MASSACHUSETTS INSTITUTE OF TECHNOLOGY

APOLLO

GUIDANCE AND NAVIGATION

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MIT APOLLO DRAWING STANDARDS

June 1964

MIT INSTRUMENTATION LABORATORY

CAMBRIDGE 39, MASSACHUSETTS

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GUIDANCE AND NAVIGATION

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FOREWORD

The purpose of the MIT APOLLO DRAWING STANDARD is to establish the requirements, format, and procedures governing the preparation, authentication, and approval of drawings and associated documentation required for the production of items, equipment, and assemblies for use in Project APOLLO.

The material contained in this publication has been prepared from pertinent sections of MIL-D-70327, MIL-STD-2, and NAVORD OSTD 599, 2nd Revision.

CONTENTS

ILLUSTRATIONS

Section 1
SCOPE

1-1 PURPOSE

This Standard supplements MIL-D-70327, and other documents listed in section 2 of this publication, in specifying the minimum requirements for the preparation of Class 1 NASA drawings. It is applicable to defining, in the finished state, assemblies and associated items for service evaluation and service use (usually prototype or production models).

1-2 DRAWING REVISIONS

Instructions for the accomplishment of revisions to drawings are set forth in this publication.

1-3 MANDATORY APPLICATION OF STANDARD

This Standard applies to drawings prepared for the National Aeronautics and Space Administration and having the following characteristics:

a. Drawings showing end product design only and defining

(1) complete NASA Assemblies,

(2) special test and checkout equipment needed for the inspection and maintenance of such assemblies, and

(3) handling equipment, packaging, and special tools.

b. Drawings (other than those showing end product design) specifying requirements for procurement, assembly, and installation of NASA items.

c. Drawings showing intermediate stages of manufacture.

1-4 DRAWINGS EXEMPT FROM STANDARD

This Standard does not apply as a mandatory document to drawings prepared for the following purposes, even though NASA drawing numbers may have already been assigned:

a. Research and development layouts and engineering sketches. (This Standard may be used as a guide in preparing such drawings.)

b. Construction Type Drawings (Buildings, Bricks, Mortar, etc.)

c. Shop accessories

1-5 DEFINITE REQUIREMENTS

Sections 2 through 16 contain definite requirements, which are stated in mandatory terms.

1-6 SYSTEM IDENTIFICATION DATA LIST (SIDL)

SIDL is the official design release disclosure package. It identifies all drawings, procurement specifications, and assembly and test procedures released by the APOLLO Change Control Board for the production, procurement, assembly, and test of APOLLO Guidance and Navigation Equipments, including Ground Support Equipments.

Section 2
REFERENCED DOCUMENTS

2-1 LIST OF REFERENCED DOCUMENTS

The following documents of the issue in effect on the date of contract or order shall be utilized as reference documents in the preparation of NASA Project APOLLO drawings.

Federal Specifications

L-F-340, Plastic Sheet, Sensitized, Dimensionally Stable
L-P-00519, Plastic Sheet, Tracing, Matte Finish
TT-I-528, Ink, Drawing, Waterproof, Black
CCC-C-531, Cloth, Tracing
DDD-C-00471, Cloth, Sensitized
UU-P-561, Paper, Tracing

Military Specifications

MIL-D-5480, Data, Engineering and Technical
MIL-P-55110, Printed Wiring General Specification
MIL-D-70327, Drawings, Undimensioned; Reproducibles, Photographic and Contact: Preparation of

Military Standards

MIL-STD-1, General Drawing Practice
MIL-STD-2, Engineering Drawings, Sizes, and Formats
MIL-STD-7, Types and Definitions of Engineering Drawings
MIL-STD-8, Dimensioning and Tolerancing
MIL-STD-9, Screw Thread Conventions and Method of Specifying
MIL-STD-10, Surface Roughness, Waviness, and Lay
MIL-STD-12, Abbreviations For Use On Drawings
MIL-STD-15, Electrical and Electronic Symbols
MIL-STD-16, Electrical and Electronic Reference Designations
MIL-STD-17, Mechanical Symbols
JAN-STD-19, Welding Symbols
MIL-STD-20, Welding Terms and Definitions
MIL-STD-22, Welded Joint Designs
MIL-STD-23, Nondestructive Testing Symbols

MIL-STD-24, Revision of Drawings
MIL-STD-28, Drawing Titles, Approved Method for Assignment of
MIL-STD-29, Springs, Mechanical, Drawing Requirements For
MIL-STD-30, Associated Lists
MIL-STD-31, Numbering and Coding of Engineering Drawings, Associated Lists and Documents
MIL-STD-129, Marking for Shipment and Storage
MIL-STD-195, Marking of Connections For Electric Assemblies
MIL-STD-196, Joint Electronics Type Designation System
MIL-STD-200, Electron Tubes, and Semiconductor Devices, Diode
MIL-STD-242, Electronic Equipment Parts
MIL-STD-681, Identification Coding and Application of Hookup Wire
MIL-STD-806, Graphical Symbols for Logic Diagrams
Bureau of Standards Publications Handbook H28, Screw Thread Standards for Federal Services and Appendices thereto
Department of Defense, Armed Forces Supply Support Center (AFSSC, formerly OASD) Manuals and Handbooks:
- M205, Military Outline of Form and Instructions for the Preparation of Specifications
- M1-2, Federal Manual for Supply Cataloging, Chapter 2, Item Identification
- H4-1 and H4-2, Federal Supply Code for Manufacturers
- H6-1, Part 1, Section A - Federal Item Indexes, Alphabetic Index of Names to Description Patterns

MIT-NASA Documents

MIT-E-1113, SIDL (System Identification Data List)
ND 1002019, Marking, General
ND 1002023, Serialization
ND 1002034, Qualification Status List

2-2 PROCUREMENT OF DOCUMENTS

Copies of the referenced documents listed in paragraph 2-1 may be obtained by directing requests to the following sources. Contractors requesting copies of documents shall include the number of the contract, letter of intent, or project for which the documents are required.

2-2.1 FEDERAL AND MILITARY SPECIFICATIONS AND MILITARY STANDARDS. Copies of Federal and Military Specifications and Military Standards may be obtained from the Superintendent of Public Documents, U. S. Government Printing Office, Washington 25, D. C.

2-2.2 BUREAU OF STANDARDS HANDBOOK. Bureau of Standards Handbook 28 may be obtained from the Superintendent of Public Documents, U. S. Government Printing Office, Washington 25, D. C.

2-2.3 DEPARTMENT OF DEFENSE MANUALS AND HANDBOOKS. Department of Defense (AFSSC) Manuals and Handbooks may be obtained from the Commanding Officer, Naval Aviation Supply Depot, 700 Robbins Avenue, Philadelphia 11, Pa.

2-2.4 MIT-NASA DOCUMENTS. MIT-NASA Documents may be obtained from the Instrumentation Laboratory Library, Massachusetts Institute of Technology, 68 Albany Street, Cambridge 39, Mass.

Section 3
DEFINITIONS

3-1 DEFINITIONS

For the purposes of this publication, the definitions in this section shall apply. Other definitions are given in MIL-D-70327 and throughout this publication as needed.

3-2 CLASS 1 NASA DRAWING

In the broad sense, a NASA drawing is any drawing prepared for the National Aeronautics and Space Administration to which a NASA drawing number has been assigned.

For the purposes of this publication, however, the term "NASA drawing" shall be restricted to those drawings defined and enumerated in paragraph 1-3 and shall not include drawings prepared for the purposes listed in paragraph 1-4. A NASA drawing conforming to this standard is a Class 1 Government Design Activity drawing, as defined by MIL-D-70327, for which National Aeronautics and Space Administration retains or assigns the responsibility for preparation or maintenance.

3-3 FAMILY TREE DRAWING

A NASA Family Tree Drawing is a Class 1 NASA Drawing which is a graphic presentation of the Indenture Level of Assembly of Components. All connecting hardware and bulk materials are specifically identified thereon, and the quantity of each item required for one (1) assembly is stated. See figure 3-1.

3-4 END PRODUCT

An end product is an item, either an individual part or assembly, in its final or completed state.

3-5 EQUIPMENT DIVISIONS

3-5.1 PART. The term "part" as employed in or in connection with NASA drawings, or National Aeronautics and Space Administration equipment, designates the following:

a. A single integral item not capable of further subdivision, for example, a casting, stamping, machined part, etc. Usually, such a part is made from a single piece of material.

b. A commercial item, such as a pressure gage, tachometer, or similar instrument, or a valve, lubrication fitting, ball bearing, etc., which normally is not taken apart during the service operation, maintenance, or overhaul of the equipment of which it forms a part.

c. An inseparable assembly of two or more pieces permanently joined together by such methods as welding, brazing, soldering, etc.

3-5.2 SUBASSEMBLY. A subassembly is a combination of two or more mechanically connected parts that can be disassembled without destruction of designed use.

3-5.3 ASSEMBLY. An assembly is a combination of mechanically connected subassemblies and/or parts that is capable of performing a specific function.

NOTE: The distinction between an assembly and a subassembly is not always exact.

3-5.4 MAJOR ASSEMBLY. The term "major assembly," as used in this publication, refers to an assembly identified by a Mark and Mod (or equivalent designation) or to a complex assembly requiring the preparation of a family tree drawing.

3-5.5 SYSTEM. A system consists of related but not mechanically connected assemblies and parts, and, as a combination, is capable of performing a specific operational function or functions. Interconnection of assemblies by electrical cables or hydraulic transmission lines does not constitute mechanical connection. (Example: Gun fire-control system, including the tracking radar, computer, and gun mount.)

3-6 TYPES OF MODELS

3-6.1 BREADBOARD MODEL. This is an assembly of preliminary circuits and parts to prove the feasibility of a device, circuit, equipment, system, or principle in rough form without regard to the eventual overall design or form of parts.

3-6.2 EXPERIMENTAL MODEL. This is a model of the complete equipment constructed to demonstrate the technical soundness of the basic idea. This model need not have the required final form or necessarily contain parts of final design.

3-6.3 DEVELOPMENTAL MODEL. This is a model designed to conform to the requirements of the performance specification. See M205. It generally has a form approximating the final concept but not necessarily a form suitable for release for production. This model may be used to demonstrate reproducibility by manufacturing methods or to establish technical requirements for production equipment.

3-6.4 PROTOTYPE (PREPRODUCTION) MODEL. This is a model that is fully interchangeable with production equipment. It is manufactured by production or semi-production tooling. This model is suitable for: (a) establishing performance limitations and reliability characteristics and (b) testing by agencies concerned with other components of the system. This model sometimes is used in operational evaluation (service tests).

3-6.5 PRODUCTION MODEL. This is a model of final design, manufactured by production tools, jigs, fixtures, and methods.

3-7 ITEMS

3-7.1 GOVERNMENT STANDARD ITEMS. Government standard items are assemblies, subassemblies, or parts that have been designated by the Department of Defense or the National Aeronautics and Space Administration as "standard" in order to minimize the number of types or kinds of items required to fulfill the needs of the United States Government.

3-7.2 COMMERCIAL ITEMS. Commercial items are supplies which normally are, or have been, sold or offered to the public commercially by any supplier.

3-7.3 ITEMS OF SPECIAL DESIGN. Items of special design are assemblies, subassemblies, or parts that are either developed under a National Aeronautics and Space Administration contract or manufactured to meet the requirements of a National Aeronautics and Space Administration application. Parts of special design are also known as "parts peculiar."

3-8 PROPRIETARY DATA

Proprietary data means data providing information concerning the details of a contractor's secrets of manufacture, such as may be contained in, but not limited to, its manufacturing methods or processes, treatment and chemical composition of materials, plant layout and tooling, to the extent that such information is not disclosed by inspection or analysis of the product itself and to the extent that the contractor has protected such information from unrestricted use by others.

3-9 MATERIALS

3-9.1 MATERIAL FOR PARTS. The material for a part is the material as furnished in the end product.

3-9.2 BULK MATERIALS. The term "bulk materials" applies to those materials that are measured in units such as weight, volume, and length.

3-9.2.1 Types. Bulk materials consist of the following:

a. Materials which, because of the manner in which they are used, are not fabricated into parts (cement, solder, welding rod, paint, lacquer, grease, oil, packing, etc.)

b. Materials used in construction where fabrication plays a minor part, i.e., cutting to length where detail drawings are not required (wire, tape, paper, pipe, cable, waveguide tubing, etc.)

3-9.2.2 Order of Preference. Bulk materials are included in the terms "Government standard item," "commercial item," etc., so that an order of preference for selection may be applied. Because documentation requirements for bulk materials differ somewhat from those for parts, bulk materials are treated as a separate category in this publication.

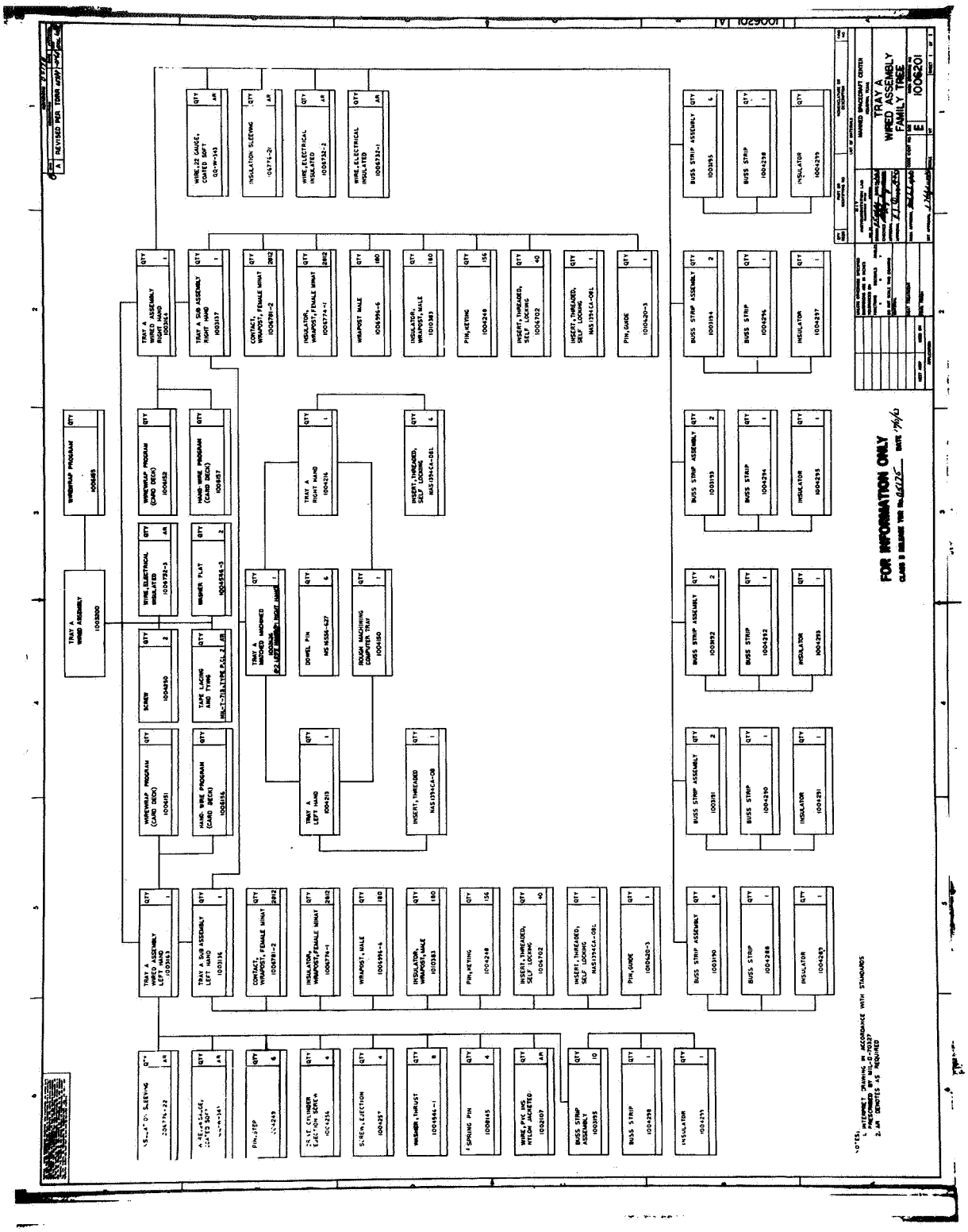


Figure 3-1. Family Tree Drawing Format.

Section 4
GENERAL REQUIREMENTS

4-1 COMPLETENESS

National Aeronautics and Space Administration drawings, when interpreted in association with the specified specifications, standards, and other documents, shall:

a. Describe items so that they may be procured, assembled, and maintained to function in accordance with the performance requirements.

b. Furnish sufficient information to permit determination of conformance to the description, and

c. Furnish the above in sufficient completeness for accomplishment without the need of research, development, design engineering, or help from the preparing organization.

4-2 USE OF PREVIOUSLY PREPARED DOCUMENTS

Maximum use shall be made of approved documents previously prepared for any use consistent with the criteria set forth in this publication.

4-3 REFERENCE DOCUMENTS

4-3.1 IDENTIFICATION ON CLASS 1 SET OF NASA DRAWINGS. All specifications, standards, instructions, and other documents referenced on drawings shall be identified by either Government or industry Standard or Specification designations.

4-3.2 PERFORMANCE OR DESIGN SPECIFICATIONS. When quality assurance and functional tests are required for items of special design, for commercial items, or for items selected from industry or design activity standards as defined in MIL-D-70327, such requirements shall be called out either on the drawing or in a specification invoked thereon.

4-4 DRAWING MATERIAL

All NASA drawings submitted for approval and authentication shall be prepared either on linen tracing cloth conforming to Federal Specification CCC-C-531 or on Mylar film conforming to Federal Specification L-F-340.

4-5 FORMAT

Drawing format, margins, and sizes shall conform to MIL-STD-2.

4-5.1 SIZE. All drawings shall be flat sizes whenever possible. Roll-size drawings shall be used only when flat sizes cannot possibly be used.

4-5.2 ZONING. Zoning shall be used on all drawings except for size A and B drawings. Zone identifications shall be placed in the space between the border lines and the trim lines. See figure 4-1 for example.

4-5.3 MICROFILM ARROWHEADS.

4-5.3.1 Flat-Size Drawings. Microfilm alignment arrowheads shall be used for all flat-size drawings. Arrowhead positioning shall be in accordance with MIL-STD-2.

4-5.3.2 Roll-Size Drawings. Microfilm alignment arrowheads shall be used for all roll-size drawings. A sufficient number of arrowheads shall be positioned across the top and bottom between the border and trim lines so that sequential microfilm shots of a roll-size drawing will provide an overlap. This overlap will provide a means of joining microfilm prints into a complete drawing print.

4-5.3.3 Match Lines. Match lines shall be used on all roll-size drawings for multiframe microfilming to facilitate matching the points after reproduction from multiframe microfilm. Match lines shall be placed inside the drawing field adjoining the margin and shall include a drawing number block for each microfilm frame as illustrated in figure 4-2.

4-5.4 TITLE AND SUPPLEMENTARY BLOCKS. Title Blocks, Revision Blocks, List of Materials Blocks, and other required drawing format shall be in accordance with MIL-STD-2 and similar to the sample drawing format. See figure 4-1.

4-5.4.1 Title Block. A preprinted title block will be supplied as part of all drawings. Subcontractors providing design services for MIT/IL shall complete the title block by inserting the company name, address, and contract number in the applicable portion of the Title Block.

4-5.4.2 Revision Block. All drawings, regardless of size, require a Revision Block.

4-5.4.3 List of Materials Block. All Assembly Drawings depicting the assembly of two or more parts shall require a List of Materials Block. Find Numbers in this block shall specifically identify all details depicted on the assembly drawing.

4-6 LEGIBILITY

NASA Drawings shall meet the legibility, contrast, and reproductive quality requirements of MIL-D-5480. Particular attention shall be paid to the tolerances; the figures shall be formed with care and the minimum height (.094) specified by MIL-STD-1 shall be maintained.

Care shall be exercised in the preparation of all drawings so that the dimensions, tolerances, notes, and delineation will be legible when microfilm copies are made for use in aperture cards.

4-7 REPRODUCIBILITY

Ink tracings and phototracings shall be right-reading and of such clarity that blueprints and reproducibles made therefrom will meet the legibility requirement of paragraph 4-6.

4-8 GENERAL DRAWING PRACTICES

General drawing practices shall be in accordance with MIL-STD-1.

4-9 DIMENSIONS AND TOLERANCES

Dimensions and tolerances shall be in accordance with MIL-STD-8.

4-9.1 DIMENSIONS. The decimal system of dimensioning is required on end-product drawings of machine parts, except for tapped holes. Common fractions are also to be used to indicate standard stock sizes of materials such as metal, wood, rubber, etc.

4-9.2 TOLERANCE METHODS. The unilateral tolerance method, the bilateral tolerance method, or the limit dimensioning method may be used on NASA drawings. When the unilateral tolerance method is used, in which the applied tolerance is either all plus or all minus, the zero limit shall be specified in the callout. Consistency shall be maintained in the application of dimensioning methods on all drawings pertaining to an equipment. When practicable, the same dimensioning method should be used to define similar features on all drawings. For example, if the limit dimensioning method is used for tolerances of size and the unilaterial or bilateral method is used for tolerances of location on one drawing, the remaining drawings in the set should be dimensioned in the same manner.

4-9.3 METRIC SYSTEM. The millimeter is employed as the unit of measurement for physical dimensions of individual optical components shown on detail drawings. The millimeter is also used on optical general arrangement drawings for expressing

separations between optical components and certain optical characteristics of the instrument involved. Occasionally, designs of foreign origin, which have been developed under the metric system, may be adopted for manufacture and use. In such cases, in converting the foreign design to conform with U.S. dimensioning practice, consideration should be given the fact that tools, such as drills, reamers, taps, dies, thread chasers, etc., are available in standard metric sizes. Therefore, when a satisfactory standard-inch-size equivalent is not available, it usually is preferable to retain the standard metric size rather than introduce a nonstandard inch size. Dimensions for the metric sizes so retained should be specified on the drawing in millimeters, followed parenthetically by their exact equivalents in decimals of an inch carried to at least five places. When adopting a metric thread design, the design should be accepted in its entirety, including metric pitch as well as metric thread form and size.

4-9.4 TYPICAL. The term "typical," when used on a NASA drawing in association with a dimension, shall be interpreted to mean that this dimension applies to all features that appear to be identical in size and configuration. The tolerance (block note or individual) stated for a dimension labeled "typical" also applies to each apparently identical feature. The term "typical" shall not be used when such use results in lack of clarity; instead, each feature shall be dimensioned separately.

4-10 SURFACE ROUGHNESS

The required surface roughness shall be specified in accordance with MIL-STD-10.

4-11 ELECTRICAL AND ELECTRONIC SYMBOLS

Electrical and electronic symbols, when used, shall be in accordance with MIL-STD-15-1. See paragraph 4-19.

4-12 REFERENCE DESIGNATIONS

Reference designations for electrical and electronic symbols, when used, shall be in accordance with MIL-STD-16.

4-13 MECHANICAL SYMBOLS

Mechanical symbols, when applicable, shall be in accordance with MIL-STD-17 See paragraph 4-19.

4-14 WELDING SYMBOLS

Welding symbols, when used, shall be in accordance with JAN-STD-19. See paragraph 4-19.

4-15 WELDING TERMS AND DEFINITIONS

Welding terms and definitions, when applicable, shall be in accordance with MIL-STD-20.

4-16 WELDED JOINT DESIGN

The design of welded joints shall be in accordance with MIL-STD-22.

4-17 NONDESTRUCTIVE TESTING SYMBOLS

Nondestructive testing symbols, when used, shall be in accordance with MIL-STD-23.

4-18 ABBREVIATIONS

Abbreviations used on drawings shall be limited to those given in MIL-STD-12, and the rules for use of abbreviations stated in that standard shall be observed.

4-19 SYMBOLS NOT COVERED BY STANDARDS

When symbolic representation is required for items not covered by Military Standards, it is preferred that symbols be selected from standards issued by the American Standards Association or by national engineering societies. Other symbols may be devised by the design activity; however, when symbols are used that are not covered by Military Standards, the meaning of each of these symbols shall be explained by a general note on the drawing.

4-20 SCREW THREADS

Screw threads shall be represented and identified on drawings in accordance with MIL-STD-9. The applicable standard for dimensions and tolerances of screw threads is Screw Thread Standards for Federal Services, the National Bureau of Standards Handbook H28 and its appendices thereto. Whenever a screw thread suitable for the purpose intended is shown in the Unified Series in Handbook H28, it shall be specified on NASA drawings. When a Unified Screw Thread is not suitable, a screw thread from the American National Series may be specified.

4-21 COLOR CODING

Color codes for wiring shall be in accordance with MIL-STD-681.

4-22 CONNECTION MARKING FOR ELECTRIC POWER ASSEMBLIES

Drawings of electric power assemblies shall specify the marking of terminal leads in accordance with MIL-STD-195.

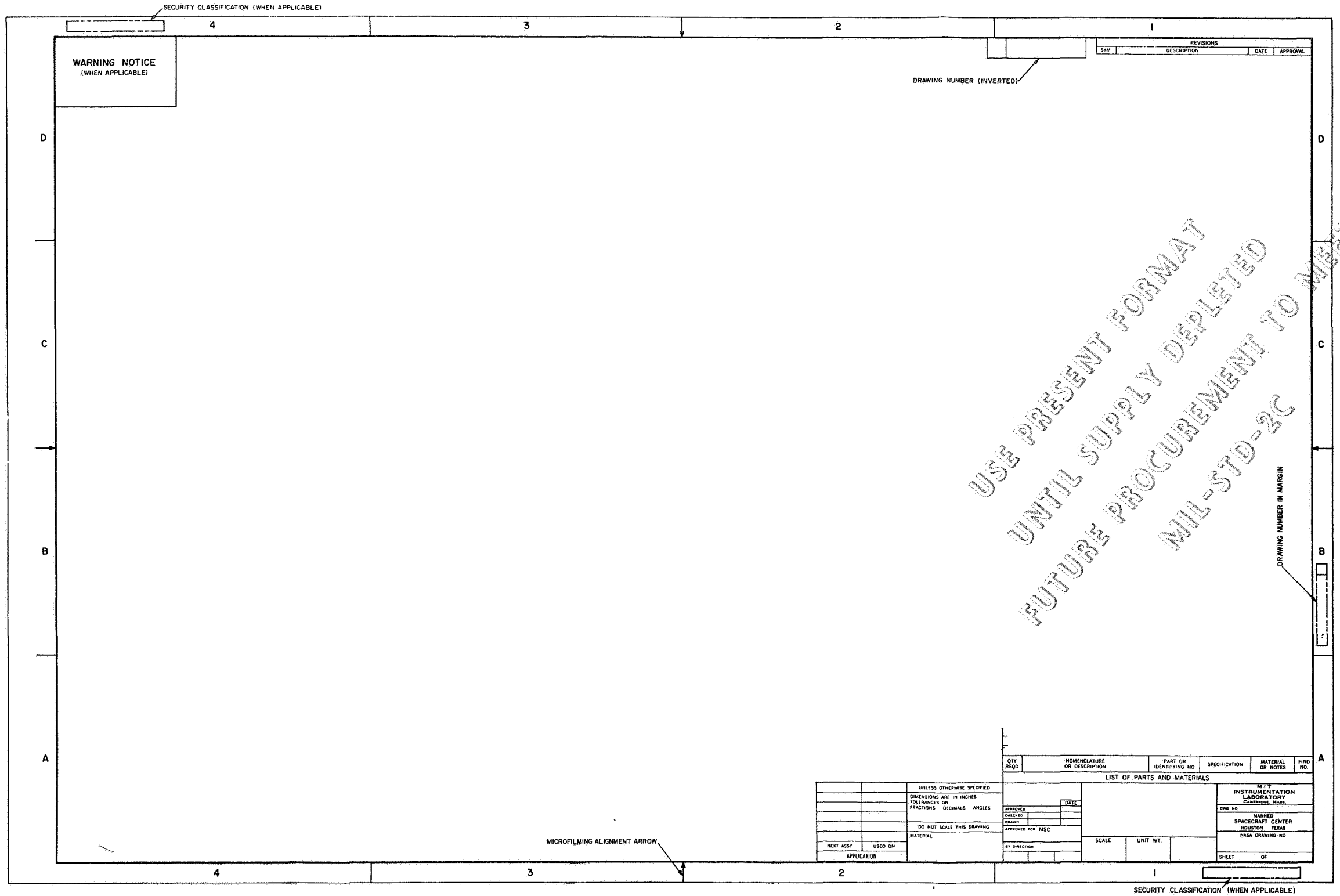


Figure 4-1. Sample Drawing Format.

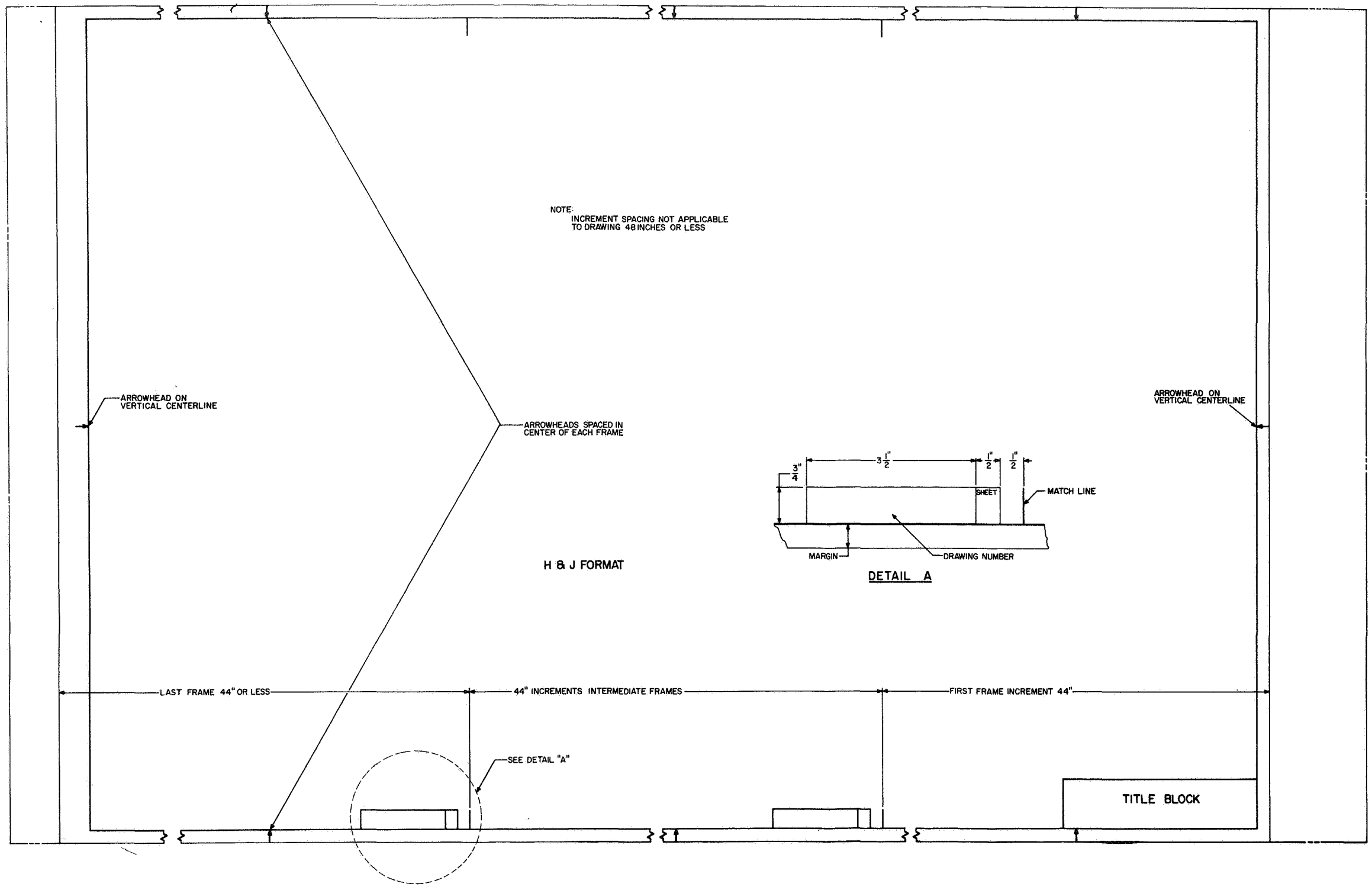


Figure 4-2. Positioning of Microfilm Arrowheads on Roll-Size Drawings.

Section 5
TYPES OF DRAWINGS

5-1 GENERAL

The types of drawings described in this section shall be prepared as applicable, depending upon the characteristics of the particular NASA item involved. Assembly drawings, drawings of all necessary subassemblies, and detail drawings for all parts (except as specifically exempted herein) shall be prepared for each major assembly. In addition, family tree, installation, wiring diagram, schematic diagram, specification control, and other types of drawings, as defined by MIL-STD-7, shall be provided when essential in procurement, manufacture, testing, stowage, repair, maintenance, and use of the particular NASA item.

5-2 ASSEMBLY DRAWINGS

5-2.1 DEFINITION. An assembly drawing is a drawing showing the relationship and identifying (part) numbers for all parts and/or subassemblies in the equipment. All assembly drawings depicting the assembly of two or more parts shall require a List of Parts and Materials Block. Find Numbers shall be listed in this block and shall specifically identify all details depicted on the drawing.

5-2.2 REQUIREMENTS AND CHARACTERISTICS. An assembly drawing shall contain sufficient exterior and sectional views to provide distinct information regarding the assembled position of each part. When a portion of this information is shown on subassembly drawings, it need not be repeated on the assembly drawing. When parts are identified on subassembly drawings, the identifying numbers shall not be repeated on the assembly drawing of next higher order; only the identifying numbers of the subassemblies shall be shown. When practicable, necessary installation dimensions, notes, etc., shall be shown on assembly drawings. When the assembly drawing depicts a major assembly (paragraph 3-5.4), a separate installation drawing shall be prepared. Such installation drawing, and the applicable revision of the pertinent wiring and schematic diagrams, etc., applicable to the major assembly shall be referenced in notes on the assembly drawing.

5-2.3 Sample Assembly Drawing Sheet. Sample assembly drawings of three major assemblies are shown in figures 5-1a, 5-1b, and 5-1c. It will be noted that figure 5-1a is a multi-sheet drawing, the other exterior views being shown on other sheets. More frequently, an assembly drawing contains sectional views, shows the attaching parts, and identifies them.

5-2.4 ELECTRICAL COMPONENTS. Electrical components may be shown on assembly drawings when they are mechanically mounted. Small electrical components, such as resistors and capacitors that are mounted by means of wire connections, are not shown on the assembly drawing, but are shown only on the electrical wiring diagram.

5-2.5 IDENTIFYING NUMBERS. Items shall be identified by Find Numbers in the field of an assembly drawing. Each Find Number shall be identified in the list of parts and materials in the following manner:

a. For items of special design, show the NASA drawing number (and dash number, if any) for each item.

b. For standard items, vendor and commercial items, and bulk materials, refer to instructions under paragraphs 3-9 and 5-24.

In lieu of showing the identifying numbers, or other designations, on the drawing field, the Find Number system described in paragraph 5-27 may be used to locate items on the assembly drawing. See figure 5-3.

5-2.6 WIRING HARNESS OR CABLE ASSEMBLIES. A wiring harness drawing shows the path followed by a group of wires laced together to form a specified shape when installed. Use of the harness simplifies the installation of equipment wiring.

A wiring harness drawing shall be prepared when a group of wires is to be laced together and installed as a harness in an equipment. The drawing may show all dimensions necessary to define the harness form and termination points, or a grid system (or vertical and horizontal graphic scales) may be provided on the drawing for use in ascertaining the required dimensional data. The drawing shall also include a wire data tabulation of wire numbers, circuit reference designations, color codes, lengths, material specification, and other data as necessary. Included in note form should be instructions or references for the preparation and installation of the harness as well as references to the applicable assembly drawing(s), Family Tree(s), the associated schematic diagram, and the wiring diagram. For example, see figure 5-4.

5-3 FAMILY TREE DRAWINGS

For each major assembly level drawing, a Family Tree Drawing shall be prepared similar to that shown in figure 3-1

Each Family Tree Drawing shall show the Indenture Level of Assembly.

All interconnecting hardware, such as nuts, bolts, washers, couplings, shafts, etc., shall be clearly identified on each Family Tree Drawing.

All bulk material, such as paint, lockwire, sealing compounds, lockfoam, epoxy resins and potting compounds, etc., shall also be clearly identified on each Family Tree Drawing.

The quantity of each item required for one (1) assembly will be stated on the Family Tree Drawing. Quantities for bulk material shall be specified "AR" (As Required).

5-4 SUBASSEMBLY DRAWINGS

5-4.1 DEFINITIONS. A subassembly drawing is a drawing showing the relationship and identifying numbers for all parts in a subordinate assembly. In view of the difficulty of establishing a sharp distinction between subassembly and assembly drawings, assembly drawings of any degree, from the lowest order of subordinate assembly to the highest major assembly, may be titled "Assembly." See figure 5-15.

5-4.2 REQUIREMENTS AND CHARACTERISTICS. The division of an assembly into subassemblies and details shall be in accordance with practical assembly and disassembly procedures. When it is either necessary or preferable to supply a particular subassembly as spare parts, rather than to supply the individual parts, the corresponding subassembly drawings shall be prepared. An assembly drawing of each step in assembling an item is not required when many steps are obvious.

5-5 ATTACHING (CONNECTING) PARTS

5-5.1 DEFINITION. Attaching (connecting) parts are the bolts, nuts, washers, etc., required to mount and retain parts and/or subassemblies on assemblies of higher order. Such parts are not physically a part of any assembly until the subassembly they attach has been installed.

5-5.2 REQUIREMENTS. Attaching parts shall be called out on the assembly drawing on which the attachment takes place and not on the drawing of the subassembly. If there is no next higher assembly drawing, the attaching parts shall be called out as loose parts with packaging instructions in the List of Parts and Material Block on the assembly drawing of the assembly requiring attachment.

5-6 DETAIL DRAWINGS

5-6.1 DEFINITION. A detail drawing is a drawing of a single part.

5-6.2 REQUIREMENTS AND CHARACTERISTICS. A detail drawing shall clearly define all features of the part, including dimensions, tolerances, materials, surface

finishes, and protective coatings (if required). All required specifications shall be referenced. Separate drawings shall be made for symmetrically opposite parts. Figure 5-5 shows a sample detail drawing.

5-6.3 APPLICATION. Detail drawings shall be prepared for all "parts peculiar" as defined by paragraph 3-7.3.

5-7 INSTALLATION DRAWINGS

5-7.1 DEFINITION. An installation drawing is an outline drawing showing the general configuration of an equipment and furnishing all information required for installation.

5-7.2 REQUIREMENTS AND CHARACTERISTICS. An installation drawing shall be provided for each major assembly, unless all necessary installation information has been shown on the assembly drawing. An installation drawing shall show all dimensional information required to make the installation. The associated assembly drawing shall be referenced in notes on the installation drawing. Figure 5-6 is a sample installation drawing. The following installation information shall be included:

a. Exterior views and dimensions in plan and elevation, including clearances required for positioning, access, and adjustment, i.e. all information necessary to determine the space requirements of the equipment.

b. Applicable general information and equipment characteristics that must be considered in locating the equipment.

c. All mounting information, including mounting hole or bolt sizes, mounting hole locations, and other mounting requirements.

d. Attaching (connecting) parts. See paragraph 5-5.

e. Electrical and/or piping interfaces.

5-8 OUTLINE DRAWINGS

5-8.1 DEFINITIONS. An outline drawing is a drawing that defines the external contour of an item usually by showing the projected views on three perpendicular planes.

5-8.2 REQUIREMENTS. The requirements for outline drawings are stated under the various types of outline drawings, such as installation, arrangement, and specification control drawings.

5-9 ARRANGEMENT DRAWINGS

5-9.1 DEFINITION. An arrangement drawing is an outline drawing in any projection that is provided for equipment familiarization and preliminary studies of co-functioning with other equipment.

5-9.2 REQUIREMENTS AND CHARACTERISTICS. When the assembly and installation drawings are not suitable for equipment familiarization and determination of co-functioning requirements, an arrangement drawing shall be prepared to meet this need. Overall dimensions and other important dimensions should be shown. Major assemblies should be identified.

5-10 FOUNDATION PLANS

5-10.1 DEFINITION. A foundation plan is an installation drawing that is concerned only with the requirements for mounting an item.

5-10.2 REQUIREMENTS AND CHARACTERISTICS. The mounting information described in paragraph 5-7.2 shall be segregated from the remainder of the installation data and shown on a separate drawing when this procedure results in a better presentation of the information. In addition to mounting hole sizes and locations, all special requirements for the foundation shall be stated. The forces and moments imposed on the foundation shall be shown. Clearances within the foundation for cables and piping shall be specified.

5-11 WORKING CIRCLE DRAWINGS

5-11.1 DEFINITION. A working circle drawing is an installation drawing that is concerned only with the clearance requirements for equipment that is rotated horizontally or elevated vertically.

5-11.2 REQUIREMENTS AND CHARACTERISTICS. The National Aeronautics and Space Administration prefers that clearance requirements involved in rotating or elevating an item of equipment for orienting, launching, or sighting be segregated from other installation data and shown on a working circle drawing. This drawing shall include a plan view on which is stated the diameter of the working circle, the radius of which is the distance in azimuth from the pivot to the point of maximum projection. When the equipment may be installed in locations in which it will not be rotated through 360 degrees, the radius in azimuth to other points that are involved in clearance determinations shall be stated. When elements are included that are elevated, the centers of rotation angles of elevation and depression as well as radii from the pivot to the end of the rotating element shall be shown on elevation views. The associated assembly drawing shall be referenced in notes on the working circle drawing.

5-12 PERSONNEL ARRANGEMENT DRAWINGS

5-12.1 DEFINITION. A personnel arrangement drawing is an outline drawing that shows the approximate positions of operating personnel.

5-12.2 REQUIREMENTS. A personnel arrangement drawing should be prepared for each item of equipment that requires on the equipment, or adjacent to it, the presence of more than two persons during operation. The figures of operating personnel should be indicated by dots or circles in their approximate locations. The job titles of the personnel should be stated.

5-13 ELECTRICAL SCHEMATIC DIAGRAMS

5-13.1 DEFINITION. An electrical schematic diagram is a drawing that shows an electrical circuit with the parts indicated by symbols located to facilitate tracing the circuit. The actual location of the parts in the equipment is disregarded.

