75A327108-2006	• •BRACKET RH (K0289)..........................			1		XBOZZ
	MS21060L5	• •PLATENUT (USE WITH INDEX 1)			1		PAOZZ
	75A327481-2003	• •PACKING LH (USE WITH			1		XBOZZ
		INDEX 1)					
	75A327481-2004	• •PACKING RH (K0289) (USE WITH			1		XBOZZ
2	NAS663V3HT	INDEX 1)..			3		PAOZZ
	MS2106013	BOLT			3		PAOZZ
		PLATENUT (USE WITH INDEX 2)...........					

4

FIGURE 30. Example of a specific repair data work package - continued.

A1-F18AC-SRM-500 **003 00**

1 February 1995

ORGANIZATIONAL MAINTENANCE

AIRCRAFT CORROSION CONTROL

GENERAL INFORMATION

Reference Material

Cleaning	WP 006 00
Stripping	WP 007 00
Chemical Treatment	WP 008 00
Priming Procedures	WP 011 00
Finish System	WP 012 00
Aircraft Weapons Systems Cleaning and Corrosion Control	NAVAIR 01-1A-509
Plane Captain Manual	A1-F18AC-PCM-000

Materials Required

Nomenclature	Part Number	HMWS Index Number
Paper, Kraft, Untreated	A-A-203	-
Plastic Sheet	LP378TY1	-
Tape, Adhesive	MIL-T-21595 TYPE 1	-
Tape, Insulation	421	-
Tape, Pressure Sensitive	MIL-T-23397 II	-
Tape, Pressure Sensitive	425	-

1-1 **DESCRIPTION**

1-2 The F/A-18A, B, C and D aircraft are a composition of aluminum, graphite epoxy, fiberglass, titanium, and steel. The airframe is primarily made of aluminum. Graphite epoxy composite and fiberglass are used for many skins and doors. Titanium is also used for skins and doors. Where maximum strength is required, beta annealed bar, plate, and forgings are used. High strength steel is used in landing and arresting gear. Hydraulic tube assemblies are titanium.

1-3 **TYPES OF CORROSION**. Information on types of corrosion, cause, and appearance is contained in NAVAIR 01-1A-509.

1-4 **PROTECTIV E COVERS**. Protective covers are necessary to aid in protecting aircraft during non-operational times. Protective covers are required for corrosion control. Procedures for installation and removal are contained in A1-F18AC-PCM-000, ground protective devices.

1-5 **SAFETY PRECAUTIONS**

1. Avoid extended breathing of solvent vapors. If this is impossible, wear a respirator.

1

FIGURE 31. Example of a typical corrosion control repair work package.

A1-F18AC-SRM-500 **003 00**

2. Do not use solvents in vicinity of smoking, sparks or open flames. Flammable solvents are extremely easy to ignite and fires may occur with explosive violence. After using flammable solvents, be certain that no traces linger on clothes or person before entering a smoking area.

3. Wear safety glasses or goggles, and rubber gloves while working with solvent.

4. Do not smoke while working with flammable solvents or while in a no-smoking area.

5. Bare filament heaters or other sources of ignition, including metal objects on shoes, are prohibited in flammable solvent areas. Electrical equipment, including flashlights, should be explosion proof. Avoid any action which may create sparks, including dragging of steel drums, metal work stands or similar objects across a concrete floor.

6. Any area larger than one square foot cleaned with a cloth moistened with a flammable solvent should be grounded during cleaning operation.

7. Isolate flammable solvent storage areas from areas of fire hazard. Electrically ground all equipment in storage area. Electrically bond dispensing and receiving containers to each other while transferring flammable solvents between containers.

8. Store and handle solvents in properly labeled safety containers and keep them closed while not in use.

9. Store solvents in cool, well ventilated areas.

10. Do not use heat producing devices to accelerate drying.

11. Dispose of all used rags, cloths, in safety disposal containers.

12. When using solvents, to reduce fire/toxic hazards, only amounts needed for short period of time should be available in work area.

13. Avoid eye/skin contact when using accelerator components because they contain reactive oxides and solvent blends which are flammable, toxic, and irritant.

14. Avoid contact with liquid nitrogen. Skin contact will cause severe destruction of body tissue by freezing.

15. Gloves are required to handle containers after removal from liquid nitrogen.

16. Spray operators must wear respirators during spray applications. Coveralls and protective barrier cream applied to bare skin is required for personal protection.

17. Only spray operator(s) will be permitted in overspray area.

18. After each job, or before break periods, spray operator(s) must thoroughly wash all exposed areas of skin using soap and water.

19. No food or drink should be allowed in or near solvent, sealant, or spray areas.

20. When using chemical treatment, protective equipment must be worn, because solution is acidic and contains fluorides.

21. Stripper specified in this manual will burn skin on contact. Adequate protective clothing, including face shield and rubber gloves, should be worn. If stripper contacts eyes, flush with water for 15 minutes and seek medical aid.

2

FIGURE 31. Example of a typical corrosion control repair work package - continued.

A1-F18AC-SRM-500 **003 00**

1-6 **MASKING**

1-7 **Windshield/Canopy Transparency Double Masking**

NOTE

Windshield/canopy transparencies must be double masked when cleaning (WP 006 00), stripping (WP 007 00), chemical treatment (WP 008 00), priming procedures (WP 011 00) and finish system (WP 012 00) is applied.

1. Cut one piece of plastic sheet slightly smaller than windshield transparency.
2. Cut one piece of plastic sheet slightly smaller than canopy transparency.
3. Tape plastic sheet around periphery of surrounding structure using 425 tape.
4. Cut one piece of plastic sheet slightly larger than windshield transparency.
5. Cut one piece of plastic sheet slightly larger than canopy transparency.
6. Position periphery of plastic sheets slightly beyond previously applied plastic sheets.
7. Apply 425 tape around periphery of plastic sheets overlapping previously applied tape.
8. Make sure all seams of tape are secure to structure to prevent any damaging materials from entering.

1-8 **Nonmetallic Surfaces Double Masking**

NOTE

Nonmetallic surfaces require double masking when: cleaning (WP 006 00), stripping (WP 007 00) or chemical treatment (WP 008 00).

1. Cut one piece of plastic sheet slightly smaller than area to be covered.
2. Tape plastic sheet around periphery of surrounding structure using 421 or MIL-T-23397 tape.
3. Cut one piece of plastic sheet slightly larger than area to be covered.
4. Position periphery of plastic sheet slightly beyond previously applied plastic sheet.
5. Apply 421 or MIL-T-23397 tape around periphery of plastic sheet overlapping previously applied tape.
6. Make sure all seams of tape are secure to structure to prevent any damaging materials from entering.

1-9 **General Masking of Aircraft**

1-10 Untreated kraft paper applied with MIL-T-21595 tape is used to cover areas not receiving cleaning (WP 006 00), stripping (WP 007 00), chemical treatment (WP 008 00), priming (WP 011 00) or finish system (WP 012 00).

NOTE

Areas too small for untreated kraft paper may be masked with MIL-T-21595 tape only.

3

FIGURE 31. Example of a typical corrosion control repair work package - continued.

A1-F18AC-SRM-300 **003 00**

1 December 1992

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

GENERAL INFORMATION

Reference Material

Daily/Special/Preservation Maintenance Requirements Cards... A1-F18AC-MRC-200
Daily/Special/Preservation Maintenance Requirements Cards... A1-F18AE-MRC-200

1-1 **INTRODUCTION**

1-2 This work package contains information related to nondestructive inspection of aircraft structure and structural components. Nondestructive inspection personnel should be familiar with this information because some is not repeated or referenced in typical or specific procedure work packages, for example, frequency of nondestructive inspections.

2-1 **FREQUENCY OF NONDESTRUCTIVE INSPECTION**

2-2 Established inspection frequency for aircraft structure or structural components is contained in (A1-F18AC-MRC-200 or A1-F18AE-MRC-200).

3-1 **EXAMPLES OF DEFECTS**

3-2 See figure 1. Defects that may develop in laminates and bonded honeycomb assemblies are shown to aid nondestructive inspection personnel in definition of suspected defects identified in specific procedure work packages.

1

FIGURE 32. Example of a nondestructive inspection general information work package.

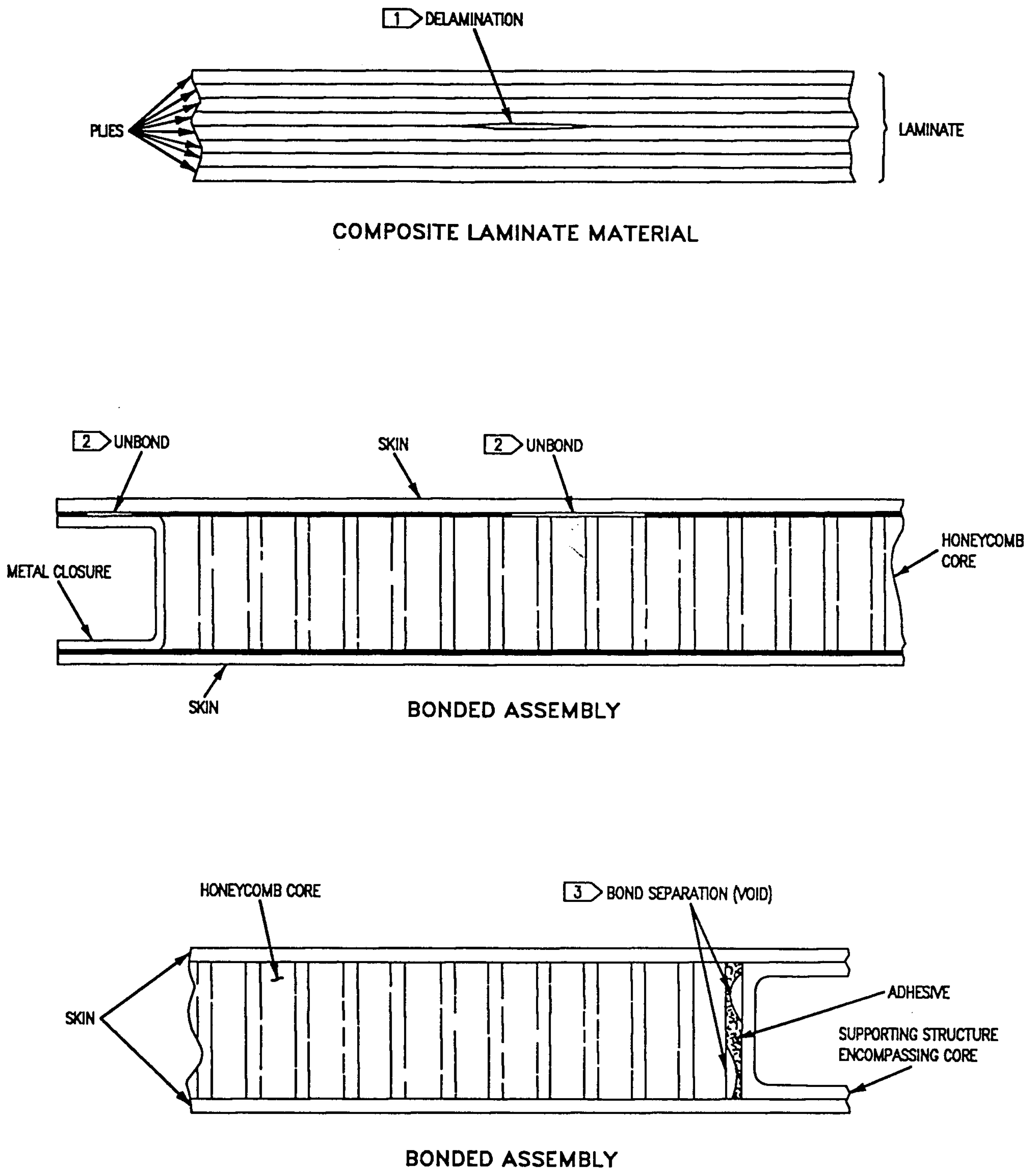


Figure 1. Examples of Defects That May Develop in Laminates and Bonded Honeycomb Assemblies.

2

FIGURE 32. Example of a nondestructive inspection general information work package - continued.

A1-F18AC-SRM-300 **004 00**

1 December 1992

ORGANIZATIONAL MAINTENANCE

NONDESTRUCTIVE INSPECTION

PENETRANT METHOD

Reference Material

Aircraft Corrosion Control	A1-F18AC-SRM-500
Stripping........	WP 007 00
Military Specification, Inspection Materials, Penetrant........	MIL-I-25135, REV E or Most Current
Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection methods	NAVAIR 01-1A-16
Plane Captain Manual	A1-F18AC-PCM-000

Support Equipment Required

Nomenclature	Part Number	CAGE Code
Black Light Capable of 1000MW Over 6 Inch Circle 15 Inches from Bulb Face	(M-16)	42201
Portable Fluroescent	ZA43 Penetrant Inspection Kit	54620
Ultraviolet Meter	J-221	62040

Materials Required

Nomenclature	Specification/Part Number	HMWS Index Number
Cleaning Cloth	CCC-C-46, TYPE I, CLASS 4	-
Penetrant, Type 1, (Fluorescent), Method C, (Solvent Removable), Sensitivity Level 2 or 3, Class 2, Solvent Remover (Non-halogenated) and Nonaqueous Developer	MIL-I-25135	-
1,1,1-Trichloroethane	0-T-620 TY1	12
Tube Type marker	673T	-

1

FIGURE 33. Example of a nondestructive inspection typical procedures work package.

A1-F18AC-SRM-300 **004 00**

1-1 **INTRODUCTION**

1-2 Penetrant inspection is nondestructive inspection for discontinuities open to surface in parts made of nonporous materials. This is done by treating surface area with fluid which penetrates surface discontinuity. Excess penetrant not in discontinuity is removed and penetrant remaining in discontinuity returns to surface by capillary action. Developer is applied to provide contrasting surface, and through absorption forms indication large enough to be visible to eye. Visual indications become distinct by fluorescence of penetrant under black light. This method is effective for detecting defects open to surface in forgings, castings, extrusions, formed sections, webs, and skins of ferrous or nonferrous material. Penetrant method of inspection requires surface inspection area be thoroughly cleaned and stripped of paint or other surface coatings, for example, dry film lubricant.

2-1 **SAFETY PRECAUTIONS**

1. Make sure safety requirements have been met before using electrical equipment near aircraft fuel cells, oxygen systems, and stores (A1-F18AC-PCM-000).

2. Refer to NAVAIR-01-1A-16 for other safety precautions to be followed when doing penetrant inspection.

2-2 **PERSONNEL QUALIFICATIONS**. Personnel doing this nondestructinve inspection should be qualified and certified to do penetrant inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

3-1 **LIGHTING REQUIREMENTS**

1. In inspection booth, white light should be less than 2 foot-candles and black light intensity should be at least 1000 micro-watts at surface of part. When checking background white light intensity, black light must be turned off or removed from inspection area.

2. For on-aircraft inspections, surface under inspection must be heavily shaded, and black light should be held close as possible to ensure bright indication. To inspect lighting adequacy, use pin or other sharp object to draw thin line of penetrant on part near inspection area. This line should be bright and distinct.

4-1 **PREPARATION OF PART**

CAUTION

Do not do prepenetrant etching on steel parts. Acid used for etching can cause embrittlement or corrosion of critical structure.

1. Part must have finish system removed before inspection. Refer to specific procedure work package for details. If specific procedure work package does not exist, chemically remove finish system (A1-F18AC-SRM-500).

1,1,1-Trichloroethane, 0-T-620TY1 **12**

2. Clean inspection area(s) with solvent-moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

2

FIGURE 33. Example of a nondestructive inspection typical procedures work package - continued.

A1-F18AC-SRM-300 **004 00**

5-1 **INSPECTION PROCEDURE**

CAUTION

Abrasive removal of material by grinding, sanding, or polishing at crack area will cause metal to be smeared in surface of crack resulting in hidden flaws. If inspection surface has been mechanically worked before inspection but after most recent aircraft flight, penetrant inspection should not normally be done unless surface is etched to remove smeared metal. Etching should not be done without depot engineering disposition.

1. Do Fluorescent Penetrant Inspection (NAVAIR 01-1A-16). Penetrant materials should conform to MIL-I-25135, Revision E. Refer to specific work package for type, method, and sensitivity level. If specific work package does not exist, or materials are not specified, use type I, Method A, sensitivity level 2 or 3. Penetrant designated in latest revision to qualified products list of MIL-I-25135.

2. Apply penetrant to area to be inspected by spraying, brushing or wiping.

3. Allow penetrant to dwell for time listed below:

Part or Ambient Air Temperature	Time
Above 120°F	Do not inspect
100 -120°F	15 minutes
60 - 100°F	30 minutes
40 - 60°F	60 minutes
Below 40°F	Do not inspect

1,1,1 – Trichlorothane, O-T-620 TYI **12**

4. Remove pentrant with non-haologenated solvent recommended by penetrant manufacturer or with solvent moistened cloth.

5. Apply Form D nonaqueous developer.

6-1 **INTERPRETATION**

1. Initial interpretation should be immediately after developer has dried. Allow developer to dwell for minimum of 5 minutes but not more than 30 minutes before making final interpretation.

2. Interpretation should be done with naked eye unless specific procedure work package instructs use of magnification.

3. Mark all linear indications detected. Linear indications are defined as those having length: width ratio greater than or equal to 3:1. Rounded indications should not be cause for evaluation unless stated in specific procedure work package or unless rounded indications form line that could indicate partially closed crack.

7-1 **ACCEPTANCE LIMITS**

1. Evaluation of all indications should be done using acceptance limits for inspection area listed in specific procedure work package. If this information is not included in specific procedure work package, refer to structural repair manual (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) damage limits for specific inspection area.

3

FIGURE 33. Example of a nondestructive inspection typical procedures work package - continued.

A1-AV8BB-SRM-300 **013 00**

1 September 1991

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

EDDY CURRENT: SURFACE INSPECTION OF ALUMINUM

Reference Material

Eddy Current: Hole Inspection	WP 014 00
Plane Captain Manual	A1-AV8BB-GAI-500
Electrical (Static) Grounding	WP 007 00

Support Equipment Required

Nomenclature	Part Number	CAGE Code
Circle Template	-	-
Eddy Current Flaw Detector	ED-520	64241
Reference Block	64900-E/C STD	52546

Materials Required

Nomenclature	Specification/Part Number	HMWS Index Number
Cloth, Cleaning	Rymple Cloth 301-Purified	-
Marker, Tube Type	673-T	-
Solvent, Dry Cleaning	P-D-680, Type 2	4

1-1 **INTRODUCTION**

1-2 This work package defines the safety requirements, surface preparation, ED-520 instrument setup and the procedure for doing surface inspections and fastener inspections.

2-1 **SAFETY REQUIREMENTS**

2-2 Make sure the safety requirements have been met before using electrical equipment near aircraft fuel cells, oxygen systems and stores (A10AV8BB-GAI-500).

3-1 **SURFACE INSPECTION**

3-2 Eddy current surface inspection is a nondestructive means of getting information on material variables, for example, alloy type, hardness, heat treat condition, thickness, cracks, and so forth. The information below describes the requirements to do an eddy current surface inspection to detect flaws in aluminum. Eddy current inspections should be done at the organizational level using intermediate level resources.

1

FIGURE 34. Example of a nondestructive inspection specific procedures work package.

A1-F18AC-SRM-300 **013 00**

4-1 **SURFACE PREPARATION**

Drycleaning Solvent, P-D-680, Type 2 **4**

1. Clean surface of inspection area of all foreign matter, grease, and oil using dry cleaning solvent.

5-1 **ED-520 TESTER SETUP**

NOTE

When using battery power, if needle does not move above red line and maintain a steady reading, recharge batteries.

1. Plug in tester or use batteries.
2. Connect probe. See specific work package for probe type.
3. Set FUNCTION switch to MED.
4. Position probe on part at designated reference point or on surface of 64900-E/C STD reference block. See WP 014 00, figure 1.
5. Turn SENSITIVITY INC counterclockwise to minimum.
6. Turn LIFT-OFF/FREQ and BALANCE controls counterclockwise to zero.
7. Turn BALANCE control to set meter pointer on scale.
8. If the BALANCE control does not bring the meter needle on scale, return the BALANCE control to zero and then turn the LIFT-OFF/FREQ knob to 0.2 of a turn (revolution), then repeat step 7.
9. If required, repeat step 8 to bring the meter needle on scale. After the meter needle is on scale, slowly turn the LIFT-OFF/FREQ knob counterclockwise to cause an up-scale needle movement.
10. Continue clockwise rotation of the LIFT-OFF/FREQ knob (adjusting the balance knob as required to keep the meter needle on scale) until the meter needle reaches a peak and starts to move in a down-scale direction.
11. When the meter needle goes from up-scale to a down-scale direction, decrease the LIFT-OFF/FREQ setting by turning the knob 0.2 turn (revolution) in the counterclockwise direction for non-shielded probes. For ferrite shielded probes, turn the knob in the same direction as before, except to 0.4 turn (revolution). At this point, the instrument should be nearly set for the 0.003 of an inch of lift-off compensation. Insert a piece of writing paper between the bare material and the eddy current probe and adjust the balance if required.
12. Remove the piece of paper from under the probe and note the direction and amount of needle movement. Adjust the LIFT-OFF/FREQ control to cause the meter needle movement to move about the same amount and direction.

2

FIGURE 34. Example of a nondestructive inspection specific procedures work package - continued.

13. Repeat steps 11 and l3 until no needle movement occurs when the piece of paper is removed from between the probe and the bare material.

14. Lock the LIFT-OFF/FREQ control.

15. Select MED mode as required to get the required inspection sensitivity. The sensitivity adjustment may require adjustment after this is done. Place the probe on the part to be inspected and adjust the BALANCE control if required. The instrument is now adjusted for 0.008 of an inch intermediate layer lift-off compensation.

    a. Using reference block, position probe on surface of block having greater conductivity, away from holes and edges. Record reading.

    b. Position probe on the half of the reference block having the lower conductivity and record reading.

NOTE

The difference in microamperes should be approximately 120 microamperes.

    c. If difference in microamperes is outside the range noted above, adjust meter deflection with SENSITIVITY screw.

6-1 **SURFACE INSPECTION PROCEDURE**.

1. If required, place probe on part to be inspected and adjust the BALANCE CONTROL to locate the meter pointer at 250. Scan part by moving probe over surface at a rate of approximately 12 inches per minute.

NOTE

Paint thickness variations will cause meter deflections. These deflections will not be as sharply defined as responses from cracks. Part thickness changes and edges will cause meter deflections as sharply defined as cracks.

2. For comparison purposes, mark with marker any part thickness changes machined subsurface edges on surfaces of part.

NOTE

Sharp movements down scale are characteristic of crack indications. Up scale deflections are not significant.

3. If balance point moves down scale when probe is near the edge of part, turn BALANCE control to return needle to 250 microamperes.

4. Set FUNCTION switch to LO and rescan areas that gave off scale meter indications with FUNCTION switch set to MED.

5. Set FUNCTION switch to HI and rescan areas giving extremely small meter indications with FUNCTION switch set to MED.

6. Move probe back and forth in suspected area of cracks.

3

FIGURE 34. Example of a nondestructive inspection specific procedures work package - continued.

7. Mark with marker area where meter needle deflection is at least twice as great as variation taken during probe movement on the standarization surface.

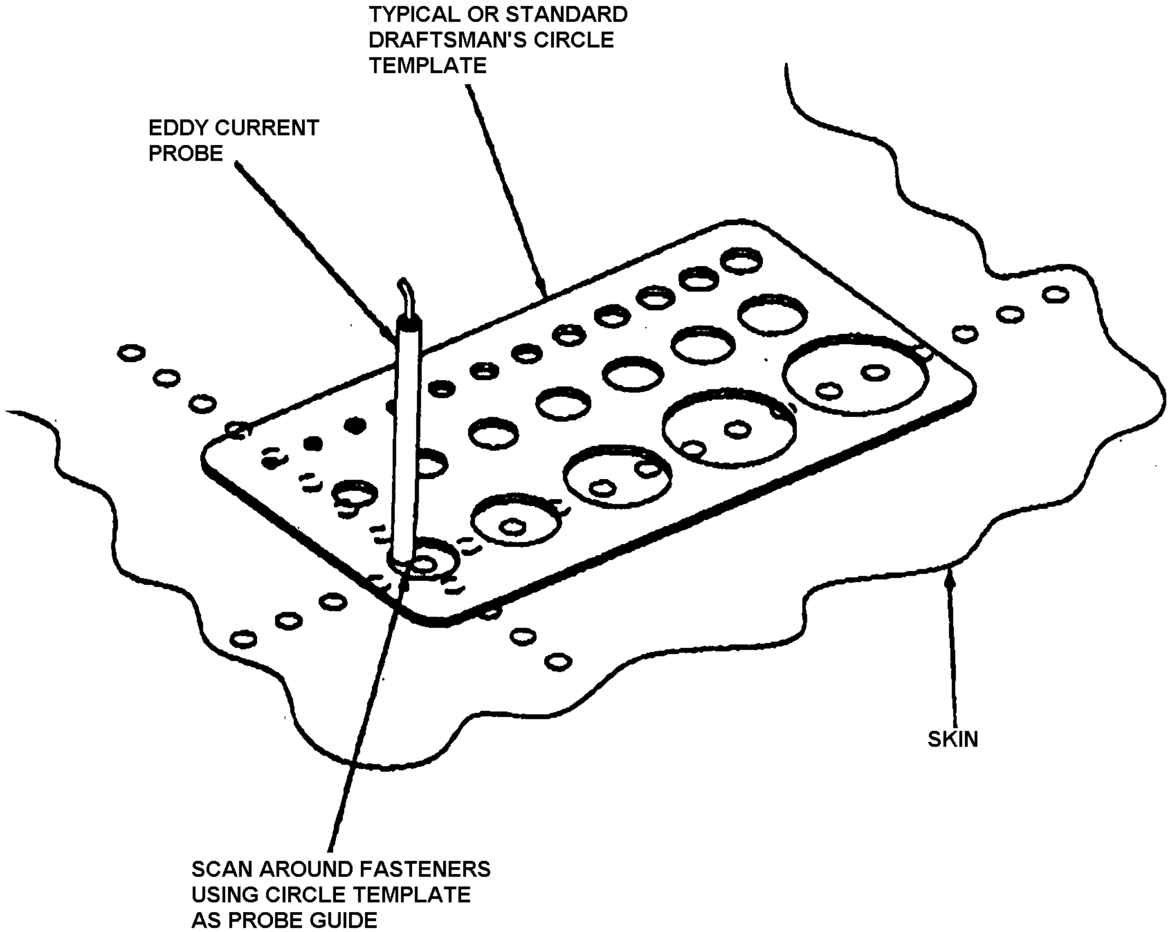


Figure 1. Eddy Current Scanning Around Fasteners Using Circle Template as Probe Guide.

FIGURE 34. Example of a nondestructive inspection specific procedures work package - continued.

TABLE A-I. GENERAL AIRCRAFT INFORMATION MANUAL, PLANE CAPTAIN'S MANUAL AND LINE MAINTENANCE MANUAL

TM CONTENTS	MIL-STD-3001 REFERENCE	ELEMENT NAME	DTD REQ'D/OPT	REMARKS
TM FRONT MATTER	1-B.5.3.1		R	
Title page	1-B.5.3.1.1	<titlepg>	R	
Numerical index of effective work packages/pages	1-B.5.3.1.2	<niewp>	R	
TPDR page	1-B.5.3.1.3	<tpdrpg>	O	
HMWS page	1-B.5.3.1.4	<hmwspg>	O	
Alphabetical index	1-B.5.3.1.5	<alphaindxwp>	O	
TM introduction	1-B.5.3.2.1.3.3	<introwp>	R	
Consolidated lists for technical directives, support equipment, materials and references WP	1-B.5.3.2.1.3.4	<consolistwp>	R	
WORK PACKAGE FRONT MATTER				
Title block				
Work package information	2-5.2.1	<titleblk>	R	
Reference material list	2-5.2.2	<wpinfo>	R	
Record of applicable technical	2-5.2.2.1	<reflist>	O	
directives	2-5.2.2.2	<ratd>	O	
Support equipment required list				
	2-5.2.2.3	<selist>	O	
DESCRIPTION WORK PACKAGES	2-5.2.4.1		R	
Introduction	2-5.2.4.1	<intro>	O	
Aircraft general description work package	2-5.2.4.1.1	<acdescwp>	O	
Aircraft description	2-5.2.4.1.1.1	<acdesc>	R	
Aircraft dimensions	2-5.2.4.1.1.2	<acdim>	R	
Aircraft materials distribution	2-5.2.4.1.1.3	<acmats>	R	
Aircraft arrangement work package	2-5.2.4.1.2	<acarrgwp>	O	
Aircraft systems description work package	2-5.2.4.1.3	<acsysdescwp>	O	
Aircraft instrument panel location work package	2-5.2.4.1.4	<acpnlwp>	O	
Danger areas and precautionary measures work package	2-5.2.4.1.5	<dangarwp>	O	
Aircraft stations work package	2-5.2.4.1.6	<acstawp>	O	
Aircraft dimensions work package	2-5.2.4.1.7	<acdimwp>	O	
Aircraft access and inspection panels and provisions work package	2-5.2.4.1.8	<acacesswp>	O	
Aircraft external power source connections work package	2-5.2.4.1.9	<acextpwrwp>	O	

FIGURE 35. Example of a partial TM technical content selection matrix.

```
<!DOCTYPE GENACIM PUBLIC "-//USA-DOD//DTD genacim 3001 Part 2 199801//EN" [
<!ENTITY DOC2 SYSTEM "pt2samp2.sgm" NDATA SGML>
<!ENTITY figure SYSTEM  NDATA CGM>
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<PRTITLE><MAINTLVL>Organizational Maintenance</MAINTLVL>
<SUBJECT>Aircraft Description</SUBJECT>
</PRTITLE>
<WPNOTICES><SUPER><PARA>This WP supersedes WP003 00, dated 15 August 1992</PARA>
</SUPER></WPNOTICES>
</TITLEBLK>
<WPINFO></WPINFO>
<PARA0>
<TITLE>GENERAL INFORMATION.</TITLE>
<SUBPARA1>
<TITLE>DESCRIPTION.</TITLE><PARA>The F/A-18A and F/A-18C are one crew member aircraft.  The F/A-18B and F/A-
18D are two crew member versions of the F/A-18A and F/A-18C. ON 161353 THRU 164692, the aircraft is powered by two F404-
GE-400 turbofan engines with afterburner.  ON 164693 AND UP, the aircraft is powered by two F404-GE-402 turbofan engines
with afterburner.  The aircraft has a
variable camber mid wing with leading edge extensions.  The two vertical stabilizers are angled outboard 20&deg; from vertical.  The
wings have a leading and trailing edge flap system to provide the desired aircraft performance and stability characteristics.  The dual
rudder and rudder actuator system provides directional control during flight. </PARA>
<PARA>The auxiliary power unit (APU) and airframe mounted accessory drive (AMAD) provide on-board power for engine
starting, electrical system operation.   In addition, the APU provides air to the environmental control systems during ground
testing.</PARA></SUBPARA1>
<SUBPARA1>
<TITLE>MISSION.</TITLE><PARA>The F/A-18A/B/C/D is designed for Air-To-Air (A/A) and Air-To-Ground (A/G) weapon
delivery. A/A and A/G stores can be loaded on the nine weapon stations shown in <EXTREF HYTIME="clink" ID="WP00400"
XREFID="loc.id">
WP 004 00</EXTREF> .  Armament also includes the M61A1 or M61A2 20MM automatic gun system. Store capability includes
conventional/nuclear capabilities. Mission range may be extended by loading three external fuel tanks on the pylons for weapon
stations 3. 5. and 7. </PARA>
</SUBPARA1></PARA0><?Pub Caret>
<PARA0>
<TITLE>DIMENSIONS.</TITLE><REFERENCE>See Figure <XREF XREFID="fig1">.</REFERENCE>
<PARA>External dimensions of the F/A-18A, F/A18-B, F/A-18C AND F/A-18D are the same except for the canopy
eight.</PARA></PARA0>
<PARA0>
<TITLE>AIRCRAFT COORDINATES.</TITLE><REFERENCE>See Figure <XREF XREFID="fig2">.
</REFERENCE>
<PARA>X, Y, and Z coordinates are measured in inches and are used as the basic aircraft coordinate system.</PARA>
<SUBPARA1>
<TITLE>X COORDINATES.</TITLE><PARA>Lines are used to indicate vertical planes dividing the aircraft from wing tip to
wing tip are called X coordinates.  X coordinate (X0.00) is the vertical plane of the aircraft symmetry. Negative X coordinates (-X)
are vertical planes to the right of X0.00.  Positive X coordinates (X) are vertical planes to the left of X0.00.</PARA>
</SUBPARA1>
<SUBPARA1>
<TITLE>Y COORDINATES.</TITLE><PARA>Lines used to indicate the longitudinal planes dividing the aircraft from nose to
tail are called Y coordinates.  Y000.00 is 60.50 inches in front of the radome nose. </PARA>
</SUBPARA1>
<SUBPARA1>
<TITLE>Z COORDINATES.</TITLE><PARA>Lines used to indicate horizontal planes dividing the aircraft parallel to an
arbitrary reference plane to ground level and to tail tip are called Z coordinates.</PARA>
</SUBPARA1></PARA0>
<PARA0>
<TITLE>MATERIAL DISTRIBUTION.</TITLE><REFERENCE>See Figure <XREF XREFID="fig3">.
</REFERENCE>
<PARA>The airframe is primarily made of aluminum. Graphite/epoxy composite is used for many skins and doors. Titanium is also
used for skins and doors.  Where maximum strength is required, beta annealed bar, plate, and forgings are used. High strength steel is
used in the landing and arresting gear. Hydraulic tube assemblies are titanium.</PARA></PARA0><FIGSECT>
<FIGURE ID="fig1"><TITLE>Aircraft Principle Dimensions</TITLE>
<GRAPHIC BOARDNO="figure"></FIGURE>
```

FIGURE 36. Example of an SGML document instance.

3-4 **Tightening Metal Fasteners**

3-5 When torquing a fastener, select a wrench whose range fits the required torque value. A torque wrench is most accurate from 25% to 75% of its stated range. A wrench with a stated range of 0 to 100 pound-feet (0-135 N-m) will be most accurate from 25 to 75 pound-feet (33.8-101.3 N-m). The accuracy of readings will decrease as you approach 0 pound-feet (0 N-m) or 100 pound-feet (135 N-m). The following ranges are based on this principle:

Stated Range	**Most Effective Range**
0-200 lb-in. (0-22.6 N-m)	4-13 lb-ft (5.4-17.6 N-m)
0-600 lb-ft (0-810.0 N-m)	50-450 lb-ft (67.5-607.5 N-m)
0-170 lb-ft (0-229.5 N-m)	44-131 lb-ft (59.4-176.9 N-m)
15-75 lb-ft (20.3-101.3 N-m)	30-60 lb-ft (40.5-81.0 N-m)

TABULAR INFORMATION (NOT LABELLED AS A TABLE)

Term	**Definition**
Equipment	One or more units capable of forming specified functions.
Icon	Pictorial representation; visual image to give immediate recognition of a hazard or to provide essential information.

DEFINITION LIST IN ALPHABETICAL ORDER, UNNUMBERED

FIGURE 37. Example of lists.

5-1 Check the following for damage during shipment:

Tool Box Cabinet and Tool Kits.
Drawer Assembly.
Filing Cabinet, Security.
Rifle Mount Assembly.
Cabinet Assembly.
Shelf Assembly-wall.
Shelf Assembly-wall.
Radio.

RANDOM LIST

1. When operating with Class I or Class II leaks, continue to check fluid levels as required in the PMRM.

2. Report Class III leaks immediately to your supervisor.

3. Refer to the Leakage Classification List below:

<u>LEAKAGE CLASSIFICATION LIST</u>

a. Class I - Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

b. Class II - Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.

c. Class III - Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

SEQUENTIAL LIST, LETTERED ALPHABETICALLY

FIGURE 37. <u>Example of lists</u> - continued.

WIRE NUMBER	WIRING DIAGRAM	WIRE HARNESS	FROM		TO		LENGTH
			ITEM	PIN	ITEM	PIN	FT. - IN.
W539 - 119 - 22	103.20	A15 - E5539 - 1	300P38	34	TB16	6B	16 - 10
W539 - 120 - 22	103.20	A15 - E5539 - 1	300P38	35	300J20	61	18 - 4
W539 - 121 - 22	103.20	A15 - E5539 - 1	300P38	37	300J20	50	18 - 4
W539 - 122 - 22	103.20	A15 - E5539 - 1	300P38	38	300J20	51	18 - 4
W539 - 123 - 22	103.20	A15 - E5539 - 1	300P38	39	300J20	52	18 - 4
W539 - 124 - 22	103.20	A15 - E5539 - 1	300P38	40	TB16	4F	16 - 10
W539 - 125 - 22	103.20	A15 - E5539 - 1	300P38	41	TB16	2H	16 - 10
W539 - 126 - 22	103.20	A15 - E5539 - 1	300P38	42	TB16	5K	16 - 10
W539 - 127 - 22	103.20	A15 - E5539 - 1	300P38	43	300J20	53	18 - 4
W539 - 128 - 22	103.20	A15 - E5539 - 1	300P38	44	300J20	54	18 - 4
W539 - 129 - 22	103.20	A15 - E5539 - 1	300P38	45	300J20	55	18 - 4
W539 - 130 - 22	103.20	A15 - E5539 - 1	300P38	46	300P 8	27	19 - 6
W539 - 131 - 20	104.10	A15 - E5539 - 1	300P32	41	300J 2	3	12 - 5
W539 - 132 - 20	104.10	A15 - E5539 - 1	300P32	42	300J 2	26	12 - 5
W539 - 133 - 20	104.10	A15 - E5539 - 1	300P34	36	300J 2	28	12 - 5
W539 - 134 - 20	104.10	A15 - E5539 - 1	SM0003		300J 6	18	7 - 2
W539 - 135 - 20	104.10	A15 - E5539 - 1	300P10	6	SM0003		4 - 6
W539 - 136 - 22	104.10	A15 - E5539 - 1	SM0003		300J14	41	12 - 7
W539 - 137 - 20	104.10	A15 - E5539 - 1	300P32	43	SP0024		6 - 10
W539 - 138 - 20	105.10	A15 - E5539 - 1	300P10	38	300J 6	15	9 - 6
W539 - 139 - 20	105.10	A15 - E5539 - 1	300P10	39	300J 6	16	9 - 6
W539 - 140 - 20	105.10	A15 - E5539 - 1	300P32	24	300P 8	30	19 - 6
W539 - 141 - 20	105.10	A15 - E5539 - 1	300P32	25	300P 8	29	19 - 6
W539 - 142 - 20	105.10	A15 - E5539 - 1	300P32	26	300P 8	31	19 - 6
W539 - 143 - 20	105.10	A15 - E5539 - 1	300P32	27	300P 8	32	19 - 6
W539 - 144 - 20	105.10	A15 - E5539 - 1	300P32	28	300P 8	6	19 - 6
W539 - 145 - 22	111.10	A15 - E5539 - 1	300P32	29	300J 2	4	12 - 5
W539 - 146 - 22	112.10	A15 - E5539 - 1	300P10	40	TB16	10H	20 -
W539 - 147 - 22	113.10	A15 - E5539 - 1	300P34	13	300J 2	55	12 - 5
W539 - 148 - 22	119.10	A15 - E5539 - 1	300P32	30	300J 2	5	12 - 5
W539 - 149 - 20	121.10	A15 - E5539 - 1	300J4	48	TB203	4	24 -
W539 - 150 - 20	121.11	A15 - E5539 - 1	TB17	1	300J22	33	6 - 6
W539 - 151 - 20	121.11	A15 - E5539 - 1	TB17	2	300J22	34	6 - 7
W539 - 152 - 20	121.11	A15 - E5539 - 1	TB17	3	300J22	35	6 - 8
W539 - 153 - 20	121.11	A15 - E5539 - 1	TB17	4	300J22	36	6 - 9
W539 - 154 - 20	121.11	A15 - E5539 - 1	300P10	7	300J14	16	16 - 2

FIGURE 38. Example of an aircraft systems wire run list.

EQUIPMENT REF. DES.	PIN	WIRE IDENTIFICATION	WIRE HARNESS	EQUIPMENT REF. DES.	PIN	WIRING DIAGRAM
066P 4	A	W557-GD116 D20N	A15-E5557-001	GD116 ACH2	-	066.10
	B	W557- 110 -22	A15-E5557-001	066 S 1	=A14	066.10
	C	W557- 340 -22 - RED	A15-E5557-001	TB 9	13F	066.12
	D	W557 - 341 -22 - BLU	A15-E5557-001	TB 9	14F	066.12
	J	W557- 92 -22	A15-E5557-001	TB 8	10A	067.10
	K	W557- 88 -22	A15-E5557-001	TB 8	8K	067.10
	L	W557- 343 -22 - BLU	A15-E5557-001	TB11	12F	066.12
	M	W557- 342 -22 -RED	A15-E5557-001	TB11	12A	066.12
	P	W557- 28 -22	A15-E5557-001	066P 2	C	066.10
	R	W557- 29 -22	A15-E5557-001	066P 2	D	066.10
	S	W557- 339 -22 -BLU	A15-E5557-001	TB 9	12F	066.12
	T	W557- 338 -22 -RED	A15-E5557-001	TB 9	12A	066.12
	U	W557- 91 -22	A15-E5557-001	TB 8	9F	067.10
	V	W557- 87 -22	A15-E5557-001	TB 8	8D	067.10
	W	W557- 93 -22	A15-E5557-001	TB 8	10G	067.10
	X	W557- 89 -22	A15-E5557-001	TB 8	7G	067.10
	Y	W557- 90 -22	A15-E5557-001	TB 8	9B	067.10
	Z	W557- 86 -22	A15-E5557-001	TB 8	8A	067.10
	A-	W557- 11 -22 -RED	A15-E5557-001	066S 1	=A15	066.10
	B-	W557- 12 -22 -BLU	A15-E5557-001	066S 1	=B18	066.10
	C-	W557- 13 -22 -YEL	A15-E5557-001	066S 1	=B17	066.10
	D-	W557- 25 -22 -RED	A15-E5557-001	066S 1	=A18	066.10
	E-	W557- 27 -22 -YEL	A15-E5557-001	066S 1	=A17	066.10
	F-	W557- 26 -22 -BLU	A15-E5557-001	066S 1	=A16	066.10
	G-	W557-GD150 B20N	A15-E5557-001	GD150 ACL2		121.10
	H-	W557- 202 -20	A15-E5557-001	TB225	3D	121.10
	J-	W557- 14 -22	A15-E5557-001	066S 1	=B16	066.10
066P 5	A	W557- 30 -22	A15-E5557-001	066J 8	A	066.10
	C	W557- 39 -22	A15-E5557-001	066J 8	C	066.10
	G	W557- 34 -22	A15-E5557-001	066J 8	G	066.10
	H	W557- 35 -22	A15-E5557-001	066J 8	H	066.10
	J	W557- 40 -22	A15-E5557-001	066J 8	J	066.10
	K	W557- 42 -22	A15-E5557-001	066J 8	K	066.10
	L	W557- 41 -22	A15-E5557-001	066J 8	L	066.10
	M	W557- 31 -22	A15-E5557-001	066J 8	M	066.10

FIGURE 39. Example of a wiring reference designation list.

WIRE NUMBER	CDL	FAN	WIRE TYPE	DIAGRAM	WIRE HARNESS	FROM				TO				LNG
						ITEM	PIN	LUG	SPL	ITEM	PIN	LUG	SPL	FT-IN
H539-119-22			EA	103.20	A15-E5539-1	300P38	34			T316	62	+		16 - 10
H539-120-22			EA	103.20	A15-E5539-1	300P38	35			300J20	61			18 - 4
H539-121-22			EA	103.20	A15-E5539-1	300P38	37			300J20	50			18 - 4
H539-122-22			EA	103.20	A15-E5539-1	300P38	38			300J20	51			18 - 4
H539-123-22			EA	103.20	A15-E5539-1	300P38	39			300J20	52			18 - 4
H539-124-22			EA	103.20	A15-E5539-1	300P38	40			TB16	4F	+		16 - 10
H539-125-22			EA	103.20	A15-E5539-1	300P38	41			TB16	2H	+		16 - 10
H539-126-22			EA	103.20	A15-E5539-1	300P38	42			TB16	5K	+		16 - 10
H539-127-22			EA	103.20	A15-E5539-1	300P38	43			300J20	53			18 - 4
H539-128-22			EA	103.20	A15-E5539-1	300P38	44			300J20	54			18 - 4
H539-129-22			EA	103.20	A15-E5539-1	300P38	45			300J20	55			18 - 4
H539-130-22			EA	103.20	A15-E5539-1	300P38	46			300P 8	27			19 - 6
H539-131-20			EA	104.10	A15-E5539-1	300P32	41			300J 2	3			12 - 5
H539-132-20			EA	104.10	A15-E5539-1	300P32	42			300J 2	26			12 - 5
H539-133-20			EA	104.10	A15-E5539-1	300P34	36			300J 2	28			12 - 5
H539-134-20			EA	104.10	A15-E5539-1	SM0003		M		300J 6	18			7 - 2
H539-135-20			EA	104.10	A15-E5539-1	300P10	6			SM000				4 - 6
H539-136-20			EA	104.10	A15-E5539-1	SM0003				3	41			12 - 7
H539-137-20			EA	104.10	A15-E5539-1	300P32	43			300J14		U		6 - 10
H539-138-20			EA	105.10	A15-E5539-1	300P10	38			SP0024	15			9 - 6
H539-139-20			EA	105.10	A15-E5539-1	300P10	39			300J 6	16			9 - 6
H539-140-20			EA	105.10	A15-E5539-1	300P32	24			300J 6	30			19 - 6
H539-141-20			EA	105.10	A15-E5539-1	300P32	25			300P 8	29			19 - 6
H539-142-20			EA	105.10	A15-E5539-1	300P32	26			300P 8	31			19 - 6
H539-143-20			EA	105.10	A15-E5539-1	300P32	27			300P 8	32			19 - 6
H539-144-20			EA	105.10	A15-E5539-1	300P32	28			300P 8	6			19 - 6
H539-145-22			EA	111.10	A15-E5539-1	300P32	29			300P 8	4			12 - 5
H539-146-22			EA	132.10	A15-E5539-1	300P10	40			300J 2	10N	+		20 -
H539-147-22			EA	113.10	A15-E5539-1	300P34	13			TB16	55			12 - 5
H539-148-22			EA	119.10	A15-E5539-1	300P32	30			300J 2	5			12 - 5
H539-149-20			EA	121.10	A15-E5539-1	300J4	48			300J 2	4	I		24 -
H539-150-20			EA	121.11	A15-E5539-1	TB17	1	1		TB203	33			6 - 6
H539-151-20			EA	121.11	A15-E5539-1	TB17	2	1		300J22	34			6 - 7
H539-152-20			EA	121.11	A15-E5539-1	TB17	3	1		300J22	35			6 - 8
H539-153-20			EA	121.11	A15-E5539-1	TB17	4	1		300J22	36			6 - 9
H539-154-20			EA	121.11	A15-E5539-1	300P10	7			300J22	16			16 - 2
										300J14				

FIGURE 40. Example of an aeronautical equipment, airborne weapons/equipment or support equipment wiring list.

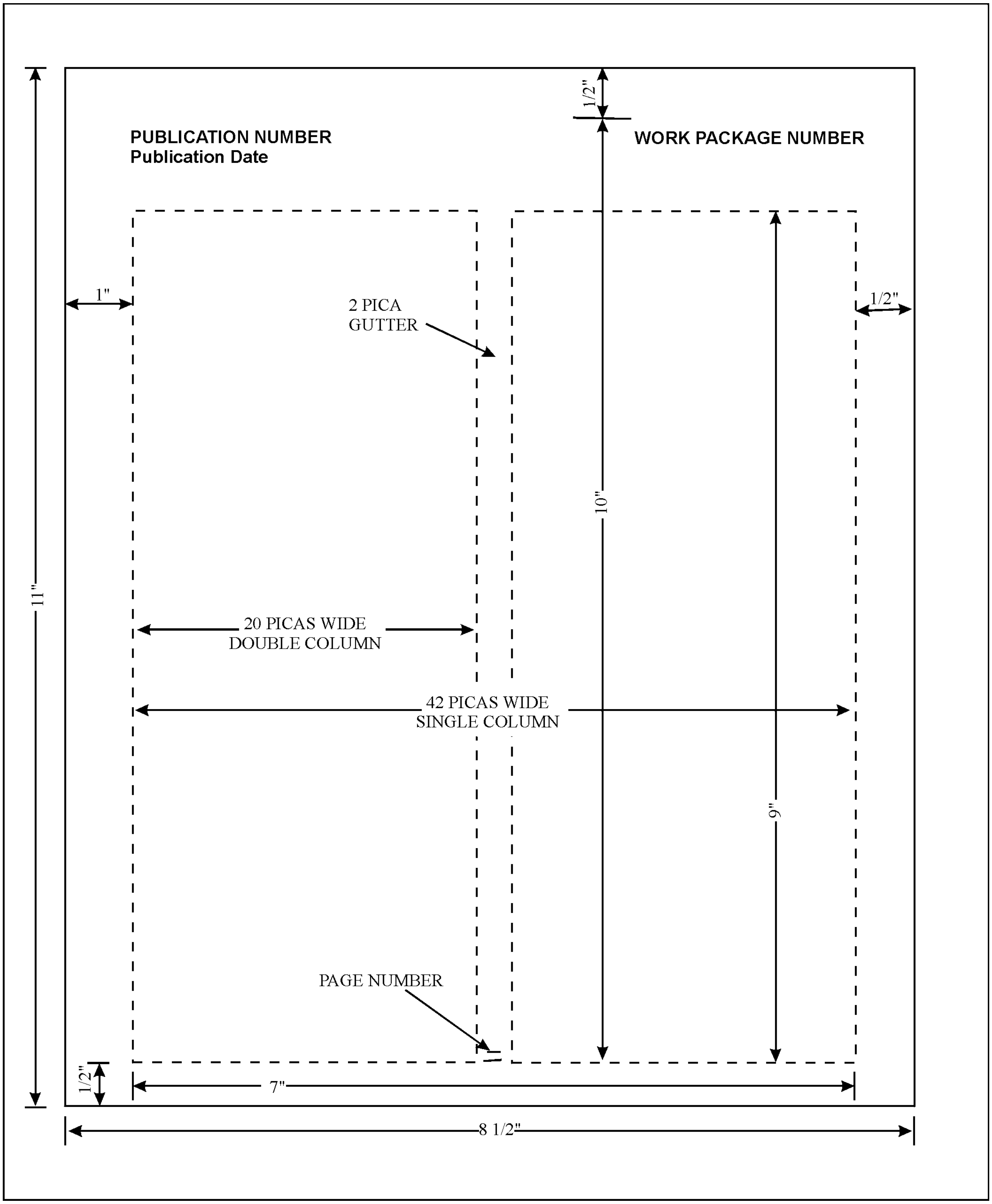


FIGURE 41. Example of a page image area.

