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EARTH RESOURCES TECHNOLOGY SATELLITE
FINAL REPORT

14 APPENDIX - OCC AND NDPF SPECIFICATIONS

PREPARED FOR

GODDARD SPACE FLIGHT CENTER
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

UNDER CONTRACT NAS5-11260

TRW SYSTEMS GROUP

IBM FEDERAL SYSTEMS DIVISION

Itek OPTICAL SYSTEMS DIVISION

EARTH RESOURCES TECHNOLOGY SATELLITE

FINAL REPORT

Volume 14 Appendix. OCC and NDPF Specifications

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APPENDIX A

This appendix contains the following subsystem specifications for the ground data handling system:

- OCC Subsystem Specification
- NDPF Subsystem Specification
- GDHS Personnel Subsystem Specification

The system-level specification for the GDHS is included in Volume 2 of this report. The equipment and software specifications for the GDHS are contained in Volumes 20 and 21 of the proposal, Part II.

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CODE IDENT 11982

TITLE

SUBSYSTEM SPECIFICATION
OPERATIONS CONTROL CENTER SUBSYSTEM
EARTH RESOURCES TECHNOLOGY SATELLITE

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SUBSYSTEM SPECIFICATION
OPERATION CONTROL CENTER SUBSYSTEM

1. SCOPE

1.1 Scope. This specification establishes the requirements for design, performance, qualification and acceptance test of the Operational Control Center Subsystem, hereinafter referred to as the Subsystem.

The Subsystem shall be a functional part of the ERTS GDHS. It shall provide a central command and control capability for the ERTS Observatory as well as providing the necessary capability for mission planning. The baseline definition is for a configuration that is collocated with the NDPF and the central computer facility.

The Subsystem will be located in Building 23, second floor at NASA/GSFC.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detail content of Sections 3, 4, and 5, the detail requirements of Sections 3, 4, and 5 shall be considered a superseding requirement. For TRW Systems documents, the latest issue shall apply.

SPECIFICATIONS

Military

MIL-D-1000 01 March 1965	Drawings-Engineering and Associated Lists

TRW Systems Group

D-13500	System Specification for Earth Resources Technology Satellites A and B
D-13590	Data Collection System, Earth Resources Technology Satellite
D-13700	Ground Data Handling System, Earth Resources Technology Satellite

TRW Systems Group

D-13710	Facilities Design

STANDARDS

Federal

595	Colors

Military

MIL-STD-100A 01 October 1967	Engineering Drawing Practices
MIL-STD-129D 11 April 1969	Marking for Shipment and Storage
MIL-STD-143A 14 May 1963	Specifications and Standards, Order of Precedence for the Selection of
MIL-STD-803A-1 27 January 1964	Human Engineering Criteria for Aircraft, Missile, and Space Systems Ground Support Equipment
MS 33586A 16 December 1958	Metals, Definition of Dissimilar

OTHER PUBLICATIONS

NASA

	Data System Development Plan, NASCOM Network

TRW Systems Group

TBD	Logistics Plan
TBD	ERTS Program Safety Plan
PAR 700-55	Procurement, Performance Assurance Requirements, Quality, Reliability, and Maintainability Provisions, Project ERTS Subcontractors for GDHS Equipment

3. REQUIREMENTS

3.1 Performance. The Subsystem shall consist of the following five functional areas:

a. Control Center

b. Planning and Analysis Area

c. Equipment Room

d. Conference Room

e. Computer Facility

The relationship of these five areas to the integrated ERTS operational system is shown in Figure 1.

3.1.1 Operational Characteristics. The Subsystem shall:

a. Generate and implement ERTS mission plans in accordance with priorities established by user input to the NDPF as approved by NASA Goddard.

b. Provide centralized control of the ERTS Observatory.

c. Provide planning, initiation, generation, transmission, and verification of commands to the ERTS Observatory. Stored program and real time commands shall be formatted and processed in a manner that is compatible with the ERTS Observatory, the NASCOM system and the STADAN and MSFN command systems.

d. Provide receiving, processing displaying, and analyzing, Observatory housekeeping data. This capability is to include the ability to analyze and evaluate data to determine spacecraft status and performance for both real time and historical trend analysis.

e. Provide for analog and digital processing of DCS data including preparation of preprocessed magnetic tape listings for further processing by the NDPF.

f. Provide for quick look of MSS and RBV data utilizing quick look equipment provided by the Government during real time passes over the NTTF.

g. Provide operational control of the STADAN and MSFN stations while in communication contact with the ERTS Observatory.

h. Provide an interface with other Government facilities to obtain ephemeris data and weather data for introduction into the mission planning cycle.

i. Provide semi-automatic or manual backup for the Subsystem functions necessary to maintain the Observatory in a safe operating condition. In addition, the command generation function will be backed up by the NDPF ADPE.

j. Provide manual override capability for all critical command and control functions affecting the safety of the Observatory.

k. Provide spacecraft simulation for both command and data acquisition functions.

3.1.1.1 Facilities. The Subsystem facilities design, construction, integration, and acceptance, requirements shall be as specified in TRW Specification D-13710.

3.1.1.2 Logistics. Spare parts and expendables for the Subsystem shall be in accordance with the TRW Systems Logistics Plan.

3.1.1.3 Personnel and Training. Personnel and training for the Subsystem shall be in accordance with TRW Specification D-13701.

3.1.1.4 Software. Software for the Subsystem is defined in Figure 1.

3.1.2 Subsystem Definition. The Subsystem shall consist of configured items, program articles (program articles are items of equipment that are purchased to commercial standards of fabrication and performance) and Government-Furnished Equipment. Each rack shall be designed to process miscellaneous functions of subsystem operation in accordance with the overall Subsystem requirements specified in Specification D-13700.

3.1.2.1 Configured Items. The Subsystem shall contain the following configured items:

Nomenclature	Configured Item No.	Specification No.
DCS Equipment Rack	TBD	EQ3-273
DCS I.F. Simulator Unit	TBD	EQ3-274
DCS Demodulator Unit	TBD	EQ3-275
DCS Synchronizing Unit	TBD	EQ3-276
DCS Signal Select Unit	TBD	EQ3-271
DCS Data Interface Buffer Unit	TBD	EQ3-272
Data Distribution Rack	TBD	EQ3-267
PCM Data Handling Equipment	TBD	EQ3-266
MODEM	TBD	EQ3-270

3.1.2.2 Program Articles. The Subsystem shall contain the following program articles:

Nomenclature	Proposed Sources
PCM Tape Recorder	Ampex Model FR1900
Eight Channel Strip	Sanborn Model 7729A

Nomenclature	Proposed Sources
Chart Recorder with Amplifier	Model 8820A (AMP)
Intercom	Government-Furnished Equipment
Communications Panel	Government-Furnished Equipment
Dial Exchange Phone Service	Government-Furnished Equipment
Teletype Terminal	Government-Furnished Equipment
Time Translator	Datatron
Frequency Counter	Hewlett-Packard
Line Amplifier Unit	Data Control Systems
Tape Recorder Patch Panel	E. Trompeter Electronics
Time Display (Rack Mounted)	Datatron 565
Time Display (Overhead Mounted)	Datatron
Video Amplifier	TBD

3.1.2.3 PCS I.F. Simulator Unit. The I.F. Simulator Unit shall accept simulated PCM messages from a stored program PCM simulator and modulate these messages onto a 75 KHz I.F. for verification tests.

3.1.2.4 DCS Demodulator Unit. The Demodulator Unit shall accept 75 KHz I.F. (with a bandwidth of 125 KHz), separate individual randomly distributed messages and demodulate these into single messages. The Demodulator Unit shall send these messages to the Synchronizing Unit as PCM and clock.

3.1.2.5 DCS Synchronizing Unit. The Synchronizing Unit shall accept up to five simultaneous messages from the Demodulator Unit and serialize them into one continuous synchronized stream for storage on tape or direct transmittal to a PCM decommutator.

3.1.2.6 DCS Signal Select Unit. The Signal Select Unit interfacing with the Line Drive Amplifiers, PCM Tape Recorders, Bit Synchronizer Demodulator Unit, and I.F. Simulator Unit, shall perform the following:

a. Selectively switch signals from the Line Drive Amplifier to the PCM Tape Recorders, Bit Synchronizer, Demodulator and I.F. Simulator Units.

b. Switch, during playback, raw data from the PCM Tape Recorder to the Bit Synchronizer or Demodulator Unit.

c. Switch I.F. Simulator Unit to the Demodulator Unit.

d. Enable time select to the Time Code Translator real time, or PCM Tape Recorders.

3.1.2.7 Data Interface Buffer Unit. The Data Interface Buffer Unit shall accept parallel bit inputs from a computer and output serial bit signals to a modem. It shall convert a 50 kilobit serial input from the modem to 4.0 kilobits and send the signal to the PCM data handling equipment.

3.1.2.8 PCM Data Handling Equipment. The PCM Data Handling Equipment shall process PCM telemetry data for the Subsystem.

3.1.3 Operability.

3.1.3.1 Reliability. All hardware that is in-line to the command and data processing functions shall be designed with a mean time to repair of not more than 90 minutes.

3.1.3.1.1 Time to Wear Out. All operational ground equipment shall be designed for an operating life time of ten years with routine maintenance.

3.1.3.2 Maintainability.

3.1.3.2.1 Maintenance and Repair Cycles. Field Maintenance shall be as defined in the TRW Systems Maintenance Plan.

3.1.3.2.2 Service and Access. The Subsystem shall be designed for ease of service. Access doors, drawers, and test points, to enable the measurement, removal, and replacement of all significant subassemblies with normally available tools.

3.1.3.2.3 Environmental Requirements. The Subsystem shall be capable of operating within a NASA furnished building. The environment within this building shall be 30^{0} to 115^{0}F, humidity 10 to 90 percent.

3.1.3.2.4 Transportability. Each component of the Subsystem shall be designed to be transported by common carrier with a minimum of protection. Special packaging will be used as necessary to assure that transportation methods do not impose design penalties.

3.1.3.2.5 Human Performance. The design of all equipment requiring man/machine interfaces shall use MIL-STD-803A, Part I as a guide.

3.1.3.2.6 Safety.

3.1.3.2.6.1 Radiation. All equipment capable of emitting dangerous radiation shall, under normal operating conditions, be properly shielded to attenuate the radiation to a safe level. Radiation warning notices must be affixed to the equipment identifying hazards in the event of equipment usage in other than normal operations.

3.1.3.2.6.2 Personnel Safety. Emergency procedures shall be provided for fire, chemical spillage, evacuation, electrical shock and disaster in accordance with ERTS Program Safety Plan.

3.1.3.2.6.3 Noise and Vibration. The noise and vibration levels associated with the Subsystem and its components in required combinations shall be controlled to the levels of tolerance to personnel as specified in MIL-STD-803A-1.

3.2 Subsystem Design and Construction Standards

3.2.1 General Design and Construction Requirements.

3.2.1.1 Selection of Specifications and Standards. Selection of specification and standards for necessary commodities and services not specified herein shall be in accordance with the provisions of MIL-STD-143A.

3.2.1.2 Materials, Parts, and Processes. Only materials, parts, and processes conforming to all requirements of Group I and V Documents of MIL-STD-143A shall be considered standard and shall be used to the maximum possible extent. Engineering drawings and associated lists shall be in accordance with the provisions of MIL-D-1000 and MIL-STD-100.

3.2.1.2.1 Dissimilar Metals. To avoid electrolytic corrosion, dissimilar metals, as defined in Standard MS-33586A, shall not be used in direct contact.

3.2.1.2.2 Flammable, Toxic, and Unstable Materials. Flammable, toxic, and unstable materials shall not be used whenever possible.

3.2.1.2.3 Standard Parts. Standard parts shall be used whenever possible provided they meet the requirements as defined in TRW Systems Document PAR 700-55.

3.2.1.2.4 Finish. The surfaces of each major equipment of the Subsystem shall be adequately finished to prevent deterioration from exposure to the specified environments that might jeopardize fulfillment of the specified performance.