5-13.2 REQUIREMENTS AND CHARACTERISTICS. An electrical schematic diagram shall be prepared for each assembly and subassembly in which there is an electrical circuit requiring analysis for purposes of manufacture or maintenance. Symbols for parts shall conform to MIL-STD-15 and shall be placed on the diagram in the position that best explains the sequence of events. The symbols shall be accompanied by reference designations conforming to MIL-STD-16. Parts lists shall be added to the pictorial part of schematic drawings in accordance with MIL-STD-7. Vendor part numbers shall not be used on NASA document - NASA part numbers shall be used.

5-14 WIRING DIAGRAMS

5-14.1 DEFINITIONS. A wiring diagram is a drawing that shows the wiring connections within an assembly that is a subdivision of a major assembly, an electronics set, or a system. Highway, airline, or pictorial wiring diagrams are acceptable.

5-14.1.1 Highway Wiring Diagram. A "highway" wiring diagram is a drawing that shows the wires or wiring harnesses as continuous lines between terminal connections. Highway wiring diagrams are either "point-to-point" type or "channel" type.

a. In the "point-to-point" type of wiring diagram, illustrated in figure 5-8, a single continuous line is shown for each wire. The paths of the lines are not intended to indicate the actual arrangement of the wires.

b. In the "channel" type of wiring diagram, illustrated in figure 5-9, individual wires are shown at each terminal; but the group of wires running from

one component to other components is combined in the form of a single heavy line. The heavy lines may approximate either the main trunks of a wiring harness (figure 5-9 corresponds with figure 5-4) or several wires lashed together. The paths of the lines may indicate the actual arrangement of the wires in the primary plane of the wiring harness, but this is not mandatory. The destination of each wire, in addition to the wire number, should be shown preferably at each terminal before the line representing the wire flows into a main channel.

5-14.1.2 Airline Wiring Diagram. An "airline" wiring diagram is a drawing that shows the destination of wires by means of station (destination) numbers, no lines being shown to represent the path of wires between stations. One or more heavy base lines are shown adjacent to the layout of the terminals of each component, and a destinctive station number is specified adjacent to each base line. A line is shown between component terminals and the adjacent base line(s) for each wire; destination station numbers and color codes are specified adjacent to each of these lines to show the stations to which the wire runs.

5-14.1.3 Pictorial Wiring Diagram. A pictorial wiring diagram is a drawing showing the physical layout of wires as they would appear on or in an assembled chassis.

5-14.2 REQUIREMENTS. A wiring diagram shall be prepared for each assembly or subassembly that includes self-contained individual electrical conductors, or a wiring harness. Simple wiring diagrams may be placed on the assembly drawing in lieu of preparing a separate drawing.

5-14.3 CHARACTERISTICS. A wiring diagram shall show the electrical, or electronic, parts in the approximate physical position in which they are mounted within the assembly. The parts shall be represented in simple outline form with only the detail needed to clearly show the wiring connections. A phantom line shall be used to indicate the portion of the equipment on which the parts are mounted. A suitable note should indicate whether the wiring connections are to be made on the near or far side in each view. The electrical parts shall be identified by the same reference designations used on the corresponding schematic diagram. If wire data are tabulated on one or more wiring harness or cable assembly drawings, such data shall be reference. Data pertaining to the remainder of the wires shall be tabulated on the wiring diagram and shall include the following:

a. Wire number code or color code for each wire

b. Wire size, type, and government specification or other identification

c. Termination data for each wire end.

Figures 5-8 and 5-9 are sample wiring diagrams.

5-14.4 PRINTED WIRING CIRCUITS. Documentation for printed wiring circuits shall be as described in MIL-P-35110.

5-15 INTERCONNECTION DIAGRAMS

5-15.1 DEFINITION. An interconnection diagram is a drawing that shows the wiring connections between assemblies that are subdivisions of major assemblies or between major assemblies or electronic sets that are subdivisions of systems. This type of drawing is also known as a cabling or cording diagram.

5-15.2 REQUIREMENTS AND CHARACTERISTICS. An interconnection diagram shall show each individual assembly, major assembly, or electronic set in the particular NASA equipment with its interconnecting cable assemblies. The assemblies, electronic sets, and cable assemblies shall be identified by nomenclature, Mark and Mod or other type designation, and drawing number. Each terminal shall be identified exactly as marked on the assembly. Figure 5-10 is a sample interconnection diagram.

5-15.3 RUNNING LISTS. These are described in section 13 and may be prepared in lieu of Interconnection Diagrams.

5-16 MECHANICAL SCHEMATIC DIAGRAMS

5-16.1 DEFINITION. A mechanical schematic diagram is a drawing that shows the operational sequence of a group of mechanical parts that are related in the performance of a particular function.

5-16.2 REQUIREMENTS AND CHARACTERISTICS. A mechanical schematic drawing shall be prepared when it is essential to the proper understanding of the mechanical operation of complex equipment. A schematic diagram may be isometric, semi-isometric, or diagrammatic. See figure 5-11. Symbols from MIL-STD-17 shall be used when applicable. Dimensions and part identifying numbers should be shown when needed for clarity. The associated assembly drawing shall be referenced in notes on the schematic diagram.

5-17 PIPING DIAGRAMS

5-17.1 DEFINITION. A piping diagram is a line drawing showing the interconnection of units or parts by piping and, in some cases, showing the sequence in the flow of fluids in the equipment.

5-17.2 REQUIREMENTS AND CHARACTERISTICS. A piping diagram shall be prepared when it is essential to the proper assembly or maintenance of the piping in a fluid system or when the flow of fluids cannot otherwise be readily determined. Symbols from MIL-STD-17 shall be used when applicable. The symbols shall be so placed that the circuit may be traced from part to part in the operational sequence, no attempt being made to indicate the actual location of the parts. Piping may be shown by symbolic line representation to distinguish the functions of the various pipes. Part identifying numbers should be shown when needed for clarity.

5-18 LUBRICATION CHARTS

5-18.1 DEFINITION. A lubrication chart is a drawing showing the various points of lubrication of the equipment and specifying the type and time of lubrication.

5-19 MULTI-DETAIL DRAWINGS

5-19.1 DEFINITION. A multi-detail drawing is a drawing depicting two or more parts.

5-19.2 REQUIREMENTS AND CHARACTERISTICS. A multi-detail drawing is permitted only when the parts shown thereon are almost alike and when it is more feasible to show the differences by actual delineation rather than by tabulation. The parts shall be assigned dash numbers for purposes of identification. The materials of which the parts are made shall be designated in accordance with the requirements of section 10, either in the material block of the drawing or in notes pertaining to each part.

5-20 TABULATED DRAWINGS

5-20.1 DEFINITION. A tabulated drawing is a drawing upon which two or more items in one category, which are similar except for one or more features, are represented. The unvarying characteristics are depicted only once; the varying characteristics are specified in tabular form.

5-20.2 REQUIREMENTS AND CHARACTERISTICS. Each part shall be assigned a dash number and shall be identified by the basic drawing number plus the dash number, for example, 0000620-1. Each dash number shall be entered in the table alongside the variable characteristics applicable to that particular part. A picture of a single part shall be drawn, the varying dimensions being coded by means of letters, which are then used as the headings for the tabular columns. A sample tabulated detail drawing is shown in figure 5-12.

5-21 DETAIL-ASSEMBLY DRAWINGS

5-21.1 DEFINITION. A detail-assembly drawing is an assembly drawing on which one or more parts are completely detailed on an assembly view, no separate drawing being prepared for such part or parts.

5-21.2 REQUIREMENTS AND CHARACTERISTICS. Detail-assembly drawings are acceptable only for items produced in very small quantities that do not require accurate or complex processing. On detail-assembly drawings, the parts detailed and the assembly itself shall be assigned dash numbers. Dash numbers, detail nomenclature, material specifications, and other information shall be given in tabular form.

5-22 INSEPARABLE ASSEMBLIES

5-22.1 DEFINITION. An inseparable assembly is a part consisting of two or more pieces permanently joined together by such methods as welding, brazing, riveting, etc. This part is not disassembled for maintenance purposes; disassembly would result in its destruction for design use.

5-22.2 REQUIREMENTS. Inseparable assembly drawings shall define the end product item, as described in paragraph 5-22 and illustrated by figure 5-13. Each piece of the inseparable assembly shall be assigned a Find Number as described in paragraph 5-27.

5-23 UNDIMENSIONED DRAWINGS

5-23.1 DEFINITION. An undimensioned drawing is a drawing that is not completely dimensioned, only control dimensions (to permit control of the image size of the drawing) being required. Additional dimensions may be shown.

5-23.2 PRACTICE. Undimensioned drawings shall not be used to define the requirements for the finished product, the only exception being undimensioned drawings are acceptable for printed circuits. For sheet metal parts of simple form, such as flanged cylinders or cubes, the drawing preferred shows each part in a final form and specifies every dimension and tolerance. For sheet metal parts of complex form, such as airfoils, the drawing preferred shows each part in final form, specifies each dimension and tolerances applicable to mating elements, and gives tables of coordinates to permit the inspection of complex contours by means of templates. When such drawings of the finished product are provided, NASA drawings showing dimensioned developed views or undimensioned flat patterns are not required. In such instances, the drawings of developed views or flat patterns are for information rather than mandatory use and shall be labeled "NONMANDATORY PROCESS."

5-24 SPECIFICATION CONTROL DRAWINGS

5-24.1 DEFINITION. A specification control drawing is a drawing that states overall, mounting, and mating dimensions and specifies other characteristics sufficient to insure physical and functional interchangeability regardless of the manufacturer. The words "Specification Control Drawing" shall be included in the title block, as illustrated in figure 5-14. Specification Control Drawings shall be prepared for commercial items as defined in paragraph 3-7.2 and further defined as items which were designed and developed by the vendor.

5-24.2 CHARACTERISTICS. Specification control drawings shall contain, when applicable, the following data:

a. Engineering requirements for the item, such as overall, mounting, and mating dimensions, tolerances, form, finish, etc., and performance and product characteristics necessary to enable the government to procure the item or to obtain an interchangeable substitute. To permit second sources greater freedom in meeting size specifications, overall dimensions, as opposed to mounting and mating dimensions, shall be expressed as maximum (with the abbreviation "MAX" following each dimension) rather than as dimensions with tolerances.

b. Information sufficient to determine compliance with the engineering requirements for the item, such as (1) engineering and evaluation tests, (2) service maintenance, adjustment, and settings, and (3) special inspection and test date. Such information should either be specified on the drawing or be invoked thereon consistent with the criteria established in specifications or other documents.

5-24.3 EXTERNAL FITTINGS. External fittings (terminals, fasteners, drain plugs, cover plates, gaskets, etc.) that may become lost or damaged shall be tabulated. The tabulation shall include a description of these fittings and a cross-reference to a suitable substitute identified by a government number when available. The description should include (when applicable) size, material, thread designation, class, type, length, etc. This tabulation shall be interpreted to mean that the vendor is not required to supply fittings conforming to the government alternative, but only required to supply fittings conforming to the description. The government alternative is shown to facilitate replacement.

5-24.4 SOURCE. The specification control drawing shall contain the following note:

PROCURE ONLY FROM APPROVED SOURCES LISTED
ON ND 1002034 FOR THIS DRAWING.

5-25 DASH NUMBER

A dash number is a number assigned to a part or assembly which, in combination with the drawing number, serves as the identifying number of the part or assembly for purposes of procurement and marking.

5-26 DASH NUMBER SYSTEM

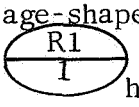
The dash number system of drawing preparation is a concept based upon the maximum practicable use of detail-assembly, tabulated assembly, and tabulated detail drawings to define minor variations in parts and assemblies. The National Aeronautics and Space Administration encourages the use of tabulated detail drawings, but requires that detail-assembly drawings be restricted to the applications stated in paragraph 5-21.

Various means of indicating dash numbers on drawings are illustrated in figures 5-15 and 5-12.

5-27 FIND NUMBER SYSTEM OF IDENTIFICATION

5-27.1 DEFINITION. A Find Number is a number assigned to a part or subassembly for the purpose of locating the part or subassembly in the field of the assembly drawing. The Find Number is also shown in the parts list on the assembly drawing. Parts and subassemblies are identified by other numbers for purposes of procurement and marking. These identifying numbers are cross-referenced to the Find Numbers in the tabulation on the assembly drawing.

5-27.2 APPLICATION AND LIMITATION. The find number system provides a quick means of locating parts on a relatively small area of a drawing having a high density of parts. Figure 5-15 is a sample drawing of an electronic chassis assembly using the find number system. The find number system of identification shall also be used to locate pieces on drawings of inseparable assemblies. See figure 5-13.

5-27.3 DRAWING REQUIREMENTS. When used in the field of the drawing, Find Numbers shall be enclosed in sausage-shaped balloons. However, it is preferable that split sausage-shaped balloons 

be used with the top of the balloon for reference designation and bottom half of balloon for find number. The find numbers on any drawing shall be assigned independently of those on any other drawing. For drawings of electronic chassis assemblies, if the outlines of resistors or capacitors are shown, the reference designations, when practicable, shall be placed within those outlines. The corresponding Find Numbers shall be omitted from the views. In such instances, a table shall be provided on the drawing to show the Find Number assigned to each item that is identified by a reference designation on the views. The same Find Number shall be used for any group of reference designations assigned to items of identical characteristics. The Find Numbers on any drawing shall be assigned independently of those on any other drawing. Find Numbers assigned to subassemblies shown on an assembly drawing shall be distinguished from those assigned to parts by adding a suffix letter to the subassembly Find Number. See figure 5-15 for Find Number applications.

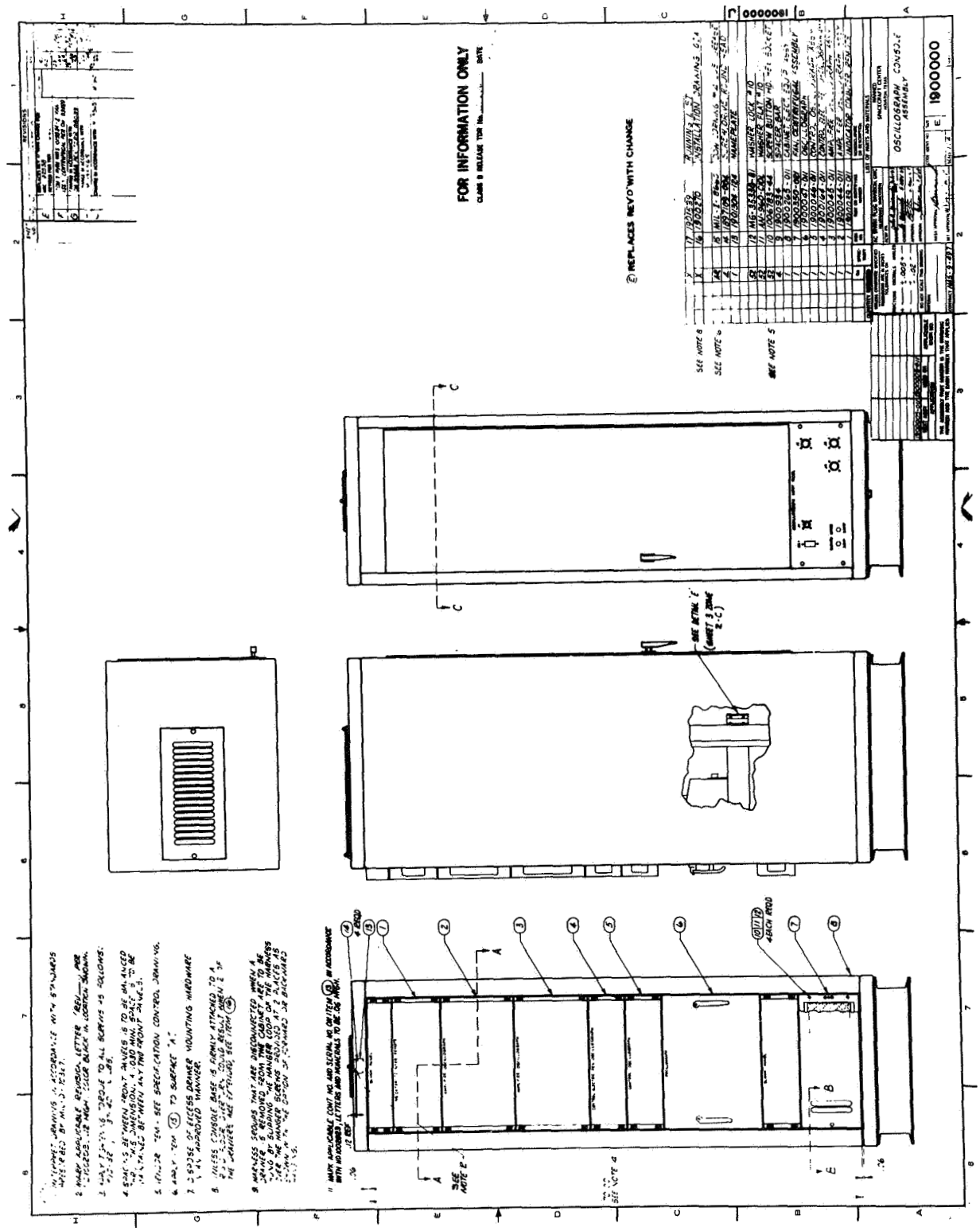
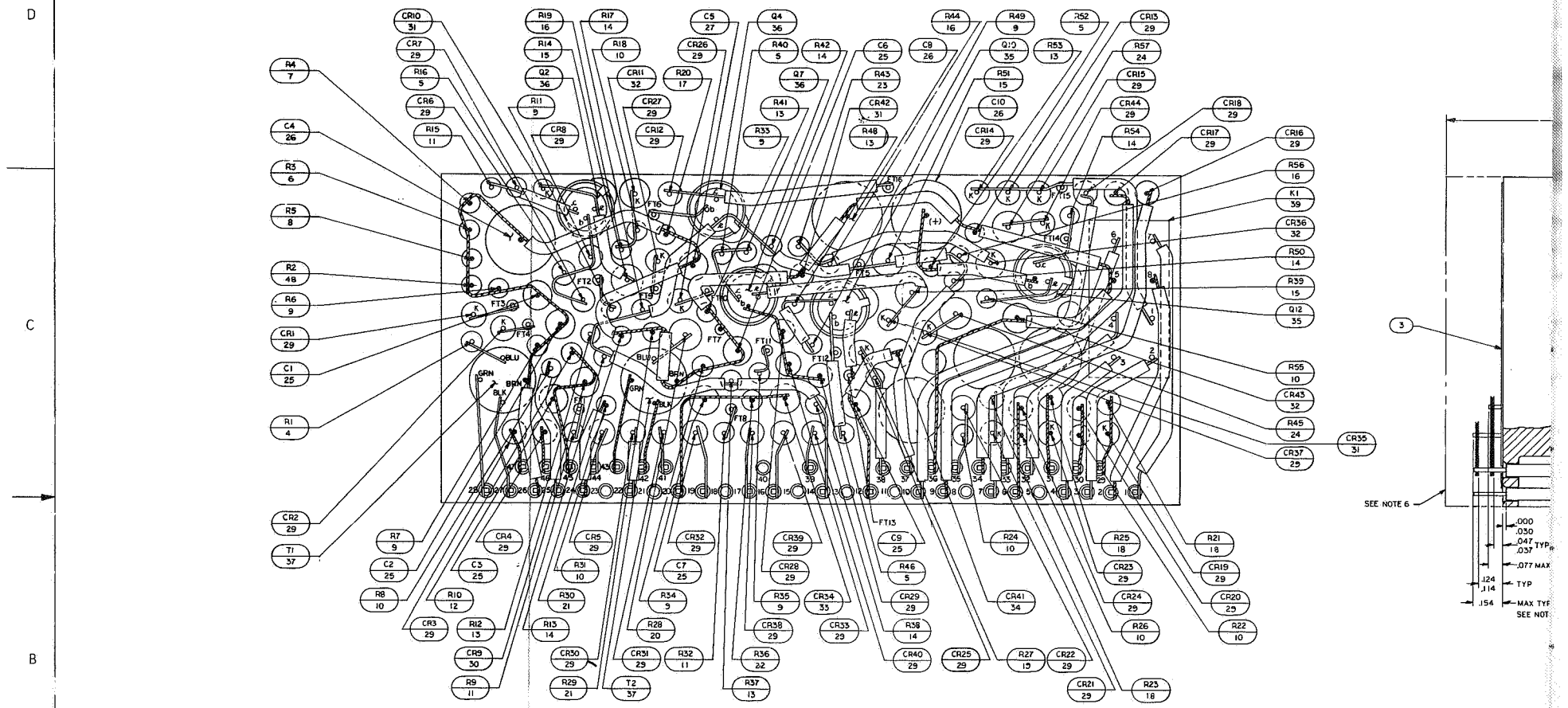


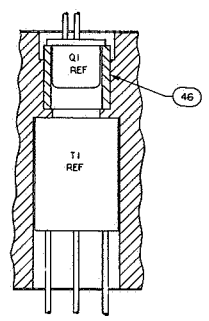
Figure 5-1a. Sample Mechanical Assembly Drawing.



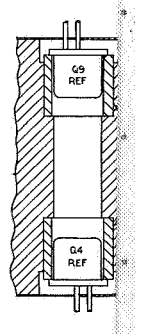
NOTES

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327
2. ASSEMBLE FIND NO. 40 AND 45 PER ND1002136
3. ALL CONNECTIONS TO BE MADE BY WELDING PER ND1002005
4. BLACK DOT AND CROSSHATCHED RIBBONS INDICATE SECOND LEVEL WIRING
5. K INDICATES CATHODE SIDE OF DIODE
6. ENCAPSULATE MODULE PER ND1002002 (BLACK POLYURETHANE FOAM) UNLESS OTHERWISE SPECIFIED PERIPHERAL ENCAPSULANT DIMENSIONS MAY EXCEED THE NOMINAL HEATSINK WIDTH AND LENGTH DIMENSIONS BY A MAXIMUM OF .005. WHEN THE HEATSINK OUTLINE EXCEEDS THE ENCAPSULANT OUTLINE THE MAXIMUM DIMENSION BETWEEN ANY HEATSINK SURFACE AND ITS RESPECTIVE ENCAPSULANT SURFACE SHALL NOT EXCEED .015. REMOVE ALL FLASHING.
7. MARK PIN NUMBERS .08 HIGH (WHITE) AND SERIALIZE AND MARK ALL OTHER CHARACTERS .12 HIGH (WHITE) PER ND1002023. CENTRALIZE AS SHOWN. ABBREVIATIONS PERMISSIBLE.
8. INDICATED AREAS TO BE FREE OF ENCAPSULATING COMPOUND
9. STAKE FIND NO. 4 THRU 39 PER ND1002009
10. AR DENOTES AS REQUIRED
11. TYPICAL SLEEVING FOR R1 THRU R13, R15 THRU R27, R29 THRU R38, R40 THRU R44 R46, R48 THRU R50, R52 THRU R56, CR10, CR35 AND CR48
12. VALUE TO BE DETERMINED BY ELECTRICAL TEST PER ATP
13. PART TO BE SELECTED FROM CHART
14. ~~ENCAPSULATING COMPOUND MUST BE 1.000/.015 INSIDE HEATSINK PERIPHERY~~

R4		R5		R10	
PART NO.	VALUE	PART NO.	VALUE	PART NO	VALUE
1006750 - 45	3.6K	1006750 - 60	15K	1010569 - 93	330
* - 46	3.9K	* - 61	16K	* - 94	360
- 47	4.3K	- 62	18K	- 95	390
- 48	4.7K	- 63	20K	- 96	430
- 49	5.1K	- 64	22K	- 97	470
- 50	5.6K	- 65	24K	- 98	510
- 51	6.2K	- 66	27K	- 99	560
- 52	6.8K	- 67	30K	- 100	620
- 53	7.5K	- 68	33K	- 101	680
- 54	8.2K	- 69	36K	- 102	750
- 55	9.1K	- 70	39K	- 103	820
- 56	10K	- 71	43K	- 104	910
- 57	11K	- 72	47K	* - 105	1 MEG
- 58	12K	- 73	51K	1010565 - 106	1.1 MEG
- 59	13K	- 74	56K		
- 60	15K	- 75	62K		
- 61	16K	- 76	68K		
- 62	18K	* - 77	75K		
- 63	20K	1006750 - 78	82K		
- 64	22K				
- 65	24K				
- 66	27K				
- 67	30K				
- 68	33K				
- 69	36K				
- 70	39K				
* - 71	43K				
1006750 - 72	47K				



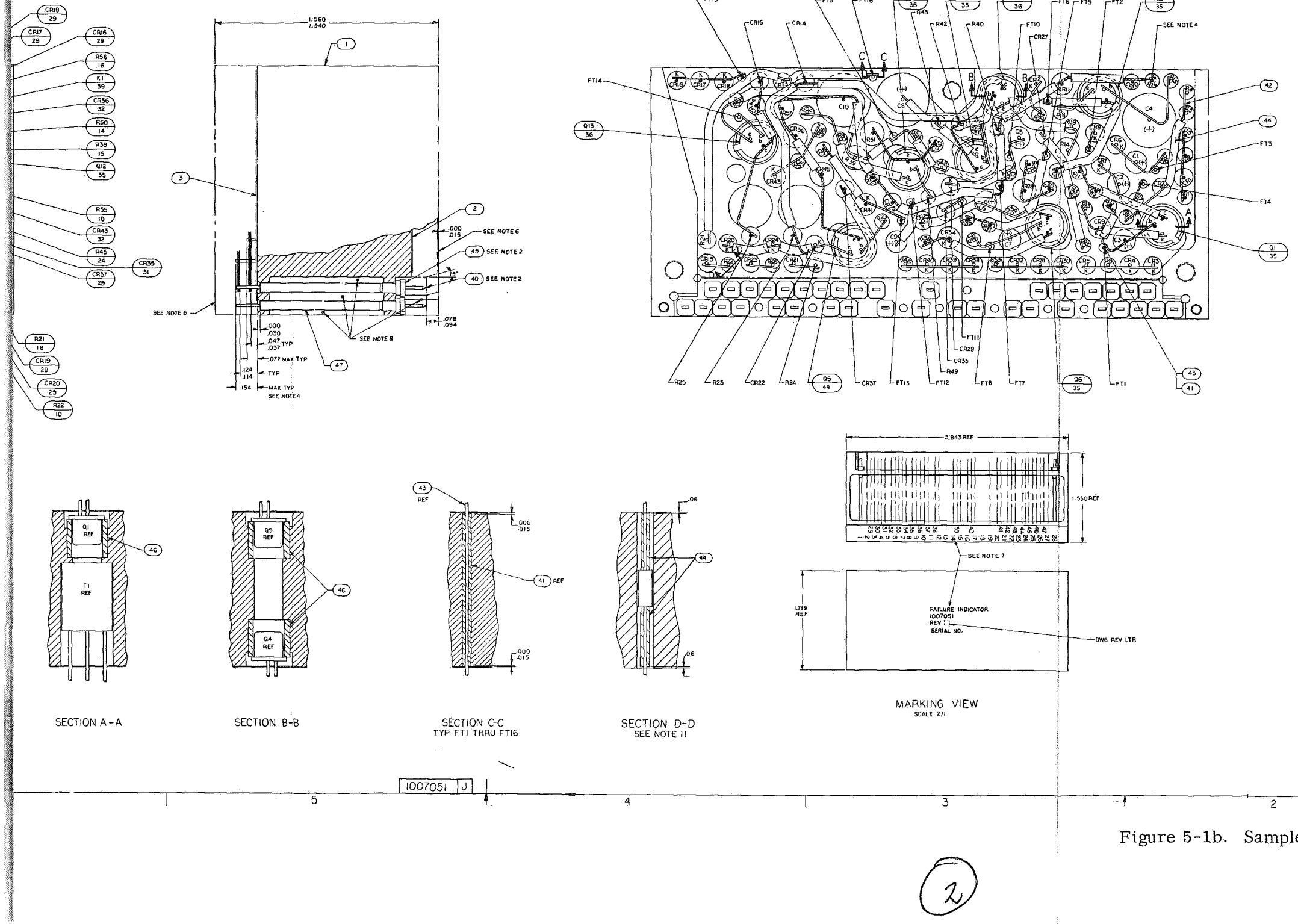
SECTION A-A



SECTION B-

0

ZONE	REVISIONS	DESCRIPTION	DATE	APPROVAL
	-	REVISED PER TORR 01779	6-14-67	WJK
	C	REVISED PER TORR 01957		
(2)	D	REVISED PER TORR 02163	7-26-67	WJK
	E	REVISED PER TORR 02534	8-14-67	WJK
(2)	F	REVISED PER TORR 03282	11-13-67	WJK
(2)	G	REVISED PER TORR 03282	11-13-67	WJK
(2)	H	REVISED PER TORR 04460	2-26-68	WJK
	J	REVISED PER TORR 05477	4-26-68	WJK



		SCHEMATIC	REF
	1010033		
1	1006752	TRANSISTOR	49
1	1006750-51	RESISTOR	48
A/R	1006776-20	INSULATION,SLEEVING ELECT	47
13	1008025 - 1	INSULATOR, BUSHING	46
38	1006775	INSULATOR,WRAPOST-MALE, MIN	45
A/R	1006776 - 21	INSULATION SLEEVING	44
A/R	1006757 - 8	WIRE ELEC .020 DIA	43
A/R	1006757 - 1	WIRE ELEC.010 X.020	42
A/R	1006776 - 22	INSULATION,SLEEVING ELECT	41
38	1006782 - 5	CONTACT, WRAPOST-MALE, MIN	40
1	1010353 - 4	RELAY	39
			38
2	1010467	TRANSFORMER	37
6	1010286	TRANSISTOR	36
6	1010397-1	TRANSISTOR	35
1	1010372 - 9	DIODE	34
1	1010372 - 4	DIODE	33
3	1010372 - 16	DIODE	32
3	1010286 - 009	DIODE	31
1	1010372 - 5	DIODE	30
35	1010385	DIODE	29
			28
1	1006755 - 57	CAPACITOR	27
3	1006755 - 89	CAPACITOR	26
6	1006755 - 69	CAPACITOR	25
2	1006760 - 43	RESISTOR	24
1	1006750 - 39	RESISTOR	23
1	1010369 - 101	RESISTOR	22
2	1006750 - 48	RESISTOR	21
1	1006760 - 48	RESISTOR	20
1	1006750 - 15	RESISTOR	19
3	1010604 - 3	RESISTOR	18
1	1006750 - 43	RESISTOR	17
3	1006750 - 53	RESISTOR	16
3	1006760 - 32	RESISTOR	15
6	1006750 - 49	RESISTOR	14
5	1006750 - 80	RESISTOR	13
X	1010369 SEE NOTE 12	RESISTOR	12
3	1006750 - 73	RESISTOR	11
7	1006750 - 32	RESISTOR	10
7	1006750 - 75	RESISTOR	9
X	1006750 SEE NOTE 12	RESISTOR	8
X	1006750 SEE NOTE 12	RESISTOR	7
1	1006750 - 45	RESISTOR	6
4	1006750 - 56	RESISTOR	5
1	1006750 - 44	RESISTOR	4
1	1008089	INSULATOR BOTTOM	3
1	1008088	INSULATOR TOP	2
1	1007038	HEATSINK	1
QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	FIND NO.

LIST OF MATERIALS

		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± DECIMALS XX±.02 XXX±.005 ANGLES ± DO NOT SCALE THIS DRAWING MATERIAL	MIT INSTRUMENTATION LAB CAMBRIDGE, MASS. DRAWN 10-18-67 CHECKED APPROVAL APPROVAL
1007152		HEAT TREATMENT	NASA APPROVAL 10-19-67
NEXT ASSY	USED ON	FINAL FINISH	MIT APPROVAL 10-19-67
APPLICATION			

MANNED SPACECRAFT CENTER HOUSTON, TEXAS

FAILURE INDICATOR MODULE ASSEMBLY

CODE IDENT NO. | SIZE J | NASA DRAWING NO. 1007051

SCALE 5/1 WT SHEET 1 OF 1

Figure 5-1b. Sample Electrical Assembly Drawing.

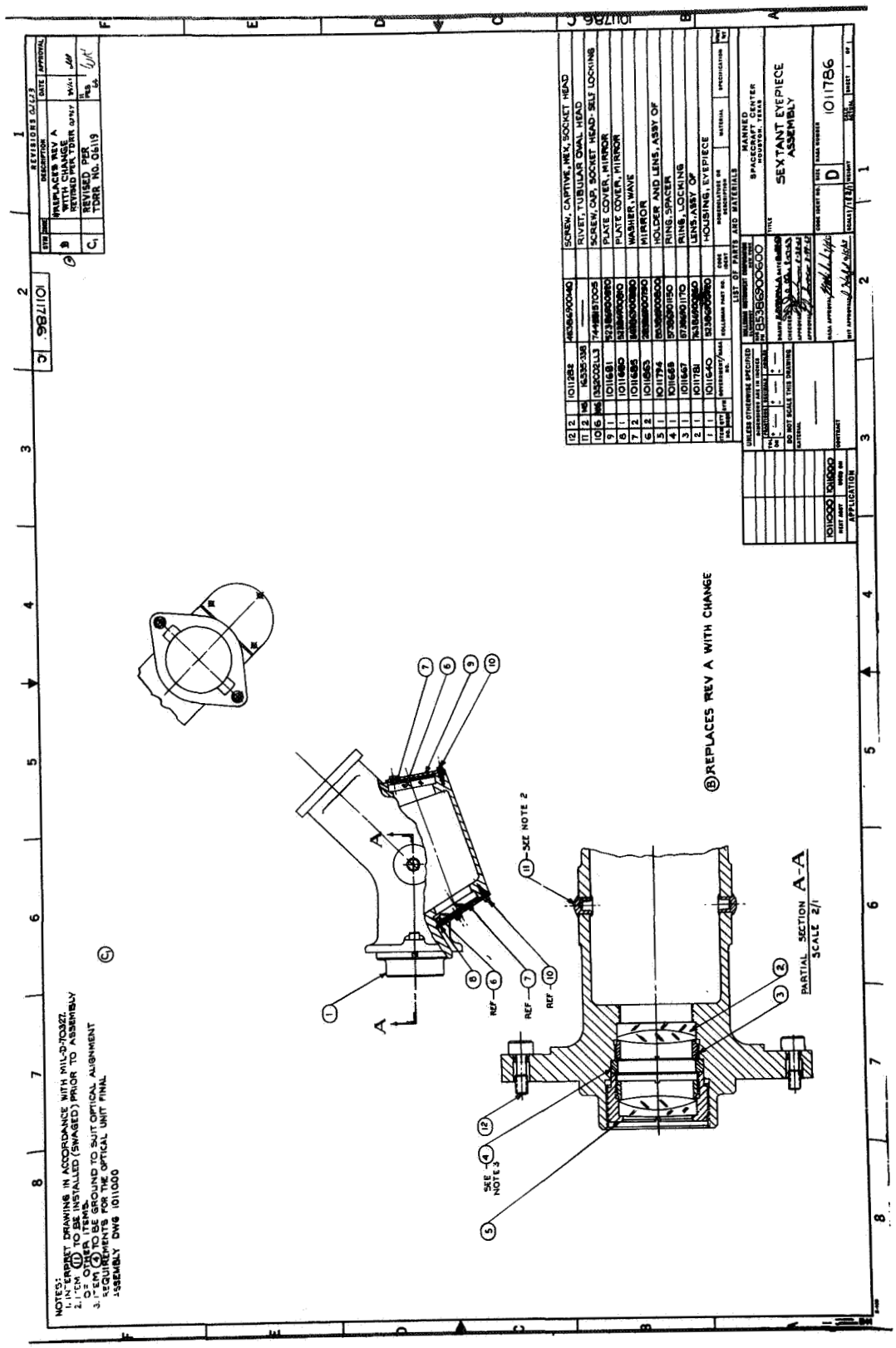


Figure 5-1c. Sample Optical Assembly Drawing.

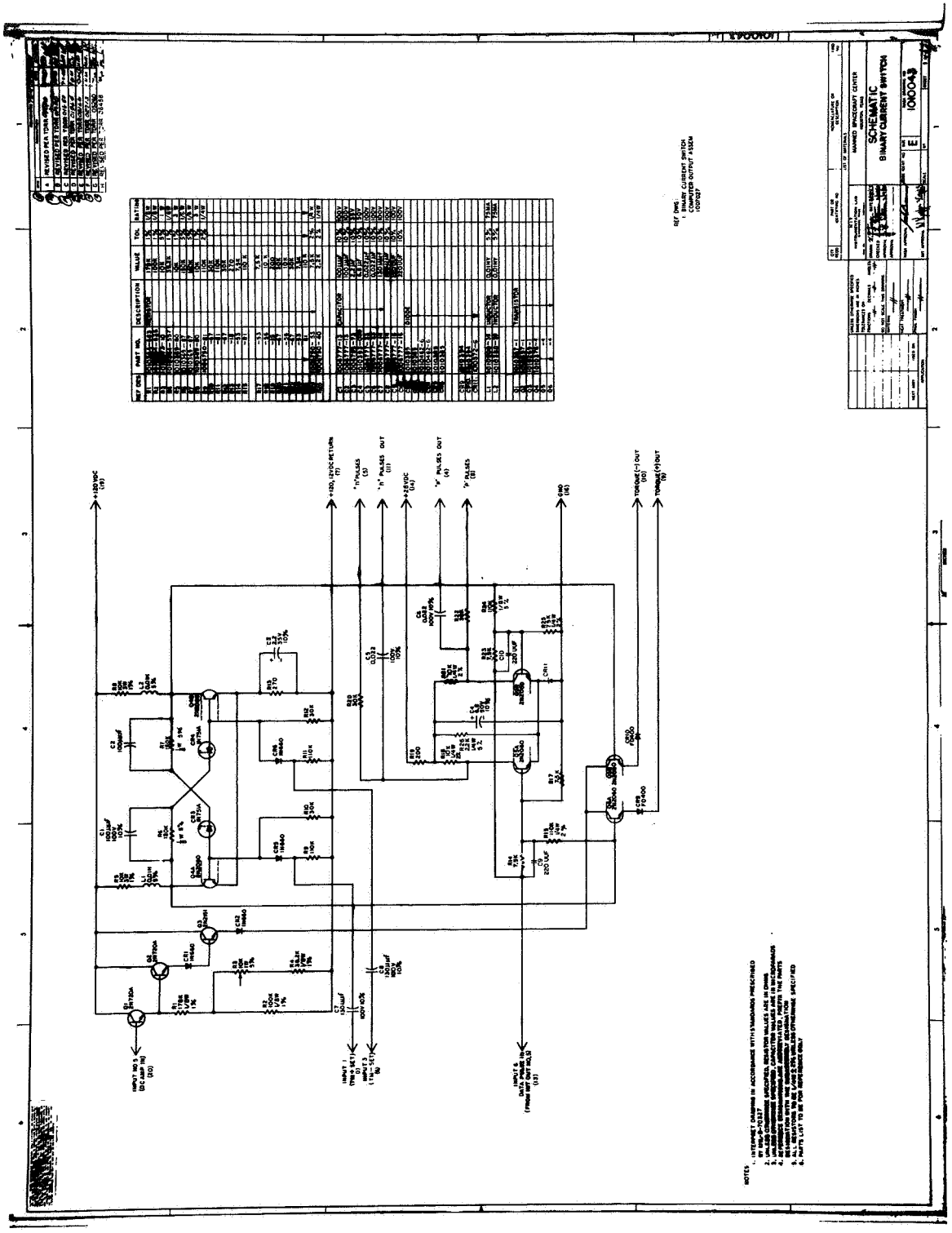


Figure 5-2. Sample Electrical Component Diagram.

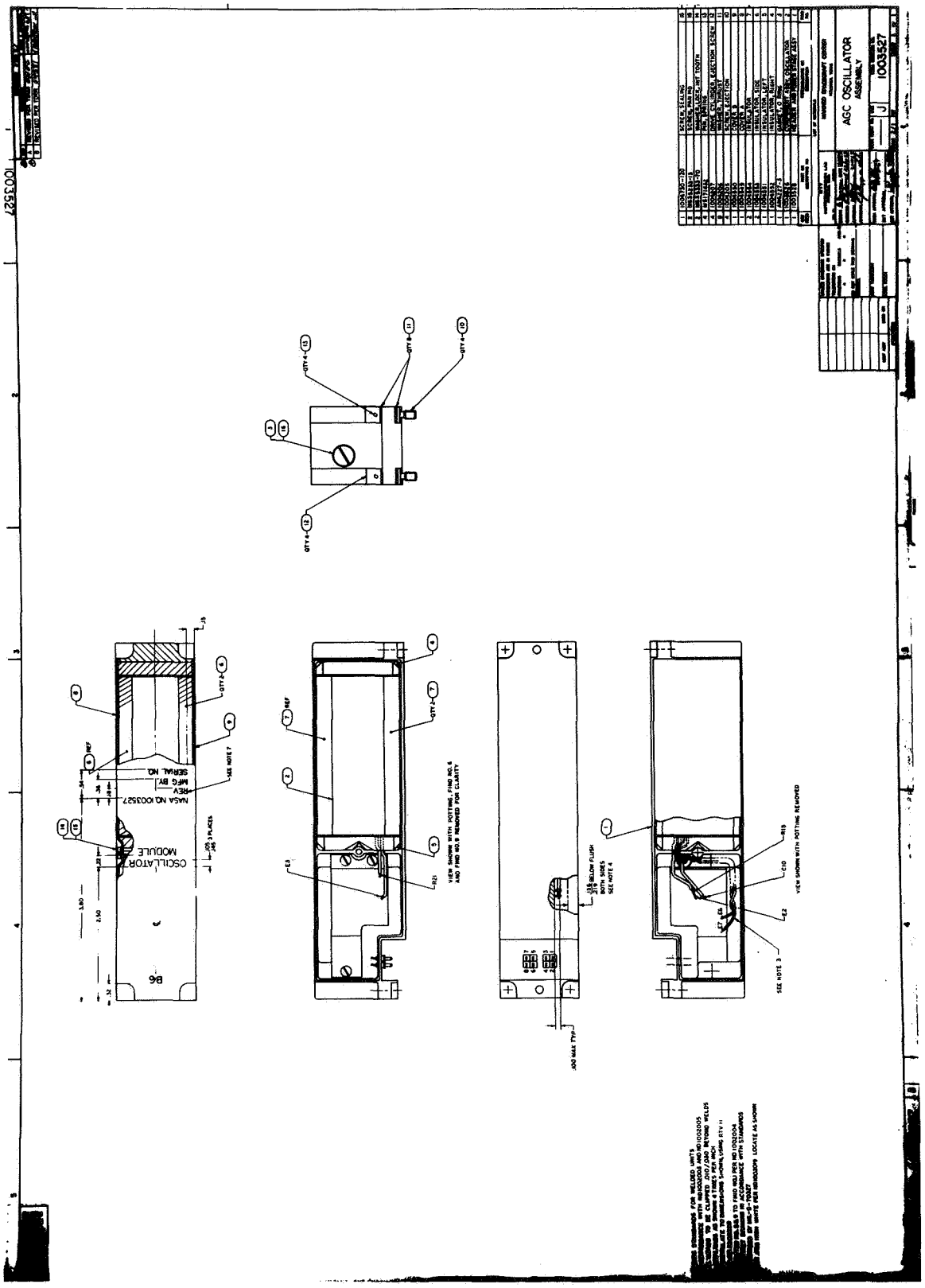


Figure 5-3. Sample Assembly Drawing Illustrating Use of Find Numbers.