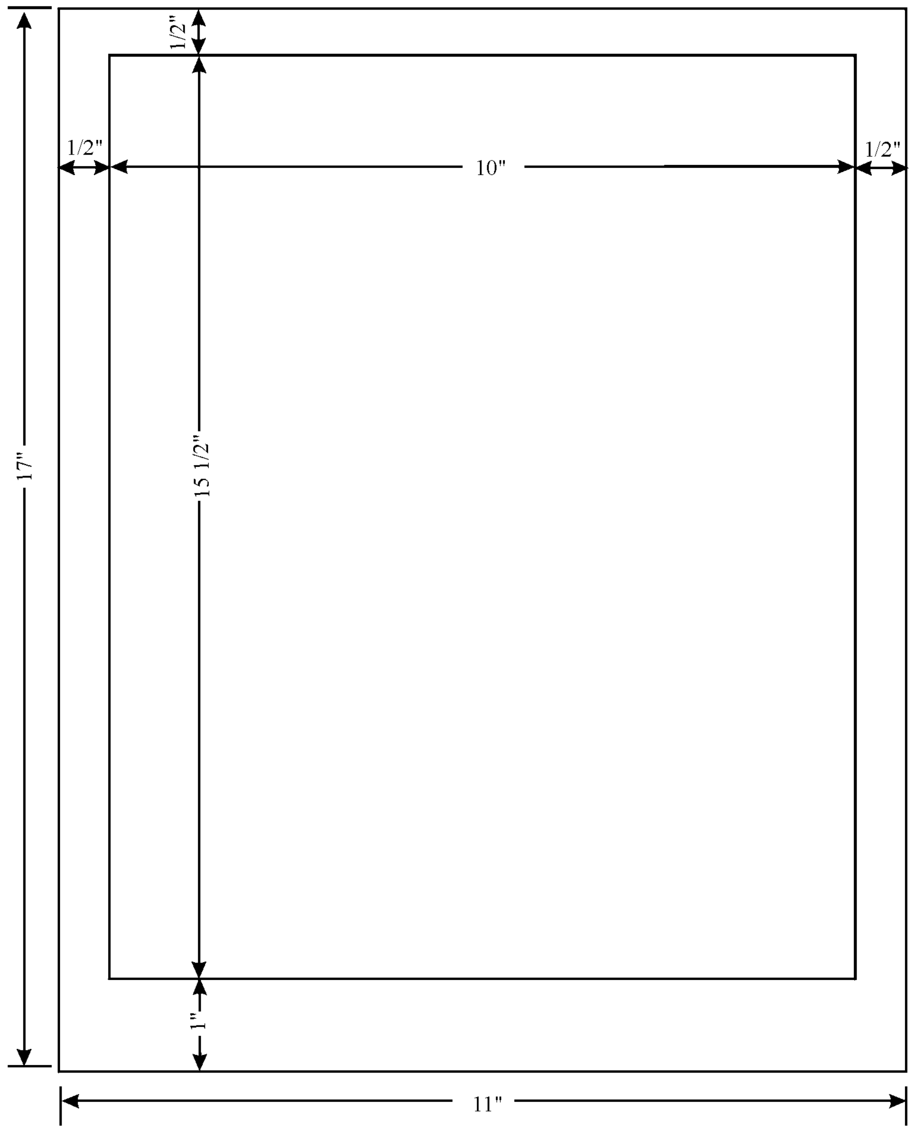
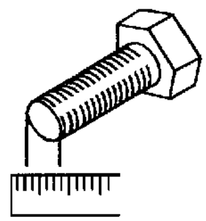
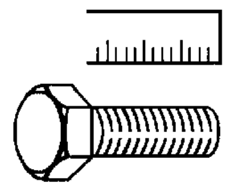


FIGURE 41. Example of a page image area - continued.

2-4 How to Use Torque Tables





1. Measure the diameter of the screw you are installing.

2. Count the number of threads per inch or use a pitch grade.

3. Under the heading SIZE, look down the left-hand column until you find the diameter of the screw you are installing. (There will usually be two lines beginning with the same size.)

4. In the second column under SIZE, find the number of threads per inch that matches the number of threads you counted in step 2. (Not required for metric screws)

FIGURE 42. Example of text wrapping.

Similarly, the mass leaving the shock front is:

$m_1 = p_1 V_1$

$m_1 = p_1 AL_1$

$m_1 = p_1 At(v - u_1)$ EQ 10

Invoking the principle of conservation of mass:

$m_0 = m_1$

$p_0 At(v - u_0) = p_1 At(v - u_1)$

$p_0 (v - u_0) = p_1 (v - u_1)$ EQ 11

EXAMPLE A

= =

Equating the work done on the system with the rate of energy increase and cancelling the *t*'s:

$p_1 u_1 A - p_0 u_0 A =$

$Ap_1 (v - u_1)(e_1 - 0.5 u_1^2) - Ap_0 (v-u_0)(e_0 + 0.5_0 2)$

EXAMPLE B

= =

2-3 Cylinder Expansion Test

2-4 An important problem faced by the designer of fragmentation warheads is that he must maximize the energy which is transferred from explosive to metal during the detonation. The most frequently encountered configuration is that of an explosive-filled metal cylinder detonated by a wave moving axially. The best scaling law that has been devised for this condition is that of Gurney, who disregarded detonation conditions and shock effects in the metal and assumed implicity that all the energy of the explosive is conserved. His equation for the cylinders is:

$$v = \sqrt{2E\left(\frac{C/M}{1+0.5\ C/M}\right)}$$

where v is the velocity to which the metal is accelerated by the explosive, E is unit energy content of the explosive, C is the weight of the explosive, and M is the metal weight. This expression of velocity in terms of C/M implies that weight-ratio scaling of explosive and metal is of prime importance and that dimensional scaling need not be considered at all. The term $2E$ has the dimensions of a velocity as was pointed out by Gurney in his original report.

EXAMPLE C

FIGURE 43. Example of equations in text.

2-6 Recovery can be accomplished by adding dilute acetic acid, but the product obtained will be impure. The heat of formation at constant pressure is -112 to -126.3 kilocalories per mole. The calculated heat of detonation is 0.367 kilocalories per gram. Lead azide is used extensively as an ingredient in initiating compositions.

$$[N = N = N] - Pb^{++}\ [N=N=N=]-$$

EXAMPLE D

= =

2-8 In the manufacturing process ethyl nitrate ($C_2H_5.ONO_2$), ethyl nitrite ($C_2H_5.ONO$), and nitroethane ($C_2H_5NO_2$) also are produced. The intermediate products of oxidation and nitration involved in the preparation of mercury fulminate are as follows:

$CH_3.CH_2OH$ $CH_3.CHO$
Ethanol Acetaldehyde

EXAMPLE E

= =

2-12 Two equations are given for the specific heat of PETN as a function of temperature:

$$C = 0.257 + (5.21 \ x \ 10^{4})\ T \ \text{ for } T \text{ £ } 140^{o} C$$
and $$C = 0.239 + (8.0 \ x \ 10^{4})\ T \sim \text{ for } 32^{o} C < T < 127^{o} C$$

EXAMPLE F

= =

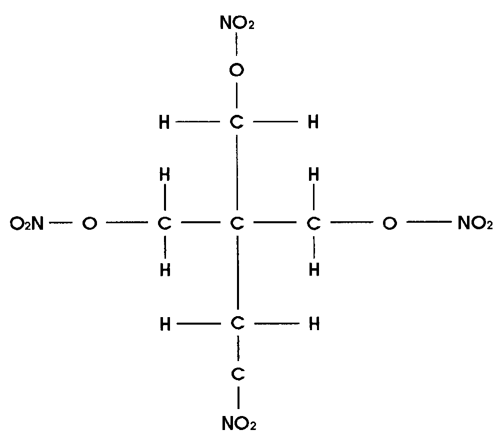


FIGURE 43. Example of equations in text - continued.

3-4 In a given amount of time, t, mass moves from one side of the shock front to the other side. By definiton, mass, m, is given as a function of density, p, and volume, V, by the equation:

$$m = pV \qquad EQ\ 1$$

The volume, V, can be expressed in terms of area, A, and length, L, by the equation:

$$V = AL \qquad EQ\ 2$$

The length, L, is the distance a particle travels in our assumed time interval, t, times the velocity, v:

$$L = tv \qquad EQ\ 3$$

By figure 3 the velocity can be seen to equal:

$$v_0 = (v - u_0) \qquad EQ\ 4$$

and

$$v_1 = (v - u_1) \qquad EQ\ 5$$

= =

By equations 1 through 5:

$$momentum\ change/t = [p_1 Atu_1 \ (v - u_1) - p_0 Atu_0 \ (v - u_0)\ ] \ / t$$

$$EQ\ 9$$

FIGURE 44. Example of numbering equations in text.

To successfully load this IETM, do the following:

1. **Uninstall** previous IETM installed on file server or PEDD, refer to the Interactive Electronic Technical Manual (IETM) Administrator Course booklet.
2. **Install** the IETM from the CD ROM Drive to the File Server or PEDD, refer to the Interactive Electronic Technical Manual (IETM) Administrator Course booklet.
3. **Delete the annots and annots.dat** folders. The following table lists the location of these folders.

CD Number	Machine Type	Location
	FOR FULLY INSTALLED IETMs	
A1-H60CD-FHJ-000	File Server	C:/ietmload/ietm/ebtbooks/books/sh60f/iracs
A1-H60CD-FHJ-000	PC or PEDD	C:/ietm/ebtbooks/books/sh60f/iracs
A1-H60CD-60B-000	File Server	C:/ietmload/ietm/ebtbooks/books/sh60bv/iracs
A1-H60CD-60B-000	PC or PEDD	C:/ietm/ebtbooks/books/sh60bv/iracs
	FOR IETMs RUNNING FROM THE CD	
A1-H60CD-FHJ-000	PC	C:/ietm/sh60fv/tmp/private
A1-H60CD-60B-000	PC	C:/ietm/sh60bv/tmp/private

FIGURE 45. Example of ETM/IETM installation data, CD label, and flyleaf data.

Installing the IETM

The IETM can be installed onto your computer's hard drive or it may be run from a compact disk (CD). The installation program will guide you through the install of your IETM. It may take up to 30 hours to completely install the IETM to your hard drive when using a single speed reader. Normal installation from a dual speed CD reader is approximately 2 hours.

For Windows 3.X

1. Click on the Windows Program Manager's **File** pulldown menu.
2. Select the **Run** option.
3. Type the letter of the CD ROM drive followed by (your CD drive letter)**:\setup.exe**
4. Installation program will begin the install.

For Windows 95

1. Click on the **Start** button.
2. Select the **Run** option.
3. Type the letter of the CD ROM drive followed by (your CD drive letter)**:\setup.exe**
4. Installation program will begin the install.

FIGURE 45. Example of ETM/IETM installation data, CD label, and flyleaf data - continued.

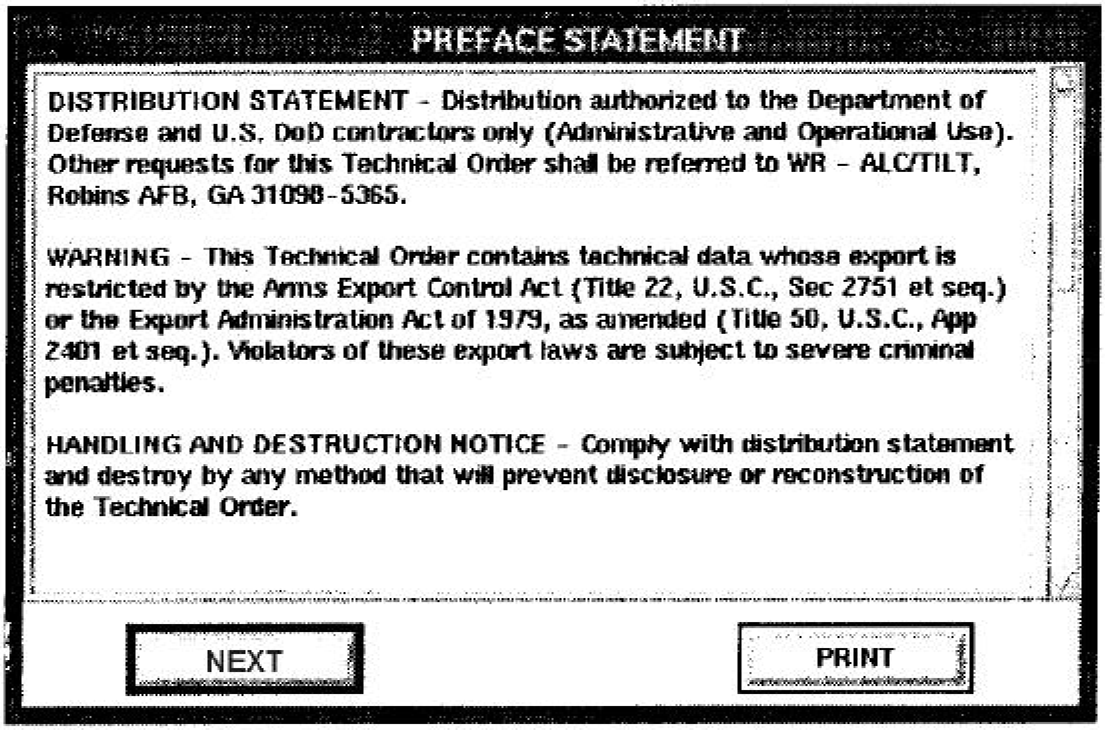


FIGURE 46. Example of preface information.

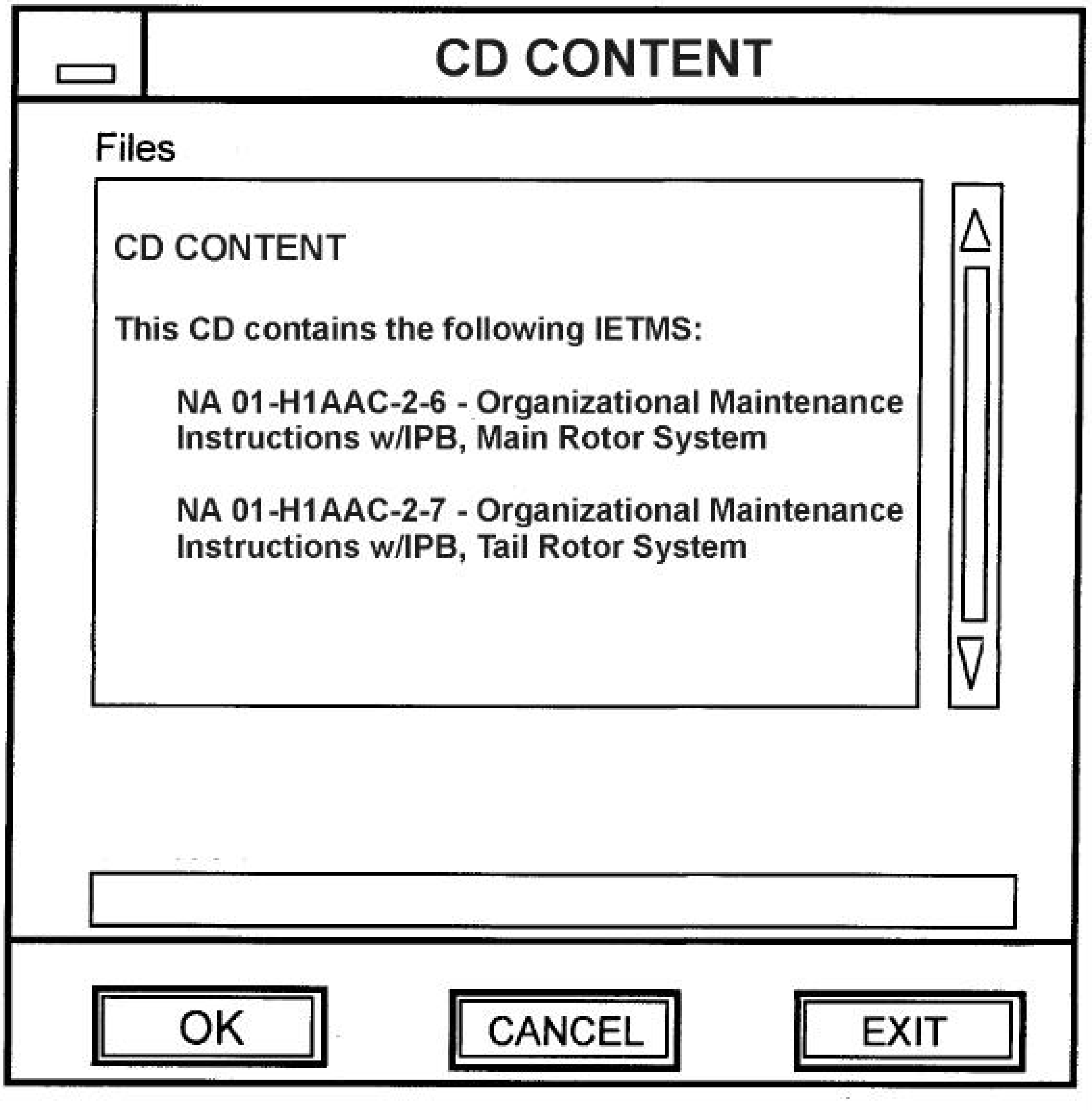


FIGURE 47. Example of CD content data.

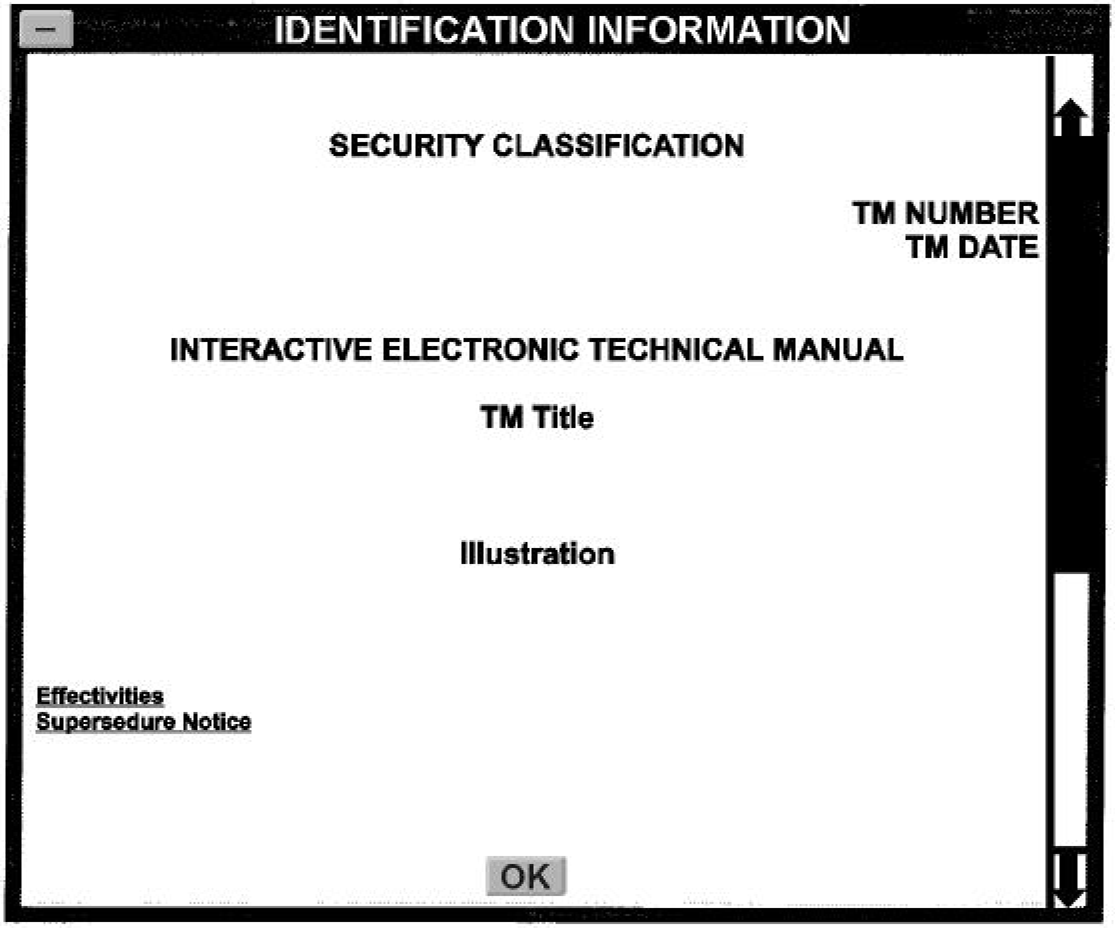


FIGURE 48. Example of title data.

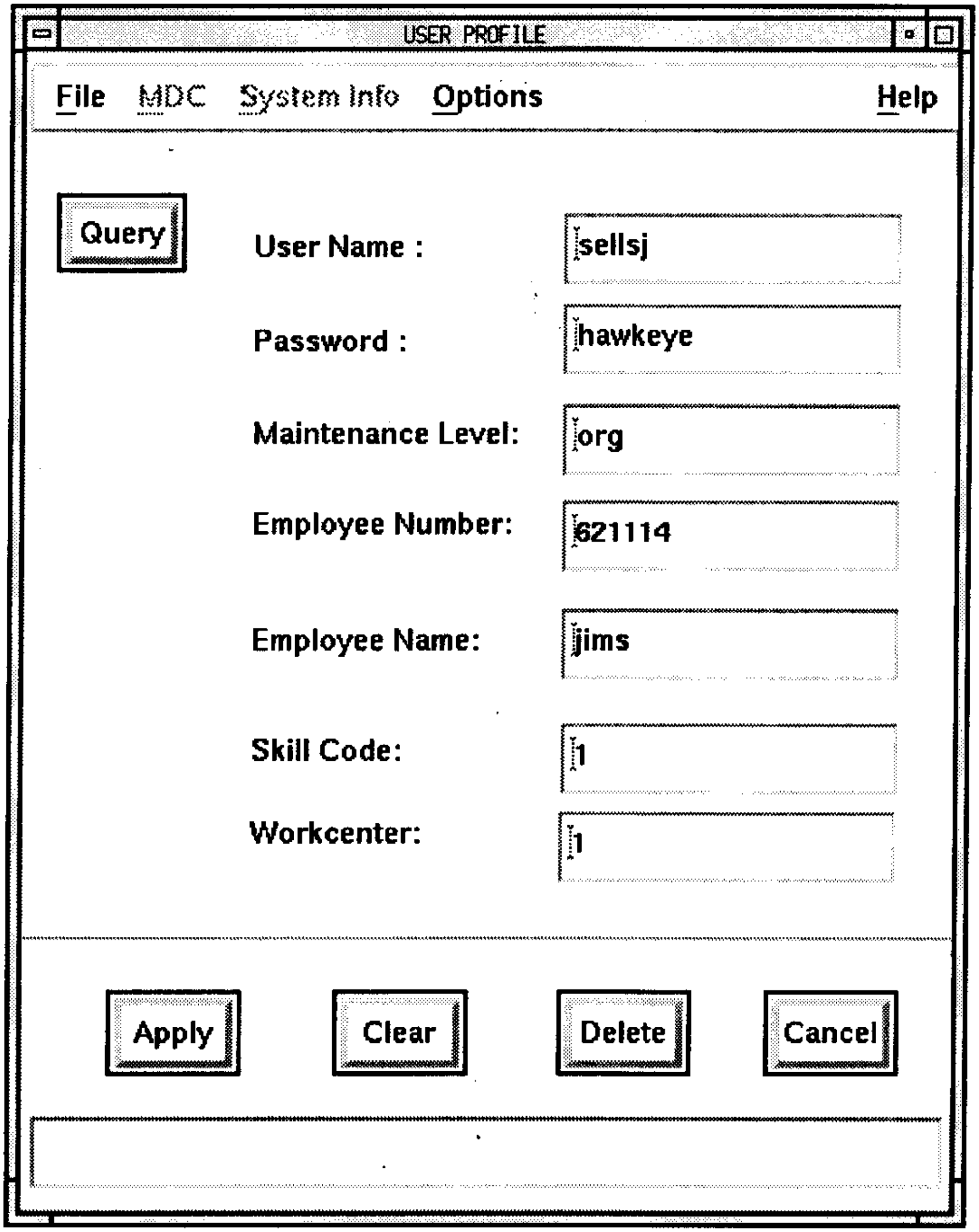


FIGURE 49. Example of log on.

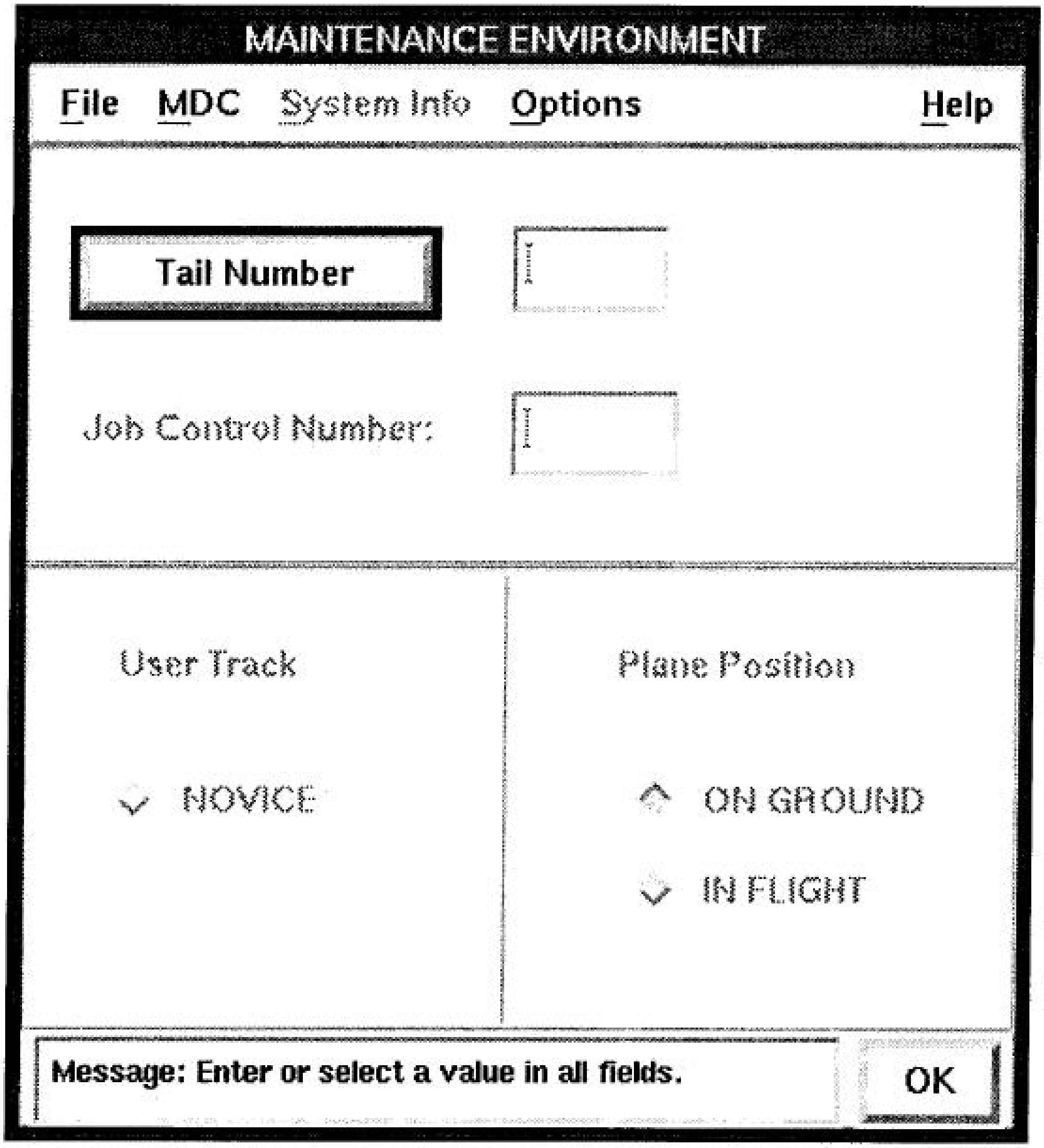


FIGURE 49. Example of log on - continued.

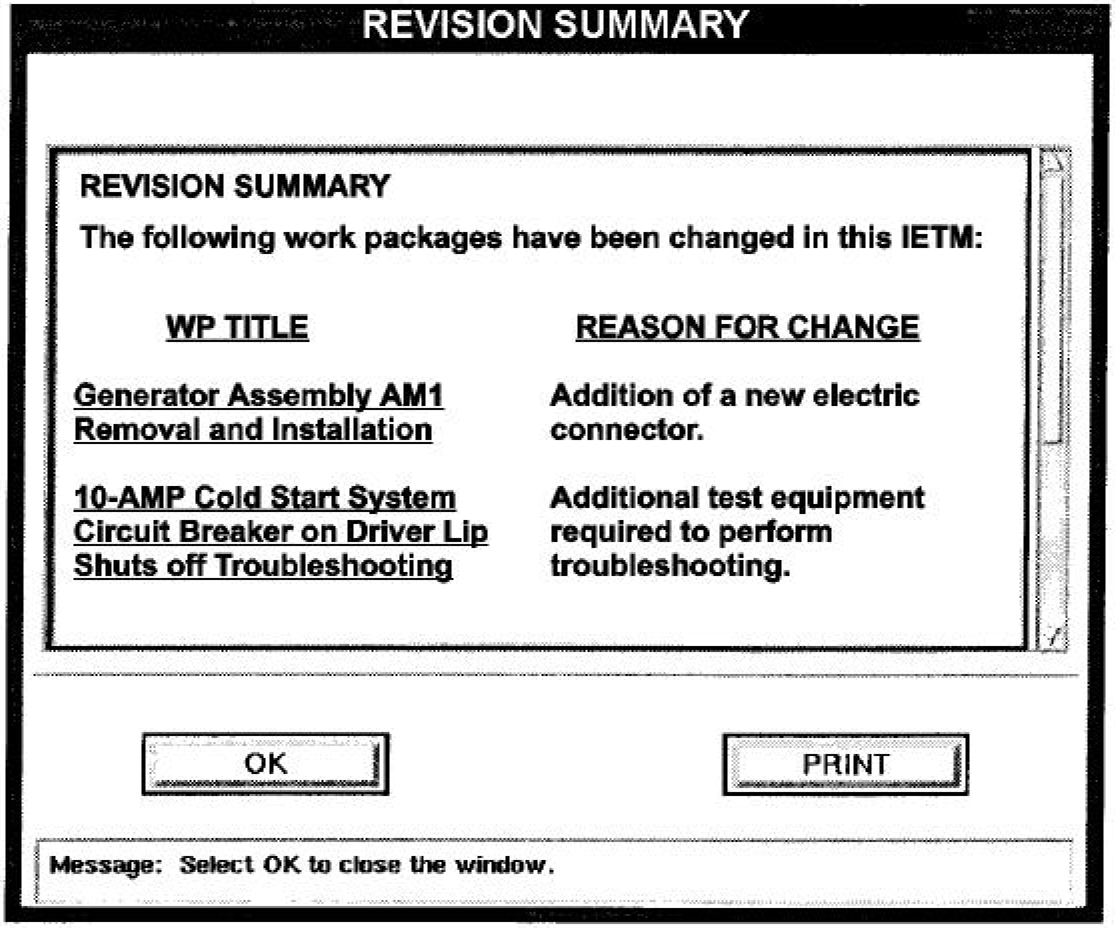


FIGURE 50. Example of revision summary.

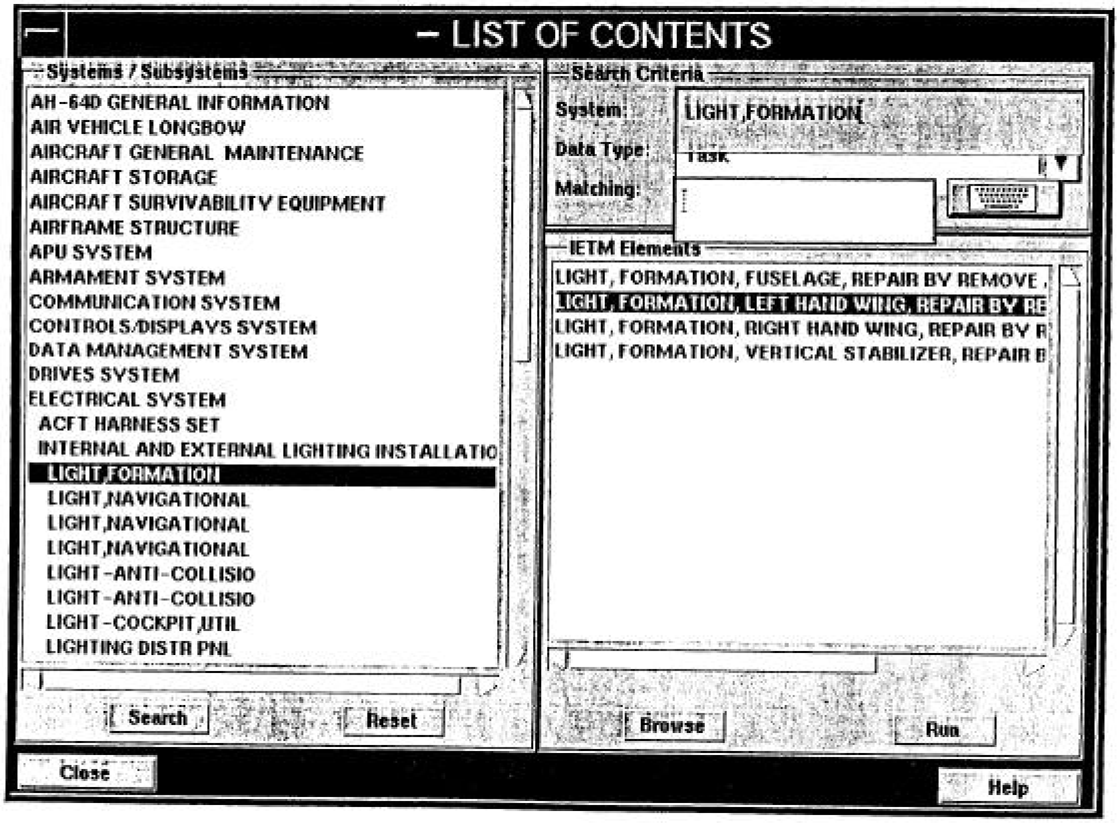


FIGURE 51. Example one of List of Contents.

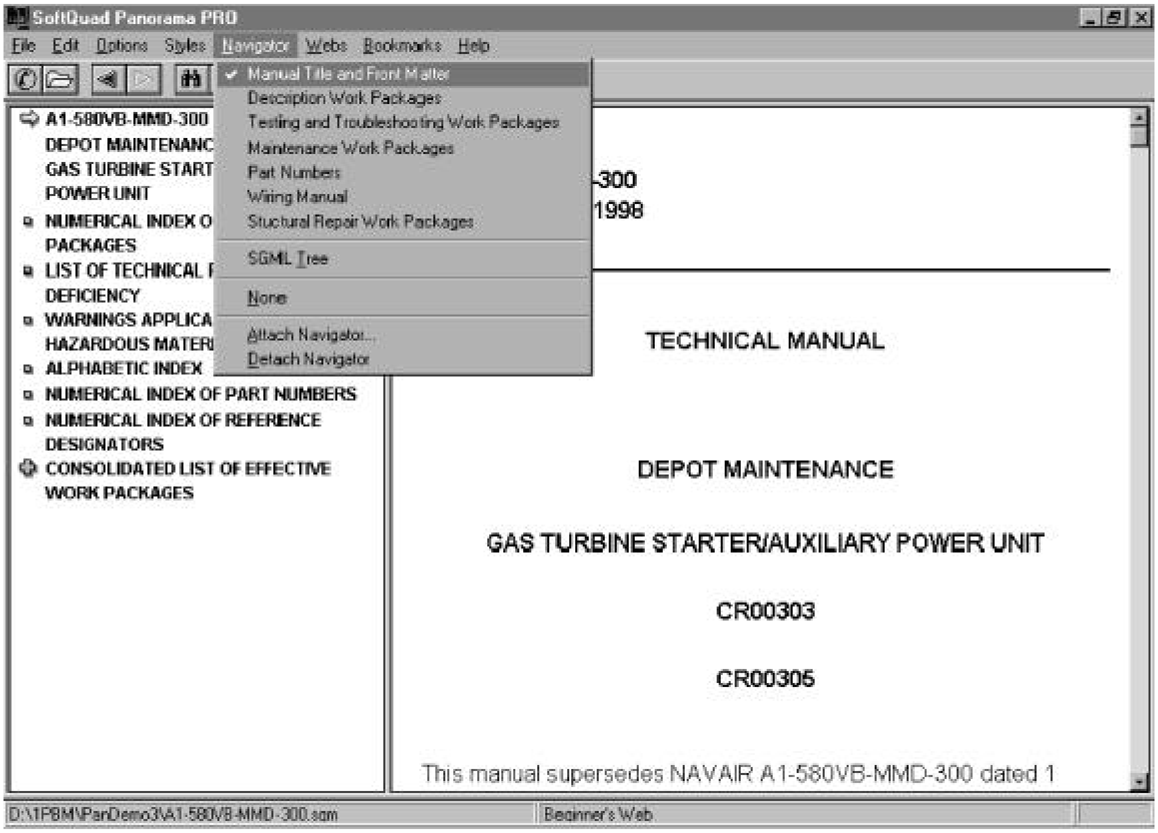


FIGURE 52. Example two of List of Contents - manual title and front matter for scrollable ETM.

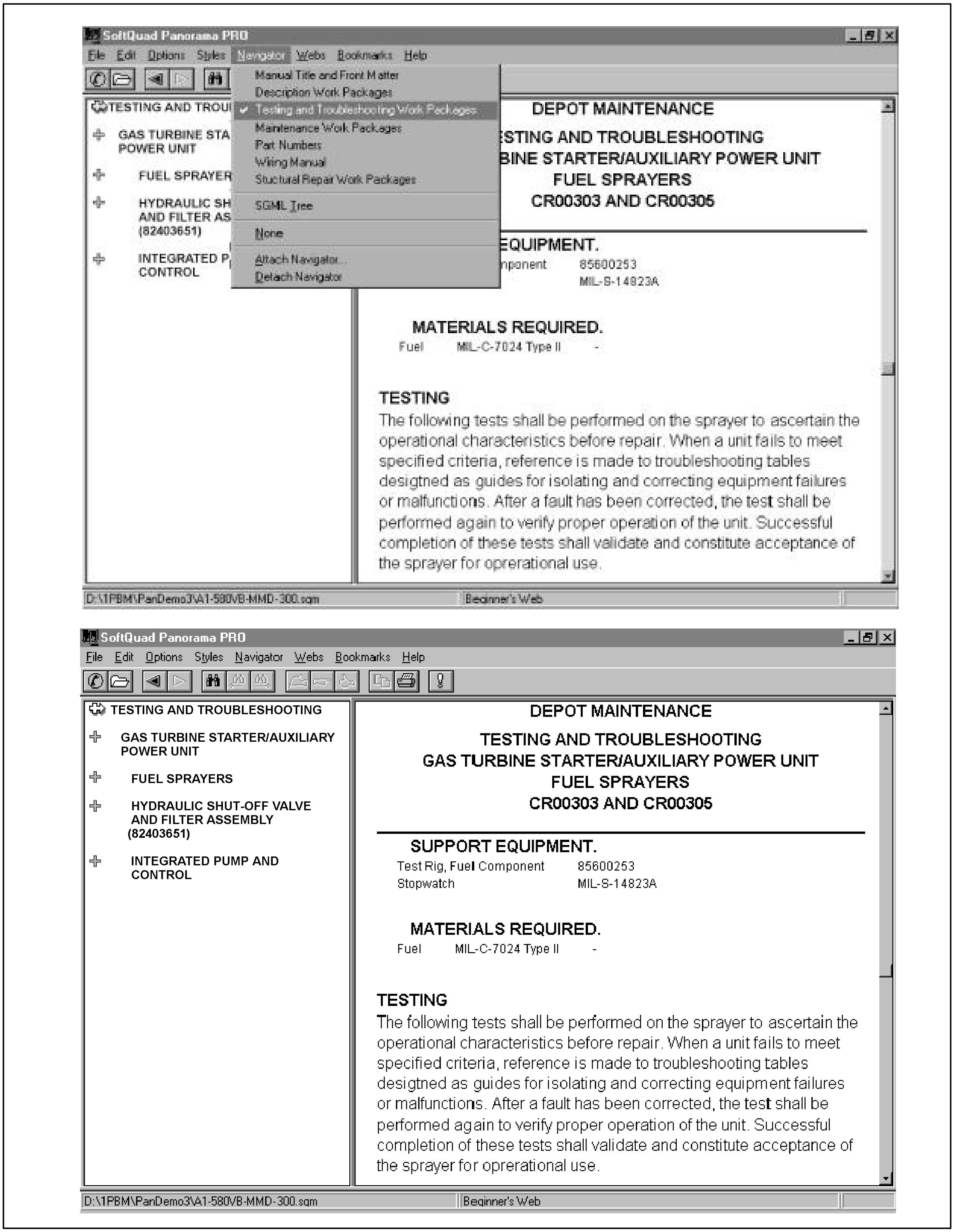


FIGURE 53. Example three of List of Contents - testing and troubleshooting work packages for scrollable ETM.

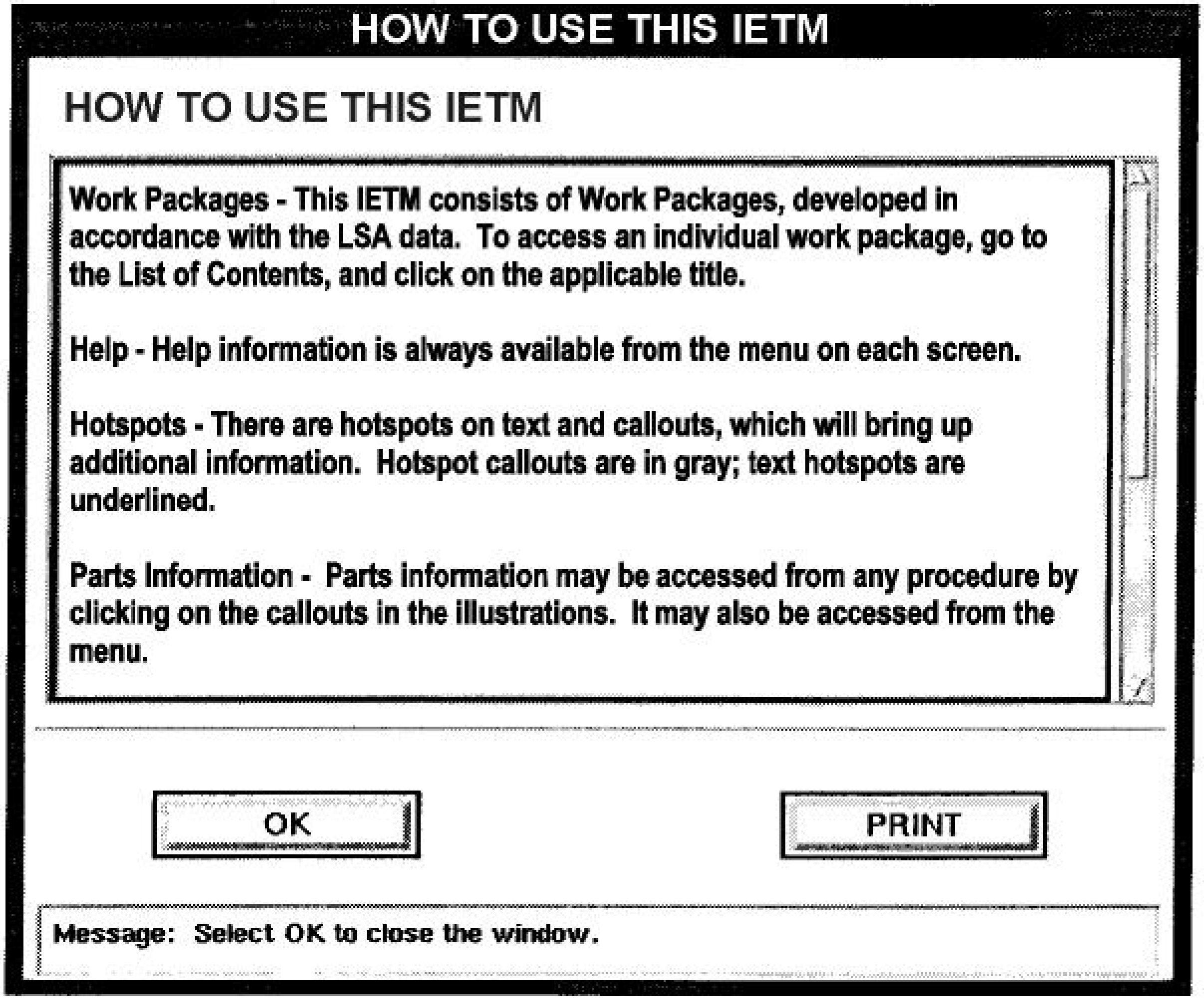


FIGURE 54. Example of "How To Use This IETM" information.

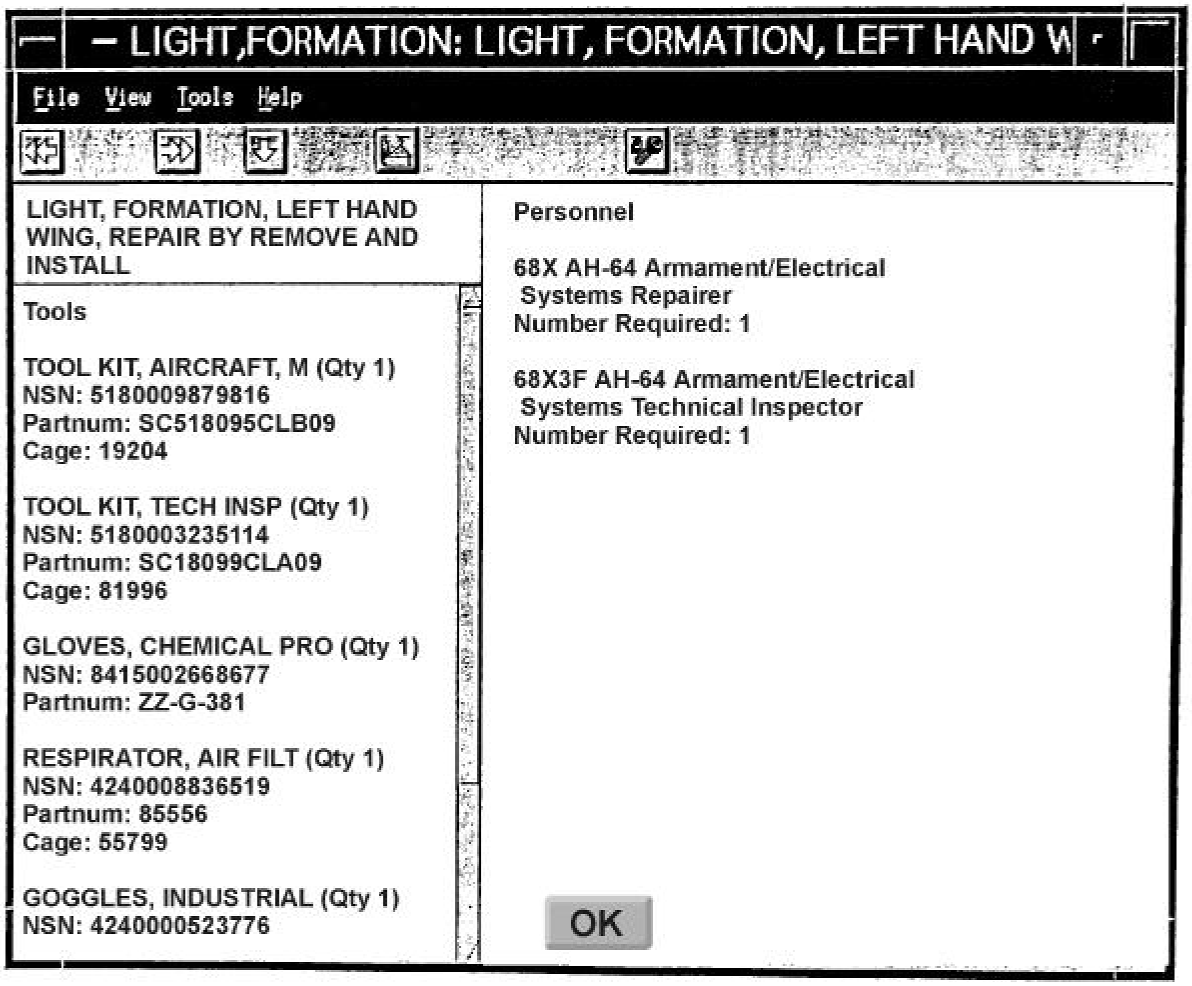


FIGURE 55. Example of WP title and example one of WP initial setup.

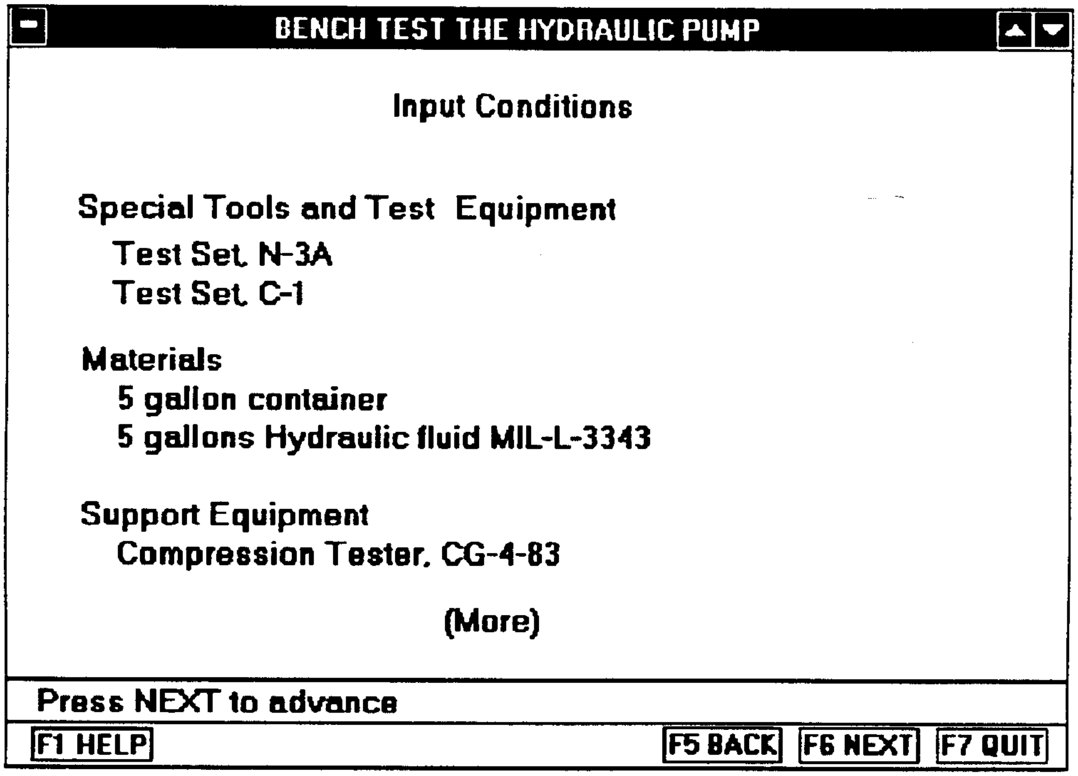


FIGURE 56. Example two of WP initial setup.

