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MILITARY SPECIFICATION

MANUALS, TECHNICAL; AIRCRAFT ENGINE INTERMEDIATE AND DEPOT MAINTENANCE, PREPARATION OF (Work Package Concept)

This specification is approved for use within the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE.

1.1 Scope. This specification covers technical manual content requirements for preparation of aircraft engine intermediate and depot maintenance instructions in work package format for uninstalled reciprocating and gas turbine engines, including turbo-prop and turbo-shaft. This specification also covers requirements for an intermediate maintenance manual supplement for the installation, positioning, and identification of external tubing, cabling, clamping and attaching hardware and a Sequence Control Chart (SCC) that graphically depicts accomplishment of complete engine repair.

1.2 Classification. The types of technical manuals covered by this specification shall be intermediate level, depot level, and combination intermediate and depot data as specified in MIL-M-81927. When specified by the requiring activity, a separate illustrated parts breakdown (IPB) shall be included.

2. APPLICABLE DOCUMENTS.

2.1 Government documents.

2.1.1 Specifications. The following specifications form a part of this specification to the extent specified herein. Unless otherwise specified in the contract, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Commanding Officer, Naval Air Engineering Center, Systems Engineering and Standards Department, ATTN: Code 53 (SESD), Lakehurst, NJ 08733-5100 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

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DISTRIBUTION STATEMENT A.

Approved for public release; distribution is unlimited.

MIL-M-81218B(AS)

SPECIFICATIONS

MILITARY

MIL-M-81927	Manuals, Technical; General Style and Format of (Work Package Concept)
MIL-M-81929	Manuals, Technical; Illustrated Parts Breakdown, Preparation (Work Package Concept)
MIL-M-85337	Manuals, Technical; Quality Assurance Program, Requirements for

2.1.2 Other government documents and publications. The following other Government documents and publications form a part of this specification to the extent specified herein. Unless otherwise specified in the contract, the issues shall be those in effect on the date of the solicitation.

NAVY

OPNAVINST 4790.2	Navy Aviation Maintenance Program
MCO P1200.7	Military Occupational Specialties Manual
NAVPERS 18068	Navy Enlisted Manpower and Personnel Classifications and Occupational Standards

(Copies of specifications and other Government documents required by preparing activities in connection with specific procurement functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS.

3.1 General. Technical manuals prepared in accordance with this specification shall be in work package (WP) format meeting the general style and format requirements of MIL-M-81927. The instructions shall consist of procedures for performing intermediate and/or depot level maintenance. Intermediate and depot maintenance will not normally be combined. Requirements of the gas turbine three degree intermediate level maintenance program in accordance with OPNAVINST 4790.2 shall be reflected, as applicable, in intermediate level maintenance procedures.

MIL-M-81218B(AS)

3.2 Format and writing style. General format and writing style shall be in accordance with MIL-M-81927.

3.2.1 Data. Requirements for aircraft engine maintenance data established in this specification shall be prepared as specified in the contract.

3.3 Arrangement. Except when noted for specific application or restricted from use in a specific application, arrangement shall be in accordance with MIL-M-81927. Arrangement of technical content work packages shall normally be as follows:

- a. Description and principles of operation
- b. Standard practices (if applicable)
- c. Engine handling in shipping container/maintenance stand
- d. Preparation for service and storage
- e. Preinduction and mandatory inspection requirements
- f. Preparation for test (pre-test set up)
- g. Engine test
- h. Troubleshooting
- i. Removal and installation of major assemblies/subassemblies
- j. Major assembly/subassembly maintenance (disassembly, cleaning, inspection, repair and assembly of subassemblies)
- k. Engine maintenance (fuel systems, lubrication system, electrical system, bleed air system and other engine systems)
- l. Support equipment maintenance

3.4 Technical content-general. Except where noted for specific application, or restricted from use in a specific application, the following guidelines apply to all maintenance manuals prepared to this specification.

3.4.1 Text. Instructions prepared in accordance with this specification shall follow the approved maintenance plan/logistics support analysis and spare parts provisioning documentation applicable to the engine or equipment covered. Data shall be based on sound engineering principles and techniques, service experience, performance data, and available reliability data. Standard shop practices and techniques contained in general maintenance engineering series manuals shall not be duplicated. When applicable, appropriate reference shall be made to these manuals in accordance with MIL-M-81927.

3.4.2 Maintenance level. Procedures shall be specifically tailored to the level of maintenance to which the manual applies. Intermediate maintenance manuals shall include coverage only to the extent of repair authorized at the intermediate level, and depot maintenance manuals shall contain complete rework instructions. When both intermediate and depot level engine maintenance coverage is specified, depot information normally shall not duplicate intermediate coverage but shall be limited to necessary supplementary depot maintenance information; appropriate reference from the depot manual to the intermediate manual and WP number shall be included.

3.4.2.1 Depot level. Depot level maintenance manuals shall include instructions and procedures that will permit repair of engine sections, modules, subassemblies, and accessories to the authorized depth contained in the maintenance plan. The extent of coverage required in depot level manuals

MIL-M-81218B(AS)

will vary depending on the type of maintenance at the intermediate level. For example, if intermediate level maintenance is performed horizontally and the depot level maintenance is accomplished vertically, an extensive depot manual may be required.

3.4.2.2 Combined intermediate- depot maintenance. Where authorized by the requiring activity, a combined intermediate depot maintenance manual shall be prepared. If the difference between intermediate level procedures and depot level procedures for a particular section, module, subassembly, accessory, or function are minor, the procedures should be covered in the same WP(s). The WP title page(s) shall identify the combined coverage. The procedures applicable to depot level maintenance shall be appropriately identified; the manual introduction shall explain the method of identifying these procedures. If the procedures between the intermediate level and depot level are major, the depot level procedures shall be covered in separate WP'S.

3.4.3 Special processes. Text shall include special processes or procedures required under extreme temperature and humidity conditions within the limits established by the design specification for the equipment covered. Text shall also include direction of rotation (CW/CCW) for torquing/turning with or without a torque adapter (multi-plier) . Left-hand thread bolts must be noted for each usage. When applicable, provisions shall be included for the recoverability of precious metals.

3.4.4 Illustrations and diagrams. Illustrations shall be prepared in accordance with MIL-M-81927. Complex systems shall be illustrated schematically or by block diagrams to the extent necessary for the technician to understand their operation. Cutaway illustrations shall not be prepared unless essential for illustrating the type of function described. Points of adjustment, including measurements, required tolerances, and methods for obtaining measurements, shall appear on illustrations of critical functioning systems requiring adjustment or rigging. Unusual operations such as those used in checking fits, shimming, clearances, and gearlash shall be illustrated when required for clarity.

3.4.4.1 Procedural illustrations. Procedural illustrations supplement the text by clarifying procedures which are complex, of a special nature, or are not obvious; these illustrations shall be included as necessary.

3.4.4.2 Exploded views. (see figure 1.) Exploded views shall be used if required to illustrate disassembly and assembly instructions. If exploded views are prepared, index numbers and a nomenclature list or legend keyed to the index numbers shall be included to identify each part. If the engine cannot be adequately illustrated by a single exploded view, separate subassembly exploded views may be included in sequence. In certain instances, exploded views prepared for the illustrated parts breakdown (IPB) can be used with minor modification. Index numbers will be reassigned to coincide with the procedural text.

3.4.5 Support equipment required. (see figure 2.) Support equipment required to perform maintenance or engine test shall be listed in the WP containing the procedure to which the support equipment applies. Only those tools and equipment authorized for use at the level of maintenance covered

MIL-M-81218B(AS)

shall be listed. If the WP contains multilevel maintenance procedures, and one or more of the support equipment items listed is authorized for use only at one level of maintenance, this application shall be indicated by the use of an asterisk (*) following the nomenclature of the item and an appropriate notation following the list. For example: "* Authorized for use at depot level only." Standard hand tools shall not be listed; however, standard measuring equipment, such as voltmeters and torque wrenches, shall be listed. The support equipment shall be listed by nomenclature in alphabetical sequence, and by type designation or part number under the heading "Support Equipment Required." Illustrations shall not be included in support of such lists, but schematics may be included in support of maintenance procedures, for example, as required to illustrate the fabrication of interconnecting cables or other locally manufactured items of this category.

3.4.5.1 Alternate items. If an approved alternate item can be used, it shall be listed by part number, in parenthesis, immediately following the prime part number. The term "or equivalent" shall not be used to indicate alternate part numbers. The requirement to list alternate part numbers shall not be interpreted to mean that the preparing activity shall perform research to include such alternates. If information on an equivalent item is furnished to the preparing activity for inclusion in the manual, the item shall be listed, as indicated above. A note or statement shall be included to explain the use of parenthesis for identification of alternate items.

3.4.6 Materials required. (see figure 2.) Materials required lists shall be included when consumable materials and expendable items are required to perform work in WP procedures. Materials required lists shall follow the support equipment required list (if applicable) in WP's containing the procedures in which the materials are used, and shall be listed by nomenclature in alphabetical sequence and by specification number or part number. The quantity of items required to accomplish the task shall be in parenthesis following the nomenclature. Materials will always be listed by Government specification numbers unless alternate identification is approved by the requiring activity.

3.5 Technical content-detailed.

3.5.1 Alphabetical index. (see figure 3.) In addition to the requirements of MIL-M-81927, the alphabetical index for intermediate maintenance manuals shall include identification of tasks applicable to each degree of intermediate maintenance. A subheading "Maintenance Allocation" and three columns identified "1st", "2nd", and "3rd" for each degree of intermediate maintenance shall be included under the "Work Package Number" heading. The alphabetical index for depot maintenance manuals shall be in accordance with MIL-M-81927.

3.5.2 Introduction. In addition to the requirements of MIL-M-81927, the introduction shall include the significant differences between models and the method of indicating those differences, if more than one engine model is covered. Only information covering uninstalled aircraft engines shall be included. The introduction shall indicate, when applicable, that the external piping, cabling, and clamping information for the engine is contained in a separate intermediate maintenance manual or supplement. When a separate illustrated parts breakdown (IPB) manual is approved, the introduction shall

MIL-M-81218B(AS)

make reference to the IPB. A historical record of applicable technical directives is required; and a complete list of reference material is also required. A support equipment and materials required list is not required in the introduction, but will be required in separate work packages as applicable.

3.5.2.1 Maintenance allocation. The introduction for an intermediate maintenance manual shall include an explanation of the maintenance allocation heading contained in the alphabetical index. It shall contain a statement that allowable maintenance shall be consistent with spare parts provisioning, support equipment and maintenance site capability and that if these conditions are not met, the engine shall be declared beyond capability of maintenance (BCM) and shall be transferred to a maintenance activity having repair capability in accordance with OPNAVINST 4790.2.

3.5.2.2 Reference material listing. The reference material list shall be prepared in accordance with MIL-M-81927.

3.5.2.3 Historical record of applicable technical directives. The historical record of applicable technical directives shall be prepared in accordance with MIL-M-81927.