3.2.1.3 Interchangeability and Replaceability. Each major equipment of the Subsystem shall be directly interchangeable in form, fit, and function with other equipments of the same part number. The performance characteristics and dimensions of like units shall be sufficiently uniform to permit equipment interchange with a minimum of adjustment and recalibration.

3.2.1.4 Workmanship. The equipments of the Subsystem shall be constructed, finished, assembled in accordance with the specifications and drawings specified herein.

3.2.1.4.1 Personnel Certification. Personnel involved in assembly, soldering, welding, or other activities requiring special technical skills shall be certified as to their capability to perform such duties effectively.

3.2.1.5 Electromagnetic Interference. As a design goal, the Subsystem shall not generate nor be susceptable to electromagnetic interference to the extent that either intra- or inter-Subsystem performance will be degraded to the point that performance will be out of tolerance.

3.2.1.6 Identification and Marking. Each individual equipment of the Subsystem shall be identified in accordance with the provisions of MIL-STD-129.

3.2.1.7 Finish. As a design goal, all racks and consoles shall be green, number 24091 and all front panels gray, number 26492, in accordance with FED STD-595.

3.3 Performance Allocations.

3.3.1 Subsystem Performance.

3.3.1.1 Allocated Performance and Design Requirements. The Subsystem shall be the operational focal point of the ERTS system and shall provide for commands to the spacecraft/observatory, interpreting real time telemetry data and planning of subsequent dat-to-day operations. The Subsystem in concert with the other elements of the system shall have the capability for:

a. Command generation, verification and validation.

b. Recording, processing and displaying real time and delayed spacecraft housekeeping telemetry data.

c. Recording real time Data Collection System Signals.

d. Process delayed Data Collection System Signals

e. Formulating operational plans and schedules for daily and projected system usage.

f. Generation of technical and operational reports describing system operation.

g. Limited self testing to provide verification of Subsystems operational readiness.

3.3.1.1.1 Command System.

3.3.1.1.1.1 The command system shall provide the following functions:

a. Generating and translocating real time commands to ground station for uplink transmission to the observatory.

b. Generating and translocating stored commands to ground stations for transmission to the observatory.

c. Controlling spacecraft modes of operation subsequent to observatory separation from the launch vehicle.

d. Switching to NDPF computer operations.

e. Generating commands for transmission by either VHF or USB equipment.

3.3.1.1.1.2 Command Capability. The Command System shall have the capability for generating and verifying spacecraft real time and stored commands in formats for either STADAN or MSFN stations and shall:

a. Display command validation and verification data,

b. Generate commands individually or in blocks modes,

c. Display updated and existing command lists or individual commands by computer means.

3.3.1.1.1.3 Generation and Translocation Redundancy. The Command System shall provide redundant command generation and translocation including manual overrides by means of:

a. Manual entry into the command computer

b. Teletype message

c. Voice message

3.3.1.1.1.4 Verification Redundancy. The Command System shall have the capability for observing command verification by means of:

a. Command display or printout prior to command translocation to the monitor station.

b. Bit-by-bit check of commands received at the STADAN site as shown on the display and the printer.

c. Telemetry.

3.3.1.1.1.5 Command Word Format. The digital word sequence contained within the 600 bit block for Unified S Band and VHF links shall be as shown in Tables I and II.

3.3.1.1.1.6 50 KB/S Format. The Command System shall formulate one or more commands in 600 bit blocks for translocation via the NASCOM 50 KB/S circuit in accordance with Figure 1.

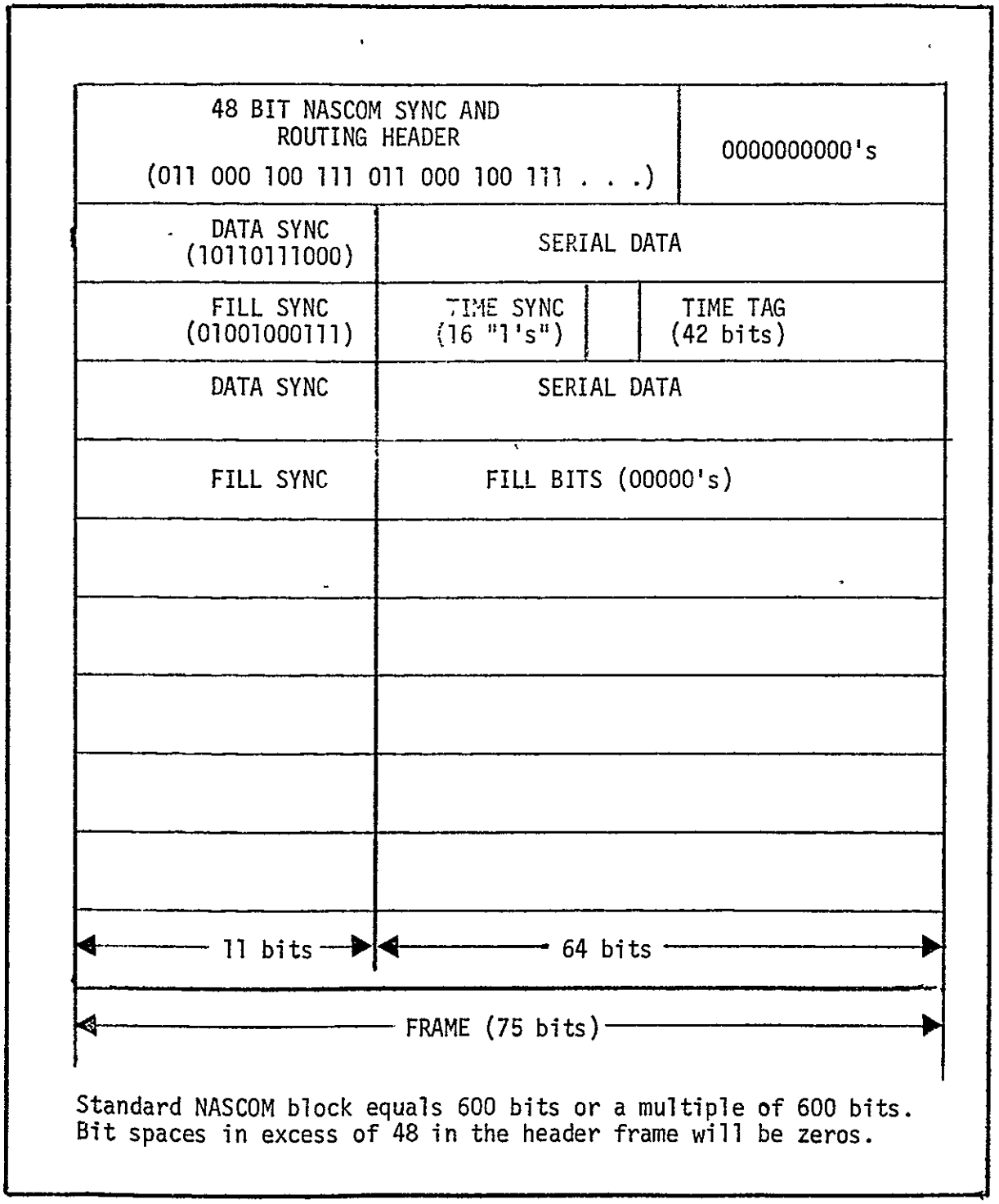
3.3.1.1.1.7 Translocation Links. The command system shall provide translocation of command messages by means of standard teletype tape reading/transmitting equipment and telecom equipment.

Table I

Storage	Number of Bits	
	USB	VHF
Apollo Address	6	None
Decoder Address	7	7
Internal Address	2	2
Programmer Mode	3	3
Programmer Word Address	7	7
Execution Time	18	18
Command	6	6
Parity	1	1
44 Bit Message Parity	1	1

Table II

Real Time	Number of Bits	
	USB	VHF
Apollo Address	6	None
Decoder Address	7	7
Internal Address	2	2
Matrix Command	8	8
Complemented Data	10	10



Standard NASCOM block equals 600 bits or a multiple of 600 bits.
Bit spaces in excess of 48 in the header frame will be zeros.

Figure 1

3.3.1.1.1.8 Command Validation. The command system shall validate the receipt of commands by remote stations prior to uplink execute.

a. STADAN shall provide notification of:

1. Command Execute
2. Request Execute
3. Operator Error

b. MSFN Stations shall provide notification of:

1. Command Reject
2. Command Repeat
3. Operator Error (subsequent to three transmissions)

3.3.1.1.2 Telemetry System

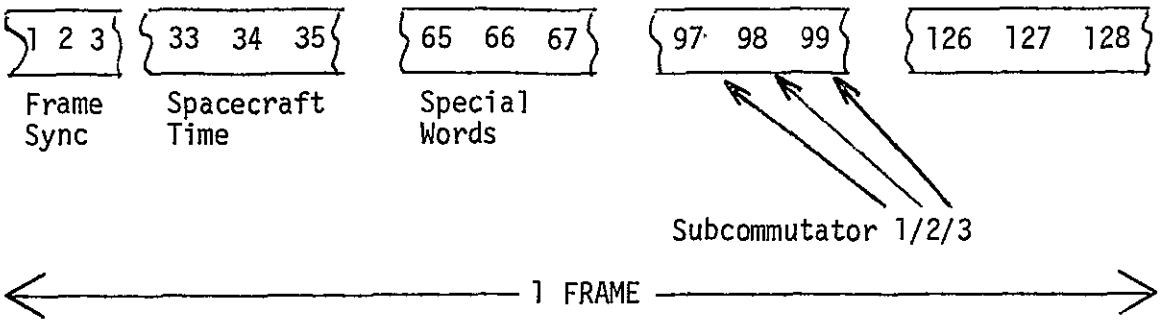
3.3.1.1.2.1 The telemetry system shall process real time and playback observatory housekeeping telemetry and display, record and process data for out-of-limit alarm and trend analysis.

3.3.1.1.2.2 Inputs

Sources. HK-TLM will originate at NTTF, Texas and Alaska. The HK-TLM will be inputted to the telemetry system following transmission.

Characteristics. HK-TLM will be received in real time at 1 K bit/sec and 32 K bit/sec or as reverse playback at 32 K bits/sec.

Format. HK-TLM shall be received in the following format (reverse for playback). Main frame shall consist of 128 nine bit words (1152 bits).



Note Subcommutator 2 can be accelerated to main frame rate of KBPS/32 KBPS

3.3.1.1.2.3 Outputs. The telemetry system shall provide the following outputs:

a. TAPE — Computing readable tape containing PCM and GMT data

b. ANALOG
1. PCM program shall be capable of 32 outputs
2. Manual selection 20 channels (maximum)

c. BACKUP
1. Digital Printer - 24 column, 40 lines per second
2. Teletype Punch - 5 level baud, 120 characters per second.
3. Numerical Displays

3.3.1.1.2.4 Operational Modes. The Subsystem shall have the following operational modes:

a. Data Processing. HK-TLM data shall be processed automatically under Subsystem computer and PCM Data Processing Equipment program control. In addition to recording housekeeping data on strip chart recorders, built-in programs shall provide for automatic monitoring of critical parameters for comparison against

established limits. Out-of-limit parameters shall be signalled by flashing lights. Capability shall be provided to monitor up to 10 parameters for failure trend analysis (intra pass).

b. Backup. As a design goal, provision shall be made for semi-automatic operation in the advent of Subsystem computer malfunction.

c. Test. Provisions shall be made for HK-TLM self test under Subsystem computer stored program control, manual supervision, or PCM simulator. Test shall be accomplished by means of end-to-end loop test using simulated PCM.

3.3.1.1.2.5 Operational Control. The HK-TLM operation shall be automatically conducted under Subsystem computer and PCM Data Handling Equipment program controller semi-automatically under operator control.

3.3.1.1.3 Data Collection System. The Data Collection System shall collect and record ground parameter data accumulated from platforms strategically located throughout the continental United States. This data shall be transmitted directly from each platform to the observatory on a non-synchronous basis. The data shall then be retransmitted to MSFN stations for transmission to GHDS. The Subsystem shall receive this data as detected I.F. and convert it to digitized data magnetic tape in computer recognizable format.