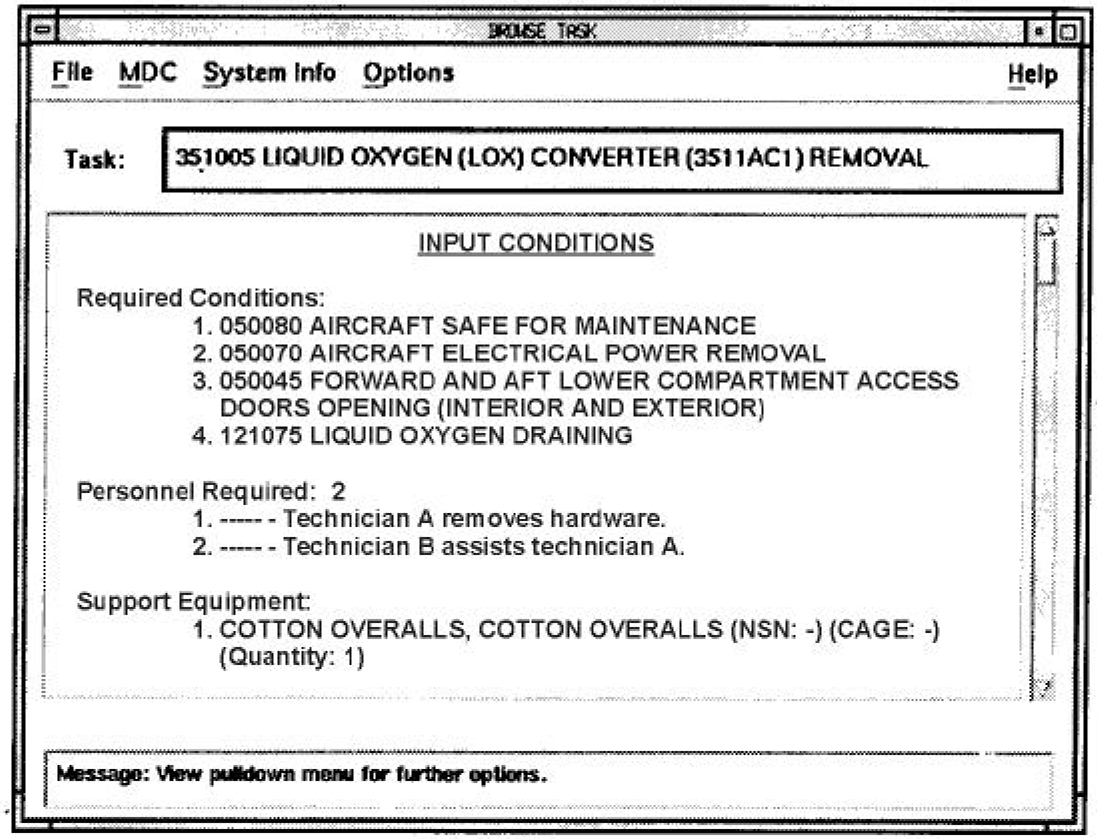


FIGURE 57. Example three of WP initial setup.

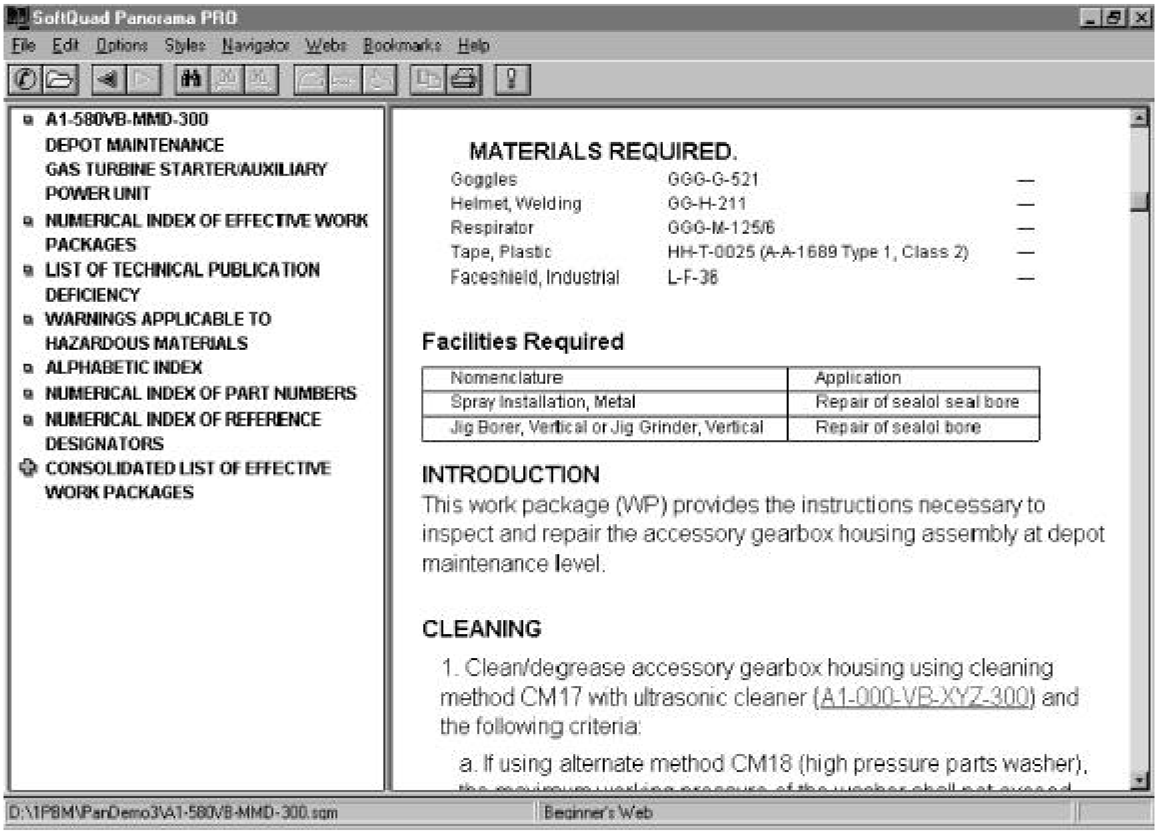


FIGURE 58. Example four of WP initial setup for scrollable ETM.

CONSOLIDATED LIST OF MATERIALS

Nomenclature	Specification/ Part Number	HMWS Index Number
Cloth, Cheesecloth	CCC-C-440 Type 1, Class 1	
Epoxy Primer Coating	MIL-P-23377 Ty 1	22
Epoxy Primer Coating	MIL-P-23377 Ty 2	22
Humidity Indicator Plug	MIL-I-26860, Type 2	
Lubricant, Solid Film	MIL-L-23398, Type 2	15

Press NEXT to advance

F1 HELP F6 BACK F7 NEXT F8 QUIT

FIGURE 59. Example of supporting information WP - consolidated list of materials.

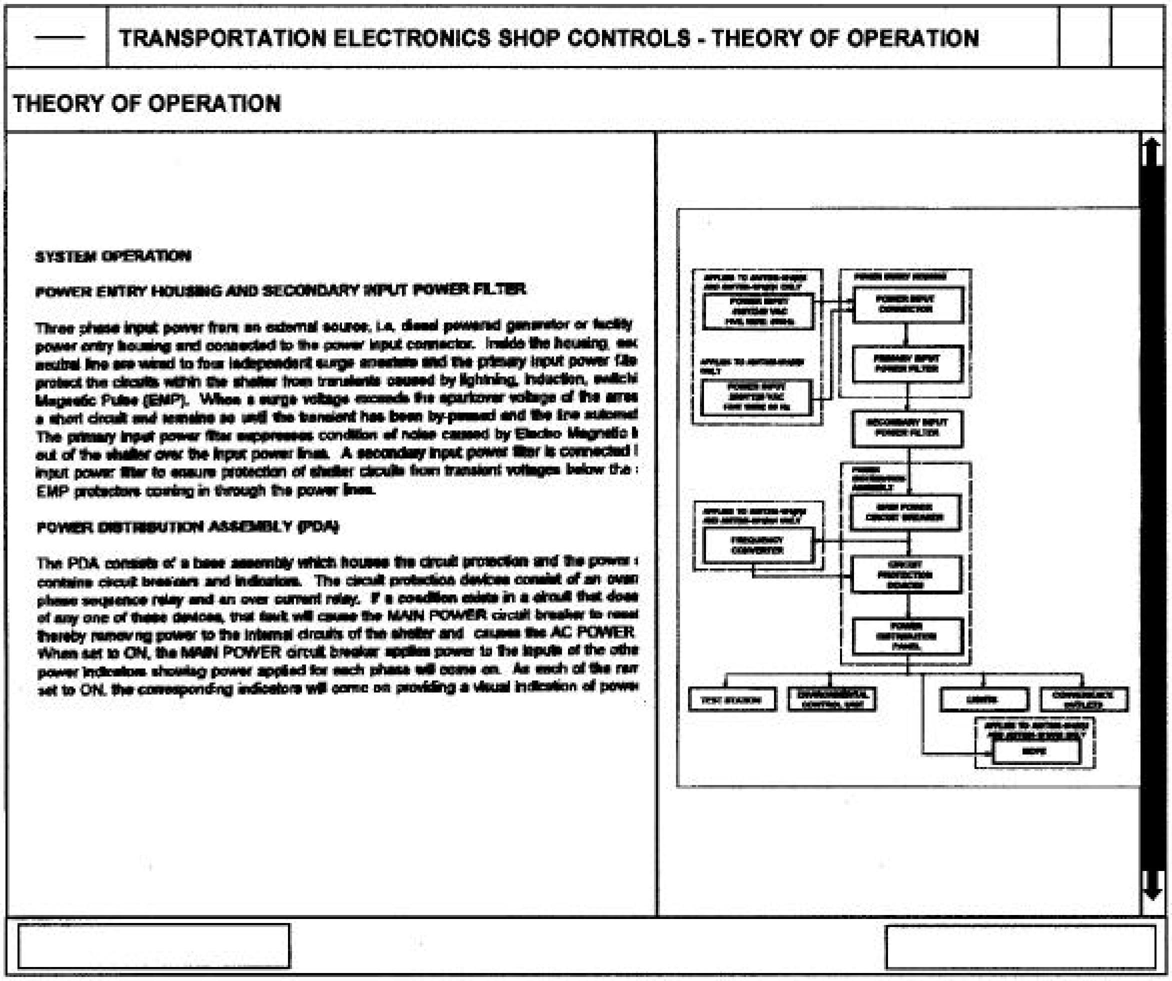


FIGURE 60. Example one of descriptive information.

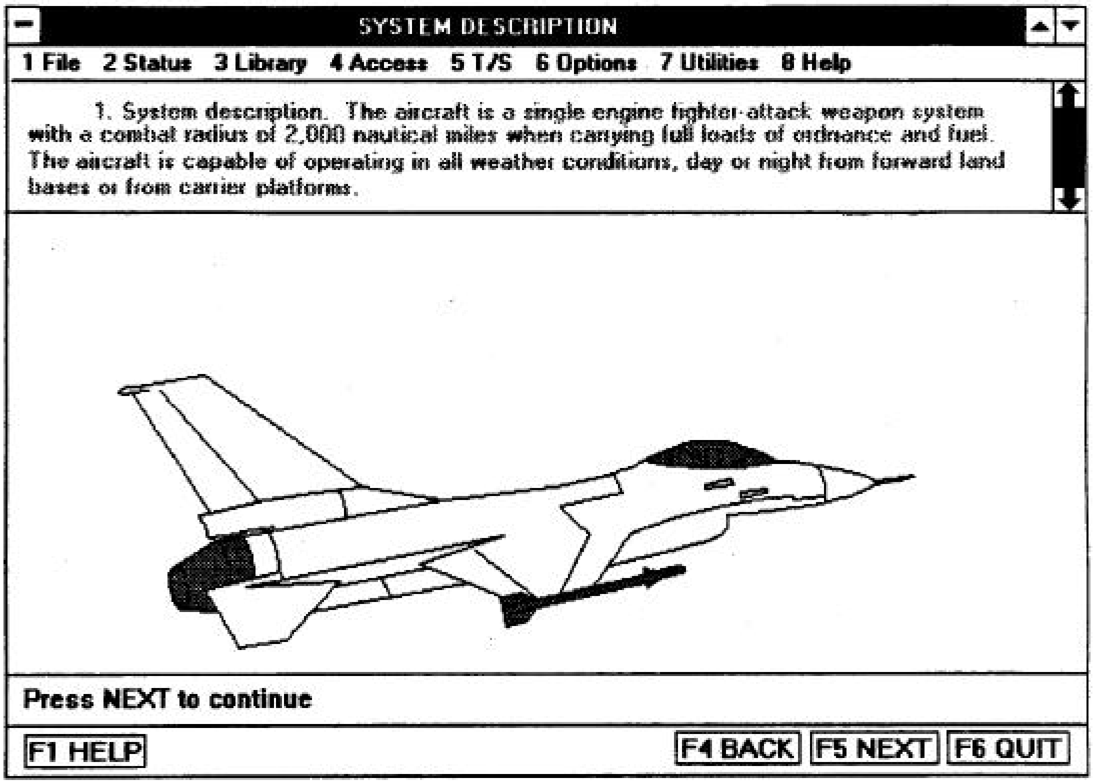


FIGURE 61. Example two of descriptive information.

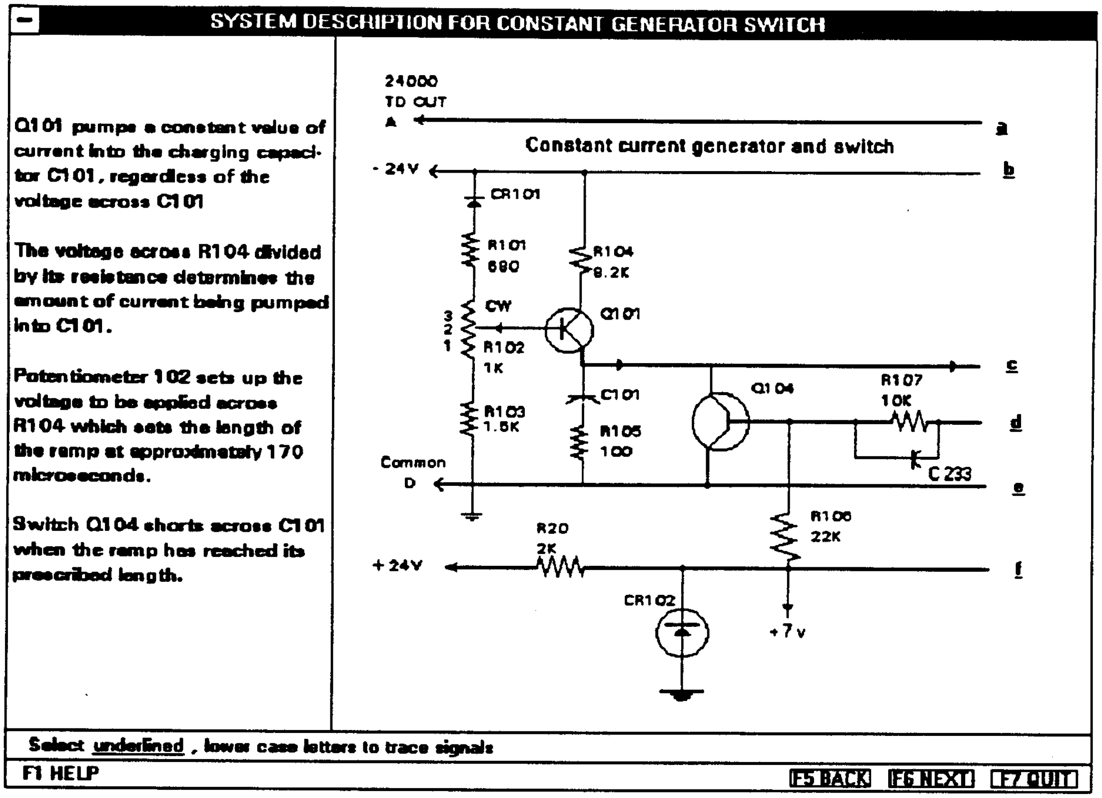


FIGURE 62. Example three of descriptive information.

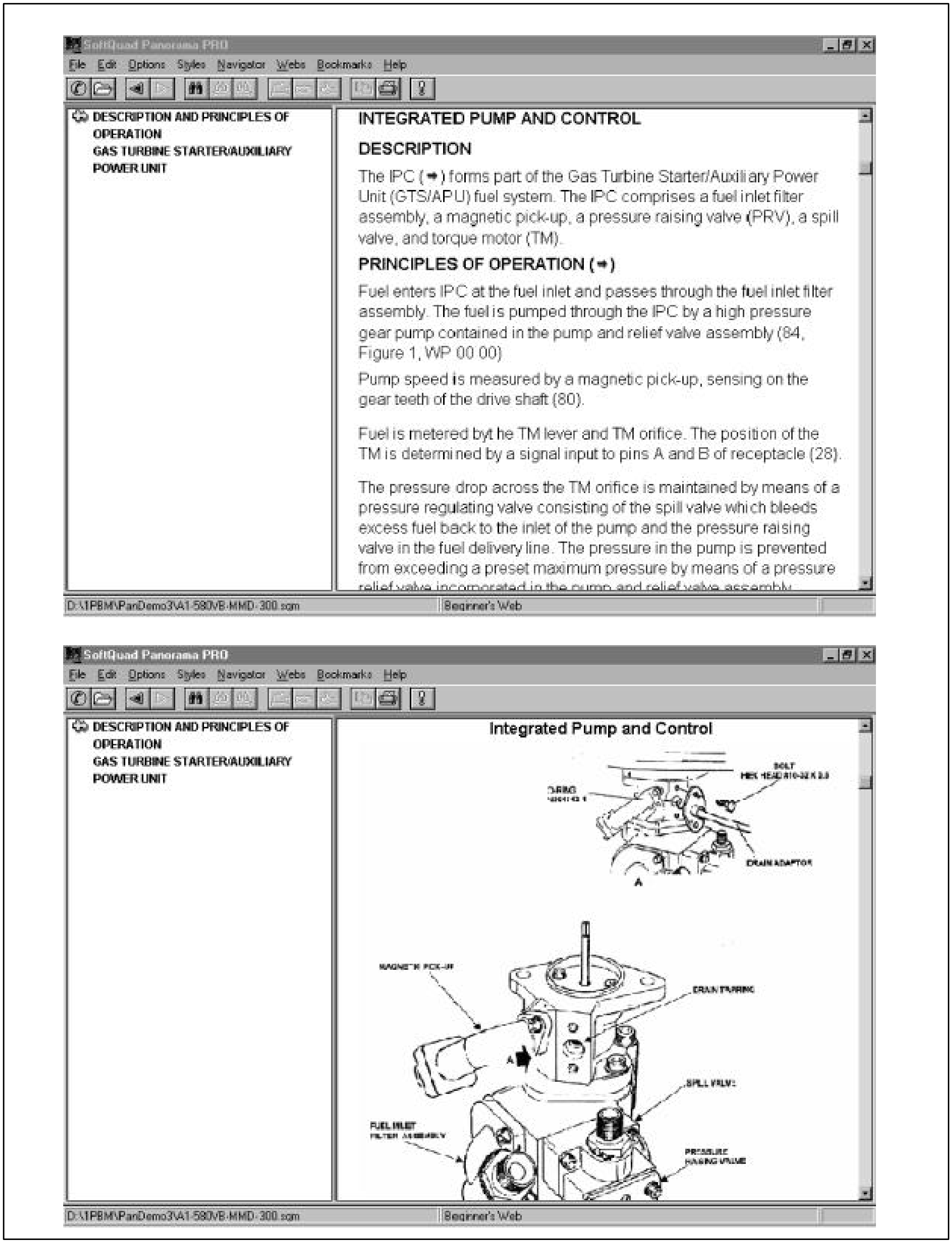


FIGURE 63. Example four of descriptive information - scrollable ETM.

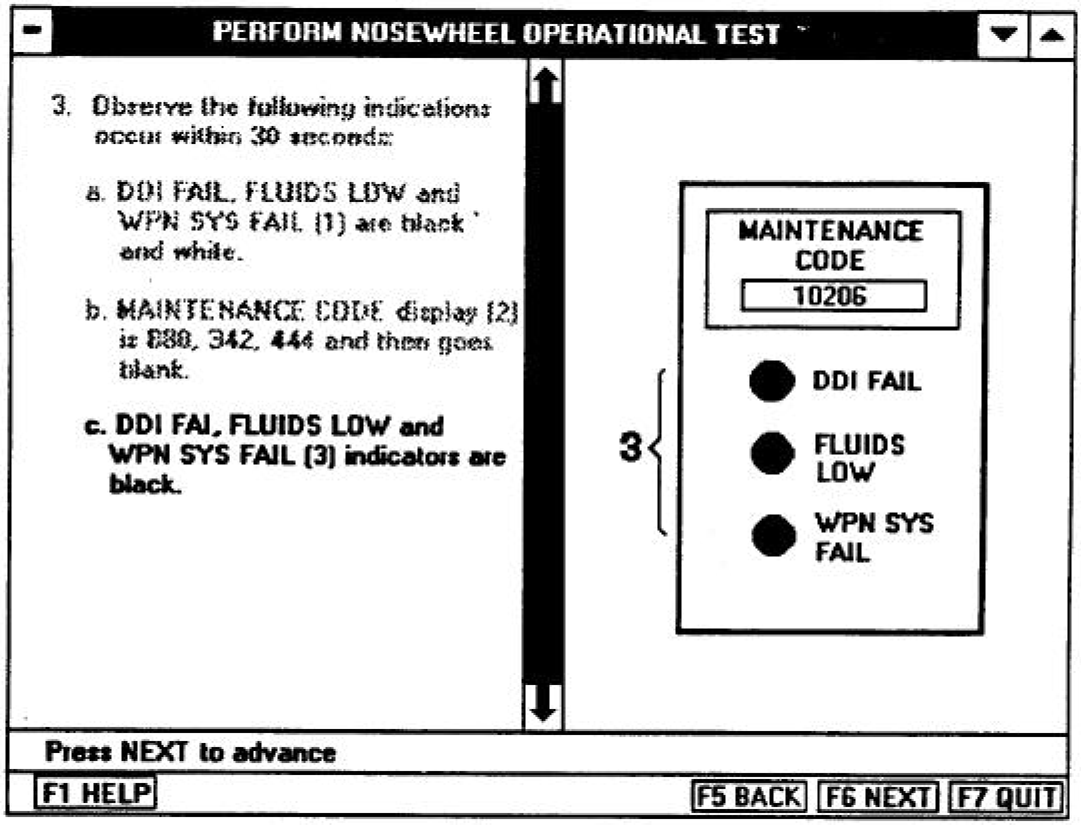


FIGURE 64. Example one of troubleshooting.

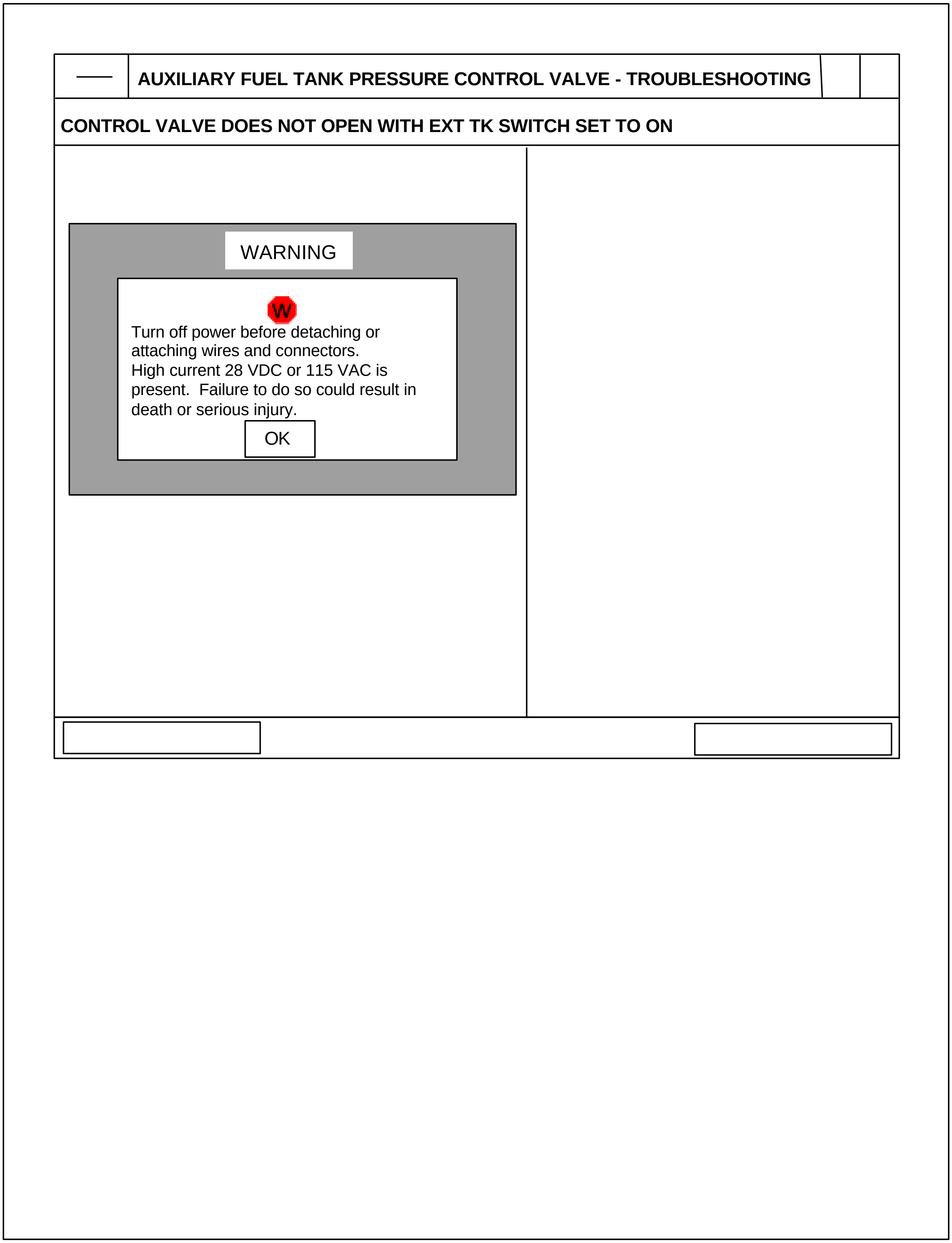


FIGURE 65. Example two of troubleshooting.

AUXILIARY FUEL TANK PRESSURE CONTROL VALVE - TROUBLESHOOTING

CONTROL VALVE DOES NOT OPEN WITH EXT TK SWITCH SET TO ON

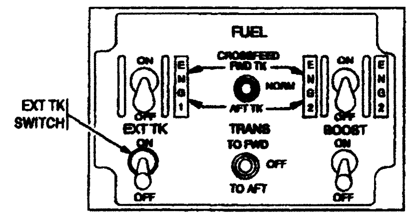
1. On pilot **FUEL** panel **EXT TK** switch is set to **ON** position, check for 28 VDC at P243-1.

Is voltage present?

Yes ◯

No ◯

[OK]



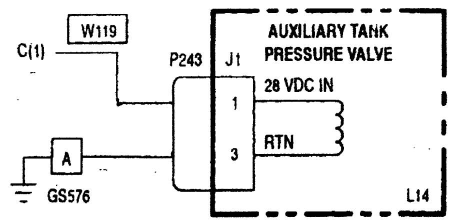


FIGURE 65. Example two of troubleshooting - continued.

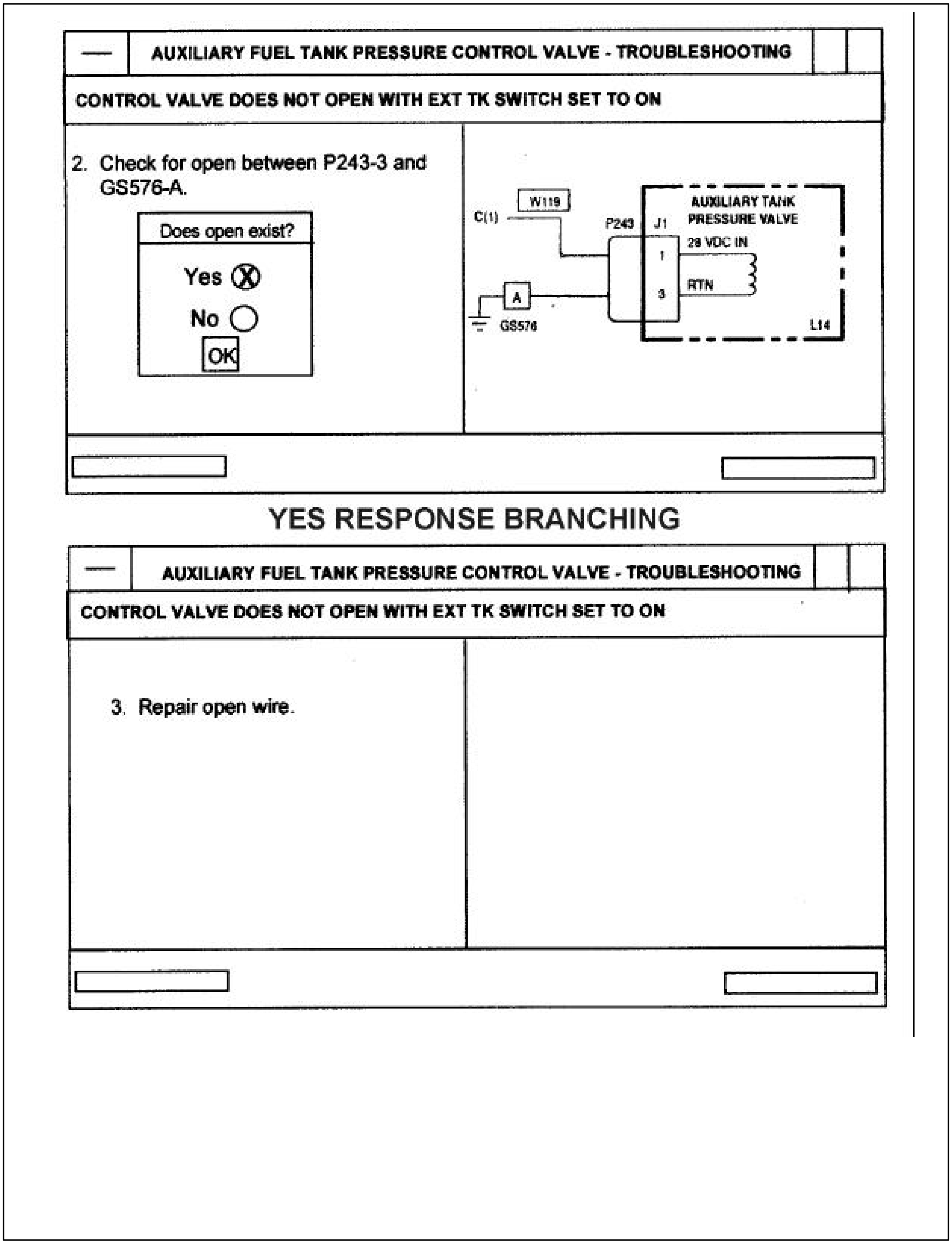


FIGURE 65. Example two of troubleshooting - continued.

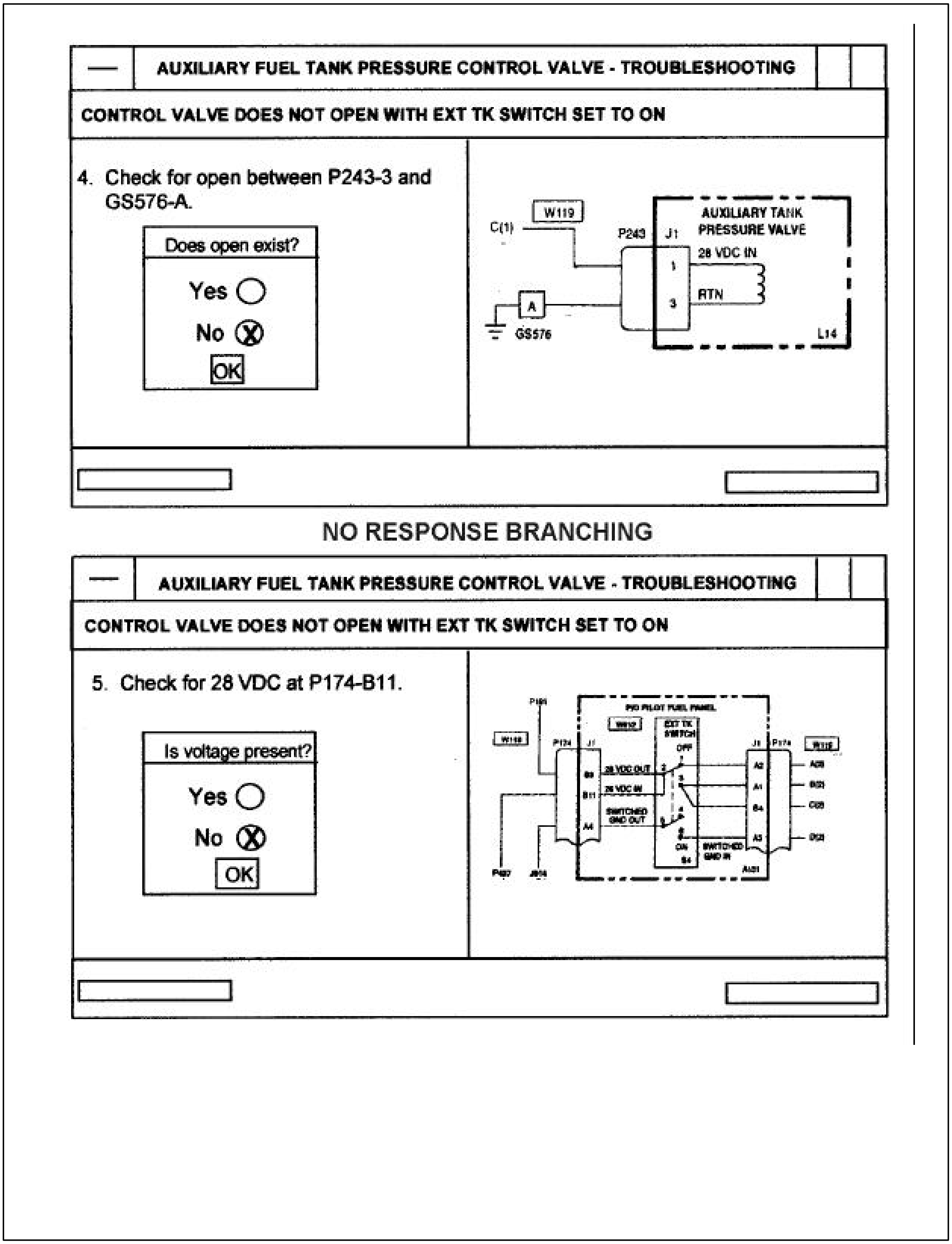


FIGURE 65. Example two of troubleshooting - continued.

AUXILIARY FUEL TANK PRESSURE CONTROL VALVE - TROUBLESHOOTING

CONTROL VALVE DOES NOT OPEN WITH EXT TK SWITCH SET TO ON

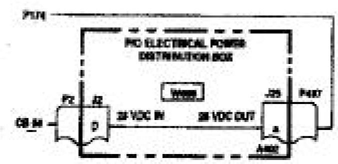
6. Check for 28 VDC at P174-B11.

Is voltage present?

Yes ○

No ⊗

OK



NO RESPONSE BRANCHING (CONT)

AUXILIARY FUEL TANK PRESSURE CONTROL VALVE - TROUBLESHOOTING

CONTROL VALVE DOES NOT OPEN WITH EXT TK SWITCH SET TO ON

7. Troubleshoot circuit protection system (dc essential bus 2-pilot station).

FIGURE 65. Example two of troubleshooting - continued.

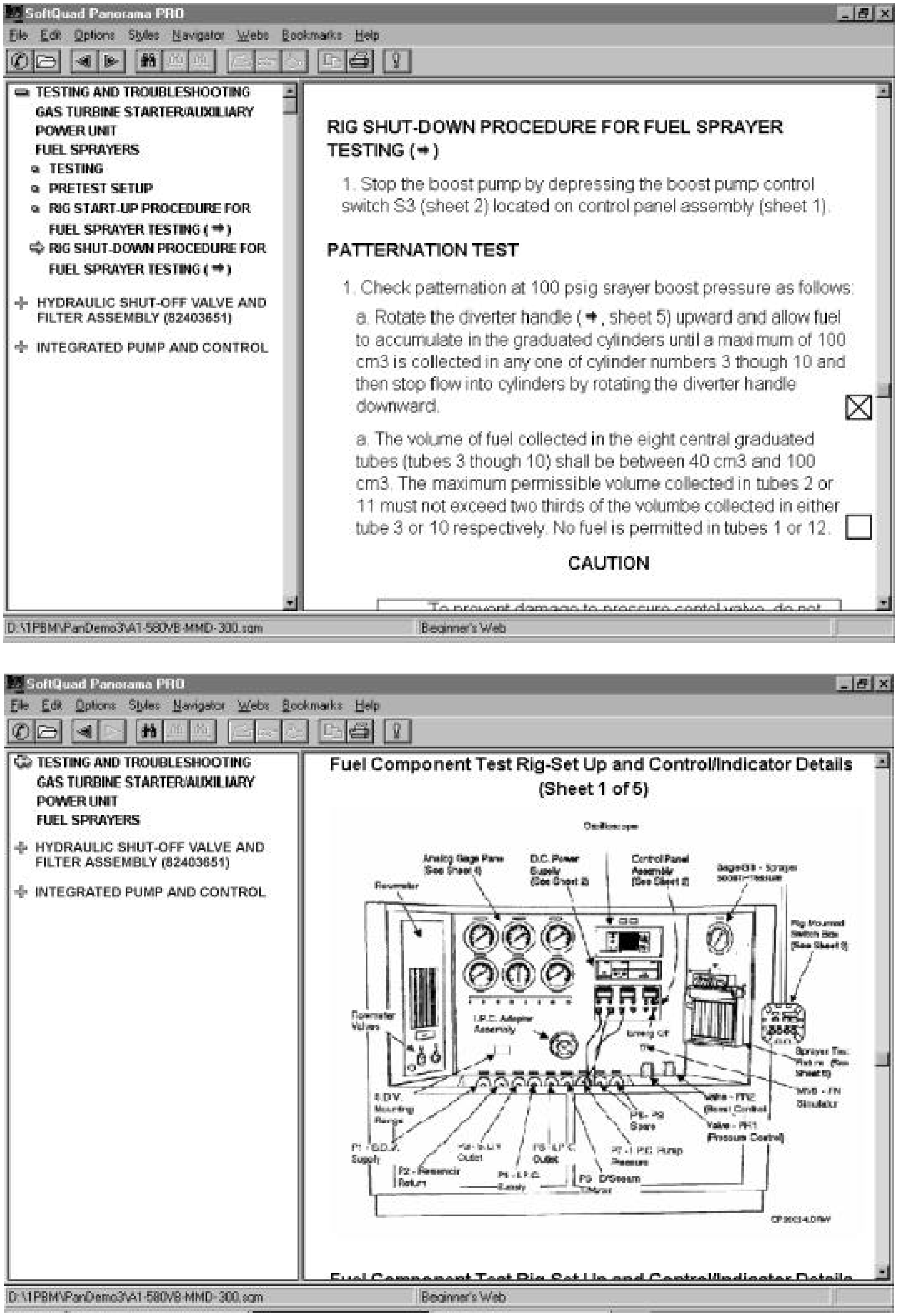


FIGURE 66. Example three of troubleshooting (for scrollable ETM).

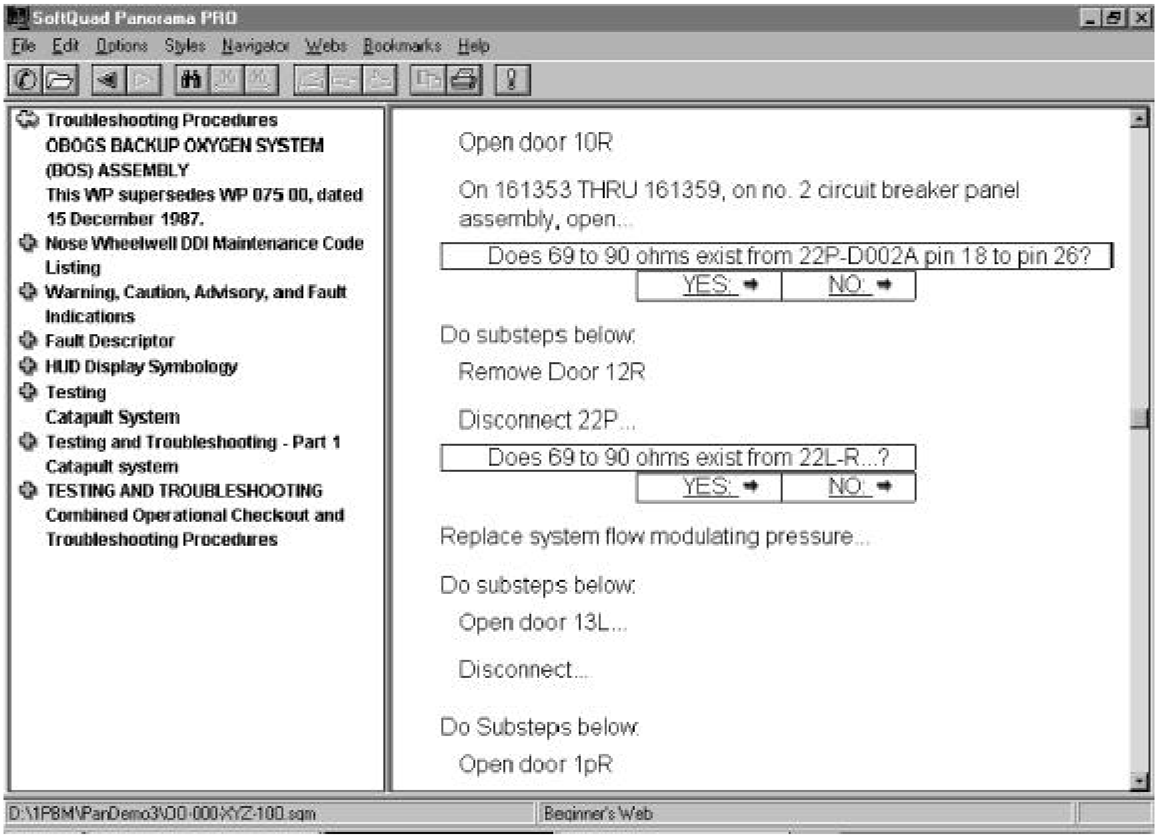
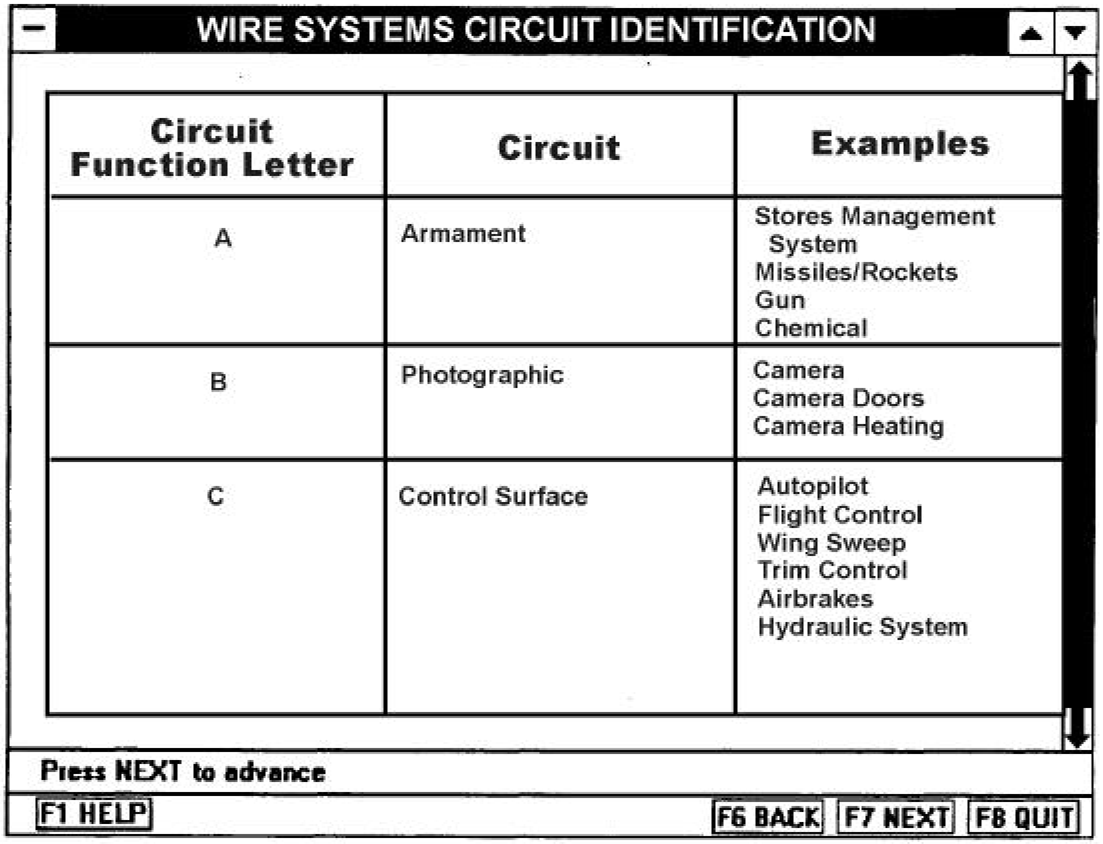


FIGURE 67. Example four of troubleshooting (for scrollable ETM).



WIRE SYSTEMS CIRCUIT IDENTIFICATION

Circuit Function Letter	Circuit	Examples
A	Armament	Stores Management System Missiles/Rockets Gun Chemical
B	Photographic	Camera Camera Doors Camera Heating
C	Control Surface	Autopilot Flight Control Wing Sweep Trim Control Airbrakes Hydraulic System

Press NEXT to advance

F1 HELP F6 BACK F7 NEXT F8 QUIT

FIGURE 68. Example of wire list.

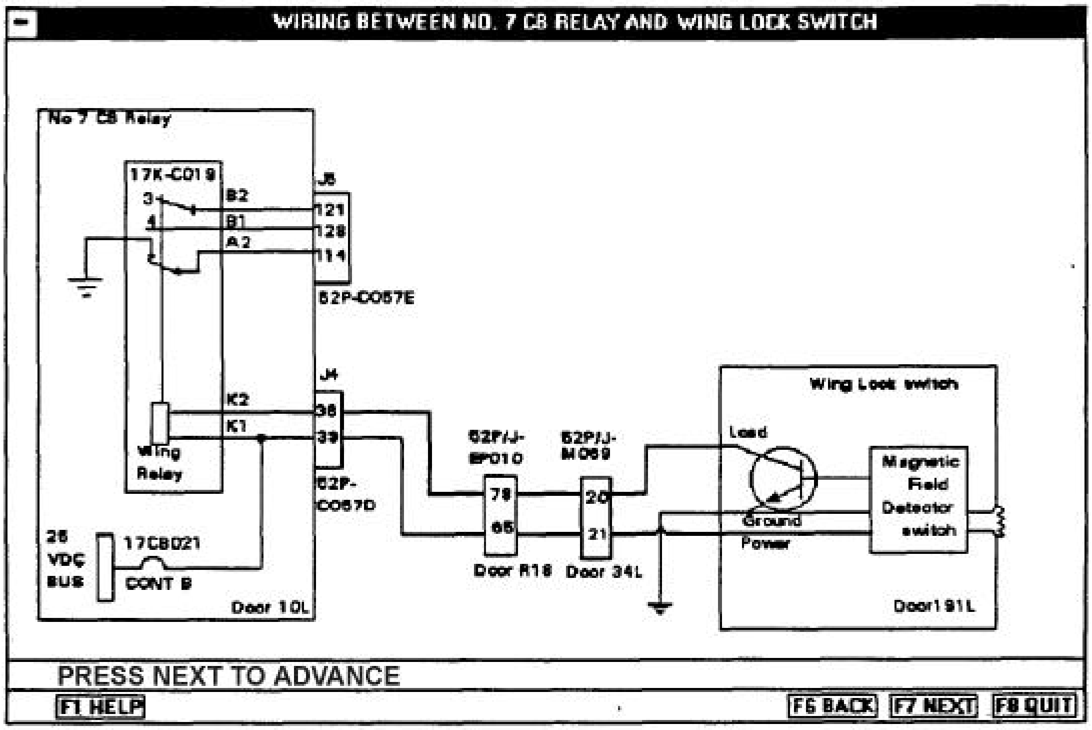


FIGURE 69. Example of wire diagram.

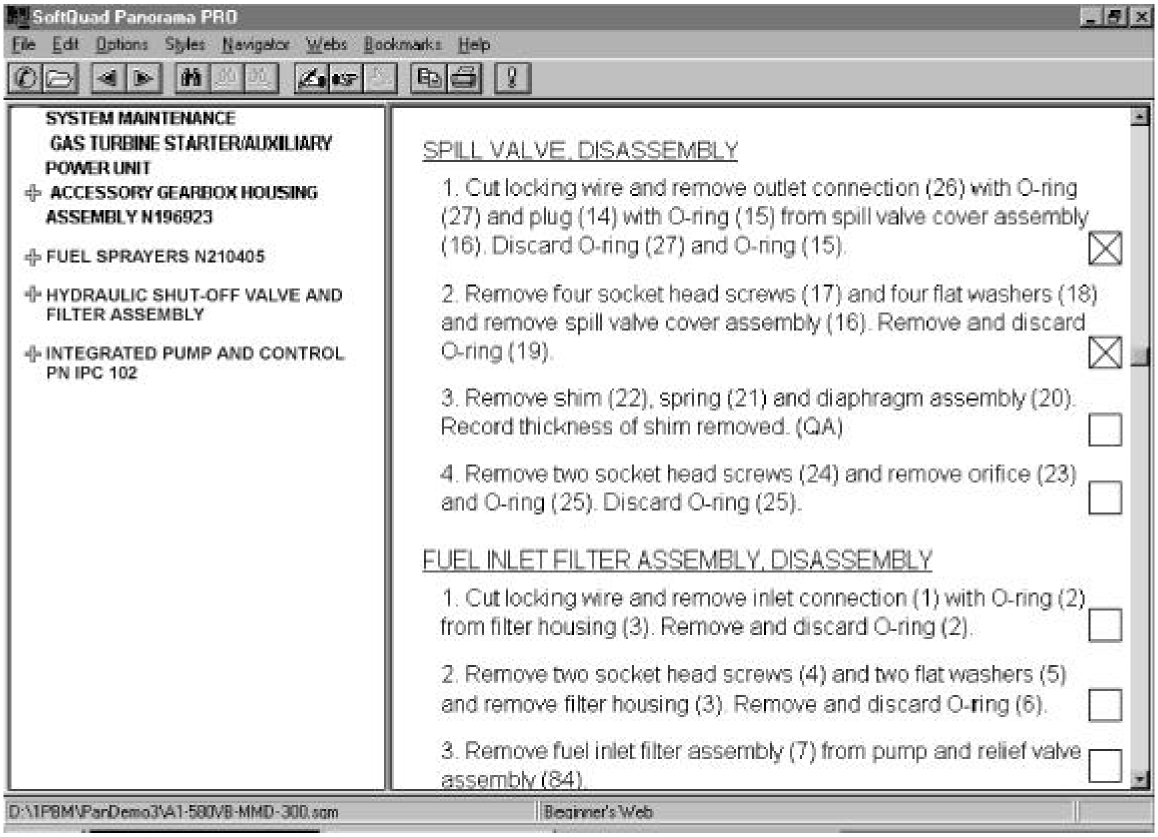


FIGURE 70. Example of procedures for scrollable ETM.