3.5.3 Support equipment work package. The consolidated list of support equipment required by MIL-M-81927 shall be a separate work package. The listing shall be tabular with nomenclature identified first in alphabetical sequence and include the part number or type designation, maintenance level and degree, and reference to Wp's in which the support equipment is required. Illustrations of support equipment shall be included for the support equipment that is not adequately illustrated for identification in Wp procedures.

3.5.4 Materials required work package. The consolidated listings of materials required by MIL-M-81927 shall be a separate work package. The consolidated list of materials shall be a tabular listing in two parts.

a. Consumable materials. The consumable materials shall be listed alphabetically by nomenclature, specification or part number, and reference to work package(s) in which used.

b. Expendable materials. The expendable materials shall be listed alphabetically by nomenclature, specification or part number, quantity, and reference to work package(s) in which used.

3.5.5 Description and principles of operation. This coverage, which is used by maintenance personnel to further understanding of the engine, shall include but not be limited to basic engine description, and description of each related system. This information on the engine and its system shall include purpose, type, series, main features, and a table of leading particulars including dimensions, weight, and other basic engine data. If more than one model is covered, the significant differences shall be explained.

3.5.5.1 Principles of operation. A complete explanation of the operation of the engine and its systems shall be included. Basic theory found in text books shall not be included. Information such as cylinder numbering, compressor stages, combustion chamber arrangement, location of major sections,

MIL-M-81218B(AS)

modules, components, and accessories shall be presented. The principles of operation shall consist of functional narrative written to facilitate understanding of the engine systems to the extent necessary to support fault detection and isolation and maintenance of the systems. This text shall describe system operation and the relationship of other systems/components during system integration. Functional block diagrams and schematics shall be used to support the text.

3.5.6 Standard practices. This coverage may be separate work package(s) and shall contain standard cleaning processes, inspection, and repair procedures, plating, welding, and other general information not contained in a separate manual. Practices and procedures that are peculiar to assemblies, subassemblies, components and accessories shall not be included in this coverage. Reference shall be made to the standard practice work package from maintenance work package(s) where applicable.

3.5.7 Engine handling in shipping container/maintenance stand. The WP shall include handling instructions for engine removal from and installation in the shipping container and maintenance stand. The coverage shall also include instructions for transferring an engine to and from a transport trailer and use of a standard Navy rail system.

3.5.8 Preparation for service and storage. These instructions shall include unpacking the engine, depreservation, preoiling, preparation for initial run, preservation, packing, and storage. In addition, this WP shall include the overall dimensions and weight of shipping and storage containers with the engine, engine sections, modules, or components packed in them. Information shall be included for corrosion control in the form of effective prevention, recognition, and elimination procedures. Instructions shall also be included for short-time storage at the intermediate level. Specific instructions shall be included for the engine and equipment concerned and shall not duplicate information provided in general series manuals, which shall be referenced as applicable.

3.5.9 Preinduction and mandatory inspection requirement. Preinduction and mandatory inspection requirements covering any engine inducted at intermediate/depot maintenance level are required as a separate Wp. The WP shall detail inspection/investigation procedures following engine removal after reported defect(s). The depth of inspection/investigation shall depend upon remaining engine life, operational requirements and economic feasibility. Applicable WP'S shall be referenced for details of removal, cleaning, inspection, repair, assembly, installation, and testing. Probable cause/corrective action, and mandatory/recommended maintenance tasks to be taken for correction of engine defects shall be detailed (see figures 4 and 5). Major inspection requirements for complete engine repair shall be identified.

3.5.10 Preparation for test. Setup procedures required to prepare the engine for test shall be included. Reference shall be made to assembly and disassembly procedures in applicable maintenance WP's, when necessary. Instrumentation and fluid, air, and electrical supply requirements shall be included. The applicable test system and engine adapter stand or cell shall be listed as support equipment. Procedures for operation of the test system, description, and location of instrumentation, controls or indicators is to be

MIL-M-81218B(AS)

covered in the test system manual only. This information is not to be duplicated in the engine maintenance manual. Other support equipment required for test setup, such as special adapter assemblies peculiar to the engine being tested and special fittings to be installed in sensing lines for monitoring and test instrumentation shall also be listed if not covered in the engine test system manual. When a special adapter manual or supplement for adaptation of the engine to the stand or cell is available or being prepared, the adapter manual or supplement shall be referenced and only those procedures necessary to insure complete installation and removal instructions shall be included. Operation, installation, description, and location of items such as indicator lights, switches, fuses, and digital meters, are to be included in the adapter assembly maintenance manual and are not to be duplicated in the engine maintenance manual.

3.5.11 Engine test. Complete instructions shall be included covering test requirements at the maintenance level covered in the manual. Test data pertaining to specific testing conditions and instructions required for use of support equipment, if applicable, shall be included. If an engine malfunction should occur, reference shall be made to the troubleshooting work package. Coverage shall include:

- a. Safety precautions
- b. Static test and motoring procedures
- c. Start-up information, operation and shutdown procedures, and emergency shutdown procedures
- d. Operating and test parameters
- e. Level of testing following specific repairs
- f. Functional test
- g. Performance evaluation worksheet
- h. Test schedule
- i. Penalty schedule
- j. Hot preservation requirements

3.5.11.1 Environmental conditions. Allowable engine performance data corrected to standard day atmospheric conditions shall be included.

3.5.11.2 Charts or curves. (see figure 6.) Performance evaluation charts or curves depicting engine operating parameters shall be included. Correction charts shall be included to show correction factors for performance evaluation.

3.5.11.3 Engine operating limits. A table of operating limits shall be included with the following column headings:

Table (number) Engine Operating Limits

Items	Limits	Remarks
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3.5.11 Test schedules and procedures. A description of the sequence and manner of accomplishing a functional or performance evaluation of the engine shall be included. All checks and adjustments shall be described in detail with appropriate references to charts or curves. For performance evaluation, a test schedule shall be presented in tabular form.

MIL-M-81218B(AS)

3.5.11.5 Test requirements. A table shall be included listing the specific test requirements for engines repaired within the scope of the manual. The table shall be prepared with the following column headings:

Table (number) Test Requirements

Parts/Modules Replaced or Repaired	Functional Test	Performance Test	Comments
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3.5.11.6 Penalty applications. A table of penalty applications shall be included outlining the additional testing required for parts reinstalled or replaced following successful completion of a performance run and shall contain the following column headings:

Table (number) Penalty Applications

Nomenclature	Reinstallation Test	Replacement Test	Comments
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A paragraph shall be inserted immediately following the table of penalty applications to read as follows:

"Parts removed to gain access to other parts or areas shall invoke the same penalties, in accordance with the table of penalty applications, as parts replaced to correct deficiencies and malfunctions. In the event that more than one penalty is invoked, the most severe shall apply."

3.5.12 Troubleshooting. Detailed procedures to determine, isolate and remedy performance difficulties on the engine and engine systems shall be included. Specific instructions shall contain special techniques, methods, limits, and instrumentation requirements, as necessary, for effective troubleshooting. Instructions shall also be included for locating and identifying malfunctions caused through interaction of integrated systems. Instructions for setup and use of support equipment including instructions for its operation during troubleshooting shall be included, if applicable. Procedures shall cover not only troubles most likely to occur, but also those of a less frequent and more complex nature. Information shall be arranged in the order of probable occurrence and shall guide the technician, in as practical a manner as possible, to the cause of equipment failure or malfunction and its repair. The sequence of steps required to remove, or repair a component or unit shall be referenced by WP number when such removal or repair is required. Troubleshooting diagrams shall be prepared in accordance with MIL-M-81927. Troubleshooting data shall be supported by functional flow diagrams, schematics and wiring diagrams, as required.

3.5.13 Removal and installation of major assemblies/subassemblies.

3.5.13.1 Removal of major assemblies/subassemblies. These instructions shall include procedures for sequential dismantling of the engine in sections, modules or major assemblies. Instructions shall indicate that care must be exercised to prevent the entrance of dirt and other foreign materials into the engine, and whenever practical, temporary covers should be used to seal all openings in the dismantled engine.

MIL-M-81218B(AS)

3.5.13.2 Installation of major assemblies/subassemblies. Instructions shall cover the final assembly of sections, modules, and major assemblies to form a complete engine prior to performance test. Step by step assembly procedures to check, align and adjust each section, module, assembly or subassembly shall be included. Precautions to be observed and quality assurance requirements shall be included. These instructions shall contain a statement that the assembled engine is to receive a checkout in accordance with applicable test instructions. When a procedure (step) states "if outside of limits go to step x," the procedure shall also direct "go to step y" if within limits.

3.5.14 Major assembly/subassembly maintenance. Maintenance of sections/modules (such as front frame, compressor, and turbine) and major sub-assemblies (such as gearboxes) shall be covered in separate WP's for each section, module, or subassembly. These WP's shall include procedures and illustrations for disassembly, cleaning, inspection, repair, and assembly. Application and operation of support equipment shall be described as they are required during maintenance and illustrated when necessary. Instructions shall specify use of approved corrosion preventive compounds, neutralization, or other protection on parts and components.

3.5.14.1 Disassembly. Instructions shall include sequential procedures for disassembly of sections, modules and subassemblies into component parts. Disassembly of component parts shall be covered only to the extent required for the authorized level of maintenance. Precautions to be observed and critical dimensions to be recorded shall be included.

3.5.14.2 Cleaning. Specific instructions for parts and subassemblies and cleaning methods such as special agents, ultrasonic, and compressed air not covered in general manuals or the standard practices WP shall be included. References to these documents shall be made, as necessary. Precautions to be observed during cleaning shall be specified. Instructions relating to preservation of metal parts and surface treatment after cleaning shall be included.

3.5.14.3 Inspection. (see figure 7.) Procedures shall include the required inspection methods, support equipment, and instructions for inspection of engine parts within the scope of the applicable level of maintenance. Inspection instructions shall encompass: failure, wear, damage, corrosion, leakage, aging, burning, malfunctioning, deformation, and deterioration that can be expected to occur during service of the engine. Allowable service limits and adequate standards for determining when parts should be repaired or replaced shall be included. Illustrations shall be prepared whenever necessary to augment inspection tables and shall be (index) numbered to correlate table(s) to figure(s). Procedures shall be included for performing special inspections required when the engine has operated beyond permissible limits, such as overspeed, overtemperature, or sudden stop. Requirements for special inspection by nondestructive methods shall be specified.

3.5.14.4 Repair. Comprehensive instructions shall be included for necessary repair to restore the engine section, module, or major subassembly to a completely satisfactory condition. Repair methods shall be specified for the correction of all deficiencies and conditions considered repairable within the scope of the level of maintenance to which the manual applies. Specific data shall be included to adequately describe repairs, including material specifications for metals when pertinent to making repairs.