3.3.1.1.3.1 Inputs. The Data Collection System shall be capable of accepting inputs from the following sources:

Data originating at NTTF at 25 KHz to 125.0 KHz
Data originating at Alaska at 3.1 KHz to 15.6 KHz
Data originating at Texas at 3.1 KHz to 15.6 KHz

3.3.1.1.3.2 Spectrum. The Data Collection System data inputted to the Subsystem shall be random signals within a 100 KHz spectrum (25 to 125.0 KHz). As many as five signals may be processed simultaneously without overloading Data Collection System data processing capability.

3.3.1.1.3.3 Message Characteristics. The Data Collection System message shall be PCM, 110 bits in length at 2.5 K bits/sec with 8 db SNR (minimum) in accordance with the following format:

25 bits	3 bits	10 bits	8 words of 8 bits plus 8 bits error coding
Preamble	Sync	Platform Address	Data

3.3.1.1.3.4 Time Randomness. Data Collection System messages may be random in time and frequency resulting in periods of no input or time coincident inputs. The functioning of the Data Collection System shall not be affected by this characteristic. In the advent of data collisions, the Data Collection System shall lose as little data as possible to enhance possible later retrieval.

3.3.1.1.3.5 Doppler Effect. The Data Collection System shall not be affected by doppler caused input frequency shifts of up to 70 Hz.

3.3.1.1.3.6 Capacity. The Data Collection System shall be capable of accepting up to five simultaneous inputs without loss of information.

3.3.1.1.3.7 Outputs. The output of the Data Collection System shall be recorded on computer readable with GMT magnetic tape.

3.3.1.1.3.8 Processing Time. Data Collection System data shall not be processed in real time. Processing shall, however, be accomplished as expediously as operational limitations permit.

3.3.1.1.3.9 Data Processing. Data Collection System data processing shall function automatically under Subsystem computer and PCM data

Handling Equipment program control. Conversion of Data Collection System data received at reduced bandwidth shall be restored to permissible input frequencies by means of recording the input to the Subsystem on magnetic tape then providing playback at increased speed. Operator functions shall consist of appropriate patching, tape loading/unloading, and initializing conditions.

3.3.1.1.3.10 Test. Provision for Subsystem contained DCS equipment shall be made using stored program simulated DCS data. Simulated DCS data shall be inputted at representative input I.F. frequencies. The resultant PCM shall be automatically tested under program control for correctness.

3.3.1.1.3.11 Provision for Future Expansion. The design of the DCS shall, to the greatest degree possible, provide for future ERTS expansion to accommodate inputs from DCS originating outside the continental United States.

3.3.1.1.4 Data Processing. The data processing system shall perform the following functions:

a. Process and display observatory housekeeping telemetry.

b. Prepare spacecraft command lists and generate commands.

c. Evaluate status of transmitted commands.

d. Monitor wideband sensor performance for determination of fulfilled video coverage and generation of reports.

e. Develop pass profiles from user requests, power budgets, weather data and satellite ephemeris.

e. Develop pass profiles from user requests, power budgets, weather data and satellite ephemeris.

f. Generate mission schedules, station support requirements, maintain operational status and mission history archive.

g. Service keyboard inputs from CRT display stations.

3.3.1.1.4.1 General Description. The computational system shall be a standard, general purpose, digital computer. Requirements for word length, instruction repertoire, memory/CPU speed and memory size are contained in Table III.

a. Addressability. The main memory shall be modular and effectively addressable.

b. Parity. All data transferred to and retrieved from memory must be parity checked.

3.3.1.1.4.1.1 Input/Output Characteristics. The basic I/O design of the Subsystem computer shall provide for I/O high-speed bus circuits to facilitate the attachment peripheral devices. Program instructions shall be available to accomplish control and status test in addition to data transfer flow.

3.3.1.1.4.2 Computer Console. The computer console shall provide the following features:

a. Operating system bootstrap for program loading.

b. Display contents of any program register or memory location.

c. Manual single instruction stepping.

d. Displaying interrupt system and half status.

Table III. OCC Computer Sizing Parameters

FUNCTION	FREQ. OF EXEC/DAY	INSTRUCTION MIX %LOGIC	%COMP	%FLOAT	PERIPHERAL STORAGE NEEDS (# OF WORDS) RANDOM	CORE REQUIREMENTS NO. OF INSTRUCTIONS	WORDS OF DATA	PERIPHERAL DEVICES (NO. & KIND)
S/C SCHEDULE	4	62	38	35	$6x10^5$	5,500	6,000	Disk
COMMAND GENERATION	4	82	18	23	$5x10^4$	7,000	5,500	Disk
MESSAGE UPDATE	4	94	6	0.1	$1x10^4$	1,400	3,000	Disk
PCM TLM PROC.	14	75	25	19	$1x10^6$	5,000	12,100	3 Tapes Disk
SENSOR COVERAGE	1	84	16	19	$1x10^4$	1,500	2,000	1 Tape Disk
DISPLAY	200	86	14	9	$2x10^4$	17,000	$2x10^4$	9 CRT

3.3.1.1.4.4 Software. The Subsystem shall contain the following functions:

a. ROMAN
b. RECOMESUP
c. RPROSTM
d. RUTSKED
e. RSENSCOV

3.3.1.1.4.4.1 ROMAN Function. The task of ROMAN during real time operations shall be to accomplish real time commanding and transmission of commands to STADAN for transmission to the Observatory. During non-real time operation, ROMAN shall accept an event list from RUTSKED and transforms it into a command list.

3.3.1.1.4.4.2 RECOMESUP Function. The task of RECOMESUP shall be to determine that the Observatory has acted upon the transmitted command.

3.3.1.1.4.4.3 RPROSTM Function. The task of RPROSTM shall be to receive telemetry data and process and display this data.

3.3.1.1.4.4.4 RUTSKED Function. The RUTSKED function shall examine user requests for sensor coverage and determine a set or list of necessary events. This events list shall be displayed to the operator so he can check its accuracy.

3.3.1.1.4.4.5 RSENSCOV Function. This function shall be used to determine satisfactual user requests.

3.3.1.1.5 Operations and Scheduling. The Subsystem shall perform analysis and gather any required information necessary to plan ERTS operationsl activities.

3.3.1.1.4.2.1 CRT Display Units. The computer shall provide nine CRT Alphanumeric Display Units which also include alphanumeric keyboards for computer communications. The displays shall be self refreshing, single screen units, typically 10 inches by 12 inches of 120 square inch viewing areas. Capability for displaying approximately 1000 characters with a minimum of 80 characters per line is required.

3.3.1.1.4.3 Peripheral Requirements. The computer shall have the following peripheral capabilities in addition to the interface logic required for operation with communications channels and special input/output devices.

a. Line Printers. Individual printers shall have printing speeds of not less than 750 lines per minute and be capable of printing a 64 character set where the lines are minimum of 132 characters in length.

b. Card Reading. The card reading unit shall be capable of reading at least 500 cards per minute and permitting the reading of 80 column binary and Hollerith cards.

c. Card Punching. The card punching unit shall be capable of punching at least 300 cards per minute of 80 column binary and Hollerith cards.

d. Magnetic Tape Units. The computer shall be equipped with six magnetic tape handlers capable of at least 90 KB character rates.

3.3.1.1.6 Display. The Unified Display System shall provide for the transferring of operator commands to data processing equipment, to display selected RBV, MSS and available analog data on console CRT displays, large screen displays, and a hard copy generator.

3.3.1.1.6.1 Inputs.

a. Video. Video signals, with blanking, shall be provided by the Digital Display Generator. Each console or display shall be connected to a dedicated output. Fourteen outputs shall be available.

b. Synchronizing Signals. Separate signals shall be provided to each display at 1050 lines, 45 Hz sequential.

3.3.1.1.6.2 Outputs.

a. Keyboard. The alphanumeric keyboard shall have 32 keys. The program function keyboard shall have a minimum of 20 keys.

b. Light Pen/Cursor Control. A light pen or trackball cursor shall be provided for use by the console operator.

c. Hardcopy. A hard copy generator shall be capable of producing dry hard copy of current display presentation in less than 10 seconds. Copy size shall be 8 1/2 by 11 inches (minimum).

3.3.1.1.6.3 Displays.

a. Monitor. Each console shall be provided with a 17 inch CRT with the following characteristics:

1. (P-4 phosphor) for image display
2. Aspect ratio 3 by 4
3. Luminance 0-40 foot Lamberts

b. Large Screen Display. Four large screen (25 inch diagonal measurement) displays shall be provided with the following characteristics:

1.	Phosphor:	P-4 (white)
2.	Aspect ratio:	3 by 4
3.	Luminance:	0-40 foot Lamberts
4.	Mounting:	Design to be yoke mounted from above

c. Keyboard. Enabled keys shall be internally illuminated under computer control.

3.3.1.1.6.4 Operation.

a. Operators Console. Each operators console shall accept inputs, video, and sync from the Digital Display Generator. Circuits shall be provided to generate sweep signals and CRT drive signals to illuminate the console 17 inch CRT. Controls shall be provided to locally adjust picture quality. Image selection shall be accomplished at the console keyboard.

b. Large Screen Display. Large screen displays, operating in the same manner as the Operators console display, shall be provided. Control shall be similarly exercised from the keyboard of the controlling console. Designatio of controlling console shall be a keyboard function.

c. Image Magnification. Provision shall be made at each console to provide 2X and 4X magnification of a selected portion of the current image. Designation of the portion of the image to be magnified shall be by either light pen or track-ball cursor.

d. MSS Operation. The MSS 15 M bit/s signal shall be relayed to the Subsystem directly from the receiver demudulator (NDPF). The NASA-furnished demultiplexer and monitor scope shall be utilized in the Subsystem to provide MSS signal presentations via a small closed circuit television camera, focused on the monitor, which inputs to the Unified Display System.

3.3.1.1.7 Operations and Planning Function. The Subsystem shall have the capability of planning, coordinating, and scheduling all ERTS system activities.

3.3.1.1.7.1 Planning Function Characteristics. The Subsystem shall be capable of outputting events lists, command lists, predicted spacescraft performance lists, and any other data necessary for system operation upon receipt of the following:

a. User requests from the NASA Data Processing Facility.

b. Ephemeris data from NASA.

c. Orbit adjust from NASA.

d. Weather data from ESSA.

3.3.1.2 Interfaces.

3.3.1.2.1 NDPF Interface. The NDPF interface shall comprise electrical signals, tapes and user requests.

3.3.1.2.1.1 Electrical.

a. Intercom. This circuit and its equipment will be furnished and installed by NASA.

b. RBV Video. A video circuit shall be provided for transmitting RBV signals from the Subsystem line amplifier to the NDPF video tape recorder with a bandwidth of 0 to 5 MHz and a level of (TBD).