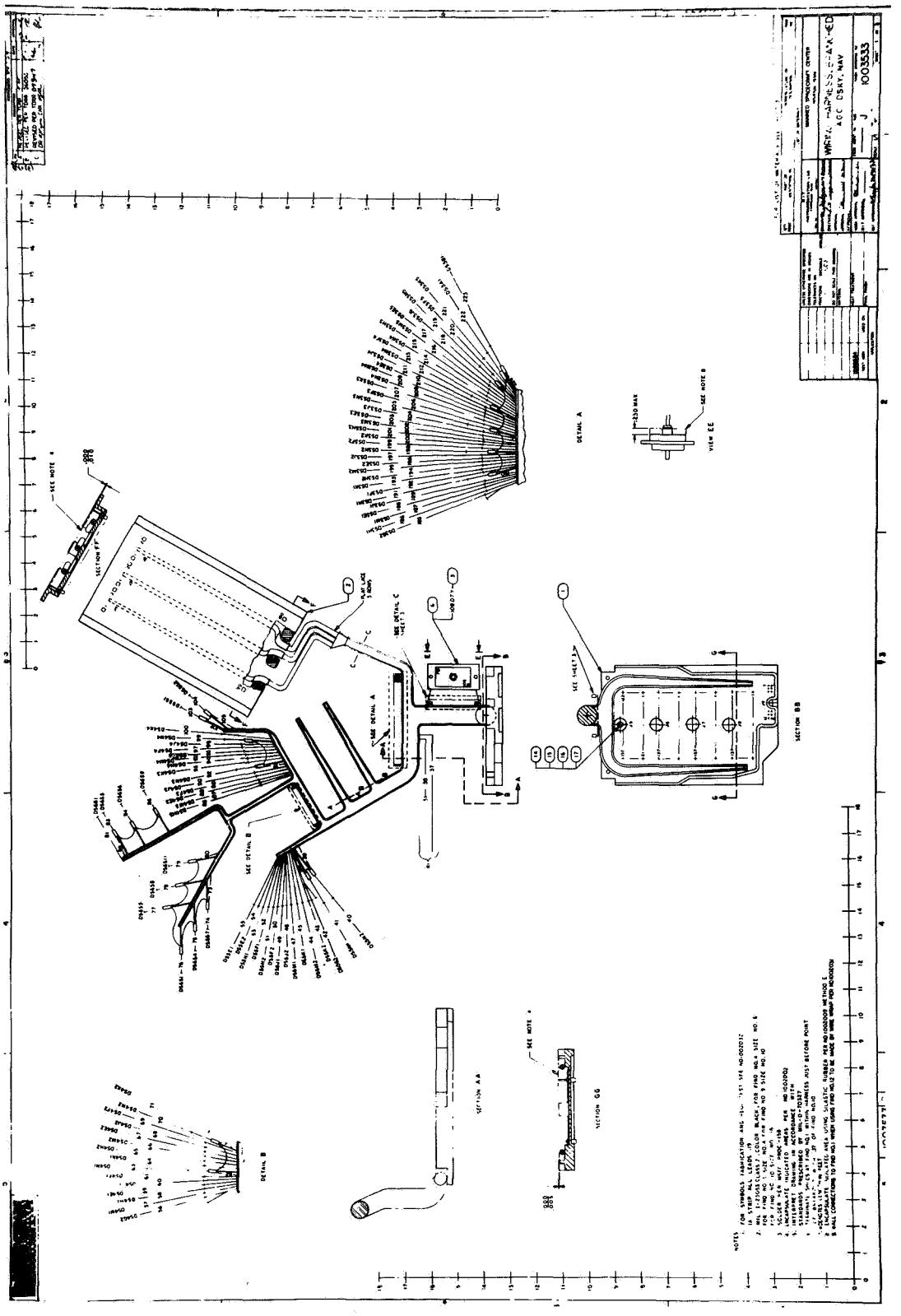


Figure 5-4. Sample Assembly Drawing, Wiring Harness, Branched (Sheet 1 of 3).

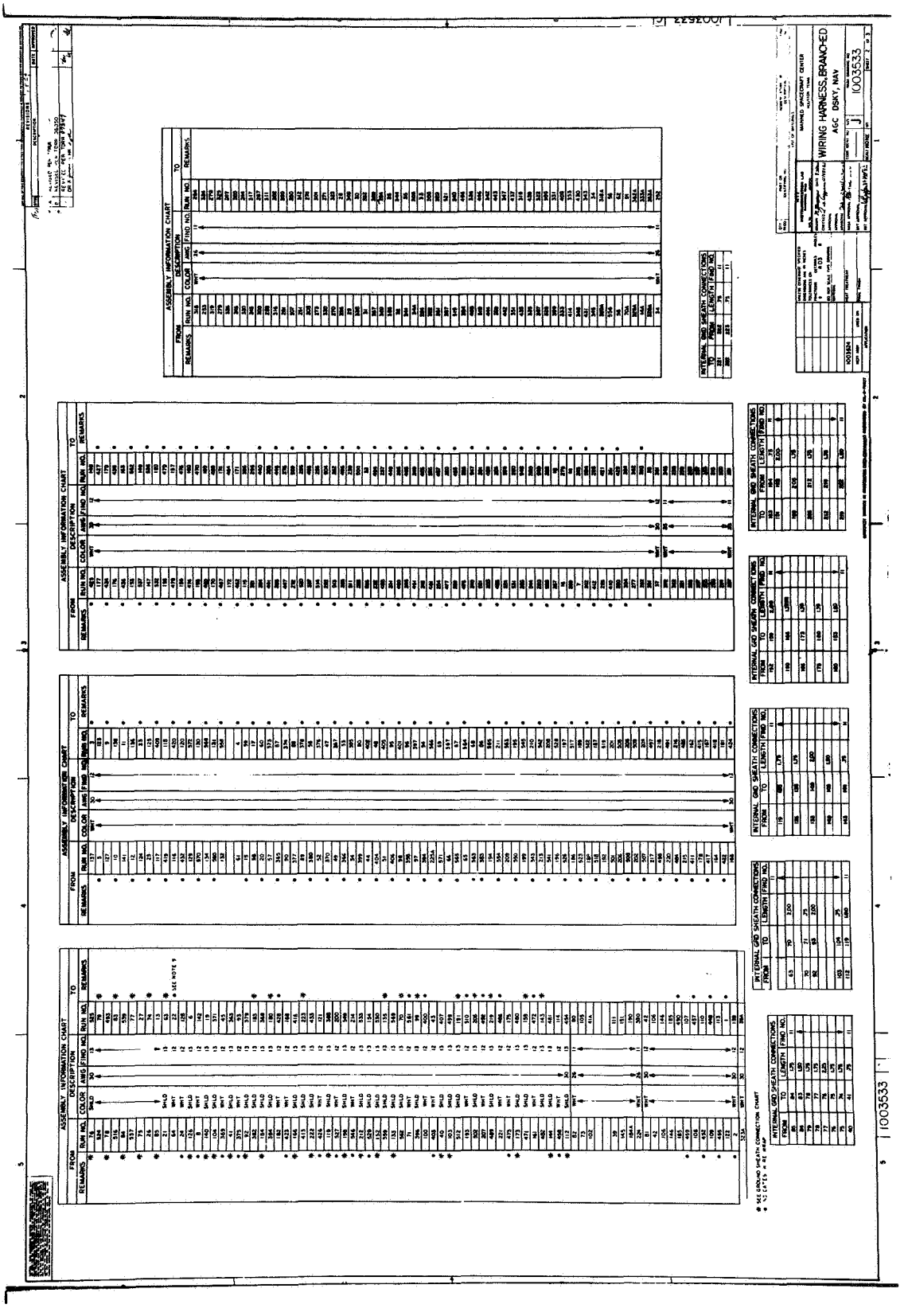


Figure 5-4. Sample Assembly Drawing, Wiring Harness, Branched (Sheet 2 of 3)

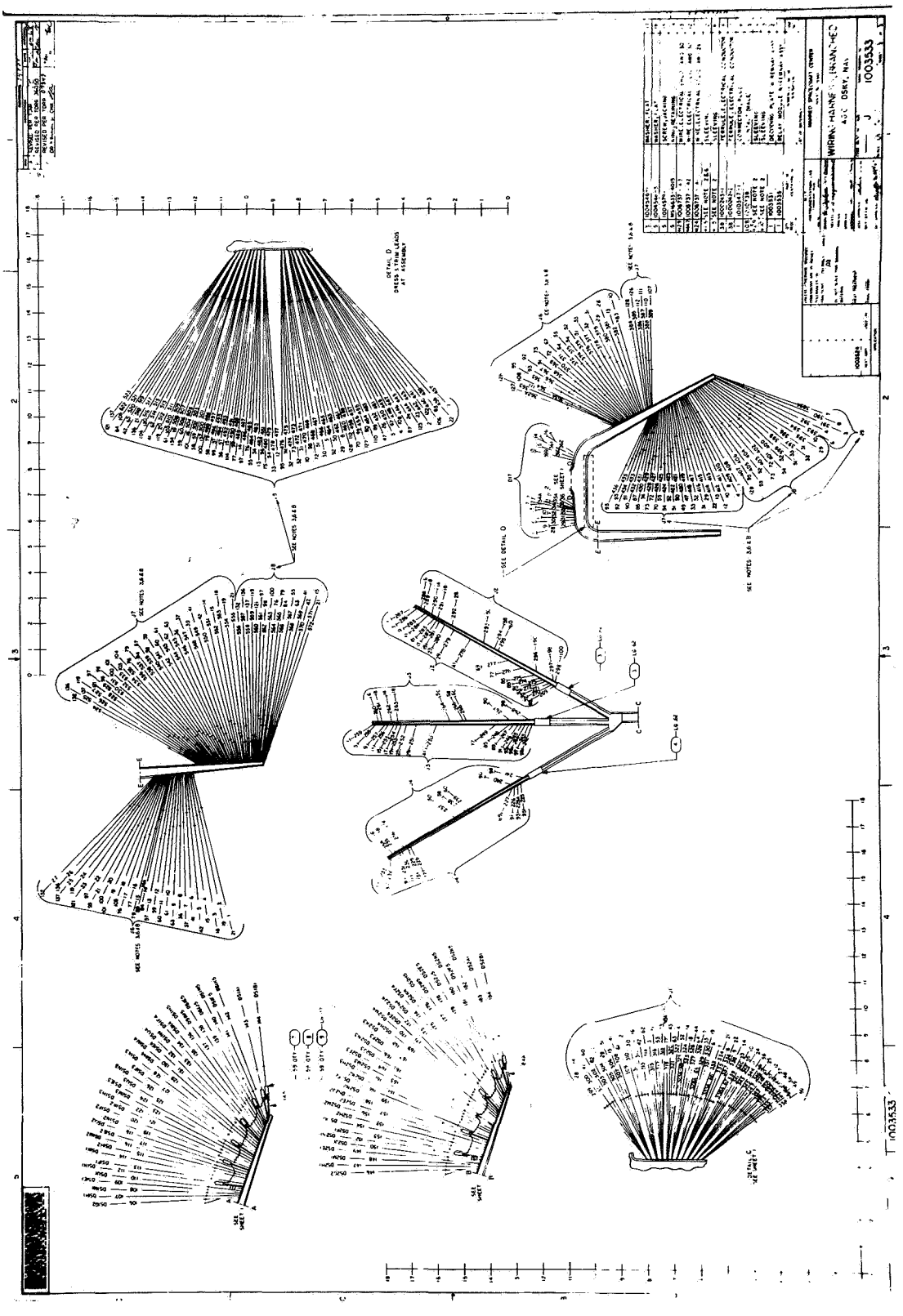


Figure 5-4. Sample Assembly Drawing, Wiring Harness, Branched (Sheet 3 of 3).

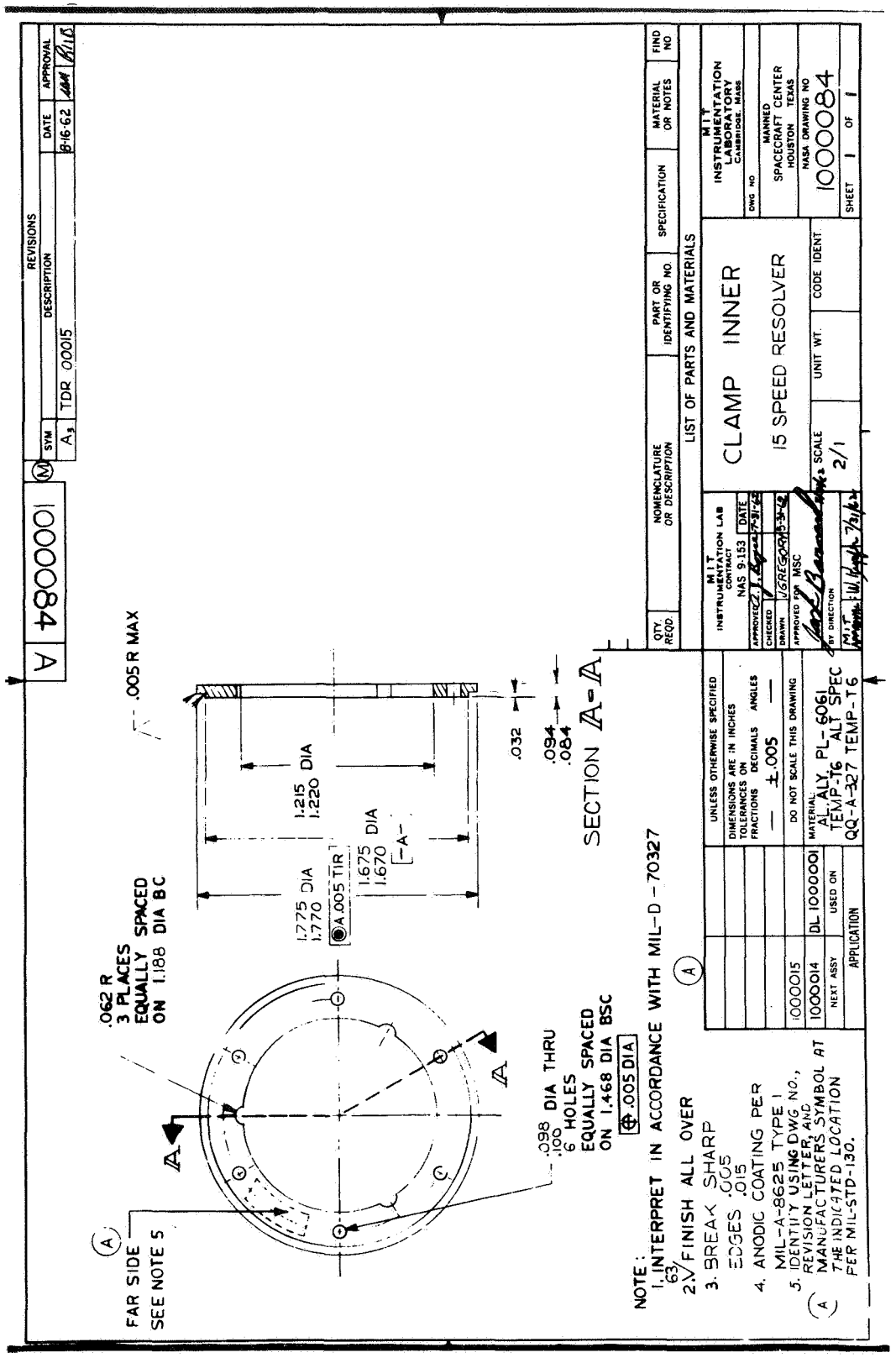
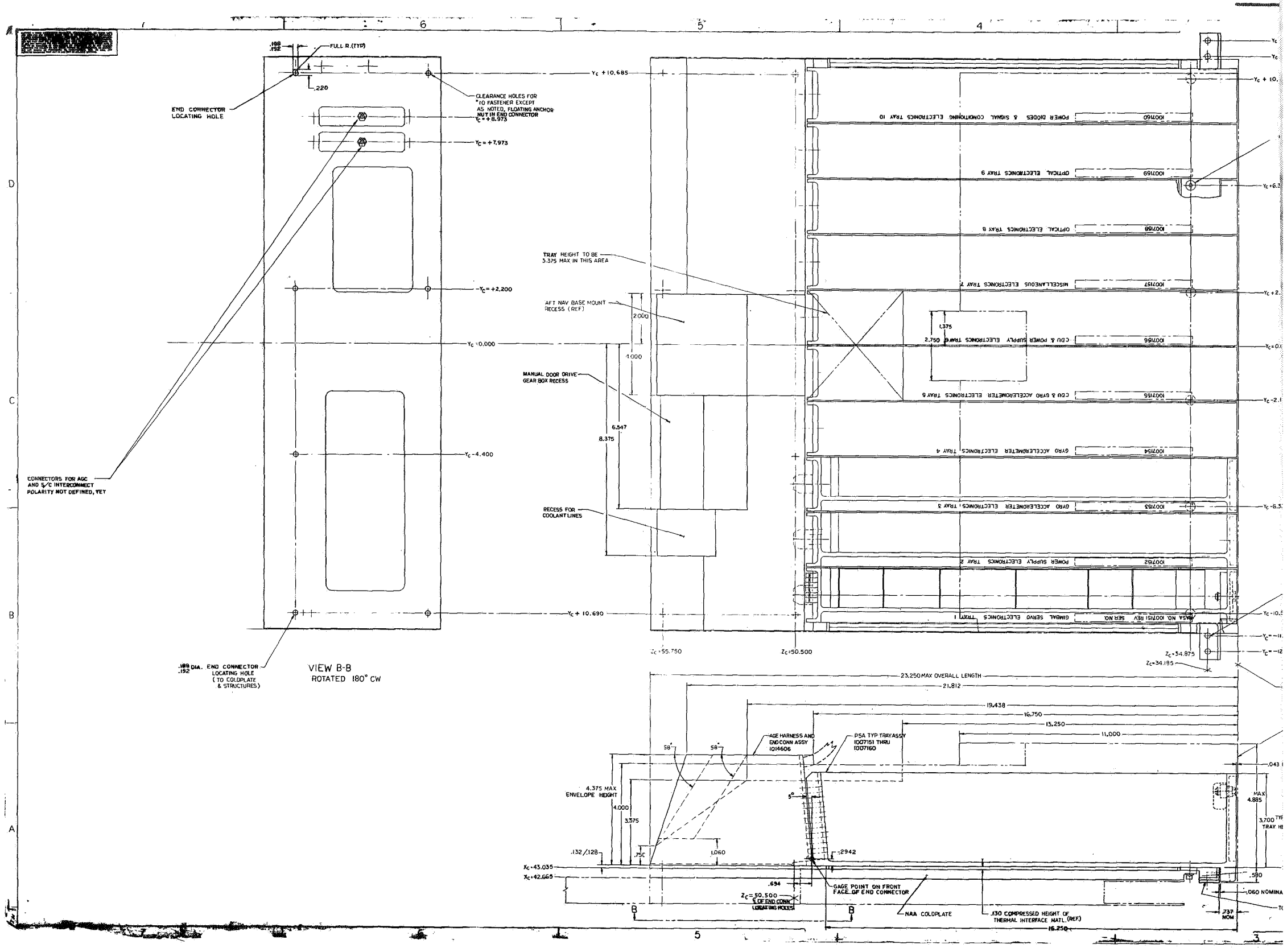


Figure 5-5. Sample Detail Drawing.


FULL R.(TYP)
.220
END CONNECTOR LOCATING HOLE
CLEARANCE HOLES FOR #10 FASTENER EXCEPT AS NOTED, FLOATING ANCHOR NUT IN END CONNECTOR
Yc = +8.973
Yc = +7.973
Yc = +2.200
Yc +0.000
Yc -4.400
Yc +10.685
Yc +10.690
CONNECTORS FOR AGC AND S/C INTERCONNECT POLARITY NOT DEFINED, YET
.189 .192 DIA. END CONNECTOR LOCATING HOLE (TO COLDPLATE & STRUCTURES)
VIEW B-B
ROTATED 180° CW
TRAY HEIGHT TO BE 3.375 MAX IN THIS AREA
AFT NAV BASE MOUNT RECESS (REF)
2.000
1.000
MANUAL DOOR DRIVE GEAR BOX RECESS
6.547
8.375
RECESS FOR COOLANT LINES
1007160 POWER DIODES & SIGNAL CONDITIONING ELECTRONICS TRAY 10
1007159 OPTICAL ELECTRONICS TRAY 9
1007158 OPTICAL ELECTRONICS TRAY 8
1007157 MISCELLANEOUS ELECTRONICS TRAY 7
1007156 CDU & POWER SUPPLY ELECTRONICS TRAY 6
1007155 CDU & GYRO ACCELEROMETER ELECTRONICS TRAY 5
1007154 GYRO ACCELEROMETER ELECTRONICS TRAY 4
1007153 GYRO ACCELEROMETER ELECTRONICS TRAY 3
1007152 POWER SUPPLY ELECTRONICS TRAY 2
MASA NO. 1007151 REV SER NO. GIMBAL SERVO ELECTRONICS TRAY 1
Zc=55.750
Zc=50.500
Zc=34.875
Zc=34.185
23.250 MAX OVERALL LENGTH
21.812
19.438
16.750
13.250
11.000
AGE HARNESS AND ENDCONN ASSY 1014606
PSA TYP TRAYASSY 1007151 THRU 1007160
58°
5°
4.375 MAX ENVELOPE HEIGHT
4.000
3.375
.132/.128
.750
1.060
.2942
Xc=43.035
Xc=42.665
.694
Zc=50.500 C OF END CONN LOCATING HOLES
GAGE POINT ON FRONT FACE OF END CONNECTOR
NAA COLDPLATE
.130 COMPRESSED HEIGHT OF THERMAL INTERFACE MATL (REF)
16.250
.043
MAX 4.885
3.700 TYP TRAY HE
.590
.060 NOMINA
.737 NOM

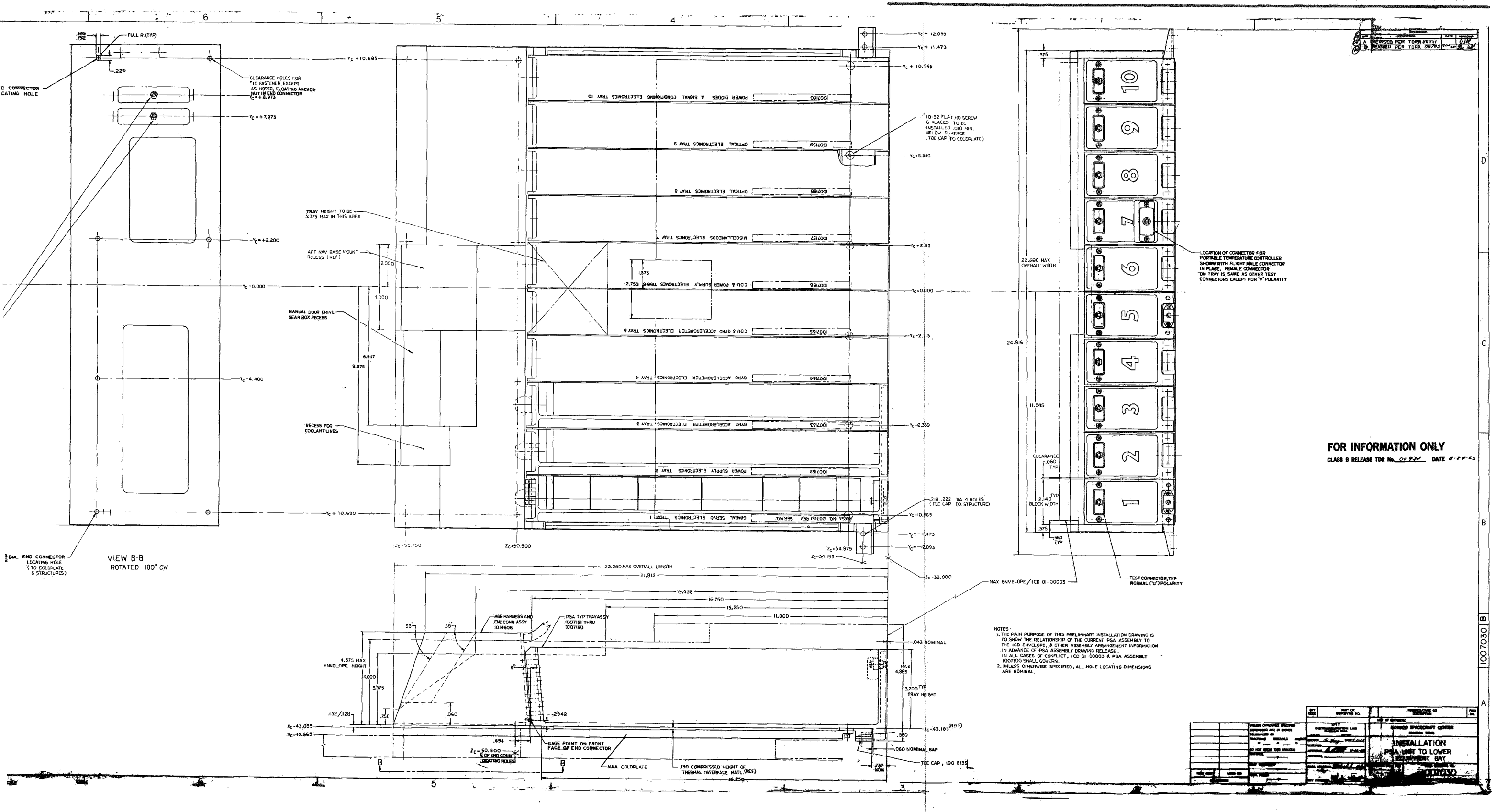


Figure 5-6. Sample Installation Drawing.

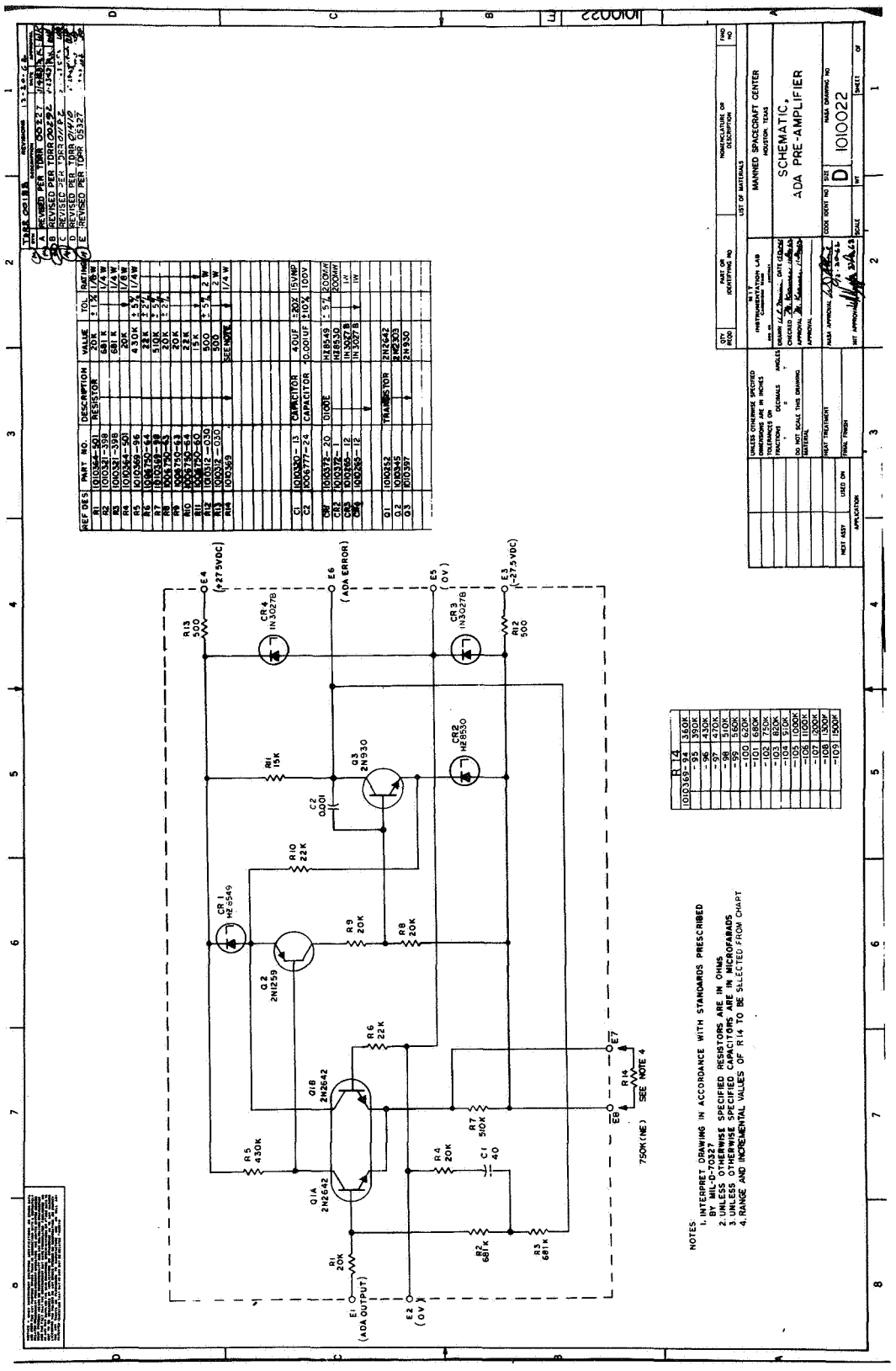
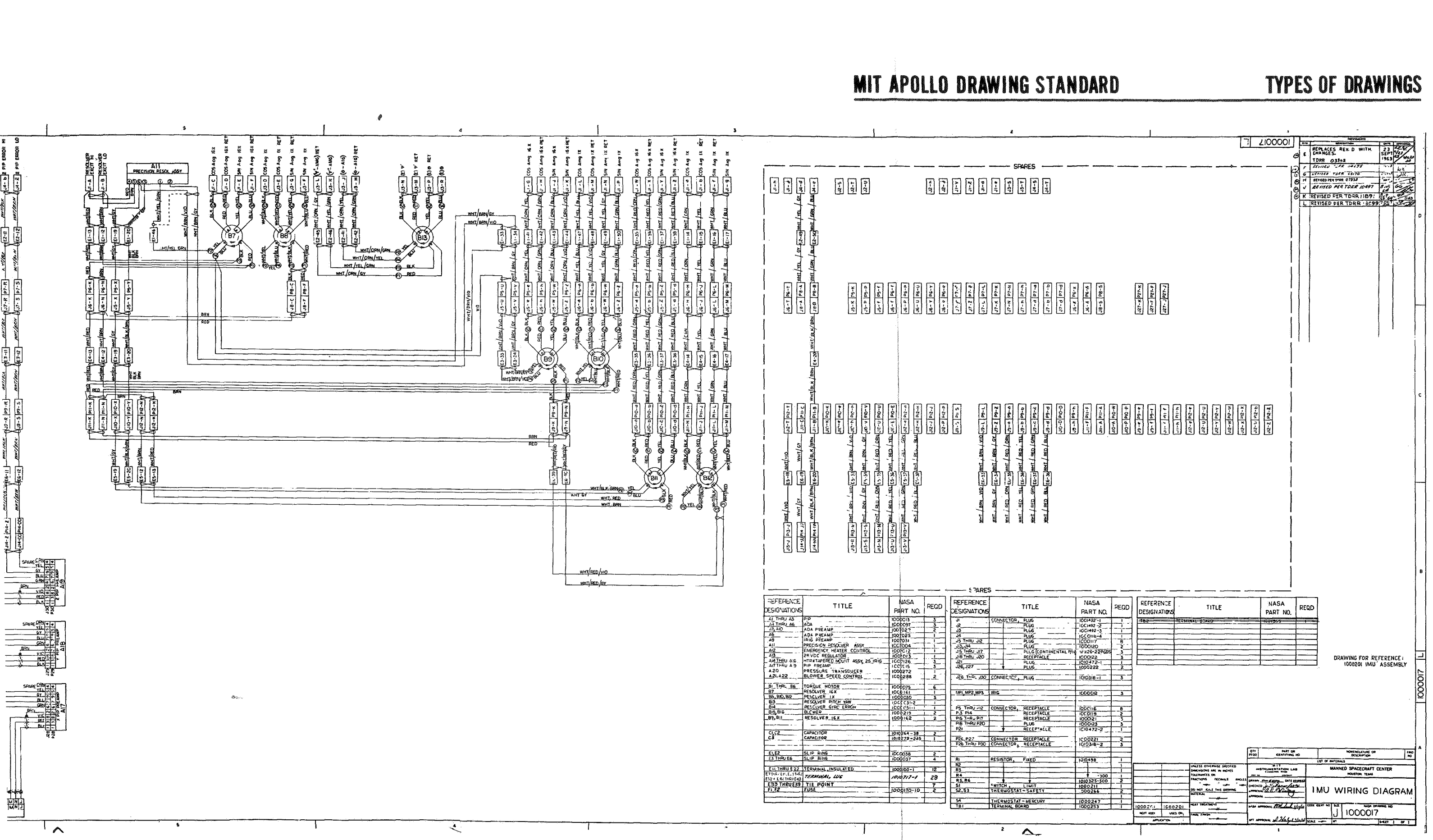


Figure 5-7. Sample Electrical Schematic Diagram.



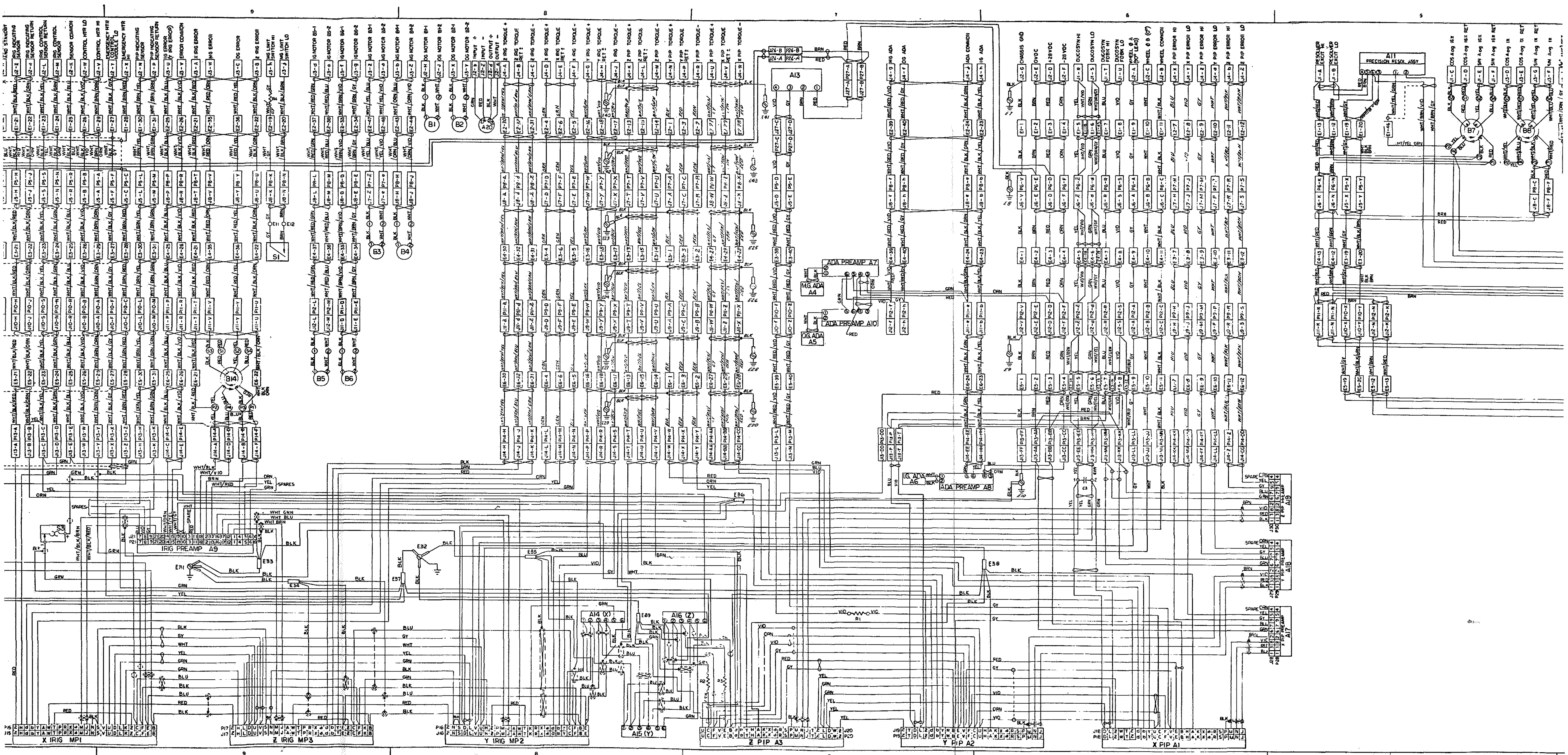
REFERENCE DESIGNATIONS	TITLE	NASA PART NO.	REQD
A1 THRU A3	PIP	1000015	3
A4 THRU A6	ADA	1000097	3
A7, A10	ADA PREAMP	1007027	2
A8	ADA PREAMP	1007025	1
A9	IRIG PREAMP	1007031	1
A11	PRECISION RESOLVER ASSY	1CC1004	1
A12	EMERGENCY HEATER CONTROL	1007012	1
A13	28 VDC REGULATOR	1007013	1
A14 THRU A16	MINIATURIZED MOUT ASSY, 25 IRIG	1CC1026	3
A17 THRU A19	PIP PREAMP	1CC1015	3
A20	PRESSURE TRANSDUCER	1000272	1
A21, A22	BLOWER SPEED CONTROL	1CC0288	2
B1 THRU B6	TORQUE MOTOR	1000075	6
B7	RESOLVER 1GX	1CC0161	1
B8, B10, B12	RESOLVER 1X	1000030	3
B9	RESOLVER PITCH YAW	1CCFC31-2	1
B14	RESOLVER GYRO ERROR	1CCFC31-1	1
B15, B16	BLOWER	1001219	2
B17, B11	RESOLVER 16X	1000162	2
C1, C2	CAPACITOR	1010264-38	2
C3	CAPACITOR	1010279-245	1
E1, E2	SLIP RING	1CC0038	2
E3 THRU E6	SLIP RING	1000037	4
E11 THRU E22	TERMINAL, INSULATED	1000100-1	12
E7 THRU E10, E23 THRU E32, E40 THRU E43	TERMINAL, LUG	1010717-1	29
E33 THRU E39	TIE POINT		7
F1, F2	FUSE	1000170-10	2

REFERENCE DESIGNATIONS	TITLE	NASA PART NO.	REQD
J1	CONNECTOR, PLUG	1CC1492-1	1
J2	PLUG	1CC1492-2	1
J3	PLUG	1CC1492-3	1
J4	PLUG	1CC0118-4	1
J5 THRU J12	PLUG	1CC0117	8
J13, J14	PLUG	1000020	2
J15 THRU J17	PLUG (CONTINENTAL P/N MJ26-22PDS)		3
J18 THRU J20	RECEPTACLE	1000022	3
J21	PLUG	1CC0472-1	1
J26, J27	PLUG	1000222	2
J28 THRU J30	CONNECTOR, PLUG	1010318-1	3
MP1, MP2, MP3	IRIG	1000012	3
P5 THRU P12	CONNECTOR, RECEPTACLE	1CC0116	8
P13, P14	RECEPTACLE	1CC0119	2
P15 THRU P17	RECEPTACLE	1000121	3
P18 THRU P20	PLUG	1000123	3
P21	RECEPTACLE	1CC0472-2	1
P26, P27	CONNECTOR RECEPTACLE	1000221	2
P28 THRU P30	CONNECTOR, RECEPTACLE	1010318-2	3
R1	RESISTOR, FIXED	1010498	1
R2			1
R3			1
R4		-300	1
R5, R6		1010325-500	2
S1	SWITCH, LIMIT	1000211	1
S2, S3	THERMOSTAT-SAFETY	1000266	2
S4	THERMOSTAT-MERCURY	1000247	1
TB1	TERMINAL BOARD	1000253	1

REFERENCE DESIGNATIONS	TITLE	NASA PART NO.	REQD
TB2	TERMINAL BOARD	1000300	1

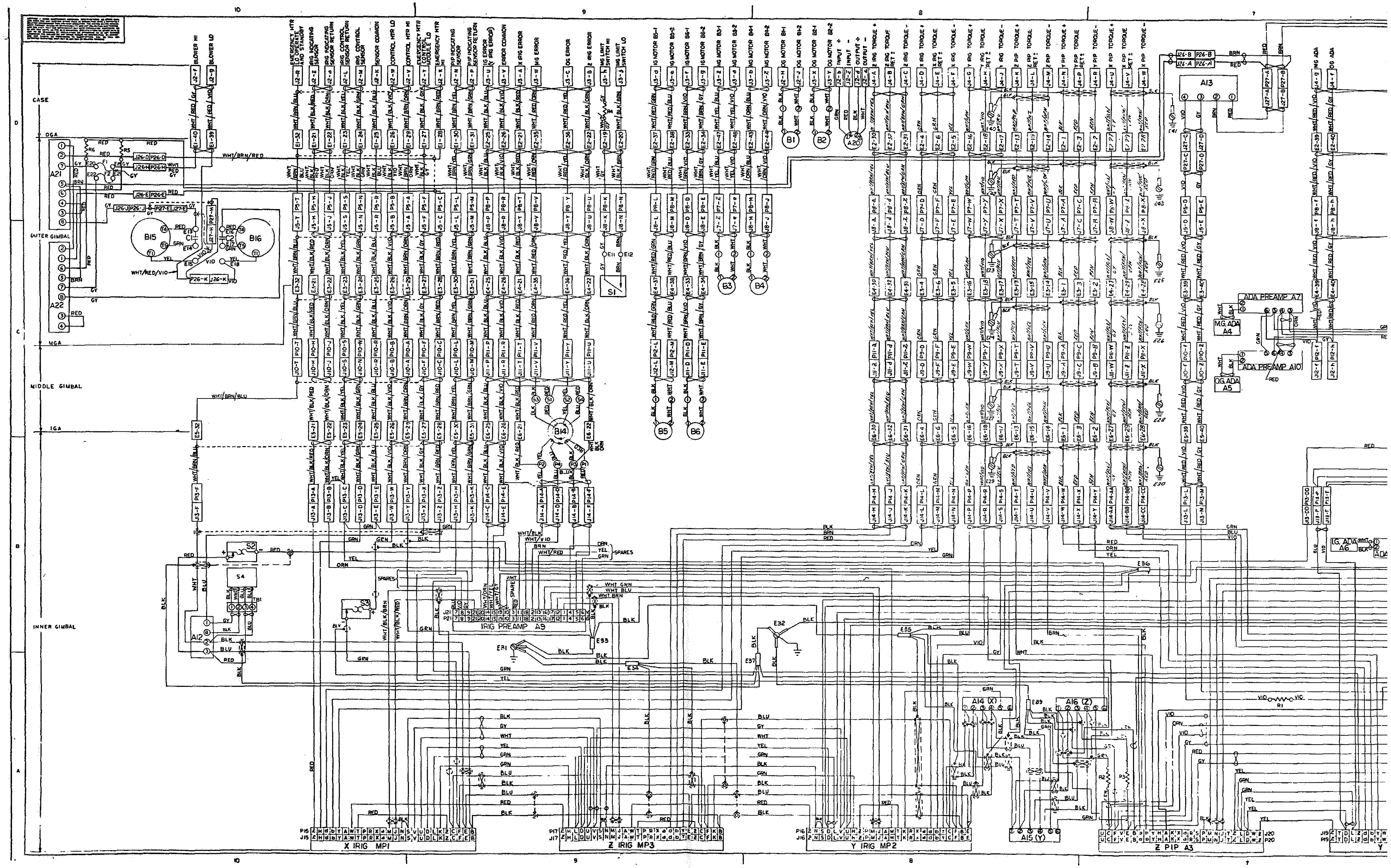
REV. LTR	DESCRIPTION	DATE	APPROVED
E	REPLACES REV. D WITH CHANGES. TDRR 03248	23 SEPT 1963	
F	REVISED PER TDRR 04138		
G	REVISED PER TDRR 05170		
H	REVISED PER TDRR 07353		
J	REVISED PER TDRR 10497		
K	REVISED PER TDRR 11897		
L	REVISED PER TDRR 13699		

Figure 5-8. Sample Highway Wiring Diagram, Point-to-Point Type.