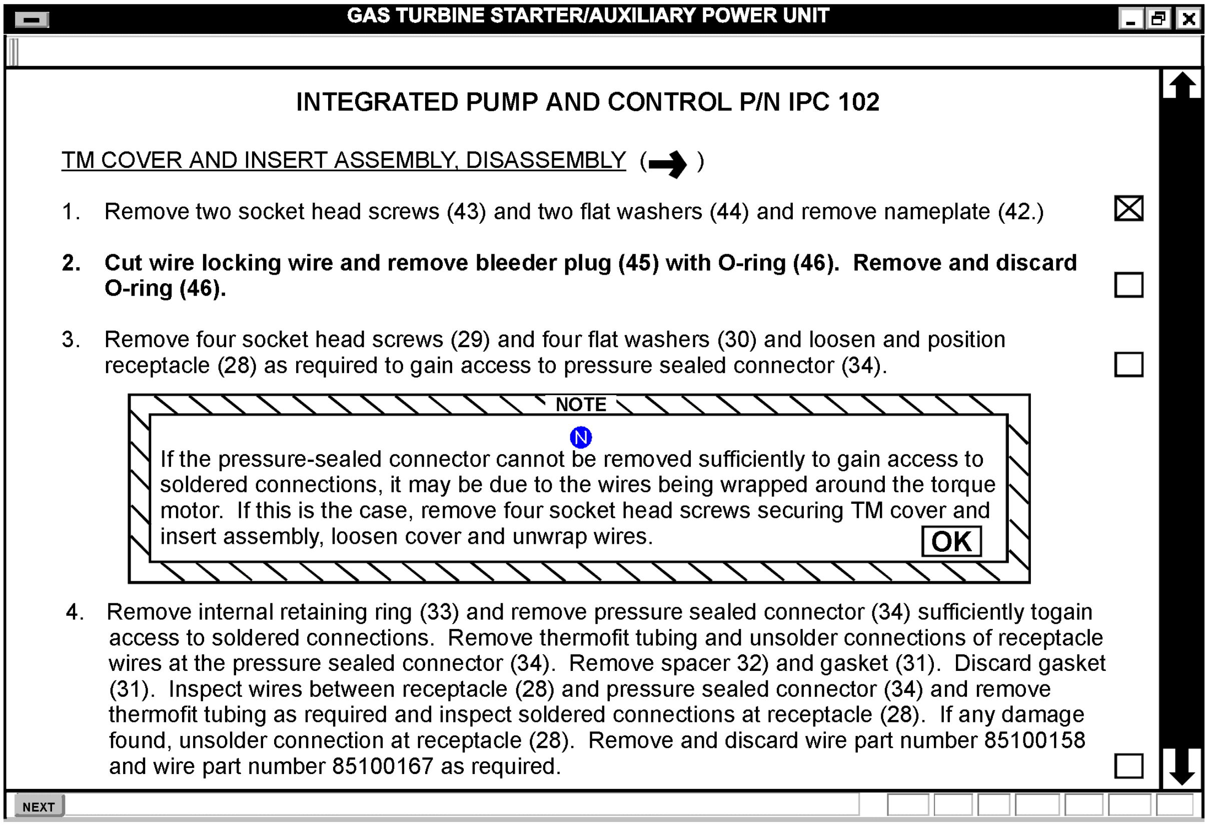


FIGURE 71. Example of procedures for IETM with unlimited number of steps (hotspotted arrow leading to graphic).

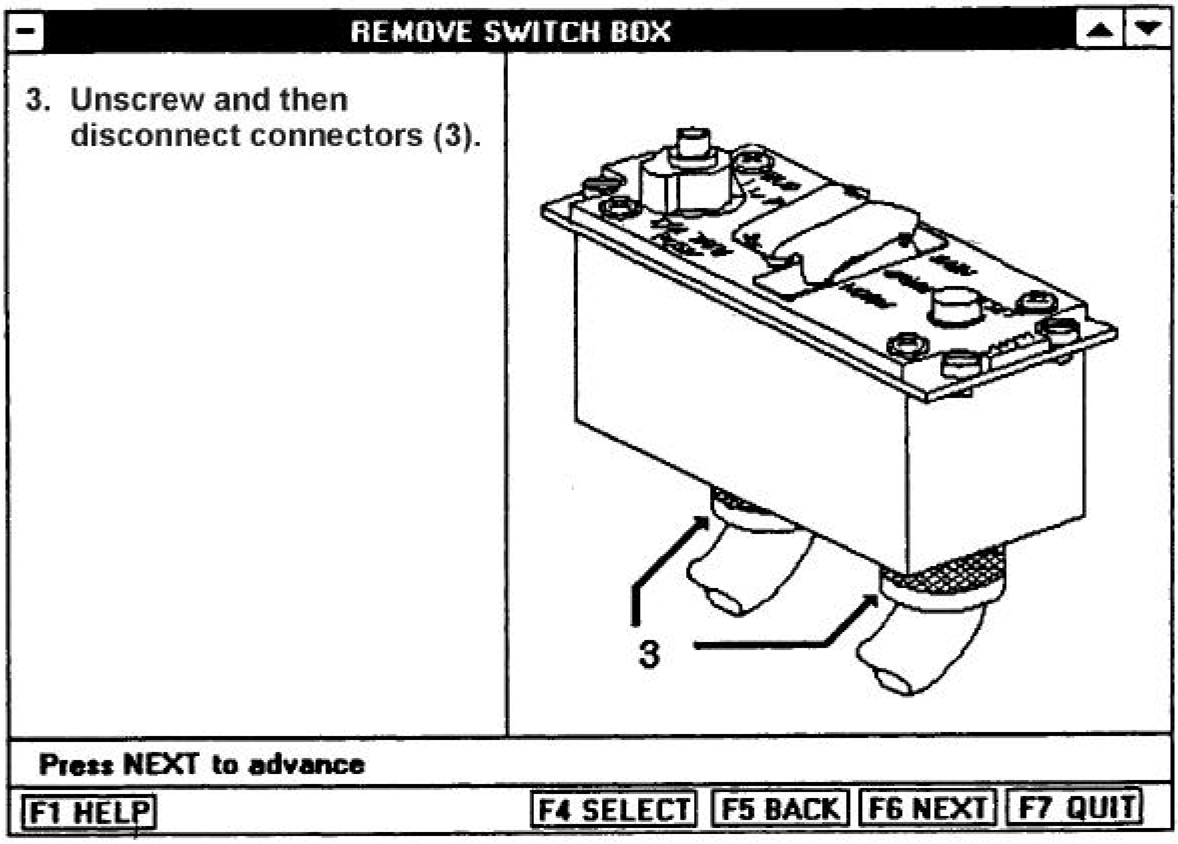


FIGURE 72. Example of procedural information with a single step.

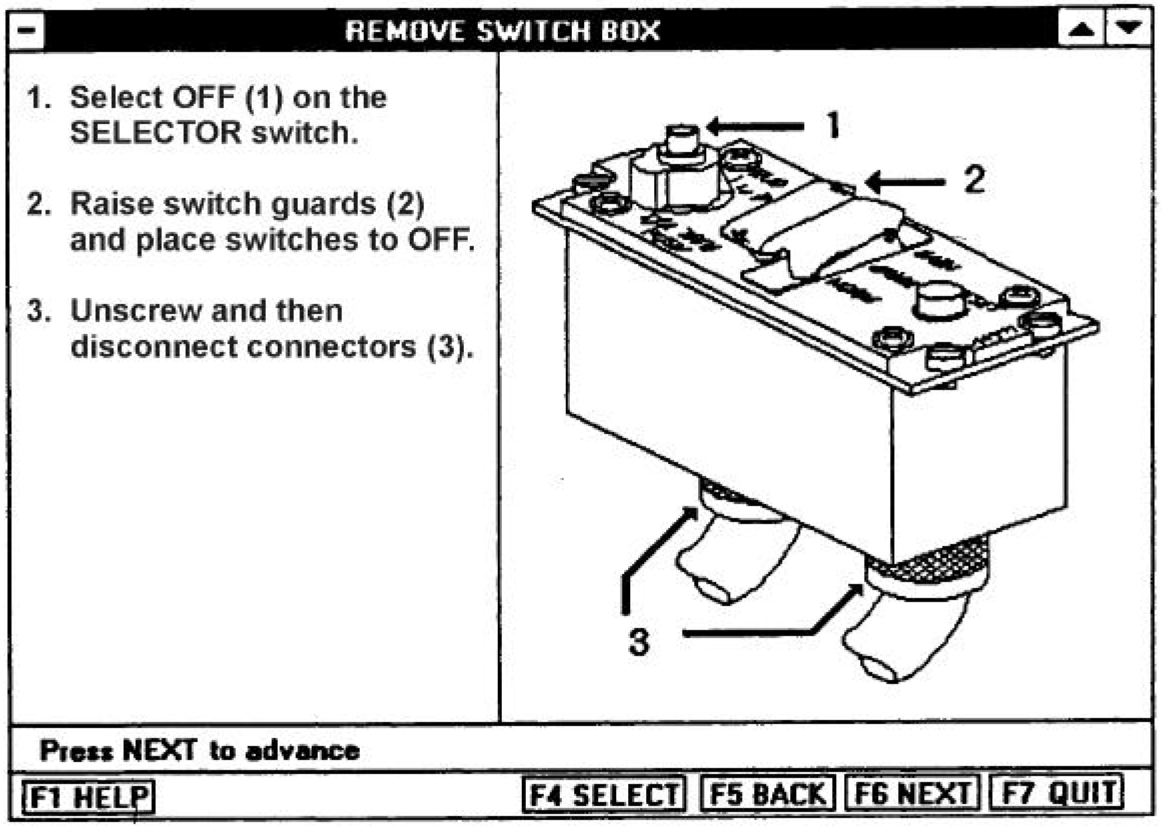


FIGURE 73. Example of procedural information with multiple steps.

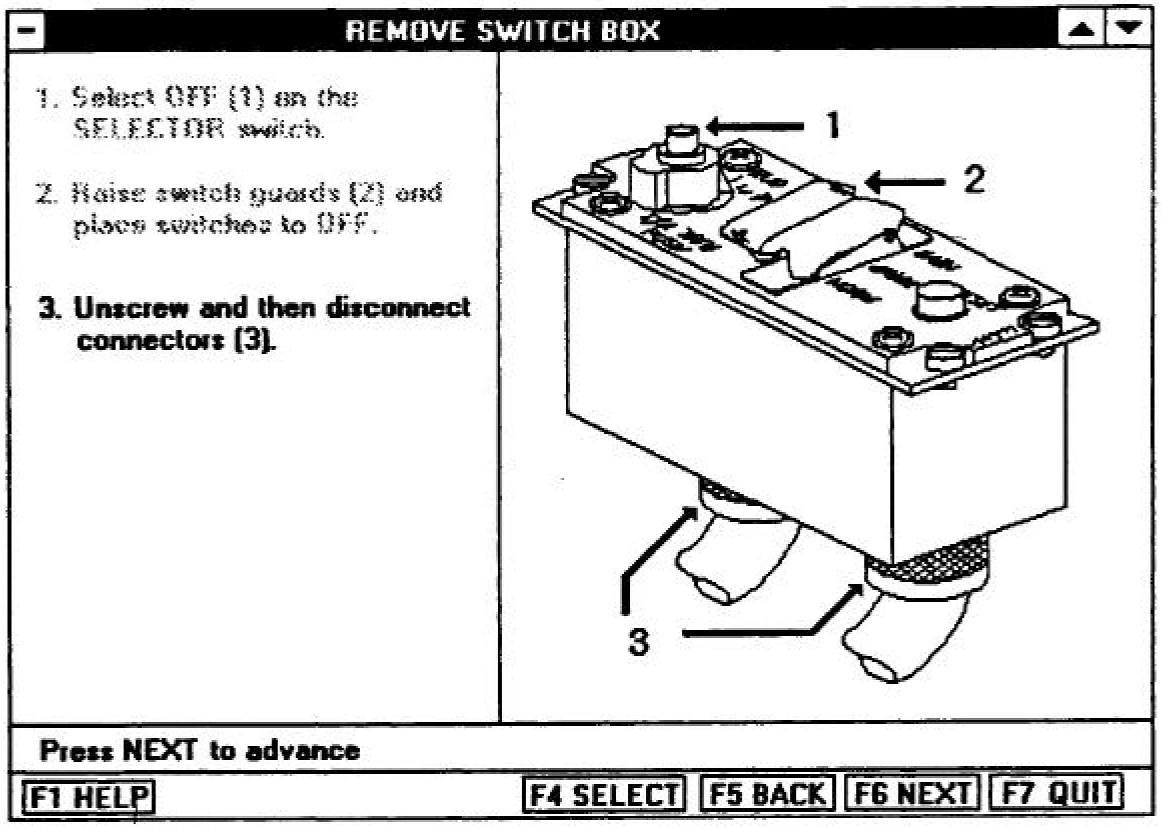


FIGURE 74. Example of procedural information with dimmed steps.

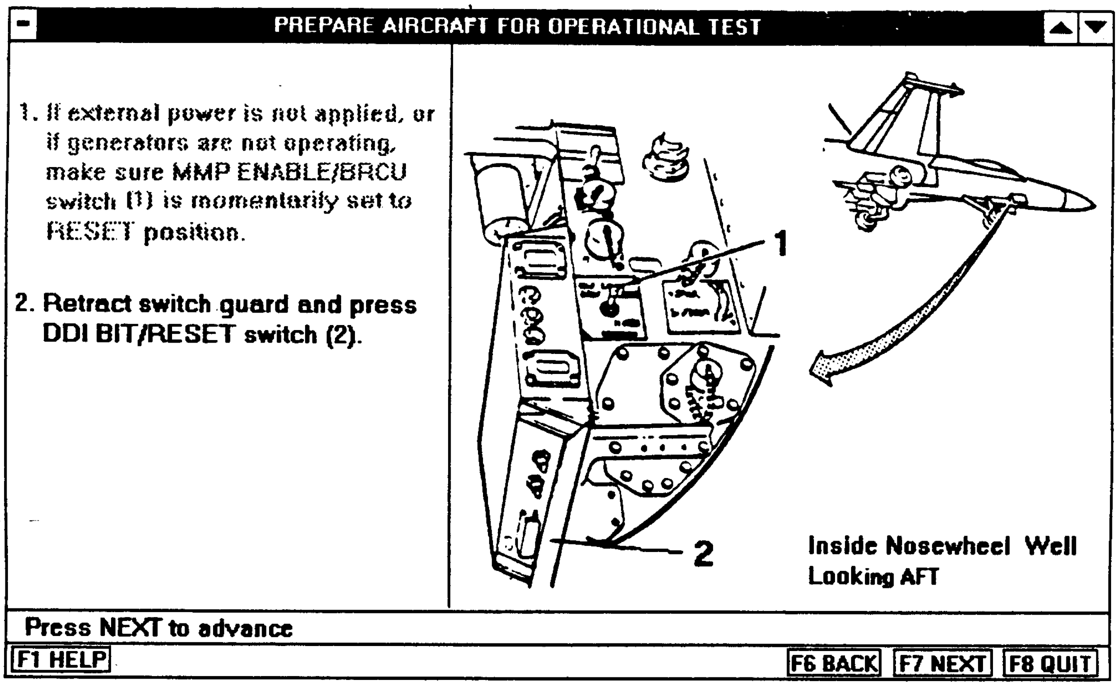


FIGURE 75. Example of procedures with locator graphic leading to detail graphic.

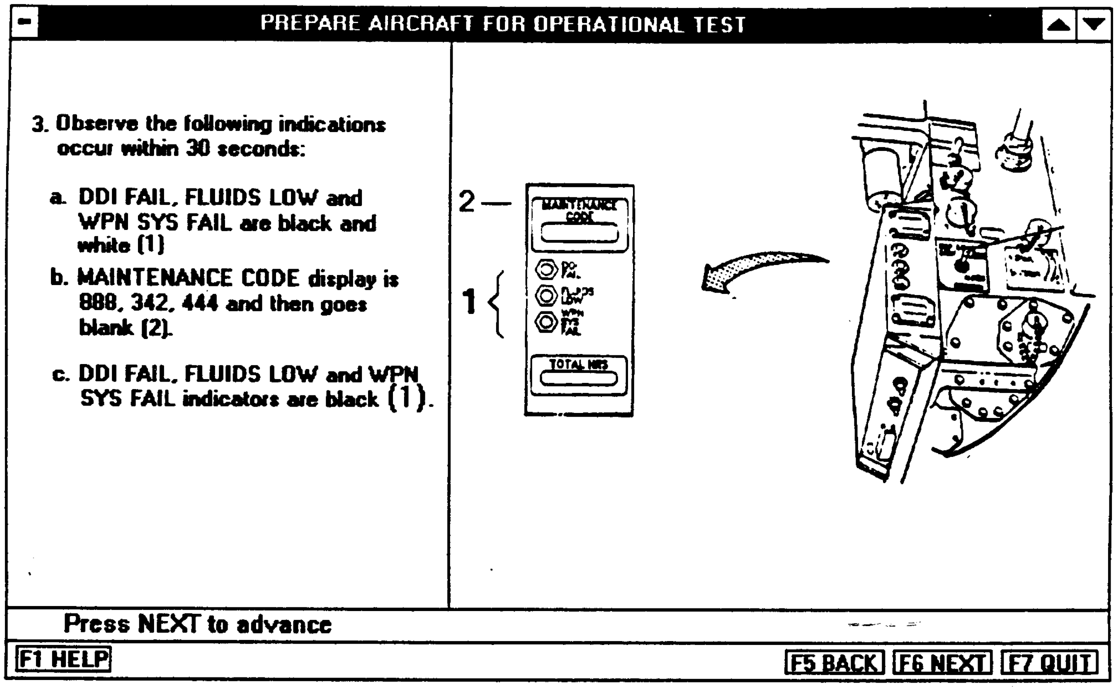


FIGURE 76. Example of procedures with previous detail graphic used as locator.

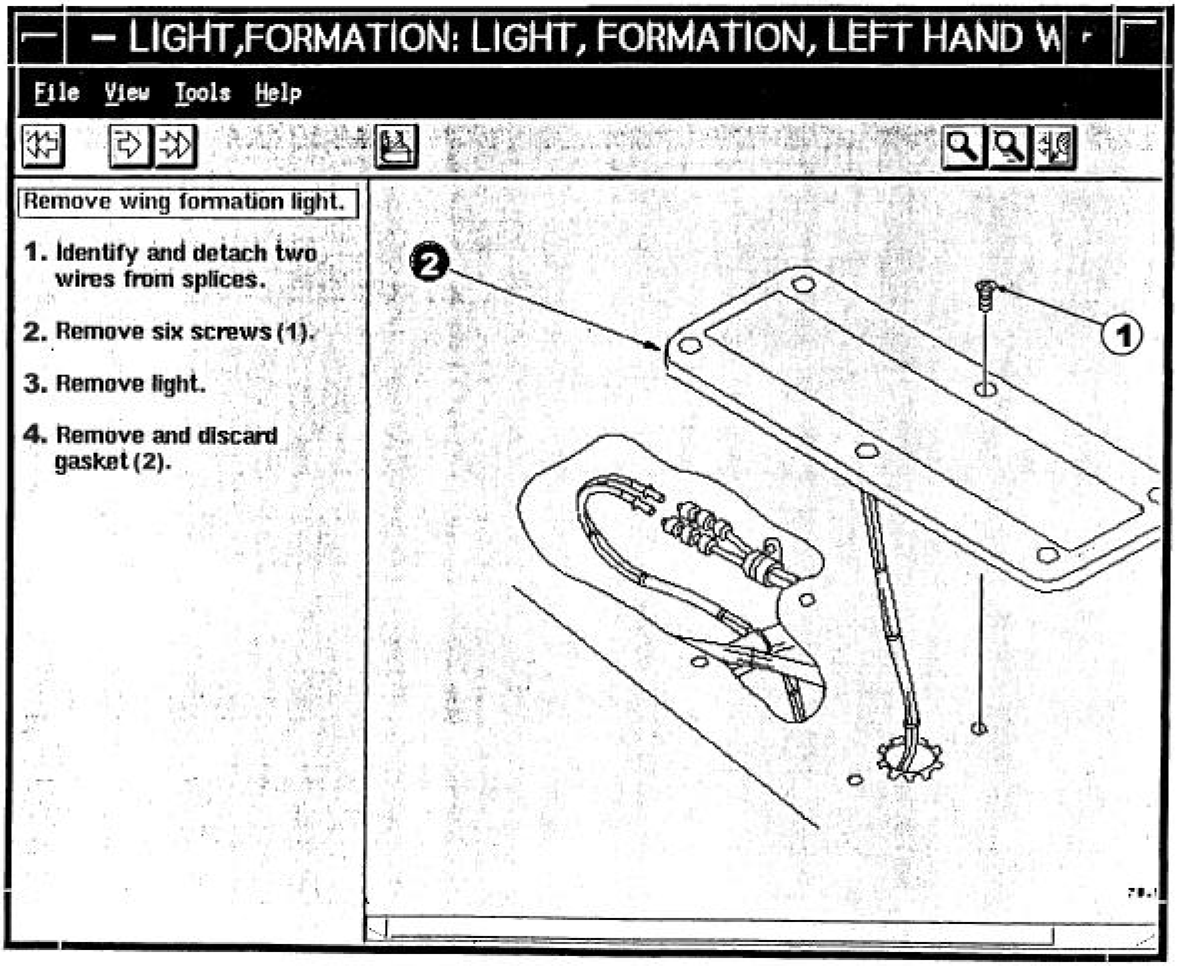


FIGURE 77. Example of procedural information with hotspot on callout.

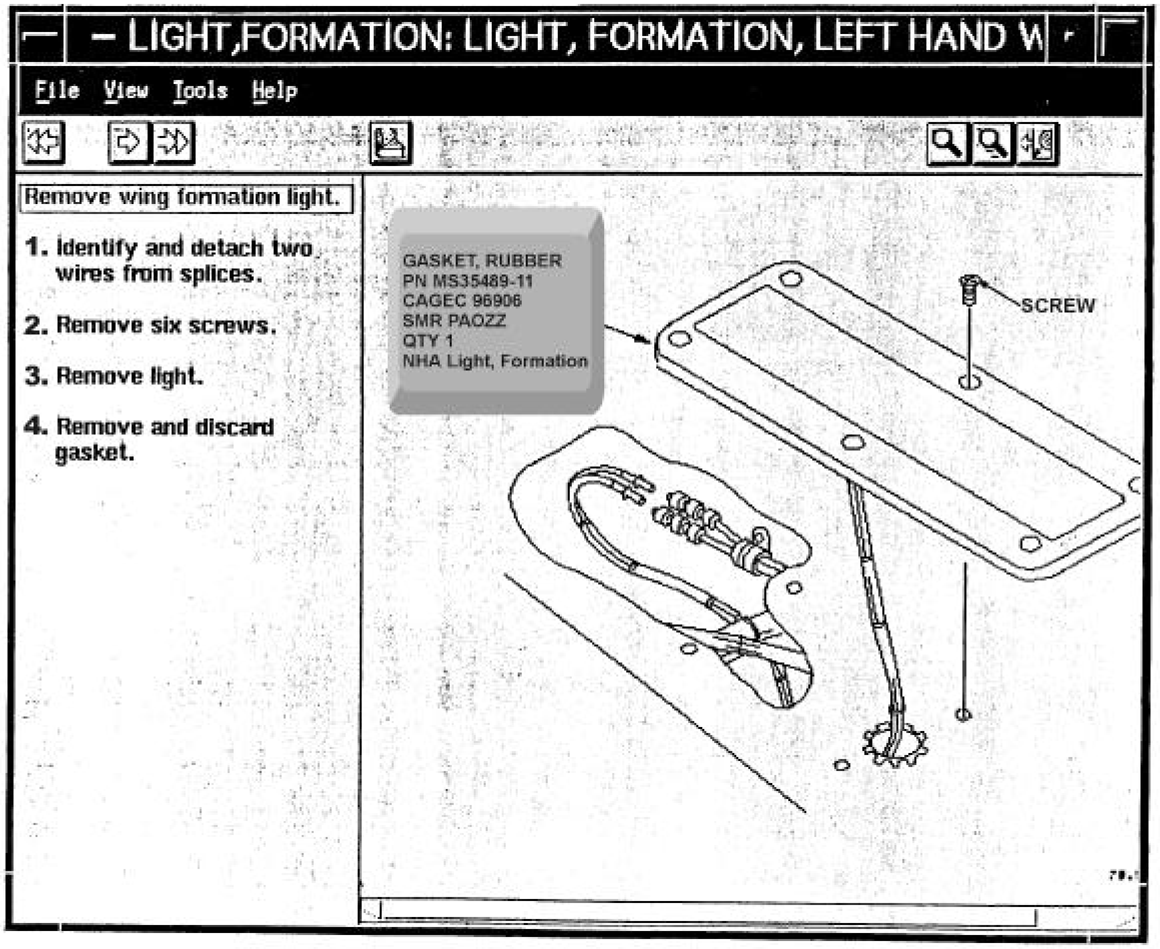


FIGURE 78. Example of procedures with parts data displayed from hotspot callout.

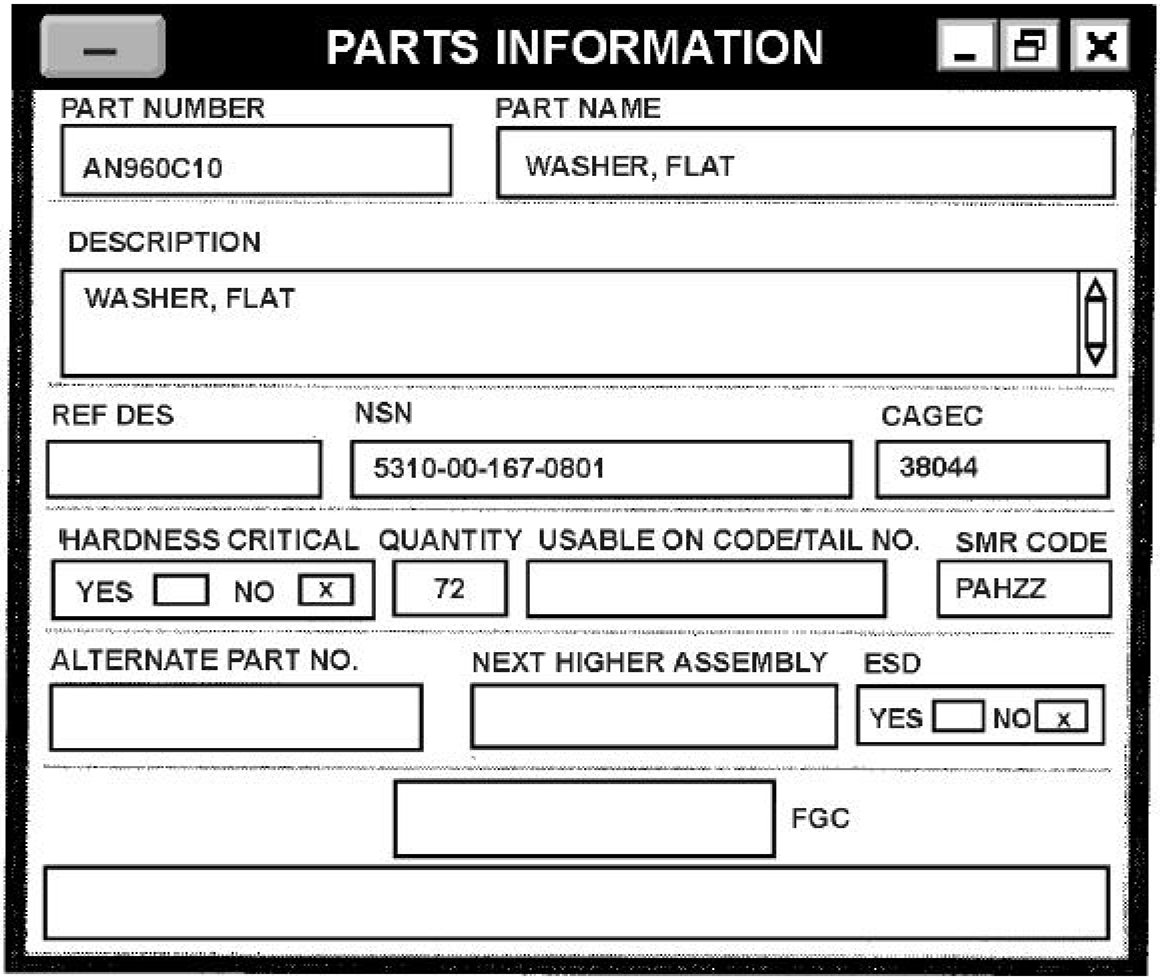


FIGURE 79. Example of parts data.

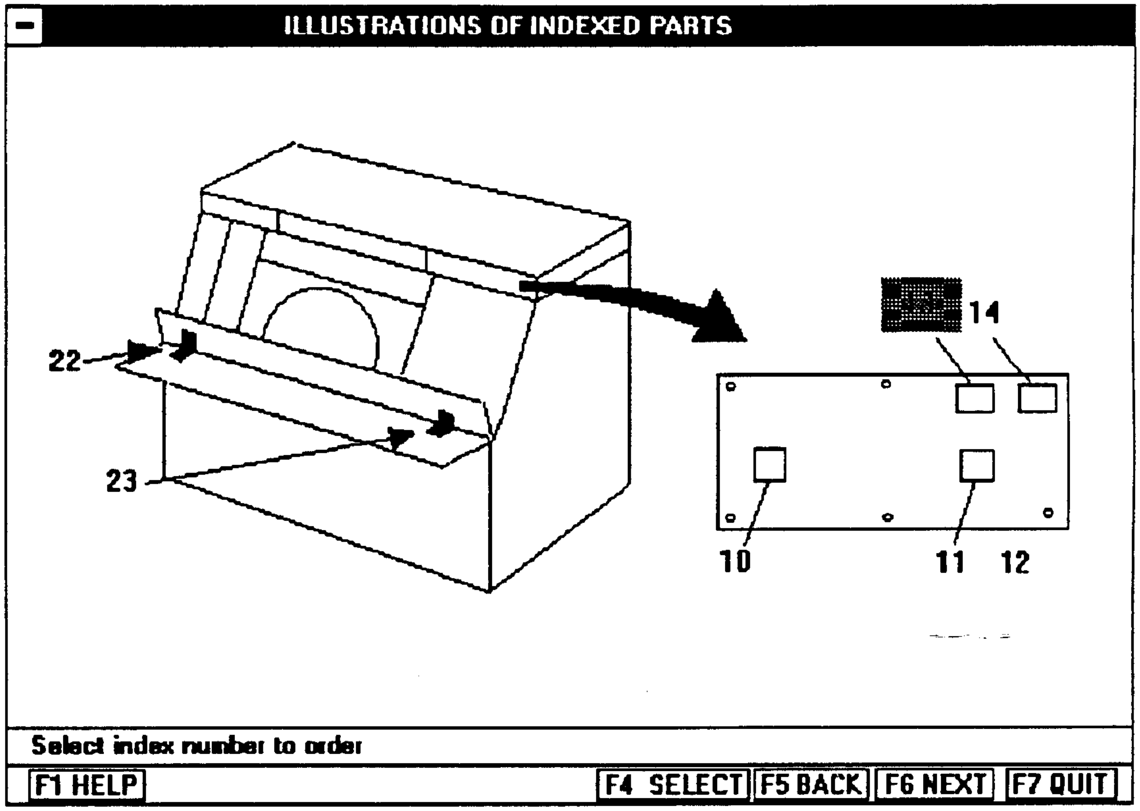


FIGURE 80. Example of an IPB illustration.

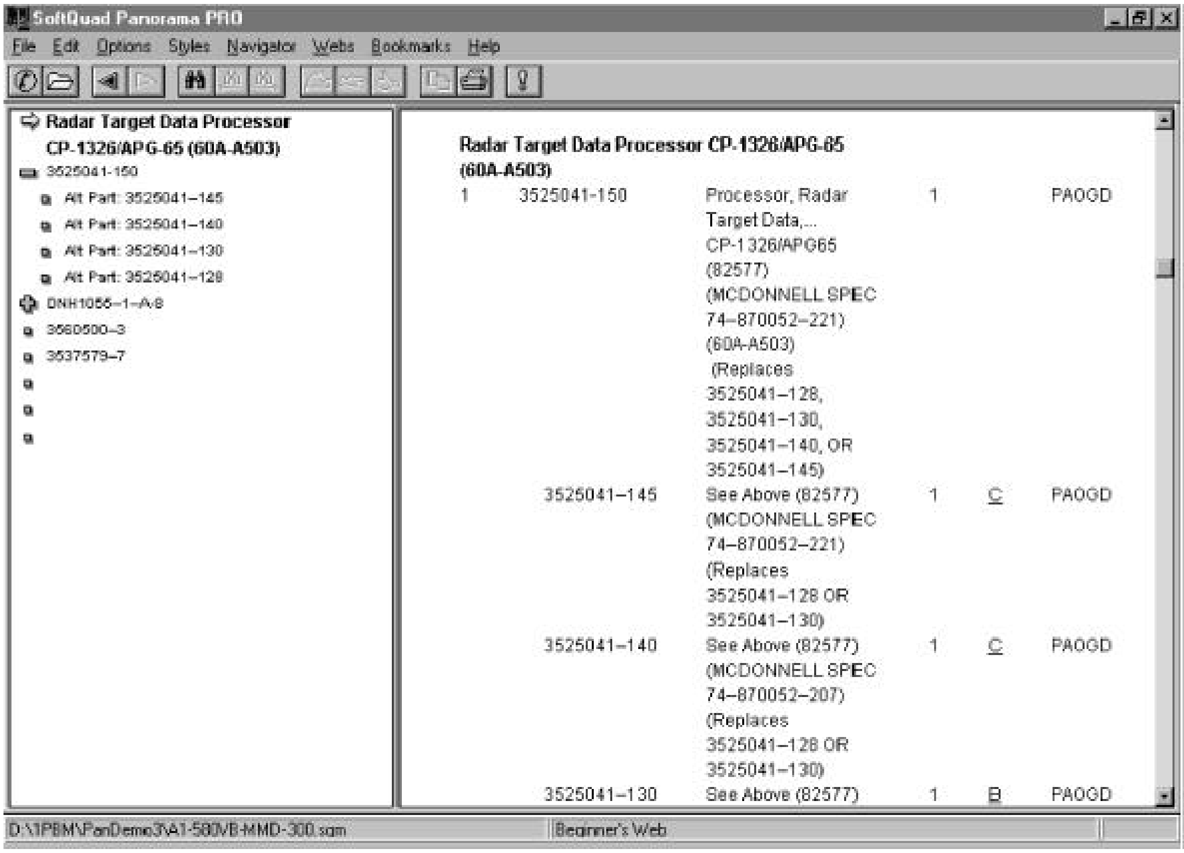


FIGURE 81. Example of IPB information in a scrollable ETM.

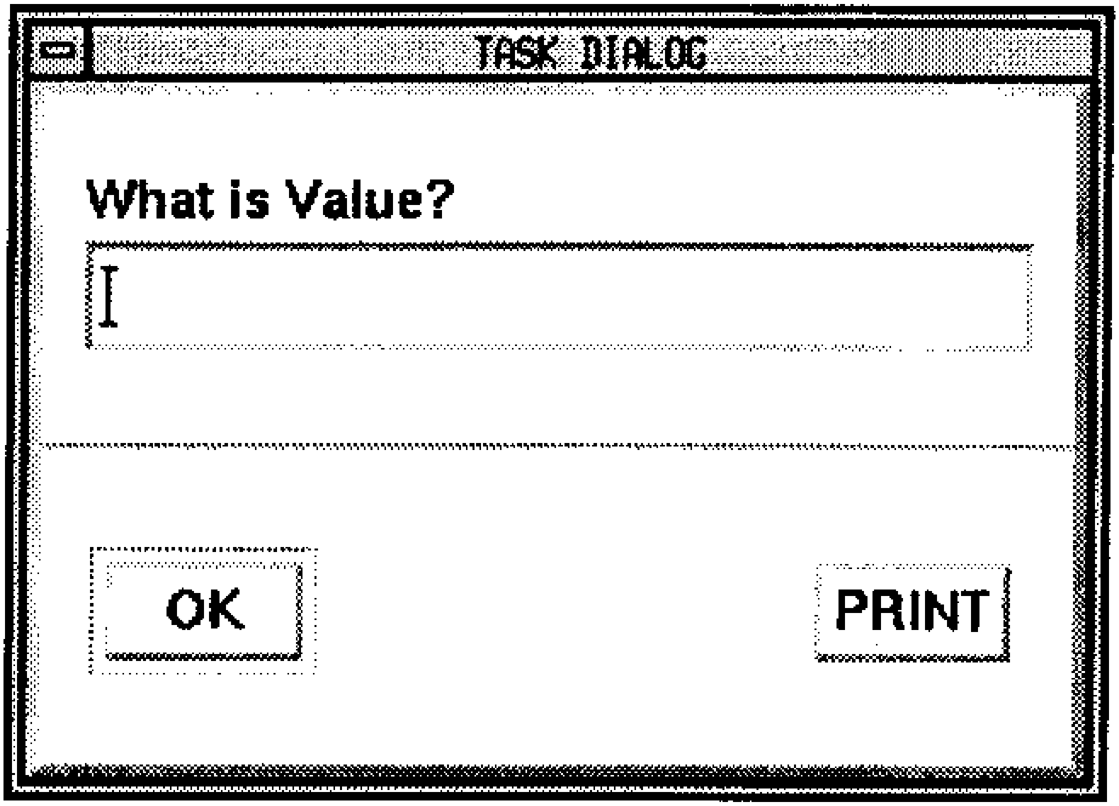


FIGURE 82. Example one of task dialog (fill-in) display.

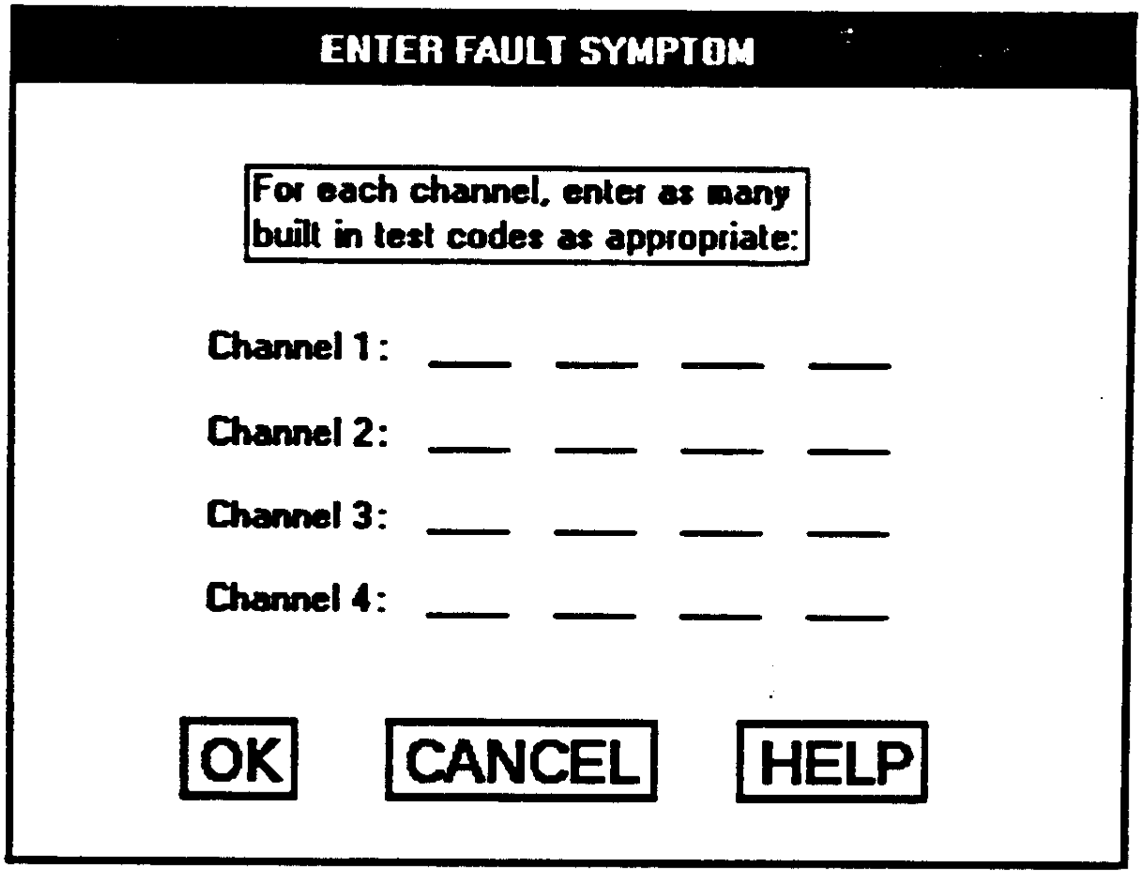


FIGURE 83. Example two of task dialog (fill-in) display.

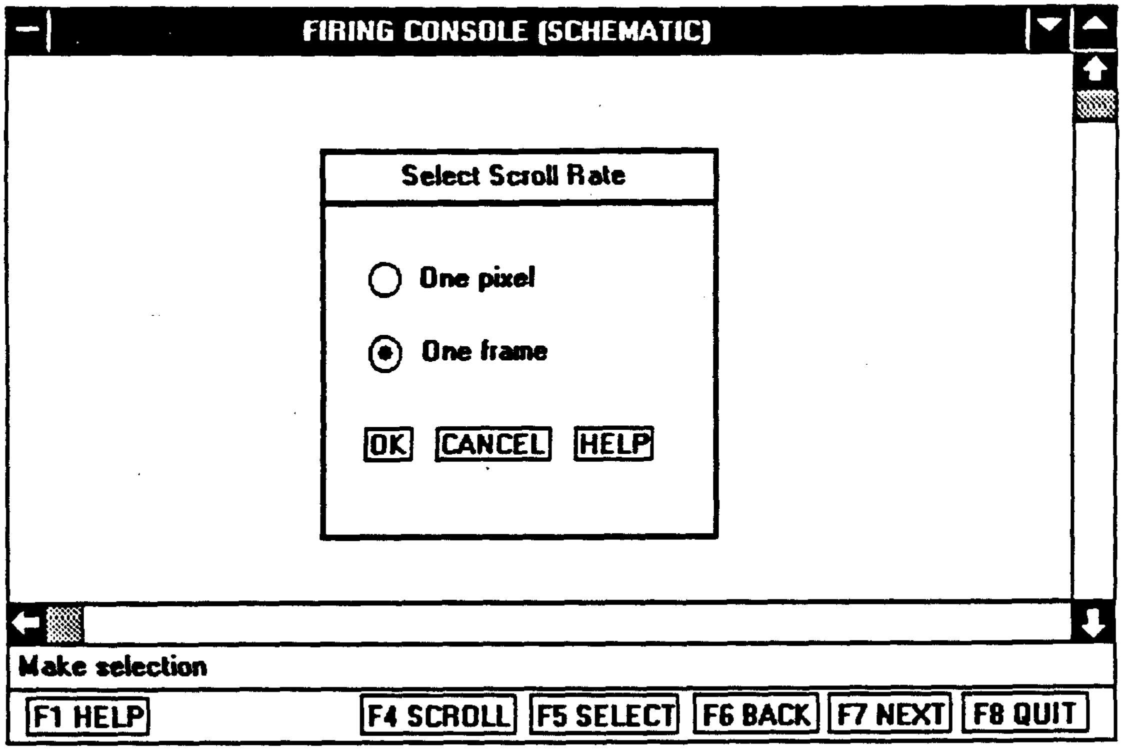


FIGURE 84. Example one of single choice task dialog.

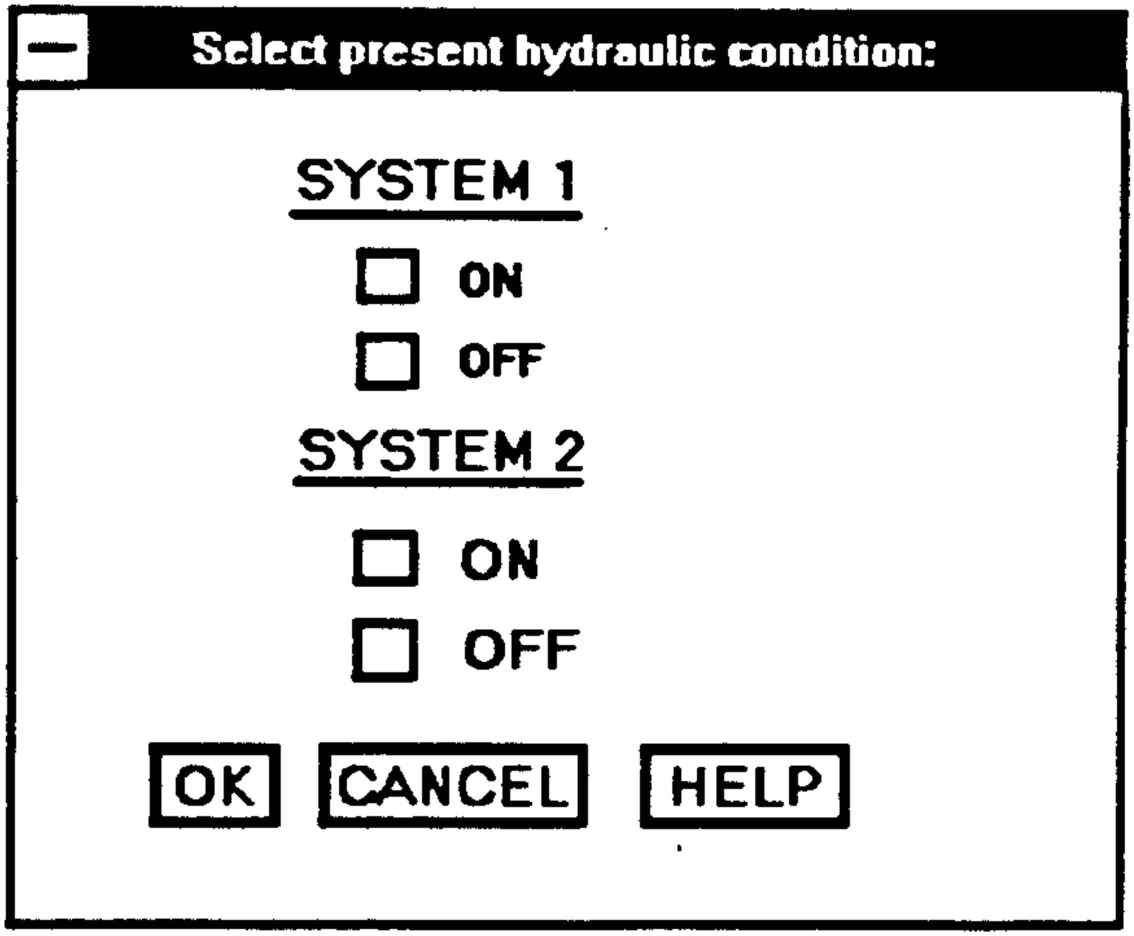


FIGURE 85. Example two of single choice task dialog (IETM only).

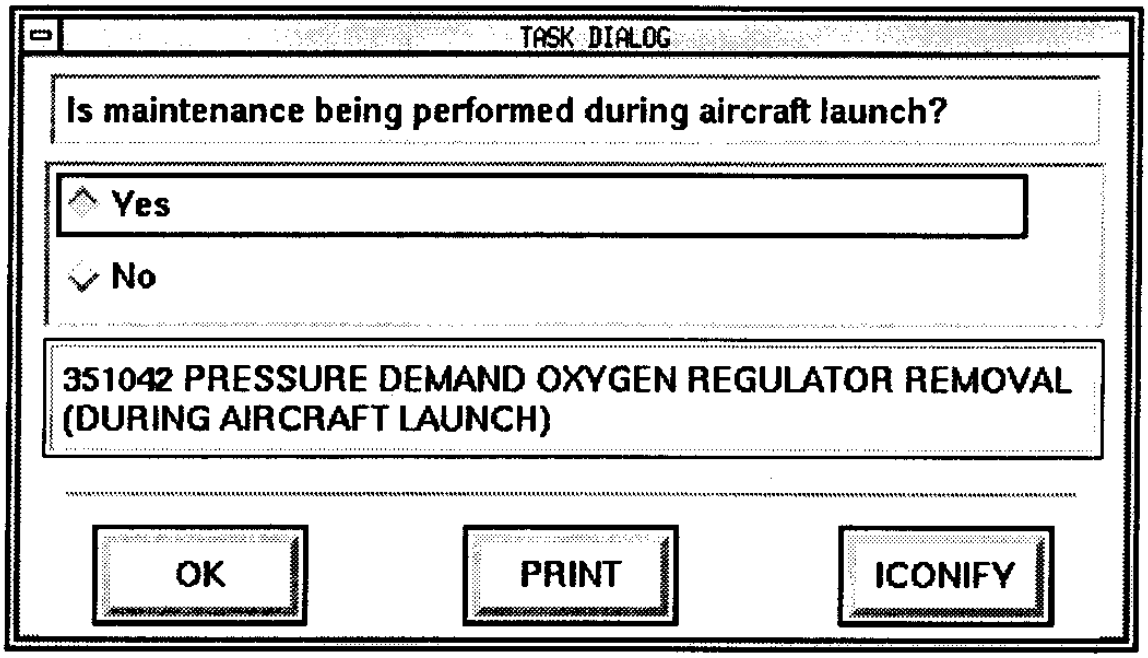


FIGURE 86. Example three of single choice task dialog.

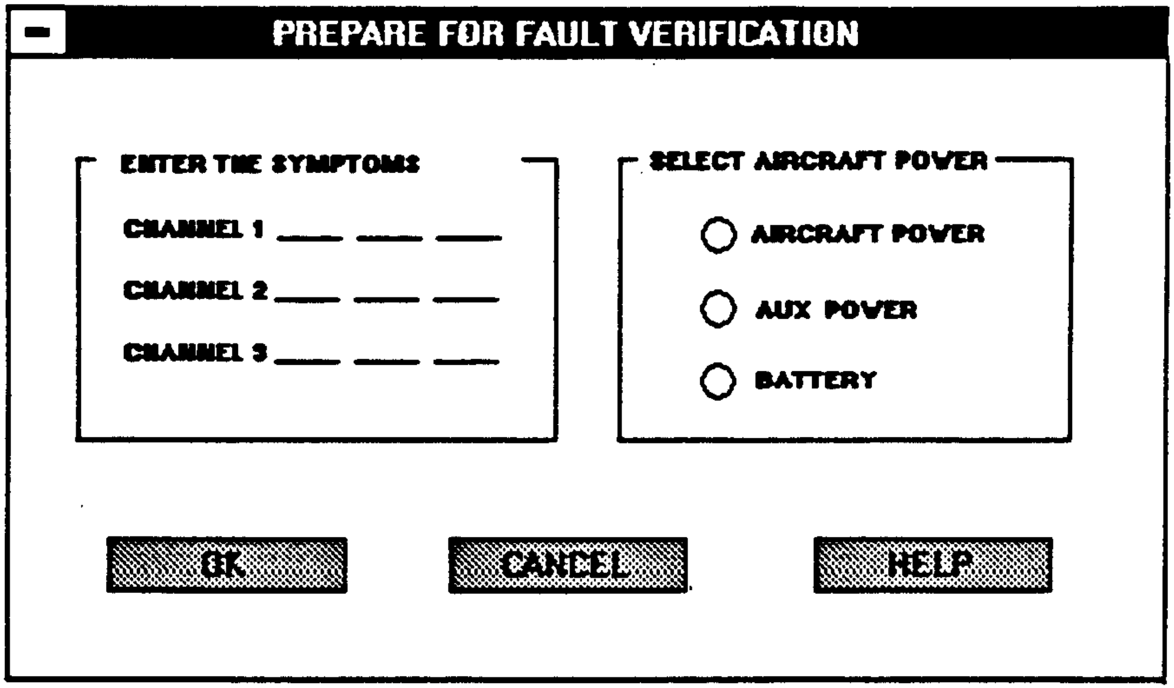


FIGURE 87. Example of composite task dialog.