3.3.1.2.1.2 Tapes. The Subsystem shall provide Data Collection System housekeeping telemetry tapes to the NDPF.

3.3.1.2.1.2.1 DCS Tape. The DCS tape shall be 1/2 inch computer readable and have two tracks of information.

a. GMT. NASA 36 bit serial time corresponding to when the data was originally recorded. Format: (TBD).

b. Platform Data. Demodulated, serialized and at baseband but with no processing of any kind. Format: (TBD)

3.3.1.2.1.2.2 Housekeeping Telemetry Tape. Housekeeping telemetry tape shall be 1/2 inch computer readable and have two tracks of information.

a. GMT. NASA 36 bit serial time corresponding to when data was recorded. Format: (TBD)

b. Telemetry data in Engineering Units (TBD)

3.3.1.2.2 User Requests. The Subsystem shall accept user requests from the NDPF in the form of punched cards.

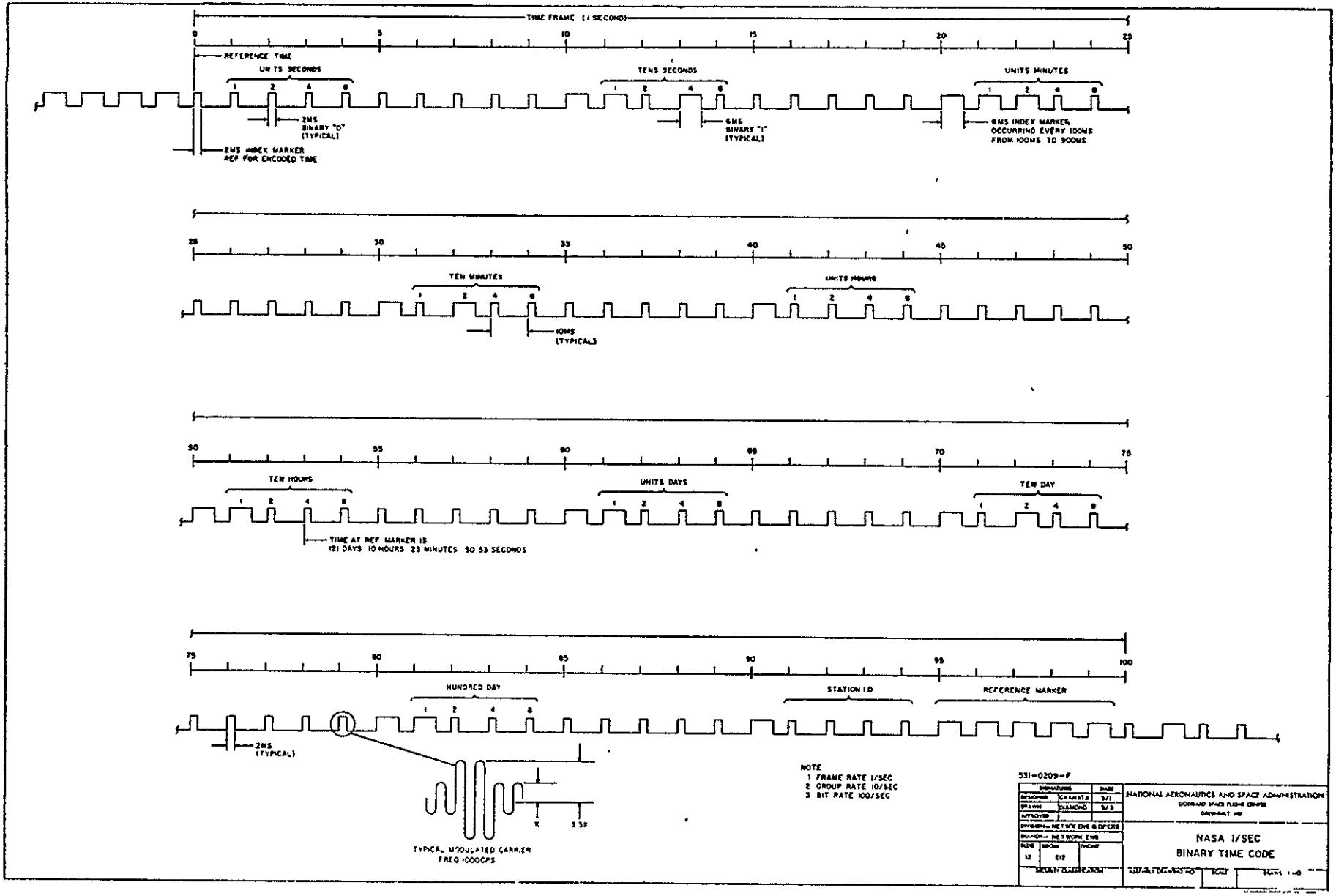
3.3.1.2.3 NTTF Interface. The Subsystem shall receive signals from the following NTTF circuits:

a. MSS.

Circuit:	Coax
Impedance:	135 ohms
Signal Amplitude:	1 volt P-P
Signal type:	Digital 14.5 MB/S

b. RBV

Circuit:	Coax
Impedance:	135 ohms
Signal Amplitude:	1 volt P-P
Signal type:	Analog 0-4 MHz


TIME FRAME (1 SECOND)
REFERENCE TIME
UNITS SECONDS
TENS SECONDS
UNITS MINUTES
2MS BINARY "0" (TYPICAL)
6MS BINARY "1" (TYPICAL)
6MS INDEX MARKER OCCURRING EVERY 100MS FROM 100MS TO 900MS
2MS INDEX MARKER REF FOR ENCODED TIME
TEN MINUTES
UNITS HOURS
10MS (TYPICAL)
TEN HOURS
UNITS DAYS
TEN DAY
TIME AT REF MARKER IS 121 DAYS 10 HOURS 23 MINUTES 50 53 SECONDS
HUNDRED DAY
STATION ID
REFERENCE MARKER
2MS (TYPICAL)
TYPICAL MODULATED CARRIER FREQ 1000CPS
NOTE
1 FRAME RATE 1/SEC
2 GROUP RATE 10/SEC
3 BIT RATE 100/SEC
531-0209-F
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NASA 1/SEC
BINARY TIME CODE

c. DCS

Circuit:	Coax
Impedance:	135 ohms
Signal Amplitude:	1 volt P-P
Signal type:	Analog 25-125.0 KHz

d. Playback Telemetry

Circuit:	Coax
Impedance:	135 ohms
Signal Amplitude:	1 volt P-P
Signal type:	Digital 32 KB/S

e. Real Time Telemetry

Circuit:	Coax
Impedance:	135 ohms
Signal Amplitude:	1 volt P-P
Signal Type:	Digital 1KB/S and 32KB/S

3.3.1.2.4 NASCOM Interface. The Subsystem interface with the following NASCOM circuits:

3.3.1.2.4.1 Teletype. Two duplex teletype circuits and attached equipment which will be furnished by NASA.

3.3.1.2.4.2 Voice. Twenty-five duplex circuits and attached equipment which will be furnished by NASA.

3.3.1.2.4.3 50 KB/S Data. Two data modems, WECO type 303, will be furnished by NASA. One will be used for commands and the other for telemetry data.

a. Command Interface. 600 bit block, 50 KB/S

b. Data Interface. 600 bit block 50 KB/S using the STADAN standard format.

3.3.1.2.4.4 Wideband.

Circuit:	Coax
Impedance:	135 ohms
Signal Amplitude:	1 volt P-P
Signal type:	DCS (Analog)
	TLM (Digital)

3.3.1.2.4.5 Time. NASA 36 bit time code per Figure 2.

3.3.1.2.5 Tape Input. The Subsystem shall receive and process 7 and 14 track instrumentation tapes containing ERTS data recorded at any ground station.

3.3.1.2.6 Manned Space Flight Network Operations Center and OPSCON Interface. The Subsystem shall be capable of voice communicating with the Manned Spaceflight Network Operations Center and the Operations Control Center for planning operations.

3.3.1.2.7 Environmental Sciences and Services Administration Interface. The Subsystem shall have the capability of teletype communicating with the Environmental Sciences and Services Administration to obtain weather data for planning mission operations.

3.3.1.2.8 Mission Flight Planning and Analysis Interface. The Subsystem shall have the capability of voice communicating with Mission Flight Planning and Analysis to obtain ephemeris and orbit adjust data for mission operations planning.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection and Test. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all test requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to TRW Systems. TRW Systems reserves the right to perform any of the tests set forth in this specification when such tests are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Inspection. Inspection of this item shall be accomplished in accordance with PAR 700-55 of TRW Systems Group Qaulity requirements.

4.3 Acceptance Tests. Acceptance tests shall be as specified in the individual configured item specifications. Subsystem testing shall be accomplished to verify the requirements of Section 3, herein.

4.4 Test Conditions. Test conditions for conducting the examinations and tests described herein shall be as defined in the applicable test specification.

4.5 Test Methods. TBD

4.6 Rejection and Retest. If a failure, malfunction, or out of tolerance performance degradation occurs during or after a test, testing shall be discontinued until the failure, malfunction, or out of tolerance condition (including design defects) is corrected. The pertinent test procedure shall be repeated until completed successfully. If the corrective action substantially affects the significance of results of previously completed tests, such tests shall also be repeated.

5. PREPARATION FOR DELIVERY

The equipment shall be packaged in accordance with good commercial practice and in a manner that will guarantee adequate protection against corrosion, deterioration and physical damage during direct shipment to TRW.

6. NOTES

(Not applicable)

10. APPENDIX

(Not applicable)

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TRW
SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

CODE IDENT 11982

TITLE

SUBSYSTEM SPECIFICATION
NASA DATA PROCESSING FACILITY
EARTH RESOURCES TECHNOLOGY SATELLITE

DATE 3/26/70 NO D-13800

SUPERSEDING: _____

PREPARED BY: S. Spiegel

APPROVAL SIGNATURES:

_____ DATE

_____ DATE

_____ DATE

_____ DATE

_____ DATE

_____ DATE

TRW SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH CALIFORNIA

AS OF 3/26/70
SUPERSEDING

SPECIFICATION CHANGE RECORD

SCN/REV	SCN/SPEC DATE	AUTHORIZATION		PRODUCTION EFFECTIVITY	PAGES AFFECTED
		ECP/CCN	OTHER		

SYSTEMS 1393 REV 11-67

(FILE DIRECTLY AFTER COVER SHEET)

SUBSYSTEM SPECIFICATION
NASA DATA PROCESSING FACILITY
SUBSYSTEM

1. SCOPE

1.1 Scope. This specification establishes the requirements for design, performance, qualification and acceptance test of the NASA Data Processing Facility Subsystem, hereinafter referred to as the Subsystem.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detail content of Sections 3, 4, and 5, the detail requirements of Sections 3, 4, and 5 shall be considered a superseding requirement.

SPECIFICATIONS

Military

MIL-D-1000 1 March 1965	Drawings - Engineering and Associated Lists

TRW Systems Group

D-13700	Ground Data Handling System, Earth Resources Technology Satellite
D-13710	Facilities Design
D-13701	Personnel and Training

STANDARDS

Federal

Fed. Std. 595	Colors

Military

MIL-STD-100A 1 October 1967	Engineering Drawing Practices
MIL-STD-129D 11 April 1969	Marking for Shipment and Storage
MIL-STD-143A 14 May 1963	Specifications and Standards, Order of Precedence for the Selection of
MIL-STD-803A-1 27 January 1964	Human Engineering Criteria for Aircraft, Missile, and Space Systems Ground Support Equipment
MS-33586A 16 December 1958	Metals, Definition of Dissimilar

OTHER PUBLICATIONS

TRW Systems Group

	ERTS Telemetry Format
N/A	Logistics Plan
PAR 700-55	Procurement, Performance Assurance Requirements, Quality, Reliability and Maintainability Provisions, Project ERTS Subcontractors for GDHS Equipment

3. REQUIREMENTS

3.1 Performance. The Subsystem shall:

a) Provide bulk and precision processing of Return Beam Vidicon (RBV) and Multi-Spectral Scanner (MSS) Tapes, in accordance with user requests.
b) Process Data Collection System data, and provide Data Collection System listings and tapes to users.
c) Process sensor and spacecraft housekeeping and attitude telemetry data.
d) Process data, using an integrated information management system.

3.1.1 Characteristics

3.1.1.1 Operational. The Subsystem shall accept housekeeping telemetry data, attitude data, ephemeris data, DCS data, RBV and MSS images on video tape from data acquisition sites and real-time MSS and RBV video data from OCC. These data shall be processed to provide the following information:

a) Image Annotation Data.
b) DCS Data.
c) Montage Catalog.
d) Index/Abstract Data.
e) Master Digital Data.
f) Corrected Images in Universal Transverse Mercator Projection, or Oblique Mercator Projection.
g) Digitized Images on Computer Compatible Tape.
h) Image and Supporting Data on Archival Tapes

3.1.1.1.1 Functions. The Subsystem shall provide the following functions:

a) Convert, record and screen imagery for dissemination, indexing, and storage.

b) Reproduce and disseminate bulk imagery users.
c) Accept and process DCS, telemetry, user abstracts, and supplementary data for incorporation into the data system.
d) Accept, account for and control user requests for precision image processing.
e) Maintain, produce and disseminate basic coverage indexes, DCS, and spacecraft performance data.
f) Maintain, produce and disseminate RBV and MSS montage catalogs.
g) Maintain all data files, film library and archives, digital data archives, historical montage data, and other hard copy products.
h) Process and distribute results of user requests for data.
i) Provide production control and accounting of all data in the system.

3.1.1.2 Facilities. The Subsystem facilities design, construction, integration, and acceptance requirements shall be as specified in TRW Specification D-13710.