X IRIG MP1
Z IRIG MP3
Y IRIG MP2
A15 (Y)
Z PIP A3
Y PIP A2
X PIP A1
IRIG PREAMP A9
A14 (X)
A16 (Z)
A17
A18
A19
ADA PREAMP A7
ADA PREAMP A10
ADA PREAMP A8
MG ADA A4
OG ADA A5
IG ADA A6
A13
A11 PRECISION RESOL ASSY
CHASSIS GND
OVDC
+28VDC
-28VDC
DUCOSYN HI
DUCOSYN LO
WHEEL COMMON
X PIP ERROR HI
X PIP ERROR LO
Y PIP ERROR HI
Y PIP ERROR LO
Z PIP ERROR HI
Z PIP ERROR LO
IG ADA
ADA COMMON
OG ADA
MG ADA
RESOLVER EXCIT HI
RESOLVER EXCIT LO
OG ERROR
MG ERROR
X IRIG ERROR
ERROR COMMON
CONTROL HTR HI
CONTROL HTR LO
SENSOR COMMON

4

3



CASE
OUTER GIMBAL
MIDDLE GIMBAL
INNER GIMBAL
IRIG PREAMP A9
X IRIG MP1
Z IRIG MP3
Y IRIG MP2
Z PIP A3
ADA PREAMP A7
ADA PREAMP A10

5

4

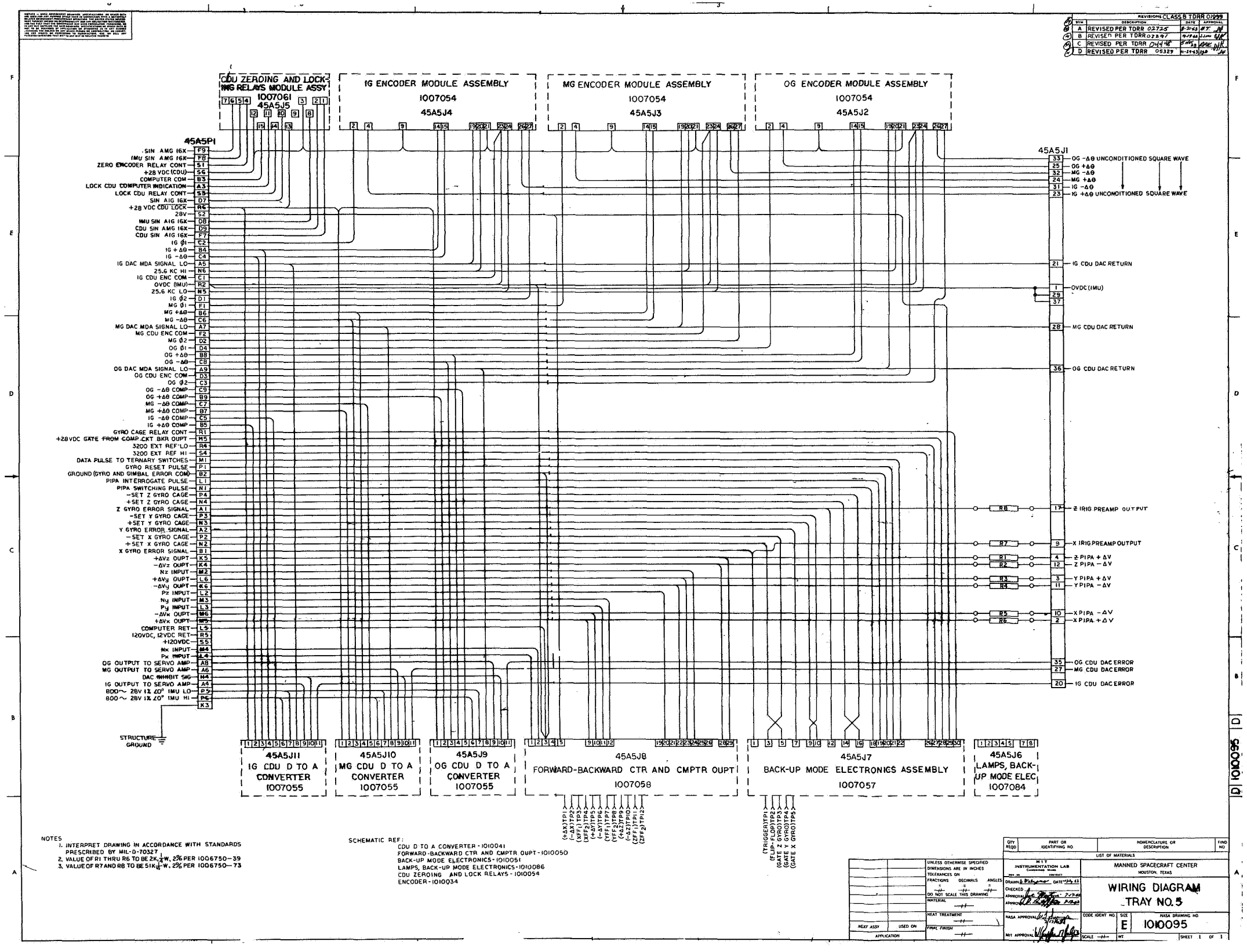


Figure 5-9. Sample Highway Wiring Diagram, Channel Type.

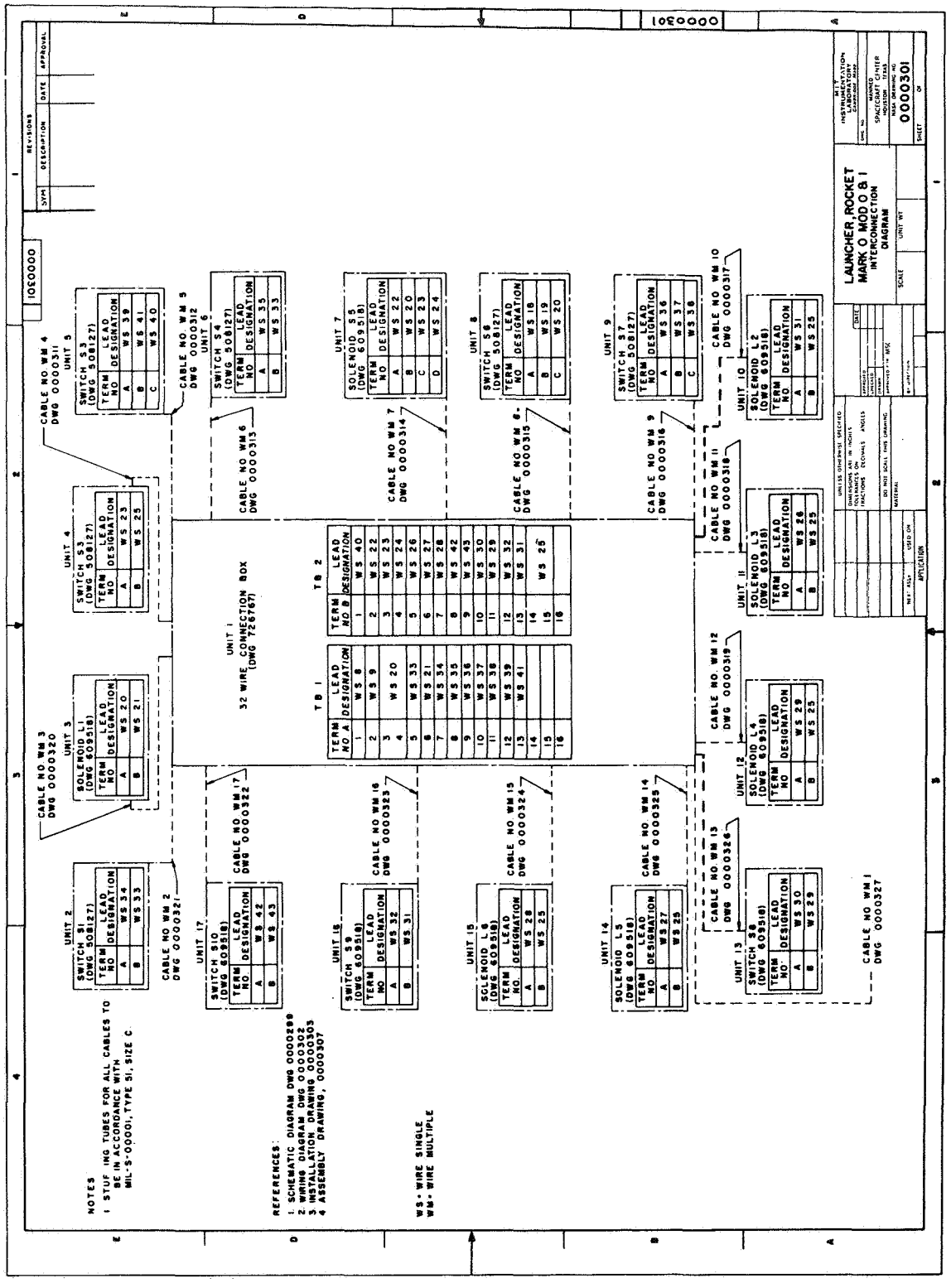


Figure 5-10. Sample Interconnection Diagram.

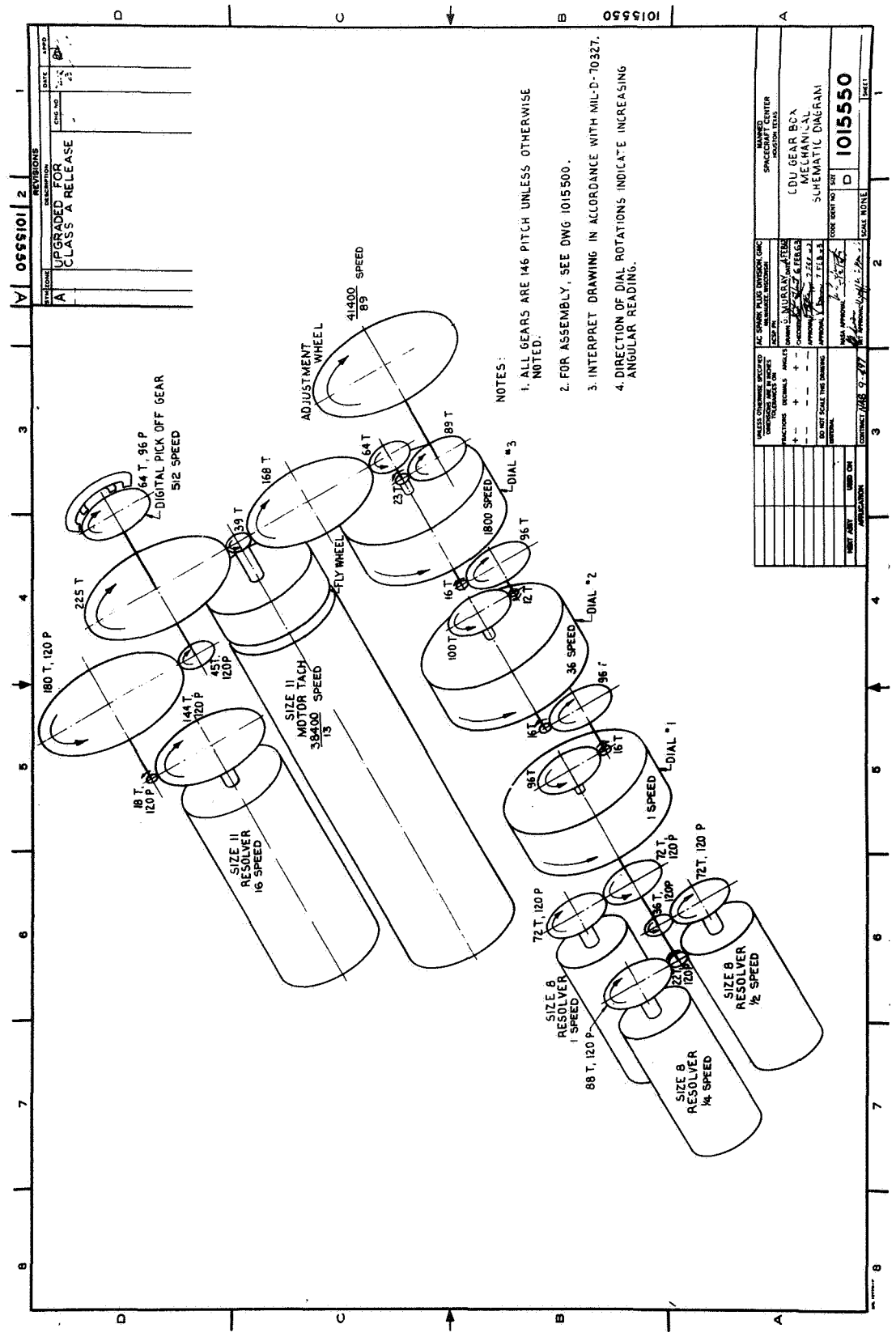


Figure 5-11. Sample Mechanical Schematic Diagram.

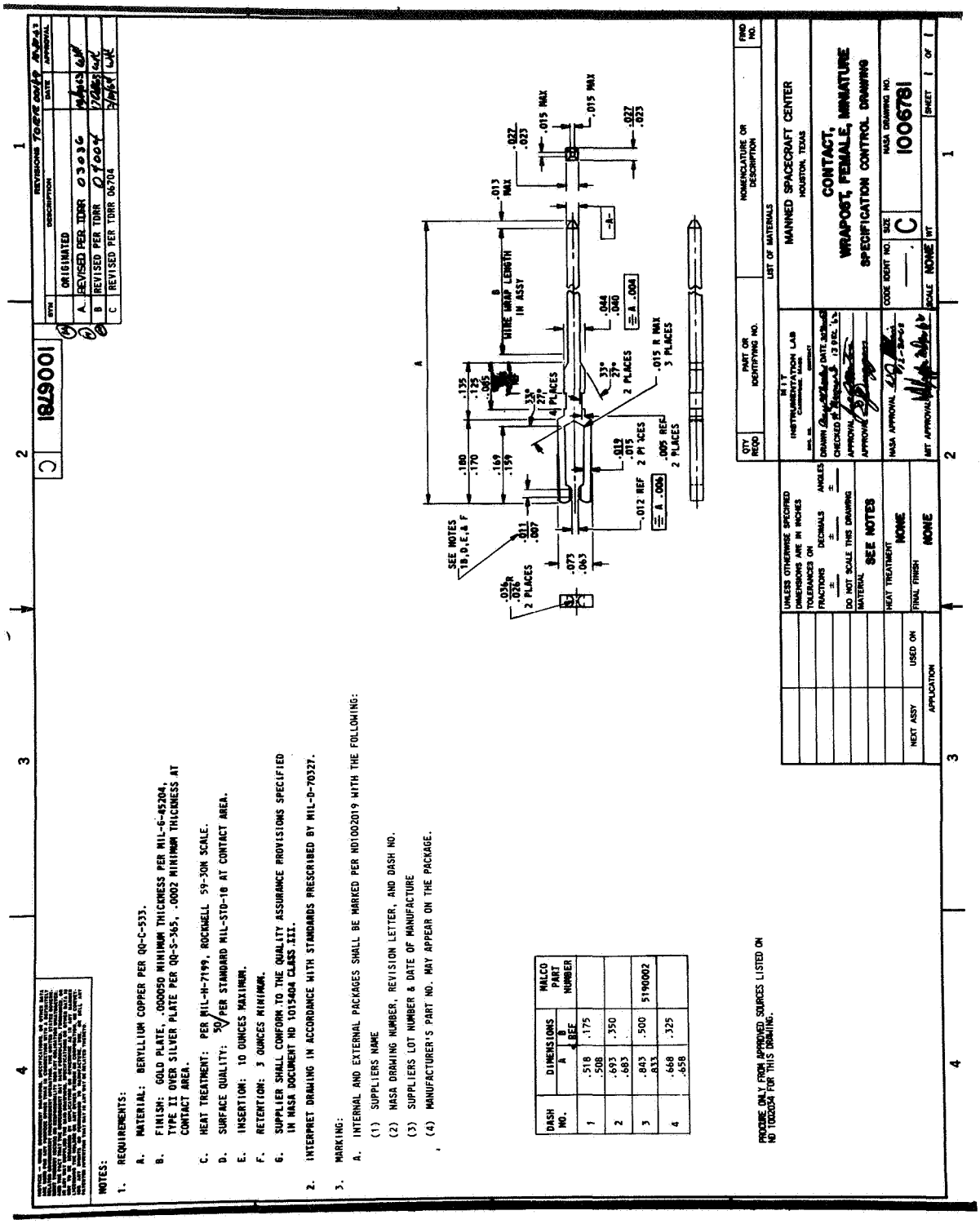


Figure 5-12. Sample Tabulated Detail Drawing.

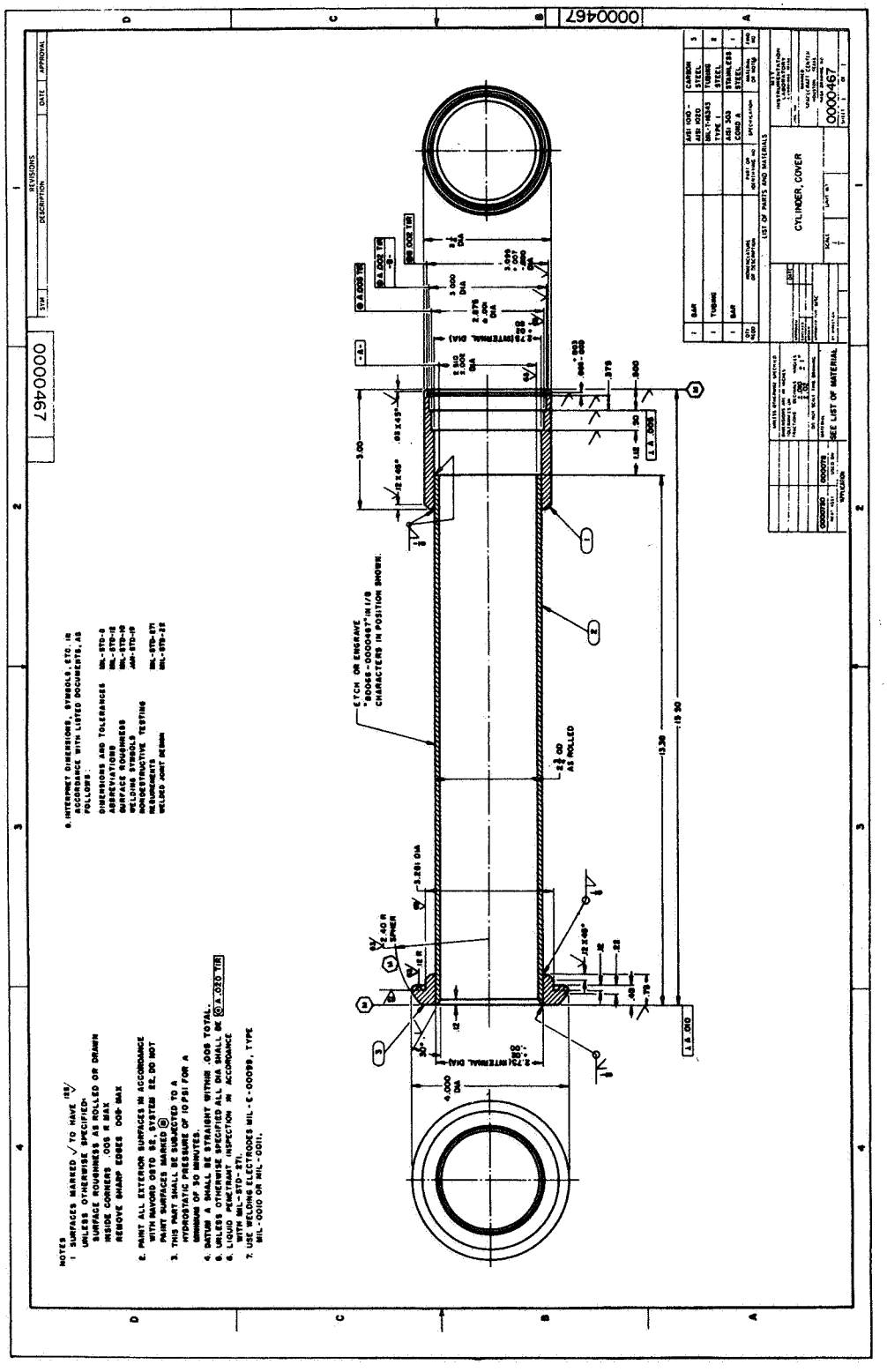


Figure 5-13. Sample End Product Drawing, Inseparable Assembly.

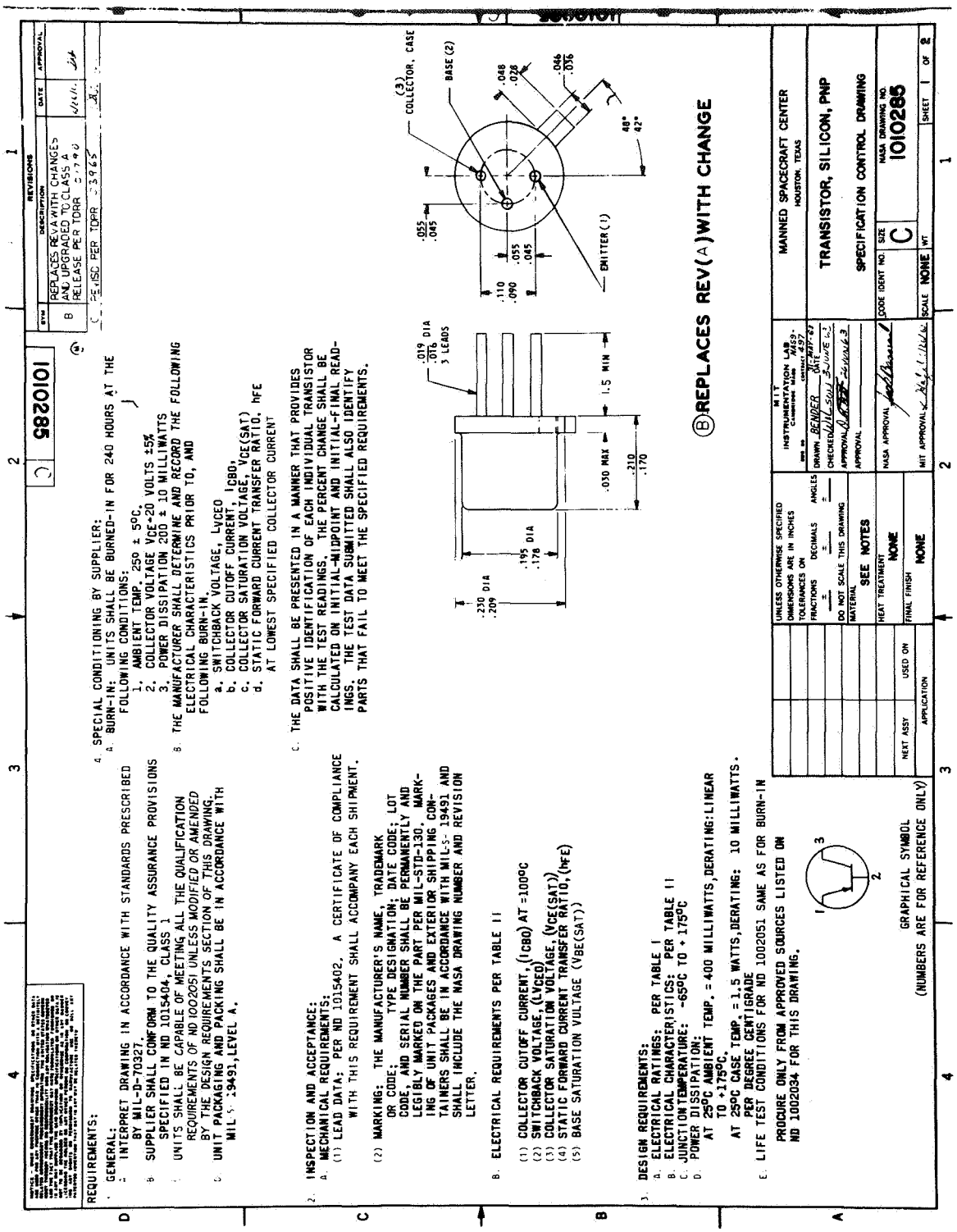


Figure 5-14. Sample Specification Control Drawing (Sheet 1 of 2).

REVISIONS	
SYM	DESCRIPTION
A	REPLACED BY REV B WITH CHANGES PER TURN ...

A 1010285

TABLE II

ELECTRICAL CHARACTERISTICS AT T_C = 25°C (UNLESS OTHERWISE SPECIFIED)					
PARAMETER	CONDITIONS	SYMBOL	SPECIFICATION LIMITS MIN	MAX	UNITS
COLLECTOR CUTOFF CURRENT	I_E=0, V_{CB}=-30V	I_{CBO}	-	1.0	uA
COLLECTOR CUTOFF CURRENT	I_E=0, V_{CB}=-30V, T_C=150°C	I_{CBO}	-	100	uA
BREAKDOWN VOLTAGE (SUSTAINING) ▷	I_C=-100mA, R_{BE} ≤ 10Ω	LV_{CER}	-50	-	VOLTS
BREAKDOWN VOLTAGE (SUSTAINING) ▷	I_C=-100mA, V_{BE} = OPEN	LV_{CEO}	-35	-	VOLTS
STATIC FORWARD CURRENT TRANSFER RATIO ▷	I_C=-150mA, V_{CE}=-10V	h_{FE}	30	90	-
STATIC FORWARD CURRENT TRANSFER RATIO ▷	I_C=-5mA, V_{CE}=-10V	h_{FE}	25	-	-
SATURATION VOLTAGE	I_C=-150mA, I_B=-15mA	V_{CE} (sat)	-	-1.5	VOLTS
SATURATION VOLTAGE	I_C=-150mA, I_B=-15mA	V_{BE} (sat)	-	-1.3	VOLTS
SMALL SIGNAL, SHORT-CIRCUIT FORWARD CURRENT TRANSFER RATIO	I_C=-50mA, V_{CE}=-10V, f=20mc	hfe	3.0	-	-
SMALL SIGNAL, SHORT-CIRCUIT, FORWARD CURRENT, TRANSFER RATIO	V_{CE}=-5V, I_C=-1mA, f=1kc	hfe	25	100	-
SMALL SIGNAL, SHORT-CIRCUIT, FORWARD CURRENT, TRANSFER RATIO	V_{CE}=-10V, I_C=-5mA, f=1kc	hfe	30	-	-
SMALL SIGNAL, SHORT-CIRCUIT INPUT IMPEDANCE	V_{CE}=-5V, I_C=-1ma, f=1kc	hib	25	35	OHMS
SMALL SIGNAL, SHORT-CIRCUIT INPUT IMPEDANCE	V_{CE}=-10V, I_C=-5mA, f=1kc	hib	-	10	OHMS
SMALL SIGNAL, OPEN-CIRCUIT REVERSE-VOLTAGE TRANSFER RATIO	V_{CE}=-5V, I_C=-1mA, f=1kc	hrb	-	$8X10^{-4}$	-
SMALL SIGNAL, OPEN-CIRCUIT REVERSE-VOLTAGE TRANSFER RATIO	V_{CE}=-10V, I_C=-5mA, f=1kc	hrb	-	$8X10^{-4}$	-
SMALL SIGNAL, OPEN-CIRCUIT, OUTPUT ADMITTANCE	V_{CE}=-5V, I_C=-1mA, f=1kc	hob	-	1.0	UMHO
SMALL SIGNAL, OPEN CIRCUIT, OUTPUT ADMITTANCE	V_{CE}=-10V, I_C=-5mA, f=1kc	hob	-	5.0	UMHO
OUTPUT CAPACITANCE	V_{CB}=-10V, I_E=0, f=1mc	Cob	-	45	uuf
SWITCHING TIME (NON-SATURATING CIRCUIT)	I_C=-40mA, V_{CC}=-18V	td+tr+tf	-	50	nsec

▷ PULSE CONDITIONS: LENGTH ≤ 300 usec; DUTY CYCLE ≤ 1%

TABLE I

MANUFACTURER'S ABSOLUTE MAXIMUM RATINGS T_C = 25°C				
COLLECTOR VOLTAGE (V_{CB})	EMITTER VOLTAGE (V_{EB})	COLLECTOR VOLTAGE (V_{CE})	COLLECTOR POWER DISSIPATION	EIA TYPE DESIGNATION (FOR REFERENCE)
V_{DC}	V_{DC}	V_{DC}	W	
-50	-5	-35	1.5	2N722

Ⓐ REPLACED BY REV B WITH CHANGES

QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES

DO NOT SCALE THIS DRAWING

MATERIAL

HEAT TREATMENT

FINAL FINISH

NEXT ASSY | USED ON

APPLICATION

MIT INSTRUMENTATION LAB CAMBRIDGE MASS

DRAWN ... DATE ...
CHECKED ...
APPROVAL ... 3/4/63
APPROVAL
NASA APPROVAL
MIT APPROVAL ... 63

MANNED SPACECRAFT CENTER
HOUSTON TEXAS

TRANSISTOR, SILICON, PNP

SPECIFICATION CONTROL DRAWING

CODE IDENT NO | SIZE C | NASA DRAWING NO 1010285

SCALE NONE | WT | SHEET 2 OF 2

Figure 5-14. Sample Specification Control Drawing (Sheet 2 of 2).

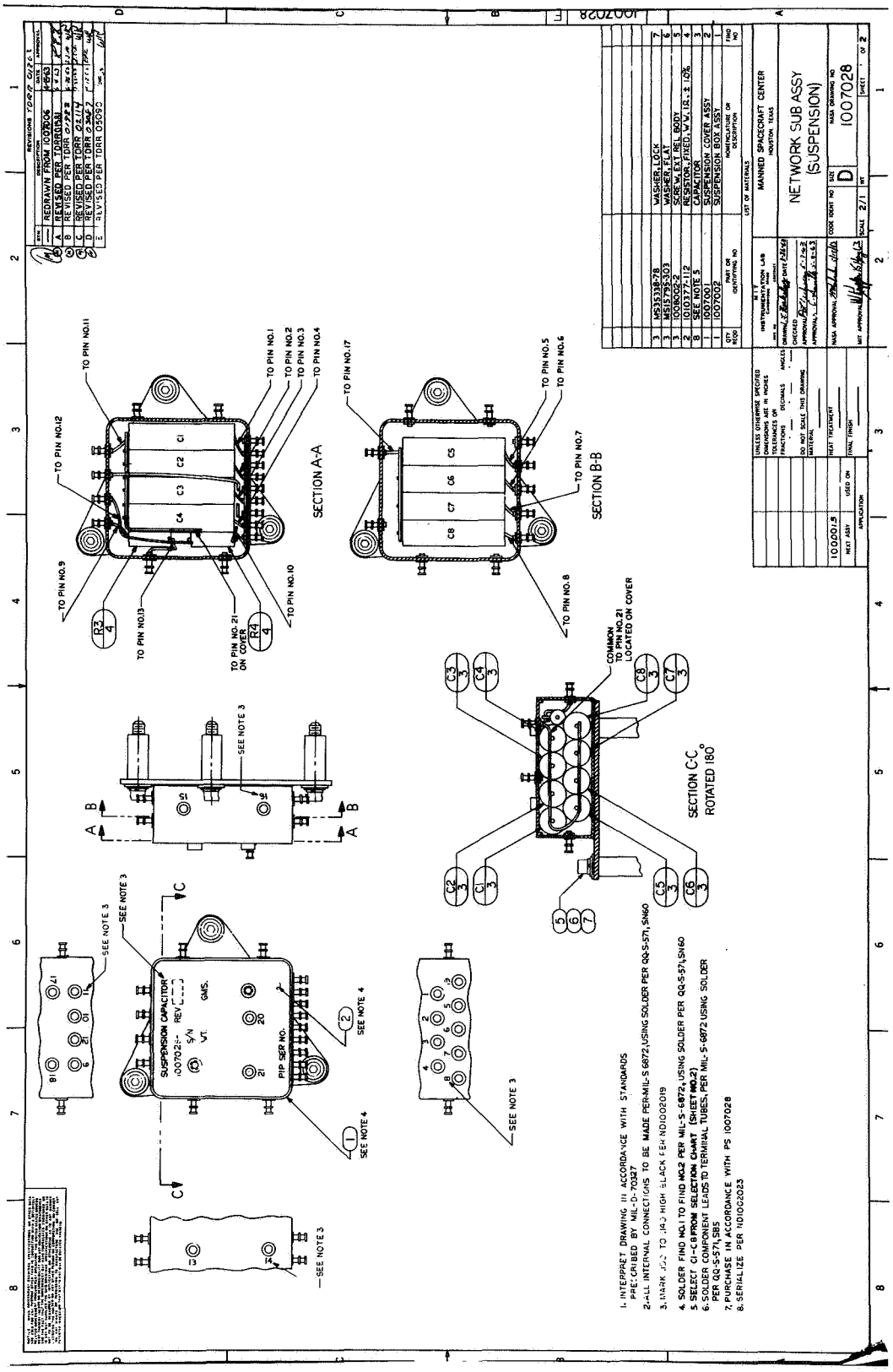


Figure 5-15. Sample Subassembly Drawing (Sheet 1 of 2).

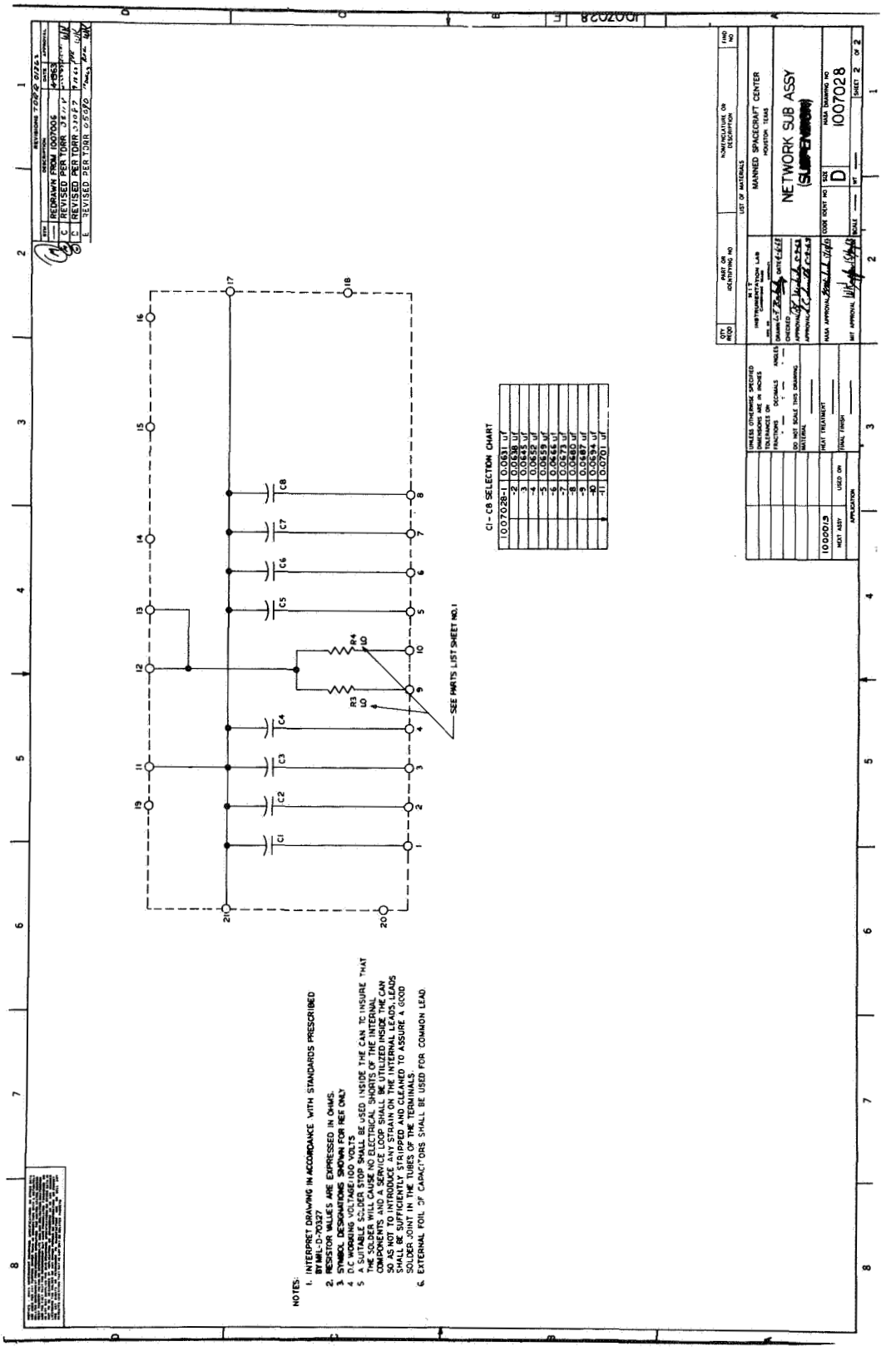


Figure 5-15. Sample Subassembly Drawing (Sheet 2 of 2).

Section 6
DRAWING SIZES AND FORMAT

6-1 SIZES

In agreement with MIL-STD-2, approved sizes for drawing forms are shown in tables 6-1 and 6-2. Of the drawing sizes listed in MIL-STD-2, only those sizes necessary for NASA drawings are listed in this publication. Use of other sizes is not permitted except by special written consent from the National Aeronautics and Space Administration.

Table 6-1. Flat Sheet Sizes

Letter Designation	Finished Sheet Size	Inside Border
A (Horiz.)	8-1/2 x 11	7-3/4 x 10-1/2
A (Vert.)	8-1/2 x 11	8 x 10-1/4
B	11 x 17	10-1/4 x 16-1/4
C	17 x 22	16 x 21
D	22 x 34	21 x 33
E	34 x 44	33 x 43
F	28 x 40	27 x 39

Table 6-2. Roll Sizes*

Letter Designation	Finished Sheet Size**	Inside Border
H	28 x 48 Min.	27 x 47 Min.
J	34 x 48 Min.	33 x 47 Min.

*The maximum length of roll-size sheets shall not exceed 144 inches, exclusive of protective margins. See paragraph 6-2 for limitation on use.

**Approximately two inches additional margin shall be provided on the left side for protection of roll-size drawings. This additional margin is optional for plastic sheets.

6-2 RESTRICTION ON USE OF ROLL SIZES

The use of roll-size drawings shall be held to a minimum. When one D or E size sheet is not sufficient to accommodate all of the required views or sections,

a multi-sheet drawing shall be made, the supplementary views and sections being placed on additional sheets of the same size as sheet 1. Roll-size drawings may be used only when it is not practicable to reduce individual views, sections, or wiring diagrams to the scale required to conform to a D or E size sheet.

6-3 SELECTION

B, C, and D sizes are preferred for NASA drawings. Drawings should be of sufficient size to provide clarity of presentation and to permit maintenance of the anticipated revision record for a minimum of one year.

6-4 FORMAT

6-4.1 ARRANGEMENT. Figures 6-1 through 6-5 show the standard arrangement of NASA drawing forms for each of the sizes given in tables 6-1 and 6-2. The format of NASA drawings shall conform to these patterns and to the requirements contained in the following paragraphs.

6-4.2 ZONING. All C, D, E, F, H, and J size drawings shall be zoned. The margin shall be subdivided into spaces in the manner shown in figure 6-6. The number and size of the zone spacings shall suit the size and type of drawing. The horizontal and vertical zones shall be identified by alphabetical and numerical entries, respectively.

6-4.3 PROTECTIVE MARGINS. Sufficient material shall be retained for protection on each end of a roll-size drawing. Three-and-one-quarter inches of material from the left border and four-and-one-half inches from the right border are required. See figure 6-5.

6-4.4 LETTERING. Lettering and numbering printed on drawing formats to indicate zoning, column headings, block titles, etc., shall conform to MIL-STD-1.