INDICATE HIGHEST CLASSIFICATION ASSIGNED TO ANY PAGE WITHIN TM

CLASSIFICATION

AE-199AG-580-000
1 May 1994

TECHNICAL MANUAL

ORGANIZATIONAL MAINTENANCE

AIRCRAFT/ARMAMENT MONITOR AND CONTROL (U)

NAVY MODEL
F/A-18C and F/A-18D
163985 AND UP

NOMENCLATURE CLASSIFICATION (U), (C), OR (S)

This manual supersedes AE-199AG-580-000/(s) dated 1 December 1992

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(This page is UNCLASSIFIED)

FIGURE 88. Example of security classification markings for a title page.

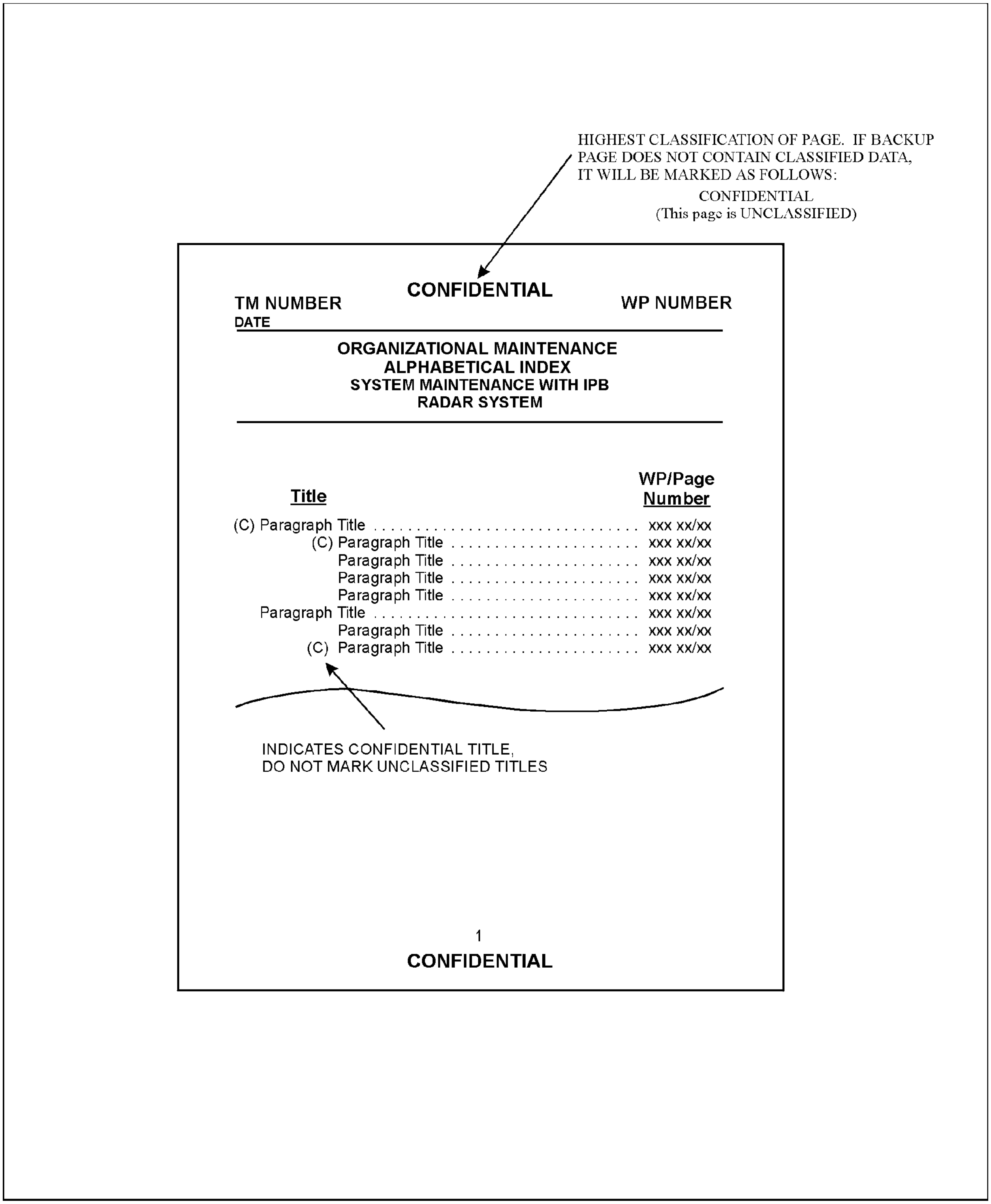


FIGURE 89. Example of security classification markings for an alphabetical index.

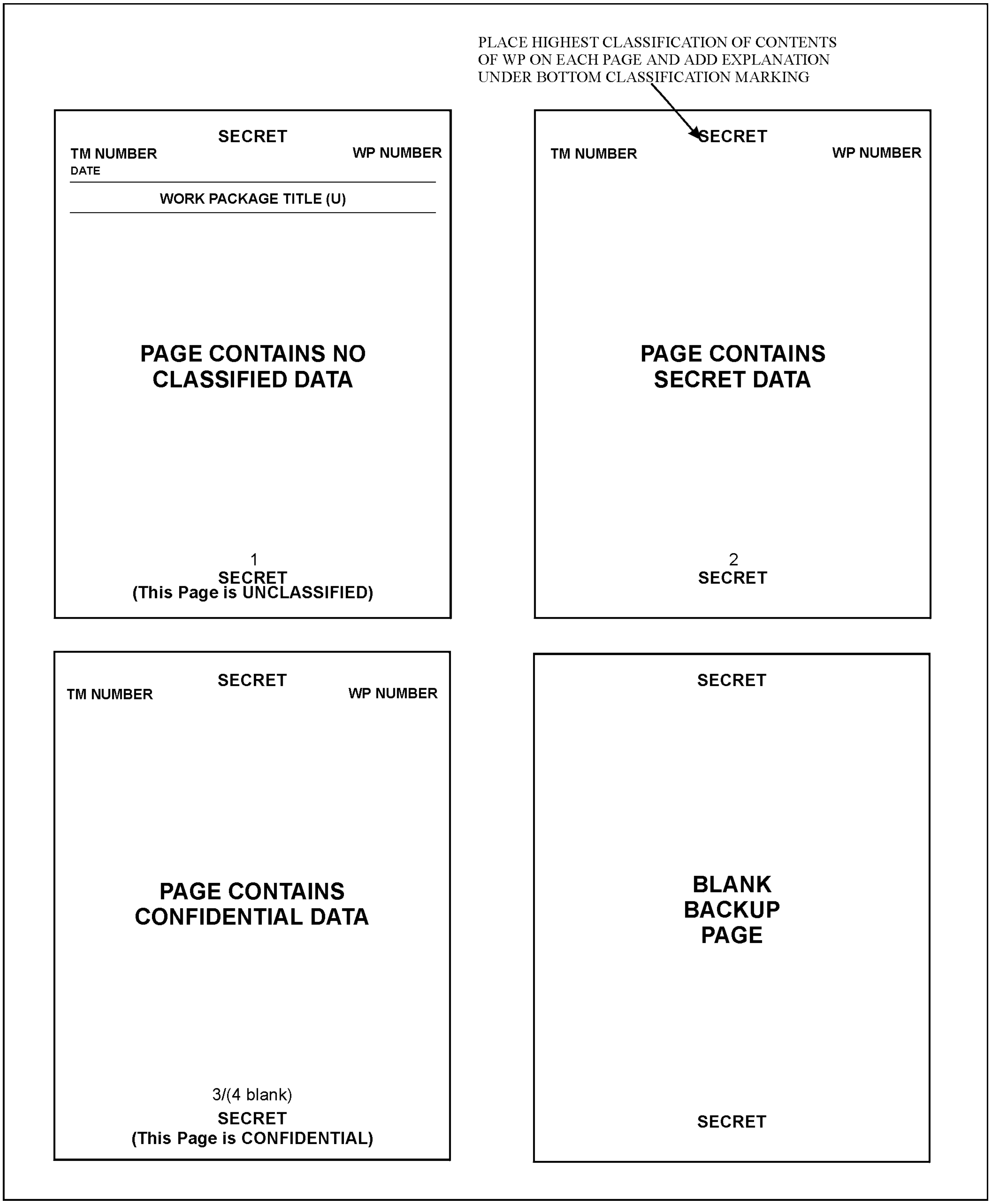


FIGURE 90. Example of security classification markings for work package pages.

UNCLASSIFIED

NAVAIR 16-30AAR47-1 **TPDR-1**
1 March 1961

INTERMEDIATE MAINTENANCE

LIST OF TECHNICAL PUBLICATION DEFICIENCY REPORTS (TPDR) INCORPORATED

MISSILE WARNING SET AN/AAR-47
Part Number 21040600

Identification No./ QA Sequence No.	Location

None

UNCLASSIFIED

FIGURE 91. Example of security classification markings for front matter pages.

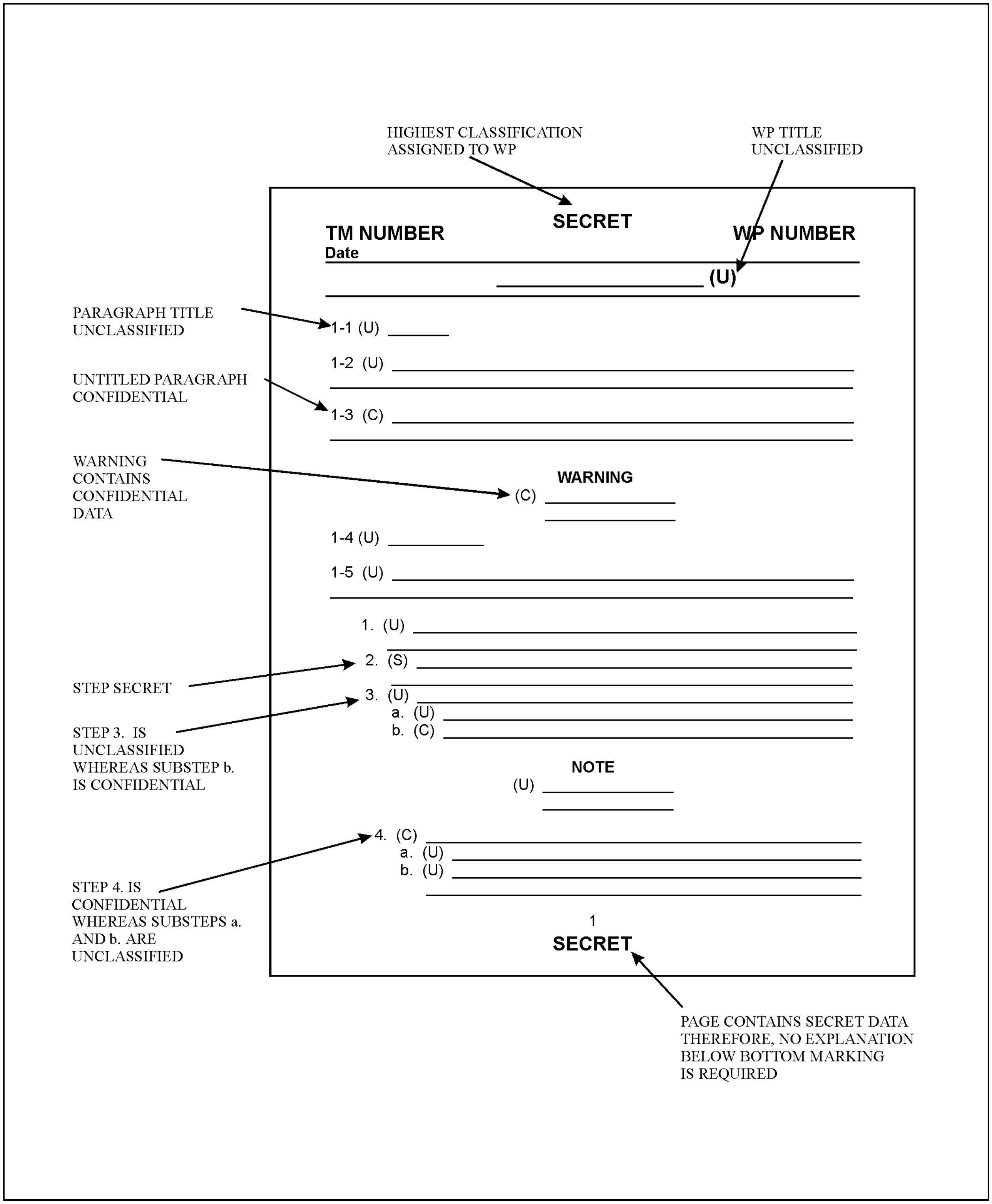


FIGURE 92. Example of security classification markings for paragraphs.

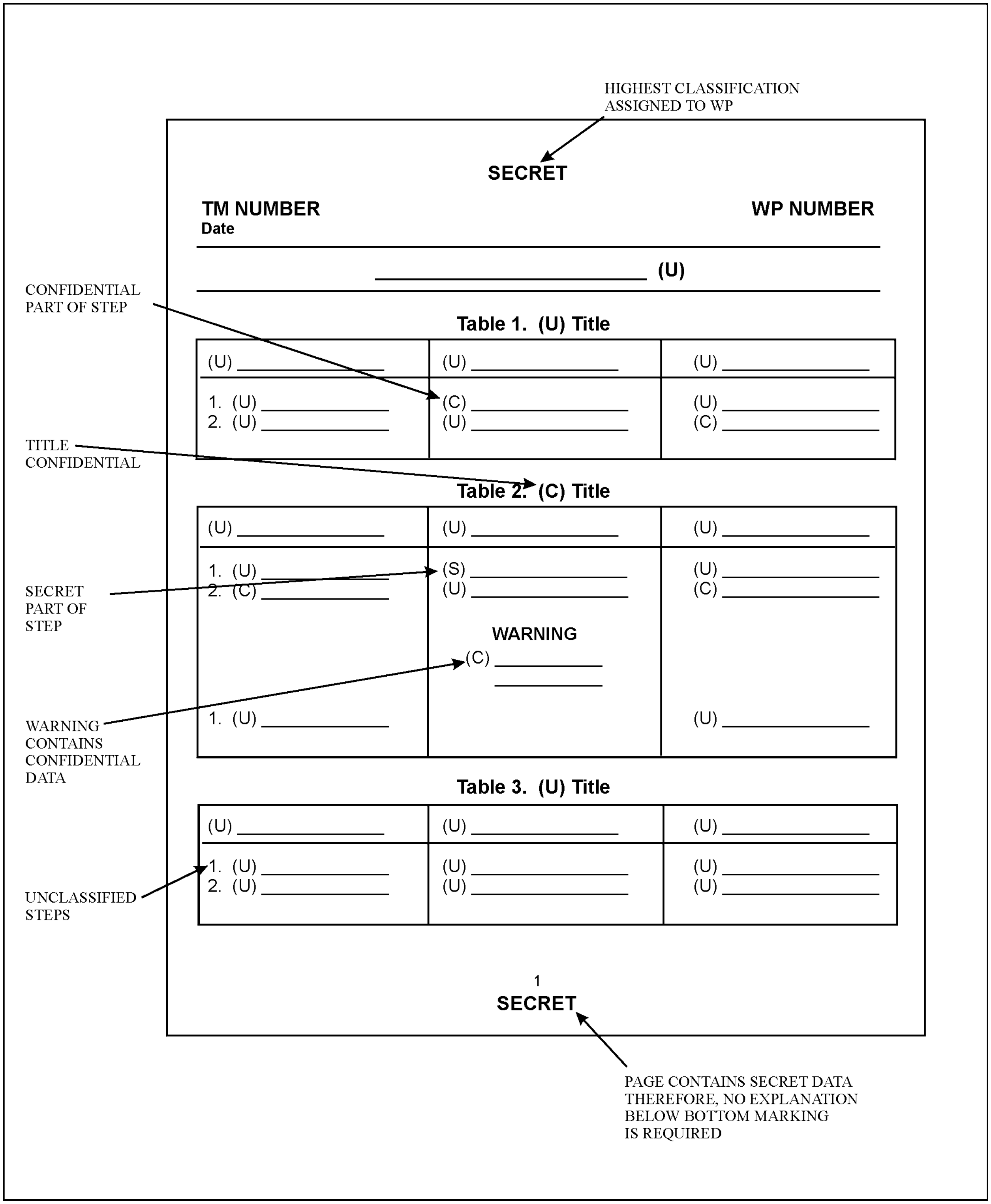


FIGURE 93. Example of security classification markings for tables.

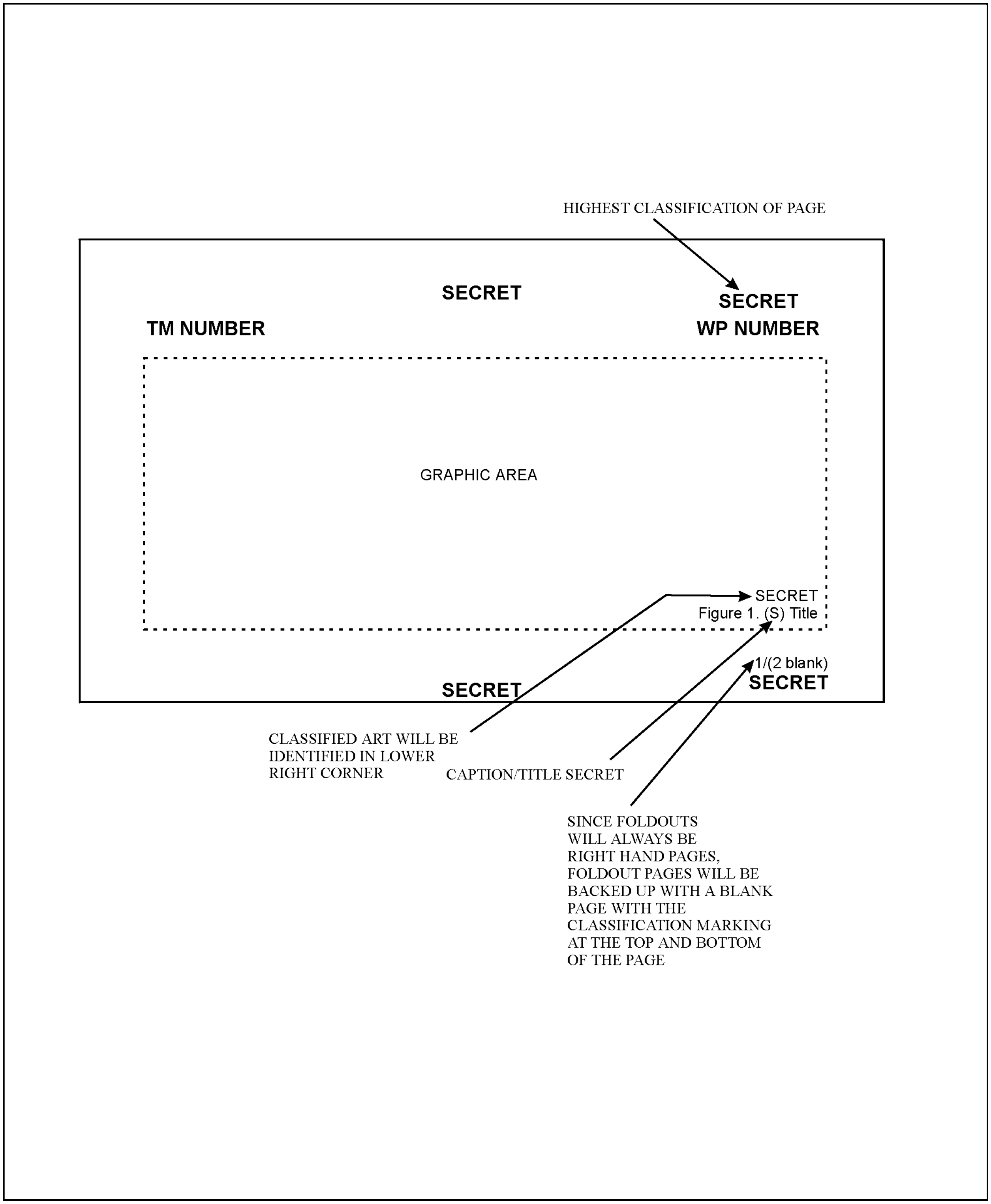


FIGURE 94. Example of security classification markings for illustrations.

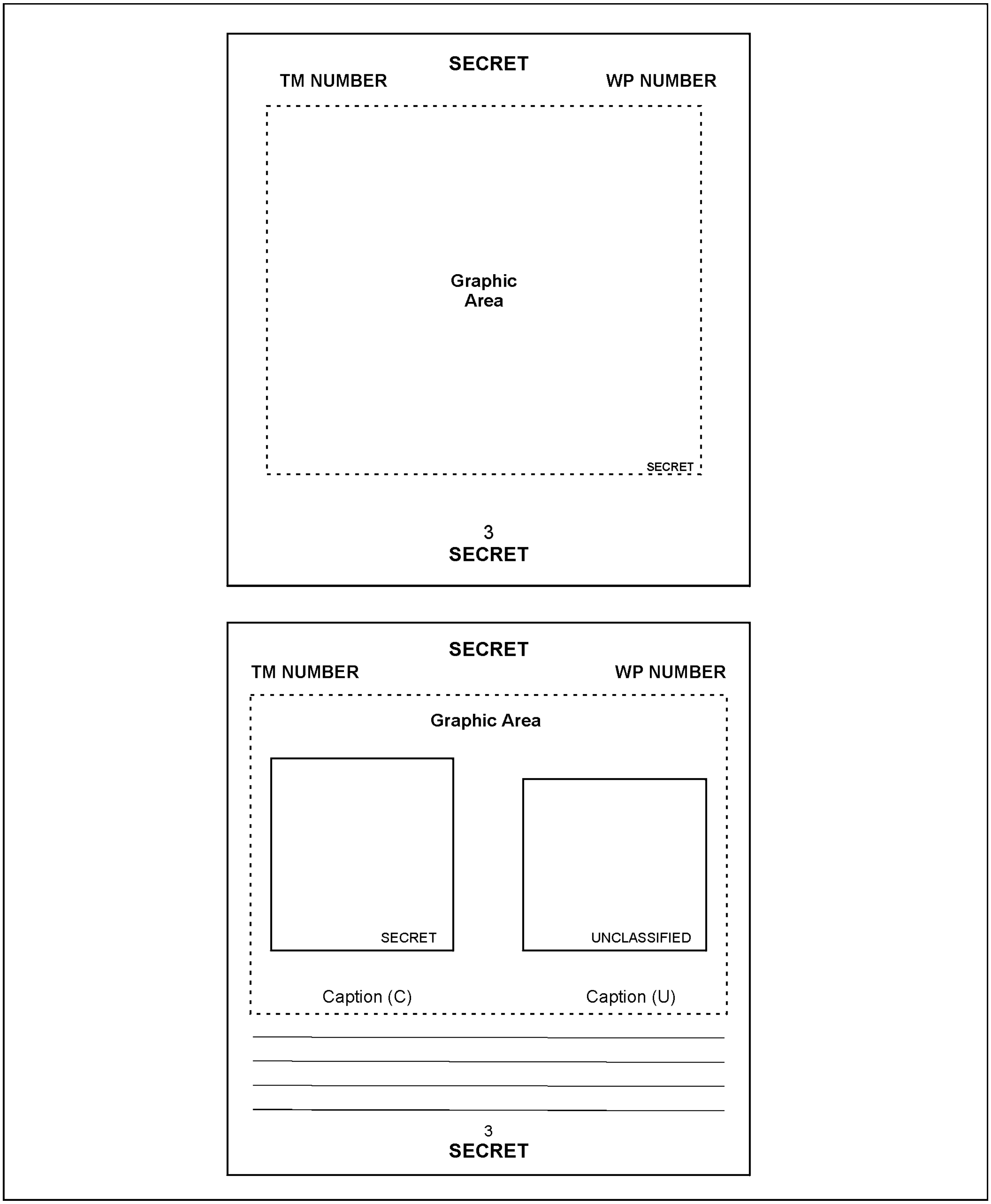


FIGURE 94. Example of security classification markings for illustrations - continued.

APPENDIX A - EXAMPLES OF TYPES OF GRAPHICS USED IN WORK PACKAGE TECHNICAL MANUALS

A.1 Scope. This appendix provides examples of the various types of graphics used in the development of page-based TMs and scrollable and frame-based TMs. Additional graphics preparation requirements for IETMs are provided in MIL-PRF-87268.

A.2 **APPLICABLE DOCUMENTS**.

This section does not apply to this appendix.

A.3 **DEFINITIONS**.

This section is not applicable to this appendix.

A.4 **GENERAL REQUIREMENTS**.

A.4.1 Illustration preparation.

A.4.1.1 Requirements for digital graphics files. Graphics files are delivered in one of three acceptable graphics formats: Computer Graphics Metafile (CGM) (MIL-PRF-28003), Continuous Acquisition and Life-Cycle Support (CALS) raster (MIL-PRF-28002), or Initial Graphics Exchange Specification (IGES) (MIL-PRF-28000). Other commercial graphic formats are acceptable if approved by the requiring activity.

a. The CGM file format is the preferred graphics file format.

b. All graphics files for a particular TM should be supplied in the same graphics format if practical. Otherwise, files may be delivered in any combination of the allowable formats.

A.4.1.2 Illustration style and format preparation. Plan, lay out, and size illustrations to effectively portray the required details, and prepare to the latest technical data.

A.4.1.2.1 Illustrations for the support of procedural data. Illustrations developed to support operator or maintenance procedures should not contain the text steps on the illustration (in the figure area).

a. Illustrations for procedures should supplement the text by clarifying procedures that are of a special nature or are not obvious.

b. Locate illustration(s) (except for foldouts) as close to the text step(s) as possible. For ETMs/IETMs, illustrations should be hotlinked to the applicable text step(s).

c. It is not necessary to illustrate each step of a maintenance procedure, such as the removal of screws with an ordinary screwdriver, lifting off a cover after the screws have been removed, etc.

A.4.1.2.2 Illustration preparation for tools and test equipment. Only uncommon or unusual uses and connections for test purposes are illustrated if it is essential to do so to avoid misunderstanding. Unusual operations should also be illustrated. Standard tools and test equipment are not illustrated, nor should self-evident or generally known uses be shown.

A.4.1.2.3 Electronic items. (Refer to figure A-1.)

a. Exploded views should not be used to identify electronic items such as components on circuit cards that are not to be disassembled for repair. Index numbers should not be stacked (i.e., showing the index numbers next to a bar at the end of a leader line) unless each item and the index number are shown in a detailed view elsewhere on the illustrations.

b. Tables may be used rather than index leader lines to provide clarity. The table(s) should be part of the figure and not part of the textual data. For GAPL illustrations, the reference designators for electronic items should cross-reference the index numbers used in the associated parts list.

c. Applicable reference designators are placed next to the index number.

d. For ETMs/IETMs, electronic parts should be linked to their applicable parts data.

A.4.1.3 Illustration detail and size.

A.4.1.3.1 Illustration detail. Style and techniques should be of a quality that will produce illustrations that will clearly, adequately, and economically portray the information to be illustrated. The amount of detail should be limited to that required to support the content of the illustration.

a. When text alone is not adequate, supplement the text by using illustrations for depicting procedures such as disassembly, assembly, removal, and installation. In addition, illustrations are used to describe an item, process, or procedure; call attention to details; and provide identification of assemblies, parts, and tools, etc. Number or nomenclature callouts can be used to key important items in the illustration to the text.

b. Present illustration views so that the TM user can best understand the text being supplemented. In most instances this will be as the user would view the item in the performance of the associated task. In some cases, however, depicting the procedure or location of parts and controls described in a procedure would better serve the user if shown as viewed from a different position.

A.4.1.3.2 Line drawings quality. Line drawings must be of high reproduction quality.

a. Primary lines that create the basic outline (object line) of the drawing components must have sufficient density (darkness), line weight, and sharpness to accommodate reproduction. Line width should be in accordance with ANSI Y14.2. When electronically or optically reproduced, the primary lines should require no additional graphic enhancement.

b. Secondary lines, such as those used to indicate extensions or measurements, are lighter than primary lines, but strong enough to reproduce clearly at the required reproduction size.

c. Shading may be used to give substance and form to the item depicted, to sharpen the contrast between the subject and its background, or to increase effectiveness.

(1) Shading and shadows are used only when necessary to provide a clear understanding of form, shape, or depth.

(2) Shading effects are not to be used for decorative purposes.

d. Accented lines may be used to emphasize detail when necessary.

e. For page-based TMs, lined, cross-hatching, or mechanical patterns used instead of color should remain clearly defined on the direct image copy. (Refer to figure A-33.)

f. Parallel lines on diagrams/schematics should be no less than 1/16-inch apart when reduced to printed size.

A.4.1.3.3 Scale. Illustrations should be prepared to as small a scale as possible consistent with effective portrayal of the graphic with all essential detail clear and legible. If prepared oversize, the illustration should meet all requirements stated herein after reduction to the proper image size. The desired sizes of illustrations for 8-1/2 inch manuals are provided below. Although not recommended, the vertical dimension of 1/4- and 1/2-page illustrations may be exceeded. The horizontal dimension may not be exceeded.

1/4-page image	3-3/8 inch (20 picas) x 4-1/4 inch (26 picas)
1/2-page image	7 inch (42 picas) x 4-1/4 inch (26 picas)
Full page image	7 inch (42 picas) x 9 inch (54 picas)

A.4.1.3.4 Letter size. For page-based TMs, the typeface size for text, dimensions and callouts on illustrations, including schematics and diagrams, should be a minimum of 8 points and a maximum of 14 points, when printed. For page-based TMs, the scale of text on illustrations should provide for a minimum final letter size, when printed, of 8 points (refer to 4.9.11.and 4.9.12). For frame-based TMs, refer to MIL-PRF-87268.

A.4.1.3.5 Electrostatic discharge (ESD) sensitive acronym. Mark figures and schematics with the ESD acronym.

A.4.2 Elements of illustrations.

A.4.2.1 Border rules and boxes. When necessary for clarity, border or bracket rules and boxes should be used to separate multiview illustrations on the same page or for locator/detail views. (Refer to A.4.2.3.2, A.5.1.3, A-5.1.5, and to figure A-2.) For IETMs, border rules and boxes do not apply.

A.4.2.2 Use of the human figure. When it is necessary to illustrate an operation, procedure, or installation, illustrations may include a human figure or parts of the body. The illustrated human figure should not obscure necessary details of the item(s) being illustrated.

A.4.2.3 Use of locator and detail views. Locator and detail views are used in many of the types of illustrations described in A.5.1 through A.5.1.10.7 to clarify or simplify a complex or busy illustration.

A.4.2.3.1 Locator views. When required by the complexity of the equipment or to assist in user orientation of part(s), illustrations should contain a locator view. The overall equipment or item is shown with the area covered by the view highlighted. The locator view may be placed anywhere on the illustration that will enhance the clarity. (Refer to figure A-2.)

A.4.2.3.2 Detail views. A detail view of a part or subassembly should be illustrated when the subject matter cannot be clearly illustrated in the main view. The desired subject matter may be identified with detail letter(s) or detail letter(s) adjacent to index number(s) on the main view and illustrated, as required, in the detail. (Refer to figure A-2.) Complex illustrations may reference sub-detail views from a detail view, and sub-detail views may reference a sub-sub-detail view. Detail views should be boxed or bracketed.

Author's Note: For ETMs/IETMs, detail views should be hotlinked to the main view. Methods other than letters may be used to identify details on main views such as a hotlink icon.

a. Sub-detail views, if necessary, may be identified with the assigned detail view capital letter prefix followed by a consecutive Arabic numeral beginning with the number 1 (e.g., A1, A2, etc.).

b. Sub-sub-detail views, if necessary, may be identified with the assigned sub-detail view's identification alphanumeric number, followed by a consecutive capital letter (e.g., A1A, A2A, etc.).

c. Sub-detail and sub-sub-detail views may also be identified by placing the item/part index number in a detail bubble (refer to figure A-2).

A.4.2.4 Credit lines.

a. The photographer's or illustrator's name should not appear on any illustration.

b. A manufacturer's name, symbol, or trademark should not appear on illustrations for the purpose of identifying the illustration.

c. If a contractor identifies an illustration with an identifying control number for retrieval purposes, the number should be placed in the lower right-hand corner of the illustration. The number should be no larger than 8-point type.

d. If a contractor's engineering drawing is included in the manual, the title block information usually located in the lower right-hand corner of the drawing should be removed prior to use in the manual.

A.4.2.5 Callouts. Index numbers, reference designators, and nomenclature are used as callouts on illustrations to identify equipment, components, and significant features. Leader lines, sweep arrows and legends are used, in combination with the callouts to enhance the illustration.

a. Use leader lines or sweep arrows to help the readers orient themselves with respect to the illustration and to provide directional movement in tasks.

b. Callouts are prepared by a mechanical or electronic method, rather than by freehand lettering. (Callouts on engineering drawings prepared in accordance with A.5.1.2 are acceptable.)

c. Callouts and their leader lines should be easily distinguishable from components and other lines of the illustration.

d. Callout leader lines or arrows are straight lines where possible. Don't allow leader lines to cross each other. Callouts should not touch the illustrated item.

e. When practical, all callouts should be placed outside the boundaries of the parts illustrated so that the parts are not obscured.

f. Use a type size no smaller than 8 points and no larger than 10 points.

g. When an item is first illustrated and its location has not yet been specified, a simplified general locator illustration may be used to identify the location of the equipment item within the system (refer to figure A-2).

A.4.2.5.1 Index number callouts. Index number callouts start with Arabic numeral 1 and continue consecutively. Index numbers continue in sequence from one sheet to another in a set of multisheet illustrations.

Author's Note: For page-based TMs only, when a series of illustrations are used within the same informational, operational or maintenance task (e.g., theory, operator instruction, or removal procedure), index numbers should continue from one illustration in that series to the next; however, if an item that already has been assigned an index number is used in more than one illustration in that series, it must retain the same index number.

a. Index numbers should be in clockwise sequence, disassembly sequence, or in order of mention in the text.

Author's Note: To improve clarity in page-based TMs, all three index number sequence methods may be used; however, the sequence method within individual WPs should remain consistent.

b. Identify all items shown as exploded. Items drawn in phantom need not be identified (refer to figure A-2).

c. Index numbers should not be contained within circles unless required for a specific reason in MIL-STD-3001-1 through MIL-STD-3001-8.

A.4.2.5.2 Nomenclature callouts. Nomenclature of more than one line should have the left margin justified when placed on the illustration. All lines of copy should parallel the horizontal edges of the figure, whenever possible. (Refer to figure A-2.)

a. Use upper case lettering for nomenclature callouts.

b. Nomenclature may appear on illustrations only if it can be done without crowding or reducing type size so as to make reading difficult. (Use diagram callouts of no smaller than 8 points.)

Author's Note: The above nomenclature requirements do not apply in the development of an IETM.

A.4.2.5.3 Reference designator callouts. Reference designator callouts are a combination of letters and numbers that identify equipment and components shown on illustrations and diagrams. Reference designators may be used alone to identify an item or may be used in combination with an index number callout (i.e., 3 (CR4)). For ETMs/IETMs, when reference designations are used, they should be linked to their applicable parts data.

A.4.2.6 Legends. When callout numbers are used (with the exception of IPB GAPL maintenance illustrations), a legend consisting of a numerical listing and associated identifying nomenclature may be included on the illustration.

a. For page-based TMs, legends should always be a part of the illustration and not part of the textual information. Nomenclature used on legends and associated text should be identical.

b. Legends are acceptable on maintenance IPB GAPL illustrations only when the illustration contains reference designations for electronic components. The legend should consist of an alphanumeric listing of the reference designations and their associated index numbers.

Author's Note: For ETMs/IETMs, legends should not be used. All callouts (index numbers and reference designations) should be linked to the applicable parts data.

A.4.2.7 Leader lines and arrowheads. Do not allow leader lines to touch the callout. Arrowheads should touch the object to which the leader line applies. Do not allow arrowheads to enter the object to which they apply. If it is necessary to enter the object to provide for greater clarity, a breakoff symbol (refer to figure A-7) should be used in lieu of an arrowhead.

a. Lines are to be uniform, short, and as straight as possible; avoid the use of dogleg-shaped lines unless absolutely necessary.

b. Leader lines should be placed at an angle.

c. Arrowheads should be used. A leader line may be highlighted if it will be easier to follow.

d. Arrowheads should be uniform in shape and size when multiple arrowheads are used on a page.

e. Lines and arrowheads should not cross or come in contact with other callout lines or arrowheads, nor should they obscure essential details.

A.4.2.8 Sweep arrows. Sweep arrows are used to help the user of the illustration orient themselves with respect to detail and locator views that appear on an illustration. (Refer to figure A-13.) Sweep arrows are also used to provide directional movement in the performance of a maintenance or operational task.

A.4.2.9 Color in illustrations.

A.4.2.9.1 Page-based TMs. Black and shades of black (one color) are normally used for TMs. Prior approval for use of color must be obtained from the requiring activity. The requiring activity will provide written approval, designating color(s) to be used.

a. When color (other than black) is required, it should be held to the minimum absolutely necessary to highlight or clarify important information.

b. The number of colors should be kept to a minimum by use of various techniques such as tints, patterns, cross-hatching, and dots.

c. Any number of shades of a primary color used can be considered as one color (e.g., a two-color printing could consist of black and three shades of red).

d. When color is approved/specified, the primary colors of red and blue should be used first.

e. Yellow should not be used alone.

A.4.2.9.2 Frame-based TMs. Color may be used when it will enhance the understanding of the data. The use of some colors may not be appropriate for certain environmental conditions. The following color limitations should apply.

a. For ETMs/IETMs that may be displayed on a monochrome system, reverse video and/or underlining should be used for hotspots rather than color.

b. The use and choice of colors will be as specified by the requiring activity.

A.5 **DETAILED REQUIREMENTS**.

A.5.1 Types of illustrations.

A.5.1.1 Photographs. Photographs may be used for illustrations. When a photograph provides for better clarity than a line drawing, the photograph should be used. Photographs should not be used on foldouts.

a. Line tracings of photographs are also acceptable. When a line tracing is prepared, proper definition of line work should be used in lieu of photo retouching. The intended subject matter should be highlighted and unnecessary background should be eliminated. Items required for reference (location) should be subdued.

b. If halftones are used, they should be detailed and sharp, free of heavy shadows, distorted objects, cluttered foregrounds or backgrounds, and should give good contrast from white, middle tones, and black.

c. Retouching may be used to emphasize detail, exclude unwanted detail, correct slight photographic defects and eliminate undesirable shadow. Tonal values should be maintained.

Author's Note: If the intention is to use photographs in lieu of line art, it is preferred that a digital camera be used to produce the required photos. This will negate the use of halftones and the need for retouching and screening. However, if the final reproducible copy is intended to produce paper output, it may be better to prepare line art in lieu of photographs. Obtain approval from the requiring activity for the use of photographs in paper TMs. For IETMs, it is preferred that a digital camera be used to produce the required photos.

A.5.1.1.1 Prescreened photographs. Although not preferred, prescreened photographs are acceptable as direct image copy provided they are screened only once. The screen of the final sized illustration will be specified by the requiring activity. When prescreened photographs are used, they should be clearly marked to indicate prescreening. Unscreened continuous tone photographs and/or original illustrations must be supplied with final reproducible copy.

A.5.1.2 Engineering drawings. Do not use engineering drawings unless specified otherwise by the requiring activity. When used, the drawings should meet the following criteria:

a. They should comply with MIL-STD-100 or user needs. They should be modified, as necessary, to meet the legibility, format, and production requirements described in this document and the contract.

b. All unnecessary data that would reduce the comprehension or clarity of the drawing should be removed. Data includes borders, title blocks, manufacturer's notes, and other irrelevant material. Manufacturer's wiring diagram drawing numbers may be retained for the preparation of aircraft wiring diagram manuals if the drawing numbers are used to develop an easy to use work package numbering concept. Grid locations, if provided, should not be removed.

c. They must be reduced or redrawn to meet technical manual page or frame size restrictions.

A.5.1.3 Multiview illustrations (**page-based TMs only**). Multiple view illustrations should be provided when necessary to identify significant features on an illustration, improve identification of parts or clarify the relationship or the location of the parts. Each view should be oriented and enlarged as necessary to identify significant features (refer to figure A-2).

a. Each view may be identified by a detail capital letter in block size print in a bubble or a caption. Orientation should be by the use of directional arrows or text. For example: "Rotated 180 degrees" as it relates to the main illustration.

b. Views may or may not be captioned, but if one view is captioned, all should be captioned. The caption should be centered with respect to the view to which it applies. Where captions are not used, the identifying letter should be so centered. When a caption and an identifying letter are used together, the identifying letter should precede the caption. Identifying letters and captions should be larger and bolder than any other lettering in the illustration. The identifying letter should be larger than the caption when both are used.

A.5.1.4 Foldout and multisheet illustrations (**page-based TMs only**). When an illustration, including diagrams, must be larger than a single TM page for clarity or to be easily viewed by the TM user, foldout presentation should be used. Foldouts should be placed at the end of the applicable work package and not at the rear of the technical manual. Foldout-foldup illustrations should not be used.

Author's Note: When approved by the requiring activity, foldouts may be placed at the rear of the applicable WP or at the rear of the TM for intermediate and depot level manuals.

a. A one-page apron is required for each printed foldout. The planning of a foldout illustration should include consideration of its usability relative to the length of each data increment.

b. A foldout illustration page should not exceed 45 inches in width (including the apron) and 11 inches in height. The image area of a foldout illustration page should not exceed 36 inches in width by 10 inches in height including the marginal copy.

c. Foldout illustrations should be printed as right-hand pages and should be backed by blank pages. Individual illustrations in groups of related illustrations capable of being presented on a single page should not be grouped together as a foldout.

A.5.1.5 Exploded view illustrations. An exploded view (refer to figure A-3) is an illustration that shows a unit separated or disassembled but with all the parts positioned in correct relationship to each other. Exploded views are used to support the IPB GAPL and additional maintenance procedures in the maintenance work packages. The following guidelines are recommended to ensure clarity of presentation:

a. Index numbers, keyed to a GAPL, legend, list, or text reference, can be used to identify parts.

b. No more than 20 items should be called out in a 7- by 10-inch area if nomenclature is used.

c. Whenever possible, the average maximum number of callouts within a 7- by 10-inch area should be

70. All callouts (numerals) should be outside the boundaries of the parts being illustrated.

d. There should not be more than five callouts (numerals) in any 1 square inch area.

e. If the criteria of subparagraphs c. and d. above cannot be met, use detail views of the figure.

f. When necessary, provide a locator view (refer to A.4.2.3.1) to show the orientation of the view with respect to its next higher assembly (NHA) and also if the illustrated item is part of a larger unit. A locator view showing the location of a weapons replaceable assembly (WRA) in an aircraft should not be provided at the depot level of maintenance. A locator view showing the location of a WRA in an aircraft may be provided at the intermediate level of maintenance when the intermediate level maintenance procedure is contained in an aircraft maintenance manual containing both organizational and intermediate maintenance procedures.

g. For maintenance IPB GAPL exploded views, index numbers should be assigned in disassembly sequence. Nomenclature callouts may be added to further clarify or identify maintenance instructions on maintenance IPB GAPL exploded views.

h. For all other exploded view illustrations, index numbers should be assigned in a clockwise order beginning with the number 1.

i. Limit the level of detail to that required to positively identify parts. Excessive detail makes the illustration complex and does not contribute to usability.

j. Use broken lines for parts shown merely for reference, but not called out. Ensure that the broken lines are legible.

k. Center (axis) lines should be used on exploded views to show parts relationship.

A.5.1.6 Cartoons. Cartoon-type drawings should not be used.

A.5.1.7 Pictorial illustrations. This class of illustration includes end item familiarization views, locator illustrations and assembly and installation illustrations which depict physical items (refer to figure A-4). It does not include exploded views. These drawings must attempt to show the "how to" instructions defined in the text. Their purpose is to present a direct duplication of what will be seen on the actual hardware. Some of the recommended guidelines for preparing pictorial illustrations are:

a. Orient the illustration so that the view represented is identical to the view the technician sees when performing the maintenance task. If the item is illustrated as installed in the end item, indicate the exact orientation of the view by using a locator view and directional arrows. For example, for a view of an item installed in an aircraft, use a locator view showing its location relative to the aircraft, and directional arrows showing which way is forward, aft, inboard, or outboard (unless the orientation is obvious). When necessary to portray position or relative location, other equipment items may be shown in phantom.

b. An alternate method, applicable to aircraft, is to provide aircraft reference numbers, such as the numbers for fuselage station, wing station, butt line and waterline. With this method, at least two of each type of reference line would be shown, so that the technician would be able to determine the orientation of the view.

c. On mechanical equipment illustrations, use no more than 20 callouts in a 7- by 9-inch area when nomenclature is used as callouts. There may be as many as 70 callout numbers in a 7- by 9-inch area, provided they are all outside the boundary of the item illustrated. If placing some callouts inside the boundary is unavoidable, use no more than 40 callouts.

d. On electronic circuit cards, use no more than 70 callouts. Use the maximum amount only when:

(1) all callout numbers are outside the boundaries of the circuit card,

(2) there are no more than five callouts in any square inch area,

(3) the callout numbers are in rows and columns.

e. When determined physically feasible, assign callout numbers clockwise in sequence, beginning in the upper left of the drawing. When an illustration is used for both IPB and maintenance information, it will be indexed in disassembly order.

f. Use straight (not doglegged) arrowheaded leader lines. In extremely rare cases, doglegged lines will be necessary due to the type of artwork. Leader lines should never cross each other.

g. For callouts or other verbal material on illustrations, use all upper case, 8-point or larger type.

h. When drawing an illustration, use the heaviest lines for the outlines of the parts being illustrated. Use medium lines for the leader lines, axis lines, and details that are necessary to identify parts.

A.5.1.8 Combination illustrations. Combining photographs or continuous tone artwork with line drawings is not recommended.

A.5.1.9 Charts and graphs as illustrations.

a. Information that would be most usable as a chart or graph should be so presented.

b. Charts and graphs are prepared as illustrations. Instructions should be provided for use and interpretation of complex graphs.

A.5.1.9.1 Line graphs.

a. Clutter. The number of ideas conveyed per graph should be minimized. Line graphs should depict a maximum of four relationships between the axis variables. Lines depicting relationships are to be coded to distinguish one from another.

b. Orientation of axes. If there is a natural orientation for the axes (for example, altitude on the vertical axis), the axes are to be so oriented.

c. Grid lines. The number of grid lines used are such that the user can read values to the required degree of accuracy. Size of the illustration is such that the grid lines should be no less than 0.1 inch apart. Grid lines are lighter than the graph lines and should not obscure detail necessary for proper use of the graph.

d. Graph scales. Graph scales are linear or nonlinear as required for proper comprehension and use. The axes should be labeled to indicate the variables and units of measurement.

A.5.1.10 Diagrams.

A.5.1.10.1 General preparation requirements. The following paragraphs describe the general preparation requirements for the various types of diagrams that may be required to support the operation and maintenance data contained in the TM.

A.5.1.10.2 Specification requirements. Refer to MIL-STD-3001-1, Appendix A and Appendix B, for specifications used for the preparation of all diagrams.

A.5.1.10.3 General methods. The specifications listed in MIL-STD-3001-1, Appendix A and Appendix B, are to be followed for general methods in acquiring diagrams. Other requirements are as follows:

a. Layout. The layout of all illustrations and diagrams should remain easily readable and compatible with the intended use. The layout of the illustrations and diagrams should enhance and support the maintenance text to which they apply.

(1) All electrical/electronic and fluid flow diagrams should conform to circuit or system flow without regard to physical arrangement of components and parts and their relative location in the system. The flow should read from left to right and top to bottom. Ideally arranged diagrams, including multi-frame drawings, should show the primary inputs in the upper left corner and should flow across and down the page/frame to end with the primary outputs in the lower right-hand corner of the diagram.

(2) Diagrams should consist of symbols grouped as circuit entities; for example, amplifiers and power supplies. Each group should be located on the diagram so that the complete diagram requires a minimum amount of wiring (electrical/electronic diagrams) or the shortest lines (fluid or mechanical). All wires/lines should be routed as directly as possible so that they cross the fewest wires/lines as possible.

b. Consistency. A standard referencing system for associated text, signal flow, and other diagrams should be used.

(1) Standard graphic symbols should be used when possible.

(2) If special graphic symbols are required, they should be made visually distinctive from other graphic symbols used and included in a special symbols chart.

(3) Official nomenclature is used for hardware, controls, indicators, switches, etc.; consistent, standard nomenclature is used for functions, signals, etc.

c. Appropriate detail. All information required to fulfill the intended purpose of the diagram should be used; overcrowding must be avoided.

(1) Complete detail should be provided for hardware, function, signal identification, measurement data (voltages and waveforms), explanatory text, connectors, terminal boards, pin numbers, signal names, reference designators, component values and tolerances, replacement components, etc.

(2) All inputs and outputs should be clearly labeled. In single-page/frame diagrams, termination points are shown for every relevant wire, pipe, etc. In multi-page/frame diagrams, unterminated line

segments should be identified by appropriate symbols with references maintaining continuity from page to page. For IETMs, hotlinks should be used to provide continuity.

(3) To the extent possible, and to keep diagram format consistent for readability, place inputs and associated labels near the diagram left or top edge and outputs and associated labels near the diagram right or bottom edge. The continued portions of multi-sheet diagrams and schematics should align, or should be labeled or hotlinked.

(4) For locating information, relevant components are identified on the diagram or referenced or hotlinked to an explanatory listing. Where applicable, the wording on the diagram should correspond exactly with the wording in the text.

d. Inappropriate data. Data not related to the purpose of the diagram should not be included. Pertinent detail of nonrepairable and nonreplaceable components should be held to a minimum.

A.5.1.10.4 Signal flow. Signal flow, especially for electrical and electronic equipment, critically affects the understandability of diagrams. To assist the TM user in following the diagram, where possible, major signal or pressure flow should be from left to right, and feedback or return flow should be from right to left. For IETMs, signal flow can be indicated using animation or color. As applicable, the methods for portraying signal flow outlined in A.5.1.10.4.1.1 through A.5.1.10.4.1.3 should be used.

Author's Note: For IETMs, signal flow for specific circuitry or for a single circuit may be displayed separate from the entire diagram by providing hotlinks on the diagram. When the hotlink is activated, only the flow for the specific circuitry or for the single circuit will be displayed. This may negate the need to use some of the methods discussed below.

A.5.1.10.4.1 Signal connections. Signal connections can be portrayed in one of three methods.

a. Point-to-point method. Shows each signal separately with a continuous line to represent its flow. (Refer to figure A-5.)

b. Highway method. Blends two or more signals together in a single line. (Refer to figure A-5.) This method is useful in showing the flow of a group of related signals. Any number of signals may be blended together. Any signal that has been blended into the main line is blended out at some other point on the line. Once a signal has been blended out of a line, it can no longer be present on that line. Each signal blended in or blended out of the line should be identified.

c. Interrupted flow method. Use special symbols to interrupt signal flow. This method may be used within a single sheet/frame of a diagram, between sheets/frames of a diagram, or between diagrams. Refer to paragraphs A.5.1.10.4.1.1 through A.5.1.10.4.1.3 for types of special symbols and techniques used to interrupt signal flow. The method used to show interrupted signal flow should be consistent on all diagrams in a TM.

A.5.1.10.4.1.1 Techniques within a single sheet of a diagram. Interrupted flow within a single sheet/frame diagram is depicted using one of the following techniques.

a. Oval connector. Used to continue signals from one area of a sheet to another area.