MIL-M-81218B(AS)

3.5.14.5 Assembly. These instructions shall cover assembly of component parts into subassemblies, sections, and modules. The use of required corrosion-preventive methods, special lubricants, gasket pastes, and other such applications shall be specified. Location of piping and cabling shall be provided. Peculiar lockwiring methods and locking devices shall be emphasized. Testing requirements and methods shall be included for in-work progress testing of subassemblies during repair and assemble. Precautions to be observed, and quality assurance requirements shall be included. As required, a calculation worksheet shall be provided identifying critical dimensions to be recorded (see figure 8) . For Service Life Limited Items, the location of part number and serial number, by specific life limited part, must be indicated (see figure 9). When a procedure (step) states "if outside of limits go to step x," the procedure shall also direct "go to step y" if within limits.

3.5.14.5.1 Dimensional limits and torque values. Coverage shall include limits to be used for determining and maintaining proper relationship between mating parts in any particular assembly. These limits shall include all such data as clearances, gearlash, and endplay. Illustrations (see figure 10) shall be prepared when necessary. When such illustrations are used they shall include reference numbers and tabulation of the limits instead of the data appearing in the text. Reference numbers on the illustrations shall have leaders to the points of clearance, gearlash, or endplay and shall be listed in numerical order. Torque values shall be called out in the text where utilized and shall be noted as a Quality Assurance procedure/step.

3.5.14.6 Local manufacture items. Information required for the fabrication of items source coded "local manufacture" (MF, MG, MH) shall be included unless the manufacture of the item is obvious. Only those items listed in the applicable IPB shall be considered. The data shall include identification of material required.

3.5.15 Engine Maintenance. WP's shall be prepared for each engine system (such as fuel, lubrication, and electrical) accessory. Procedures for removing and installing the accessories from/to an assembled basic engine shall be included. The coverage shall include instructions for inspection, lubrication, adjustment, testing, troubleshooting, and minor repair. For accessories having separate maintenance manuals, reference shall be made to applicable manual numbers and titles.

3.5.16 Support equipment maintenance. When separate support equipment maintenance manuals or maintenance requirements cards (MRC) are not procured for peculiar support equipment furnished by the preparing activity, maintenance instructions for such equipment shall be included in a separate WP. Instructions for required fabrication of peculiar tools, when such fabrication is approved by the requiring activity, shall be included. Concise step-by-step procedures shall be included for proper care and fabrication of support equipment while in and out of service. These procedures shall cover instructions for storage, preventive maintenance, lubrication, operating checks and adjustments. End items of support equipment coded as technically non-repairable shall be included but, shall be supported by an illustration and parts list only.

3.5.17 Illustrated parts breakdown. Unless otherwise specified, separate IPB manuals shall be prepared (see 6.2.1). The IPB for the engine, its

MIL-M-81218B(AS)

sections, modules, subassemblies, accessories, and support equipment shall be prepared in accordance with MIL-M-81929. When prepared as part of the WP, the IPB shall follow the maintenance instructions to which it applies. When prepared as a separate WP, the IPB shall follow the maintenance WP to which it applies. When the IPB is prepared as a separate manual, it shall cover both intermediate and depot level.

3.6 External tubing, cabling and clamping intermediate maintenance manual supplement. When specified in the contract, (see 6.2.1), an intermediate maintenance manual supplement shall be prepared. This coverage shall contain necessary information for the proper installation, positioning and identification of external tubing, cables, clamping and attaching hardware. The alphabetical index of each technical content WP shall include, in addition to paragraph heading, all figures contained in the WP. The technical content WP's shall be arranged as follows:

- a. Bracket installation
- b. External components
- c. Tubing, cabling and clamping installation
- d. Critical clearances

3.6.1 Numerical index. (see figure 11.) A numerical index of external parts by part number, cross referenced to their installation sequence number shall be prepared. This index identified as WPO01 01 shall follow the alphabetical index.

3.6.2 Bracket installation. (see figure 12.) Illustrations shall be prepared identifying the engine flanges and views of each flange that brackets are secured to. Flange identification and view direction, spacer size and location, bracket part numbers, angle location and direction, bolt head direction, and torque values shall be provided.

3.6.3 External components. This coverage shall indicate what external components, such as, gearboxes, pumps, valves, and controls, must be installed prior to installation of tubing and cables. Reference shall be made to the applicable maintenance WP's.

3.6.4 External tubing, cabling and clamping installation. (see figure 13.) Illustration of the sides, top, and bottom views of the engine showing all tubing, cabling, clamping and attaching hardware as it would appear when properly and completely installed shall be prepared. These illustrations shall be drawn as foldouts and to a scale that assures the external configuration is legible. All foldout illustrations shall be prepared as right hand pages in accordance with MIL-M-81927. Circled numbers shall reflect installation sequence of each external part. The sequence number, part number, nomenclature, and zone figure for detailed installation data shall be prepared in tabular form as indicated on figure 13. Critical clearance items shall be identified.

3.6.4.1 Zone references. An illustration depicting the engine zones shall be prepared as shown on figure 13.

MIL-M-81218B(AS)

3.6.4.2 Zone detail views. A detailed view of each engine zone shall be prepared as shown on figure 13. These zone detail figures shall contain complete information necessary to install all external parts and attaching hardware. A key (figure 13) shall be prepared for each detail view.

3.6.5 Critical clearances. (see figure 14.) This coverage shall illustrate the specific critical clearance areas and identify the minimum allowable measurement that is required to ensure sufficient clearance exists in those areas.

3.7 Sequence control chart. (see figure 15.) When specified in the contract (see 6.2.1), a sequence control chart (SCC) shall be prepared. The SCC shall be a graphic presentation that will program the accomplishment of complete engine repair (CER) in a logical order. The presentation shall contain the major CER tasks and their required sequence, oriented to actual work time and manpower utilization.

3.7.1 Format. Format of the SCC is illustrated on figure 15.

3.7.1.1 Image area. The image area of the SCC shall be 17 inches high by 50 inches long.

3.7.1.2 Upper portion. The upper portion of the SCC shall contain the following:

a. Table including identification of crew members, their rating (RTG), Military Occupational Specialty (MOS), and applicable WP's.

(1) Crew member no. - Number assigned to each specialist (no. 1 is normally the crew leader) .

(2) RTG/MOS - The type of rating and MOS shall be determined in accordance with NAVPERS 18068 and MCO P1200.7.

(3) Applicable WP's - The WP numbers of tasks assigned to each specialist. The WP's are in the engine intermediate maintenance manual.

b. Work Area Chart - An illustration of the engine with a breakdown of work areas numbered and identified in a legend.

c. Title block (centered) with notation that chart is to be used with applicable work packages (WP's) in engine intermediate maintenance manual and other applicable technical manuals (corresponding MRC's and tubing, piping and clamping manual supplement) .

d. Table with blocks for job numbers, times and dates for four engines.

e. Publication number, date and supersedure notice, when applicable.

3.7.1.3 Middle portion. Blocks in the middle portion of the SCC shall be arranged to identify specific tasks in the logical sequence of accomplishment. The block width shall be lined up with the time brackets in the lower portion. The task title and number shall be the same as the intermediate maintenance

MIL-M-81218B(AS)

manual. The WP number shall be placed in the upper right hand corner of each block. The work area number(s) shall be located in the lower right hand corner. WP's which contain major engine inspection requirements shall be identified by placing an asterisk before the WP number. Task assignments to specific crew members shall be shown at the left. Identification of the major engine inspection asterisk shall be shown.

3.7.1.4 Lower portion. A graph coordinate for TIME shall be divided into equal vertical increments of one hour, and each hourly increment shall be subdivided in six equal parts rated at ten minutes each. The graph shall display the total clock hours required to process the engine and individual tasks. In addition, the time allowed each crew member to accomplish specific tasks will permit a computation of manhours per task. If task time is excessive and could cause the length of the SCC to exceed 52 inches, a reduction of areas used to reflect time shall be made by grouping large individual time lapses of more than two hours into smaller increments. The tasks shall be listed by WP number in parentheses with the left parenthesis located at the time the task will begin and the right parenthesis at the time the task will be completed. Blocks for engine identification number and supervisor and crew member number shall be included at the left of the lower portion. The lower portion shall include provisions that will permit tracking and recording of four engines.

3.7.2 Type size. Type size shall be as shown on figure 15.

3.7.3 Paper stock. The SCC shall be printed on white 50 pound paper.

3.7.4 Folded dimension. The SCC shall be folded accordion style to approximately 7 1/2 x 12 inches, and so folded that the publication number will be visible.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the preparing activity is responsible for performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the preparing activity may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements. (see 6.2.1).

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the preparing activity's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the preparing activity of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

MIL-M-81928B(AS)

4.2 In-process review, validation and verification. In-process reviews, validation and verification of technical manuals shall be as directed by the requiring activity and in accordance with MIL-M-85337.

5. PACKAGING.

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-M-81927.

6. NOTES.

6.1 Intended use. Technical manuals prepared in accordance with this specification are intended for use by maintenance personnel in performing intermediate and depot level maintenance of uninstalled aircraft engines.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Whether a combined maintenance manual with IPB is required (see 3.5.17) .
- c. Whether an external tubing, cabling and clamping manual supplement is required (see 3.6) .
- d. Whether a sequence control chart is required (see 3.7) .
- e. Quality assurance provisions (see 4).

6.3 Definitions.

6.3.1 Requiring activity. The organization of a using military service or that organization delegated by a using service, which is responsible for the selection of and determination of requirements for a specific support element.

6.4 Figures contained in this specification. The figures contained in this specification are intended to illustrate methods of technical data presentation. They shall not be interpreted as limiting the technical content requirements that are established by the text matter to which the figures apply.

6.5 Subject term (key word) listing.

- aircraft engine maintenance
- external tubing, cabling and clamping
- illustrated parts breakdown
- military specification
- sequence control chart

MIL-M-81218B(AS)

6.6 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy-AS
(Project TMSS NO 214)

MIL-M-81218B (AS)