3.1.1.3 Logistics. Spare parts and expendables for the Subsystem shall be in accordance with the TRW Systems Logistics Plan.

3.1.1.4 Personnel and Training. Personnel and training for the Subsystem shall be in accordance with TRW Specification D-13701.

3.1.2 Subsystem Definition. The Subsystem shall consist of Government Furnished Equipment (GFE), configured items, program articles, and automatic data processing equipment (ADPE). Configured items are items to be designed and fabricated. Program articles are items of equipment that are purchased to commercial standards of fabrication and performance. The ADPE shall be digital computer equipment and peripherals selected for the Subsystem. The configured items shall be assembled into a rack configuration.

3.1.2.1 Government Furnished Equipment. The Subsystem shall contain the following GFE items:

Nomenclature	GFE Item No.	Specification No.
RBV Tape Reproducer		
MSS Tape Reproducer		

3.1.2.2 Configured Items. The Subsystem shall contain the following configured items:

Nomenclature	Proposed Source	Configured Item No.	Specification No.
RBV Bulk Process Control Unit	IBM		EQ 2-245
MSS Bulk Process Control Unit	IBM		EQ 2-247
Tape-to-Film Control Unit	IBM		EQ 2-248
High Density Tape Control Unit	IBM		EQ 2-243
Precision Photo Restitutor	ITEK		EQ 2-250
Unified Display System	Hazeltine		EQ 3-265
Laser Beam Recorder	IBM(RCA)		EQ 2-246
High Density Tape Drive Unit	IBM (AMPEX)		EQ 2-244

3.1.2.3 Program Articles. The Subsystem shall include the following program article specified and procured as shown:

Nomenclature	Proposed Source
Versamat Black and White Film Processor	ITEK
Light Tables	Richards
Kodak Film Splicer	ITEK
Versamat Color Film Processor	ITEK
Kodak Pre-inspect/Splicer	ITEK
Kodak Rapid Color Print Processor	ITEK
Kodak Print Cutter	ITEK
Registration Punch Color Printing	ITEK
Registration Board Color Printing	ITEK
Color Printing Point Light Source	ITEK
Densitometer	ITEK

Nomenclature	Proposed Source
Sensitometer	ITEK
Chemical Analysis Set	ITEK
MacBeth Color Analyser	ITEK
Kodak Sensitometric Processor	ITEK
Equipment Maintenance Set	ITEK
Color Film Developer - Carr	ITEK
Black and White LogEtronic Printer	ITEK
Opto Mechanisms Comparator Model 527	Opto Mechanisms
Comparator and Data Logger and Maps on Film	ITEK
Pako Print Washer	ITEK
Pako Print Dryer	ITEK
Miller Holzwarth Printer	ITEK
Black and White Durst Enlarger Printer	ITEK
Black and White Morse Printer	ITEK
Color LogEtronic Printer	ITEK
WA Brown Copy Camera	ITEK
Kodak Film Cleaner and Waxer	ITEK

3.1.2.4 Automatic Data Processing Equipment. The Subsystem shall have automatic data processing equipment the characteristics of which will permit operation in accordance with the requirements of this specification.

3.1.3 Operability

3.1.3.1 Reliability. The Subsystem shall provide availability, in accordance with TRW Systems Document, PAR 700-55, for processing observatory data. The MTBF, as a design goal, shall exceed 1000 hours. The MTTR, as a design goal shall not exceed four hours.

3.1.3.2 Maintainability

3.1.3.2.1 Maintenance and Repair Cycles. Field maintenance will be as defined in the TRW Systems Maintainability Program Plan.

3.1.3.2.2 Service and Access. The Subsystem shall be designed for ease of service. Access doors, drawers, and test points, to enable the measurement, removal, and replacement of all significant subassemblies with normally available tools shall be provided.

3.1.3.3 Environmental Requirements. The Subsystem shall be capable of operating within a NASA furnished building. The environment within this building shall be as shown in TRW Specification No. D-13710.

3.1.3.4 Transportability. Each component of the Subsystem shall be designed to be transported by common carrier with a minimum of protection. Special packaging will be used as necessary to assure that transportation methods do not impose design penalties.

3.1.3.5 Human Performance. The design of all equipment requiring man/machine interfaces shall use MIL-STD-803A, Part I as a guide.

3.1.3.6 Safety

3.1.3.6.1 Radiation. All equipment capable of emitting dangerous radiation shall, under normal operating conditions, be properly shielded to attenuate the radiation to a safe level. Radiation warning notices shall be affixed to the equipment identifying hazards in the event of equipment usage in other than the normal operation.

3.1.3.6.2 Personnel Safety. Emergency procedures shall be provided for file, chemical spillage, evacuation, electrical shock and disaster.

3.1.3.6.3 Noise and Vibration. The noise and vibration levels associated with the Subsystem and its components in required combinations shall be controlled to the levels of tolerance to personnel as specified in MIL-STD-803A-1.

3.2 Subsystem Design and Construction Standards

3.2.1 General Design and Construction Requirements

3.2.1.1 Selection of Specifications and Standards. Selection of specification and standards for necessary commodities and services not specified herein shall be in accordance with the provisions of MIL-STD-143A.

3.2.1.2 Materials, Parts, and Processes. Only materials, parts, and processes conforming to all requirements of Group I and V Documents of MIL-STD-143A shall be considered standard and shall be used to the maximum possible extent. Engineering drawings and associated lists shall be in accordance with the provisions of MIL-D-1000 and MIL-STD-100.

3.2.1.2.1 Dissimilar Metals. To avoid electrolytic corrosion, dissimilar metals, as defined in Standard MS-33586A, shall not be used in direct contact.

3.2.1.2.2 Fungus Nutrient Materials. Materials that are nutrients for fungus shall not be used when their use can be avoided. Where used and not hermetically sealed, materials shall be treated with a suitable fungicidal agent. If materials are used in an hermetically sealed enclosure or if they are used and stored in a continuously controlled environment, fungicidal treatment will not be necessary.

3.2.1.2.3 Flammable, Toxic, and Unstable Materials. Flammable toxic, and unstable materials shall not be used whenever possible.

3.2.1.2.4 Standard Parts. Standard parts should be used whenever possible provided they meet the requirements as defined in TRW Systems Document PAR 700-55.

3.2.1.2.5 Finish. The surfaces of each major equipment of the Subsystem shall be adequately finished to prevent deterioration from exposure to the specified environments that might jeopardize fulfillment of the specified performance.

3.2.1.3 Interchangeability and Replaceability. Each major equipment of the Subsystem shall be directly interchangeable in form, fit, and function with other equipments of the same part number. The performance characteristics and dimensions of like units shall be sufficiently uniform to permit equipment interchange with a minimum of adjustment and recalibration.

3.2.1.4 Workmanship. The equipments of the Subsystem shall be constructed, finished, and assembled in accordance with the specifications and drawings specified herein.

3.2.1.4.1 Personnel Certification. Personnel involved in assembly, soldering, welding, or other activities requiring special technical skills shall be certified as to their capability to perform such duties effectively.

3.2.1.5 Electromagnetic Interference. As a design goal, the Subsystem shall not generate nor be susceptable to electromagnetic interference to the extent that either intra- or inter- Subsystem performance will be degraded to the point that performance will be out of tolerance.

3.2.1.6 Identification and Marking. Each individual equipment of the Subsystem shall be identified in accordance with the provisions of MIL-STD-129.

3.2.1.7 Finish. As a design goal, all racks and consoles shall be green, number 24091 and all front panels gray, number 26492 in accordance with FED-STD-595.

3.3 Performance Allocations

3.3.1 Subsystem Performance

3.3.1.1 Allocated Performance and Design Requirements

3.3.1.1.1 Subsystem Inputs

3.3.1.1.1.1 Imagery Input. The Subsystem shall accept for processing the following data on video tape, using Government Furnished Equipment (GFE) video tape reproducers:

a) Return Beam Videcon (RBV) video magnetic tape.
b) Multi-Spectral Scanner (MSS) magnetic tape.

3.3.1.1.1.2 Telemetry Tape Input. The Subsystem shall accept for processing the following telemetry data on computer compatible magnetic tape:

a) Spacecraft housekeeping telemetry tape.

b) Sensor housekeeping telemetry tape.

c) Data Collection System tape.

3.3.1.1.1.3 Processed Data Tapes. The Subsystem shall accept for processing the following data on computer compatible magnetic tape:

a) Predicted ephemeris computer tape.

b) Computed ephemeris computer tape.

3.3.1.1.1.4 User Input Data. The Subsystem shall accept for processing the following data on computer compatible tape, special forms, or film:

a) Abstract forms from users.

b) Special user requests.

3.3.1.1.1.5 Support. The Subsystem shall accept for operator use the following data:

a) Reference maps.

b) Supplementary hard copy reference material.

3.3.1.1.2 Image Processing. The Subsystem shall process the input data in two basic quality modes of operation, bulk mode and precision mode. Precision mode shall be treated as a Request mode, and implemented in two functional categories, Precision Mode I and Precision Mode II. These modes are defined as follows:

a) Bulk Mode. Bulk mode shall have the following characteristics:

1) Convert image to high density digital tape.

2) Geometric corrections of Return Beam Vidicon images and Multi-Spectral Scanner images by the Precision Photo Restitutor under computer control.

3) Reseau detection and location of all RBV image data.

4) Photometric corrections for shading effects and channel gain variation derived from transmitted calibration signals.

5) No radiometric corrections.
6) Geographic tick marks and annotation data on film.
7) Film size will be 9-1/2 inches.
8) Color composite (request only)

b) Precision Mode I. Precision Mode I shall have the following additional characteristics:
1) Geometric corrections of RBV and MSS images by digital computer implementation using attitude telemetry data, verified ephemeris, and ground truth data, where feasible, and image transformation into Universal Transverse Mercator or Oblique Mercator Projection.

2) Photometric corrections same as Bulk Mode one.
3) No radiometric corrections.
4) Film size shall be 9-1/2 inches.

c) Precision Mode II (Special Request Mode). This mode is the same as Precision Mode I with choice of one or more of the following:
1) Image motion compensation where possible.
2) Image transformations into specified grids.
3) Image enhancement including blemish removal.
4) Modulation transfer function correction.
5) Structured noise removal.
6) Reseau removal with cosmetic fill-in.
7) Radiometric adjustment for atmospheric effects.
8) Non-standard composite color balance.

3.3.1.1.3 Functional Description of Configured Items and Program Articles.

3.3.1.1.3.1.1 RBV Bulk Process Control Unit. The RBV Bulk Process Control Unit shall provide the following functions:

a) Control the motion of the synchronous RBV Reproducer.

b) Accept video image data and PCM telemetry data.
c) Digitize and buffer a portion of the image data.
d) Introduce identifying header, annotation, and photometric correction data supplied by the computer.
e) Control the output of all data, except telemetry, in a standard, compact format suitable for archival to a synchronous high density tape recorder.
f) Control the high density tape recorder.

3.3.1.1.3.1.2 MSS Bulk Process Control Unit. The MSS Bulk Process Control Unit shall provide the following functions:

a) Accept uncorrected data read from MSS image tapes.
b) Supply framed image data and identifying annotation and calibration data for storage on a high density tape.
c) Control the motion of the synchronous MSS tape reproducer.
d) Search the MSS tape to establish the desired initial positions for framing continuous scan data into separate images.
e) Select image data and calibration data associated with one spectral band from among four (five for ERTS-B) recorded in parallel.
f) Dynamically buffer and reformat the selected spectral band data.
g) Introduce identifying header and annotation data supplied by the computer.
h) Output data to an archival high density tape recorder in a standard, compact format.
i) Control the motion of a synchronous high density tape recorder.