(1) Any number of signals may be bracketed together.

(2) Each signal is identified at its source bracket and destination bracket.

(3) Oval connectors should have a unique letter identifier inside the oval. (Refer to figure A-6.)

(4) The position of the source and destination connectors can be identified by zone numbers. (Refer to A.5.1.10.4.1.2 c.)

b. Signal returns. Used to continue signal returns within a single sheet of a diagram.

(1) Returns have a unique number identifier inside the network.

(2) Each return is labeled the first time it appears on the diagram (preferably on the left edge of the diagram). (Refer to figure A-7.)

c. Breakoff symbols. Only power forms, clock pulses, and other multiuse, minor signals use the breakoff symbol technique.

(1) Each signal is identified adjacent to its breakoff symbols.

(2) The source of signals is shown at the left edge of the diagram. (Refer to figure A-7.)

Author's Note: For IETMs, if this method is used, the origin and destination of the signal should be hotlinked.

A.5.1.10.4.1.2 Techniques between sheets of a diagram. Interrupted flow between sheets of a diagram should be depicted using one of the following techniques.

a. Boat symbol. Used to continue signals from the right edge of one sheet to the left edge of the following sheet within a multisheet diagram (adjacent sheets of a diagram only).

(1) Used for single signals only.

(2) Boat symbols have a unique letter inside the boat. (Refer to figure A-8.)

b. Numerical or letter identifier. Used to continue signals between sheets of a diagram. Refer to figure A-8 for an example of numerical identifiers. A unique letter identifier may also be used in lieu of numbers.

c. Oval connector. Used to continue signals from one area of a diagram to another. Application is the same as within a single sheet of a diagram. (Refer to figure A-6.) For identification of source and destination areas, the following recommended zoning requirements are used for multisheet diagrams:

(1) Vertical zones are numbered; horizontal zones are lettered.

(2) The number of horizontal zones are limited to 10.

(3) Zones are always numbered as below, even if all zones are not used on any sheet.

Sheet 1	Starts with Zone 1
Sheet 2	Starts with Zone 11
Sheet 3	Starts with Zone 21, etc.

Author's Note: For IETMs, zoning does not apply. The origin and destination of the signal should be hotlinked.

A.5.1.10.4.1.3 Techniques between diagrams. Interrupted flow between diagrams is depicted using one of the following techniques.

a. Oval connectors. Source and destination figure numbers are inserted before zone references. (Refer to figure A-6.)

b. Pyramid diagram. Diagram number is included from one diagram to another. (For example, include reference to 1 on diagram 2 and reference to 2 on diagram 1.) (Refer to figure A-8.)

Author's Note: For IETMs, zoning does not apply. The origin and destination of the signal should be hotlinked.

A.5.1.10.4.2 Signal difference. Various techniques are available to indicate signal flow, signal importance, and type, such as the following. (Refer to figure A-9.)

a. Use wide lines to represent major signals.

b. Use special arrowheads to indicate signal types.

c. For page-based TMs, use different colors if approved by the acquiring activity (refer to A.4.2.9).

d. For IETMs, use animation or color.

A.5.1.10.4.3 Signal junctions. The relative importance of signals may also be indicated by the way signal junctions are represented. Subordinate junctions are used to indicate differences in signal importance. Coordinate junctions are used to indicate equality in signal importance. (Refer to figure A-10.)

A.5.1.10.5 Schematic and functional flow diagrams. Electrical schematic diagrams should be prepared in general accordance with ANSI Y14.15. (Refer to figures A-11, A-12, and A-13.) Electrical and electronic schematics and fluid and mechanical schematics should conform to circuit or system flow without regard to physical arrangement of components and parts and their relative locations. The flow should read from left to right and from top to bottom. Diagrams, to the extent possible, should show the primary inputs in the upper left corner and should flow across and down the illustration to end with the primary outputs in the lower right corner of the diagram. When diagrams are specifically prepared for maintenance purposes, as much of the following information as applicable should be included. Any additional information that is available and that will not disrupt the flow or understanding of the diagram should be included in the illustration.

a. Use standard symbology and representation when depicting electronic circuitry. That is, whenever a standard circuit, such as a Darlington amplifier or a logic gate is used in a schematic, it should be recognizable. Ideally, all the components that perform one function, such as an amplifier, should be drawn in the same area of an illustration.

b. Dividing a small circuit on two pages/frames of an illustration is to be avoided. This should increase the technician's ability to recognize the circuit and should reduce the need for detail in the principles of operation.

c. An illustration should limit the number of components in any 2-inch square area. This limit should not exceed 12 components. For example, figure A-14 displays two selected 2-inch square areas encompassing only six and seven components in a fairly crowded situation. The total number of components displayed in any full page/frame schematic or foldout should not exceed 80 components on any page/frame.

d. Each component in the schematic must be identified. The labeling should be brief but contain sufficient information to assure proper understanding and maintenance performance. For IETMs, components shown on the schematic should be hotlinked to the applicable parts information data.

e. For callouts, component designations, and other textual material on schematics, use all upper case 8-point type or larger.

f. Briefly explain any nonstandard or uncommon symbols in a legend on each figure where they are used. Place the legend and any additional notes in the lower left portion of the diagram. A detailed explanation of nonstandard or uncommon symbols should be fully defined in the technical manual introduction. For IETMs, the legend should be hotlinked from where the symbols are used on the diagram.

g. There should be no more than 15 intersections in any 2-inch square area. This includes all line intersections, whether an electrical connection is made or not. Figure A-14 is an example of a schematic with few intersecting lines.

h. Clearly label all inputs and outputs. Inputs should be at the left of an illustration and outputs at the right.

i. Clearly label DC resistance of windings and coils (if more than 1 ohm).

j. Include or hotlink an illustration of CRT display next to the point at which it will be observed, usually at a designated test point (TP).

k. Show wiring requirements for critical grounding points, shielding, pairing, etc.

l. Include power or voltage ratings of parts.

m. Include indication of operational controls or circuit functions.

n. Show warning notations for electrical hazards at maintenance points.

o. Specify circuit voltage values at significant points (tube pins, test points, terminal boards, etc).

p. Specify significant circuit resistance values at designated reference points (information may be in tabular form).

q. For page-based TMs, include zones (grid system) on complex schematics. When technical data is prepared from engineering drawings, zone reference may be the same.

r. For page-based TMs, include circuit element zone locations (on complex schematics) in tabular form on the drawing or associated document when such location of information will facilitate use of the schematic.

s. Signal flow direction in main signal paths should be emphasized.

t. Device ratings should be located close to the device symbol to assure correct identification. Polarity markers should be shown on all instrument transformers and capacitors.

u. Piece part details are shown only when replacement is authorized at the maintenance level covered or when understanding is required for fault isolation.

v. For nonreparable assemblies, all inputs and outputs are shown with enough detail to understand how inputs relate to outputs (complete details for simple circuits and symbols for complex circuits).

A.5.1.10.5.1 Circuit parameters. Circuit parameters should be marked according to their reference designations (if applicable), types, and values. When these markings tend to clutter the field of the illustration, a table of these markings, in order of reference designation (electrical or electronic diagrams) or nomenclature (fluid or mechanical diagrams) should be included, or tabular data referenced, for all circuit parameters. For IETMs, this circuit parameter data should be hotlinked. Reference designations should agree with those used in related engineering drawings. Nomenclature should be in accordance with 4.9.15. Normal operating conditions and other conditions specified by the applicable technical content standards should be indicated.

A.5.1.10.5.2 Test point identification symbols. Identification of test points by symbols should not be employed where the test points are readily identifiable by other means; for example: "Test jacks (TP-5)," "Connector pins (J100-M)," and "Component pins (X4-2, Q1-E, and Z5-14)" are readily identifiable points and do not require symbols. Test points that are not otherwise identifiable (artificial test points) should be identified by test point symbols. The test point symbol should be an encircled upper case letter and an Arabic numeral. These test points will be referred to in the text such as "Test point A2."

A.5.1.10.5.3 Use of artificial test points. Artificial test points should be used when specific voltage and resistance test points, used in checking a circuit, are otherwise unidentifiable. Different letters should be assigned to each component (on a diagram); for example, test points A1, A2 and A3 in component 1, test points B1, B2 and B3 in component All test points should be identified on the diagram by their assigned identifying code.

A.5.1.10.5.4 Components shown on schematic diagrams. When it is necessary to show components of a system on a schematic diagram, the general shape of the component and a minimum amount of detail should be illustrated. For IETMs, the illustration may be hotlinked. This requirement applies to those components that will be easily recognized by the reader and, therefore, would assist him in interpreting the diagram. It does not apply to components without definitive shapes or recognizable detail. For example, if an electronic component is located in a container that is essentially a box without dials or switches, an outline of a "box" will suffice. The nomenclature of the component shown should appear adjacent to the item (refer to figure A-15).

A.5.1.10.6 Functional diagrams. Functional block diagrams are designed to provide a simplified description of particular operation or maintenance actions. The functional blocks are logically or sequentially arranged to describe the action taking place and show all input and output signals. Variations of the block diagram approach can be used to describe principles of operation, troubleshooting and maintenance efforts. Most principles of operation are described in text form with supporting functional block diagrams as shown in figure A-16. The following general guidance is provided concerning the preparation of block diagrams:

a. Abide by the basic schematic requirements that apply equally as well to functional flow diagrams.

b. Functional block diagrams show the complete system or subsystem on one sheet (if possible). (Refer to figure A-16.) Methods to be used include functionalizing components, grouping subfunctions into functions, or continuing until the complete system or subsystem can be shown on one sheet or frame. (For page-based TMs, a foldout may be used when approved by the acquiring activity; refer to A.5.1.4).

c. Functional diagrams should provide enough details to relate the input to output signals by using arrowheads to indicate signal flow direction when necessary and specifying signal characteristics and tolerances in pictorial or tabular form. Indicate direction flow by arrows. Signal flow (electric/electronic) or fluid/pneumatic flow should be from left to right. For IETMs, signal flow may be depicted using animation or color.

d. Functional diagrams should account for all maintenance significant components by ensuring the user can relate the schematic diagram to the functional diagram, blocking the components on the schematic to correspond with blocks on the functional, or providing a table relating components to functional blocks.

e. Functional diagrams should show hardware boundaries by using solid, dashed, or dotted lines; various line weights; or different colors or shades (when approved by the requiring activity).

f. Always give full consideration to the presentation method.

g. Avoid reverse directional flow except for feedback. Feedback flow should be from right to left. For IETMs, flow may be depicted using animation or color.

h. Label all inputs and outputs of each block on the diagram. The label can consist of the name of the input or output, a waveform or symbol in the flow line itself.

i. Identify all test points clearly and distinctly. When required, place all waveforms in close proximity to the appropriate test point or hotlink the waveform data from the test point. If impractical, provide a good reference to its location.

j. Define any nonstandard or uncommon symbols in a legend on each diagram on which they appear. Place the legend and any required notes in the lower left portion of the diagram. For IETMs, the legend data should be hotlinked.

k. Uncommon symbols and their definition should be numbered in numerical sequence.

A.5.1.10.7 Cutaway diagrams. Cutaway diagrams (refer to figure A-17) employ pictorial symbols of components drawn with interconnecting lines. Diagrams of this type provide a simplified method of showing piping between components with the general piping arrangement emphasized. Complete principles of operation of the flow path are difficult to explain as only the external features of the components are shown. Internal flow within a component is not shown, thereby not fully describing the flow of the liquid or gas. Arrowheads are used to show direction of mechanical action or fluid flow. For IETMs, direction of mechanical action or fluid flow may be depicted using animation or color.

A.5.1.10.8 Combination diagrams. The combination diagram utilizes the best features of the graphic, pictorial and cutaway diagrams and symbols in the same drawing with integral interconnecting lines. Diagrams of this type are best for illustrating principles of operation because they emphasize piping, function and flow paths for each component and best describe the flow path of the fluid or gas (refer to figure A-17).

A.5.1.10.9 Logic diagrams. (Refer to figure A-18.)

a. Logic diagrams are used to show digital circuitry operation. Graphic symbols from IEEE STD 91-84 are used. If the logic circuit has no specified symbol, it can be identified with a rectangle that is labeled to show all circuit functions.

b. Power and clock connections are identified in a truth table or are connected using breakoff signals.

c. When necessary for clarity, a truth table or timing diagram should be prepared or should be referenced or hotlinked from another diagram. For logic functions, the truth table timing diagram may be shown inside a block to describe the relation of input to output signals. (Whenever possible, truth tables should be placed in the text area, or hotlinked, and not on the figure.) (Refer to figures A-19 and A-20.)

A.5.1.10.10 Simplified diagrams. Simplified diagrams include key components for explanatory purposes and omit selected components or groups of components, or details for clarity. Simplified circuitry and/or simplified functional divisions indicate excluded or included components in the diagram title (for example, "Figure 3. Simplified R-T Control Circuit with Cockpit Control Switch in Off Position (All Relays Unoperated.")). Refer to figure A-21.

A.5.1.10.11 Partial diagrams. Partial diagrams are used to show all circuit details completely and reference all destinations of input or output connections. (Refer to figure A-22.)

A.5.1.10.12 Test diagrams. There are two types of diagrams used to support test procedures. Test diagrams (refer to figure A-23) are used to show test stimuli, item (or circuitry) under test, and test measurement components. Test setup diagrams (refer to figure A-24) are used to show the interconnection between the test equipment and the unit (s) under test. The setup diagram may be presented schematically or pictorially.

a. When diagrams exist for the item under test, a block diagram representation may be used.

b. In TMs containing testing data, the item under test should be emphasized (shown in detail); in test equipment maintenance TMs, the test equipment should be emphasized.

A.5.1.10.13 Power distribution diagrams. Power distribution diagrams depict components involved in power input, power form generation, and power distribution. They are grouped by power flow. (Refer to figure A-25.)

A.5.1.10.14 Pyramid diagrams.

a. Pyramid diagrams are a set of interrelated diagrams consisting of:

(1) A master block diagram.

(2) Detailed block diagrams.

(3) Schematic diagrams.

b. If the equipment covered is complex, several levels of detailed block diagrams may be required. (Refer to figure A-26.)

A.5.1.10.15 Wiring diagrams/illustrations. Weapon systems and equipment, engines, and support and test equipment that have wiring or cabling should include interconnection information in one or more forms such as wiring and cabling diagrams and wire bundle access and routing illustrations. Wire lists are also considered interconnection information but are not illustrations and are covered under tabular data (refer to 4.9.7.1).

A.5.1.10.15.1 Wiring diagrams. Wiring diagrams (refer to figure A-27) should be structured and developed in accordance with the requirements contained in MIL-STD-3001-5. To facilitate training and consistency in presentation, the wiring requirements contained in SAE-AS59881 should be followed whenever possible when preparing the wiring diagrams. These requirements include the standard methods for identifying wiring system circuit functions, individual wires, connectors and terminal boards, and assigning reference designations. In general, the layout of wiring diagrams should be the same as for schematic diagrams (refer to A.5.1.10.5); however, the following additional ground rules apply.

a. Each line representing the wires and interconnections should be coded or otherwise identified.

b. Each wire should be shown individually.

c. Each wire should be drawn so that it can be traced from point of origin to destination.

d. Wires located within a cable harness should be shown as a single wire. Wire bundling techniques for aircraft system wiring should not be used.

e. Normally, aircraft wiring diagrams are drawn and scaled for a foldout presentation. However, to facilitate on-aircraft wire chasing and troubleshooting, wiring diagrams may be drawn and scaled to a 11-inch x 8-1/2-inch landscape format and included in a normal size TM. These two formats should not be combined in the same TM.

f. Wire colors may be indicated by using color designation codes. Indication of color designations is preferable when many colors and color combinations such as BK-W are to be shown. Recommended single- and two-letter color designations for use specifically on diagrams are as follows:

Wire Color	Designation
Black	BK
Brown	BR
Red	R
Orange	O
Yellow	Y
Green	G
Blue	BL
Violet	V
Purple	PR
Gray	GY
Slate	S

White W

g. A junction of lines will be indicated by a dot at the junction of the lines. Lines crossing each other, without a dot, indicate that they are not connected in any way.

A.5.1.10.15.2 Wire bundle routing illustrations. For aircraft wiring systems, illustrations should be provided showing the routing of all aircraft bundle assemblies throughout the aircraft (refer to figure A-28).

A.5.1.10.16 Cable diagrams. This type of cable interconnect diagrams is included in equipment and support equipment TM if the technician must install or remove cables when performing test procedures, installation, assembly, disassembly, modification, service, etc. (Refer to figure A-29.)

a. Cable diagrams provide all the information necessary to make the electrical connection between assemblies, chassis, bays, units, and systems in an easily understood format.

b. Each cable diagram should consist of an illustration and accompanying table. If cable routing is of a special nature, it should be so noted. For very complex systems where routing is of great importance, additional diagrams showing desired cable locations may be necessary. (Refer to figure A-29.) The accompanying table should meet the following requirements:

(1) Cable entries are listed in numerical order or by preferred connection sequence.

(2) Cable origin should precede the cable destination.

(3) Cable origin and destination include assembly name, assembly jack number, and cable plug number.

(4) Both table and illustration should appear on the same page or facing pages. For IETMs, the table should be hotlinked from the applicable illustration. The table is considered text and is not part of the figure.

c. Cable diagrams show all related connectors. Assembly names and jack numbers should be listed.

d. For simple equipment, a table may not be needed, and an interconnection diagram that actually shows the routing of the cables may be substituted (refer to figure A-30). The internal connections of the equipment or assemblies are usually omitted.

A.5.1.10.17 Piping diagrams. Weapon systems or equipment that include piping in their design are supported with information in the form of piping diagrams. The diagrams should meet the requirements for illustrations and diagrams presented in this handbook. (Refer to figure A-31.)

A.5.1.10.18 Fluid power/gas diagrams. Fluid power/gas diagrams illustrate those systems that transmit and/or control power through the use of pressurized fluid, within a closed circuit of tubing, pipes or hoses or combination thereof. ANSI Y14.17 provides for fluid power/gas diagrams that are drawn either as graphic, pictorial, cutaway, or combination drawings. In addition to the general requirements for the preparation of schematic diagrams provided in A.5.1.10.5, refer to the additional requirements provided in A.5.1.10.18.1 and A.5.1.10.18.2.

A.5.1.10.18.1 Arrangement of symbols. Where components have a specific mechanical, functional, or otherwise important relationship to one another, their symbols should be so placed in the diagram to illustrate their relationship in the circuit. Where a component requires a specific mounting position, its symbol should be so drawn and a NOTE added to point out the correct positioning. Spacing should provide room for adjacent data without crowding.

A.5.1.10.18.2 Conductors. Interconnecting lines between various components in a diagram represent a means of conducting fluid or gas. The lines are a very important part of the system and should be drawn very carefully. For clarity, lines should always be straight and direct. Lines are not intended to pictorially illustrate the actual piping or fittings. Horizontal and vertical lines should be used. Square corners and 90-degree intersections should be used. Conductors may be drawn as either single or double lines dependent upon the type of diagram being used.

a. Single lines are used in graphic diagrams.

b. Double lines are used in cutaway diagrams.

c. Pictorial and combination diagrams may use single or double lines or both.

A.5.1.10.18.2.1 Single lines. Conductors which convey power actuating fluid, either pressure or return, are called working lines and should be drawn as a single unbroken line. Conductors that carry fluid that is used to actuate components are called pilot lines and should be drawn as a series of long dashes. Sensing lines, if very short such as gage lines, should be drawn the same as the line to which it connects. Internal seepage of components or exhaust pilot fluid is returned to the tank by drain lines. The lines are drawn as a series of short dashes. Working, pilot and drain lines should be drawn thick line width. Sharp angles (90 degrees) should be used when lines drawn between symbols change direction. Dashes should join at corners. Fluid and electrical lines, unless they are interrelated, should not be combined in one diagram. Graphic symbols for fluid power diagrams present symbols for both pneumatic and hydraulic media in the same diagram.

A.5.1.10.18.2.2 Double lines. Double lines should be used to illustrate the conductors in cutaway diagrams. Double lines are sometimes used in pictorial diagrams to illustrate the piping arrangements more clearly. The included space between double lines can be used to show relative pipe size and may also be used to indicate functions such as working, pressure, pilot, return, drain, bleed, different fluids, etc., when crosshatching, shading, etc., are used. Double lines should be drawn thick line width.

A.5.1.10.18.2.3 Joining lines. Single lines which join should terminate with or without a dot. If no dot is used, then one of the two joining lines should dead end. Dash lines should begin and end with a dash of full length at the junction with other lines. Double lines forming a junction should have square corners.

A.5.1.10.18.2.4 Crossing lines. Single and double lines should cross with or without a loop. Where dash lines and solid lines cross, the solid line should intersect the dash and not the space between the dashes.

A.5.1.10.18.3 Component data. Nomenclature, names, notes and values are sometimes necessary in addition to the components symbol for circuit analysis, installation or service. This component data can be either on the diagram or be identified through the use of index numbers with an accompanying legend. For, IETMs, the legend data may be hotlinked. If the nomenclature, name, note or value is placed on the diagram, it must be positioned so that it does not interfere with the piping or other features of the diagram.

A.5.1.10.18.4 Rotation. Direction of rotation should be indicated by an arrow. It is understood that the arrow is on the near side of the shaft to denote direction of rotation. Arrows pointing in opposite directions for the same motor shaft indicate the shaft can rotate in either direction. The text covering the component will stipulate whether the direction of rotation is as the component is viewed from the front or the rear.

A.5.1.10.18.5 Direction of flow. Direction of flow in conductors will be shown by arrowheads on single lines or by arrows within the double lines. For IETMs, direction of flow can be depicted using animation or color.

A.5.1.10.18.6 Port identification. Functional ports of components should be clearly identified in the diagram. Identification should agree with the port identification on the component and its installation drawing. Identification should appear adjacent to or within the symbol and should be as close as practical to the port being identified (refer to figure A-32).

A.5.1.10.18.7 Pattern code. Interconnecting lines in diagrams are sometimes patterned to show pressure, flow, special functions, return, drain, or different fluids during selected phases of operation. A note, preferably located in the lower left corner of the sheet, should identify and illustrate the code for each condition used. Only those lines performing active functions for the phase shown should be coded (refer to figure A-33). For IETMs, direction of flow can be depicted using animation or color.

A.5.1.10.18.8 Component enclosure. Where some of the components in the circuit are furnished as an assembly, it will be so indicated in the diagram. A center line should surround a complete symbol or group of symbols which represent the assembly. The center line represents the component enclosure. A note adjacent to the enclosure may be required to identify the component.

A.5.1.10.18.9 Identifying components. In many cases it may be more effective to identify the components of a circuit with index numbers rather than having the component nomenclature on the illustration. When index numbers are used, they will be placed outside the illustration area with an arrowheaded leader line to the component. A legend will be provided on the illustration. It should be keyed to the illustration by the assigned index number and approved nomenclature of the indexed component. For IETMs, the legend data should be hotlinked.

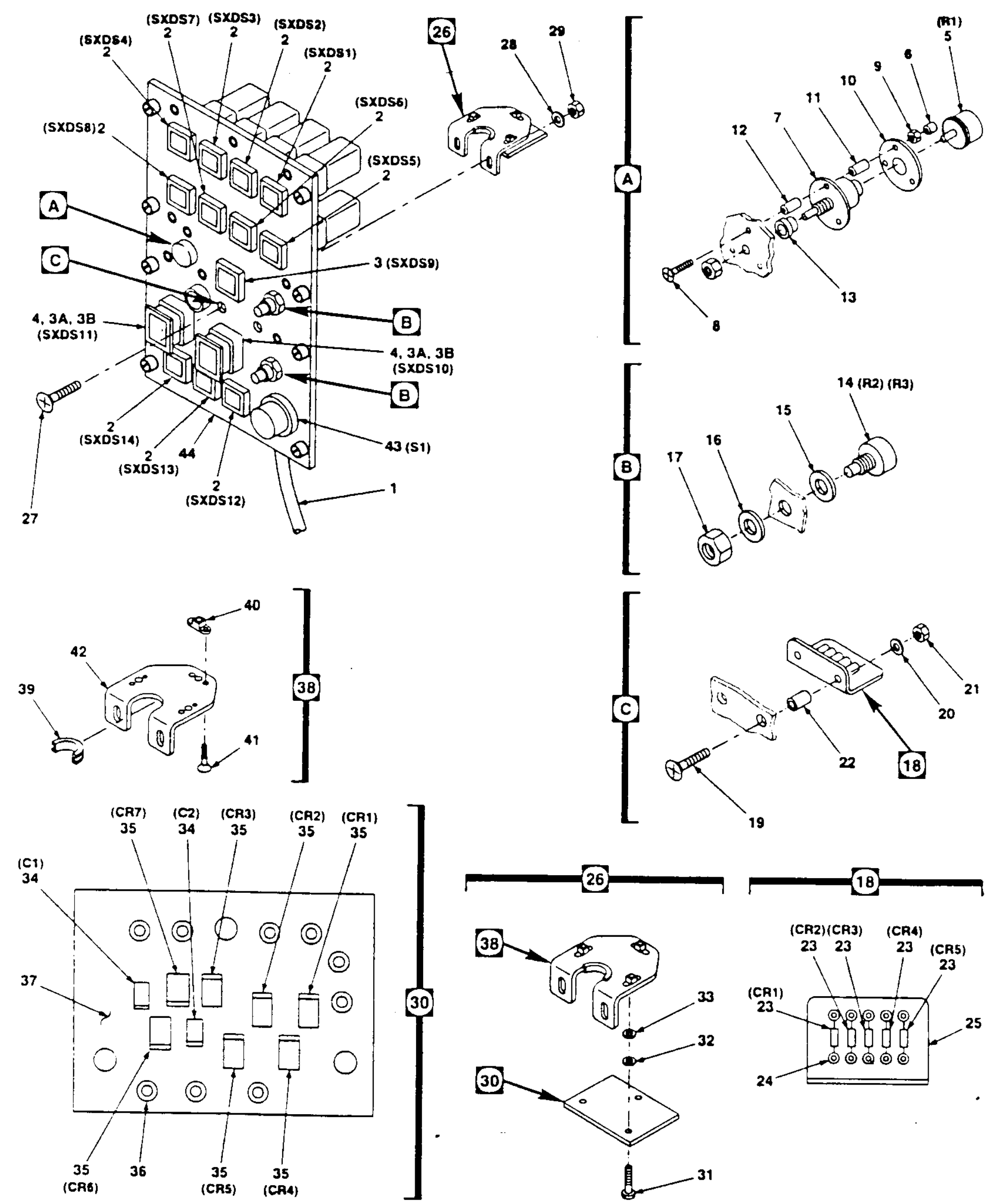


FIGURE A-1. Example of an electronic component card illustration.

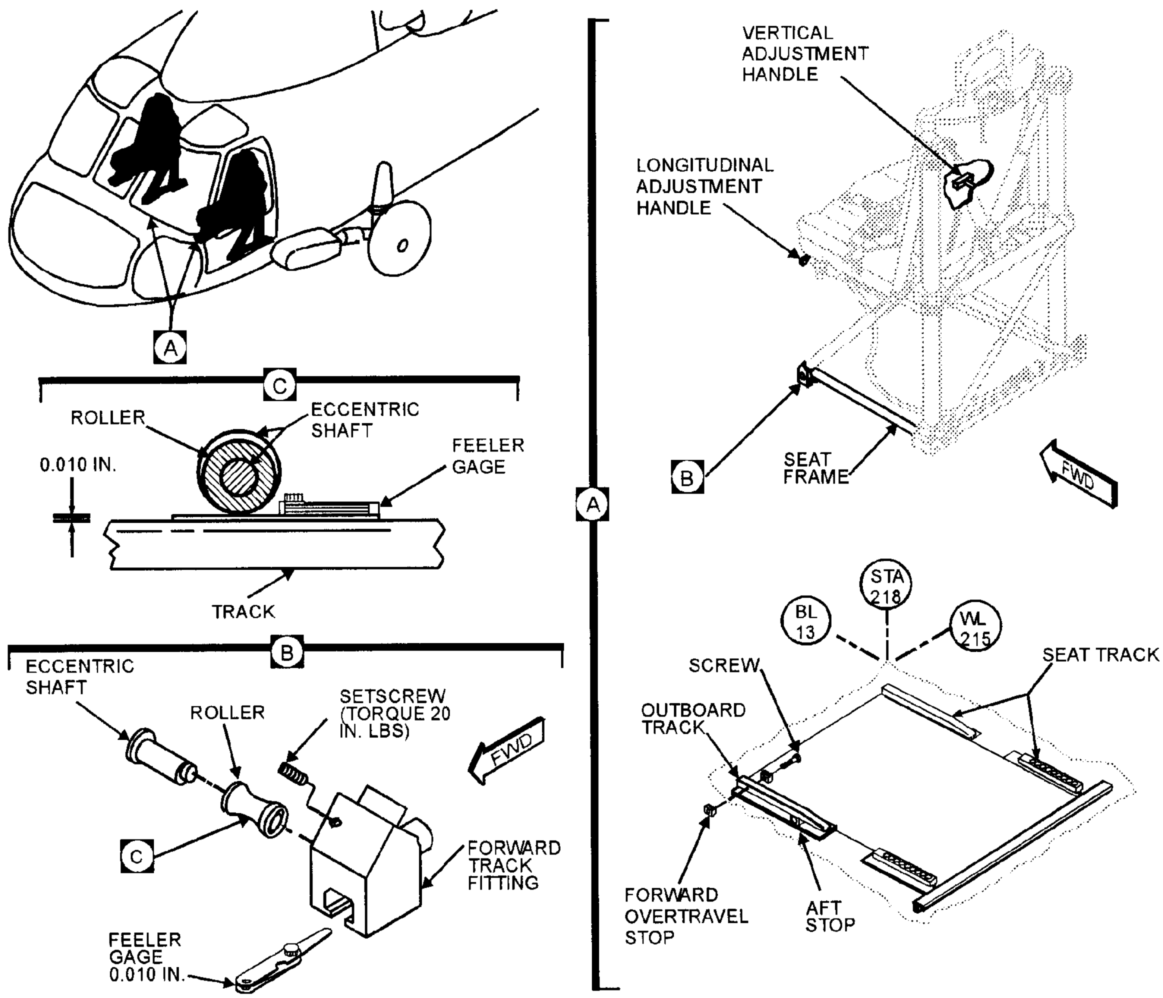


FIGURE A-2. Example of multiview, locator view and detail view illustrations.

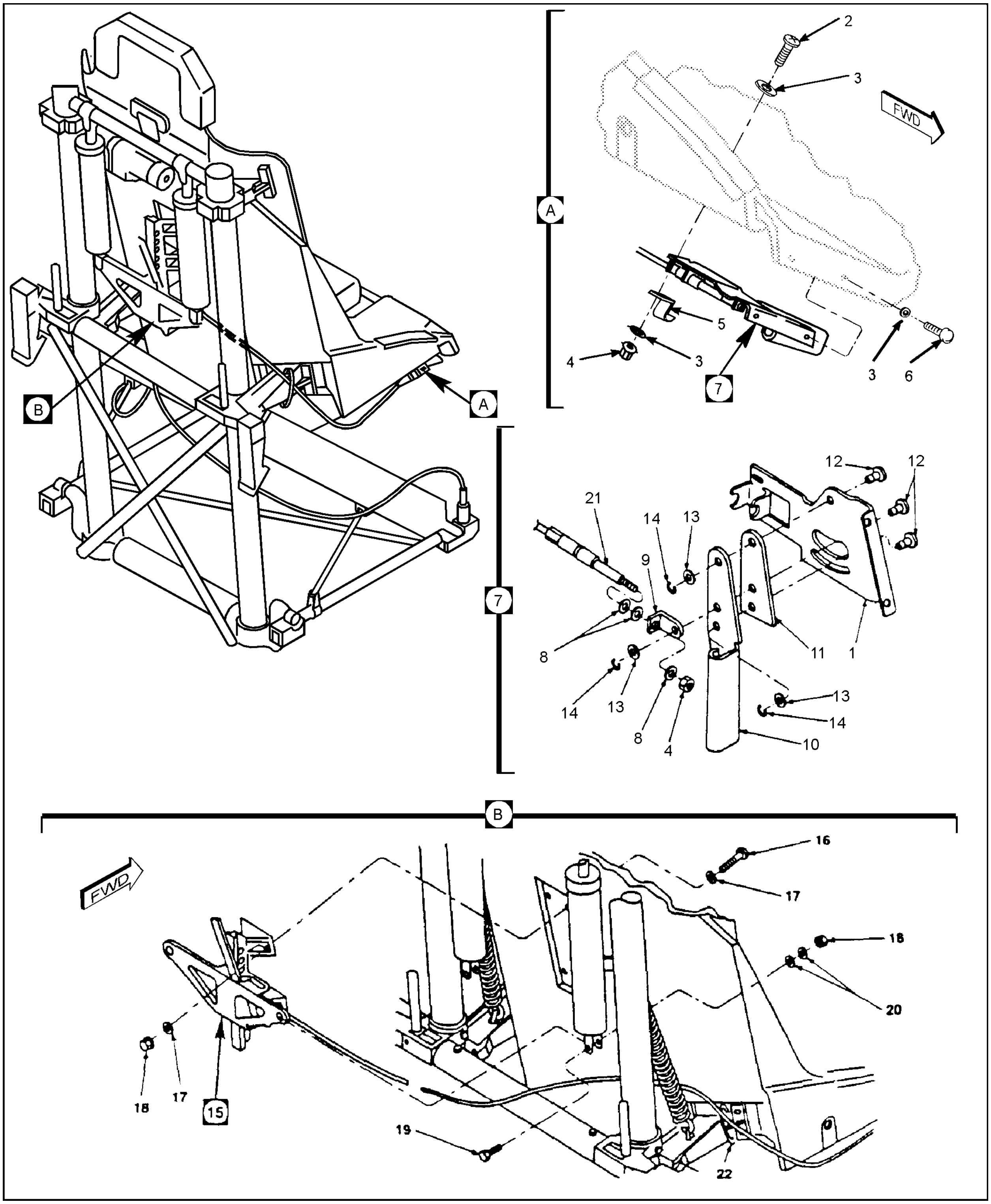


FIGURE A-2. Example of multiview, locator view and detail view illustrations - continued.

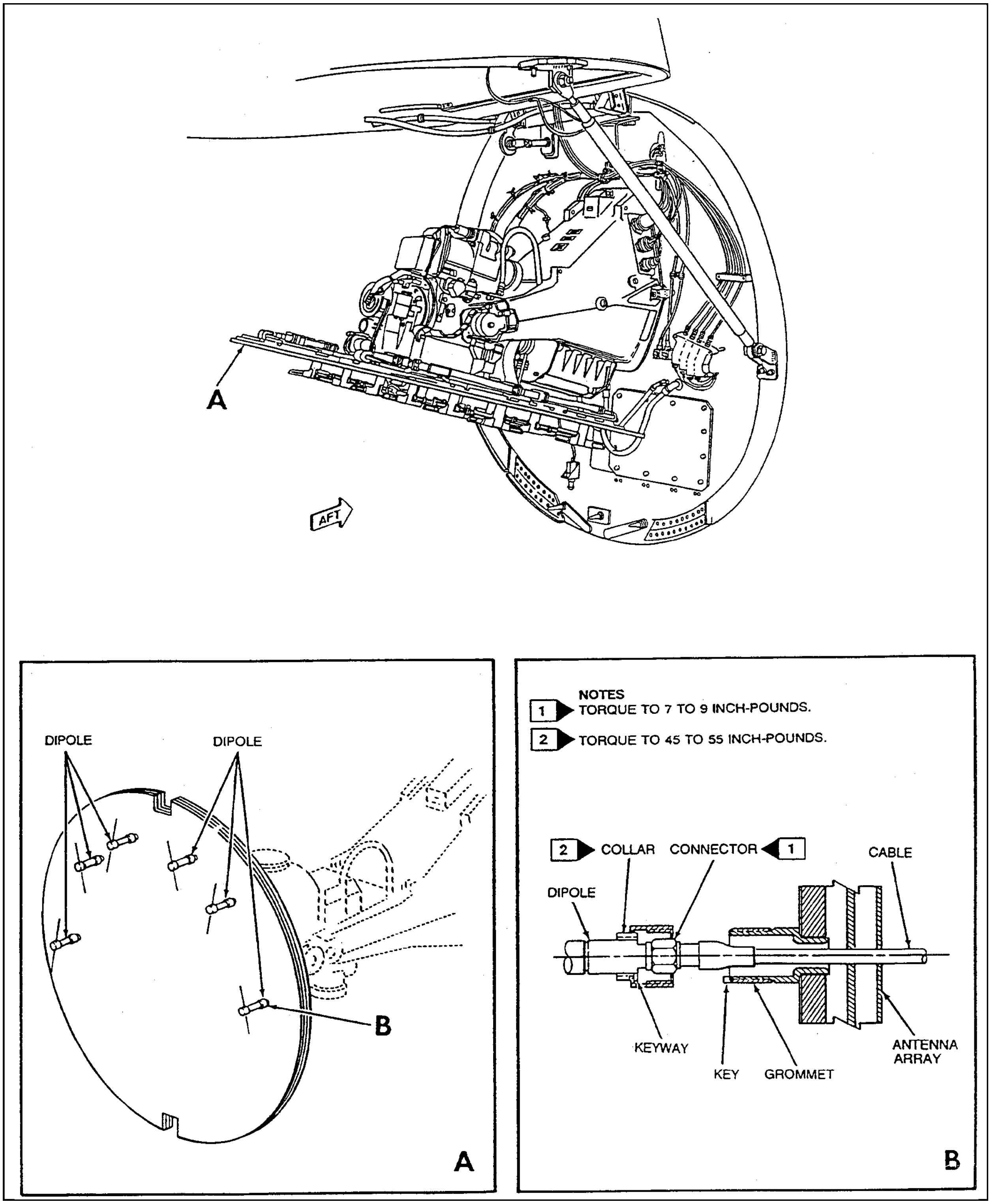


FIGURE A-2. Example of multiview, locator view and detail view illustrations - continued.

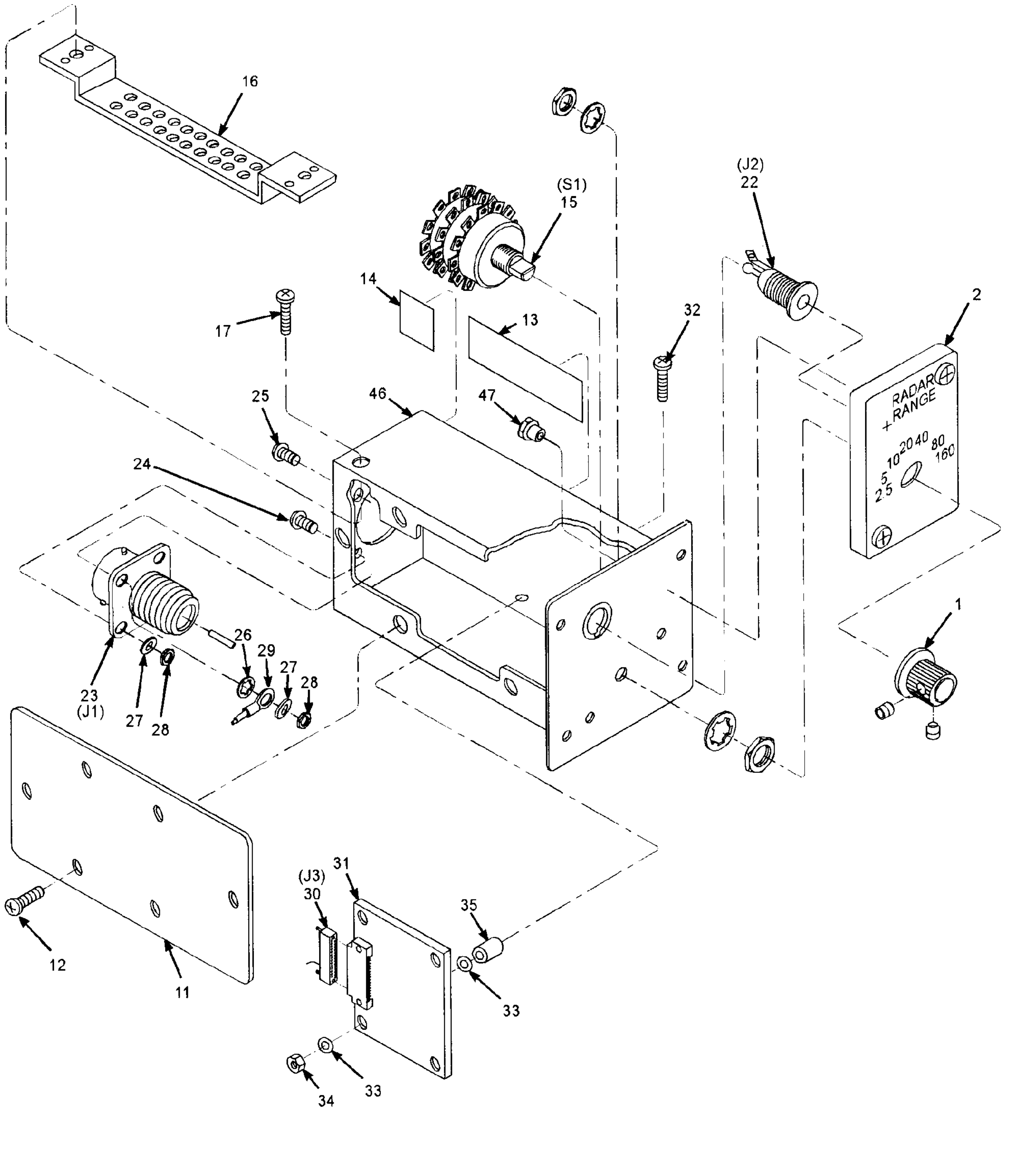


FIGURE A-3. Example of an exploded view.

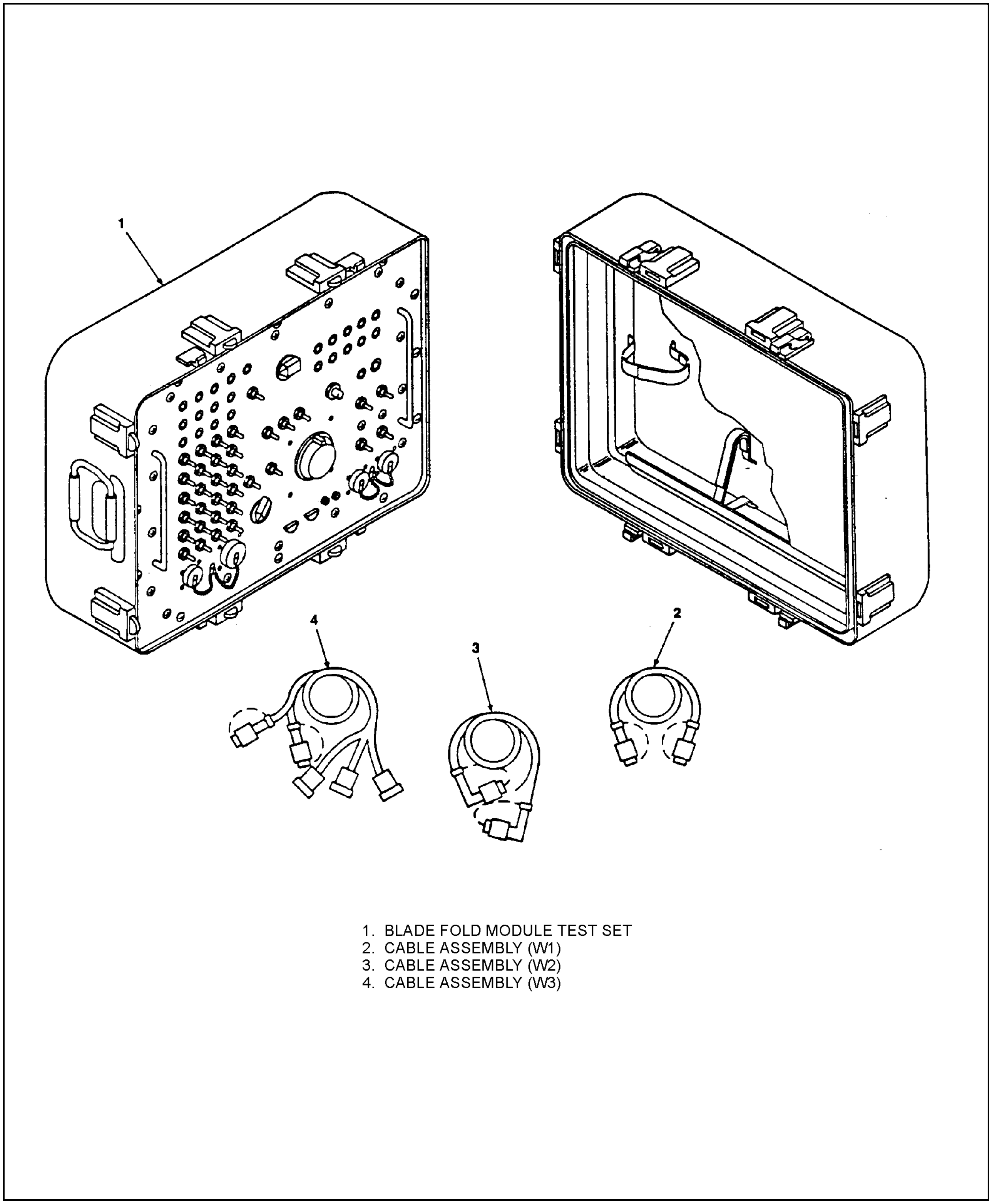


FIGURE A-4. Example of a pictorial.

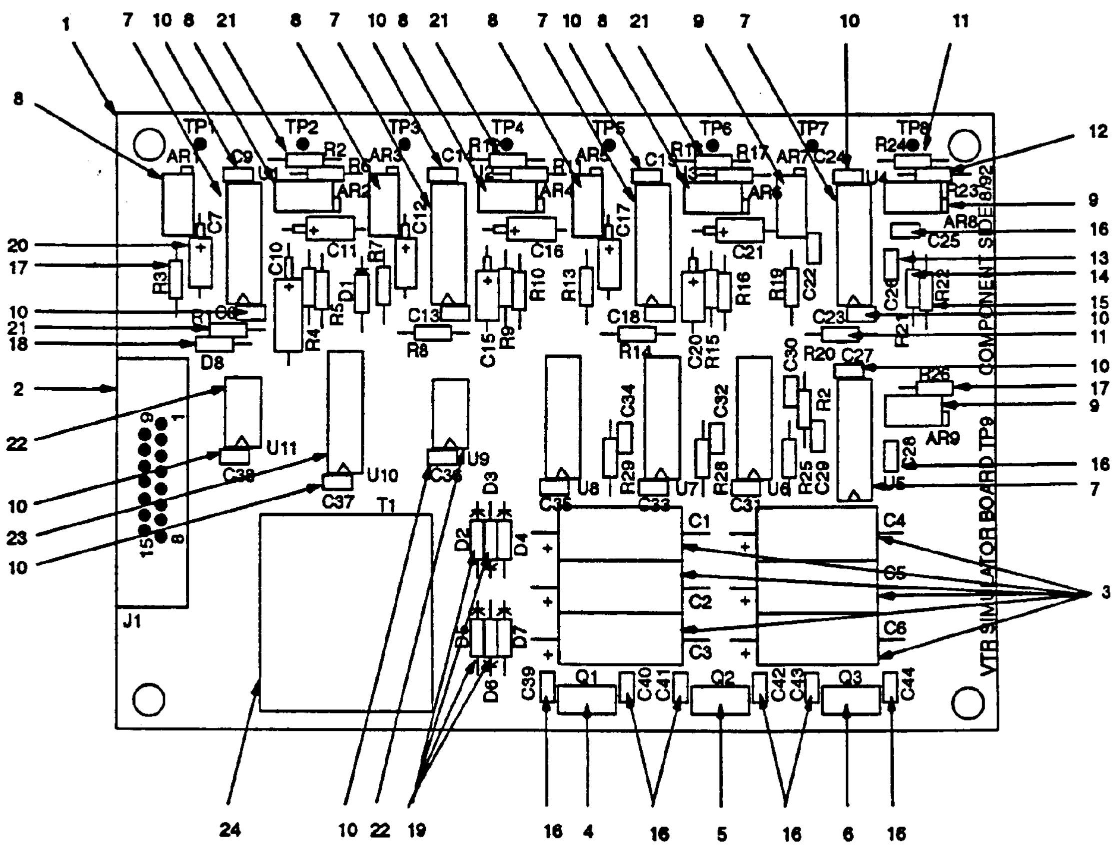


FIGURE A-4. Example of a pictorial - continued.

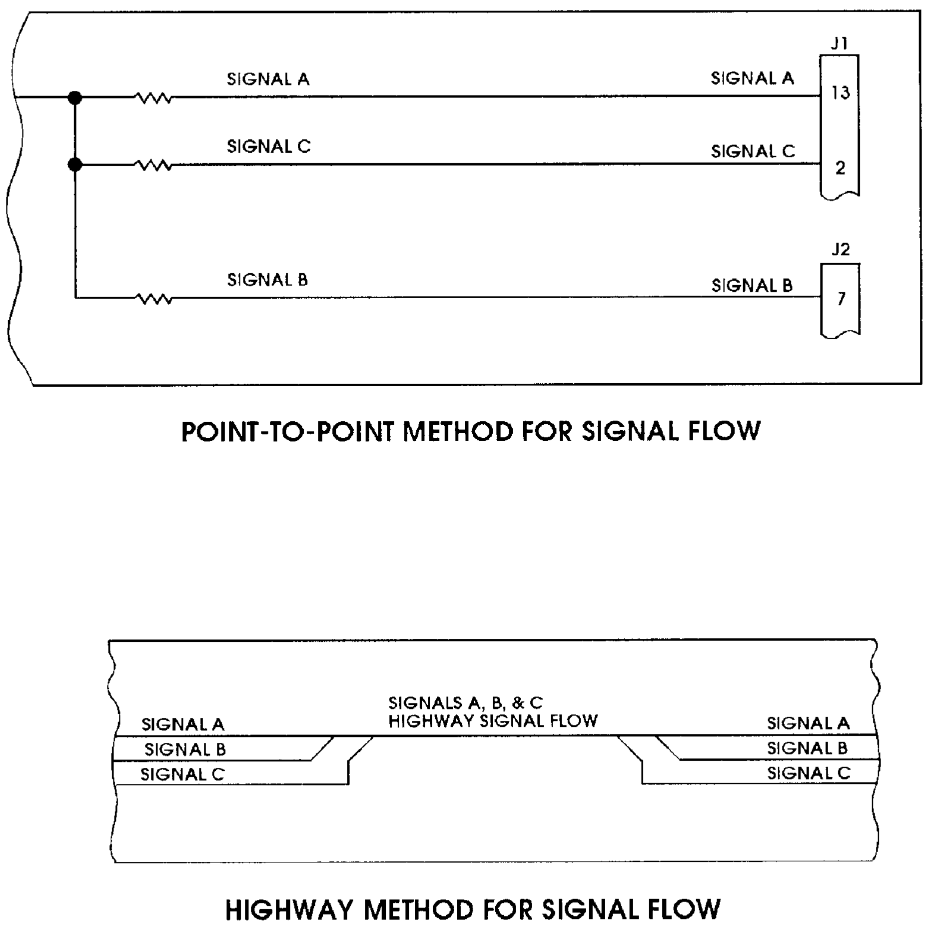
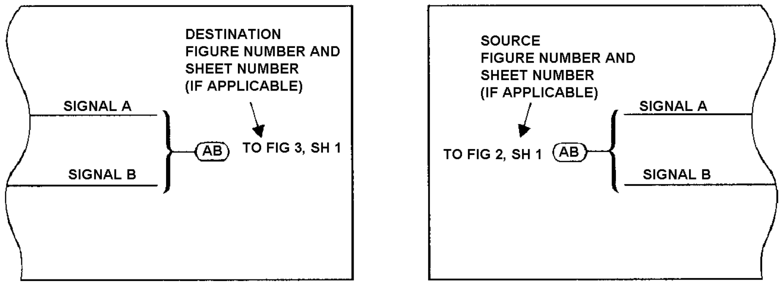
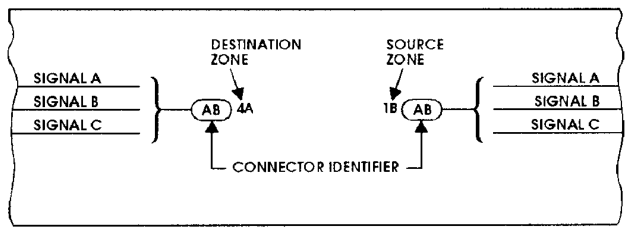


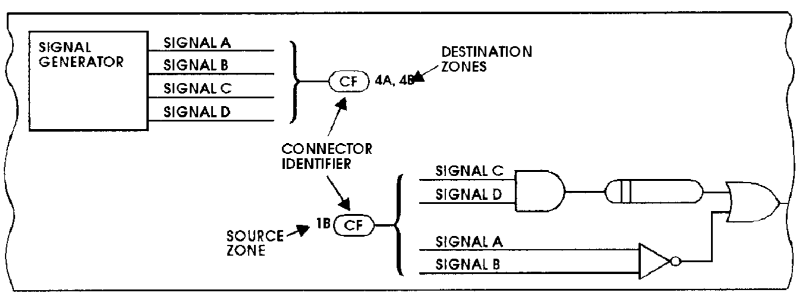
FIGURE A-5. Example of point-to-point and highway method signal flow.