A1-720XX-MMI-000

015 00

Page 7

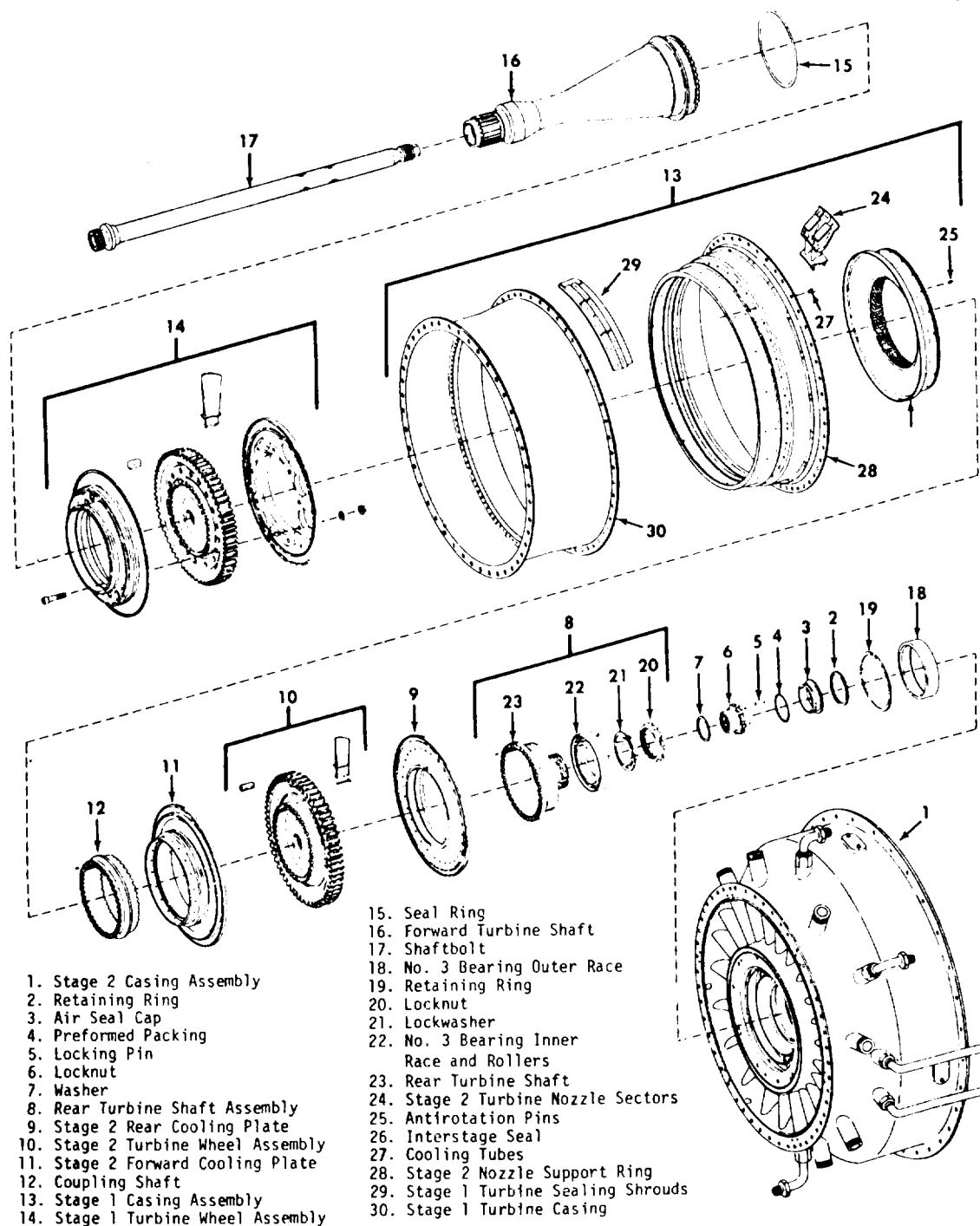


Figure 2. Gas Generator Turbine Section

FIGURE 1. Example of an exploded view.

A1-720XX-MMI-XXX**017 00**

Page 8

5. COMPRESSOR FRONT CASING ASSEMBLY.**Support Equipment Required**

Nomenclature	Type Designation/ Part Number	CAGE
Adapter	1C3914	XXXXXX
Fixture	1C4971	XXXXXX
Holder	1C5479	XXXXXX
Wrench	1C2717	XXXXXX

Materials Required

Nomenclature	Specification No./ Part Number
Anti-Seize Compound	MIL-C-25681
Cotterpin (30)	MS9245-30
Cotterpin (40)	MS9245-88
Lockwire	MS2099NC32
Sealant	MIL-S-27276
Trichloroethane	MIL-T-81533

CAUTION

The upper and lower casing halves are matched parts. Replace both halves if replacement of either is necessary.

- a. Place casing on work table front down.

- b. Install bushings, spacers and lower arms on vanes, stages 5 and 6 as follows:

(1) Assemble a plastic bushing in the tang end of stage 5 and 6 vanes. Assemble vanes stage 5 and 6 to casing (figure 8).

NOTE

The spacers that seat against the casing are available in four thicknesses and are colored for identification; the thinnest spacers are blue, then gray, red and the thickest green.

(2) Install adapter, 1C3914. Hold vanes with holder, 1C5479. Torque adapter to 55-65 inch pounds. Remove holder.

(3) Wear in vane bushings until frictional drag is 4 to 8 inch pounds.

(4) Remove adapter and apply compound, MIL-C-25681, to vane threads. Install lever arm to vane and secure with locknut finger tight. Complete all 5th and 6th stage vanes.

NOTE

Use offset lever arm on first vane each side of split line. Make certain sleeve on nut enters hole in lever arm.

FIGURE 2. Example of support equipment required and materials required lists.

MIL-M-81218B(AS)

A1-720XX-MMI-XXX

15 June 1979

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Page 1

ALPHABETICAL INDEX
AND
MAINTENANCE ALLOCATION
INTERMEDIATE MAINTENANCE
JXX-XXX AIRCRAFT ENGINE

<u>Title</u>	<u>1st</u>	<u>WP Number</u>	
		<u>Maintenance Allocation</u>	<u>2nd</u>
			<u>3rd</u>
Afterburner	046 00	046 00	046 00
Assembly	046 00	046 00	046 00
Disassembly	046 00	046 00	046 00
Installation	019 00	019 00	019 00
Removal	019 00	019 00	019 00
Anti-icing Indicator	073 00	073 00	073 00
Anti-icing Valve	074 00	074 00	074 00
By-pass Indicator			
Consumable Materials	002 00	002 00	002 00
Combustion Liners			
Assembly	053 00	053 00	053 00
Cleaning	053 00	053 00	053 00
Disassembly	053 00	053 00	053 00
Installation	029 00	029 00	029 00
Removal	029 00	029 00	029 00
Compressor Section			
Assembly	056 00	—	—
Disassembly	056 00	—	—
Installation	038 00	—	—
Removal	038 00	—	—
Compressor Rotor			
Cleaning	060 00	—	—
Inspection	060 00	—	—
Installation	042 00	—	—
Removal	042 00	—	—
Repair	060 00	—	—
Drain Manifold	066 00	066 00	066 00
Engine Performance	014 00	014 00	014 00
Engine Preservation	007 00	007 00	007 00

FIGURE 3. Example of an alphabetical index.

MIL-M-81218B (AS)

TABLE 1. PROBABLE CAUSES OF AND CORRECTIVE ACTION FOR REPORTED/CONFIRMED DEFECTS

Reported/Confirmed Defects	Probable Cause	Corrective Action
1. LP compressor, foreign object damage (FOD)/ native object damage (NOD)	a. FOD: ingestion of harmful material (stones, gravel, birds etc.) into engine	Perform maintenance tasks in table 2 as required to correct defect
	b. NOD: broken engine components (blade, disk, nut, bolt, bearing failure etc.)	
2. HP compressor FOD/NOD (rotor replacement not required)	a. FOD: ingestion of harmful material (stones, gravel, birds etc.) into engine	Perform maintenance tasks in table 2 as required to correct defect
	b. NOD: broken engine components (blade, disk, nut, bolt, bearing failure etc.)	
3. HP compressor FOD/NOD (rotor replacement required)	a. FOD: ingestion of harmful material (stones, gravel, birds etc.) into engine	Perform maintenance tasks in table 2 as required to correct defect
	b. NOD: broken engine components (blade, disk, nut, bolt, bearing failure etc.)	
4. HP/LP turbine NOD	Broken engine components, (blade, disk, nut, bolt, bearing failure etc.)	Perform maintenance tasks in table 2 as required to correct defect
5. Engine overtemperature	a. Hot stagnated engine start on the ground or in the air	Perform maintenance tasks in table 2 as required to correct defect
	b. Unscheduled overfuelling during flight or ground running	

FIGURE 4. Example of probable cause/corrective table.

MIL-M-81218B(AS)

A1-F402A-MMI-210

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TABLE 2. MANDATORY/RECOMMENDED MAINTENANCE TASKS

TASK No.	TASK	WORK PACKAGE	COMPLETE ENGINE REPAIR (CER)	LP COMPRESSOR FOD/NOD	HP COMPRESSOR FOD/NOD (Rotor replacement not required)	HP COMPRESSOR FOD/NOD (Rotor replacement required)	HP/LP TURBINE NOD	ENGINE OVERTEMPERATURE	LOW HOVER PERFORMANCE (High JPT/low thrust)
1.	Inspect engine externally for cracks, corrosion, fretting, oil leaks, fuel leaks, general condition, hose pressure dates and missing components; use visual (white-light) method (WP007 00) of inspection. Record all defects and determine corrective action to be performed.		X	X	X	X	X	X	X
2.	Inspect LP compressor internally (as far as possible) for general damage. If damage is found perform tasks listed under LP COMPRESSOR FOD/NOD.				X				X
	<div style="border: 1px solid black; padding: 5px; text-align: center;">WARNING</div> <p>Exercise extreme care when turning the rotor; the small clearances and considerable momentum could cause injury to personnel or damage to equipment.</p> <p>Hand-turn LP compressor rotor assembly using hand-turning gear; be sure that rotor is not binding and listen for abnormal noises. If either, or both of these conditions exist, perform tasks listed under LP COMPRESSOR ROTOR SHAFT ASSEMBLY BINDING FAST RUNDOWN TIMES.</p> <p>Rotate HP compressor rotor assembly using hand-turning gear; be sure that rotor is not binding and listen for abnormal noises. If either, or both of these conditions exist, perform tasks listed under HP COMPRESSOR ROTOR BALANCED REPAIRABLE ASSEMBLY BINDING FAST RUNDOWN TIMES.</p>		X						X
		04200	X						X

FIGURE 5. Example of mandatory/recommended maintenance tasks table.

MIL-M-81218B(AS)