3.3.1.1.3.1.3 Tape to Film Control Unit. The Tape-to-Film Control Unit shall provide the following functions:

a) Accept data read from RBV or MSS high density bulk archival tapes or high density precision processed image tapes and supply the data to a laser beam image recorder to produce annotated imagery on film.

b) Provide motion control of the synchronous high density tape reproducers.
c) Provide a search capability to establish the initial high density tape position prior to image reproduction.
d) Provide the ability to distinguish between RBV or MSS and bulk or precision processed data according to the header information read from the tape and cause the line to adapt as required.
e) Generate tick marks and a sensitometric gray scale to be merged with image data.
f) Output the merged image data to the laser beam recorder at the rate demanded by the laser beam recorder.
g) Decode and output the annotation data to a block annotation device at the laser beam recorder.
h) Motion control of the synchronous laser beam recorder.

3.3.1.1.3.1.4 High Density Tape to Computer Control Unit. This unit shall interface an archival high density tape reproducer/recorder to the computer, generate control commands to the tape unit, and monitor tape recorder operation. Image data and associated data stored on archival tapes shall be input to the computer through the control unit; conversely, image data and associated data from the computer shall be output to the high density tape through this unit. The capability to operate in either configuration shall be provided within one unit; the desired configuration shall be switch selectable.

3.3.1.1.3.1.5 Precision Photo Restituter. The PPR shall be a highly accurate electro-optical device that is capable of printing an output image so that it is in registration with a second or control image, even though there may be high-order relative geometric distortions between the two images. The PPR shall be operated so that it may restitute an image in a known or preprogrammed manner.

The PPR shall employ an analog image correlation system that can measure zero- and first- order distortions over a small area of the image.

The error signals derived from the correlator shall be used to drive an optical system that will remove these errors. The optical system shall also be capable of being driven in an open loop manner from information supplied by a digital computer. The PPR will print black and white master images and composite color separation masters.

Corrected images shall be annotated by a tick mark and fiducial mark generator directly after image exposure. Alphanumeric data shall be added by exposing the film to a cathode-ray tube display.

3.3.1.1.3.1.6 Unified Display System. The Unified Display System shall be capable of providing a stable, flicker-free display of alphanumeric and special characters, closed circuit television imagery, and limited graphics with manual input using alphanumeric and program function keyboards and trackball - cursor.

3.3.1.1.3.2 Program Articles

3.3.1.1.3.2.1 Laser Beam Recorder (LBR). The LBR shall produce film images on a continuous roll of 9-1/2 inch film: each image shall consist of two fields: an LBR picture field and an alphanumeric field. The LBR shall accept data from three parallel sources of the control unit to produce these fields: one 7-bit parallel source providing 6-bit BCD character codes plus parity in a serial stream of 525 characters to produce the annotation field in typewriter-like fashion (fixed format) and two 7-bit parallel sources each providing 128 binary coded intensity values for the LBR picture field.

The LBR shall operate in either of two modes selected by the control unit: Mode A (RBV) and Mode B (MSS). In either mode each scan in the picture field shall contain 4482 picture elements. The intensity value of each element shall be the result of an analog gain correction by one of the 7-bit binary coded (intensity) inputs to the other 7-bit binary coded intensity value presented in parallel synchronism to the LBR. In Mode A the picture field shall contain 4230 scans.

In Mode B there shall be 2710 scans. The rate of advance of the film in Mode A shall be 2710/4230 times the rate of advance in Mode B. The beam aperture shall be changed accordingly. The scan rate shall be 400 lines per second. The picture field in each case shall consist of a 7.7 inches by 7.7 inches image area, surrounded by geographical tick marks and sensitometric gray scales. A block at the top of the format gives alphanumeric data. The LBR shall provide for frame fiducials, frame binary code, external selection of one of seven gamma correction values provided by the control unit, to increase the effective scene contrast ratio between the sensor data and the output data. The total picture area including annotation shall be 8.6 inches wide by 9 inches high.

3.3.1.1.3.2.2 High Density Tape Drive Unit. The High Density Tape Drive Unit shall interface with various equipments to provide the means for archiving all bulk data in digital form, for reading the data to generate film imagery, or to input and output image data to the computer. The High Density Tape Drive Unit shall record or reproduce digital data at several selectable rates that can be externally varied about the nominal rate. There shall be five externally selectable tape speeds and uniform packing density for recording data at 100, 200, 400, 800, and 1600 K 32-bit words per second.

The unit shall also provide for an external speed control mode whereby a tape produced on one unit at any selected internal speed control can be read on another unit at any of the five selected rates with external speed control over the range of ± 10 percent of the selected speed.

3.3.1.1.3.2.3 Photographic Equipment. The Subsystem shall use the following program articles as part of the Photographic Laboratory.

a) Kodak Versamat Model 11-CM. Chemical processing of black and white film and paper.
b) Kodak Versamat Model 1411. Chemical processing of color film and paper.

c) LogEtronic Printer Model SP 10/70. Contact printing of B/W film, paper.

d) LogEtronic Printer Mark III. Contact printing of color film, paper.

e) Itek Recording Densitometer (RD-2). Producing sensitometric curves to assess quality of developed film.

f) Kodak Film Cleaner, Waxer (Clinton Model II). Cleaning film, applying protective wax coating.

g) Kodak Pre-inspection/splicing Table (012-66-26). Preparing rolls of unexposed film in lengths required for each processing step.

h) Kodak Film Splicer (Denver). Splicing short lengths of developed film into longer rolls for subsequent printing operations

i) Kodak Print Cutter (FM-111). Cutting film and paper into lengths required for dissemination.

j) Brown 24 Copy Camera. Photographing coverage montage.

k) Kodak Rapid Color Processor. Developing color prints for special requests.

l) Miller Holzwarth Printer (1119). Contact printing sheet prints.

m) Durst Enlarger (V-184). Exposing enlargements.

n) Richards Light Table. Film inspection.

o) Kodak Sensitometric Processor. Developing sensitometric strips for Quality Assurance.

p) Itek Portable Sensitometer. Exposing sensitometric grey scales on film for Quality Assurance.

q) MacBeth Color Analyzer. Determining exposure and filtration for color printing.

r) OptoMechanisms Comparator (527). Measuring photo and map coordinates for ground truth.

s) Pako Print Washer. Washing B/W paper prints.

t) Pako Print Dryer. Drying B/W and color paper prints.

u) Morse Contact Printer (A-14). Exposing montage prints.

v) Condit Registration Punch and Registration Board. Registering and exposing composite color negatives.

w) Equipment Maintenance Set. Maintaining photo equipment.

x) Chemical Analysis Set. Quality Assurance testing of photo chemical solutions.

y) Calumet or Carr Color Processor. Chemical processing of sheet color film.

z) Carr Film Drying Cabinet. Drying sheet color film.

3.3.1.1.4 Software Subsystem Functions. NDPF software shall consist of six major functions:

a. Operating System

b. PCM Telemetry and DCS Data Processing

c. Information Management

d. Data Base and Files

e. Digital Image Processing

f. Image Processing Support

Each of the major functional areas consist of modules and routines as shown in Figure 1 (see page 11).

3.3.1.1.4.1 Operating System Functions. The operating system shall provide a comprehensive set of language translators, utility programs and service routines operating under the supervision and coordination of an integrated control program.

The operating system shall consist of the following modules and routines.

a. Executive Support Services Module

Routines

1) Initial loader
2) Interrupt processor
3) System Information Reservoir

The Executive Module provides a collection of main core-resident services to facilitate high level processing decisions and control flow routing. Composite services perform interrupt processing, executive administration, system initialization and centralization of system data and information.

b. Job Control Module

Routines

1) Job input reader

2) Job starter/stopper
3) Job output writer

The Job Control Module controls the progression of jobs through the system and assists the individual jobs as they evolve from the starting phase through the termination phase. Job Control exercises control in the areas of input job stream processing, work query management, job initialization/ termination and job output retrieval.

c. Housekeeping Support Services Module

Routines

1) File and storage protection
2) System accounting routine

This module provides a set of routines whose basic responsibility is to centralize general housekeeping duties thereby freeing other routines from having redundant logic. In this category fall the duties of protecting data from accidental or intentional destruction and preparing utilization statistics for the various system resources.

d. Input/Output Module

Routines

1) Input/Output Controller
2) Device dependent I/O services
3) Access methods
4) Inter-device I/O handler
5) Operator query/command coordinator

The Input/Output Module is a collection of services whose primary objective is to provide the necessary input/output support for the NDPF computing environment. Maximum flexibility is achieved because I/O support may be requested at various levels. The higher the

level requested, the more work this module will do for the requestor. Efficiency is also realized through the centralization of all I/O handling activities.

e. Control Program Services Module

Routines

1) Request director
2) Execute error analyzer
3) Remote program accessor
4) Termination coordinator
5) Multi-programming facility
6) Intermediate result generator
7) Program linkage services
8) System resource serializer
9) Main storage allocator
10) System timing services

The Control Module provides NDPF users with a useful array of services in order to exploit the power and versatility of ERTS computers. These services are designed to assist the user by providing him with access to the total system resources and by relieving him of certain basic housekeeping duties. The proper use of this module will result in improved and efficient programs.

f. System Support Processor Module

Routines

1) Basic assembler
2) Compilers
3) Report generator
4) Pre-execution modulizer

System support processors provide a series of support services to assist the application programmers in implementing the elements of the ERTS application software system. These processors will allow

the software programs to be developed and maintained economically by using programming languages and techniques best suited for the application.

g. System Utilities Module

Routines

1) Modify file content
2) Modify volume content
3) Monitor data base content
4) Data file merge
5) Data file sort

Systems Utilities provides a wide range of utility services to monitor, maintain and manipulate the system and application program data bases. Such services as displaying file and volume content, creating new files, modifying file and volume content, sorting and merging of data files and providing for recovery from catastrophic errors are included.

h. System Library Module

Routines

1) Arithmetic subroutines
2) Functional subroutines
3) Catalog entry routines
4) Catalog retrieval routine
5) Ephemeris update routine

The System Library provides commonly needed services for application programs such as calculating arithmetic values (sine, square root, etc.), bit manipulation and conversion.

i. Display Subsystem Module

Routines

1) Graphics support formatting
2) Graphics support retrieval
3) Graphics support I/O

4) Print support services
5) Digital TV support
6) Teleprocessing (terminal) support

The Display Subsystem contains those services which can be developed independent of the applications in support of display devices. As such the application programmer will transmit to these routines the data that is to be displayed and the routines will handle the formatting and I/O.

3.3.1.1.4.2 PCM Telemetry and DCS Processing (TIDP) Function. PCM Telemetry and DCS data processing software shall provide the capability for the creation of the PCM data base. This function shall be divided into PCM pre-processing and PCM Data Base generation. The pre-processor shall perform time oriented computations, time analysis, attitude determination and annotation data calculations. The data base generator shall perform the data oriented functions; conversion to engineering units, data quality evaluation, redundant data elimination, formatting and output. The function shall contain the following software modules:

a. Attitude Determination Module: The attitude determination module shall derive spacecraft three axis attitude and attitude rates from measurements of pitch, roll and yaw angle errors, momentum wheel ratio, solar panel data and ground truth data.

b. PCM Pre-processor Module: The pre-processor module correct the GMT attached to the PCM telemetry and generate a tape schedule for maximum efficiency in reading the digitized PCM tapes. It shall initialize a data file with the corrected GMT and orbital parameters.

c. Image Annotation Module: This module shall compute and summarize the parameters required for video image annotation of ERTS images, and will generate Index/Abstract data for subsequent Information Management processing.

d. PCM Data Base Generator Module: This module shall generate a data base to create the Master Digital Data Tape. The data base shall contain the calibrating housekeeping, corrected GMT, orbital and attitude data.

e. DCS Data Base Generator Module: The PCM data base generator will generate the DCS data base which contains the verified, identified and calibrated DCS messages.