6-4.5 DRAWING NUMBER BLOCKS. Drawing number blocks shall be located as outlined below. See section 8 for information on drawing numbers.

6-4.5.1 A and B Size Drawings. Locate drawing number block as follows (figures 6-1 through 6-4):

a. Lower right-hand corner of the title block.

b. Drawing number block at upper border (except figures 6-2 and 6-3).

6-4.5.2 C, D, E, and F Size Drawings. Locate drawing number block as follows (figure 6-5):

a. Lower right-hand corner of the title block.

b. Drawing number block at right-hand border (D size at upper border).

6-4.5.3 H and J Size Drawings. Locate drawing number blocks as follows

a. Lower right-hand corner of the title block.

b. Outer ends of protective margins.

c. To left of match lines at 44-inch increments along lower border.

6-4.6 REVISION BLOCK. The revision block, shown in figure 6-7, shall be provided on all sizes of NASA drawings. See figure 6-1 through 6-5 for location of block.

6-4.7 SECURITY CLASSIFICATION BLOCK. The security classification block shall be of uniform size (2 x 2-5/8 inches), except on the alternative A-size format. See figures 6-2 and 6-3. The security classification note is not included on the printed drawing form. Nevertheless, the security classification, together with the warning note, shall appear on all classified drawings in the locations shown in figures 6-1 through 6-5 in conformance with section 11.

6-4.8 TITLE BLOCK. The overall size of the title block shall be in accordance with figure 6-9 for all sizes of NASA drawings. Figure 6-9 illustrates title block formats that are acceptable for use on NASA drawings. Proposed Title Block formats shall be submitted to MIT for approval prior to adoption.

6-4.9 SUPPLEMENTARY BLOCKS. Figure 6-8 defines the basic dimensions and format of the supplementary blocks. The location of these blocks on the drawing is indicated in figures 6-1, 6-2, 6-4, and 6-5.

6-4.10 APPLICATION BLOCK. Figure 6-8 defines the basic dimensions and format of the application block (also called a "usage block") for all sizes of drawings except the A size. On A size drawings, the headings shall be at the tops of the columns. The location on the drawing is shown in figures 6-1, 6-2, 6-4, and 6-5.

6-4.11 PHYSICAL PROPERTIES BLOCK. NASA activities and contractors who so desire may add the physical properties block specified by MIL-STD-2 to the left of the application block on formats for B size and larger NASA drawings.

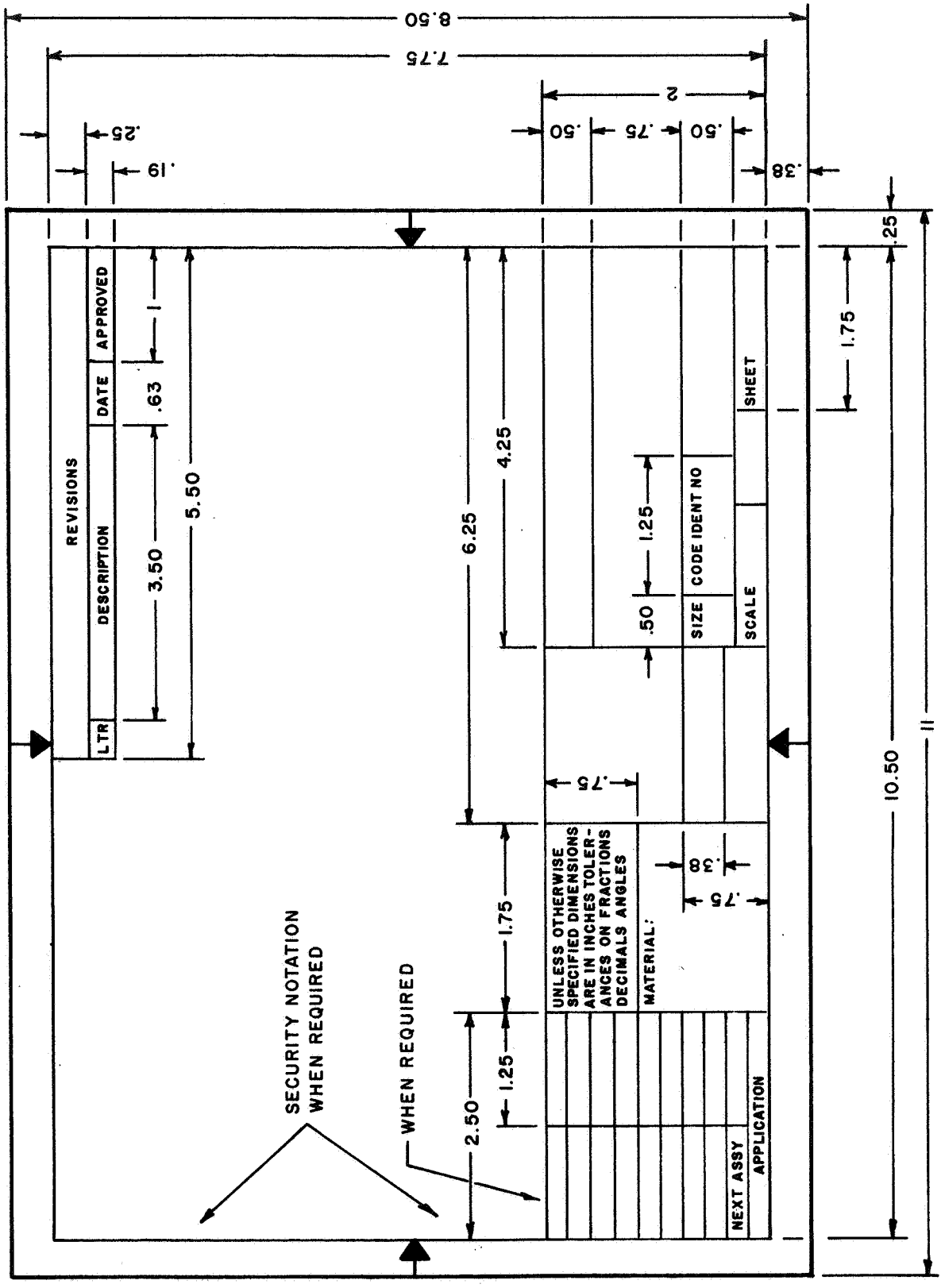


Figure 6-1. A Size Drawing Format.

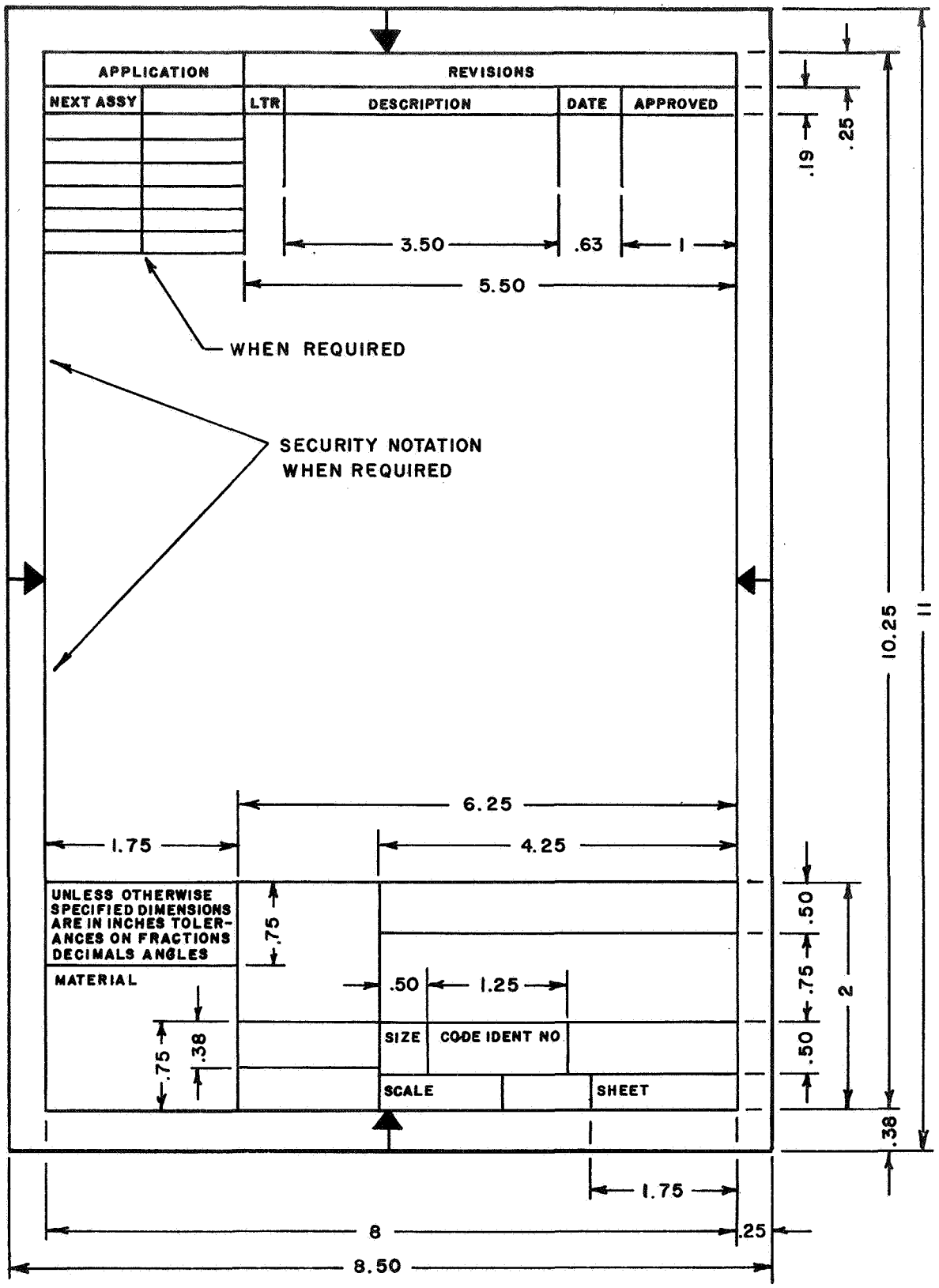


Figure 6-2. Alternative A Size Drawing Format.

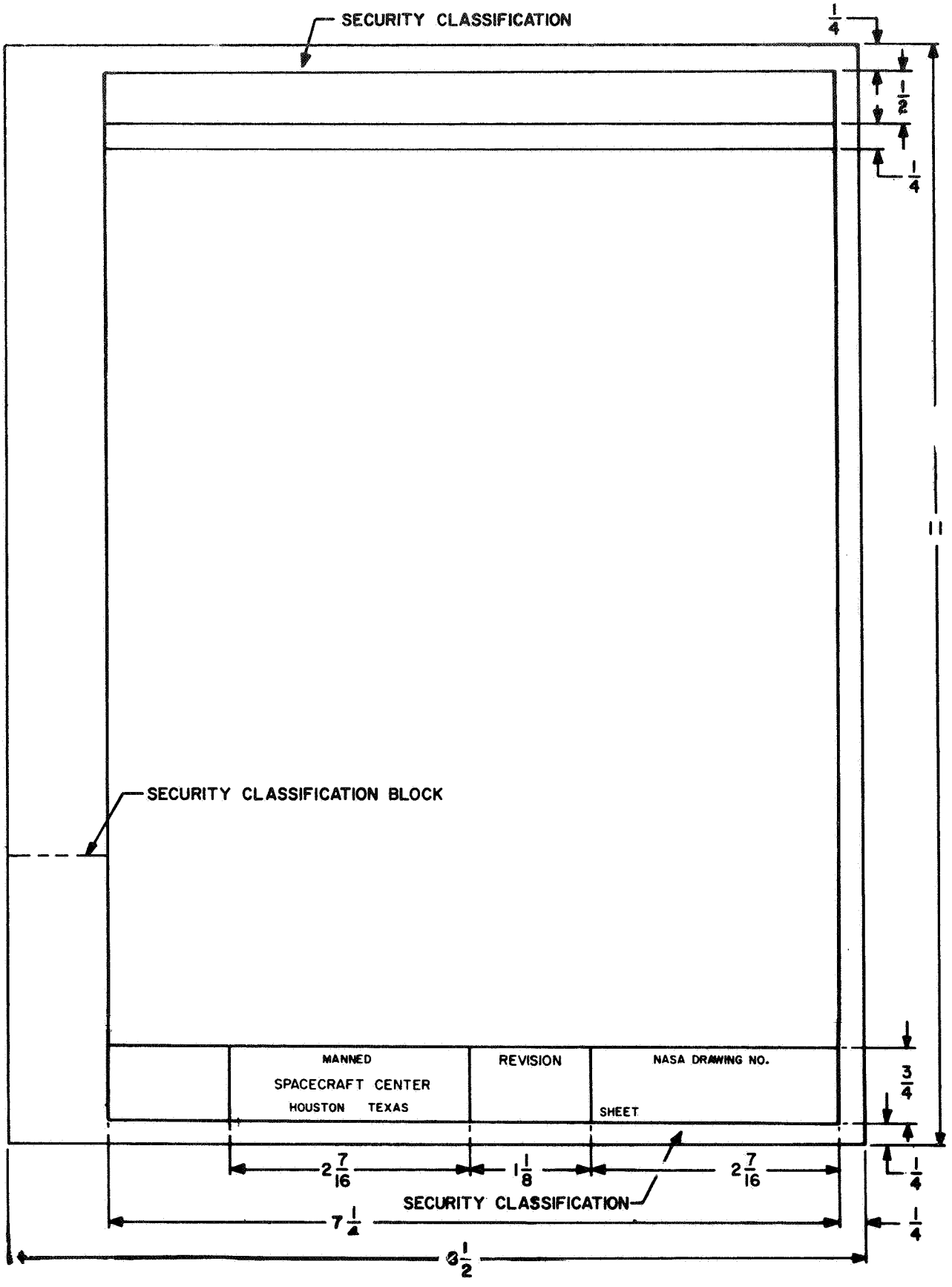


Figure 6-3. Alternative A Size Continuation Sheet Drawing Format.

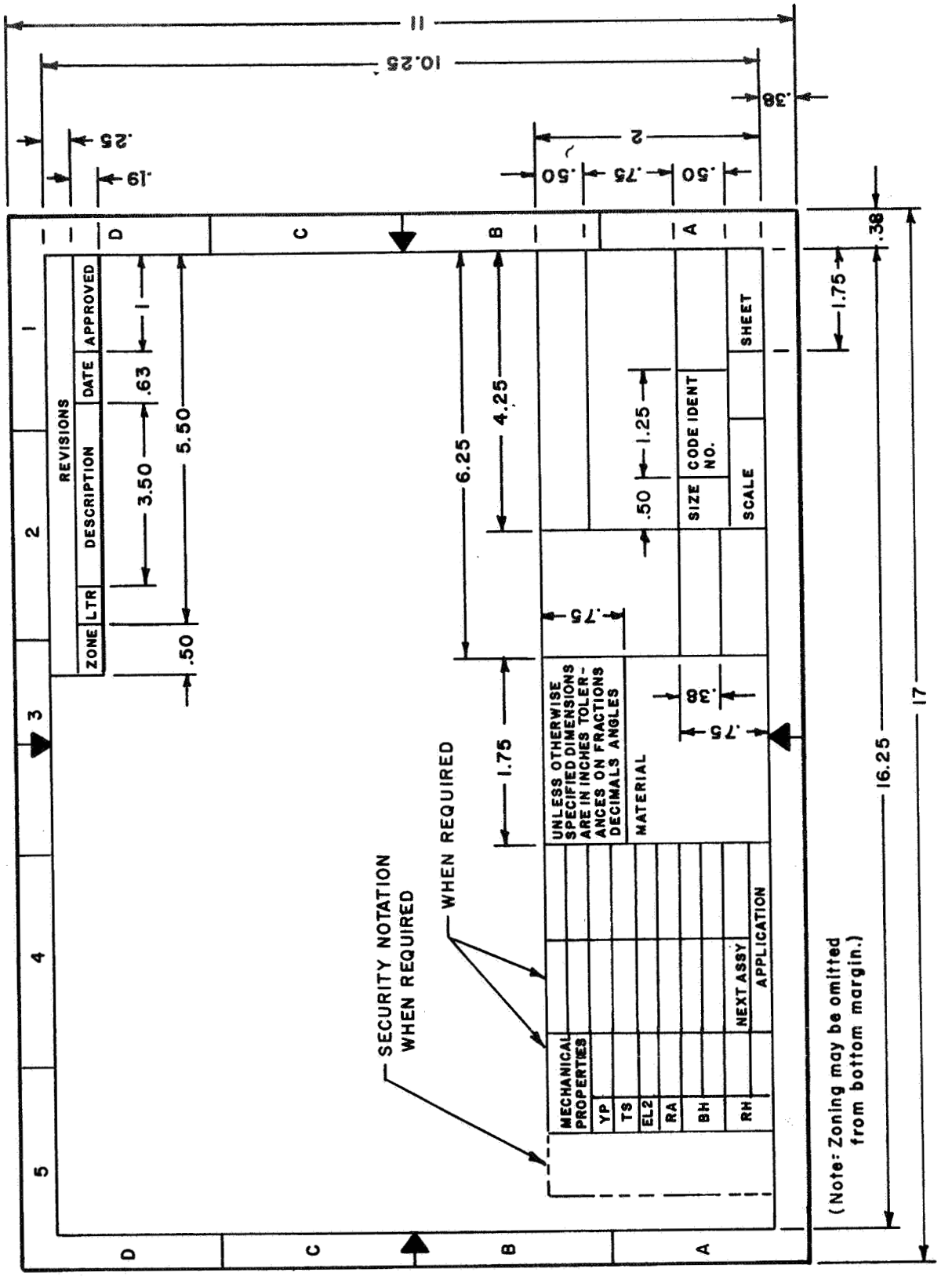


Figure 6-4. B Size Drawing Format.

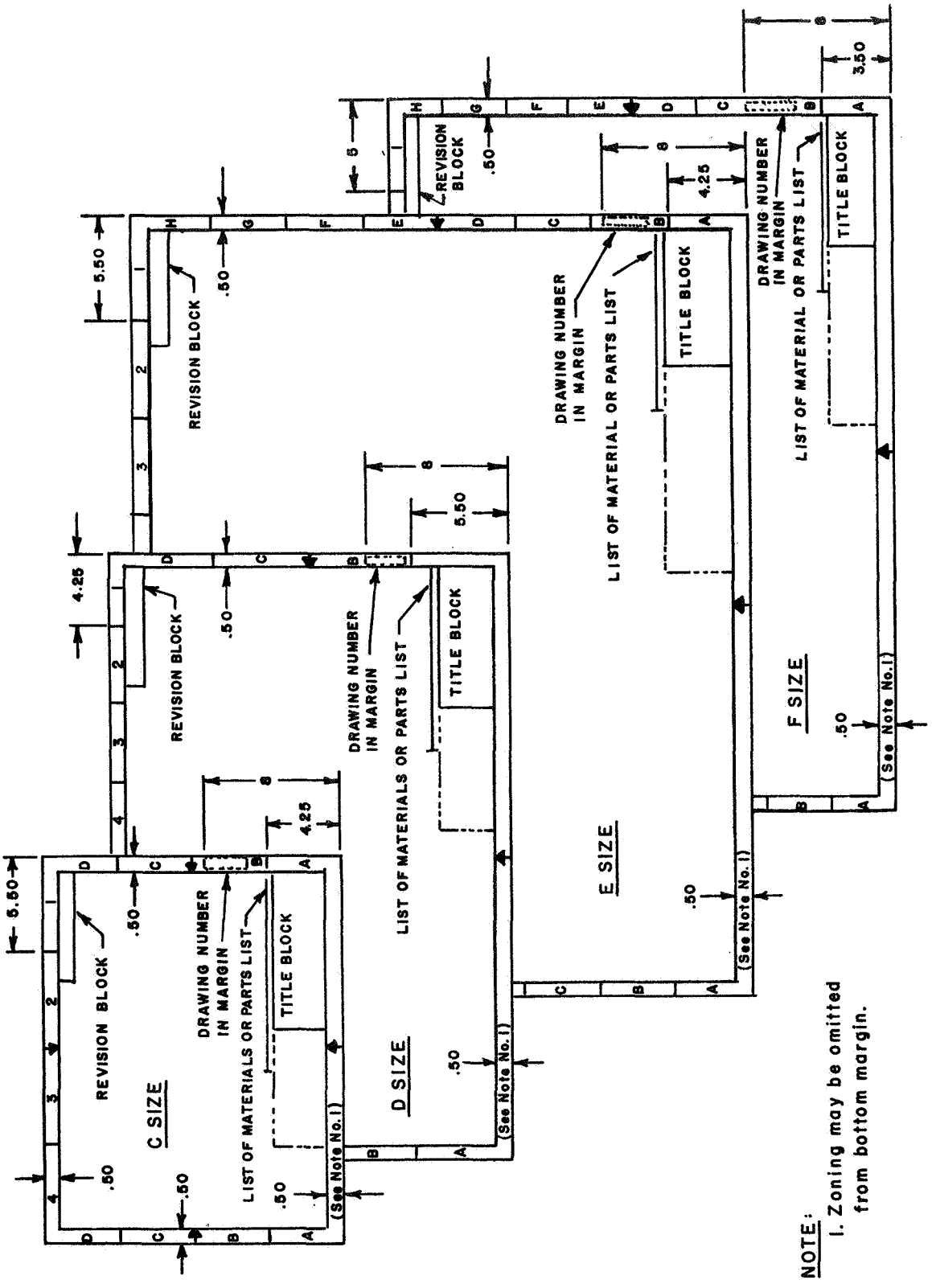


Figure 6-5. C, D, C, and F Size Drawing Format.

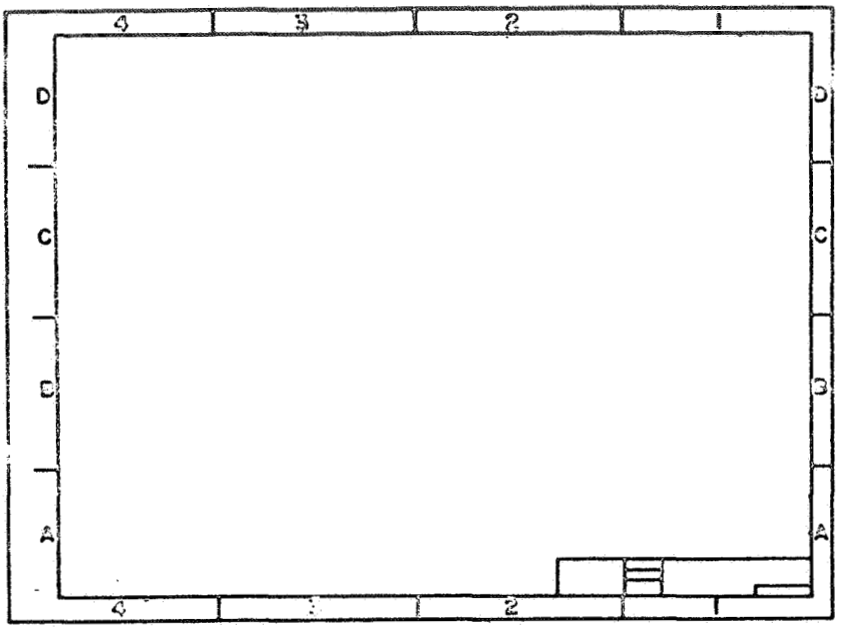


Figure 6-6. Zoning.

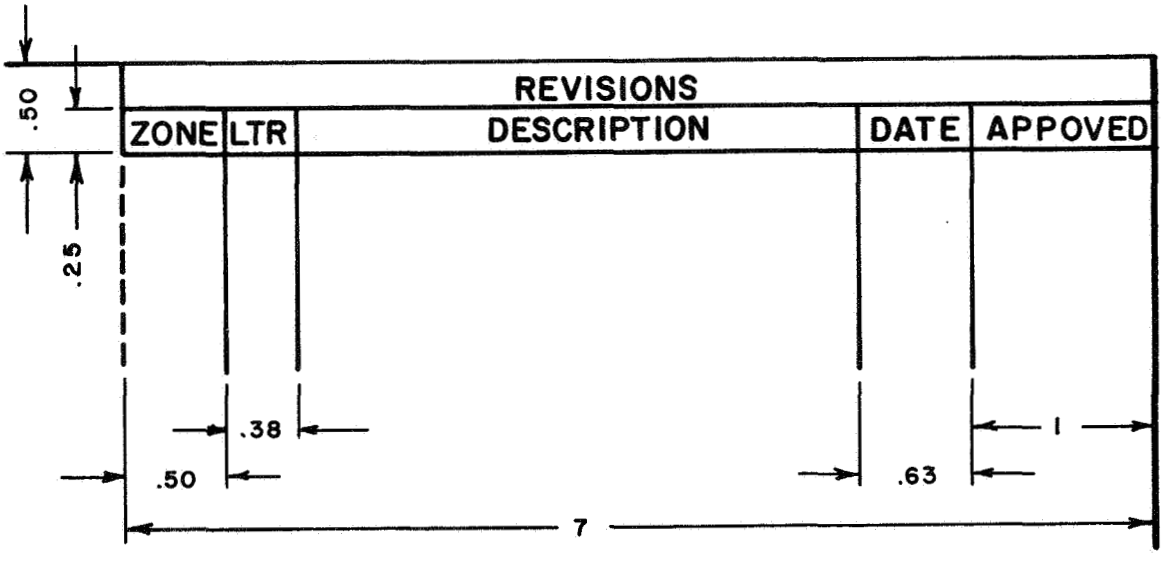


Figure 6-7. Revision Block. (for all sheet sizes except A and B)

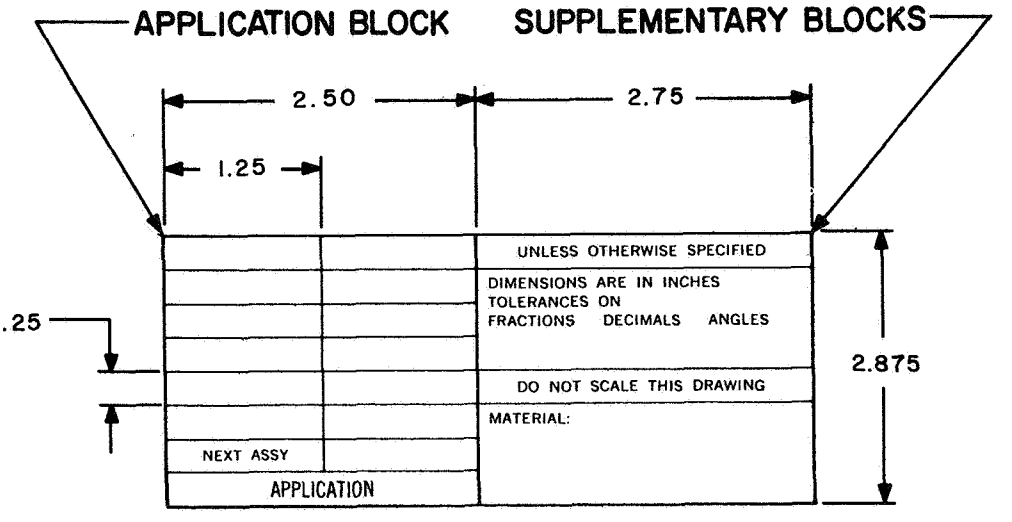
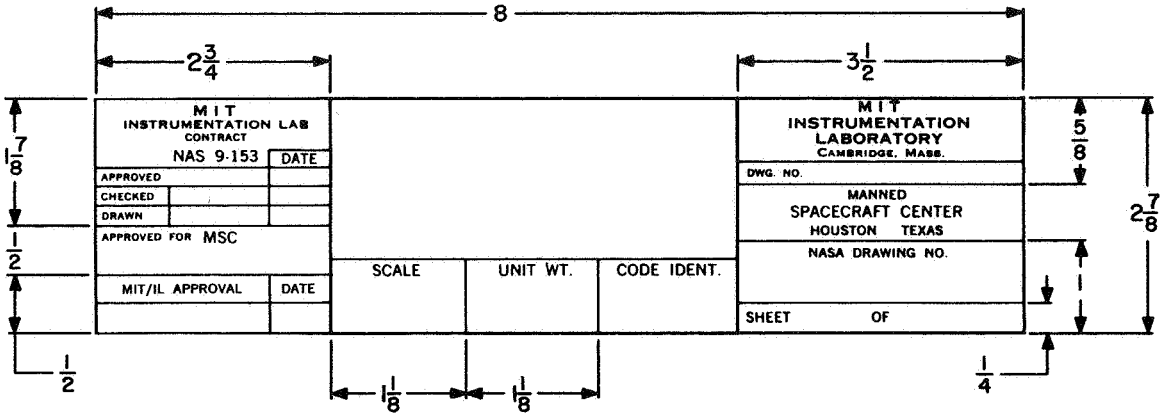
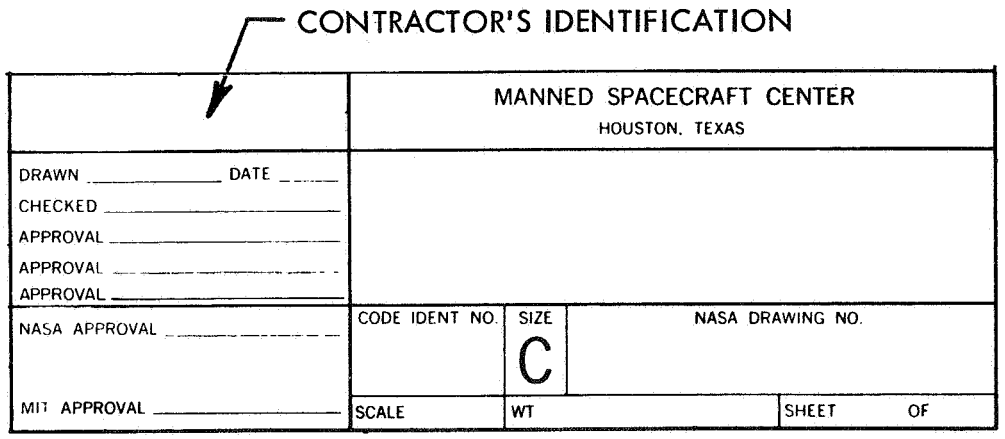


Figure 6-8. Application and Supplementary Blocks.





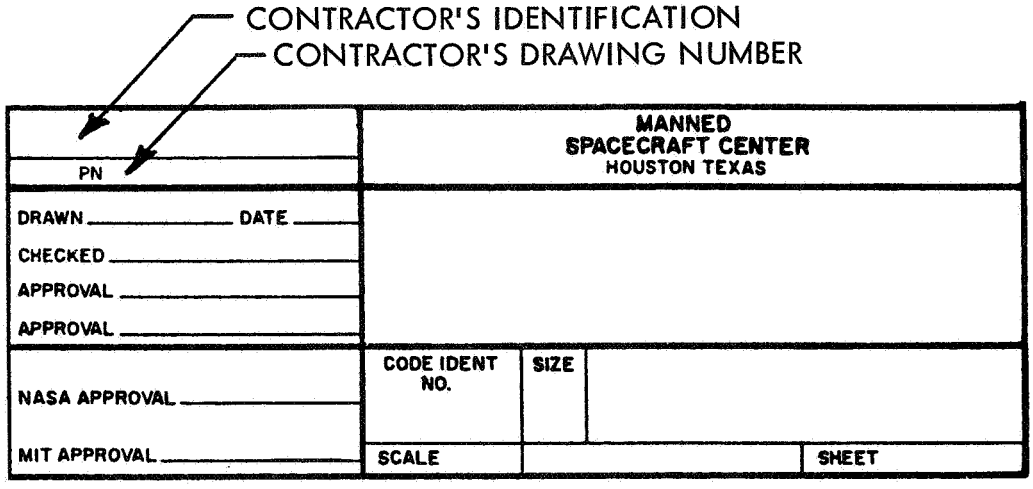


Figure 6-9. Title Block for Drawing Prepared by NASA Activitiy or Contractor.

Section 7
ENTRIES IN TITLE AND APPLICATION BLOCKS

7-1 ENTRIES IN TITLE BLOCK

7-1.1 CONTRACTOR'S NAME. When a contractor is the preparing activity, the name of the contractor shall be printed, stamped, or lettered in opaque characters in each of the two blocks for which a typical entry is illustrated in figure 6-9.

7-1.2 NAME OF NASA ACTIVITY. When a drawing is prepared by a NASA Activity, the name of such activity shall be printed, stamped, or lettered in opaque characters in the block for which typical entries are illustrated in figure 6-9.

7-1.3 CONTRACTOR'S DRAWING NUMBER. See paragraph 8-7.

7-1.4 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION CONTRACT NUMBER. The NASA contract under which the drawing was prepared shall be entered in the left-hand contractor's block. Numbers of subsequent contracts on which the drawing is used shall not be entered.

7-1.5 SCALE. The scale of each drawing, other than diagrams, shall be entered in the scale block, in accordance with MIL-STD-1.

7-1.6 DRAWING TITLE. See section 9.

7-1.7 DRAWING NUMBER. See section 8.

7-1.8 AUTHENTICATION BLOCKS. See section 14.

7-2 APPLICATION BLOCK

The purpose of the application block is to provide a means for determining the equipment in which the part or assembly shown on the drawing is used. Properly filled in, this block reveals the parts and assemblies that have a diversity of uses; and it aids in determining the effects of a change in the part or assembly shown on the drawing.

7-2.1 ENTRIES. Appropriate entries shall be made in the application blocks of all NASA drawings. The following procedures shall be followed.

7-2.1.1 When to Enter. For the original and all subsequent applications of a part or assembly, the appropriate entries to a next assembly shall be made in the application block. SCD's do not require this entry. Multi-use drawings need not exceed three entries.

7-2.1.2 Use of Revision Procedure. Entries or deletions made in the application block shall conform to section 15.

7-2.1.3 What to Enter. In the "Next Assembly" column, enter the drawing number of each next higher assembly on which the part or assembly shown on the drawing is called out.

7-2.2 NOTIFICATION TO CUSTODIAN OF MASTER. For further requirements concerning application data, see paragraphs 16-2.15 and 16-7.

Section 8
DRAWING NUMBERS AND SHEET NUMBERS

8-1 GENERAL

Every Class 1 NASA drawing shall bear a NASA drawing number.

8-2 PLACEMENT

NASA drawing numbers shall be entered in the drawing number blocks as required by MIL-STD-2B and as shown on sample drawing format, figure 4-1.

8-3 SIZE

The NASA drawing number entered on the drawing formats shall be not less than 1/4-inch high.

8-4 ASSIGNMENT OF DRAWING NUMBERS

8-4.1 NUMBERING. Drawing Numbers for NASA Project APOLLO will begin with the number 1000001.

8-4.2 NUMBER ASSIGNMENT. Requests for assignment of blocks of drawing numbers shall be directed to the MIT APOLLO Management Office. (Procedures for control of issuance of NASA drawing numbers will be prepared upon receipt of information indicating NASA policy for such controls.)

8-4.2.1 MIT/IL Number Allocation. MIT/IL shall be assigned the block of drawing numbers from 1000001 through 1099999 for allocation to subcontractors on Guidance and Navigation Equipments.

8-4.2.2 Number Usage Report. Each Participating Contractor shall submit a monthly report of drawing number usage to the APOLLO Management Office. Each report shall identify the following:

a. G&N Subsystem Assembly

b. Title of Drawing

c. Name of Preparing Activity

8-5 USE OF DRAWING NUMBER ON MULTIPLE SHEETS

Different drawing numbers shall not be assigned to sheets portraying different views of the same item nor to sheets portraying information normally included under the same drawing title.

8-5.1 SHEET NUMBERS FOR MULTIPLE-SHEET DRAWINGS. Only one drawing number shall be assigned to all sheets of a multiple-sheet drawing, each sheet being identified by both the basic drawing number and the sheet number. The sheets shall be numbered consecutively, each sheet indicating the total number of sheets.

Example: SHEET 1 OF 4

SHEET 2 OF 4

SHEET 3 OF 4

SHEET 4 OF 4

Figures 15-7 through 15-10 illustrate methods of indicating additional sheets.

8-6 QUARTERLY REPORT OF USED DRAWING NUMBERS

NOTE: Procedures controlling the reporting of drawing number usage will be written up when correct information is available as to NASA control requirements.

8-7 CONTRACTOR'S DRAWING NUMBER

The contractor's drawing number may be entered in the space provided in the drawing title block on Class 1 NASA drawings. See figure 6-9.

Section 9
DRAWING TITLES

9-1 GENERAL

The drawing title shall consist of the nomenclature for the item and subtitles selected in accordance with the following instructions. The drawing title shall be entered in the title space of the title block. Required sizes of characters and sample titles are illustrated in figure 9-1.

9-2 NOMENCLATURE

Nomenclature consists of an item name, or an item name and additional identification data, including an approved Mark and Mod or other type designation when applicable.

9-2.1 ITEM NAME. An item name is either a basic name or a basic name followed by the modifiers necessary to distinguish between item concepts having the same basic name.

9-2.2 RULES FOR SELECTION OR DEVELOPMENT OF ITEM NAME.

9-2.2.1 Approved Item Name. When practicable, an approved item name shall be selected from AFFSC Cataloging Handbook H6-1, Federal Item Identification Guides for Supply Cataloging, Part 1, Section A, "Alphabetic Index of Names."

9-2.2.2 Development of Name. When the procedure of paragraph 9-2.2.1 does not provide a suitable item name, a name shall be developed in accordance with the policy of the Federal Cataloging Program. General rules for the development of names are stated in AFFSC Cataloging Manual M1-2, section 220.

9-2.3 DEFINITION OF NAME TERMS.

9-2.3.1 Basic Name. A basic name is either a "basic noun" word or a "basic noun phrase." A basic noun shall be used as follows:

a. As an item name only when it establishes a single concept of an item.

Example: BAROSWITCH

b. As the first word or group of words in an item name, followed in inverted sequence by the least number of modifiers necessary to establish a single concept of an item.

Examples: (1) BATTERY, WET, PRIMARY

(2) GEAR, BEVEL

When a basic noun word does not establish a basic concept of the item, a basic noun phrase shall be used. In this situation, the use of the inverted sequence with the basic noun followed by a modifier would lead to a misunderstanding. It is necessary, therefore, to use the words in a straightforward sequence.

Examples:	(1)	Acceptable:	BATTERY COMPARTMENT, SERVICE MODULE
		Unacceptable:	COMPARTMENT, BATTERY, SERVICE MODULE
	(2)	Acceptable:	CONTROL UNIT, PARACHUTE, DROGUE
		Unacceptable:	UNIT, CONTROL, PARACHUTE, DROGUE

In the above examples, battery compartment and control unit are the basic noun phrases; the other words are modifiers.

9-2.3.2 Basic Name Modifiers. A basic name modifier is a single word, hyphenated word, or group of words that expresses the differentiation necessary to restrict the area established by a basic name to a single concept of an item. The modifiers shall serve to narrow the area established by the basic name concept. Modifiers should indicate what an item is (its shape, structure, or form) or what the item does (its function). A word directly qualifying a modifying word shall precede the word it qualifies.

Examples: FILTER, AGC DETECTOR

The word "AGC" qualifies "DETECTOR."

9-2.4 SECURITY CLASSIFICATION RESTRICTIONS. No words or terms should be used in drawing titles which would disclose information in any of the established security categories. See section 11.

9-2.5 TYPE DESIGNATIONS. Type designations are assigned, when applicable, for the identification of NASA equipment. The National Aeronautics and Space Administration uses two kinds of type designations: (1) AGE and Subsystem Designations and (2) Joint Electronic Type Designations.

9-3 ASSEMBLY DRAWING TITLES

The title of an assembly drawing shall be the item nomenclature of the assembly represented and the subtitle "ASSEMBLY," unless the word "assembly" is a part of the item name. In addition, if a multiple sheet drawing is involved, a sheet title shall follow the subtitle.

Examples: (1) ASSEMBLY

PLAN VIEW

(2) ASSEMBLY

FRONT VIEW AND SECTIONS

When a descriptive name (not essential in distinguishing an item that has an item name and type designation) has been assigned by the National Aeronautics and Space Administration, this name should be included in parenthesis between the nomenclature and the subtitle. See figure 9-1.

9-4 DETAIL DRAWING TITLES

The title of a detail drawing shall be the item nomenclature. In addition, when drawings are prepared to show intermediate stages in the production process, the particular stage shall be described by a subtitle under the item nomenclature on the appropriate sheet or drawing.

Examples: (1) NOMENCLATURE

MACHINING DETAILS

(2) NOMENCLATURE

MACHINED

(3) NOMENCLATURE

ROUGH WELDMENT

(4) NOMENCLATURE

FORGING

9-5 TABULATED DRAWING TITLES

The title of a tabulated drawing shall be the common nomenclature of all the items represented thereon.

9-6 TITLES FOR OTHER TYPES OF DRAWINGS

The titles for types of drawings other than those listed above shall be the item nomenclature and, under such nomenclature, a subtitle that describes the type of drawing.