A1-720XX-MMI-000

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Page 22

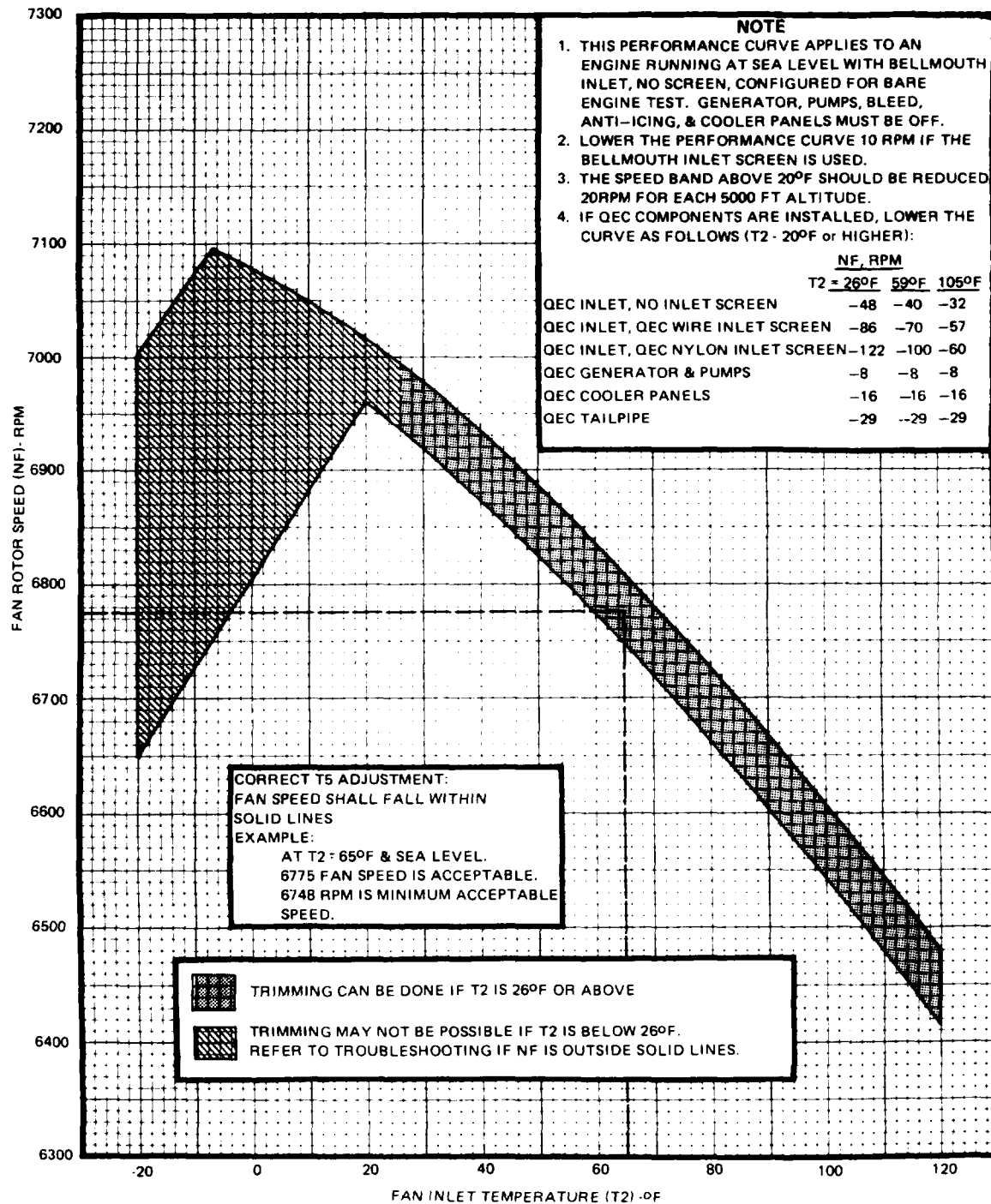


FIGURE 6. Example of an engine performance curve.

A1-F402A-MMI-200**068 00****Page 9****TABLE 2. INSPECTION OF BUSHINGS**

Inspect	Max. Serviceable Limits	Max. Repairable Limits	Corrective Action
1. 1st stage bushings for:			
a. Wear			
(1) Wall thickness	0.0555 in. min thickness	Not repairable	Replace bushing
(2) Outside diameter	0.622 in. min dia	Not repairable	Replace bushing
2. 2nd stage bushing for:			
a. Wear			
(1) Wall thickness	0.056 in. min thickness	Not repairable	Replace bushing
3. 3rd stage bushings for:			
a. Wear			
(1) Flange thickness	0.050 in. min thickness	Not repairable	Replace bushing
(2) Wall thickness	0.055 in. min thickness	Not repairable	Replace bushing
(3) Outer diameter	0.499 in. min dia	Not repairable	Replace bushing
(4) Bore diameter	Up to 0.389 in. dia	Not repairable	Replace bushing
b. Damage (other than detailed in this table)	Not serviceable	Not repairable	Replace bushing

FIGURE 7. Example of inspection procedures.

MIL-M-81218B(AS)

A1-F402A-MMI-200

Change 1

019 00**Page 9**

ENGINE S/N :

ENGINE MODEL NO : F402-RR-404A

BUILD DATE :

BUILD ACTIVITY :

LP COMPRESSOR SECTION

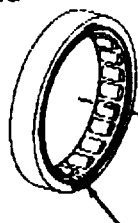
WORK PACKAGE	DIMENSION / CLEARANCE	LIMIT (INCHES)	RECORD
129 00	BLADE TIP CLEARANCE LPC3 / LPC CASE	0.060 MIN.	
129 00	LPC2 VANES		
	DIMENSION A	20.290 MIN.	
	DIMENSION B	20.420 MAX.	
129 00	BLADE TIP CLEARANCE LPC2 / LPC CASE	0.080 MIN.	
129 00	LPC1 VANES		
	DIMENSION A	16.908 MIN.	
	DIMENSION B	17.052 MAX.	
129 00	BLADE TIP CLEARANCE LPC1 / LPC CASE	0.135 MIN.	

BR 23424B/404A

FIGURE 8. Example of dimension calculation work-sheet.

MIL-M-81218B(AS)

BEARING OUTER RING



PART NUMBER
AND
SERIAL NUMBER

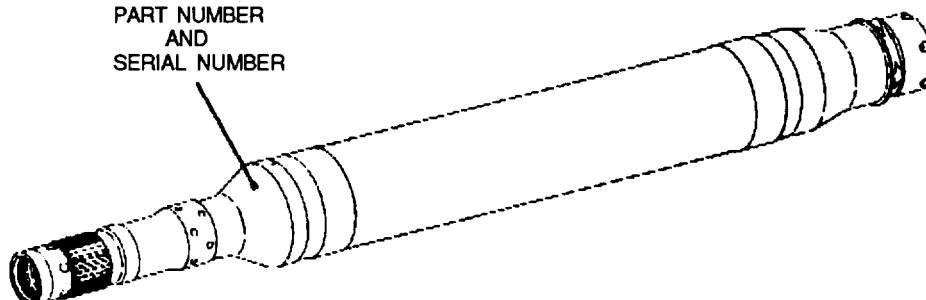
BEARING INNER RING



PART NUMBER
AND
SERIAL NUMBER

NO. 4 CYLINDRICAL ROLLER BEARING

PART NUMBER
AND
SERIAL NUMBER



FAN DRIVE SHAFT ASSEMBLY

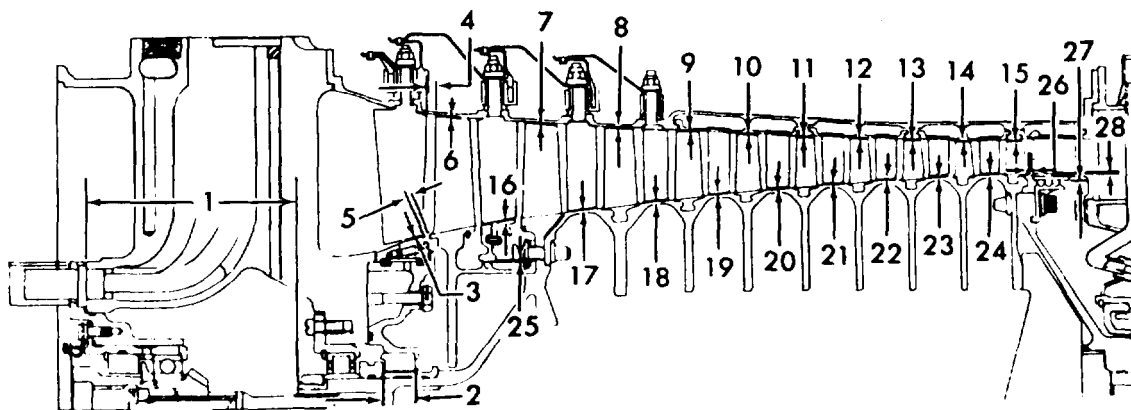
FA-U-5-2127-1

FIGURE 9. Example of location of part number and serial number for service life limited items.

MIL-M-81218B (AS)

A1-720XX-MMI-100**015 00**

Page 16



No.	Description	Min.	Max.
1	Front Frame - Rotor Shaft	15.637	15.662
2	Front Main Bearing - Rotor Seal	1.328	1.357
3	Stator Vane Tip - Rotor Spool	0.021	0.032
4	Stator Vane Platform - Rotor Blade Tip	0.535	0.561
5	Stator Vane Tip - Rotor Blade Platform	0.225	0.250
6	Stator Casing - Stage 1 Rotor Blade	0.021	0.032
7	Stator Casing - Stage 2 Rotor Blade	0.021	0.029
8	Stator Casing - Stage 3 Rotor Blade	0.015	0.025
9	Stator Casing - Stage 4 Rotor Blade	0.014	0.026
10	Stator Casing - Stage 5 Rotor Blade	0.014	0.025
11	Stator Casing - Stage 6 Rotor Blade	0.013	0.022
12	Stator Casing - Stage 7 Rotor Blade	0.013	0.022
13	Stator Casing - Stage 8 Rotor Blade	0.013	0.022
14	Stator Casing - Stage 9 Rotor Blade	0.013	0.024
15	Stator Casing - Stage 10 Rotor Blade	0.013	0.022
16	Stage 1 Stator Vane - Shroud	0.004	0.017
17	Stage 2 Stator Vane - Rotor Spool	0.013	0.026
18	Stage 3 Stator Vane - Rotor Spool	0.013	0.023
19	Stage 4 Stator Vane - Rotor Spool	0.013	0.023
20	Stage 5 Stator Vane - Rotor Spool	0.013	0.023
21	Stage 6 Stator Vane - Rotor Spool	0.013	0.023
22	Stage 7 Stator Vane - Rotor Spool	0.013	0.023
23	Stage 8 Stator Vane - Rotor Spool	0.013	0.022
24	Stage 9 Stator Vane - Rotor Spool	0.013	0.022
26	Stage 10 Rotor Blade - Seal Ring	0.061	0.095

FIGURE 10. Example of dimensional limits.

A1-720XX-MMI-000

15 June 1979

001 01

Page 1

**INTERMEDIATE MAINTENANCE SUPPLEMENT
NUMERICAL INDEX OF PART NUMBERS TO SEQUENCE
F424 - W - 406 AIRCRAFT ENGINE**

1. INTRODUCTION.

2. This work package contains the numerical index of external engine parts by part number, cross

referenced to their installation sequence number. Once an installation number is known, refer to WP005 00 to locate part and figure keys to locate applicable zone (s) for installation information.

PN	Sequence	PN	Sequence
659561	(42)	672491	(139)
659563	(110)	672493	(138)
659564	(5)	675755	(54)
659566	(43)	675757	(53)
659567	(10)	676007	(46)
659575	(57)	676962	(91)
659585	(7)	677672	(67)
659590	(61)	678943	(27)
661397	(102)	678945	(38)
661399	(100)	678948	(115)
661459	(92)	679047	(20)
661617	(116)	679799	(129)
661622	(79)	679804	(130)
661645	(72)	679806	(131)

FIGURE 11. Example of a numerical index.