OVAL CONNECTORS USED TO CONTINUE SIGNALS BETWEEN DIAGRAMS



OVAL CONNECTORS USED TO CONTINUE SIGNALS



OVAL CONNECTORS USED TO CONTINUE SIGNALS TO MORE THAN ONE DESTINATION

FIGURE A-6. Example of oval connectors to continue signals.

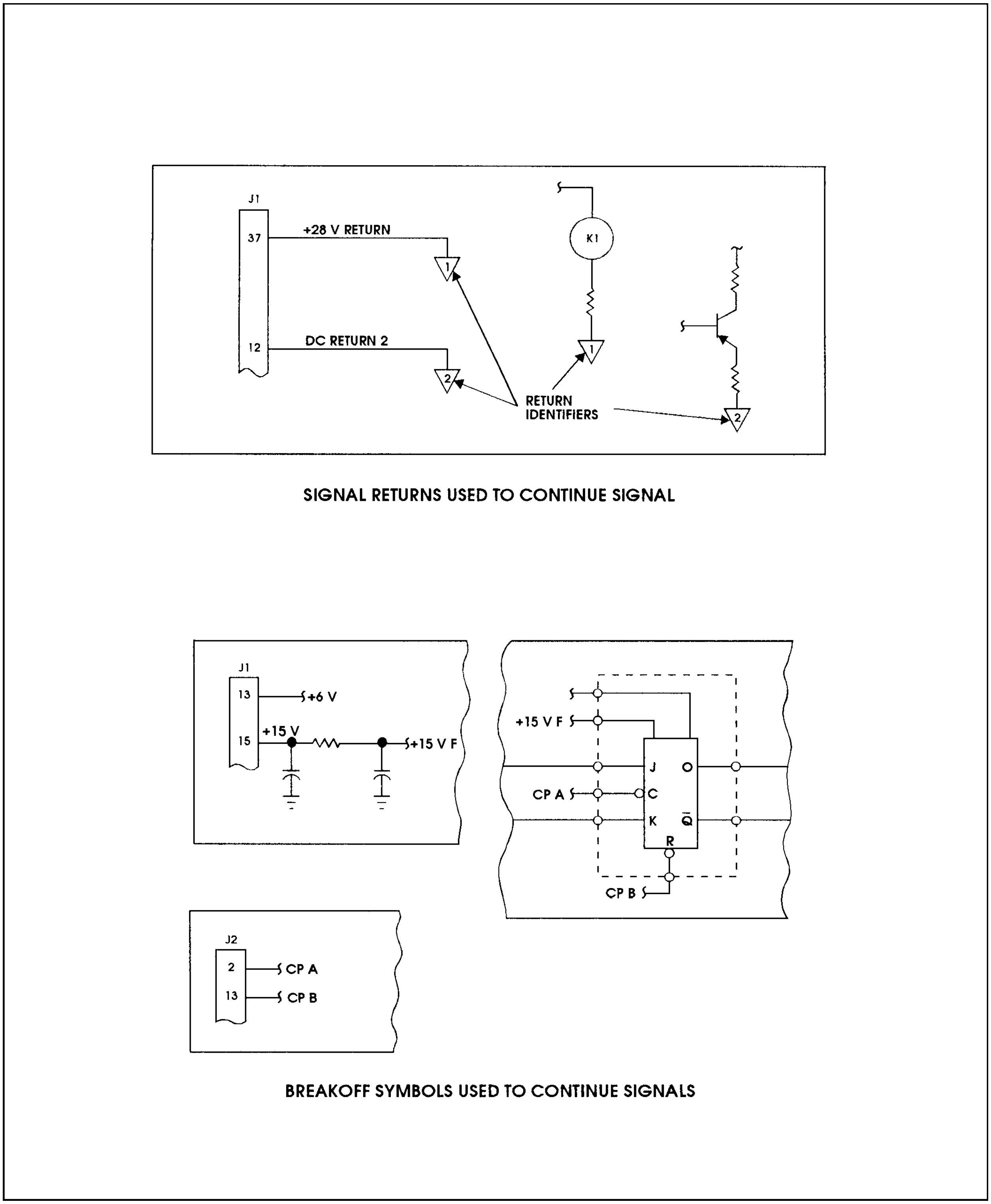


FIGURE A-7. Example of signal returns and breakoff symbols.

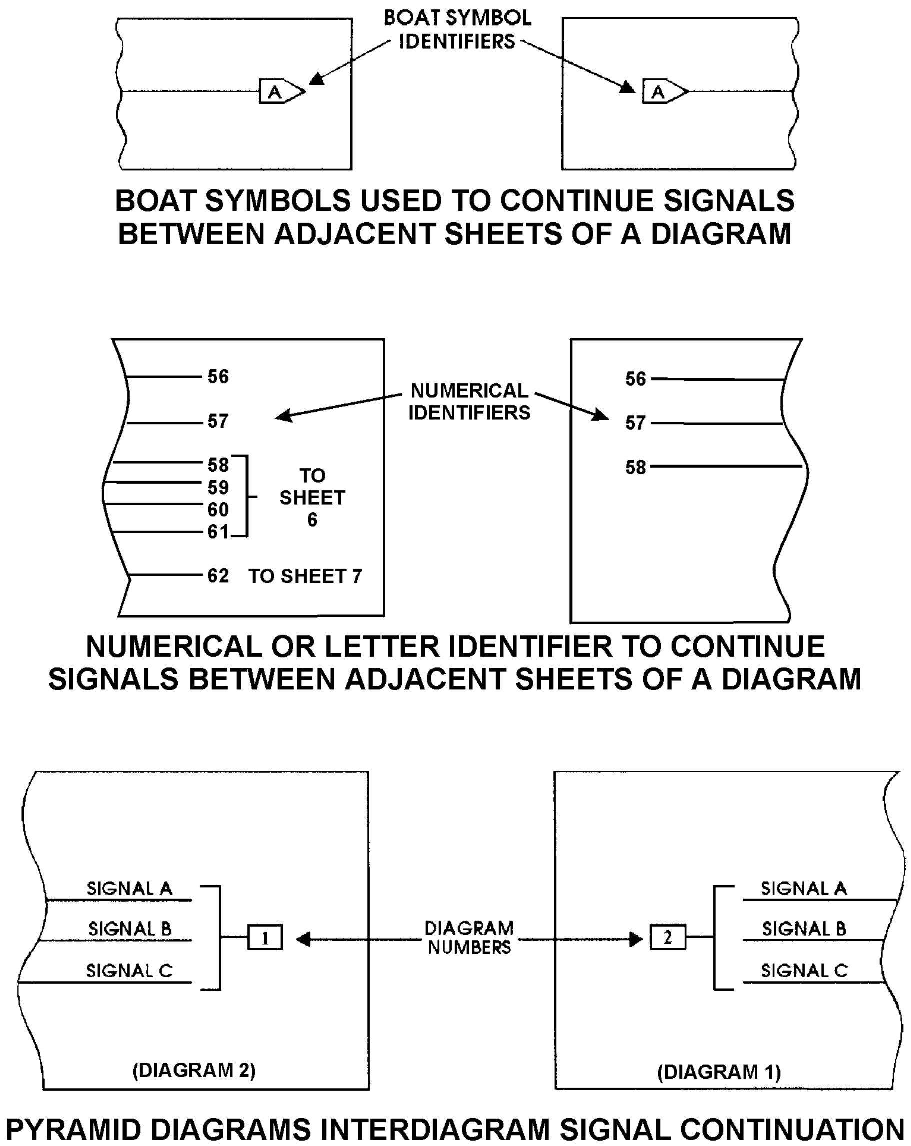


FIGURE A-8. Example of boat symbols, numerical identifiers, and pyramid method.

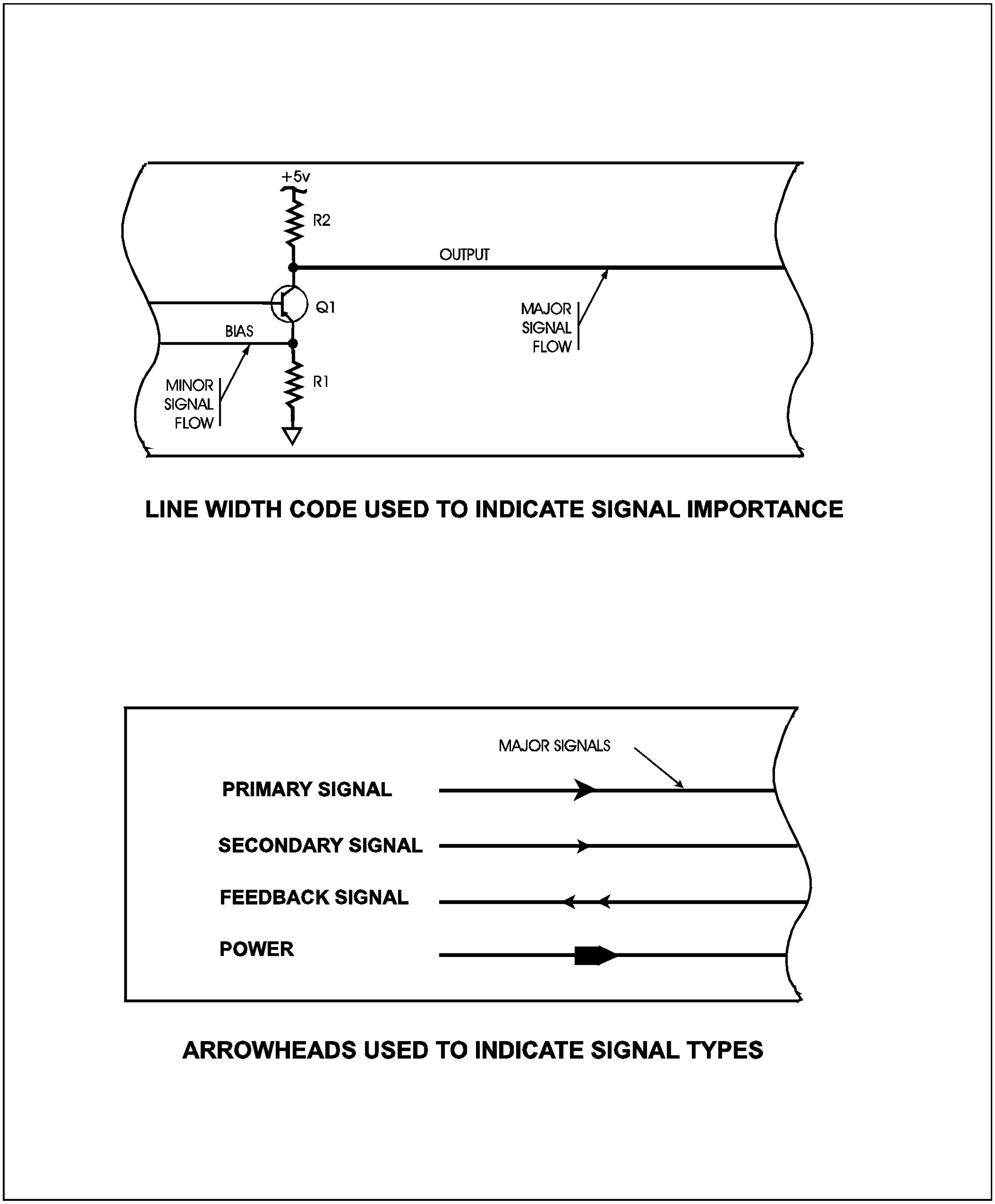


FIGURE A-9. Example of signal difference techniques.

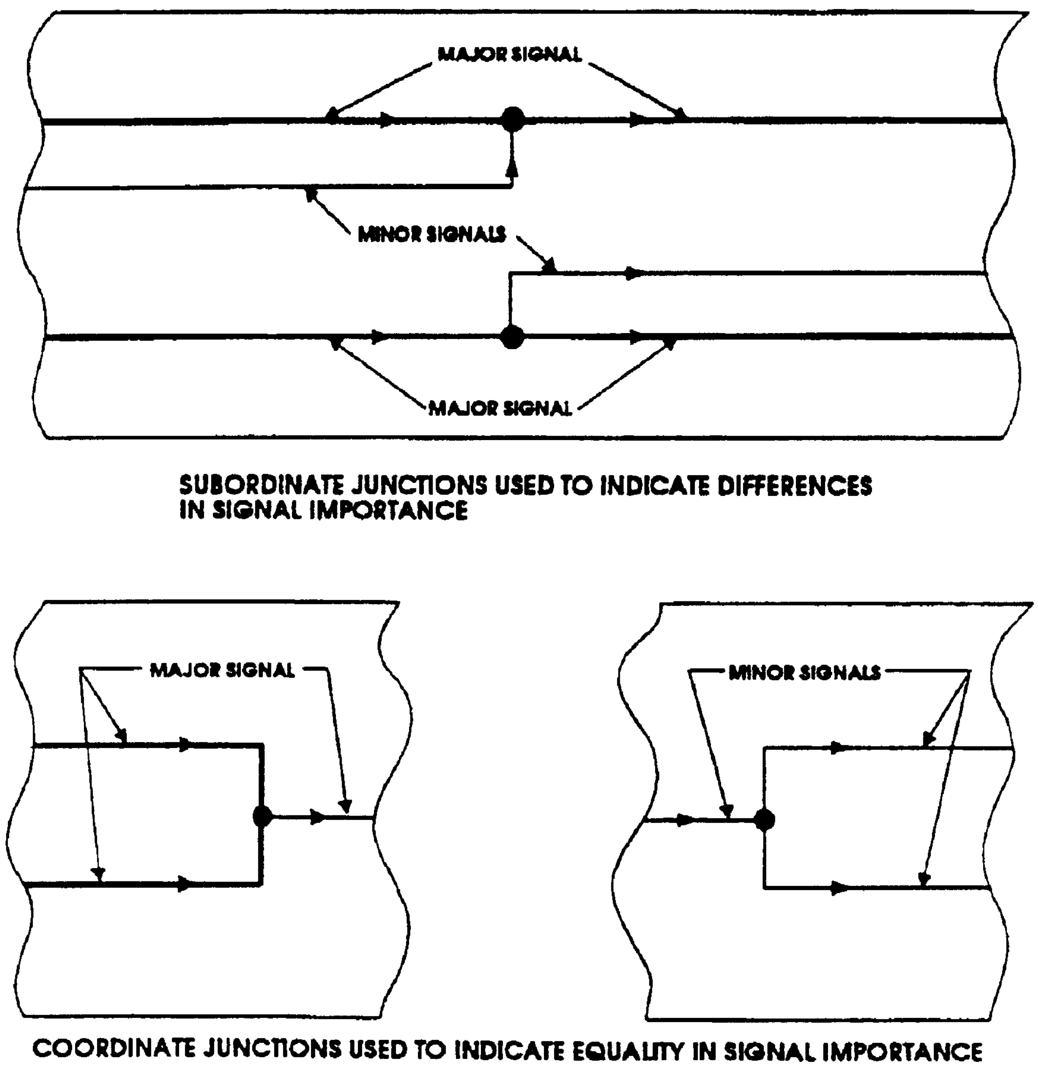


FIGURE A-10. Example of subordinate and coordinate junctions.

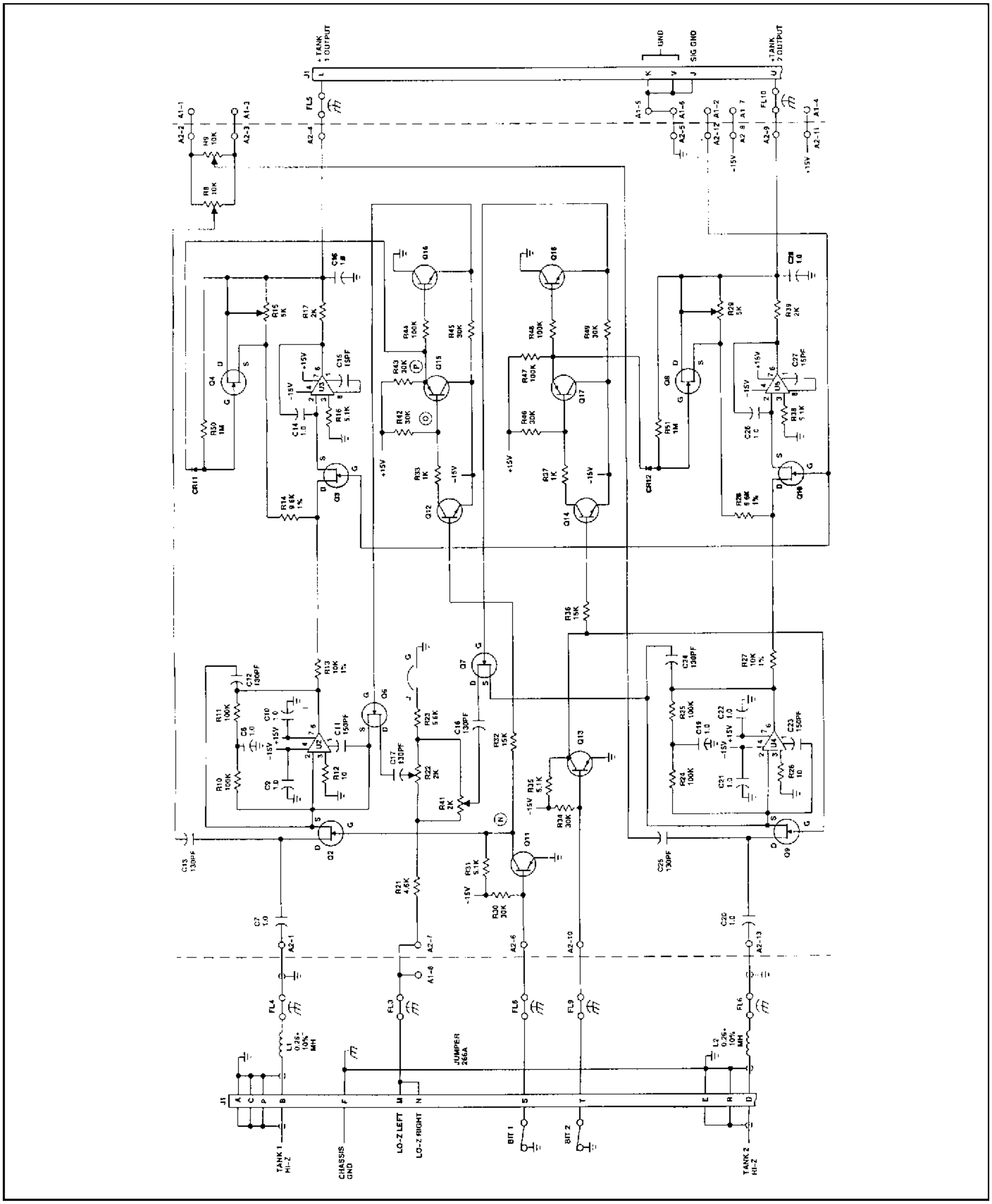


FIGURE A-11. Example of a hardware schematic diagram.

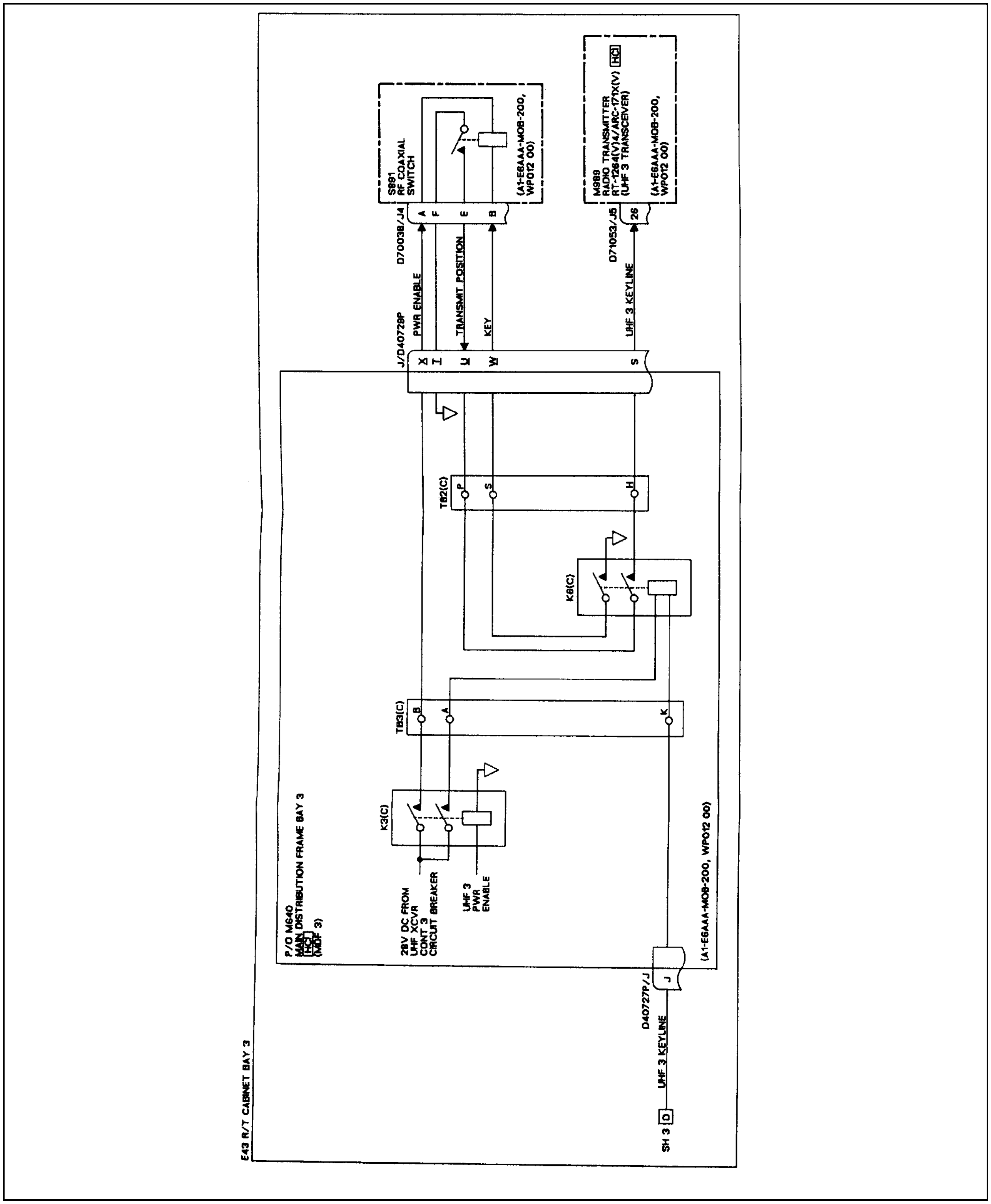


FIGURE A-12. Example of a functional schematic.

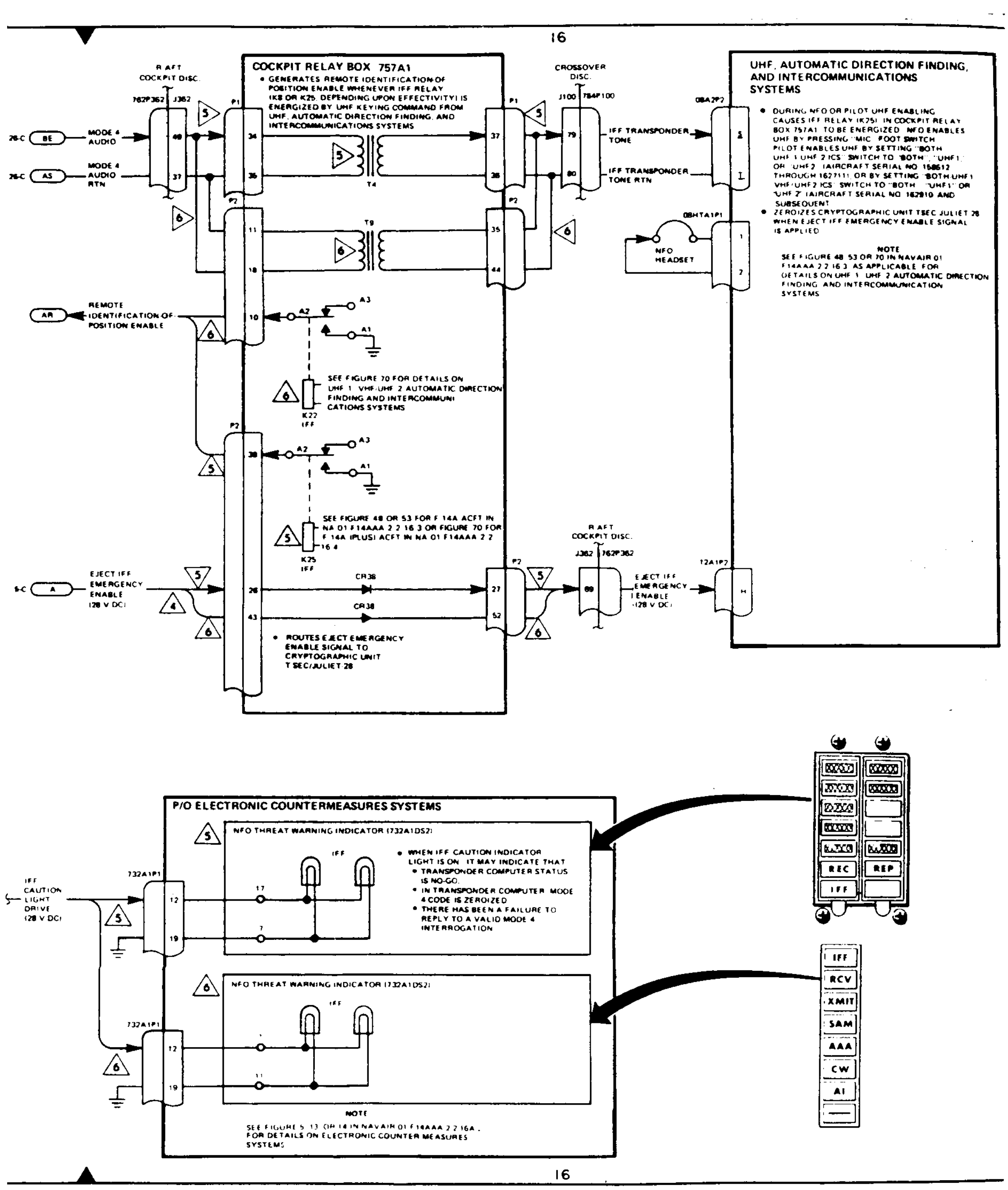


FIGURE A-13. Example of a functional flow diagram.

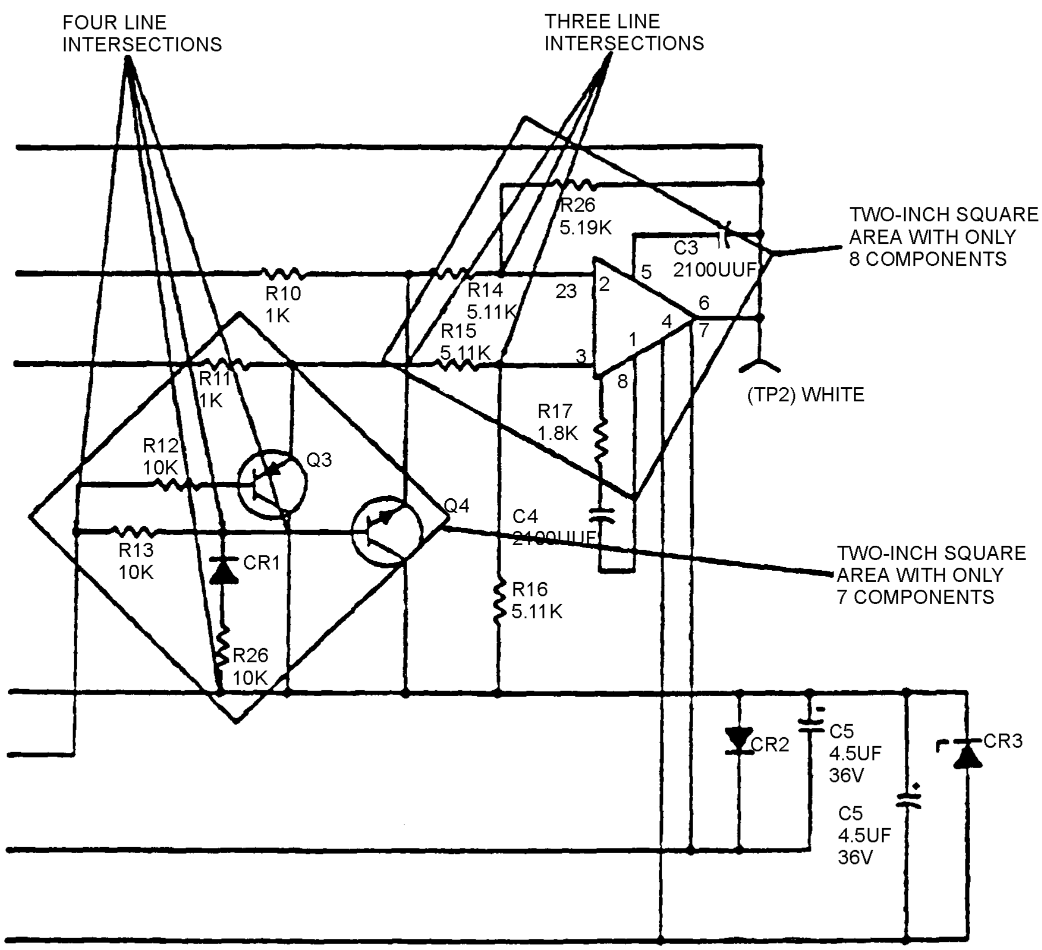


FIGURE A-14. Example of uncrowded schematic diagram.

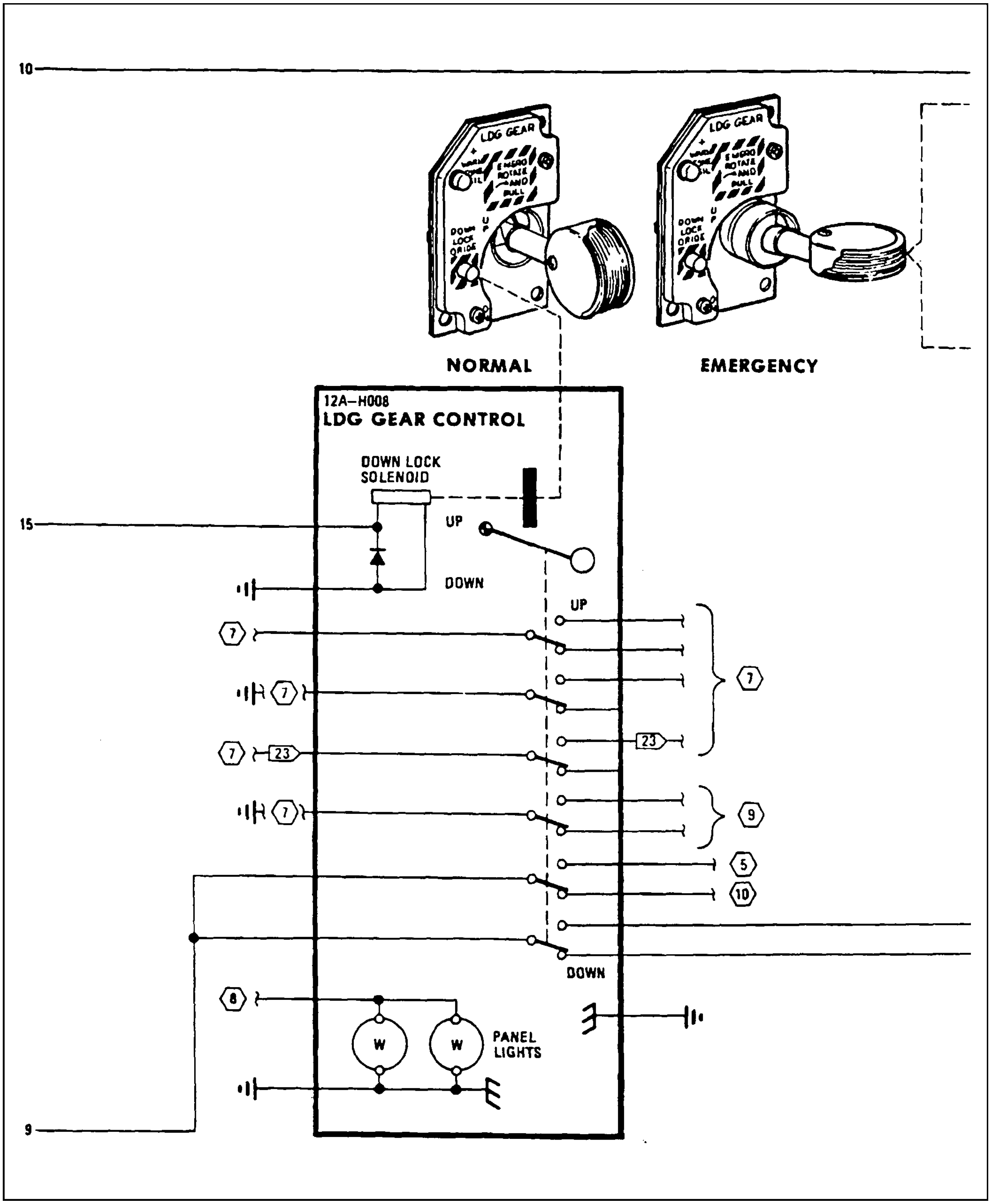


FIGURE A-15. Example of components drawn on a schematic.

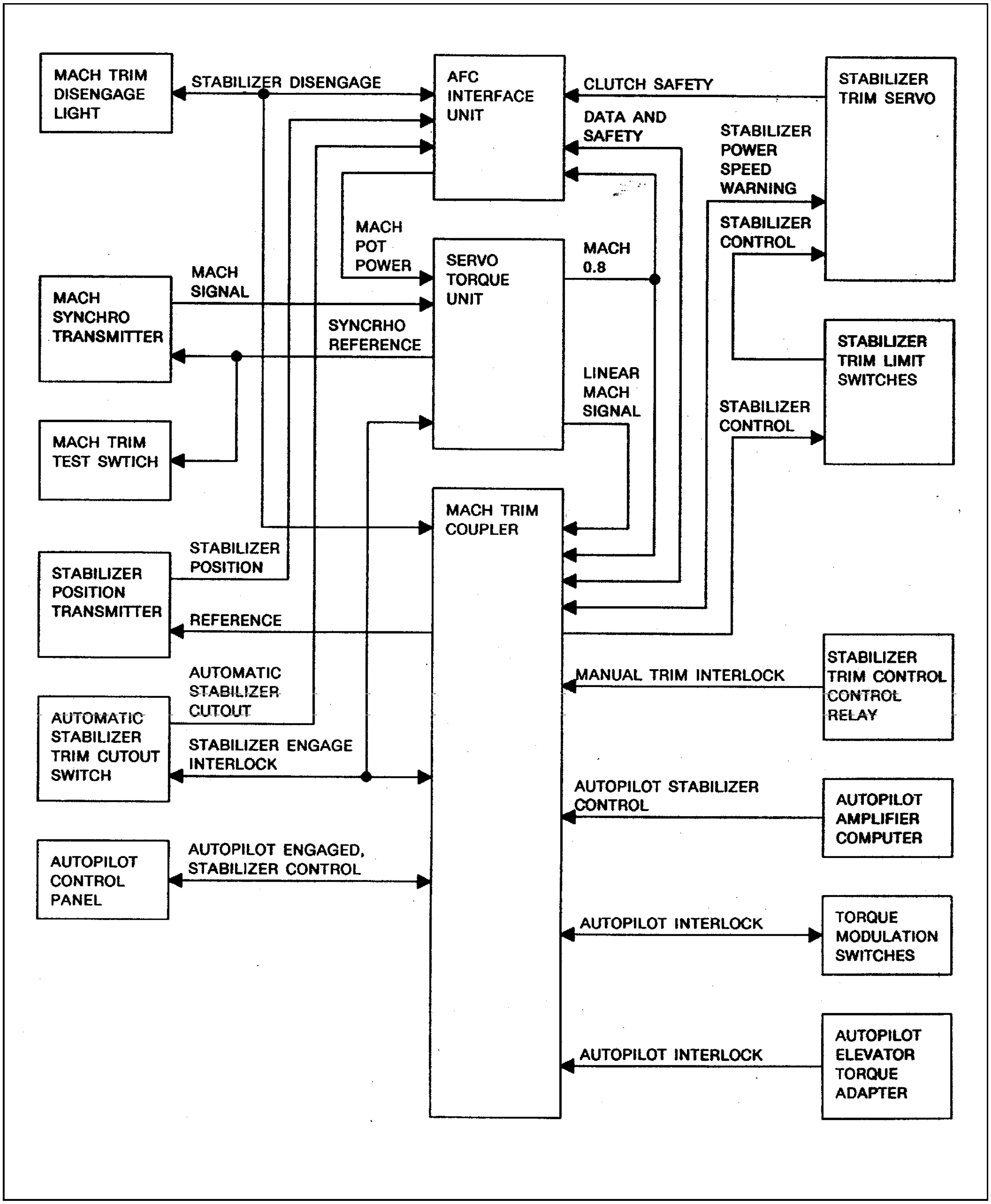


FIGURE A-16. Example of a functional block diagram.

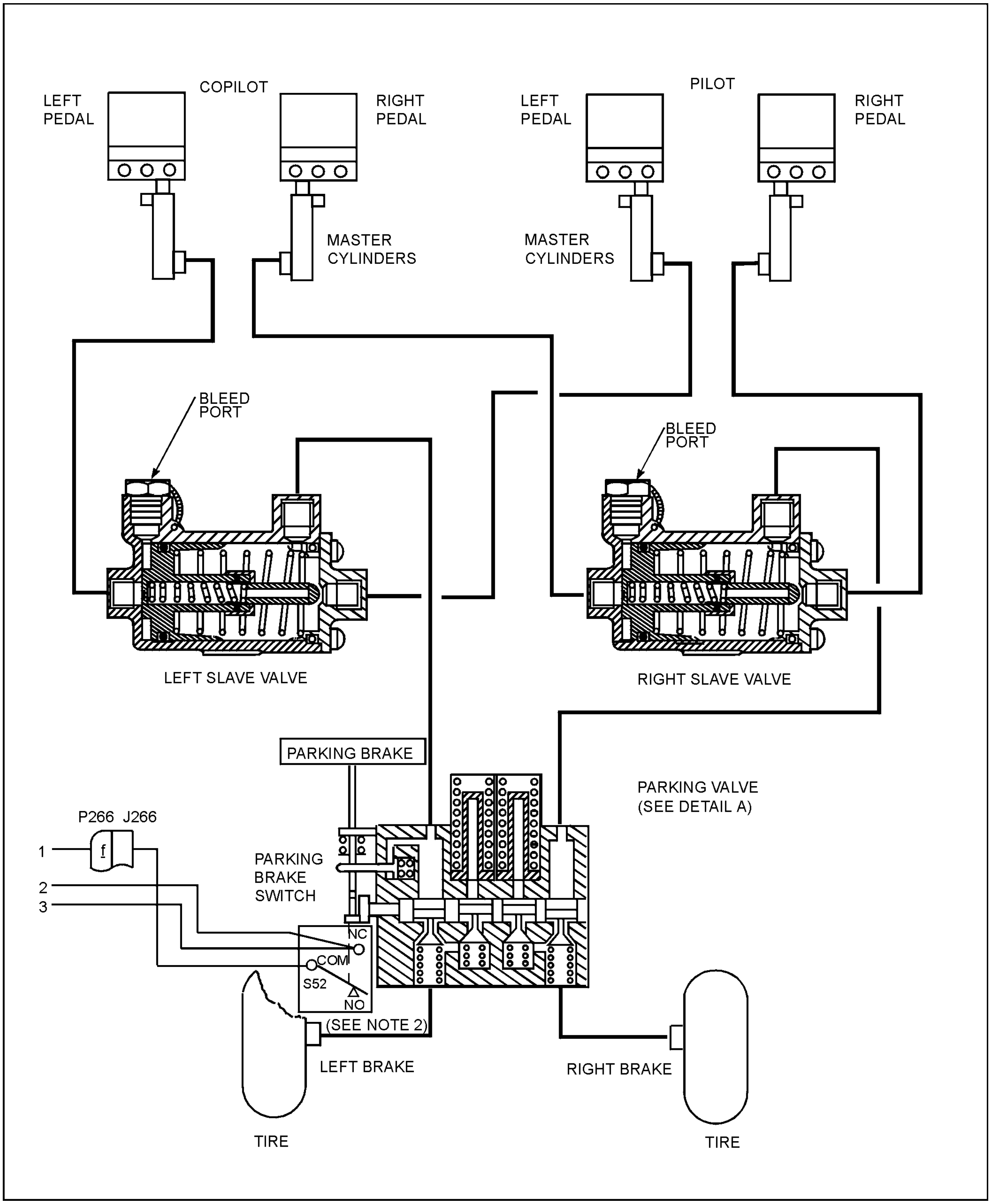


FIGURE A-17. Example of a cutaway diagram.

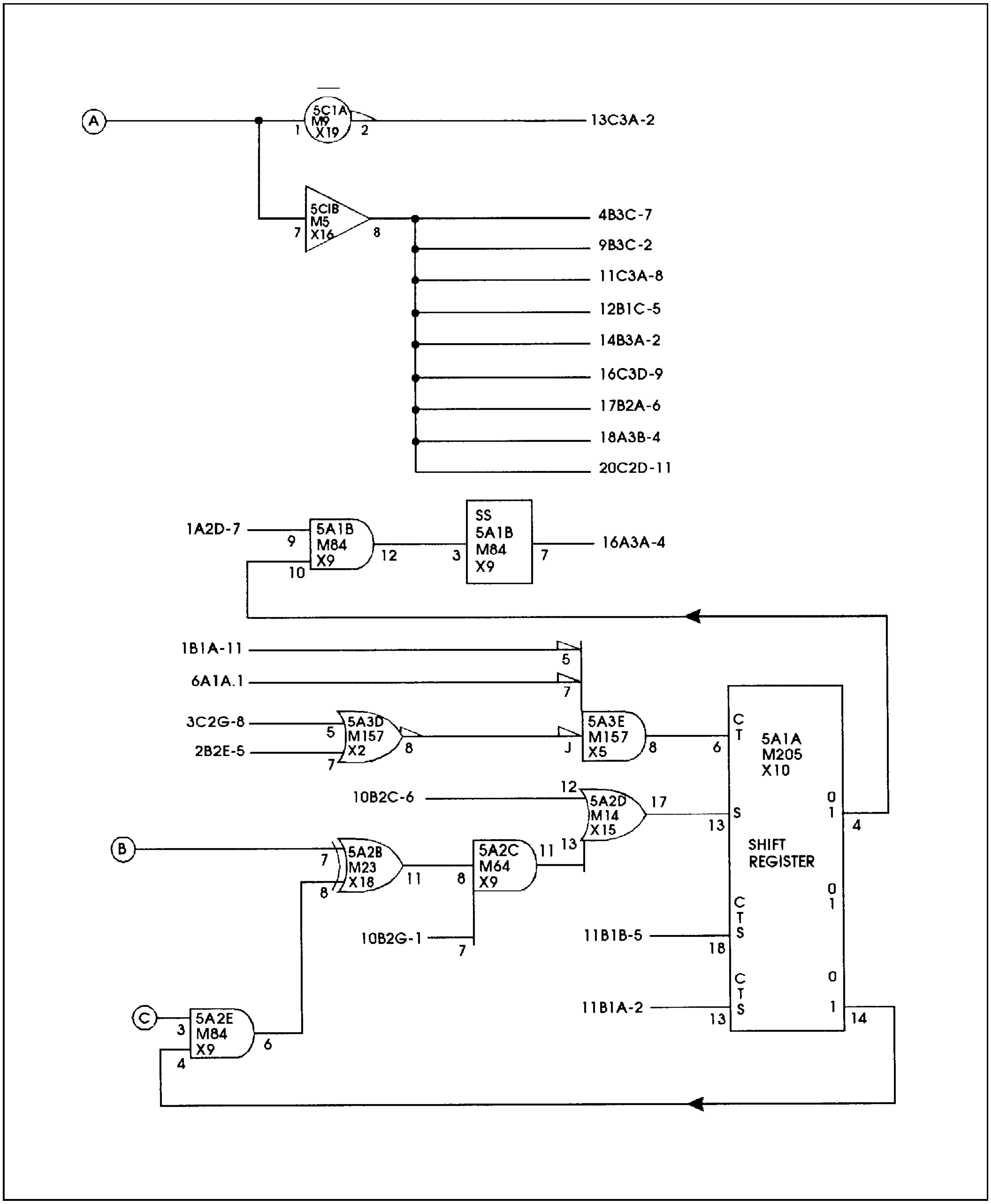


FIGURE A-18. Example of a logic diagram.

J - $\overline{K}$ FLIP-FLOP TRUTH TABLE

STARTING CONDITION (OUTPUT)		INPUT CONDITION		RESULT AT END OF CLOCK PULSE (OUTPUT)	
A	B	J	$\overline{K}$	A	B
L	H	L	L	NO CHANGE	
		L	H	NO CHANGE	
		H	L	H	L
		H	H	H	L
H	L	L	L	L	H
		L	H	NO CHANGE	
		H	L	L	H
		H	H	NO CHANGE	
A	B	SET	RESET	RESULT (OUTPUT)	
L	H	H	H	NO CHANGE	
		L	H	H	L
		L	L	DISALLOWED STATE	
		H	L	NO CHANGE	
H	L	H	H	NO CHANGE	
		L	H	NO CHANGE	
		L	L	DISALLOWED STATE	
		H	L	L	H

THE J-$\overline{K}$ FLIP-FLOP IS A MULTIPURPOSE STORAGE ELEMENT WHEREIN THE K INPUT IS INTERNALLY INVERTED. DEPENDING ON THE WIRING AT THE J-$\overline{K}$ INPUTS, THIS FF CAN BE CONFIGURED TO FUNCTION AS A J-K TYPE FF, J-$\overline{K}$ TYPE FF, D-TYPE FF OR A T-TYPE (TOGGLE) FF.

FIGURE A-19. Example of a truth table.

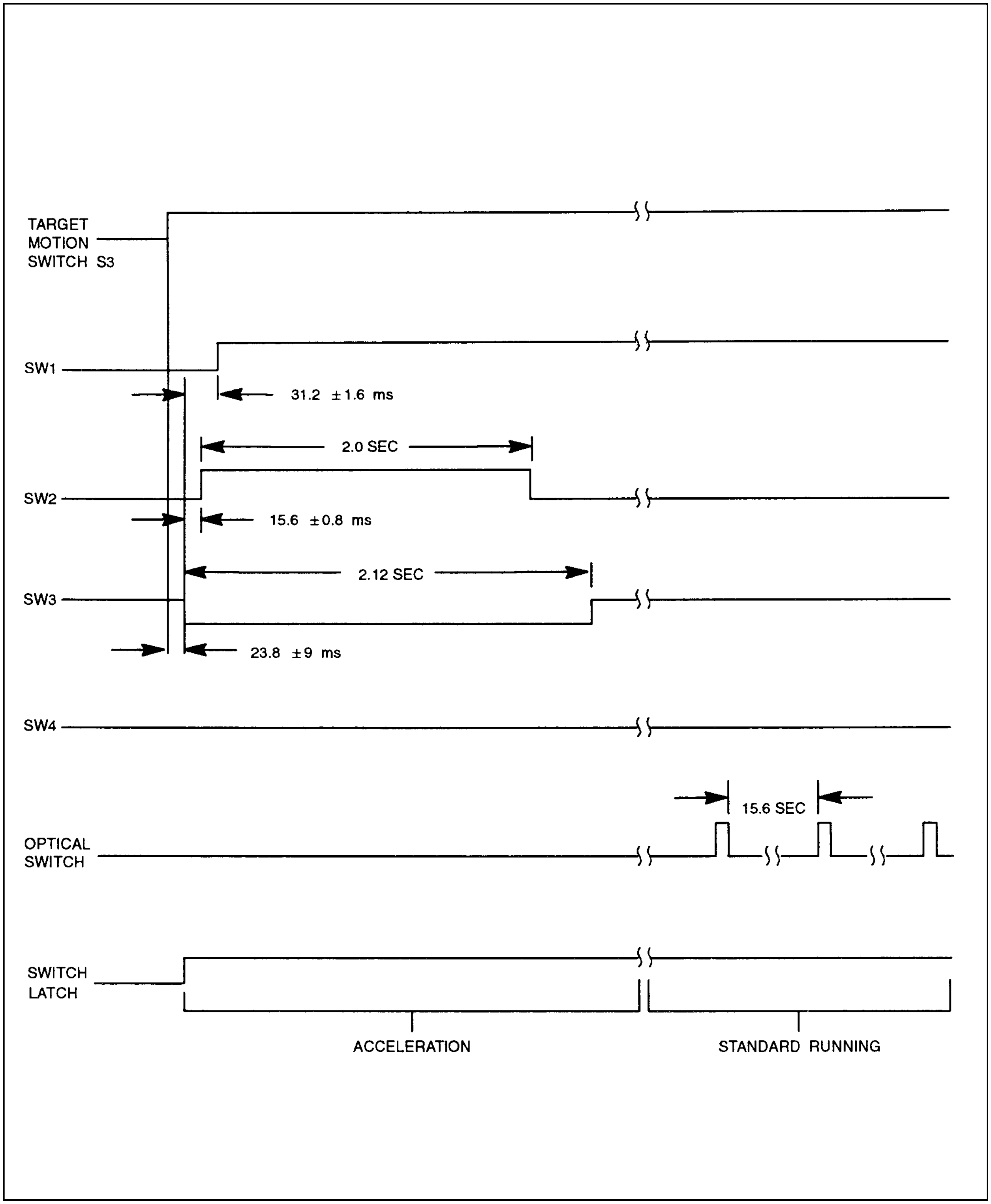


FIGURE A-20. Example of a timing diagram.