Examples:

(1) NOMENCLATURE

INSTALLATION DRAWING

(2) NOMENCLATURE

WORKING CIRCLE

(3) NOMENCLATURE

SCHEMATIC DIAGRAM

(4) NOMENCLATURE

WIRING DIAGRAM

(5) NOMENCLATURE

MECHANICAL SCHEMATIC DIAGRAM

(6) NOMENCLATURE

SPECIFICATION CONTROL DRAWING

(7) NOMENCLATURE

FAMILY TREE DRAWING

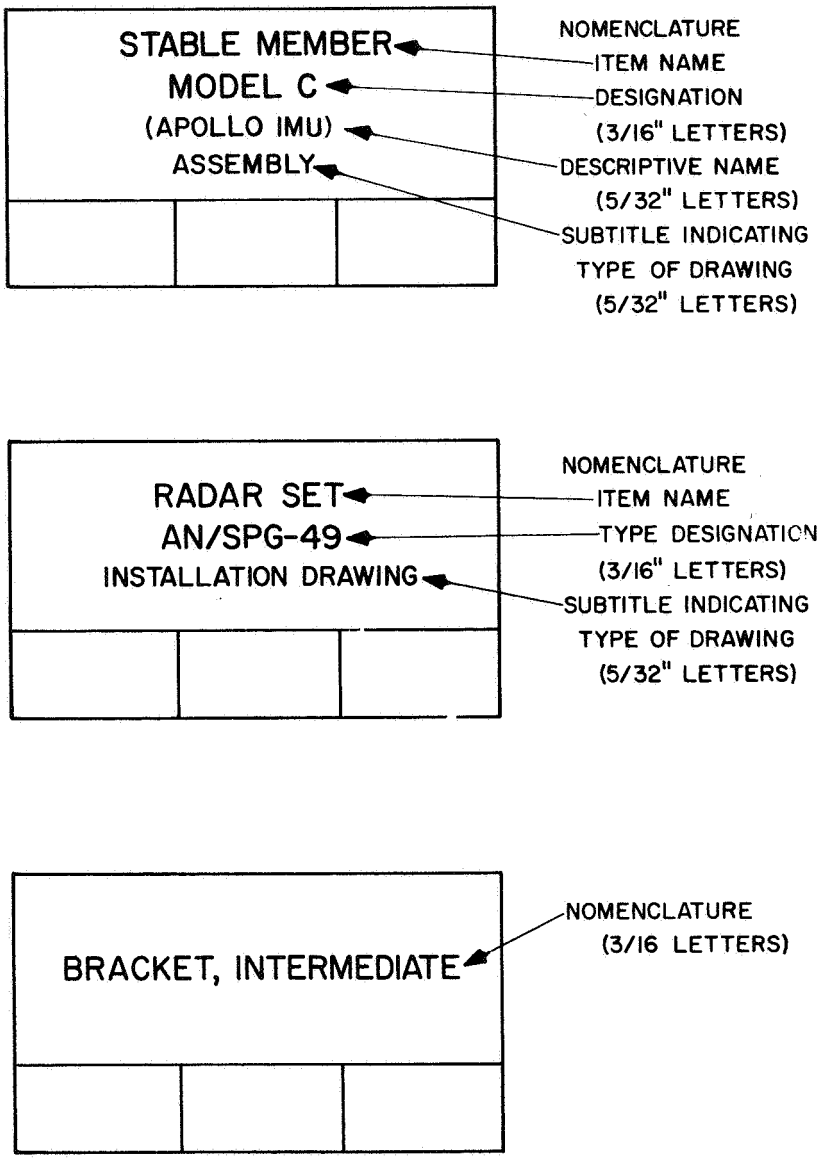


Figure 9-1. Drawing Titles and Sizes of Characters.

Section 10
DESIGNATION OF MATERIALS FOR PARTS

10-1 GENERAL

10-1.1 ENTRY IN MATERIAL BLOCK. The material as furnished in the end product shall be specified on the detail drawing in the material (title) block space. When this space is inadequate, enter therein "See Note" and specify the end product material in a note on the field of the drawing.

10-1.2 ISSUE OF SPECIFICATION. Drawings shall contain no reference to the date of issue of a specification or the revision status thereof except in instances where only a particular issue is considered satisfactory.

10-1.3 SUPPLEMENTARY REQUIREMENTS. When specifications are used to designate material, notes may be added on the field of the detail drawing covering supplementary requirements, treatments, essential details, etc. Such notes, however, shall not change the requirements of the specification.

10-2 EXAMPLES OF MATERIAL SPECIFICATION ENTRIES TO BE MADE ON DRAWINGS

The following are examples of material specification entries to be made on drawings. Materials for parts shall be designated on drawings in a manner conforming with these examples.

> NOTE: When specifying the type, class, grade, etc., of material on a drawing, it is important to use the letter designations (upper or lower case) exactly as they are used in the applicable specification.

a. Reference to Government Specifications

Example a(1): STEEL, BARS QQ-S-633, FS 1010 TO 1030, INCL

Example a(2): RUBBER, MIL-R-1149, CLASS 1

Example a(3): PLASTIC, MOLDED, MIL-P-14, TYPE CF1-40

b. Notes detailing mechanical, chemical, or other properties and performance or proof tests

Example b(1): MATERIAL SPECIFICATION

MATERIAL SHALL BE STEEL HAVING A MAXIMUM SULFUR CONTENT OF .05 PERCENT AND A MAXIMUM PHOSPHORUS CONTENT OF .04 PERCENT. QUENCH AND TEMPER TO THE FOLLOWING MINIMUM MECHANICAL PROPERTIES, OBTAINED ON TEST SPECIMENS TAKEN IN THE INDICATED SECTION AND DIRECTION:

YIELD STRENGTH (.2 PERCENT OFFSET) — 90000 PSI

TENSILE STRENGTH — 105000 PSI

REDUCTION OF AREA — 50 PERCENT

PART SHALL HAVE THE "FREEDOM FROM MATERIAL DEFECTS" SPECIFIED IN MIL-P-16594

Example b(2): MATERIAL SPECIFICATION

TUBE, STEEL, SEAMLESS, MIL-T-20157

TYPE E (SPECIAL)

O D 1.05, WALL THICKNESS .12

WT PER FT 1.19 LBS

WORKING PRESSURE 1000 PSI

HYDROSTATIC TEST PRESSURE 3000 PSI

c. Reference to Quality Specifications

Example c(1): STEEL CASTING, ASTM A 27-52T

GRADE 60-30

ALTERNATE QQ-S-681, CLASS 1

Example c(2): GASKET, SYNTHETIC RUBBER

BINDER, AMS 3231

ALTERNATE MIL-G-7021, CLASS 1

Example c(3): CORROSION-RESISTING STEEL PLATE FOR FUSION WELDING

ASME CODE SPEC. NO. SA 240

GRADE S, NO. 1 FINISH

ALTERNATE MIL-S-854, CLASS 1

CONDITION A, NO. 1 FINISH

Example c(4): CARBON STEEL STRIP, COLD ROLLED, ASTM 109, NO. 1 TEMPER, NO. 1 FINISH

ALTERNATE QQ-S-636 NO. 1 CONDITION, DULL FINISH

Example c(5): NAVAL BRASS, ASTM B 21-52, ALLOY A, B, OR C

ALTERNATE MIL-B-994, COMPOSITION A, B, OR C

d. Reference to Commercial Designations

Example d(1): FREE CUTTING BRASS ROD, SAE 72, SOFT

ALTERNATE QQ-B-626, COMPOSITION 22, SOFT

Example d(2): ALUMINUM SHEET, SAE 201, H32 (1/4 HARD)

ALTERNATE QQ-A-318, H32 (1/4 HARD)

Example d(3): HOT ROLLED CARBON STEEL SHEET

ALTERNATE QQ-S-636, HOT ROLLED CONDITION

Example d(4): STEEL, AISI 4130, 4137, 8630-8637, INCL, 8735

ALTERNATE QQ-S-624, FS 4130, 4137, 8630, 8635.

QUENCH AND TEMPER TO HARDNESS RC 23-28

Example d(5): STEEL, SAE 4615 OR 8615

ALTERNATE MIL-S-866, CLASS 4615 OR 8615

CARBURIZE .02-.04 INCH DEEP AND HARDEN TO

RC 58-62

Section 11
SECURITY CLASSIFICATION

11-1 GENERAL

Each NASA drawing requiring security classification, whether prepared by a NASA Activity or private contractor, shall be classified under one of the following categories as defined in the NASA Security Manual for Classified Matter:

a. Top Secret

b. Secret

c. Confidential

11-1.1 LOCATION OF CLASSIFICATION. The appropriate security classification shall be located on drawings as illustrated in figures 6-1 through 6-5.

11-1.2 LETTER SIZE. On drawings, the security classification shall be stamped or lettered in heavy opaque letters at least 1/4-inch high.

11-2 ENTRIES IN SECURITY CLASSIFICATION BLOCK. The security classification block required on each classified NASA drawing and list shall contain the appropriate security classification and warning note in the following arrangement:

CONFIDENTIAL

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18 U.S.C., SECTIONS 793 AND 794, THE TRANSMISSION OR REVELATION OF WHICH IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

11-2.1 LOCATION OF CLASSIFICATION BLOCK. The security classification block shall be located on classified drawings as illustrated in figures 6-1 through 6-5.

11-3 RESPONSIBILITY FOR DETERMINING CLASSIFICATION

Drawings applicable to a particular NASA equipment shall be classified in accordance with instructions issued by the National Aeronautics and Space Administration.

11-4 SECURITY RECLASSIFICATION AND DECLASSIFICATION

When authorized in accordance with instructions issued by NASA, reclassification and declassification shall be accomplished in the following manner.

11-4.1 RECLASSIFICATION. The reclassification of a NASA drawing shall be indicated on the master by lining out the existing classification and adding the new classification. The procedures for identifying and recording revisions, stated in section 15, shall be followed. On a drawing, the authority for making the change shall be entered in the description column of the revision block as follows:

"CLASSIFICATION CHANGED TO

BY AUTHORITY OF

DATE "

11-4.2 DECLASSIFICATION. Declassification of a drawing shall be accomplished on the master by lining out the existing classification and entering the authority as described in paragraph 11-4.1 and by using the following note:

"CLASSIFICATION CANCELED BY AUTHORITY OF

DATE "

11-4.3 SECURITY NOTATION ON COPIES. Holders of copies of NASA drawings that have been reclassified or declassified by the proper authority shall, upon notification, change the classification appearing on such copies and indicate the authority next to the change in classification.

Section 12
DRAWING NOTES

12-1 NOTES OF LOCAL CHARACTER

Notes of local character, such as drill notes, thread notes, etc., that require leaders to indicate the features to which they apply, shall be located in the field of the drawing in positions adjacent to such features. Unless a leader is drawn to each feature, each note shall state the number of features to which it applies.

12-2 GENERAL DIMENSIONAL TOLERANCE NOTES

The general tolerances entered in the supplementary block, figure 6-8, shall control all dimensions applied to the drawing except those specifically labeled "Max," "Min," "Ref," "Datum," or "Basic," or dimensions having tolerances applied directly thereto, or dimensions controlled by notes or documents invoked on the drawing.

12-3 GENERAL NOTES

Notes of general character that do not require leaders to indicate where they apply, and for which provision has not been made in the supplementary blocks of the drawing format, shall be located adjacent to the left border and to the left of all views.

12-4 NUMBERING OF NOTES

General notes shall be numbered consecutively. Local notes that apply to two or more widely separated areas of a drawing may be grouped with the general notes, numbered, and referenced by number in the field of the drawing, as "See Note_____." Numbers are not to be enclosed in any way.

12-5 MATERIAL AND HEAT TREATMENT NOTES

Instructions regarding material notes and heat treatment notes are contained in section 10.

12-6 NOTES INVOKING SPECIFICATIONS

12-6.1 IDENTIFICATION OF SPECIFICATIONS. See paragraph 4-3, "Reference Documents," for requirements concerning identification of specifications on drawings.

12-6.2 DETAIL SPECIFICATIONS APPLICABLE TO ITEM. When a detail specification has been prepared to cover the item shown by a drawing, the specification is the primary procurement document; the drawing supplements the specification. Therefore, the specification shall be invoked without any qualifying heading.

In such cases, the first general note or one of the reference notes (paragraph 12-9) shall be similar to the following example:

ALL REQUIREMENTS OF MIL-E-00008 APPLY

This note shall not be placed under the words "Unless otherwise specified" or "Except as noted."

12-6.3 GENERAL SPECIFICATIONS OR DETAIL SPECIFICATION NOT ENTIRELY APPLICABLE. When certain provisions of a specification are applicable but exceptions to the specification are stated on the drawing, the drawing is the primary procurement document and the specification is supplementary. Therefore, a statement requiring conformance with the specification shall be included on the drawing; but this statement shall be qualified either by the phrase "Unless otherwise specified" or by listing only the applicable portions.

If a table of characteristics is shown on the drawing, the note invoking the specification preferably should follow this table. A note similar to one of the following examples shall be used:

a. UNLESS OTHERWISE SPECIFIED HEREON, THE REQUIREMENTS OF MIL-E-00008 APPLY.

b. ACCEPTANCE TESTS OF MIL-E-00008 APPLY.

c. ENVIRONMENTAL REQUIREMENTS AND QUALITY ASSURANCE PROVISIONS OF MIL-E-00008 APPLY.

12-6.4 PROCESS SPECIFICATIONS. Applicable process specifications shall be invoked by an individual general note referring to each process.

12-7 NOTES INVOKING STANDARDS

12-7.1 IDENTIFICATION AND APPLICABILITY OF STANDARDS. See section 4 for requirements concerning (a) the means of identifying "reference documents" on drawings and (b) the general applicability of various standards. Government, industry, or company standards shall be invoked by notes on each drawing to which they apply, consistent with the limitations imposed herein regarding the use of such standards.

12-7.2 TYPICAL NOTES INVOKING STANDARDS. Standards required to assure correct interpretation of a NASA drawing shall be invoked on the drawing by a note similar in format to the following.

"INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327."

12-8 IDENTIFICATION MARKING NOTES

Each drawing of an item, except drawings of parts that do not have a sufficient or suitable surface, shall include identification marking instructions in accordance with ND 1002019. The following are examples of typical identification marking notes:

a. MARK "0000590," IN 1/8 CHARACTERS IN POSITION SHOWN USING BLACK STENCIL INK TT-I-558 AND COVER WITH CLEAR LACQUER MIL-L-1118.

b. STEEL STAMP, ETCH, OR ENGRAVE, "0000590" IN 3/16 CHARACTERS IN POSITION SHOWN.

c. MARK "0000590-1" IN 1/4 CHARACTERS IN POSITION SHOWN, CAST INTEGRAL.

d. BAG OR TAG PER ND 1002019.

The characters shown in the marking note shall consist of the NASA drawing number, a dash, and the revision letter (if any). The identification marking note may be included in the general notes or placed in the field of the drawing. The position in which the identification mark is to be located shall be indicated on one of the views, either by a dot-dash rectangle or by the figures comprising the drawing number. If a rectangle is shown, a leader shall be run from the rectangle either to the words "Identification Mark" or to the complete marking note.

12-8.1 ASSEMBLIES. The marking instructions for major assemblies identified by means of type designations shall be stated on one of the following drawings:

a. detail drawing of the identification plate (nameplate),

b. assembly drawing, or

c. detail drawing of the part (housing, weldment, etc.) on which the identification is to be marked.

12-9 DRAWING REFERENCE NOTES

Requirements for notes referring to other drawings are stated in the paragraphs on "Types of Drawings" in section 5 of this publication. Such reference notes may either be included with the general notes or be located in a separate group in the space above the title block.

12-10 PROTECTIVE COATING NOTES

General instructions on the materials, methods, and processes approved for use in the painting of NASA equipment are stated in NAVORD OSTD 52 (presently being rewritten as a MIL-STD). Instructions on preparatory treatments for painting and on chemical treatments that are used for corrosion prevention of unplated surfaces also are contained in OSTD 52. Notes specifying the required protective coating shall be included in the general notes on detail drawings. The following are examples of typical notes applicable to protective coatings:

a. PREPARE ALL EXTERIOR (and/or interior) SURFACES FOR PAINTING IN ACCORDANCE WITH MIL-C-007, GRADE XX, TYPE XX.

b. PAINT ALL EXTERIOR SURFACES, EXCEPT SCREW THREADS, IN ACCORDANCE WITH NAVORD OSTD 52, SYSTEM NO. 22.

c. ANODIZE IN ACCORDANCE WITH MIL-A-0005, TYPE II.

12-11 NONDESTRUCTIVE TESTING POSITION NOTES

When strength or surface requirements of castings or weldments necessitate the use of nondestructive tests, notes specifying the required tests shall be placed either on a separate "Nondestructive Testing Position Drawing" or on the detail drawing of the part. The following are examples of typical notes:

a. INTERPRET NONDESTRUCTIVE TESTING SYMBOLS IN ACCORDANCE WITH MIL-STD-23.

b. PERFORM AT POSITIONS INDICATED (or complete) RADIOGRAPHIC EXAMINATION IN ACCORDANCE WITH MIL-I-0005.

c. PERFORM AT POSITIONS INDICATED (or complete) MAGNETIC PARTICLE INSPECTION IN ACCORDANCE WITH MIL-I-0008.

12-12 NOTES APPLICABLE TO WELDMENTS

The following notes pertaining to weldment drawings are shown as examples only and shall not be construed as representing the requirements of the National Aeronautics and Space Administration for notes on a specific drawing:

a. USE WELDING ELECTRODE MIL-E-00099. TYPE MIL-0011. USE WELDING FLUX MIL-F-00036 TYPE A CL. 1.

b. WELD BY INERT-GAS CARBONARC PROCESS, USING WELDING ROD QQ-R-006, TYPE I, CL. FS-RA 143.

c. STRESS RELIEVE HEAT TREAT AT XX TO XX° F FOR A MINIMUM OF XX HOURS, FURNACE COOL.

d. INTERPRET WELDING SYMBOLS IN ACCORDANCE WITH JAN-STD-19.

12-13 TYPICAL GENERAL NOTES

The wording of similar notes on NASA drawings shall be reasonably uniform. The following examples, however, are for guidance only and shall not be construed as representing the requirements of the National Aeronautics and Space Administration.

12-13.1 PARTS FINISHED ALL OVER, UNIFORM ROUGHNESS, PLATED.

Examples:

a. FINISH ALL OVER 

b. UNLESS OTHERWISE SPECIFIED: INSIDE CORNERS. $\begin{smallmatrix}.01\\.02\end{smallmatrix}$ R

c. DIMENSIONS, TOLERANCES, AND SURFACE ROUGHNESS HEIGHT RATINGS APPLY AFTER PLATING.

d. GOLD PLATE IN ACCORDANCE WITH MIL-G-45204, TYPE 2, CLASS 3.

e. APPLICABLE STANDARDS MIL-STDS-8, 9, 10.

12-13.2 PARTS FINISHED ALL OVER, VARYING ROUGHNESS.

Example:

UNLESS OTHERWISE SPECIFIED:

XX ALL OVER

NOTE: Each remaining machined surface shall be marked with the prescribed roughness symbol enclosing the allowed roughness rating.

12-13.3 CASTINGS, FORGINGS, BAR STOCK, EYC., VARYING ROUGHNESS, ONE RATING PREDOMINATING.

Example:

SURFACES MARKED √ TO HAVE XX UNLESS OTHERWISE SPECIFIED: CAST FINISH.

NOTE: Each remaining machined surface shall be marked with the prescribed roughness symbol enclosing the allowed roughness rating.

12-13.4 PARTS FINISHED ALL OVER, UNIFORM ROUGHNESS.

Example:

FINISH ALL OVER XX

NOTE: No roughness symbols are required in the delineation of the part.

12-13.5 PARTS FABRICATED FROM SHEET METAL.

Example:

UNLESS OTHERWISE SPECIFIED: SURFACE ROUGHNESS AS ROLLED OR DRAWN.

PUNCHED, CUT, OR MACHINED SURFACES TO HAVE XX

Section 13
RUNNING LISTS

13-1 GENERAL

Running lists consist of tabular data and instructions required to establish wiring connections between different units of an equipment or different equipments of a system.

13-1.1 USE OF RUNNING LISTS. Running Lists may be furnished in lieu of external interconnection diagrams. See paragraph 5-15. They may also be included in the field of the drawing as a tabulated listing. See figure 5-4.

13-1.2 FORMS. The forms used for the preparation of running lists shall be in accordance with figures 6-2 and 6-3. The continuation sheet, shown in figure 6-3, shall be converted as necessary for running list applications, as illustrated in figures 13-2, 13-3, 13-13, and 13-14. Figures 13-1 thru 13-14 illustrate a typical running list.

13-1.3 IDENTIFICATION. Running Lists shall be identified by NASA drawing numbers. Sheet numbering shall be as described in paragraph 13-1.5.

13-1.4 PREPARATION OF A RUNNING LIST.

13-1.4.1 Title Sheet and Title Block. Only the title sheet (figure 13-1) shall be signed or initialed and authenticated in accordance with section 14.

The title block shall show the nomenclature of the equipment for which the running list is prepared. The "Revision Status of Sheets" column shall include the sheet number of each sheet of the running list. Revision block entries shall be made in accordance with paragraph 15-8.7.

13-1.4.2 Revision Status of Sheets. "Revision Status of Sheets," figure 13-2, shall serve as a continuation of the revision status record on the title sheet. The revision status continuation sheet shall be included in the running list when the number of sheets exceeds the space provisions of the printed format of the title sheet. Figure 13-2 is included in the sample running list to illustrate the required format.

13-1.4.3 Revision Description. The "Revision Description" continuation sheet, figure 13-3, shall serve as a continuation of the revision description record on the title sheet. The continuation sheet shall be added to the running list when the space provided for that purpose on the title sheet becomes exhausted. Figure 13-3 is included in the sample running list to illustrate the required format.

13-1.4.4 Index to Equipment Interconnecting Information. The index, figure 13-4, shall serve as a table of contents for the interconnection data applicable to the running list. It consists of a listing by title of each sheet cross-referenced to its applicable sheet number.

13-1.4.5 Reference Document. This sheet(s), figure 13-5, shall contain a listing of drawings or other documents required to interpret equipment interconnection information. Titles of such documents may be included optionally.

13-1.4.6 Notes and Illustrations. This sheet(s), figure 13-6, shall contain all information and instructions required to supplement tabular data and shall contain illustrations, as shown in figures 13-7 through 13-10, when necessary to insure clarity.

13-1.4.7 Cable Running Sheet. A separate sheet, figure 13-13, shall be prepared for each cable. It shall contain the following information in the spaces provided: cable number, cable type, number of active wires, and unit designation numbers of the units between which the cable runs. Data for each of the wires of the cable are listed as follows in the columns provided: the terminal numbers of the units to which each cable is attached, the designation number assigned to the wire, and its color code. All wires in the cable not used shall be listed and designated "spare" in the function column.

13-1.4.8 Strapping. A strapping sheet, figure 13-14, shall be prepared for each unit in which strapping wires are installed. It shall list the designation number of the unit, the type of wire used, and the terminal designation numbers to which each end of the strapping is attached. Brief functional characteristics should be entered in the function column.

13-1.5 NUMBERING OF SHEETS. Running List sheets shall be numbered consecutively, beginning with the title sheet as sheet 1. Revision continuation sheets, figures 13-2 and 13-3, shall be included next in sequence to the title sheet. For example, when continuation sheets are added by revision to supplement the title sheet, they shall be numbered 1a, 1b, etc. If added to supplement existing continuation sheets initially included in the running list, each sheet added will be numbered the same as the sheet it supplements but with progressive letter suffixes, 1a, 2a, 2b, etc.

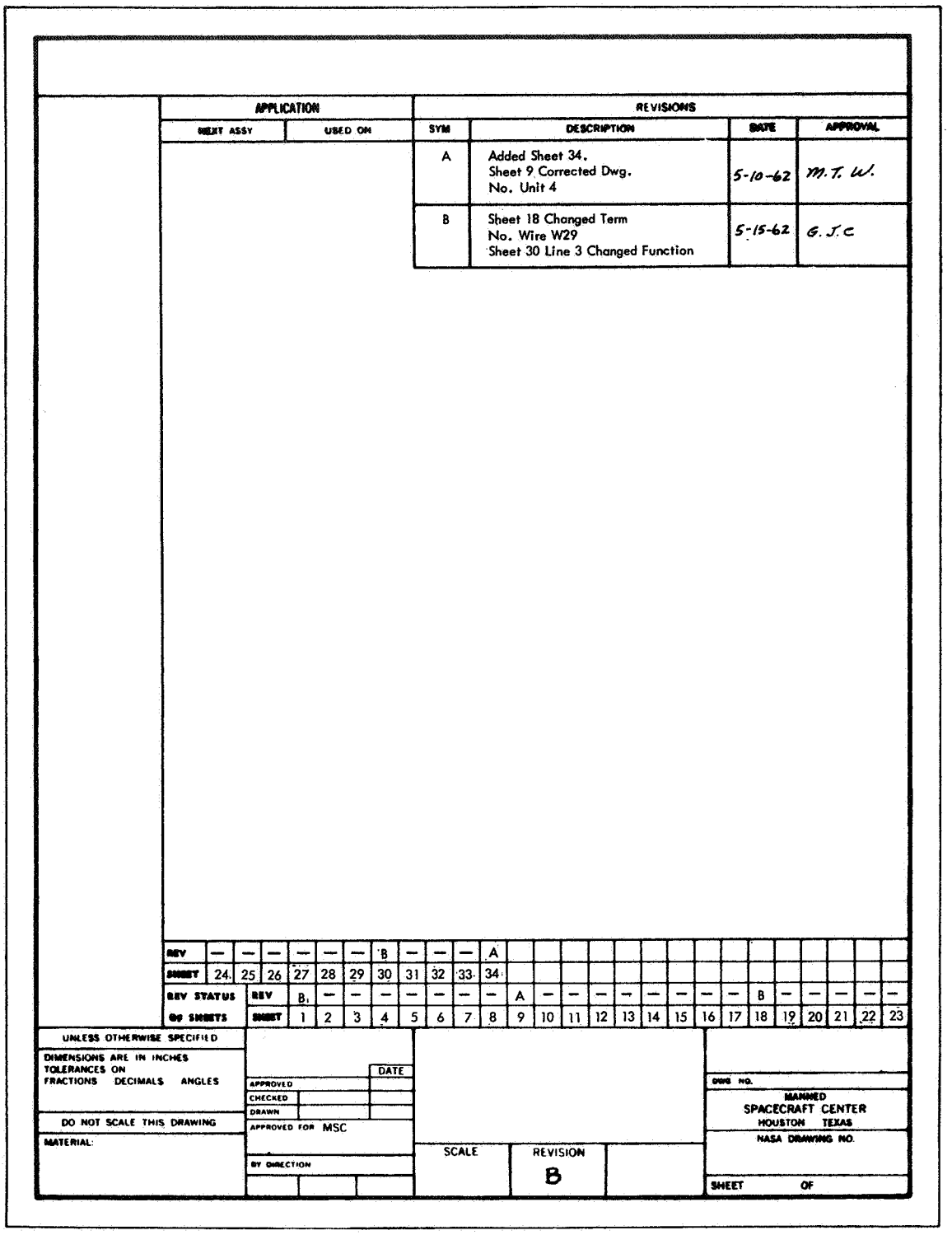
13-1.6 REVISION OF RUNNING LISTS. Revisions to running lists shall be accomplished as specified in paragraph 15-16 for Alternative A-size drawings. An exception to those requirements is that revisions need not be targeted if a brief description of the revision is entered in the revision description column. A sample running list, figures 13-1 through 13-14, contains examples of typical revision action.

When a "revision status" continuation sheet is added to the running list by revision, a note shall be added to the first sheet and shall read:

"Revision status of sheets continued on sheet _____."

When a "revision description" sheet is added, the note shall read:

"Revision descriptions continued on sheet _____."



APPLICATION		REVISIONS			
NEXT ASSY	USED ON	SYM	DESCRIPTION	DATE	APPROVAL
		A	Added Sheet 34. Sheet 9 Corrected Dwg. No. Unit 4	5-10-62	M. T. W.
		B	Sheet 18 Changed Term No. Wire W29 Sheet 30 Line 3 Changed Function	5-15-62	G. J. C

REV	—	—	—	—	—	—	B	—	—	—	A															
SHEET	24	25	26	27	28	29	30	31	32	33	34															
REV STATUS	REV	B	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	B	—	—	—	—	—		
OF SHEETS	SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES
DO NOT SCALE THIS DRAWING
MATERIAL:

APPROVED DATE
CHECKED
DRAWN
APPROVED FOR MSC
BY DIRECTION

SCALE
REVISION B

DWG NO.
MANNED SPACECRAFT CENTER HOUSTON TEXAS
NASA DRAWING NO.
SHEET OF

Figure 13-1. Title Sheet.

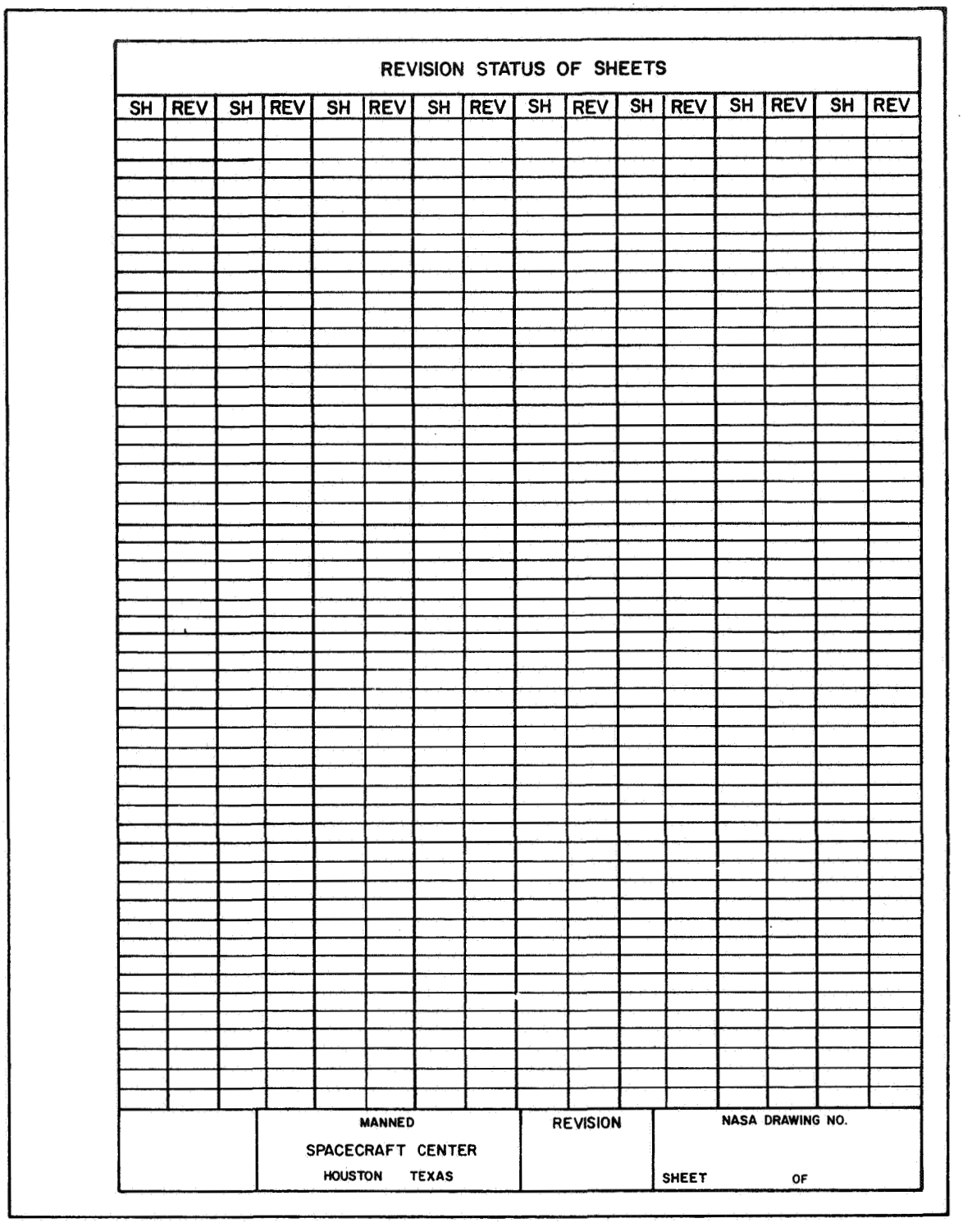


Figure 13-2. Revision Status of Sheets. (Conversion of Alternative A-Size Continuation Sheet.)

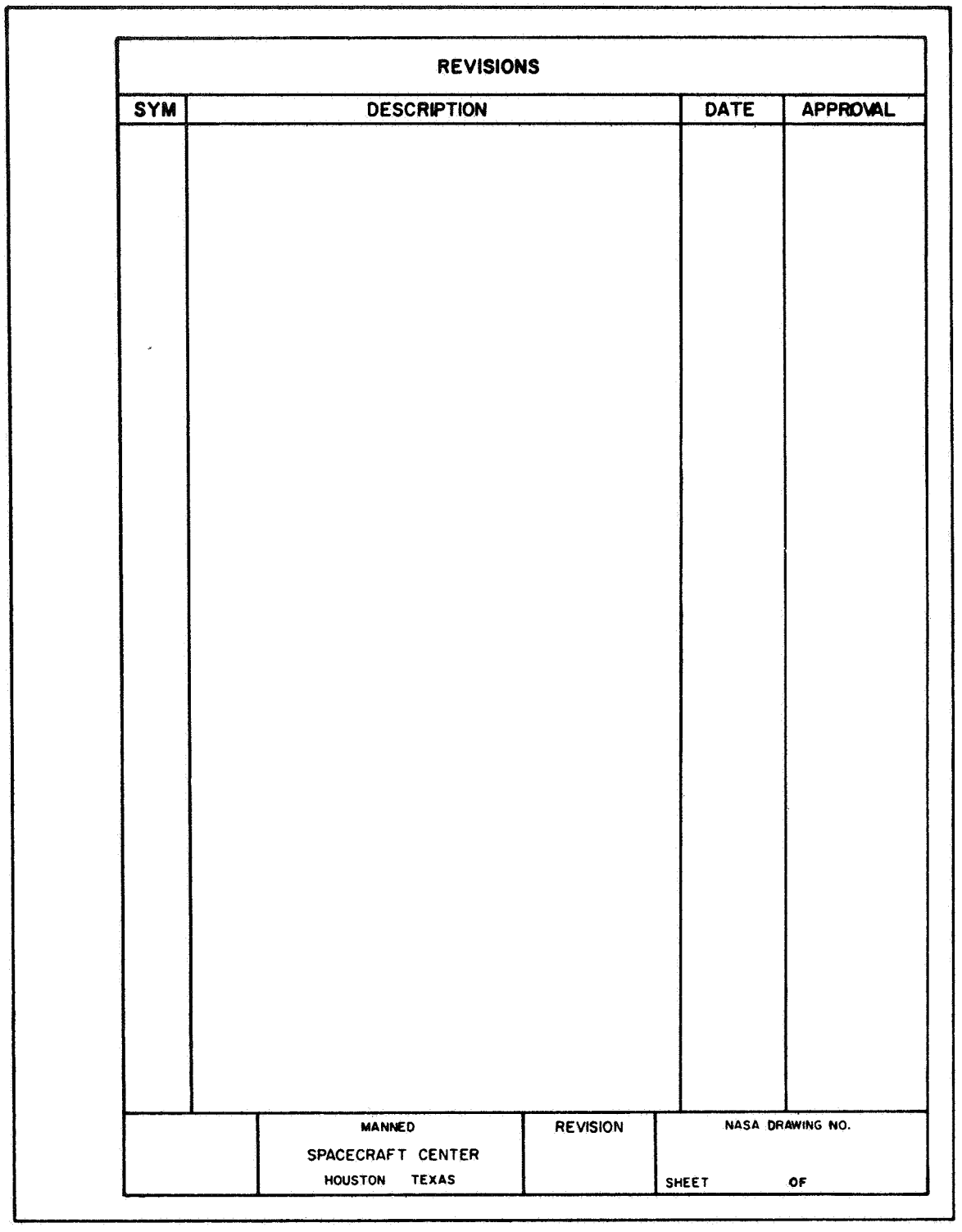
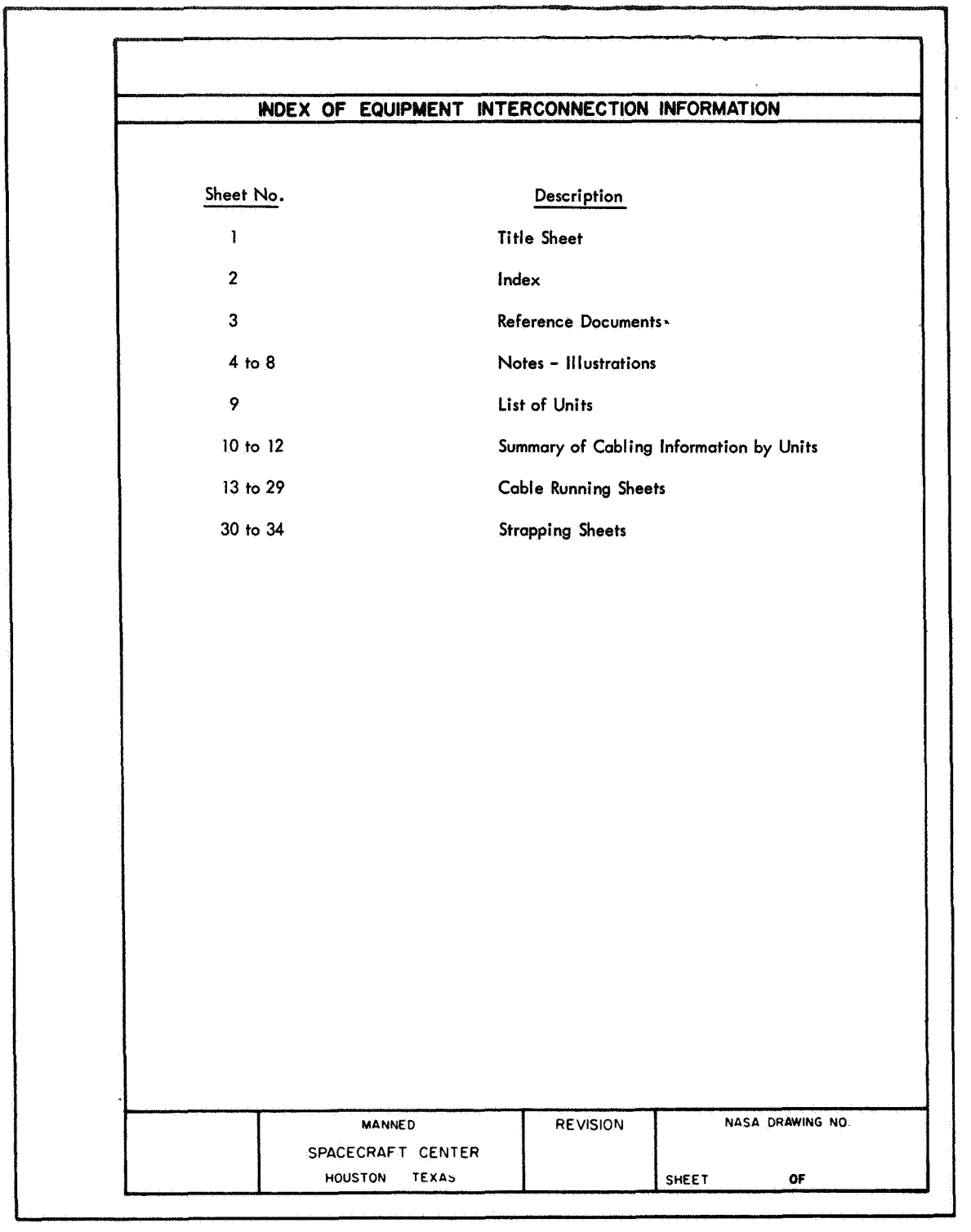


Figure 13-3. Revision Description. (Conversion of Alternative A-Size Continuation Sheet Format.)



INDEX OF EQUIPMENT INTERCONNECTION INFORMATION

Sheet No.	Description
1	Title Sheet
2	Index
3	Reference Documents
4 to 8	Notes - Illustrations
9	List of Units
10 to 12	Summary of Cabling Information by Units
13 to 29	Cable Running Sheets
30 to 34	Strapping Sheets

	MANNED SPACECRAFT CENTER HOUSTON TEXAS	REVISION	NASA DRAWING NO. SHEET OF

Figure 13-4. Index of Equipment Interconnection Information.

REFERENCE DOCUMENTS

000258

000260

000277

000278

000279

000280

000441

000442

000443

000454

000455

000711

	MANNED SPACECRAFT CENTER HOUSTON TEXAS	REVISION	NASA DRAWING NO. SHEET OF

Figure 13-5. Reference Documents.

NOTES - ILLUSTRATIONS

1. Moisture and fungus proof in accordance with MIL-T-152.
2. Cable lengths to be determined at assembly.
3. Wire marking: Wire markers for each conductor to be marked with the designation of the applicable terminal number of the unit.
4. Wire markers to be marked with terminal numbers indicated on cable running and strapping sheets and installed before installing terminal lugs.
5. Terminal lugs (MIL-E-16366) to be installed on all active conductors.
6. Two (2) cable tags to be marked with each cable number and installed on appropriate cable at entrance to equipment.
7. Units listed on sheets 9, 10 to 12, and 30 to 34 are compiled in order by designation number of units.

	MANNED SPACECRAFT CENTER HOUSTON TEXAS	REVISION	NASA DRAWING NO. SHEET OF

Figure 13-6. Notes and Illustrations.

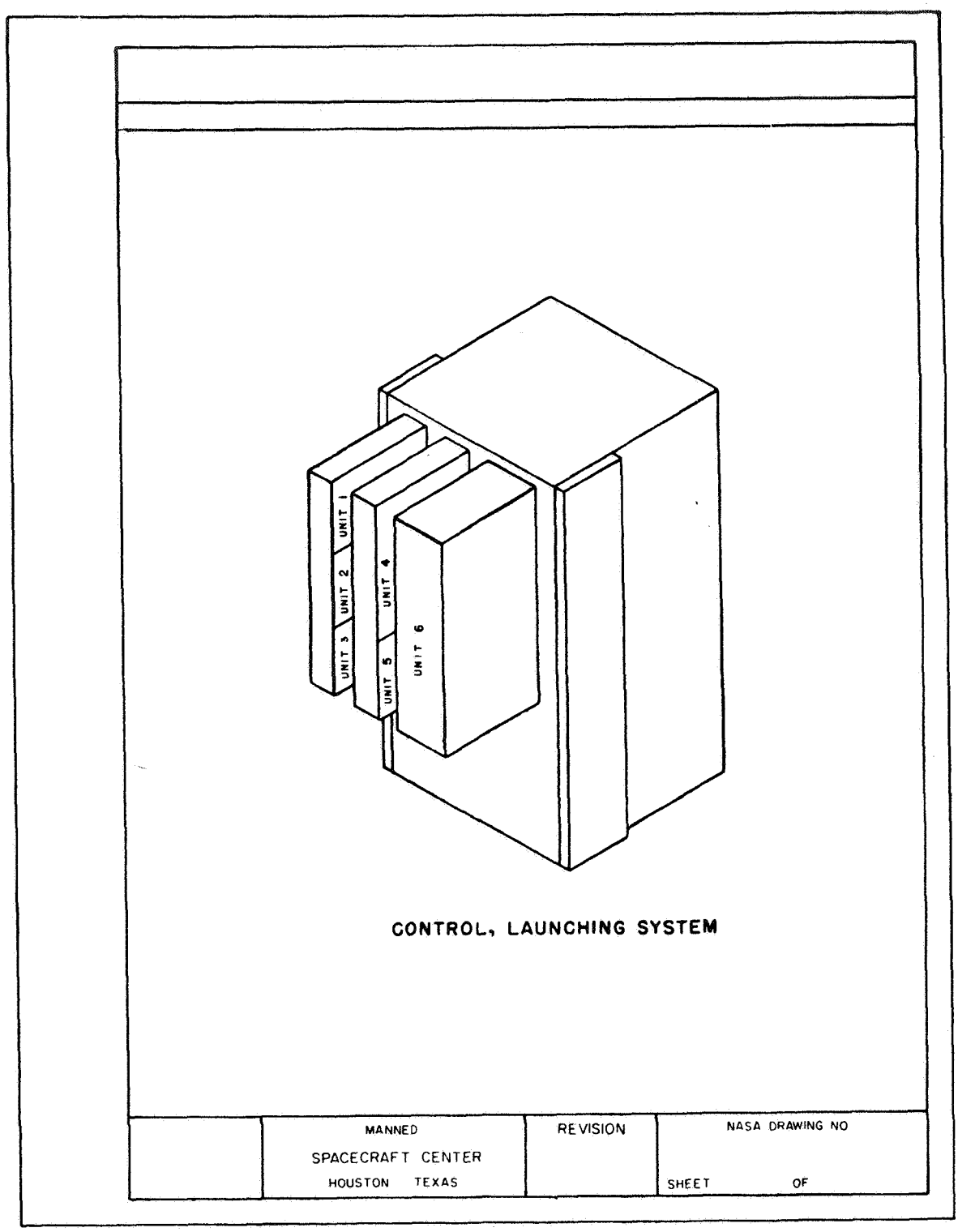


Figure 13-7. Launcher Control.