MIL-M-81218B(AS)

A1-720XX-MMI-100

003 00

Page 2

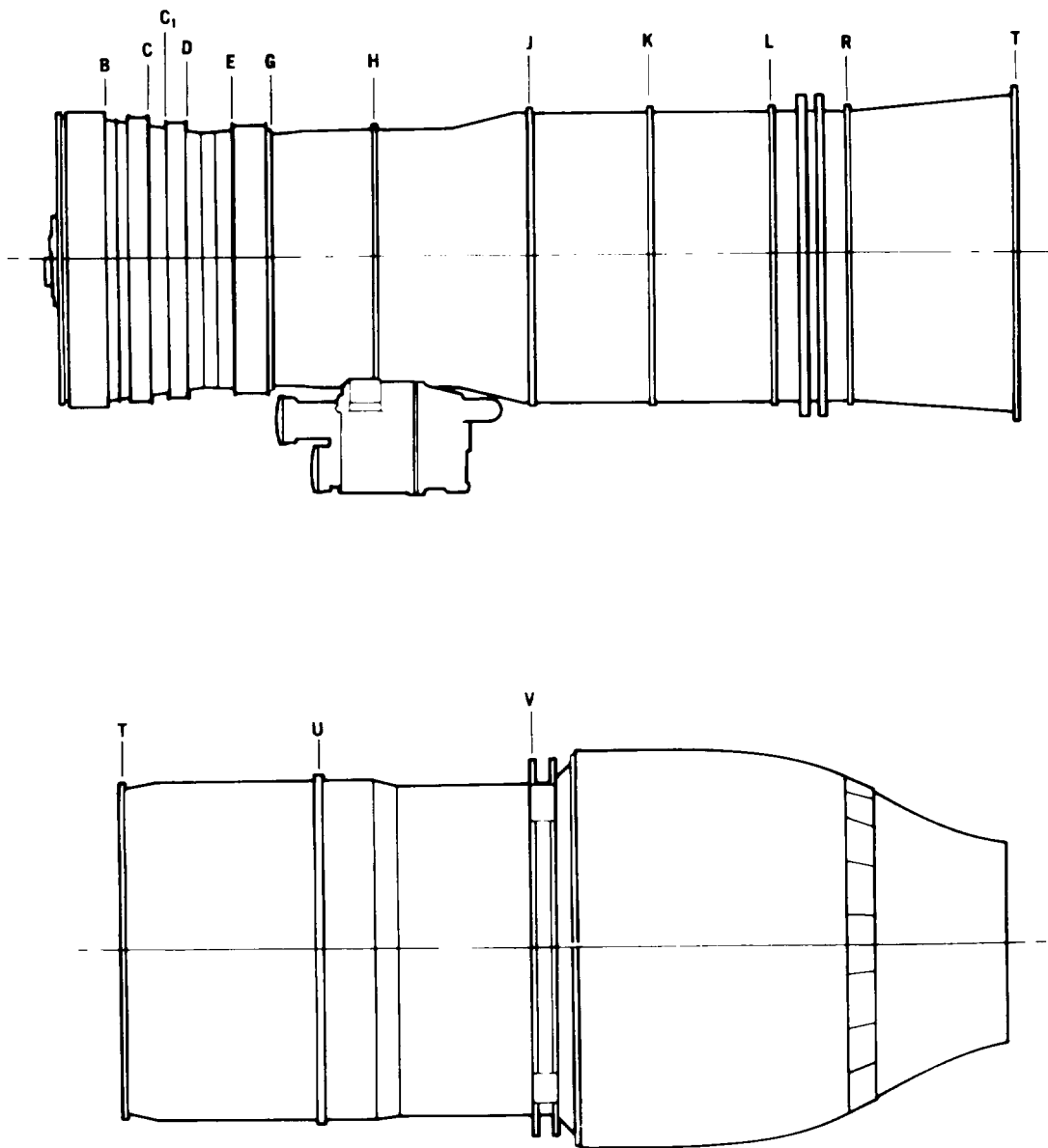
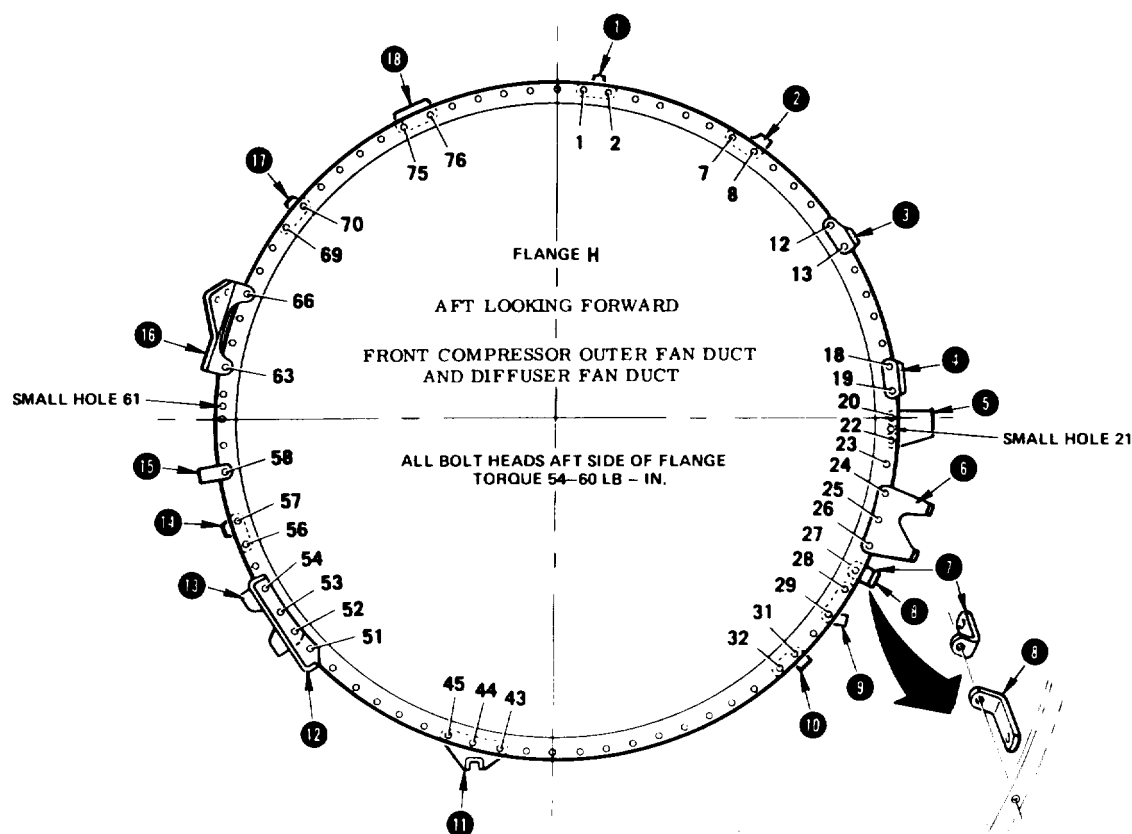


FIGURE 12. Example of bracket installation.

MIL-M-81218B (AS)

A1-720XX-MMI-100**003 00**

Page 3



Bracket Item	Part Number	Angle Direction	Remarks	Bracket Item	Part Number	Angle Direction	Remarks
1	675075	FWD		10	569761	FWD	564723 bolt, holes 31, 32
2	675076	FWD		11	569760		569749 bolt, holes 43, 45 569754 bolt, hole 44.
3	675077	AFT		12	569758	AFT	564723 bolt holes 51, 52, 53, 54
4	569768	AFT		13	569755	FWD	
5	675765	FWD	564717 bolt, holes 20, 22	14	675075	FWD	564717 bolt, holes 56, 57
6	665339	AFT	564717 bolt, holes 24, 25, 26	15	MS9601-367	FWD	564717 bolt, hole 58
7	444540	FWD	569765 bolt, hole 27	16	715034	AFT	
8	569765	AFT		17	675067	FWD	
9	679442	FWD	564717 bolt, holes 28, 29	18	675068	FWD	641231 nut clip on bracket

NOTE a. Use 572212 bolt and 489162 nut in hole 21 right side and hole 61 left side.
b. Use 567192 bolts unless otherwise noted
c. Use 564706 nuts unless otherwise noted

FIGURE 12. Example of bracket installation. - Continued

MIL-M-81218B(AS)

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A1-720XX-MMI-100

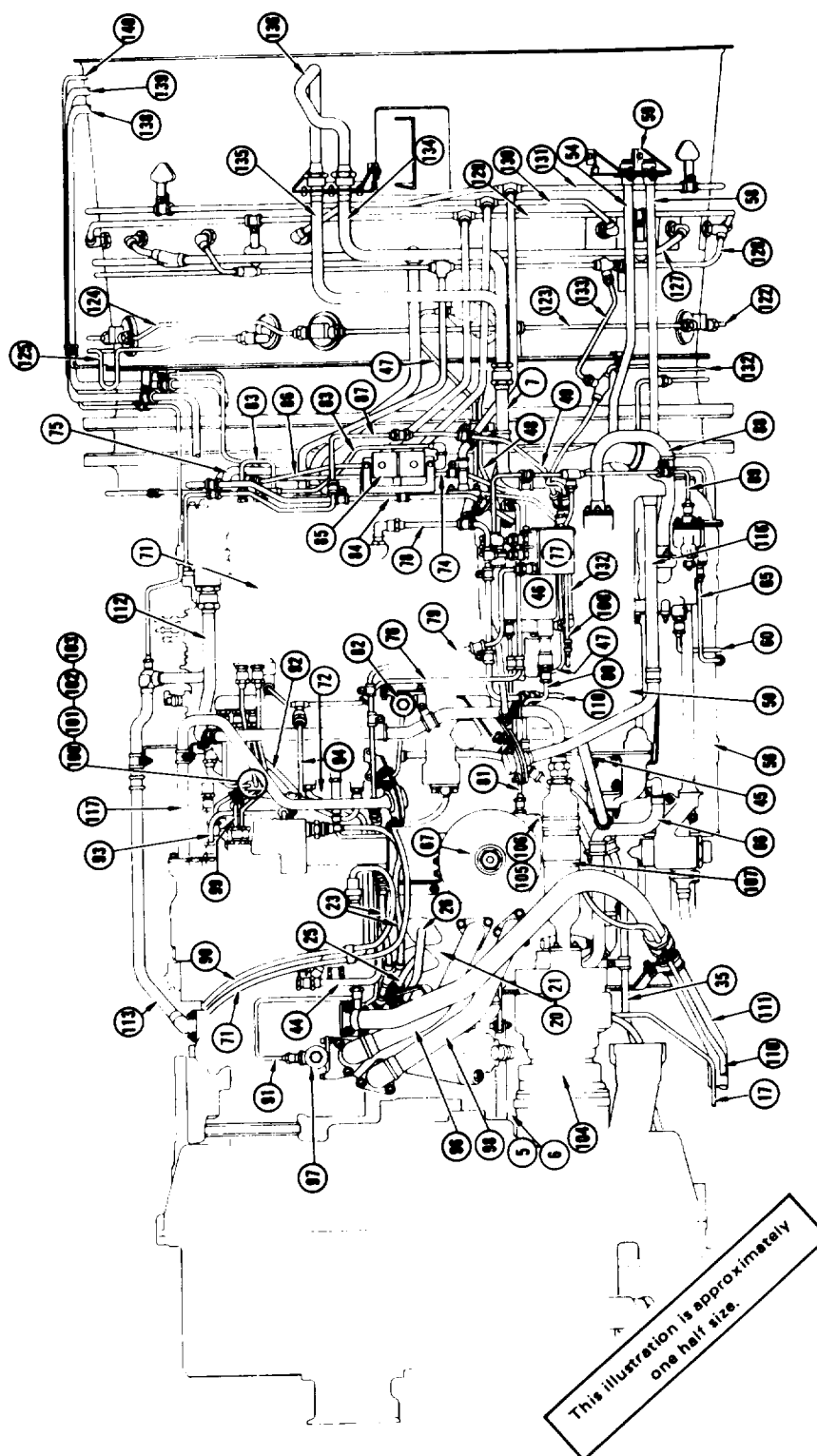


Figure 3. Engine Bottom View

FIGURE 13. Example of external tubing, cabling, and clamping installation.