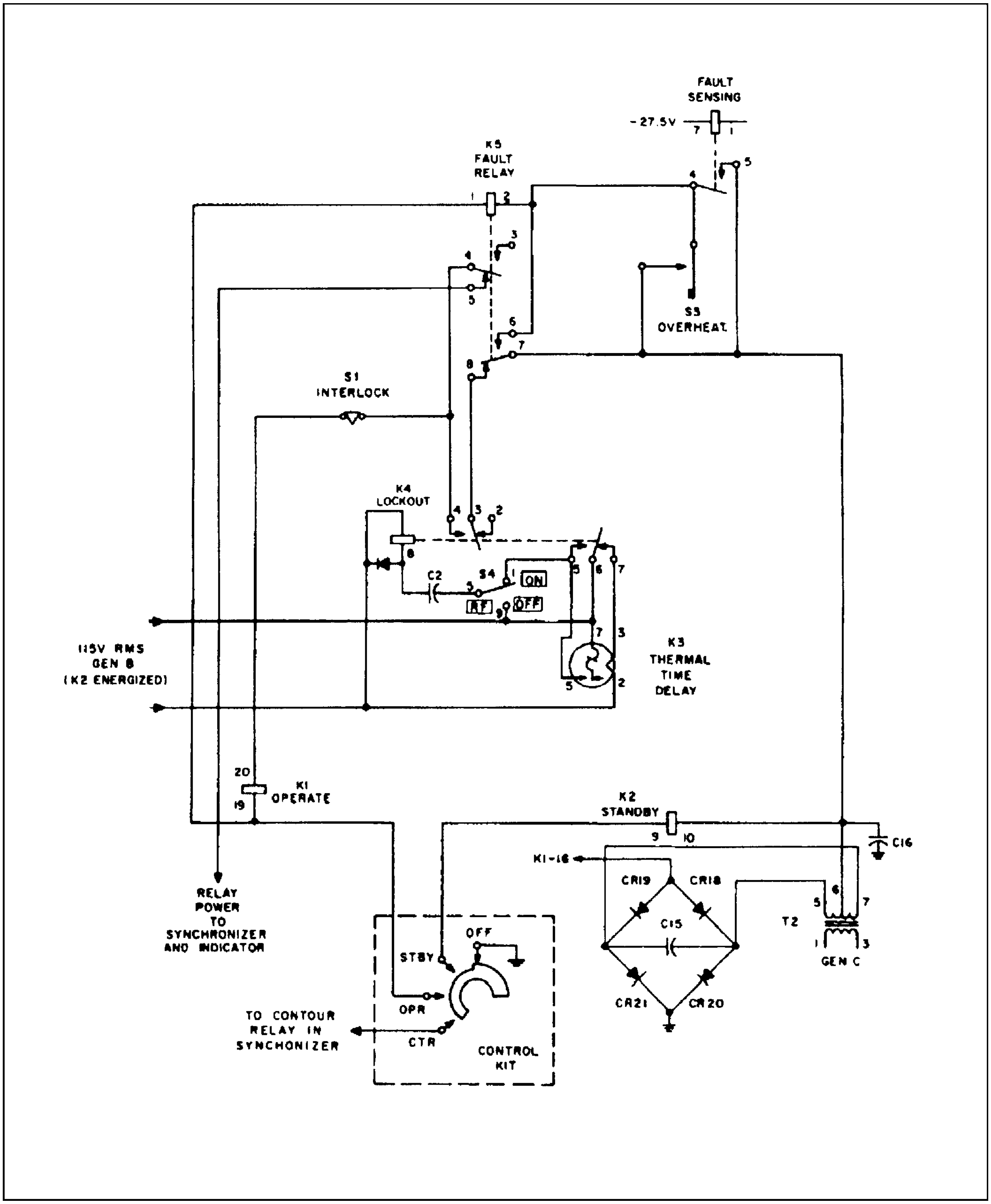


FIGURE A-21. Example of a simplified diagram.

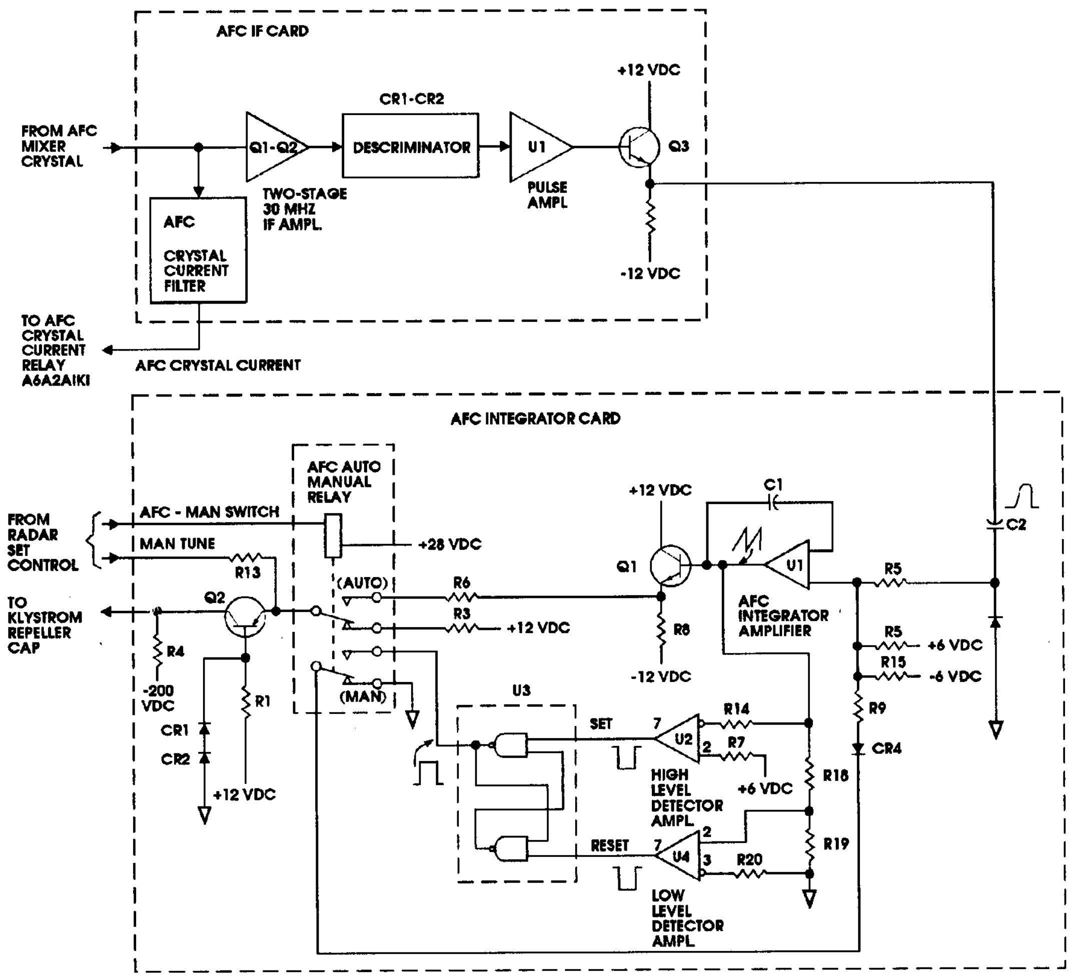


FIGURE A-22. Example of a partial diagram.

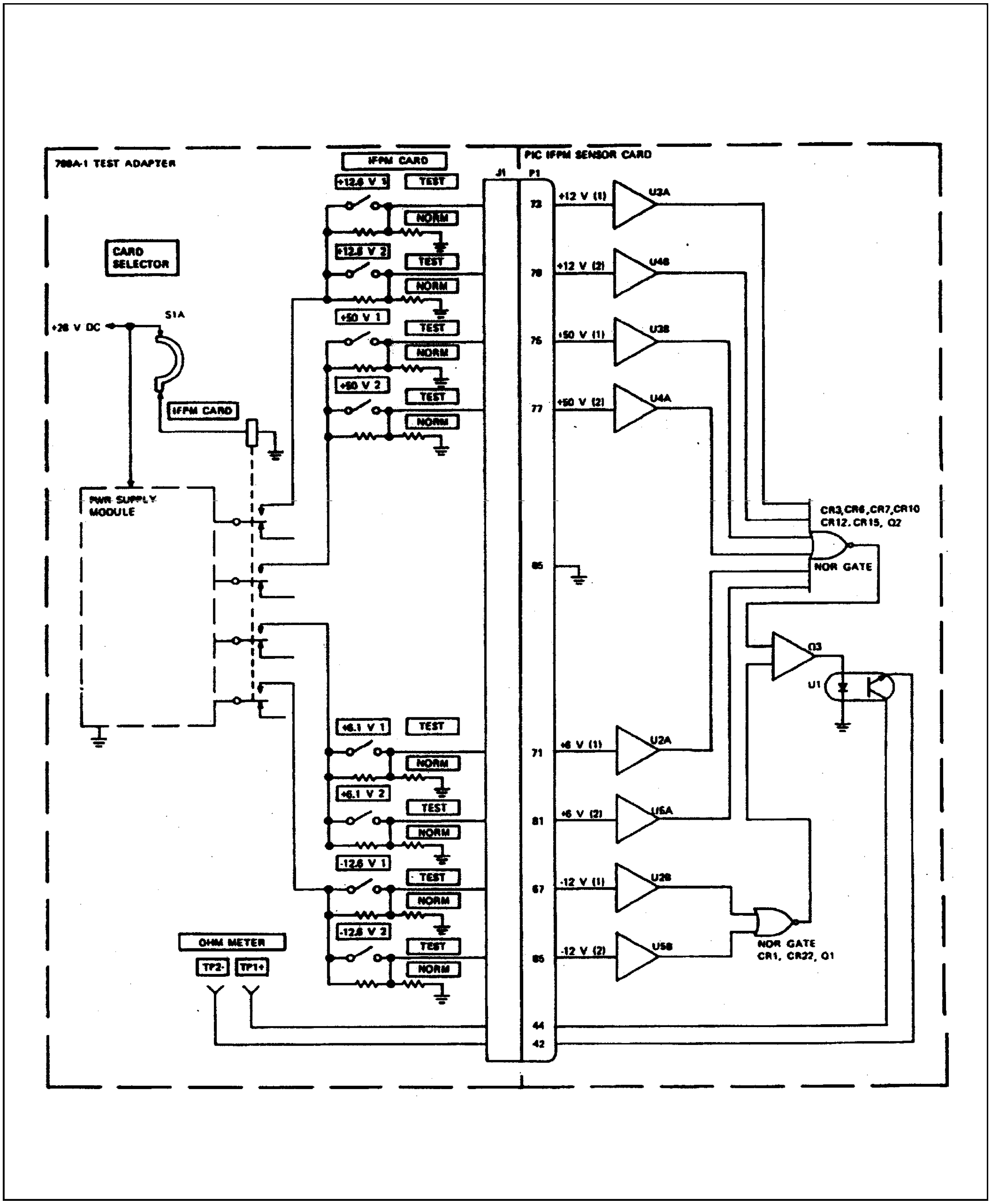


FIGURE A-23. Example of a test diagram.

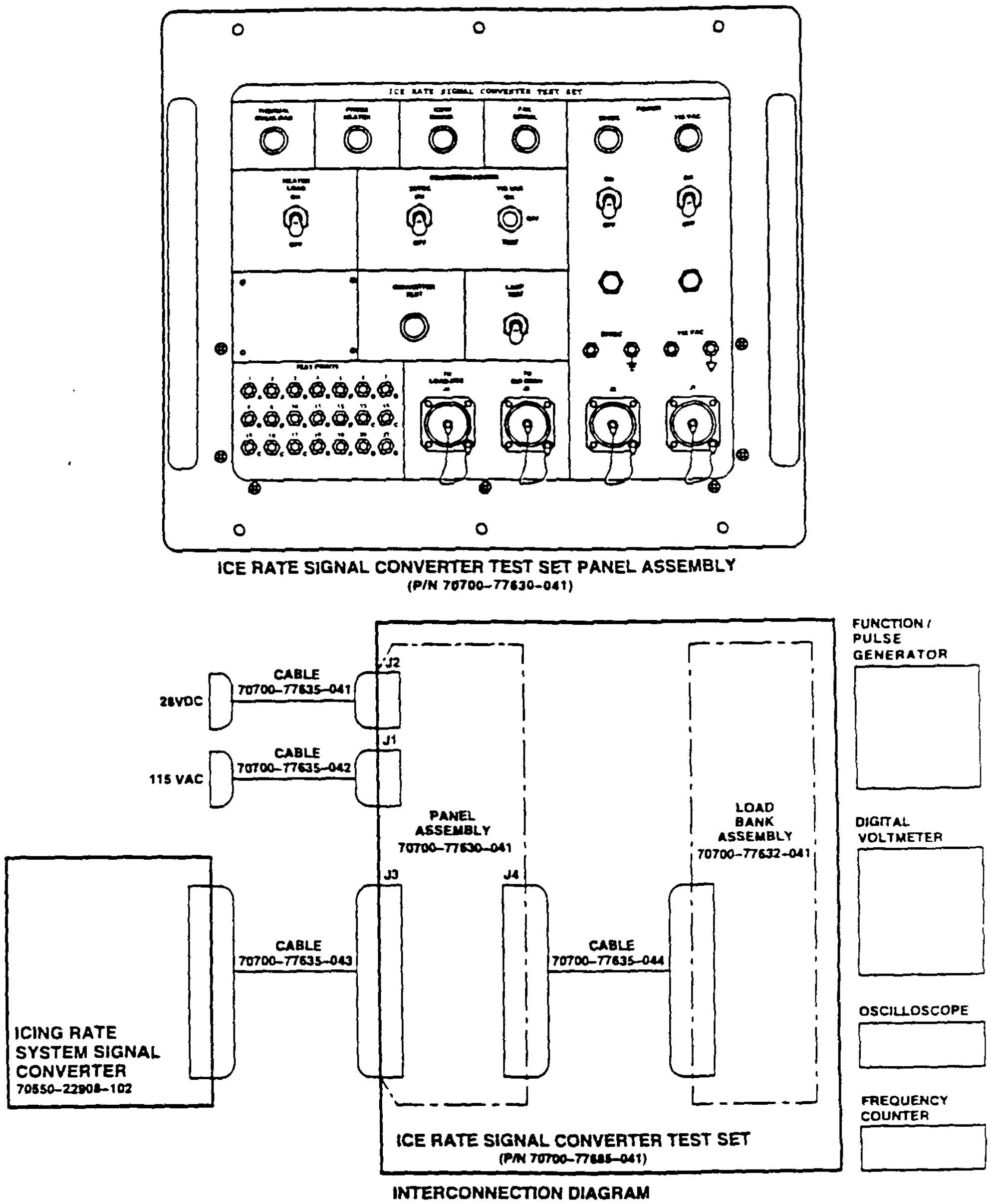


FIGURE A-24. Example of a test setup diagram.

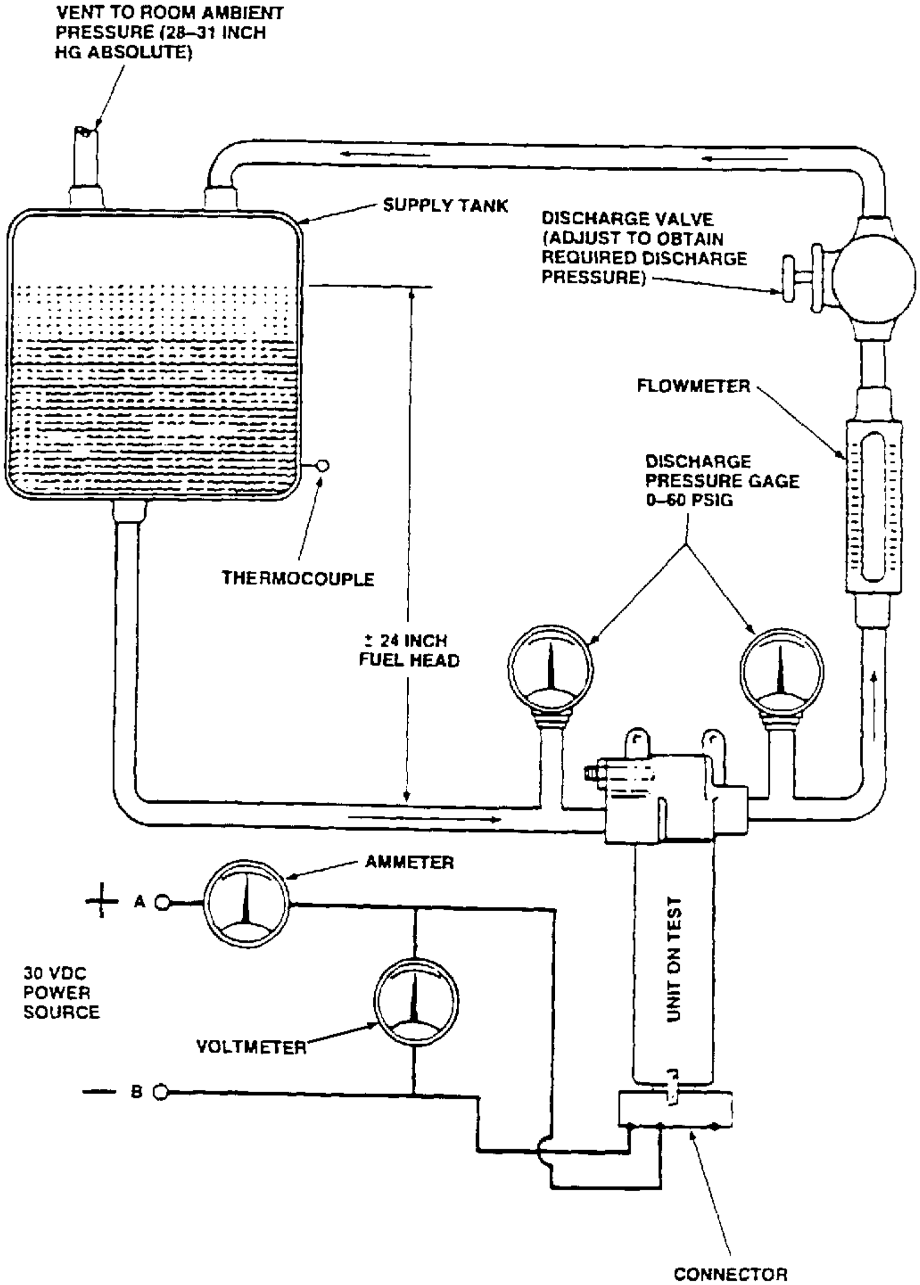


FIGURE A-24. Example of a test setup diagram - continued.

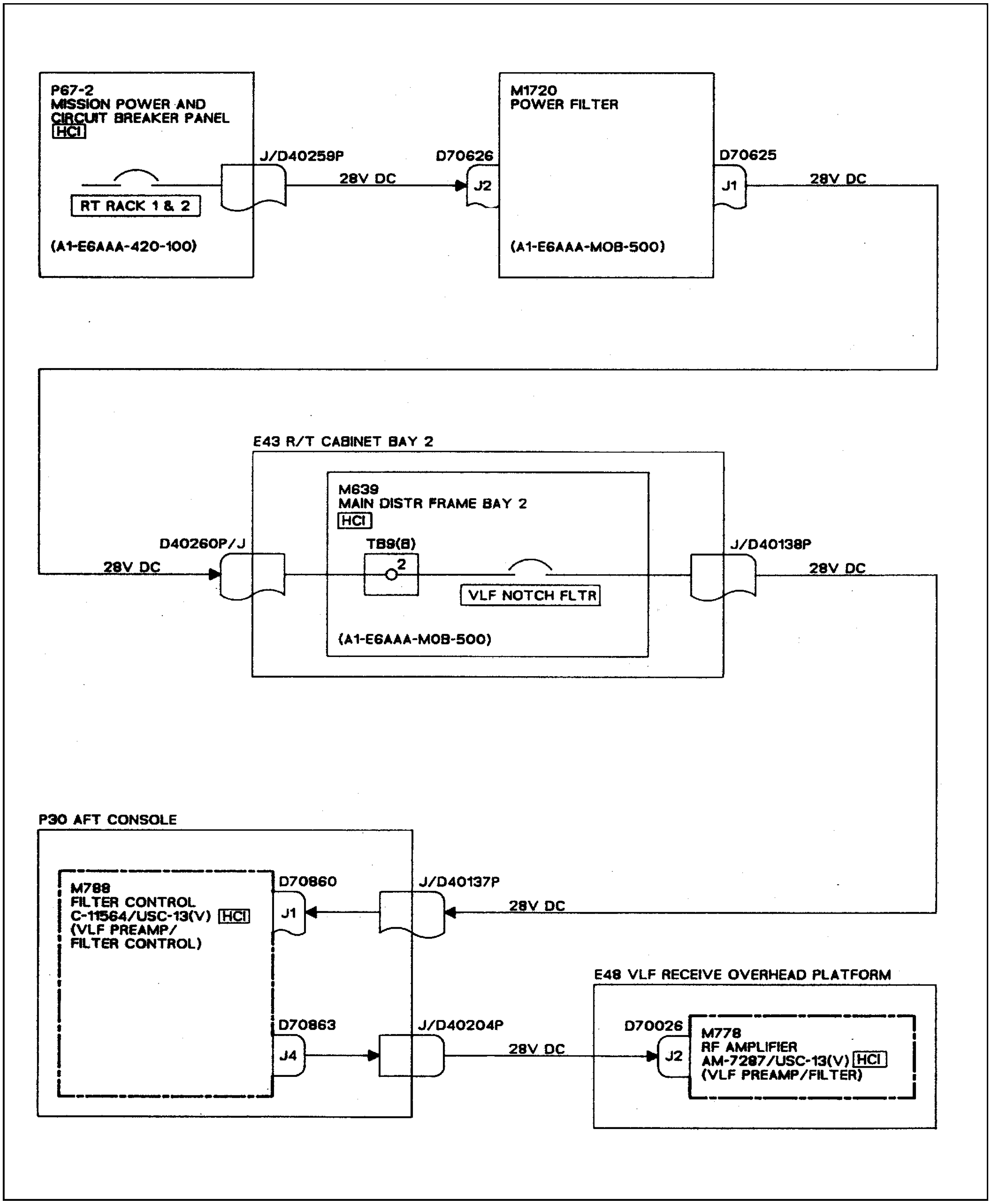


FIGURE A-25. Example of a power distribution diagram.

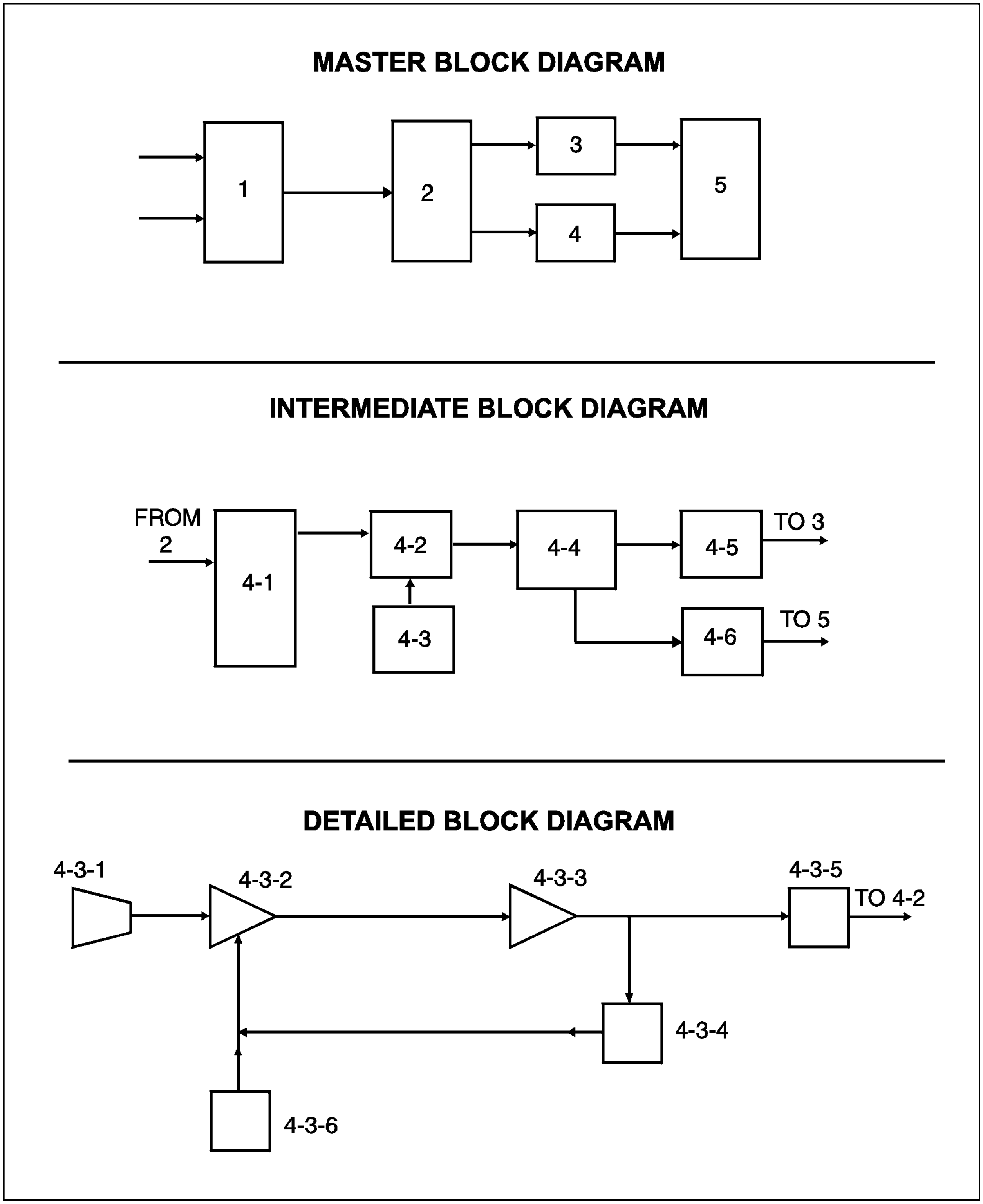


FIGURE A-26. Example of a pyramid diagram.

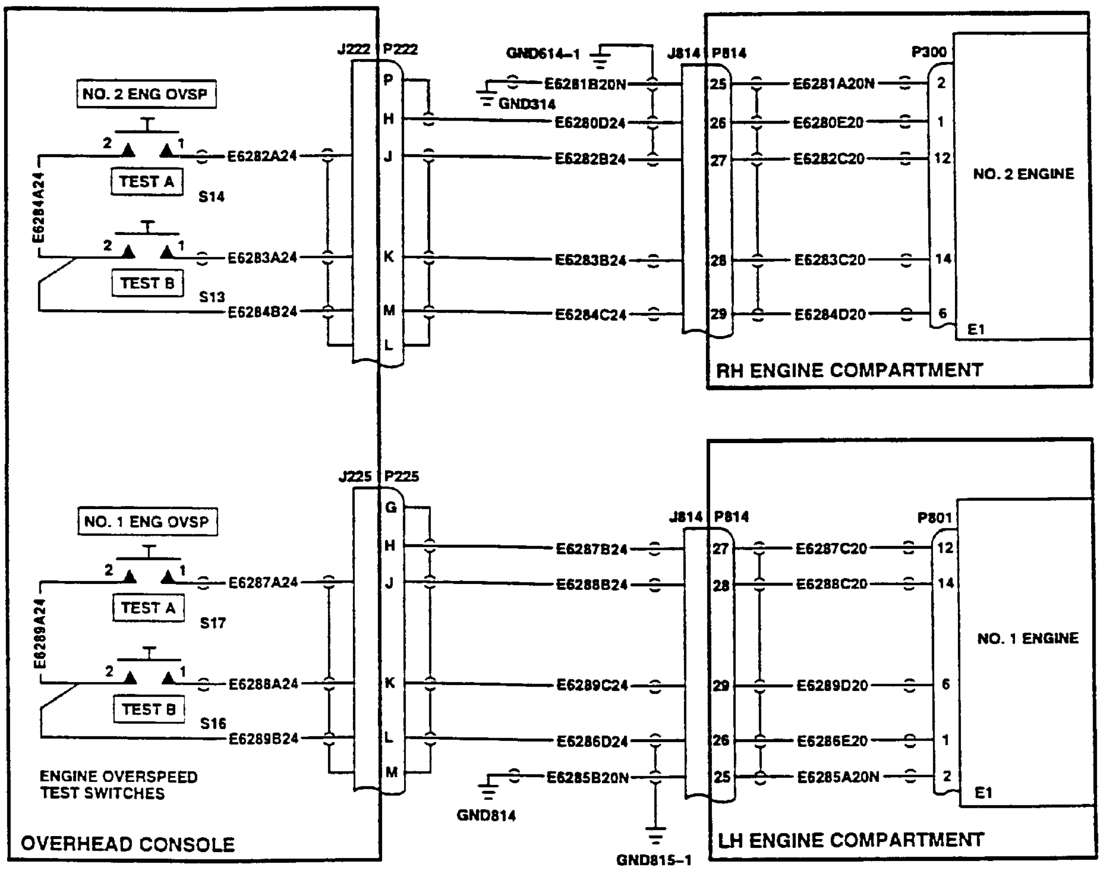


FIGURE A-27. <u>Example of a wiring diagram</u>.

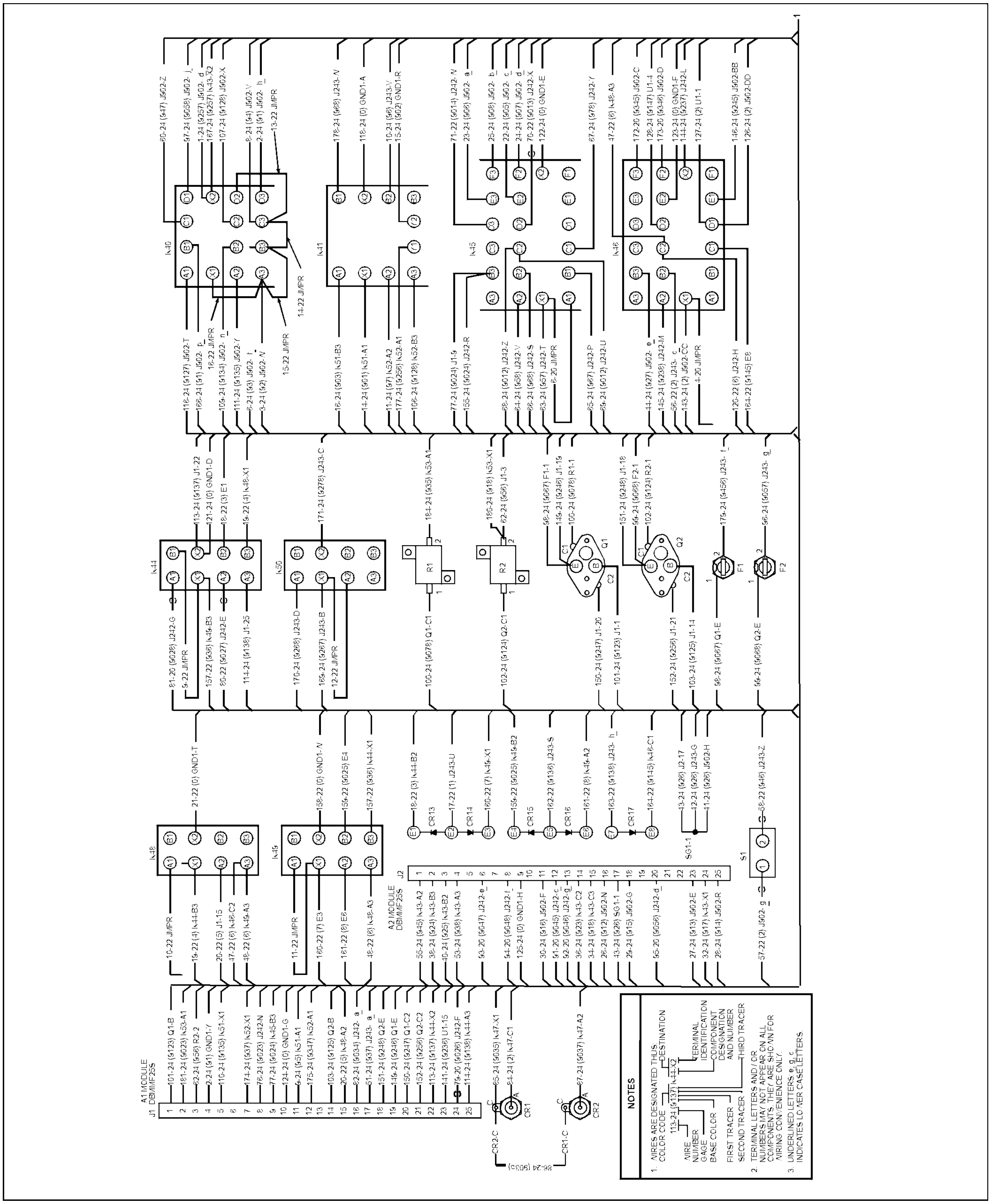


FIGURE A-27. Example of a wiring diagram - continued.

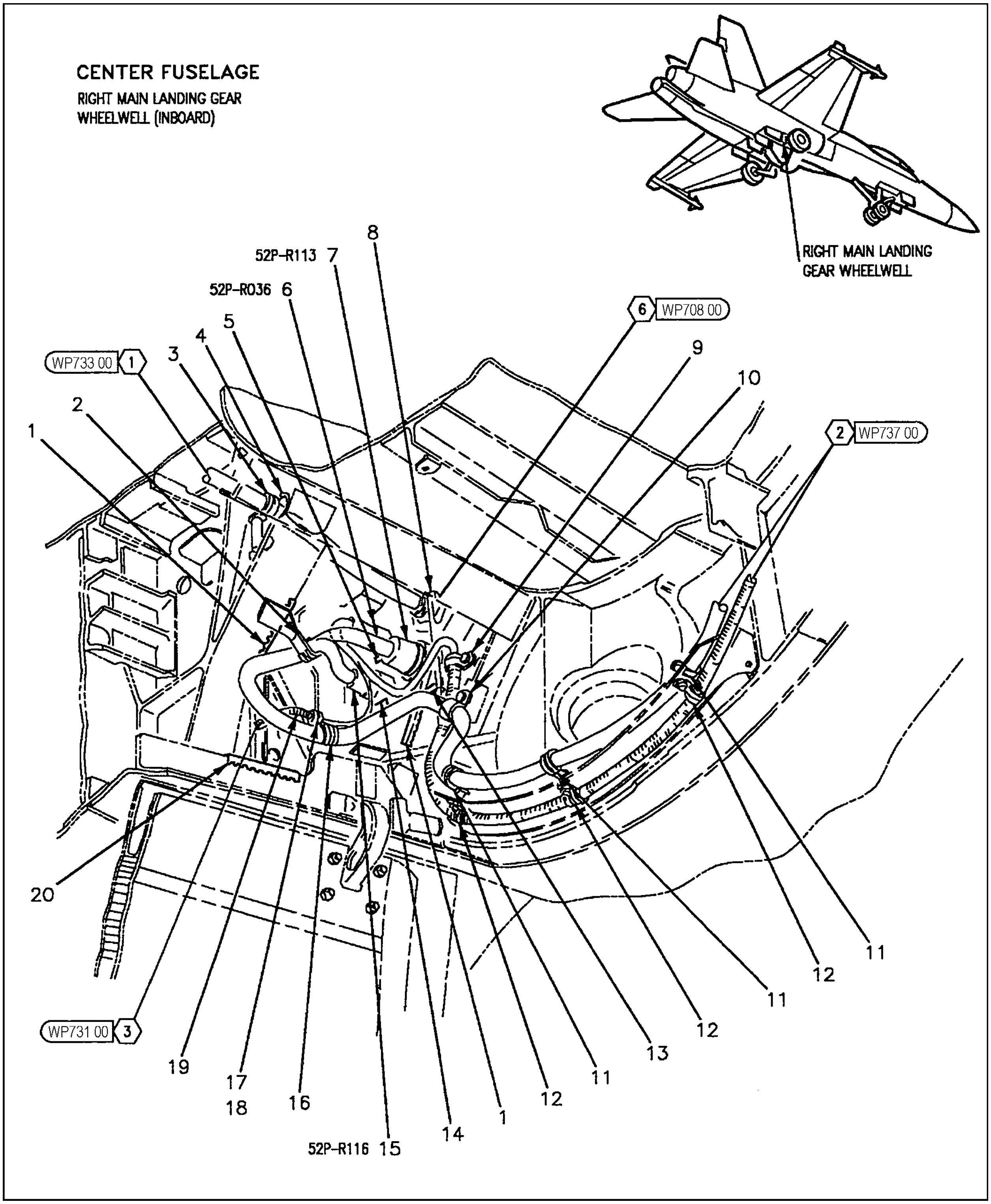
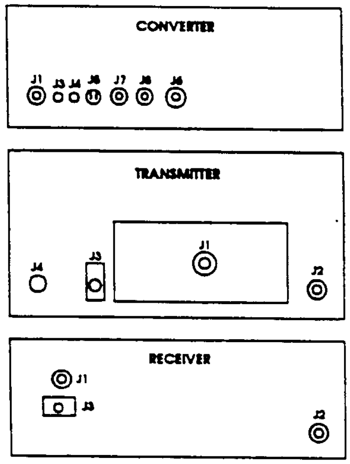


FIGURE A-28. Example of a wiring bundle routing illustration.



CABLE	FROM			TO		
	ASSEMBLY	JACK	CABLE PLUG	ASSEMBLY	JACK	CABLE PLUG
W101	CONVERTER	J1	P1	RECEIVER	J3	P2
W102	CONVERTER	J5	P1	RECEIVER	J1	P2
W103	CONVERTER	J7	P1	TRANSMITTER	J2	P2
W104	CONVERTER	J8	P1	RECEIVER	J2	P2
W106	CONVERTER	J6	P1	TRANSMITTER	J3	P2
W108	CONVERTER	J3	P1	TRANSMITTER	J4	P2
W107	CONVERTER	J4	P1	TRANSMITTER	J1	P2

FIGURE A-29. Example of a cabling diagram with table.

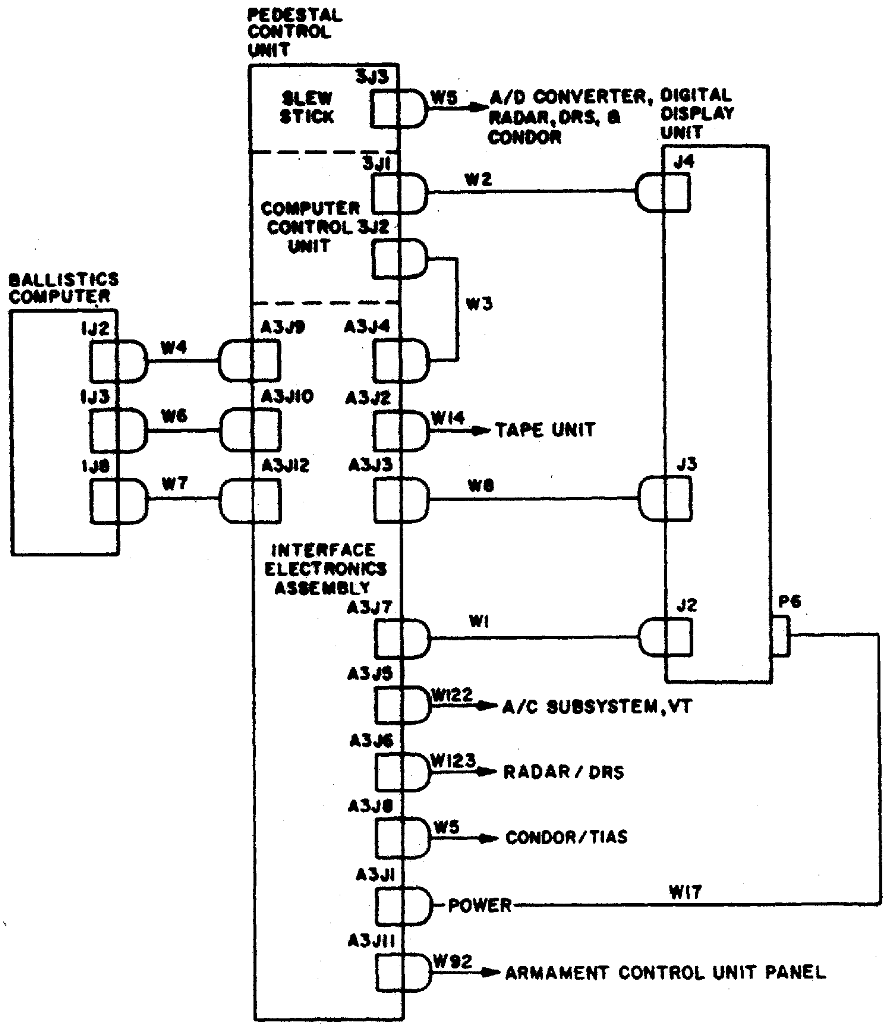


FIGURE A-30. Example of a cable interconnect diagram.

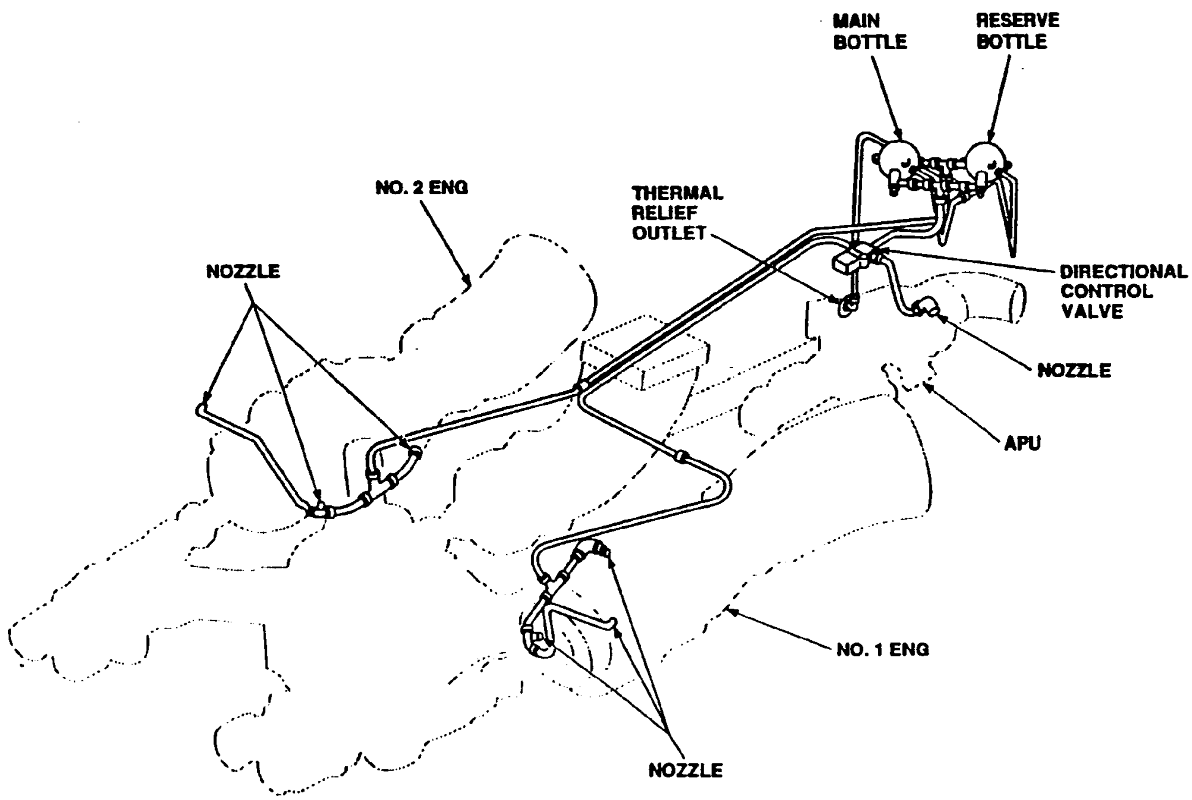


FIGURE A-31. Example of a piping diagram.

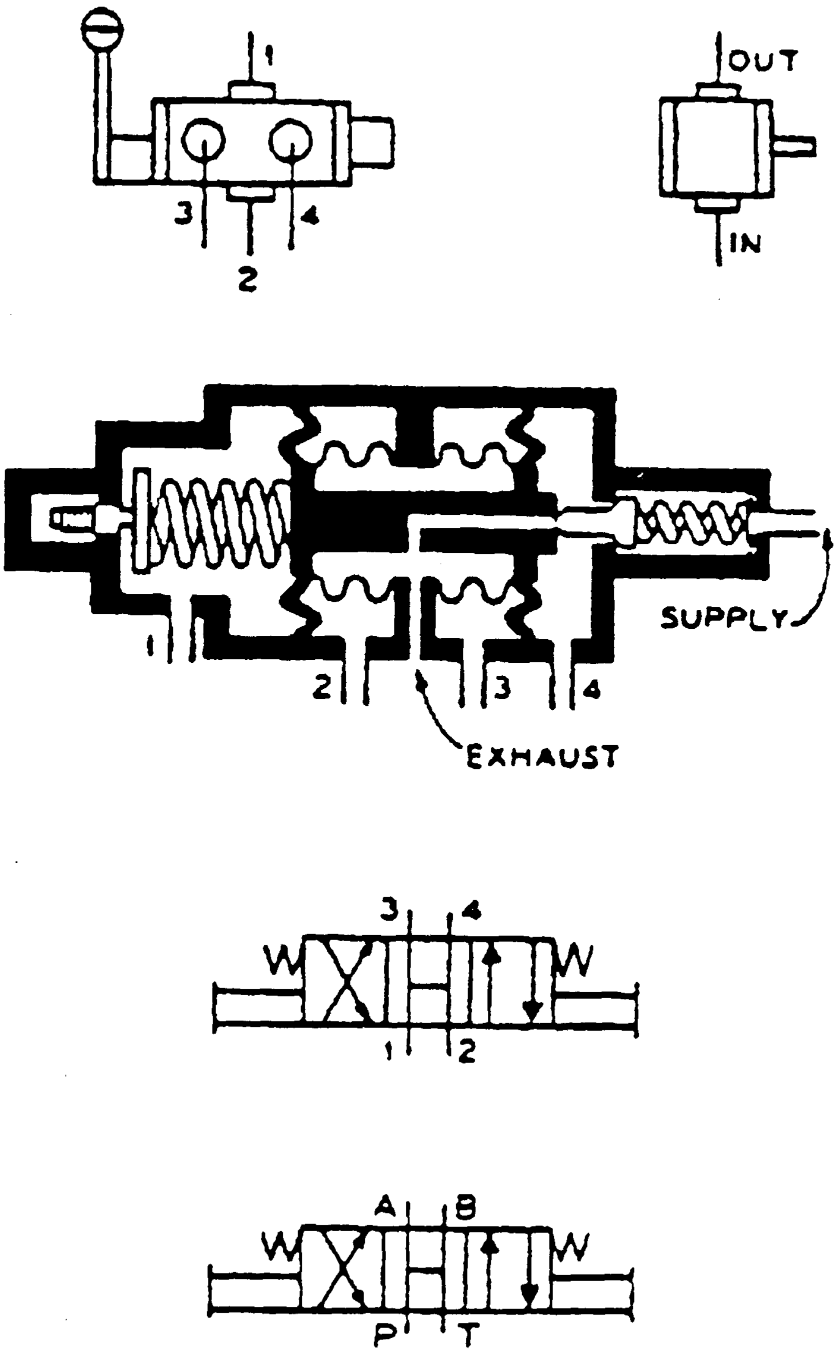


FIGURE A-32. Example of port identification.

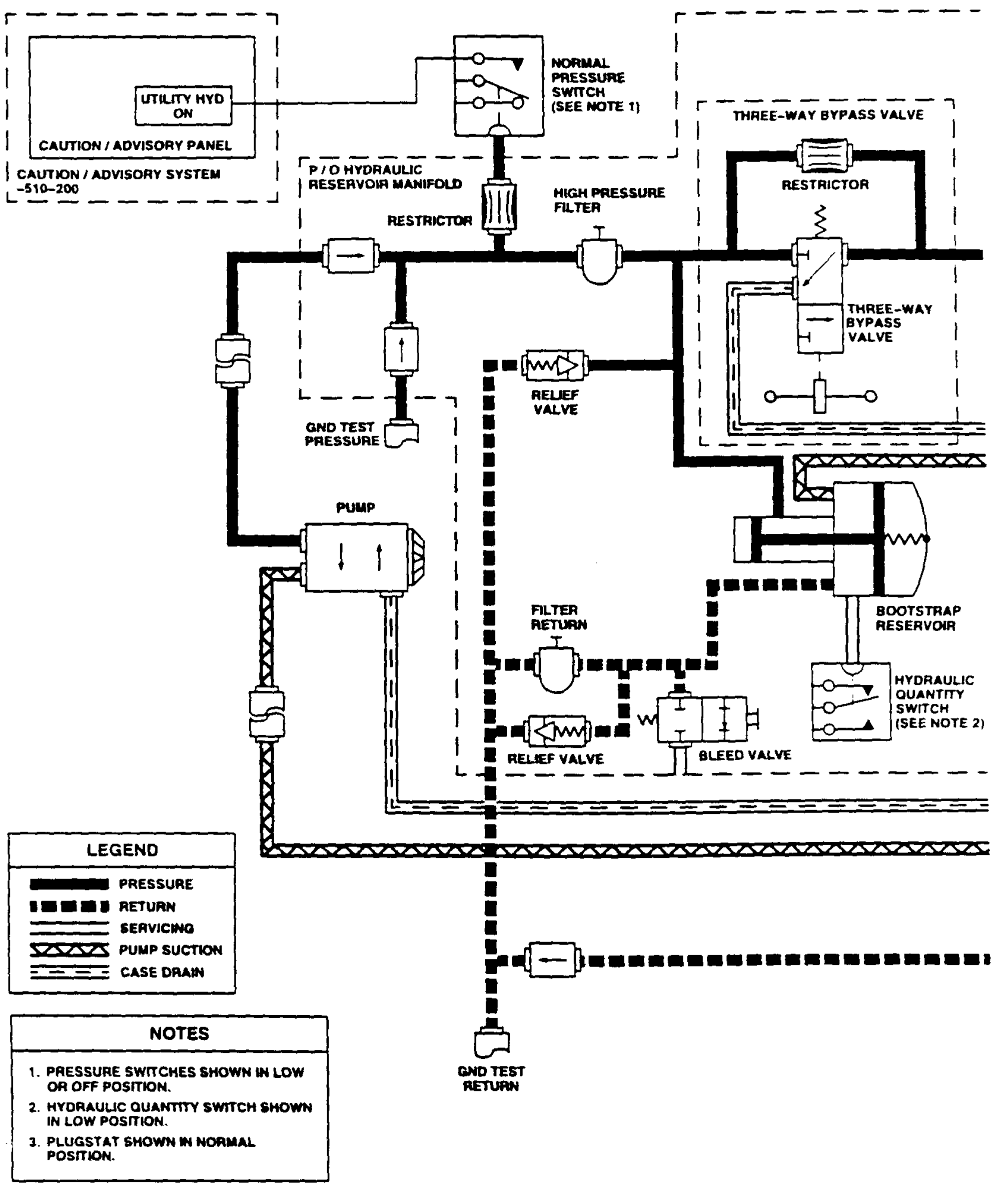


FIGURE A-33. Example of pattern codes.

CONCLUDING MATERIAL

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