3.3.1.1.4.3 Information and Data Management Function. The Information Management Function shall create and maintain the NDPF data files from which it shall subsequently retrieve and output selected data. It shall support the operating system in the use of graphic display devices and remote terminal facilities. It shall perform file revision and indexing operations and provide for the maintenance of application libraries. The function shall contain the following modules:

a. Input Processing Module: This module shall screen, edit, convert and sort the data input transactions as a preprocessor to data file entry.

b. File Creation Module: File Creation shall translate file format and index specifications pertaining to data field name, size, position and type into file formats and data index directions as a guide to subsequent data file operations.

c. File Maintenance Module: The File Maintenance Module shall enable input data to be processed and merged with existing data file content by facilitating the addition, deletion or modification of data values. Associated data indexes shall be maintained in accordance with the updated contents of indexed data fields.

d. File Retrieval and Sort Module: File Retrieval shall translate retrieval specifications into instructions for performing a data index and file search. Errors in the specified retrieval language statements shall be detected and flagged for corrective action.

e. Report Generation Module: This module shall process retrieved or direct file data to generate a data report whose content, format, and output media is specified in a high level output language. Data report specifications shall be compiled to create executable instructions that formulate the output data content and control the output format and media as required.

f. File Revision Module: The File Revision Module shall restructure an existing NDPF data file so that its contents are preserved and its format modified to permit the integration of additional data fields. Specification of data field additions, deletions, and/or changes in data field name, size, location and type are processed and the existing data file transformed into a newly revised data file in concert with the generation of a completely new file structure definition.

g. Remote Terminal Processing Module: The Remote Terminal module shall process file updates, retrievals, and outputs via a remote terminal, input/output display unit. Communication between the terminal operator and the computer files is established to rapidly alter and process data inputs and requests.

h. Utilization Support Services Module: This module shall provide special software capabilities that sustain generalized data file operations by fulfilling those needs that are auxiliary, yet necessary to the information management function. Standard table generator and lookup routines and a means of storing and calling the routines and subroutines that comprise the set of production programs are provided.

3.3.1.1.4.4 NDPF Data Base and Files Functions. The NDPF data base and files shall provide a centralized and automated library for ERTS data inputs and internally generated products and shall be a vehicle for providing data to all system users.

3.3.1.1.4.5 Image Processing Function. Image Processing shall be comprised of two functions: Digital Image Processing and Image Processing Support.

3.3.1.1.4.5.1 Digital Image Processing. Digital image processing shall provide a means by which the major errors in ERTS imagery can be corrected. This function shall contain modules that correct the effects of sensor induced geometric and radiometric distortions as well as the errors caused by variations in spacecraft altitude and attitude.

The Digital Image Processing Modules shall be:

a. Digital Image Processing Control: This is the control routine for the digital image processing software. It initializes the image processing options from input control cards. In response to external requests, it calls all routines required for the processing of an image.

b. Read High Density Tape: This routine reads the annotation and image from high density tape into core memory.

c. Write Image Onto Direct Access Storage. The input image will be placed on a direct access storage device. This operation will be simultaneous with either of the above two read modules.

d. Search Attitude and Ephemeris Tape. For an RBV image, this program searches the S/C attitude and ephemeris time history tape to retrieve pitch, yaw, roll, altitude, sun angle and principle point for RBV exposure time. For an MSS image it searches the S/C attitude and ephemeris time history tape and stores S/C yaw angle and principle point for the MSS image time interval.

e. Detect Reseau (Precision Mode I and II; Bulk Mode II) The reseau points are the key elements in RBV geometric correction. This module provides a fast and efficient method of locating the points.

f. Read Image from Direct Access Storage. This routine reads a specified image area from Direct Access Storage into core memory. This program is used when performing the image processing options (such as geometric correction, radiometric correction, etc.) and when writing the image on High Density Tape or 1600 BPI Tape.

g. Compute Photometric Calibration Tables. This module processes the RBV calibration images to determine correction for shading, channel gain, and gamma.

h. Characterize Structured Noise (Precision Mode II). The module computes the noise correction for the image for those cases where that noise is synchronized with the power supply.

i. Remove Structured Noise (Precision Mode II). This program reads in the structured noise correction table and removes the noise from each line of an image.

j. RBV Single Point Radiometric Correction (Precision Mode II). This program applies a "single point" radiometric correction to RBV images. Shading, gamma and atmospheric scattering and video level adjustment can be combined into one, composite, single point correction.

k. MSS Single Point Radiometric Correction (Precision Mode II). This module uses the MSS calibration data to compute either a simple gain adjustment or a combined gain and gamma correction. Atmospheric scattering and video level adjustment can be included in the same correction and applied to all lines of an MSS "image."

l. Remove Reseau (Precision Mode II). A cosmetic improvement is made by removing the reseau marks and filling them in with video values computed by interpolation on the surrounding video data.

m. Remove Blemishes (Precision Mode II). Remove predefined blemishes on the RBV image by an averaging technique to fill in the bad spots.

n. Compute RBV Output to Input Image Mapping (Precision Mode I and II, Bulk Mode II). A single output to input RBV image mapping is computed to account for the effects of scan distortions, S/C attitude and altitude variations, and desired output projection.

o. Compute MSS Output to Input Image Mapping (Precision Mode I and II). A single output to input MSS image mapping is computed to account for the effects of S/C attitude and altitude variations as well as the desired output projection.

p. Apply Geometric Correction (Precision Mode I and II; Bulk Mode II). This routine applies geometric correction using biquadratic interpolation.

q. Apply Multi-Point Radiometric Correction (Precision Mode II). This program performs a multi-point radiometric correction on input images. The correction applied are any or all of the following: IMC, MTF and a variety of image enhancement.

r. Write High Density Tape (All Modes). This routine writes the processed image and annotation data on High Density Tape.

s. Write 1600 BPI Output Tape (Precision Mode I and II). This program writes the processed image and annotation data on 1600 BPI Tape.

3.3.1.1.4.5.2 Image Processing Support Function. This function shall contain the following modules:

a. External Equipment Control Module. This module shall provide top-level control to the RBV and MSS bulk processing. It shall interface the RBV and MSS Bulk Line Control Units to provide control to the RBV and MSS Reproducers and High Density Tapes.

b. Image Generation Control Module. This module shall provide control for and monitor the PPR when operating in the Open Loop Mode and Closed Loop Mode. During the Open Loop Mode it shall compute the improved spacecraft attitude and position, correct reseau positions, incorporate earth curvature and lens calibration and put the four computed incremental values (X position, Y position, zoom, rotation) into

PPR coordinates. During the Closed Loop Mode it shall monitor the PPR operation and accumulate yaw error estimate for refined attitude determination.

3.3.1.2 Interface Requirements.

3.3.1.3.1 The subsystem shall interface with the Operations Control Center and GSFC and users.

3.3.1.2.2 Precision Photo Restituter Interface. The PRR shall interface with the computer through a parallel data adapter.

3.3.1.2.3 MSS Bulk Process Control Unit Interface. The MSS Line Control Unit shall interface directly with the MSS tape reproducer, the computer, and an archival high density tape drive.

3.3.1.2.4 RBV Bulk Process Control Unit Interface. The RBV Bulk Line Control Unit shall provide a high-speed channel interface with the computer for exchanging general process control commands and status codes, inputting calibration image data from RBV tape to the computer for photometric correction computation, transferring specific telemetry data to the computer, and outputting the header, annotation, and photometric correction data from the computer to the control unit. The control unit shall also interface directly with the RBV reproducer, the computer, and an archival high density tape drive.

3.3.2 Workload Volume. The design of the subsystem shall be based upon the following imagery volumes:

a. The image input rate for Case A shall be 315 images per day based upon a seven day week. This total is comprised of 180 MSS images and 135 RBV images. Processing of these images must be performed in a 40 hour week. The daily rate will be 441 images, comprised of 252 MSS images and 189 RBV images.

b. The image inputs for Case B shall be 1315 total images per day based on a seven day week. The total is based on 564 Return Beam Vidicon images and 751 Multi-Spectral Scanner images. Processing of these images may take place in three shifts per day, seven day week. ERTS B will total 940 MSS images due to the addition of a fifth spectral channel.

3.3.3 Storage and Retrieval. The Subsystem shall provide for storage and retrieval of active and archive library data.

3.3.3.1 Active Library Data. The Active Library Data shall include the following data:

	Data Category	Data Item	Original Form	Media	Daily Volume
a.	Data Files	Index/Abstract	Digital	Disk	31,500 bytes
		DCS	Digital	Mag. Tape	164,000 bytes
		Master Digital Data	Digital	Mag. Tape	14.7 megabytes
		DCP	Digital	Disk	Small
		Production Control	Digital	Disk	6,000 bytes
		Library Index	Digital	Disk	8,000 bytes
b.	Hard Copy	Montage Catalog	Image Mosaic	Film	2 sheets (18 days)
		Abstract Catalog	Alpha-numerics	Paper	Variable
		Maps	Paper	Film	300 (monthly)
c.	Original Data	S/C Telemetry	Analog	MT	20 Tapes
		Ephemeric	Digital	MT	1 Tape
		DCS	Analog	MT	6 Tapes
		RBV Imagery	Analog	VT	4 Tapes
		MSS Imagery	Analog	VT	4 Tapes
d.	Digital Processed Imagery	RBV	Digital	MT	
		MSS	Digital	MT	

Data Category	Data Item	Original Form	Media	Daily Volume	
e. User Requested Data	Precision RBV	Digital	MT	A - 9 frames	
	Precision MSS	Digital	MT	A - 13 frames	
	Digitized RBV	Digital	MT	A - 2 frames	
	Digitized MSS	Digital	MT	A - 13 frames	
f. Imagery				ERTS A Case A	ERTS B Case B
Bulk	RBV	BW Image	Film	189	495
	MSS	BW Image	Film	252	825
Bulk Corrected	RBV	BW Image	Film	189	495
	MSS	BW Image	Film	252	825
	RBV Composite	Color Image	Film	13	33
	MSS Composite	Color Image	Film	26	66
g. Analog	RBV	BW Image	Film	9	25
	MSS	BW Image	Film	12	41
	RBV Composite	Color Image	Film	3	8
	MSS Composite	Color Image	Film	6	16

Data Category	Data Item	Original Form	Media	Daily Volume	
				ERTS A Case A	ERTS B Case B
h. Digital Precision	RBV	BW Image	Film	9	25
	MSS	BW Image	Film	12	41
	RBV Composite	Color Image	Film	3	8
	MSS Composite	Color Image	Film	6	16

3.3.3.3.2 Archive Library Data. The Archive Library data shall include the following data:

	Data Catalog	Data Item	Original Form	Media	Volume/Period Per Day
a.	Data Files	Index/Abstract	Digital	H.D.H.C. MT	ERTS B, Case B, Vol = 115,500 bytes/day
		DCS	Digital	H.D.H.C. MT	ERTS B, Case B, Vol = 820,000 bytes/day
		Master Digital Data	Digital	H.D.H.C. MT	
		Attitude History	Digital	MT	Recopy cycle of archive tapes will be based on results of test tape checks
b.	Hard Copy	Montage Catalog	Image	Film	Bind into 1 volume yearly
		Abstract Catalog			
		Maps			Maps will be on film
c.	Original Data	S/C Telemetry			Data in Master Digital Data File
		Ephemeris			Data in MDD and Attitude History Files
		DCS			Data in DCS File
d.	Digital Processed Imagery	RBV	Digital	HD, HC, MT	Case A-315 frames/day Case B-1315 frames/day
		MSS	Digital	HD, HC, MT	
e.	User Required Data	Precision RBV			Case B, ERTS B 25 frames/day
		Precision MSS			Case B, ERTS B 41 frames/day
		Digitized RBV			Case B, ERTS B 5 frames/day
		Digitized MSS			Case B, ERTS B 41 frames/day

	Data Catalog	Data Item	Original Form	Media	Volume/Period Per Day
f.	Imagery Bulk	RBV			Destroy if all frames are bulk corrected.
		MSS			
	Bulk Corrected	RBV	BW Image	Film	Master is second generation positive.
		MSS	BW Image	Film	Master is second generation positive.
		RBV Composite	Color Image	Film	Master is second generation positive.
		MSS Composite	Color Image	Film	Master is second generation positive.
	Analog Precision	RBV	BW Image	Film	Master is second generation positive.
		MSS	BW Image	Film	Master is second generation positive.
		RBV Composite	Color Image	Film	Master is second generation positive.
		MSS Composite	Color Image	Film	Master is second generation positive.
	Digital Precision	RBV	BW Image	Film	Master is first generation positive.
		RBV Composite	Color Image	Film	Master is third generation negative.
		MSS Composite	Color Image	Film	Master is third generation negative.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection and Test. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all test requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to TRW Systems. TRW Systems reserve the right to perform any of the tests set forth in this specification when such tests are necessary to assure that supplies and services conform to prescribed requirements.