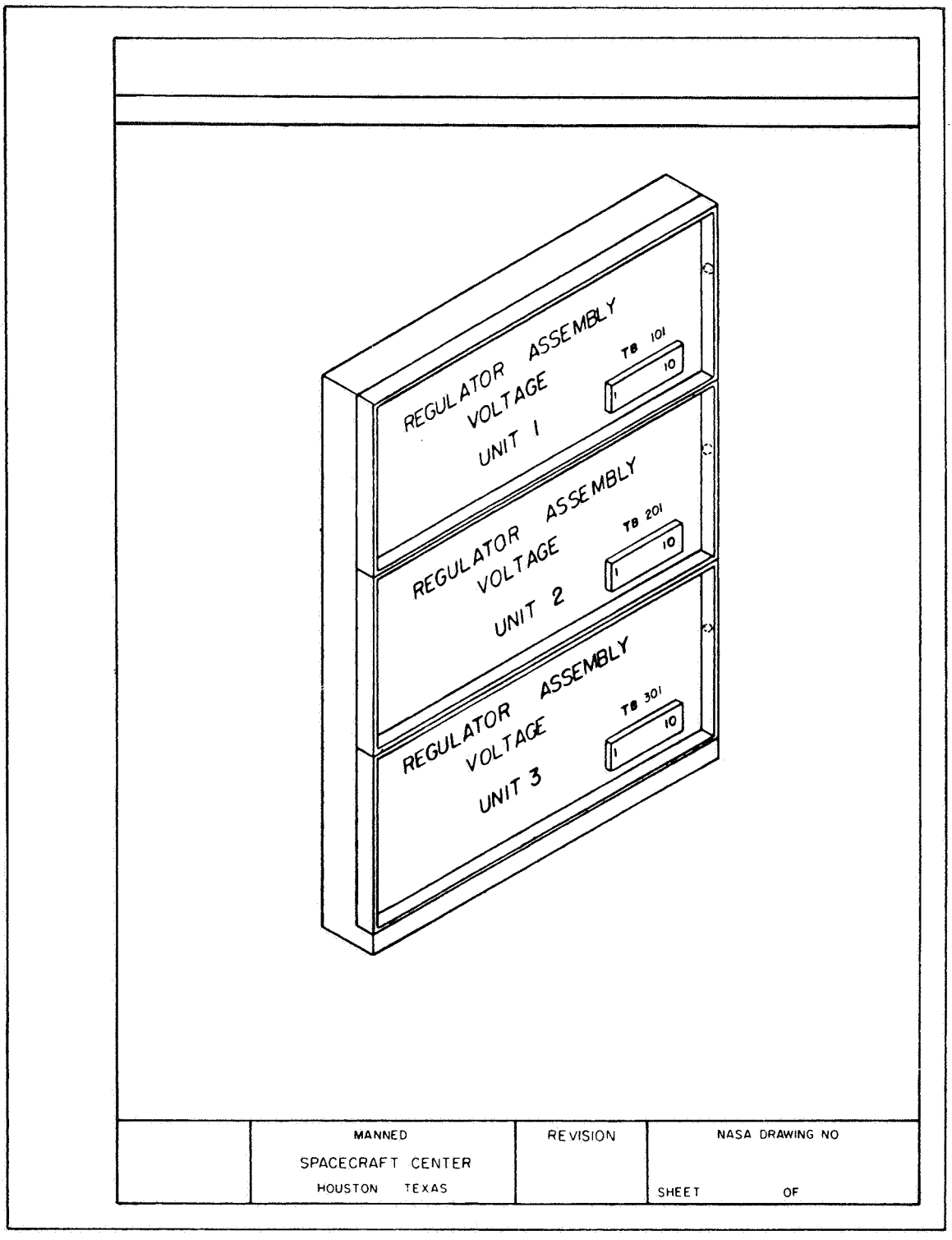


Figure 13-8. Regulator.

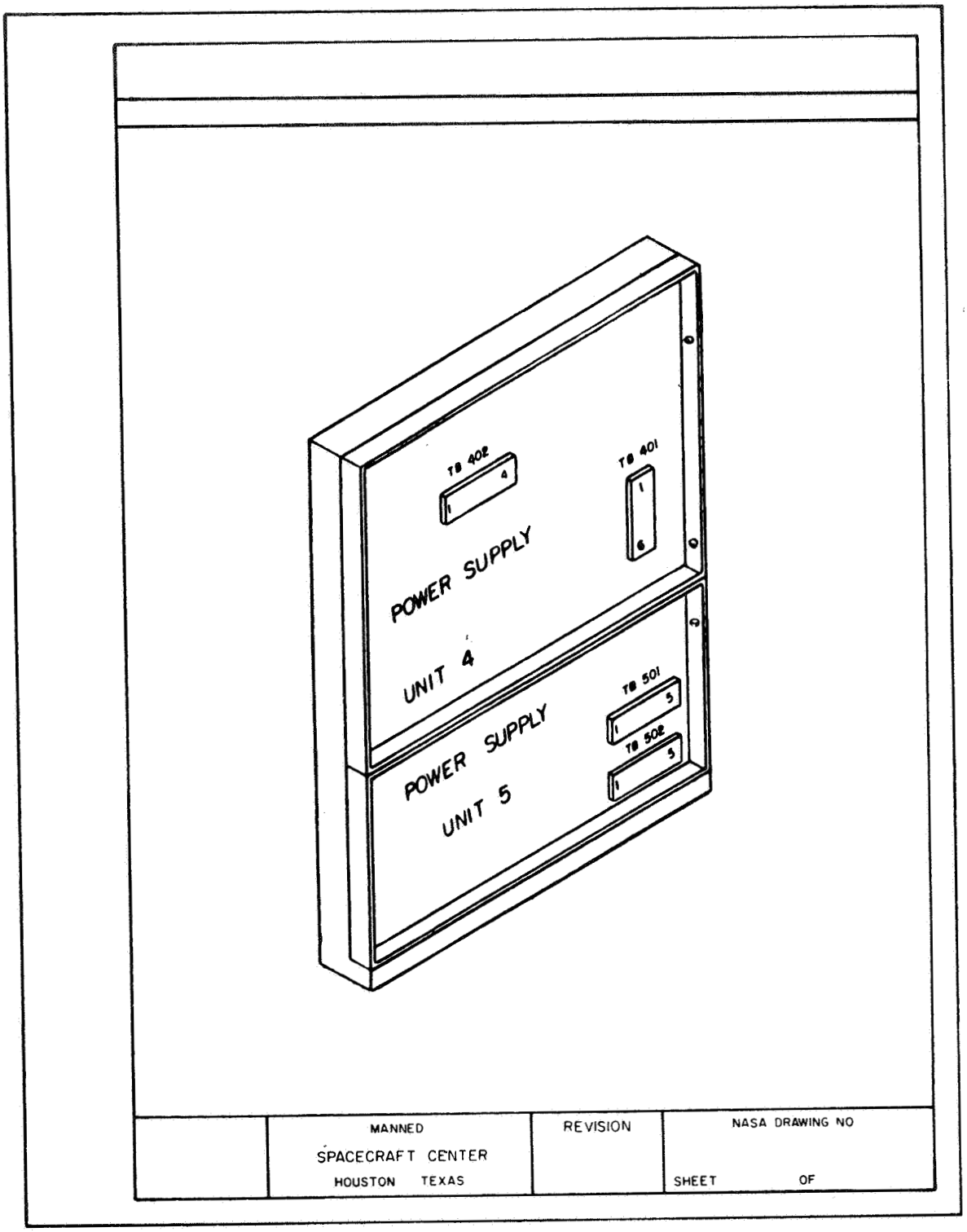


Figure 13-9. Power Supply.

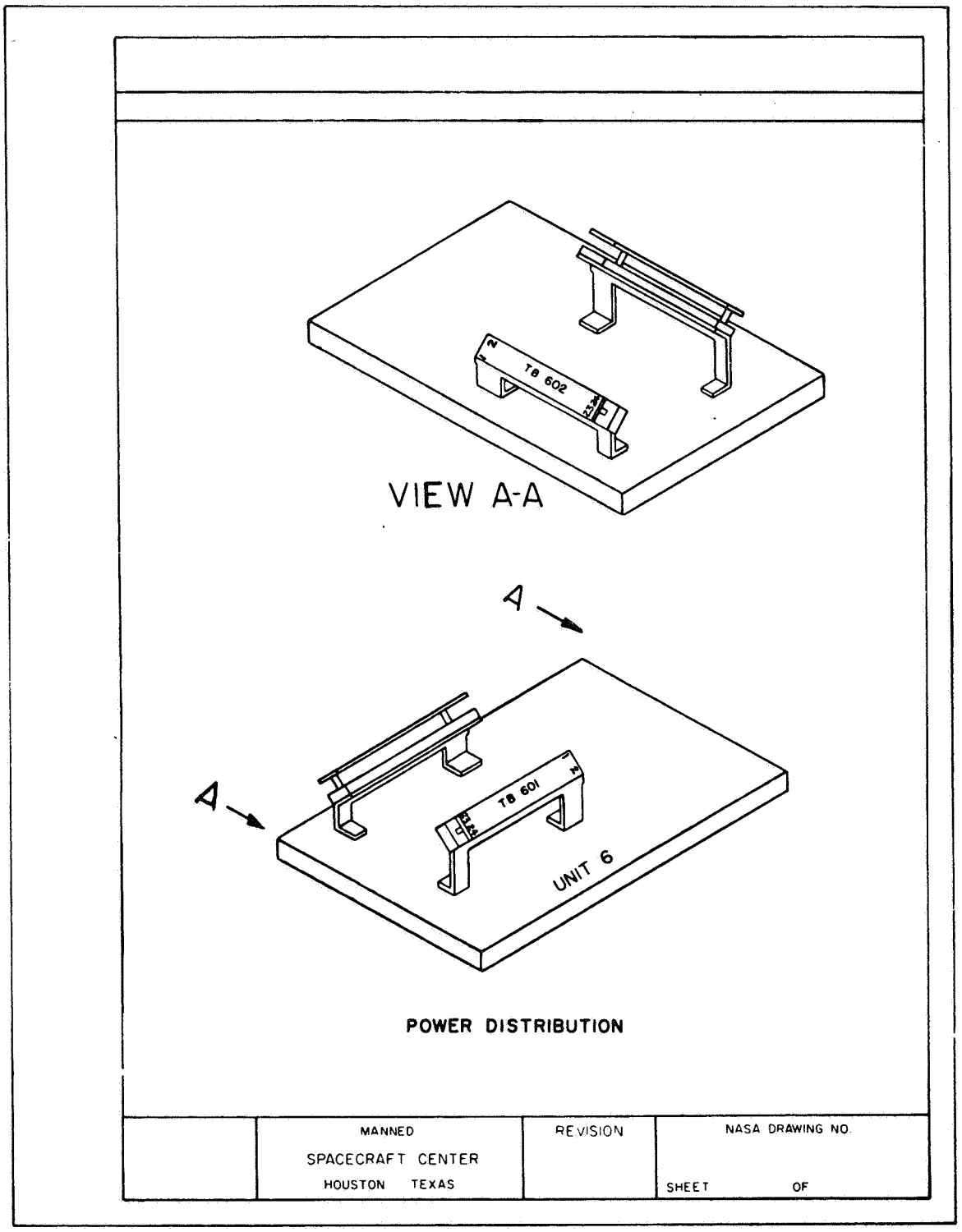


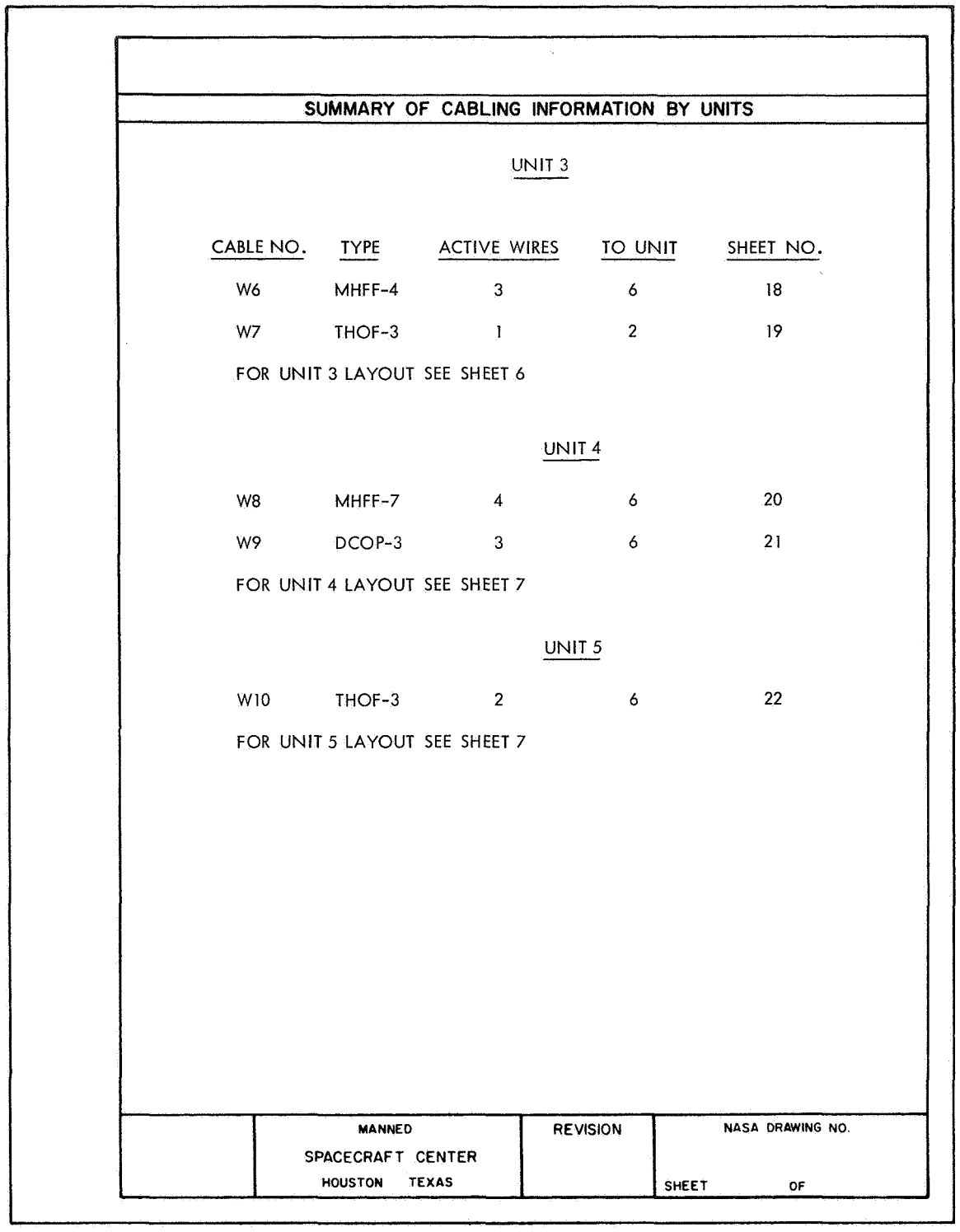
Figure 13-10. Power Distribution.

LIST OF UNITS

UNIT DESIGNATION	CABLE SUMMARY SHEET NO.	TITLE	DWG No.
1	10	Regulator	000277
2	10	Regulator	000278
3	11	Regulator	000279
4	11	Power Supply	000280
5	11	Power Supply	000442
6	12	Power Distribution	000711

	MANNED SPACECRAFT CENTER HOUSTON TEXAS	REVISION	NASA DRAWING NO. SHEET OF

Figure 13-11. List of Units.



SUMMARY OF CABLING INFORMATION BY UNITS

UNIT 3

CABLE NO.	TYPE	ACTIVE WIRES	TO UNIT	SHEET NO.
W6	MHFF-4	3	6	18
W7	THOF-3	1	2	19

FOR UNIT 3 LAYOUT SEE SHEET 6

UNIT 4

W8	MHFF-7	4	6	20
W9	DCOP-3	3	6	21

FOR UNIT 4 LAYOUT SEE SHEET 7

UNIT 5

W10	THOF-3	2	6	22

FOR UNIT 5 LAYOUT SEE SHEET 7

	MANNED SPACECRAFT CENTER HOUSTON TEXAS	REVISION	NASA DRAWING NO. SHEET OF

Figure 13-12. Summary of Cabling Information by Units.

CABLE NO. W6			CABLE NO.		
CABLE TYPE MHFF-4			UNIT A UNIT 3		
ACTIVE WIRES 3			UNIT B UNIT 6		
UNIT A TERM NO.	WIRE NO.	WIRE COLOR	UNIT B TERM NO.	FUNCTION	LINE
TB301-1	W27	Wht	TB602-13	440V 400 Cycles	1
TB301-2	W28	Grn	TB602-21	440V 400 Cycles	2
TB301-4	W29	Blu	TB602-10	120V 400 Cycles	3
		Blk		SPARE	4
					5
					6
					7
					8
					9
					10
					11
					12
					13
					14
					15
					16
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					39
					40
					41
					42
					43
					44
					45
	MANNED SPACECRAFT CENTER HOUSTON TEXAS		REVISION B	NASA DRAWING NO. SHEET OF	

Figure 13-13. Cable Running Sheet. (Conversion of Alternative A-Size Continuation Sheet Format.)

CABLE NO.	CABLE NO. STRAPPING
CABLE TYPE MIL-W-16878 Ty. E12	UNIT A UNIT 3
ACTIVE WIRES	UNIT B

UNIT A TERM NO.	WIRE NO.	WIRE COLOR	UNIT B TERM NO.	FUNCTION	
TB602-2			TB602-4	[illegible]V 440 Cycles	
TB602-6			TB602-8	120V 440 Cycles	
TB602-10			TB602-12	135V 440 Cycles	

	MANNED SPACECRAFT CENTER HOUSTON TEXAS	REVISION	NASA DRAWING NO. SHEET OF

Figure 13-14. Strapping Sheet. (Conversion of Alternative A-Size Continuation Sheet Format.)

Section 14
AUTHENTICATION AND PERFORATION OF MASTER

14-1 GENERAL

A NASA drawing is not an official National Aeronautics and Space Administration document until it has been authenticated. Authentication consists of review by the Design Review Board and approval by the MIT APOLLO Configuration Control Board. The detail procedures are defined in MIT Report E-1186.

14-2 STAGES OF DEVELOPMENT

A NASA drawing may be authenticated and released for limited use at various stages of development prior to production for service use. Under such circumstances, a note shall be placed on the drawing to indicate the purpose of the release and to restrict the use of the drawing. Typical examples of release notations are:

(1) RELEASED FOR INFORMATION ONLY

(2) RELEASED FOR PROCUREMENT OF MATERIAL ONLY

(3) RELEASED FOR SERVICE TEST MODELS ONLY

(4) RELEASED FOR PRODUCTION PLANNING ONLY

Prior to release for manufacture of production models, or when the limitation no longer applies, such notes shall be removed. If the drawing has been authenticated, removal of such notes shall be by formal revision.

14-3 DRAWINGS PREPARED BY CONTRACTORS

NASA drawings prepared by Contractors shall be signed or initialed by the draftsmen, checkers, and technical personnel responsible for the adequacy of design. Each drawing then shall be signed in the contractor's certification block by an official or authorized employee of the contractor to certify that the drawing is complete and defines the design conforming with all contractual documents. The drawings shall then be presented to the MIT APOLLO Configuration Control Board for authentication in accordance with E-1186.

14-4 DESIGN APPROVAL AND DRAWING AUTHENTICATION

14-4.1 DESIGN APPROVAL. Design approval of APOLLO Guidance and Navigation equipment documents shall be the responsibility of the Configuration Control Board at the Massachusetts Institute of Technology estabilshed in MIT-E1186.

Configuration Control Board review and approval is required for original issuance, and subsequent changes or revision to any drawing, specification, publication, or document.

For the purpose of expediting the availability of drawings and documents for research and development purposes, Configuration Control Board action shall be divided into Class "A" and Class "B" releases.

14-4.1.1 Class "A" Release. Documents released as Class "A" are those which are determined by the project or design engineer to be used for flight schedule design. Such drawings and documents must be checked for format, completeness, and interfaces, and be processed through the MIT Design Review Board prior to submission to the APOLLO Configuration Control Board for authentication. Step-by-step procedures prescribing action required on a Class A Release is contained in MIT Report E-1186, Technical Data Release Procedures.

14-4.1.2 Class "B" Release. Documents released as Class "B" are those which are released for preflight units. These are R&D units, such as determining operating characteristics, design parameters, size and weight requirements, and breadboard models. A Class B release document can be upgraded to a Class A document upon approval by the Configuration Control Board.

Drawings and Documents released as Class B are not subject to review for format, completeness, and interfaces and do not require Design Review Board action prior to release by the APOLLO Configuration Control Board.

Each Class B drawing shall contain the following legend:

FOR INFORMATION ONLY

CLASS B RELEASE TDRR No._____ DATE_____

This legend is placed near the right-hand margin of the drawing approximately midway between the revision block and the title block.

Class B release documents submitted for upgrading to a Class A release shall be reviewed for format, completeness, interface, and must be reviewed by the Design Review Board prior to submission to the Configuration Control Board for upgrading.

Step-by-step procedures prescribing action required on a Class B release is contained in MIT Report E-1186, Technical Data Release Procedures.

14-4.2 DRAWING AUTHENTICATION. Drawing authentication shall be the responsibility of the National Aeronautics and Space Administration. Such responsibility may be delegated to an Engineering Support activity.

14-5 MASTER

The "master" of a NASA drawing is the initial drawing, or the ink tracing, or phototracing copy thereof, on which is maintained or will be maintained the revision record recognized as official by the National Aeronautics and Space Administration.

14-6 PERFORATION OF MASTER

Immediately after authentication, all sheets of a NASA drawing shall be PERFORATED ONLY (not inked) with the word "MASTER, " in letters 3/8 to 1/2 inch in height, directly above the title block.

14-7 DUPLICATES OF MASTER

Aside from the master, no additional phototracing of a NASA drawing shall be made without the written approval of the National Aeronautics and Space Administration. Reproducible copies of the master should be autopositives or vandykes in order to avoid the confusion that results from the existence of more than one phototracing of the same drawing.

When the existence of duplicate phototracings has been authorized, the following legend shall be stamped or lettered on each duplicate tracing:

"DUPLICATE -- REVISE ONLY TO MATCH MASTER. "

The word "duplicate" shall be in letters 3/8 inch in height, and the remainder of the legend shall be in letters approximately 3/16 inch in height. The location of the legend shall be the same as specified in paragraph 14-8 for the perforation of masters.

14-8 AUTHENTICATION OF MULTI-SHEET DRAWINGS

Each sheet of a multi-sheet drawing, as described in paragraph 8-5.1, shall be signed or initialed, authenticated, and perforated "MASTER" in accordance with the foregoing requirements.

14-9 SUBMISSION OF MASTER DRAWINGS AND MICROFILM APERTURE CARDS

Detailed procedures controlling submission of master drawings and microfilm aperture cards will be delineated in separate correspondence to APOLLO Participating Contractors.

Section 15
REVISION OF DRAWINGS

15-1 GENERAL

This section covers the methods for revising NASA drawings and for identifying and recording revisions thereon. It contains the provisions of MIL-STD-24 and certain additional requirements.

Revision of Class A Release Documents (paragraph 14-4.1.1) are divided into classes: Class 1, Class 2, and Class 3. Details pertaining to these classes of revision are contained in paragraph 15-17.

15-2 DEFINITION

The term "revision" as used in this publication refers to any change made on a NASA drawing after one or more of the following conditions has developed:

a. The drawing has been authenticated.

b. The portrayed or subject NASA item has been submitted to the Government for inspection, evaluation, final delivery, or any other reason.

c. The drawing has been released for manufacture of prototype (preproduction) or production models.

15-3 REVISION FORMS

All revisions shall be described adequately on a formal change order document as per MIT-E-1186.

15-4 REVISION RECORD ON MASTER

The official revision record shall be maintained on the master (paragraph 14-7) of each drawing. The time lag between the approval of revision directives or engineering change orders and incorporation of the revision on the master shall be reduced to a practicable minimum.

15-5 REVISION OF DUPLICATES

When approved duplicate tracings exist (paragraph 14-7), these duplicate tracings shall be revised only to agree with revisions that have been made on the master or to agree with explicit revision directives that have been approved in accordance with revision procedures established by the National Aeronautics and Space Administration.

15-6 CONTRACTOR'S REVISION BLOCK

A contractor's revision block may be included within the standard drawing form for recording preauthentication changes made by the contractor. This block shall be clearly identified as the contractor's in order to avoid confusion with the NASA revision block. Entries made in this block need not be erased at the time of authentication, but all revision symbols and other references to such entries shall be removed from the drawing field.

15-7 METHODS FOR REVISING DRAWINGS

Revisions may be made by erasure, crossing out, addition, or replacement. In order of preference between revisions by erasure and revisions by crossing out, revision shall normally be made by erasure except when retention of the delineation is essential for record purposes; then the crossing-out method shall be used. In general, any change in a dimension of a part should also be made to scale on the affected portion of the delineation; however, it is permissible to leave the delineation unchanged when the new proportion of the part is not noticeably different from the original one. In cases where change to scale is not made, the practice outlined in MIL-STD-1 under "Dimensions Not to Scale" shall be followed.

15-7.1 ERASURE. A description of the revision performed shall be given in the revision block or by reference to the revising document.

15-7.2 CROSSING OUT. Changes in delineation, dimensions, or notes shall be accomplished by crossing out (cancellation) with a series of parallel lines (preferably at a 45-degree angle to the horizontal) without obscuring the information thus changed. The superseding data, as required, shall be located near crossed out data. When the change requires partial crossing out of delineation and when space permits, additional complete or partial views to clarify the change shall be provided in lieu of interposing the corrected delineation in the existing views.

The crossing-out method shall not be used (1) when the impending revision is of such magnitude as to render the drawing illegible or cause uncertainty as to interpretation or (2) when the revision can be accomplished more economically by the "replacement" method described in paragraph 15-9.

15-7.3 ADDITION. This method of revision involves the addition of new information to a drawing. Such information may include additional dimensions, notes, and other manufacturing data as well as new views on assembly and similar drawings.

15-7.4 REPLACEMENT. See paragraph 15-9.

15-8 RECORDING REVISIONS ON DRAWINGS

15-8.1 REVISION LETTERS. Letters used in revision symbols shall follow in alphabetical sequence except that the letters "I," "O," "Q," and "X" shall not be used. When revisions are numerous enough to exhaust the alphabet, the revision following the letter "Z" shall be lettered "AA," the next "AB," the next "AC," etc. Should letters "AA" to "AZ" be exhausted, the next sequence shall be "BA," "BB," "BC," etc. Uppercase letters shall be used for indicating revisions.

15-8.2 REVISION BLOCK ENTRY. Each revision shall be recorded in the revision block of the drawing, as illustrated in figures 15-1 through 15-12. The following instructions shall govern the revisions.

15-8.2.1 Identifying Letter. The revision letter shall be entered in the "Letter" column of the revision block.

15-8.2.2 Description of Change. Reference shall be made therein to the formal change order document directing the change. When a change is made by crossing-out, the reference is normally only to the document number directing the change.

15-8.2.3 Date. The authentication date of the revision shall be entered in the date column.

15-8.2.4 Approval. Authentication of the revision shall be made in the approval column.

15-8.2.5 Zone Column. Entries in the "Zone" column are optional except on drawings showing schematic and wiring diagrams, and lubrication charts, on which zone entries shall be made because the use of revision symbols is prohibited.

15-9 REPLACEMENT

Replacement is defined as the substitution of a new authenticated master drawing, as described in paragraph 14-7, for the previous authenticated master drawing of the same drawing number.

15-9.1 TYPES OF REVISION. Replacement shall be confined to the following two types of revisions:

a. Replacement without change.

b. Replacement with change not affecting safety, life, or physcial and functional interchangeability.

15-9.2 CONDITIONS. Replacement shall be accomplished when:

a. master has deteriorated to such an extent that legible prints cannot be produced therefror

b. required revision would unduly crowd the drawing, thereby making it illegible or causing uncertainty as to interpretation.

c. revision can be accomplished more expeditiously by replacement than by revision of the existing drawing.

d. phototracing is to be substituted for an authenticated master drawing, except as stated in paragraph 15-9.4.3.

15-9.3 AUTHENTICATION. If replacement is accomplished by phototracing, the original authentication shall suffice. If replacement is accomplished by means of an ink tracing, the new master shall be authenticated in the same manner as prescribed for a new drawing in section 14.

15-9.4 RECORDING ACTION. The revision action shall be recorded on both the old and the new drawing, except as stated in paragraph 15-9.4.3. Changes incorporated on the new drawing shall be indicated as required by paragraph 15-8. A revision letter next in sequence and a subscript number shall be entered in the revision block on the old drawing together with a statement that the drawing has been replaced, either with change or without change, by the drawing of next revision. The revision letter next in sequence to that entered in the revision block on the old drawing and a subscript number shall be entered in the revision block on the new drawing together with a statement that the new drawing replaces the drawing of the previous revision either with change or without change.

15-9.4.1 Note Above Title Block on Old Drawing. In the space above the title block on the old master, the following note shall be entered:

"REPLACED WITHOUT CHANGE, (or WITH CHANGE, when applicable)

BY REV_____ (enter the revision letter entered in the revision block

of the new master)."

The note shall be preceded by a revision symbol containing the same revision letter that is entered in the revision block. The note shall be in bold letters approximately 0.20 inch in height. See figures 15-1 and 15-3.

15-9.4.2 Note Above Title Block on New Drawing. In the space above the title block on the new master, the following note shall be entered:

"REPLACES REV_____ (enter the revision letter entered in the revision block of the old master), WITHOUT CHANGE (or WITH CHANGE, when applicable)."

The note shall be preceded by a revision symbol containing the same revision letter that is entered in the revision block. The note shall be in bold letters approximately 0.20 inch in height. See figures 15-2 and 15-4.

15-9.4.3 Exceptions. When an authenticated master drawing is replaced by a phototracing and neither retouching on the field of the drawing nor "cleanup" of the revision record is required, such replacement shall be accomplished without official revision action. The old drawing shall have either the word "TRACED" written across the title block or the note "REPLACED WITHOUT CHANGE" lettered above the title block. If, however, the new phototracing requires retouching because of illegibility, the replacement shall be accomplished by official revision action as described in paragraph 15-9.4.

15-9.5 PREVIOUS REVISION NOTATIONS. All previous revision notations shall be omitted from the new drawing. This includes the omission of the previous revision record from the revision block and the removal of symbols, cross-outs, and revision notes from the field of the drawing. The revision block of the new drawing shall show only the revision letter next in sequence as required by paragraph 15-9.4.

15-10 TRACING UNAUTHENTICATED DRAWINGS

The instructions of paragraph 15-9 are not applicable to the process of tracing drawings before authentication or before the occurrence of conditions (b) or (c) of paragraph 15-2. When it is intended that the ink tracing or phototracing will become the master, the word "traced" shall be written across the title block of the old unauthenticated drawing (whether drawn in pencil or ink); and it shall be placed in the inactive files. When checking of the new tracing has been completed, the old unauthenticated drawing, if not used under conditions (b) or (c) of paragraph 15-2, may be destroyed at the option of the design activity or contractor.

15-11 CHANGES IN DESIGN REQUIRING NEW IDENTIFICATION

When the design of a part or assembly is changed in such a manner that any one of the following conditions occurs, either a new drawing with a new drawing

number shall be prepared or a new part or dash number shall be assigned to the new design as delineated on the old drawing.

a. Condition 1 exists when parts or assemblies in service use either must be replaced by parts or assemblies of the new design or must be modified to conform thereto in the interest of safety or to eliminate unsatisfactory functioning.

b. Condition 2 exists when the design is changed to such an extent that the parts or assemblies of the new design are not physically and functionally interchangeable with parts or assemblies of the old design.

c. Condition 3 exists when parts or assemblies of the old design are limited to use in specific equipments or in specific serial number or G&N designations and the parts or assemblies of the new design are not so limited as to use.

When none of the above conditions occurs in connection with a change in design of a part or assembly, the identification number shall not be changed. The change shall be processed as a revision to the old drawing. The identification number shall not be changed when new usage is found for an existing part.

15-11.1 EFFECT OF CHANGES IN PARTS UPON IDENTIFICATION OF ASSEMBLIES. When one or more parts are substituted in an assembly for other parts with which they are noninterchangeable, the following rules shall govern the identification of subordinate assemblies and assemblies of higher order.

15-11.1.1 Dash Number System Used. When the dash number system is used to distinguish between assemblies with minor variations shown on the same assembly drawing, a new dash number shall be assigned on the subordinate assembly drawing and on each affected assembly drawing of higher order.

15-11.1.2 Dash Number System Not Used. When the dash number system is not used, if the substitution of parts has no effect upon the safety or physical and functional interchangeability of the subordinate assembly itself, no new assembly drawing shall be prepared; the identification shall remain unchanged. If there is an effect upon these characteristics, a new assembly drawing identified by a new drawing number shall be prepared. The same rules shall be applied to the determination of whether to change the identification of assemblies of higher order.

15-12 OBSOLESCENCE

a. When a part shown on a mono-detail drawing or an assembly drawing is removed from service use, the drawing representing the item shall be revised to show that it is obsolete. The notation "OBSOLETE" shall be entered both in the revision block and above the title block. See figure 15-5.

b. When a part or an assembly of a new design is substituted in all service applications for one shown on a mono-detail or an assembly drawing (conditions 1 and 2 of paragraph 15.11), revision action shall be invoked to substitute the new drawing identity on all applicable assembly drawings. No indication of the substitution shall appear on the new drawing except in the application block, described in paragraph 7-2. The old drawing shall be revised to add "OBSOLETE," as described in paragraph 15.12(a).

15-13 INACTIVATION

When new drawings are prepared to meet Condition 3 of paragraph 15.11, no indication shall appear on the new drawing except in the application block, described in paragraph 7-2. The old drawing, however, shall be revised to add the notation "INACTIVE. For New Procurement Use_____:" in accordance with figure 15-6.

15-14 REVISION OF MULTIPLE-SHEET DRAWINGS

15-14.1 REVISION OF MULTIPLE-SHEET DRAWINGS

Upon revision of any or all sheets of a multiple-sheet drawing, the revision letter of all sheets will be advanced to the next revision letter regardless of whether there is a change made on the sheet or not. At no time will any individual sheet of a multiple-sheet drawing bear a revision letter different from that shown on sheet 1 of the drawing.

15-14.2 REVISION OF BOOK TYPE DRAWINGS

Book type drawings, such as Harness and Wire List drawings shall be exempt from the requirements of paragraph 15-14.1 Revisions to such Book type drawings shall be accomplished in accordance with paragraph 5.3.3 of MIL-STD-24B.

15-14.3 ADDITIONS. When a multi-sheet drawing is revised to add a new sheet(s), the following note, preceded by a revision symbol, shall be placed above the title block on the new drawing(s): "THIS SHEET ADDED." This same note shall be centered in the revision block.

15-15 REPLACEMENT OF MULTI-DETAIL DRAWINGS

To replace a multi-detail drawing completely, follow the procedure described in paragraph 15-9. When space on the original drawing is insufficient for accomplishing the revision of a part, or when for any other reason it is desired to make a mono-detail drawing of a part shown on a multi-detail drawing, the detail of the original part shall be replaced. The new drawing of the part shall carry the original dash number and the same basic drawing number. The original drawing and the new sheet become sheets of a multi-sheet drawing, and the necessary entries shall be made in the drawing number spaces as described in paragraph 8-5.1.

Revision of an old style multi-detail drawing by replacement of one detail is illustrated in figures 15-11 and 15-12. The action shall be recorded on the old drawing in the following manner:

a. Enter in the revision block the next revision letter and applicable subscript number.

b. In the block containing the part to be replaced, cross out all delineation pertaining thereto; and add this note:

> "REPLACED WITHOUT CHANGE (or WITH CHANGE, when applicable) BY SHEET NO. _____." (Enter the sheet number on which the part has been re-detailed.)

The note shall be preceded by a revision symbol containing the same revision letter that was entered in the revision block of the drawing. The note shall be in bold letters approximately 0.20 inch in height.

c. Delete the designation of material for the replaced part.

d. Enter in the revision block the same revision letter as that used on the old drawing together with the statement that the part on the new drawing replaces the part on the old drawing either with change or without change. If changes are made, they shall be indicated and recorded on the new drawing in accordance with paragraph 15-8.5.

e. In the space above the title block on the new master, the following note shall be entered:

> "REPLACES PC NO. _____, SH. _____, (enter sheet number on which part previously was detailed) WITHOUT CHANGE" (or "WITH CHANGE", when applicable). In this note, substitute "DASH NO." for "PC NO.", if appropriate.

The note shall be preceded by a revision symbol with the same revision letter as that entered in the revision block of the new drawing. The note shall be in bold letters approximately 0.20 inch in height.

15-16 REVISION OF ALTERNATIVE A-SIZE DRAWINGS

The revision procedure for Alternative A-size drawings and Alternative A-size continuation sheet drawings shall be as specified in paragraph 15-14 for multi-sheet drawings. Revision records shall be maintained on the first sheet in the spaces provided and on continuation sheet(s) when space provisions on sheet 1 are exhausted. Alternative A-size continuation sheet drawing forms shall be converted for continued revision action as illustrated in figures 13-2 and 13-3 for Running Lists.

15-17 CLASSES OF REVISION

Revision to drawings and documents released as Class A Documents (paragraph 14-4.1.1) are divided into classes: Class 1, Class 2, and Class 3.

It shall be the responsibility of the originator of a proposed revision to determine the class of revision and to process the revision in accordance with the applicable sections of MIT Report E-1186, Technical Data Release Procedure. Care should be taken, when designating a revision, to consider the effects on interface activities, including logistics, training, operation, etc.

15-17.1 CLASS 1 REVISIONS. Class 1 revisions are those which are technically necessary to meet a design requirement. They are necessary to make the hardware function as required for mission accomplishment. The effectivity of a Class 1 revision is stated at the time of release and the effectivity is mandatory. This type of revision may affect the compatibility, life, interchangeability, function, or safety of an item, and includes those tests or test specifications that affect the interchangeability of items.

Class 1 revisions which affect the interchangeability of a physical part result in a new part number. The part number changes are carried through the drawing numbering structure to the level of the highest assembly which is either serialized or whose interchangeability is affected. Class 1 changes must be approved by MIT DRB prior to CCB.

15-17.2 CLASS 2 REVISIONS. Class 2 revisions are those which are desirable but not technically necessary from a system function point of view. They include changes required to comply with documentation format specifications, to relax tolerances, or to make other changes of a similar nature. No system effectivity is specified, and the change is incorporated on the basis of no schedule impact. If a cost impact exists, an acceptable value will be determined by NASA through the use of CRN forms. A Class 2 revision cannot change form, fit, or function as to effect interchangeability and will not result in modification or scrap of any previously manufactured items.

15-17.3 CLASS 3 REVISIONS. Class 3 revisions are those which are technically desirable, but are not technically necessary to insure system function. These are changes of the type which improve ease of manufacturing, increase yield, or are product improvements. The Contractor will indicate the effectivity, determined on the basis of minimum schedule impact. MIT/IL may request a statement of the impact a specified effectivity might produce. The extent of acceptable cost impact will be determined by NASA. Class 3 revisions require coordination and control of effectivity in order that development planning and system usage can be correlated with a controlled matching set of revisions and must have DRB approved prior to CCB action.

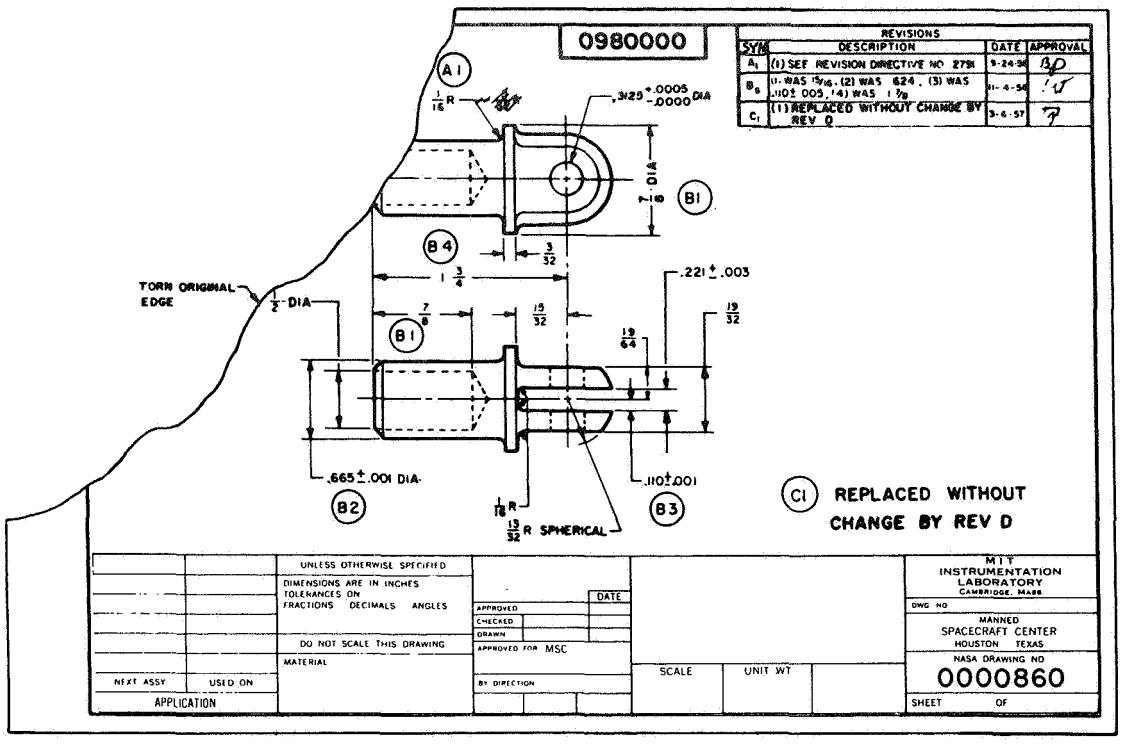

Figure 15-1. Sample Revision Showing Drawing Replaced Without Change.