MIL-M-81218B(AS)

A1-720XX-MMI-100**005 00**

Page 5

Key to figure 1 (continued)

Sequence	PN	Nomenclature	Zone Figures
(124)	585543	Left P _t 7 tube lower (rear P _t 7/T _t 7 junctions)	15, 16, 26
(125)	585547	P _t 7 manifold (P _t 7 forward system)	15, 16, 17, 23
(126)	628189	No. 6 bearing oil pressure tube	17, 22, 23
(127) ★	679809	AB manifold, Zone 4	15, 16, 17, 22
(128) ★	{ 679828 731434 }	AB manifold, Zone 1 }	16, 17, 22, 26
(129) ★	679799	AB manifold, Zone 2	16, 17, 23
(130) ★	679804	AB manifold, Zone 3	22, 23, 26
(131) ★	679806	AB manifold, Zone 5	17, 22, 23
(132)	728048	AB sensing manifold	15, 22
(134)	666382	Airframe oil cooler tube (upper right)	15, 22, 23
(135)	666385	Airframe oil cooler tube (lower left)	26
(136)	618171	Airframe oil cooler bypass tube	15, 16, 17
(137)	648233	P _t 7 tube (to ENC)	15, 16, 17, 26
(138)	672493	AB nozzle open tube	22, 26
(139)	672491	AB nozzle close tube	17, 23
(140)	672489	AB nozzle coolant (drain) tube	15, 16, 22

NOTE

★ items indicate critical clearances must be maintained. See WP006 00 for specific areas.

FIGURE 13. Example of external tubing, cabling, and clamping.
installation. - Continued

MIL-M-81218B(AS)

A1-720XX-MMI-100**005 00**

Page 6

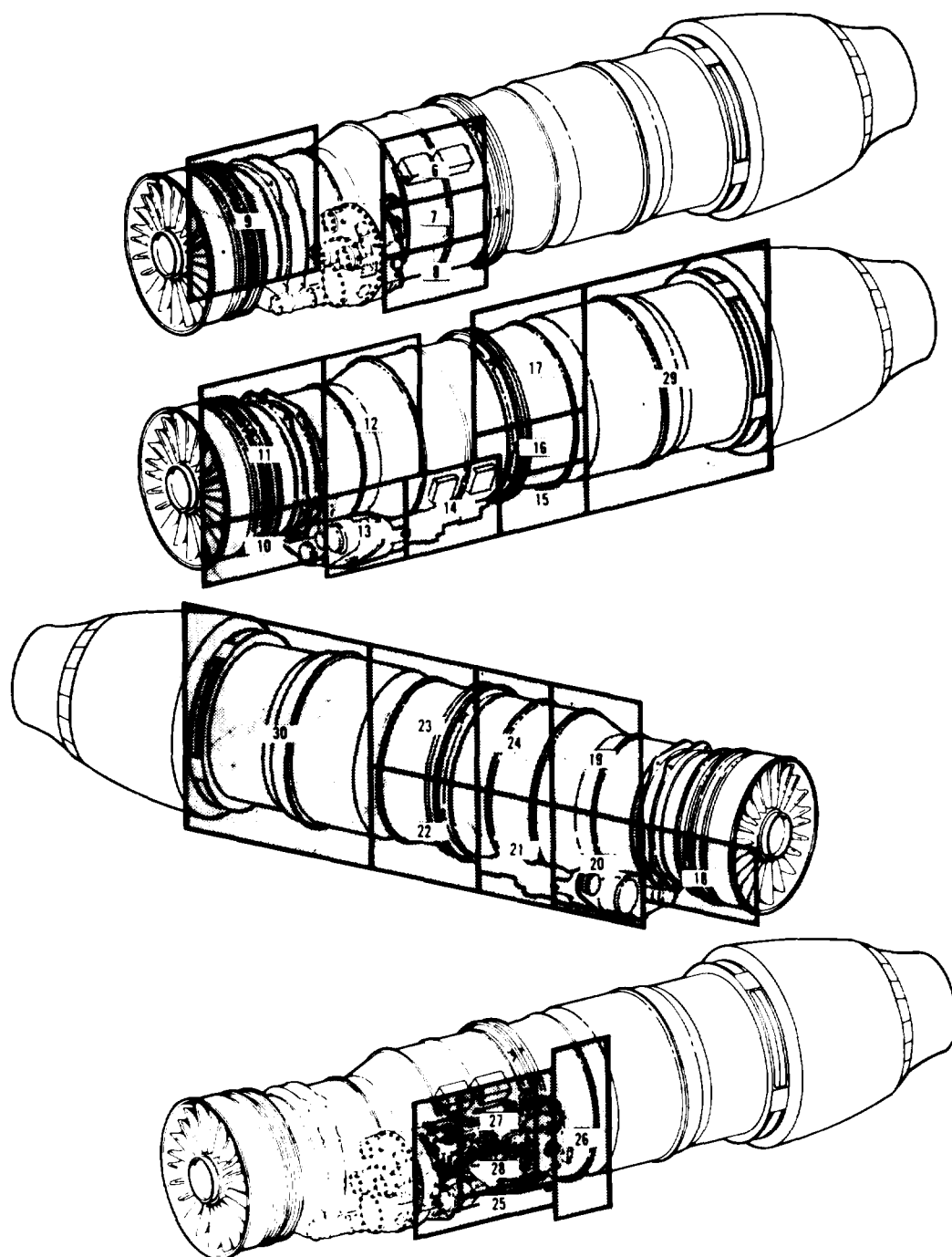


Figure 5. Engine Zones

FIGURE 13. Example of external tubing, cabling, and clamping installation. - Continued

A1-720XX-MMI-100

005 00

Page 7

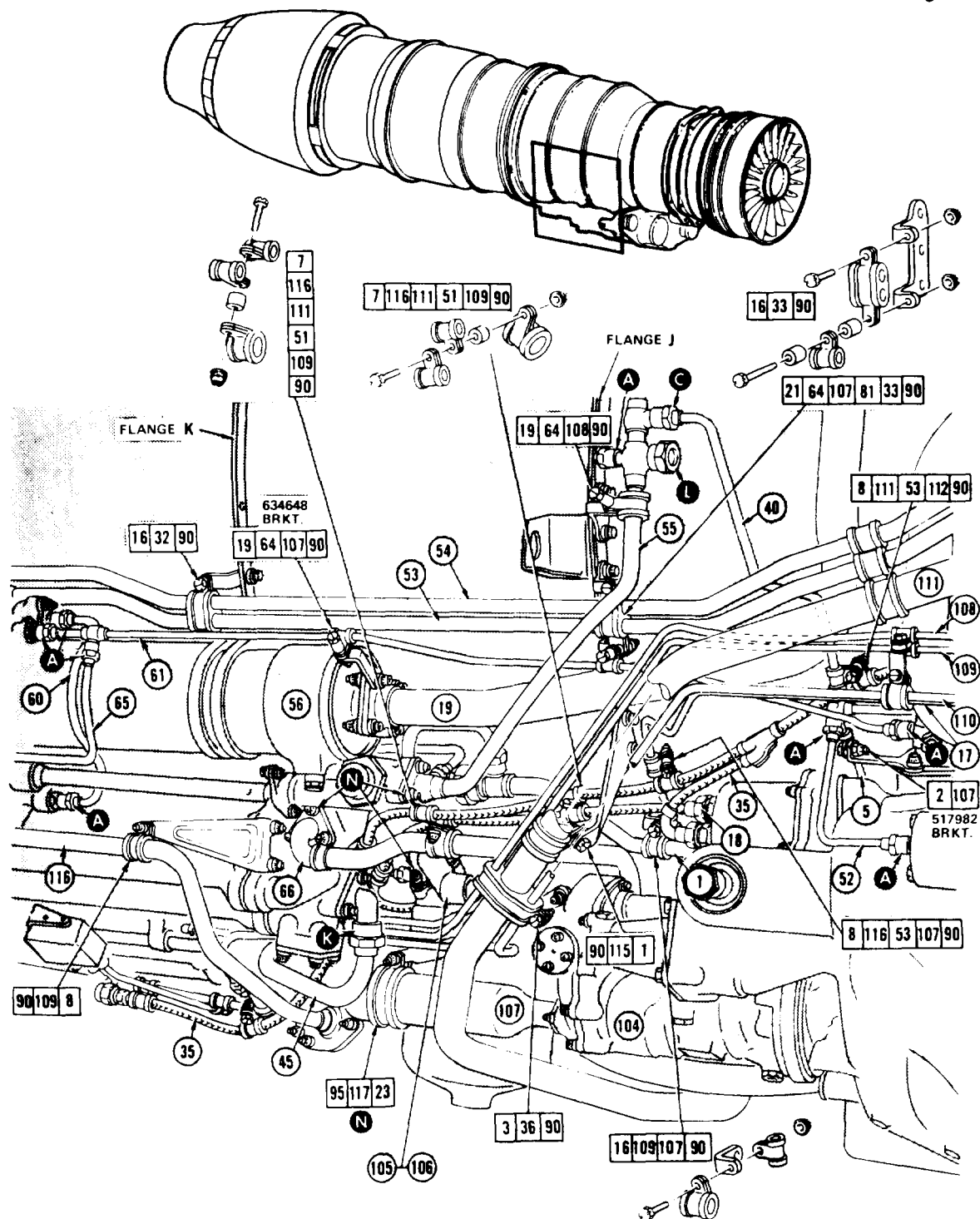


Figure 21. Zone Detail View

FIGURE 13. Example of external tubing, cabling, and clamping installation. - Continued

MIL-M-81218B(AS)

A1-720XX-MMI-100**005 00**

Page 8

Key to figure 21

Index Code	PN	Name	Specifications
1	545962	Screw	0.500 inch long
2	504578	Screw	0.562 inch long
3	511105	Screw	0.438 inch long
7	496366	Screw	0.875 inch long
8	545964	Screw	0.625 inch long
16	546286	Screw	0.562 inch long
19	564738	Screw	1.062 inch long
21	528085	Screw	1.500 inch long
23	566462	Screw	0.625 inch long (1/4 x 28)
32	567164	Clamp	
	523824	Cushion	Qty (2)
33	581862	Clamp	Qty (2)
	523824	Cushion	Qty (2)
36	523993	Clamp	
	523992	Cushion	
51	510275	Spacer	0.238 inch long, 0.438 inch OD
90	488589	Nut	
95	564705	Nut	
107	310612	Loop clamp	
108	310622	Loop clamp	
109	310623	Loop clamp	
111	310614	Loop clamp	
112	310621	Loop clamp	
115	310630	Loop clamp	
116	310637	Loop clamp	
117	641689	Loop clamp	
A		Torque	90 — 100 lb-in.
C		Torque	270 — 300 lb-in.
K		Torque	900 — 1000 lb-in.
L		Torque	200 — 220 lb-in.
N		Torque	75 — 85 lb-in.