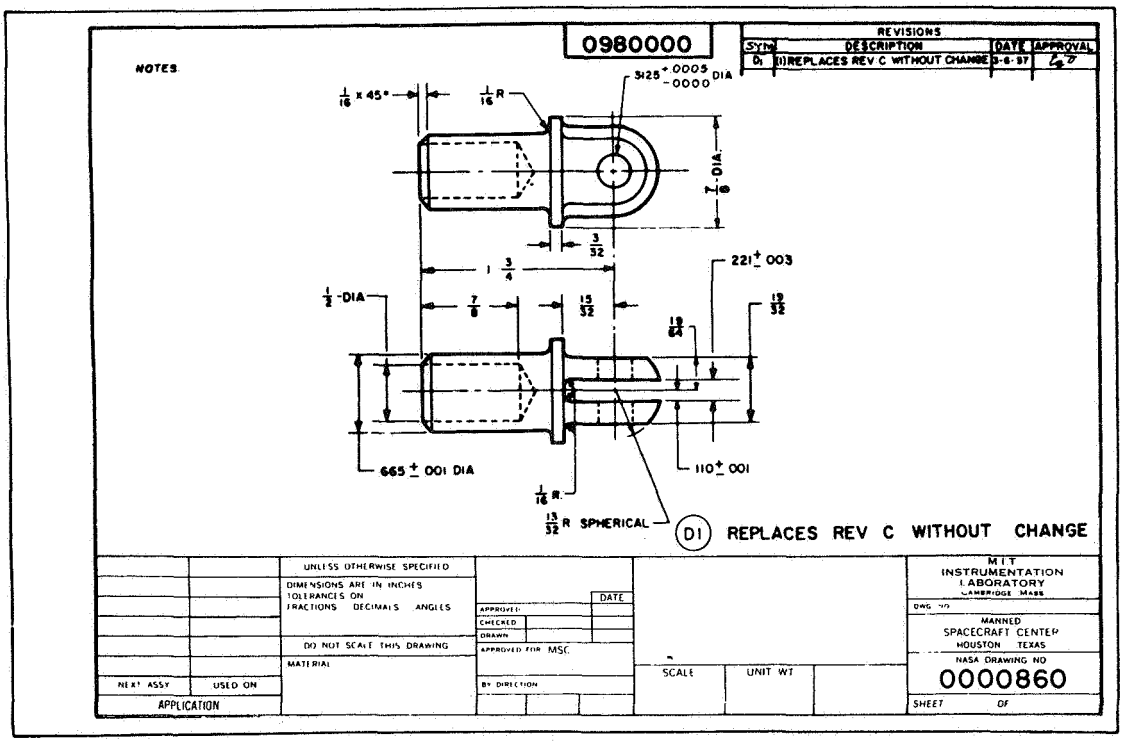

Figure 15-2. Sample Revision of Drawing to Replace Figure 15-1 Without Change.

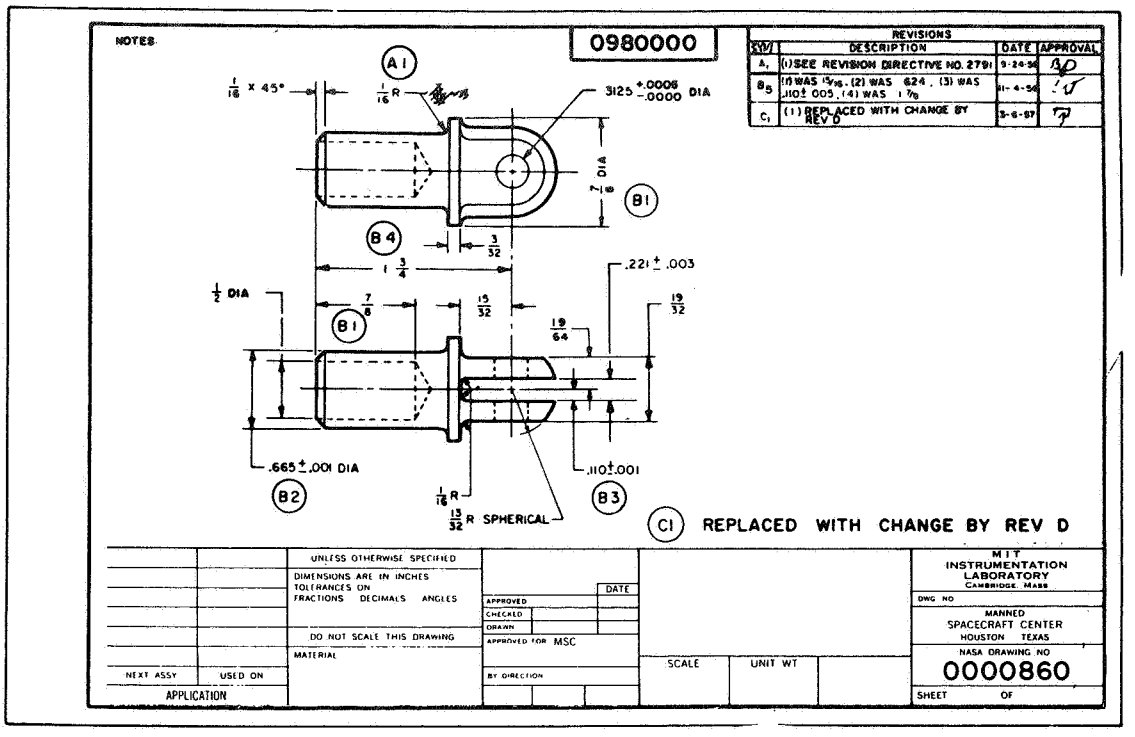

Figure 15-3. Sample Revision Showing Drawing Replaced With Change.

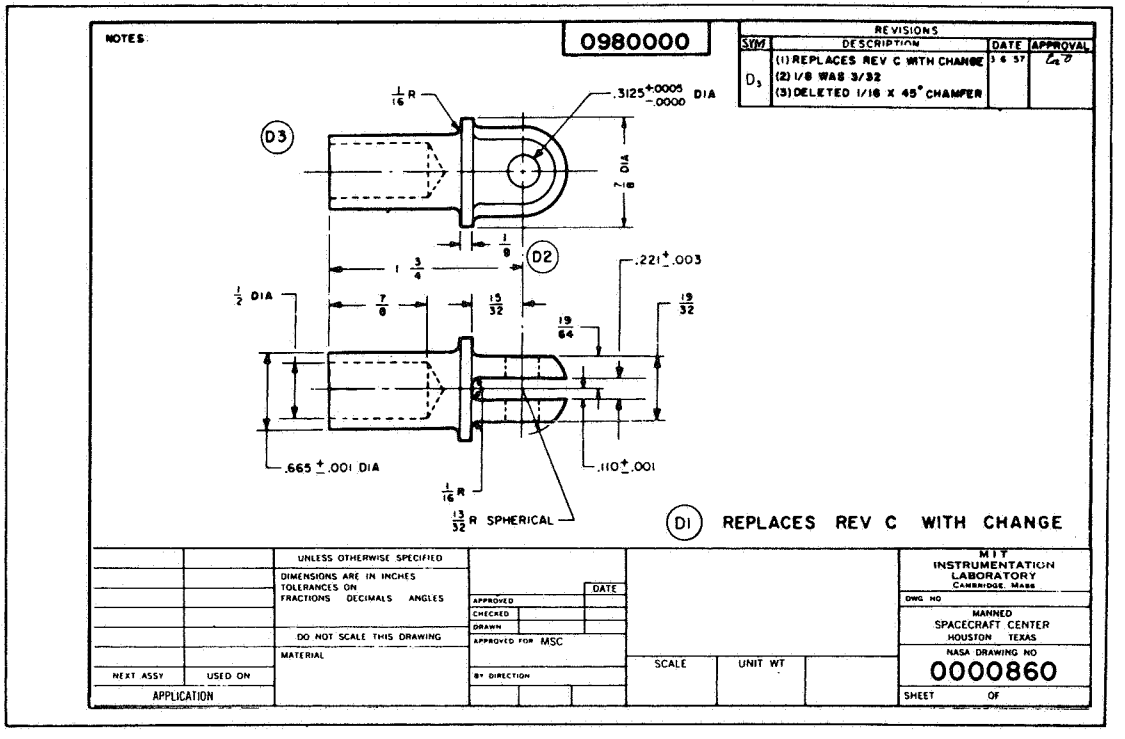

Figure 15-4. Sample Revision of Drawing to Replace Figure 15-3 With Change.

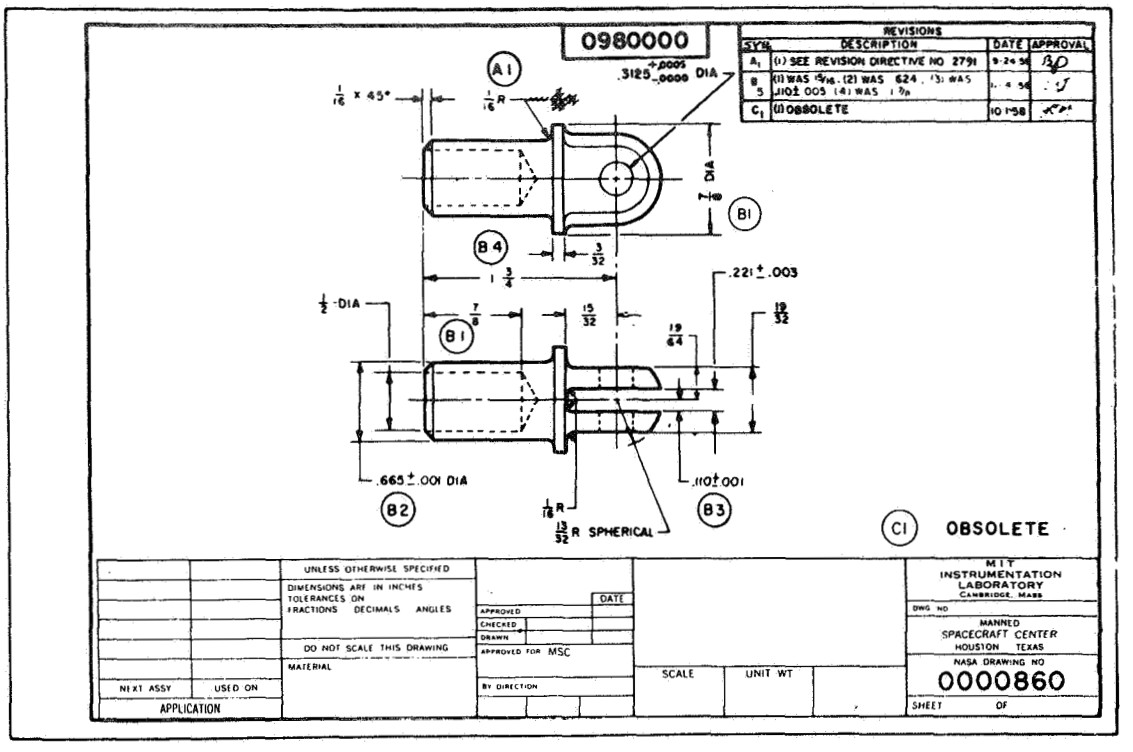

Figure 15-5. Sample Revision Showing Drawing Obsoleted Due to Design Change.

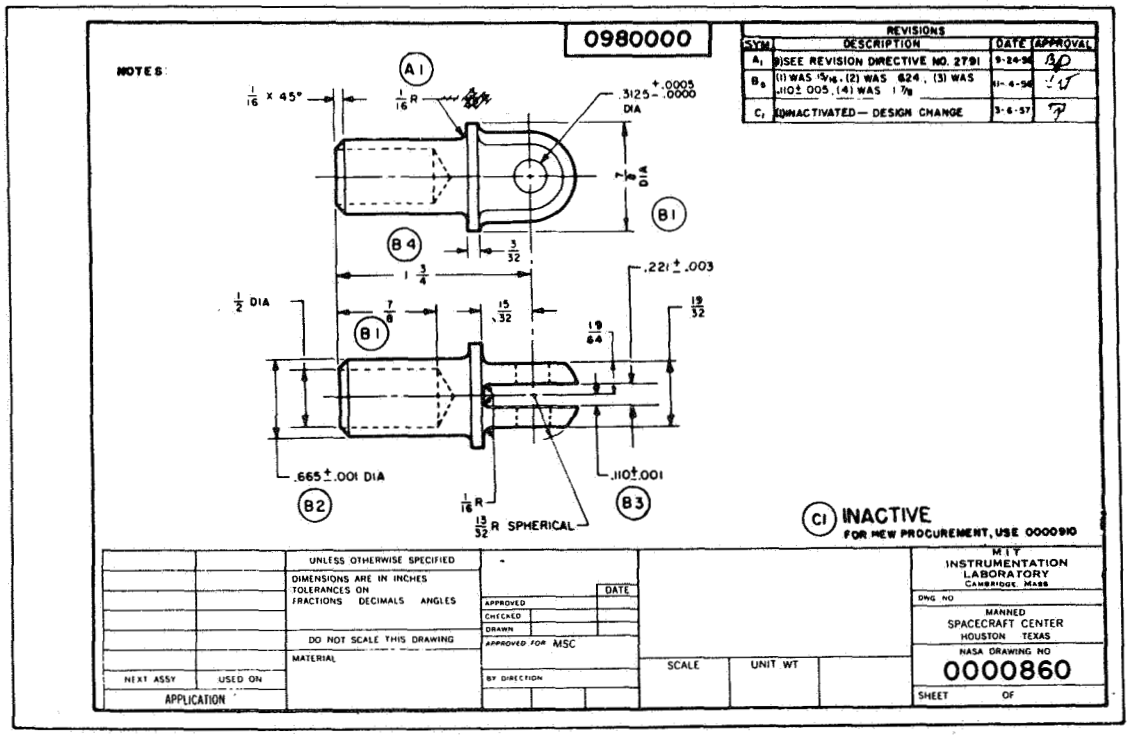

Figure 15-6. Sample Revision Showing Drawing Inactivated Due to Design Change.

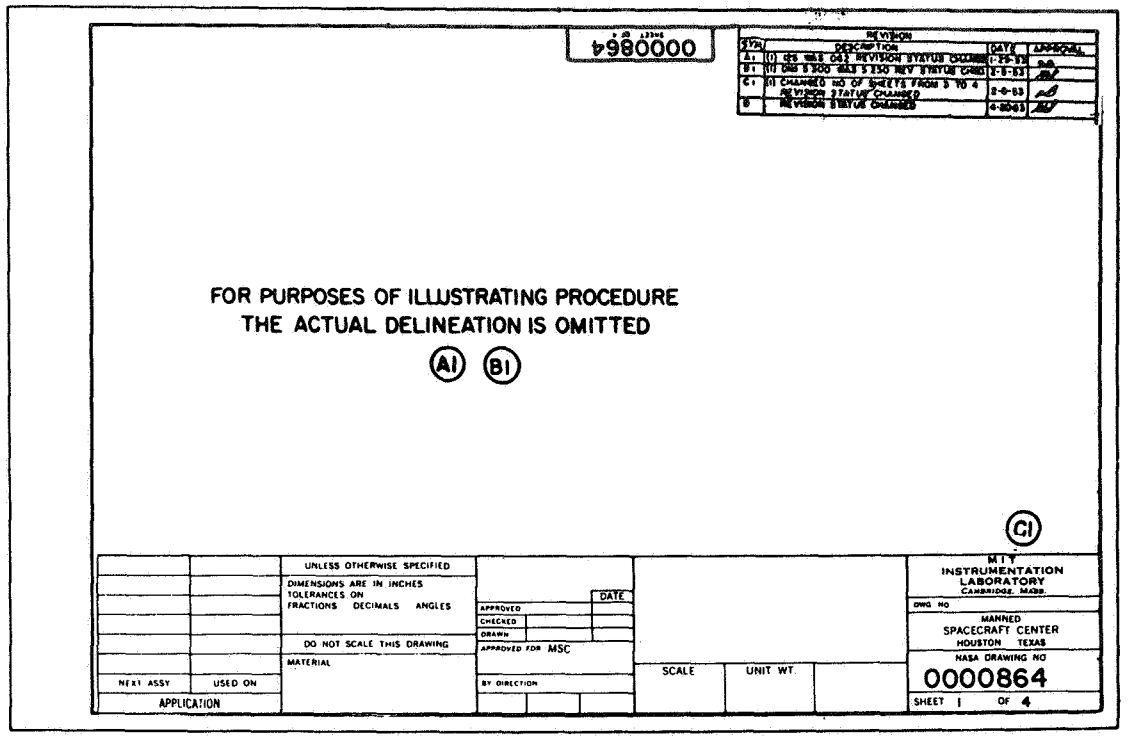

Figure 15-7. Sample Revision of Multiple Sheet Drawing, Sheet 1.

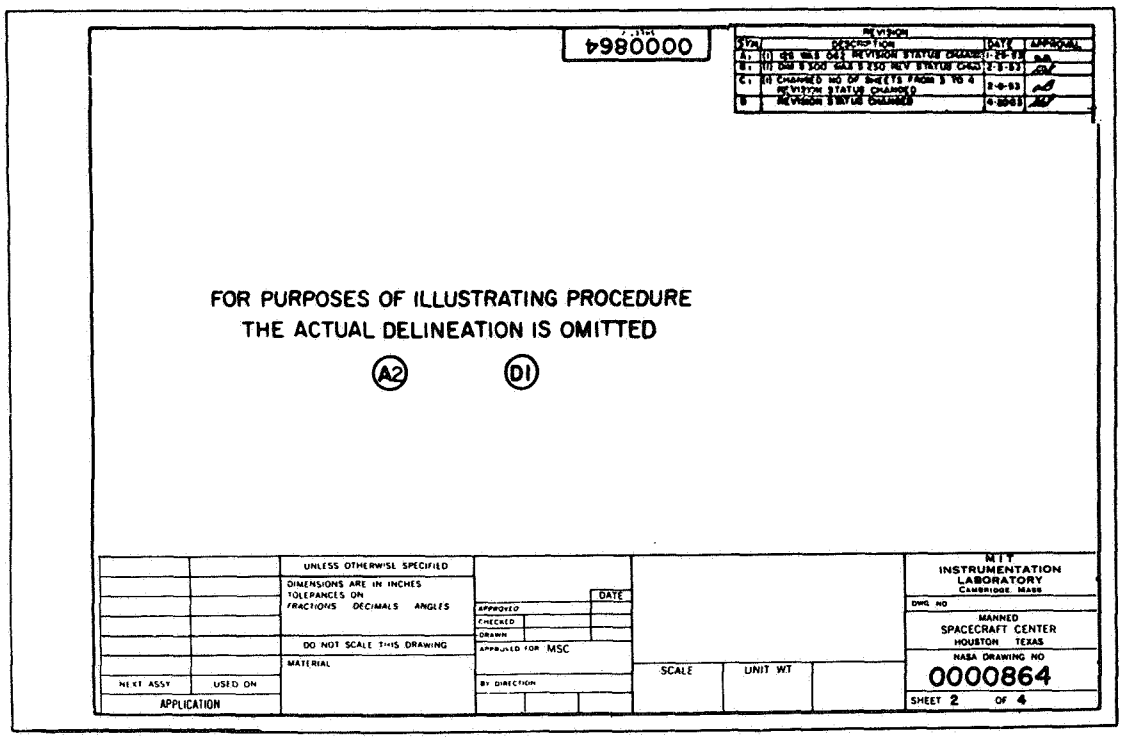

Figure 15-8. Sample Revision of Multiple Sheet Drawing, Sheet 2.

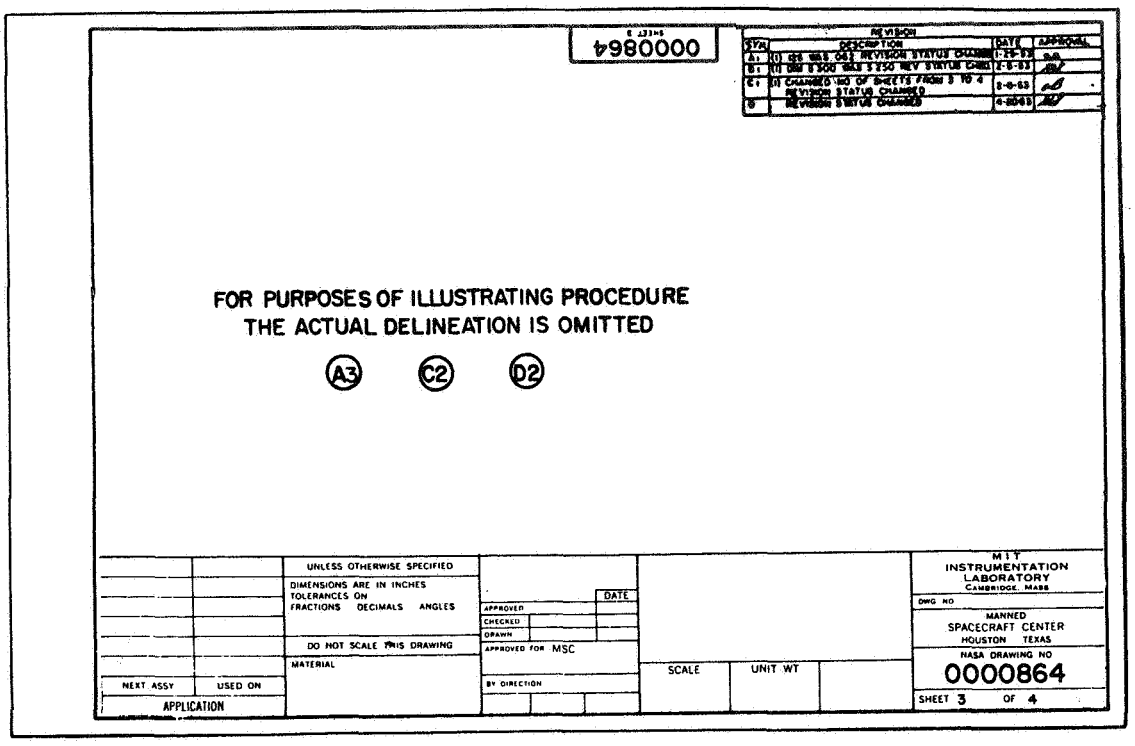

Figure 15-9. Sample Revision of Multiple Sheet Drawing, Sheet 3.

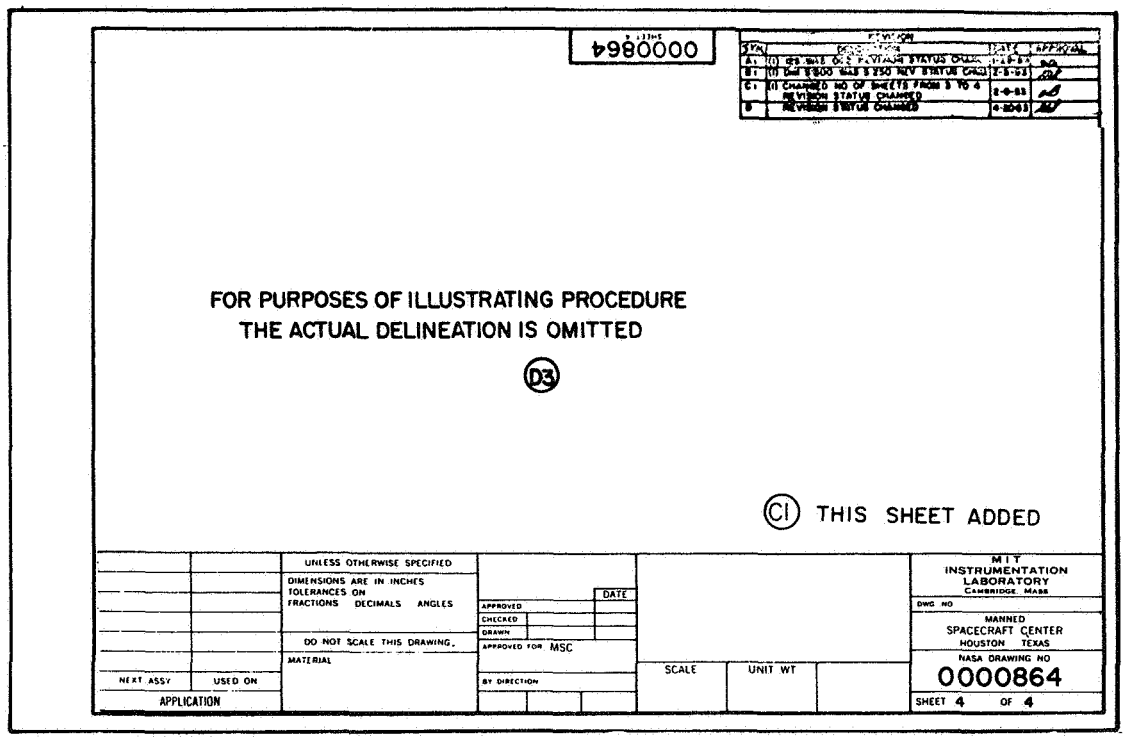

Figure 15-10. Sample Revision of **Multiple Sheet** Drawing, Sheet 4.

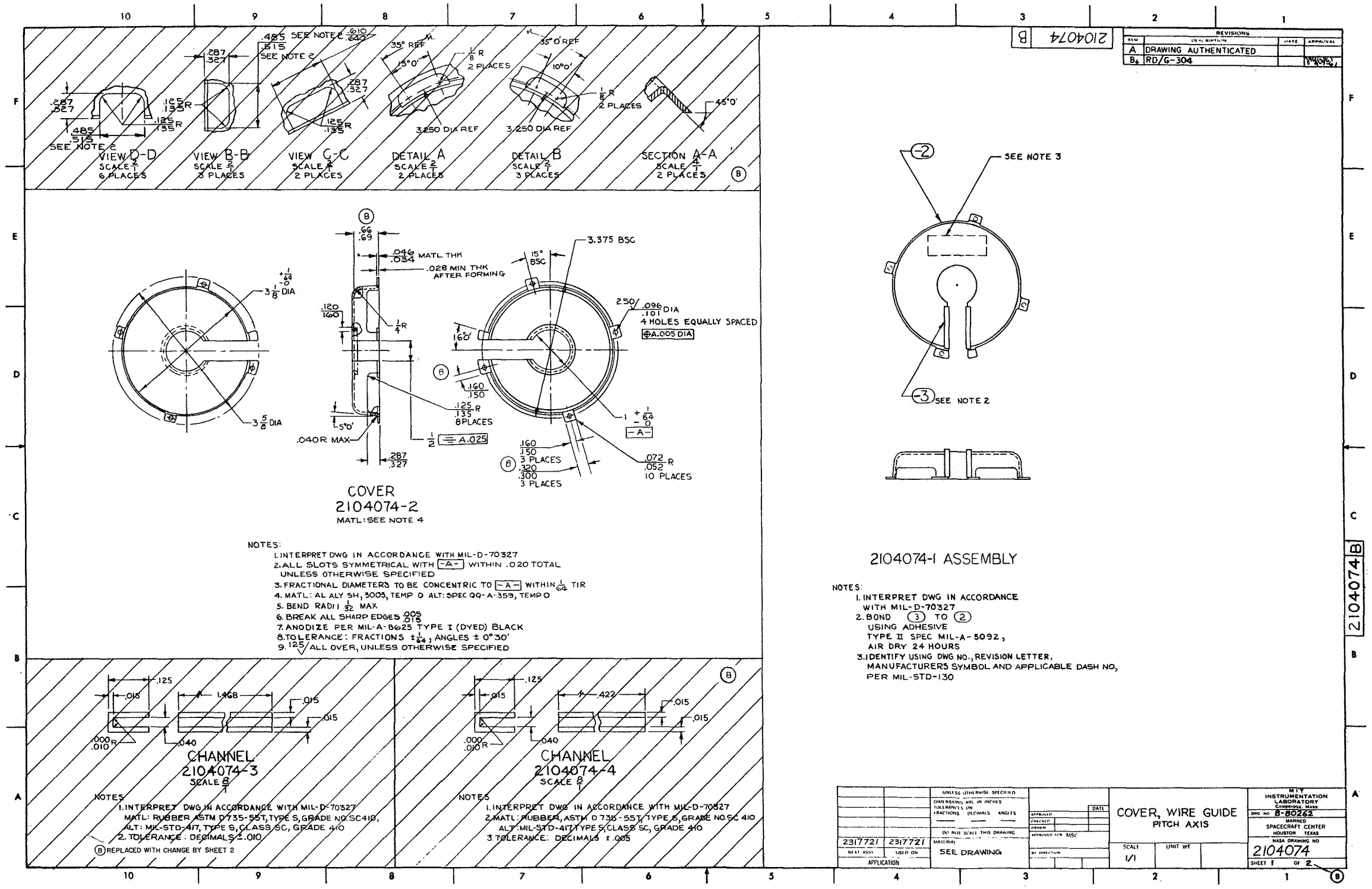

Figure 15-11. Sample Revision Showing Multi-Detail Drawing With Detail of One Part Replaced.

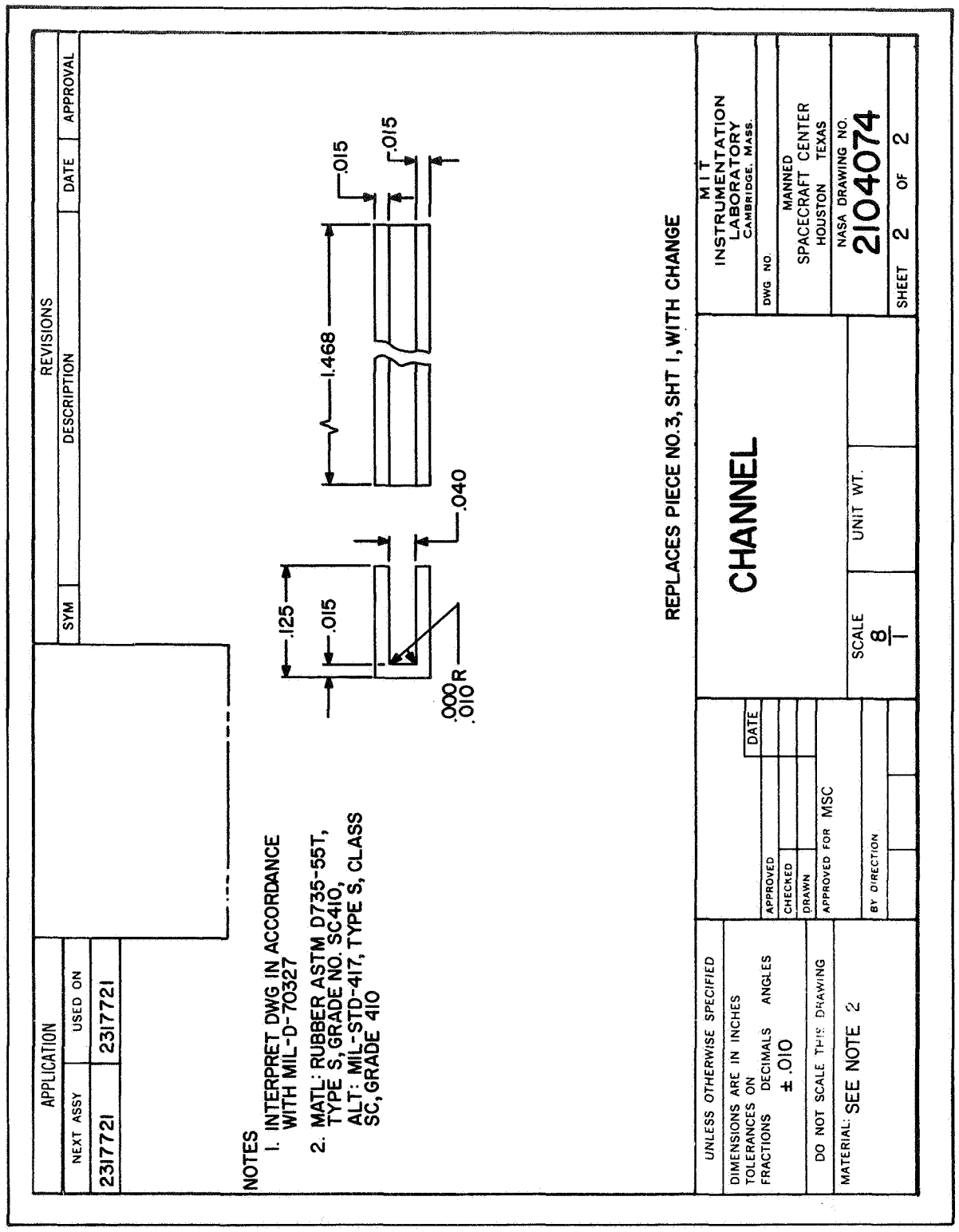

Figure 15-12. Sample Revision Showing Drawing to Replace One Detail of Figure 15-11 With Change.

Section 16
DOCUMENTATION AND IDENTIFICATION OF STANDARD ITEMS, VENDOR AND COMMERCIAL ITEMS, AND BULK MATERIALS

16-1 SELECTION OF STANDARD ITEMS, COMMERCIAL ITEMS, AND BULK MATERIALS

Standard items, commercial items, and items previously documented shall be selected in the order of preference.

16-2 DOCUMENTATION REQUIRED FOR STANDARD ITEMS, COMMERCIAL ITEMS, AND ITEMS PREVIOUSLY DOCUMENTED

16-2.1 MS PARTS APPROVED BY NASA. No further documentation is necessary for such parts.

16-2.2 ITEMS DEFINED BY FEDERAL OR MILITARY SPECIFICATIONS APPROVED BY NASA. No further documentation is required if an item is completely defined by the specification and if the means of identification is complete.

16-2.3 MS PARTS NOT COORDINATED WITH NASA. No further documentation is necessary if a part is completely defined by the MS sheet and specifications invoked thereon.

16-2.4 ITEMS DEFINED BY FEDERAL OR MILITARY SPECIFICATIONS NOT COORDINATED WITH NASA. No further documentation is necessary if an item is completely defined and identified by the specification.

16-2.5 AN PARTS. No further documentation is required.

16-2.6 ITEMS SELECTED FROM NAVORD OSTD 600. No further documentation is required if the pertinent pages of OSTD 600 either state sufficient requirements or invoke Federal or Military Specifications to completely define the items for purposes of procurement from more than one source. (Reference to a manufacturer's catalog number does not constitute a specification of requirements.)

16-2.7 ITEMS DEFINED BY INDUSTRY SPECIFICATIONS AND STANDARDS. No further documentation is required if an item is completely defined and if the means of identification is complete.

16-2.8 ITEMS DEFINED BY COMPANY (CONTRACTOR) SPECIFICATIONS AND STANDARDS. For Class 1 Set of Drawings, see paragraph 3-2. If neither government standard items nor items defined by industry specifications and standards meet the design requirements and a company (contractor's) standard part is suitable, the documentation requirements of paragraph 16-2.11 apply.

16-2.9 PREPARATION OF NASA DRAWINGS. If either the description or the identification for an item in the subject documents of paragraphs 16-2.1 through 16-2.8 is incomplete and if selection from other documents listed in the order of preference is not feasible, drawings shall be prepared. See paragraph 16-2.11.

16-2.10 ALTERED STANDARD ITEM. When an item defined by a document covered by Groups I through IV of paragraph 3.4 of MIL-D-70327 must be altered or selected, a drawing(s) shall be prepared in accordance with one of the following alternatives.

16-2.10.1 Alternative 1. The drawing shall be complete in all respects and shall require no reference to the document from which the item was selected. A notation similar to one of the following examples may be added to the drawings:

(1) MAY BE MADE FROM MS 00027.

(2) MAY BE SELECTED FROM AN 00014 FOR COMPLIANCE WITH CHARACTERISTICS STATED HEREON.

16-2.10.2 Alternative 2. The drawing shall be complete in all details that relate to the alteration. A notation similar to the following examples, when appropriate, shall be added to the drawing:

(1) FOR DETAILS NOT SHOWN, SEE MS 00015.

(2) MODIFY AN 00016 AS SHOWN HEREON.

(3) SELECT FROM MS 00017 FOR COMPLIANCE WITH TOLERANCES SPECIFIED HEREON.

16-2.11 VENDOR AND COMMERCIAL ITEMS. When a vendor or commercial item is used in a NASA equipment, the following documentation is required for Class 1 Set of Drawings. Vendor part numbers shall not be used on NASA documents, NASA part numbers shall be used.

16-2.11.1 Nonrepairable Item. NASA Specification Control drawing shall be prepared.

16-2.11.2 Repairable Item. When such an item is capable of service maintenance and repair, the following class 1 drawings shall be prepared:

(1) Either detail drawings of all parts or, as a minimum, a detail drawing of each part that is listed on the provisioning list as a repair part.

(2) An assembly drawing of each subassembly listed on the provisioning list.

(3) An assembly drawing of the complete item. The outline, mounting, and mating dimensions shall be shown on the assembly drawing or an installation drawing.

16-2.11.3 Specification. For either repairable or nonrepairable vendor or commercial items, when essential performance requirements or quality assurance provisions cannot be stated on the drawing(s) by means of simple notes, such requirements shall be prescribed by notes referencing a government or industry specification. If no suitable government or industry specifications exists, a new specification shall be prepared for the item.

16-2.12 ALTERED OR SELECTED VENDOR AND COMMERCIAL ITEMS. The documentation requirements of paragraph 16-2.11 apply. In addition, all details that relate to the alteration or selection shall be incorporated on the drawings in the manner described in paragraph 16-2.10.

16-2.13 ITEMS NOT COVERED BY DEFINITIONS OF PARAGRAPHS 3-9. Items which neither were developed under a government contract nor are sold or offered to the public, but which were developed by industry and are sold or offered for sale to the government, shall be documented in the same manner as specified for commercial items in paragraph 16-2.11.

16-2.14 PROPRIETARY DATA. Proprietary data, as defined by paragraph 3-8, shall be furnished in accordance with the terms of the contract when needed to supplement the documentation required by paragraph 16-2.11 for the reprocurement or manufacture of items used in NASA equipments.

16-2.15 ITEMS PREVIOUSLY DOCUMENTED. The instructions of paragraphs 16-2.9 and 16-2.11 apply to the preparation of new drawings when the design activity does not know that the particular item has been previously documented by NASA drawings and specifications. When existing NASA drawings and specifications are

technically incomplete, the design activity shall initiate action to revise such documents rather than prepare documents identified by new numbers. NASA drawings need not be redrawn or revised solely for the purpose of achieving agreement with the latest revision of this standard. When the drawings and specifications for "items previously documented" are complete, no further documentation is necessary. If, however, the design activity is the custodian of the master NASA drawing, the additional application data shall be entered in the application block.

16-3 IDENTIFICATION OF STANDARD AND COMMERCIAL ITEMS ON ASSEMBLY DRAWINGS

16-3.1 MS PARTS. MS parts shall be identified by the MS part number.

16-3.2 ITEMS DEFINED BY FEDERAL OR MILITARY SPECIFICATIONS.

a. Such items that have a type designation shall be identified by the specification number and type designation.

Example: SPEC MIL-M-6. MR 26WO50DCUA

b. Other items shall be identified by the specification number and by such other details extracted from the specification (grade, class, type, style, size, etc.) as are required to fully establish identification.

Example: SPEC FF-S-103. TYPE III. STYLE 4, 1/4-28UNF, 3/4 LONG

16-3.3 AN PARTS. AN parts shall be identified by the AN Part Number.

16-3.4 ITEMS SELECTED FROM NAVORD OSTD 600. Such items shall be identified by the identification number shown in OSTD 600.

16-3.5 ITEMS DEFINED BY INDUSTRY SPECIFICATIONS AND STANDARDS. Such items shall be identified by the identification number shown in the document involved.

Example: RETMA-STD--153, RCM 15 A 050 M, CAPACITOR

16-3.6 ITEMS DOCUMENTED BY NASA DRAWINGS. Items documented by NASA drawings under the requirements of paragraphs 16-2.8 through 16-2.15 shall be identified on assembly drawings in the List of Parts and Materials Block by the NASA drawing number and the dash number (if any). Bulk material called out in ND documents referenced on drawings should not be repeated as a find number in the List of Parts and Materials.

16-4 SELECTION OF BULK MATERIALS

Bulk materials shall be selected in the order of preference.

16-5 DOCUMENTATION REQUIRED FOR BULK MATERIALS

The documentation requirements of paragraphs 16-2.1 through 16-2.8 apply to bulk materials selected from sources corresponding with these paragraph headings.

Quality specifications and descriptions and commercial designations are subdivisions of the classification "Industry Standards," as defined in MIL-D-70327.

When a required bulk material is not covered by a government or industry specification or standard, nor by a company document authorized for use (see paragraph 4-2), either a NASA specification or a NASA drawing shall be prepared to completely define the bulk material.

16-6 IDENTIFICATION OF BULK MATERIALS ON DRAWINGS

The means of identification stated in paragraphs 16-3.1 through 16-3.6 apply to bulk materials selected from sources corresponding with these paragraph headings. Bulk materials documented as required by paragraph 16-5 shall be identified by the applicable Military Specifications or NASA drawing number.

Examples c and d of paragraph 10-2 illustrate the means of identifying bulk materials described and controlled by quality specifications and descriptions or by commercial designations. Reference to an alternate material covered by a government specification is not required for bulk materials identified by quality specifications or commercial designations, providing the order of preference has been identified.

16-7 REPORTS REQUIRED

Items of Special Design, Previously Documented. If an activity other than the design activity is the custodian of the master, NASA shall be advised by letter concerning the new application of the part.

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(Numbers shown in this Index refer to Sections and Paragraphs. No page references are given)

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