NOTE

All clamp screws/nuts, torque 36 — 40 pound-inches unless otherwise specified.

FIGURE 13. Example of external tubing, cabling, and clamping installation. - Continued

A1-720XX-MMI-100

006 00

Page 2

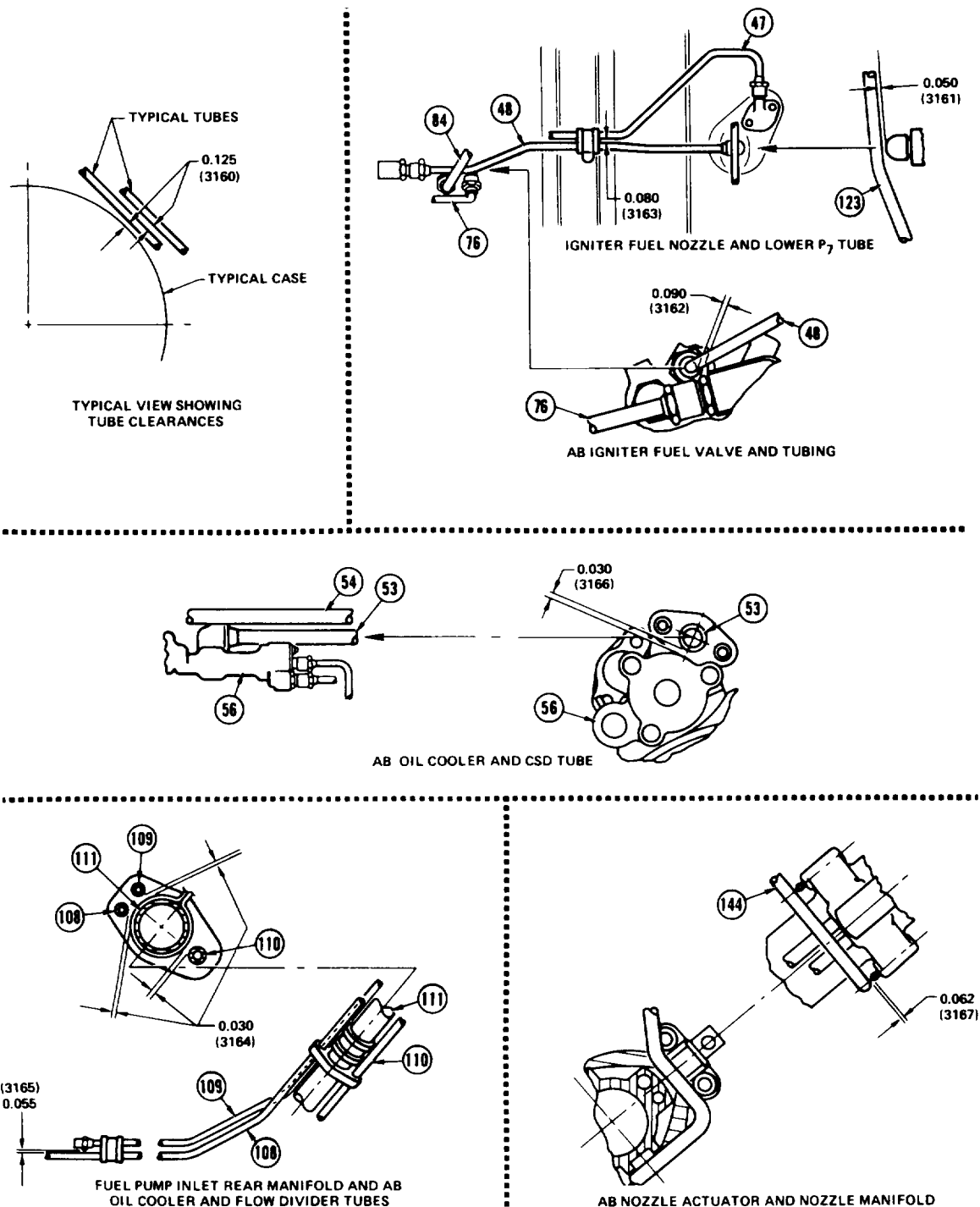


FIGURE 14. Example of critical clearances.

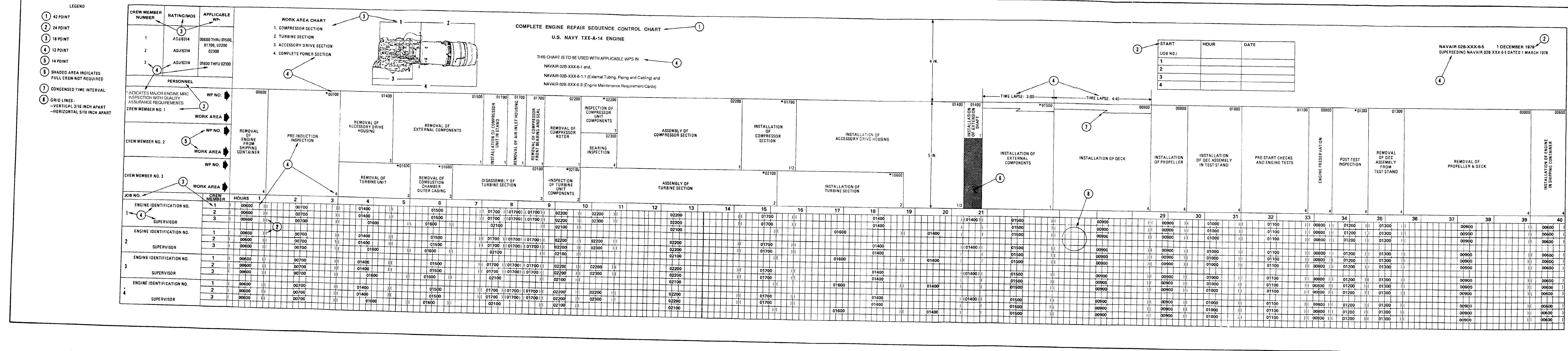


FIGURE 15. Example of SCC format.

MIL-M-81218B(AS)

ALPHABETICAL INDEX

Paragraph		Page
A		
6.2.1	Acquisition requirements	15
3.5.1	Alphabetical index	5
3.4.5.1	Alternate items	5
2.	Applicable documents	1
3.3	Arrangement	3
3.5.14.5	Assembly.	11
B		
3.6.2	Bracket installation	12
C		
6.6	Changes from previous issue	16
3.5.11.2	Charts or curves	8
1.2	Classification	1
3.5.14.2	Cleaning.	10
3.4.2.2	Combined intermediate-depot maintenance	4
3.6.5	Critical clearances	13
D		
3.2.1	Data.	3
6.3	Definitions	15
3.4.2.1	Depot level	3
3.5.5	Description and principles of operation	6
3.5.14.5.1	Dimensional limits and torque values	11
3.5.14.1	Disassembly	10
E		
3.5.7	Engine handling in shipping container/ maintenance stand	7
3.5.11.3	Engine operating limits.	8
3.5.15	Engine maintenance	11
3.5.11	Engine test	8
3.5.11.1	Environmental conditions	8
3.4.4.2	Exploded views	4
3.6.3	External components	12
3.6.4	External tubing, cabling and clamping installation	12
3.6	External tubing, cabling and clamping intermediate maintenance manual supplement	12
F		
6.4	Figures contained in this specification	15
3.7.4	Folded dimension-sequence control chart	14
3.2	Format and writing style	3
3.7.1	Format - sequence control chart	13

MIL-M-81218B(AS)

ALPHABETICAL INDEX (Cent'd)

Paragraph		Page
G		
3.1	General	2
2.1	Government documents	1
H		
3.5.2.3	Historical record of applicable technical directives	6
I		
3.5.17	Illustrated parts breakdown	11
3.4.4	Illustrations and diagrams	4
3.7.1.1	Image area - sequence control chart	13
4.2	In-process review, validation and verification	15
3.5.14.3	Inspection	10
5.13.2	Installation of major assemblies/subassemblies	10
6.1	Intended use	15
3.5.2	Introduction	5
L		
3.5.14.6	Local manufacture items	11
3.7.1.4	Lower portion - sequence control chart	14
M		
3.5.2.1	Maintenance allocation	6
3.4.2	Maintenance level	3
3.5.14	Major assembly/subassembly maintenance	10
3.4.6	Materials required	5
3.5.4	Materials required work package	6
3.7.1.3	Middle portion - sequence control chart	13
N		
6.	Notes	15
3.6.1	Numerical index	12
O		
6.2	Ordering Data	15
2.2	Order of precedence	2
2.1.2	Other government documents and publications	2
P		
5.	Packaging	15
5.1	Packaging requirements	15
3.7.3	Paper stock - sequence control chart	14
3.5.11.6	Penalty applications	9

MIL-M-81218B(AS)

ALPHABETICAL INDEX (Cent'd)

Paragraph		Page
P (Cent'd)		
3.5.9	Preinduction and mandatory inspection requirements	7
3.5.8	Preparation for service and storage	7
3.5.10	Preparation for test	7
3.5.5.1	Principles of operation	6
3.4.4.1	Procedural illustrations	4
Q		
4.	Quality assurance provisions	14
R		
3.5.2.2	Reference material listing	6
3.5.13	Removal and installation of major assemblies/ subassemblies.	9
3.5.13.1	Removal of major assemblies/subassemblies	9
3.5.14.4	Repair	10
3.	Requirements	2
6.3.1	Requiring activity	15
4.1.1	Responsibility for compliance	14
4.1	Responsibility for inspection	14
S		
1, 1.1	Scope	1
3.7	Sequence control chart	13
3.4.3	Special processes	4
2.1.1	Specifications	1
3.5.6	Standard practices	7
6.5	Subject term (key word) listing	15
3.5.16	Support equipment maintenance	11
3.4.5	Support equipment required	4
3.5.3	Support equipment work package	6
T		
3.5	Technical content-detailed	5
3.4	Technical content-general	3
3.5.11.5	Test requirements	9
3.5.11.4	Test schedules and procedures	8
3.4.1	Text	3
3.5.12	Troubleshooting	9
3.7.2	Type size-sequence control chart	14
u		
3.7.1.2	Upper portion-sequence control chart	13

MIL-M-81218B (AS)

ALPHABETICAL INDEX (Cent'd)

Paragraph		Page
	z	
3.6.4.2	Zone detail views	13
3.6.4.1	Zone references	12

(See Instructions – Reverse Side)

(TO DETACH THIS)

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