4.2 Inspection. Inspection of this item shall be accomplished in accordance with PAR 700-55 of TRW Systems Group Quality requirements.

4.3 Acceptance Tests. Acceptance tests shall be as specified in the individual configured item specifications. Subsystem testing shall be accomplished to verify the requirements of Section 3, herein.

4.4 Test Conditions. Test conditions for conducting the examinations and tests described herein shall be as defined in the applicable test specification

4.5 Rejection and Retest. If a failure, malfunction or out of tolerance performance degradation occurs during or after a test, testing shall be discontinued until the failure, malfunction, or out of tolerance condition (including design defects) is corrected. The pertinent test procedure shall be repeated until completed successfully. If the corrective action substantially affects the significance of results of previously completed tests, such tests shall also be repeated.

5. PREPARATION FOR DELIVERY

The equipment shall be packaged in accordance with commercial practices which will guarantee adequate protection against corrosion, deterioration and physical damage during direct shipment to TRW.

6. NOTES

(Not Applicable)

10. APPENDIX

(Not applicable)

TRW
SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

CODE IDENT 11982

TITLE

SUBSYSTEM SPECIFICATION

GROUND DATA HANDLING SYSTEM PERSONNEL

ERTS

DATE 4/1/70 NO. D-13701

SUPERSEDING: _____

_____

PREPARED BY: _____

APPROVAL SIGNATURES:

_____ DATE

W W Ryan 4/1/70 DATE

_____ DATE

R. Mordaunt 4-1-70 DATE

_____ DATE

R. Graves DATE

SPEC NO. D-13701

TRW
SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH CALIFORNIA

AS OF 4/1/70
SUPERSEDING

SPECIFICATION CHANGE RECORD

SCN/REV	SCN/SPEC DATE	AUTHORIZATION		PRODUCTION EFFECTIVITY	PAGES AFFECTED
		ECP/CCN	OTHER		

SYSTEMS 1393 REV 11-67

(FILE DIRECTLY AFTER COVER SHEET)

SUBSYSTEM SPECIFICATION
GROUND DATA HANDLING SYSTEM PERSONNEL

1. SCOPE

1.1 Scope. This specification establishes the requirements for staffing the Earth Resources Technology Satellite Ground Data Handling System to include both the Operation Control Center and the NASA Data Processing Facility. It covers qualitative and quantitative requirements for position manning by organization functional elements, selection and training of personnel, and operation and maintenance manual requirements.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the exact issue shown, form part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detail content of Sections 3, 4, and 5, the detail requirements of Section 3, 4, and 5, shall be considered superseding requirements. For TRW Systems documents, the latest issue shall apply.

SPECIFICATIONS

TRW Systems Group

D-00001	Technical Manual Preparation Guide

OTHER PUBLICATIONS

TRW Systems Group

EBC-G085	ERTS Functional Requirements Analysis for ERTS Operations Control and Data Processing, Volume 1, Functional Flow Diagrams
EBC-G086	ERTS Functional Requirements Analysis for ERTS Operations Control and Data Processing, Volume 2, Requirements Allocation Sheets
	GDHS Staffing and Material Usage Plan

3. REQUIREMENTS

3.1 Performance. GDHS personnel shall be selected and trained to be capable of performing the following general duties encompassing tasks described in TRW Document EBC-G086, ERTS Functional Requirements Analysis for ERTS Operations Control and Data Processing, Volume 3, Requirements Allocation Sheets.

a) Planning observatory missions.

b) Commanding and controlling the observatory orbital operations.

c) Diagnosing observatory performance anomalies and instituting contingency procedures.

d) Processing user queries and producing standard and special reports based upon available ERTS data.

e) Performing computer operations in support of ERTS satellite operations control and data processing.

f) Performing imagery and photo processing to produce bulk and precision imagery from ERTS generated digital data tapes.

g) Maintaining electronic, electro-mechanical and optical equipments to the level of on-line replaceable units and repairing equipment components which require only routine disassembly and reassembly to replace failed equipment items.

3.2 Organization. GDHS organization is displayed as follows:

3.2.1 Top-level organization is shown in Figure 1.

3.2.2 Operations Control Center organization shall be as shown in Figure 2.

3.2.3 The organization of the NASA Data Processing Facility shall be as shown in Figure 3.

3.3 Manning.

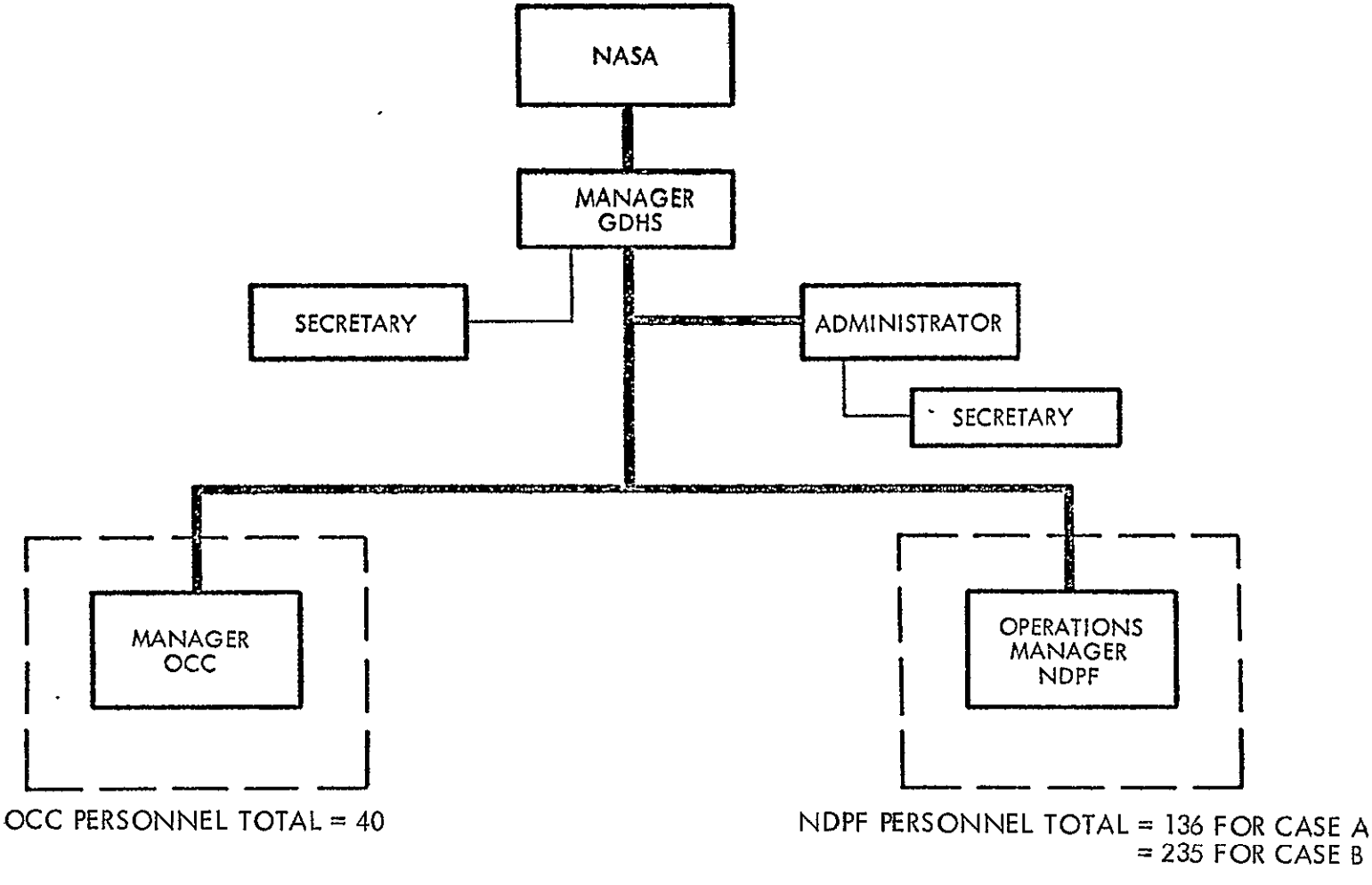

Figure 1. GDHS Top Level Organization Chart

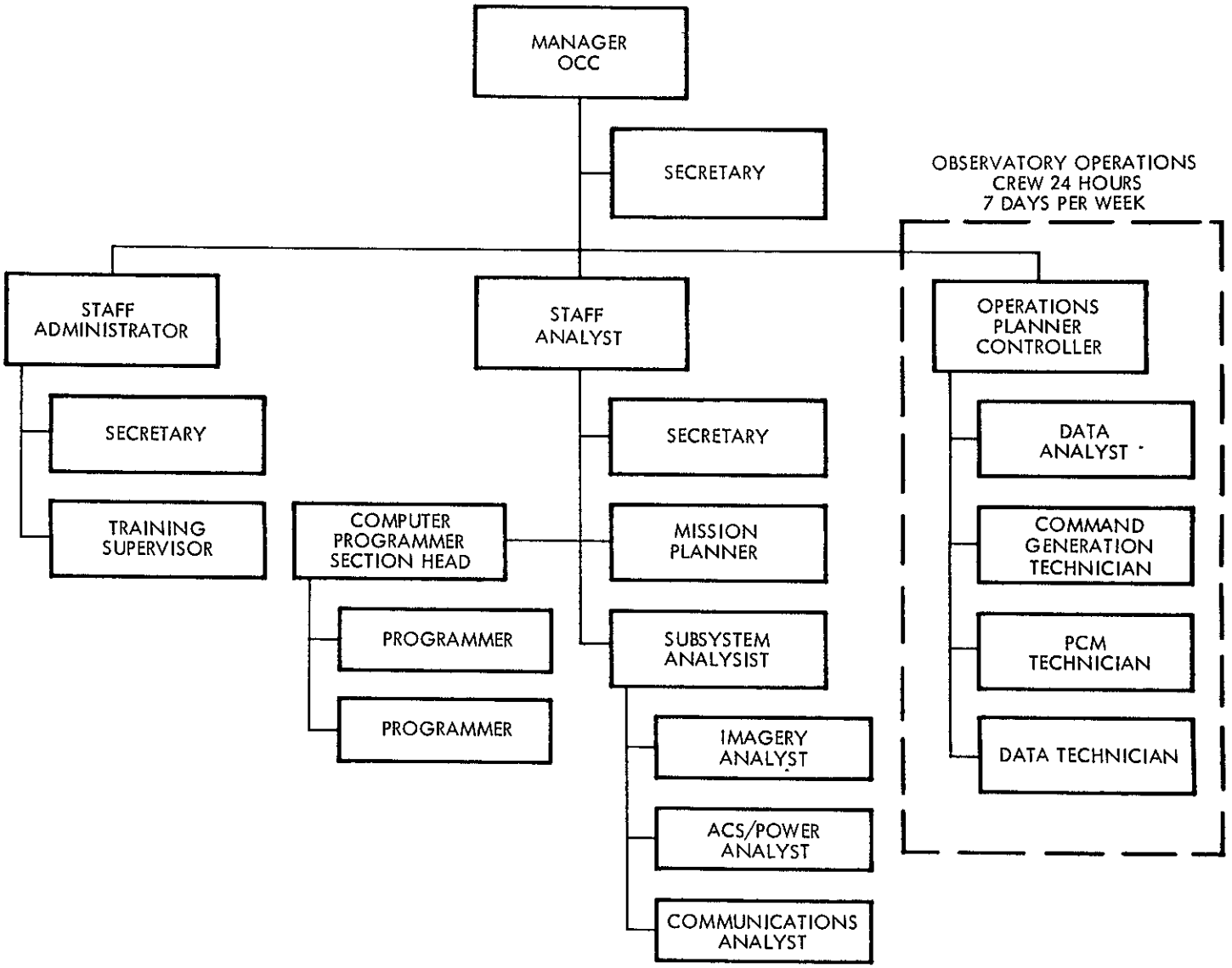

Figure 2. OCC Organization Chart

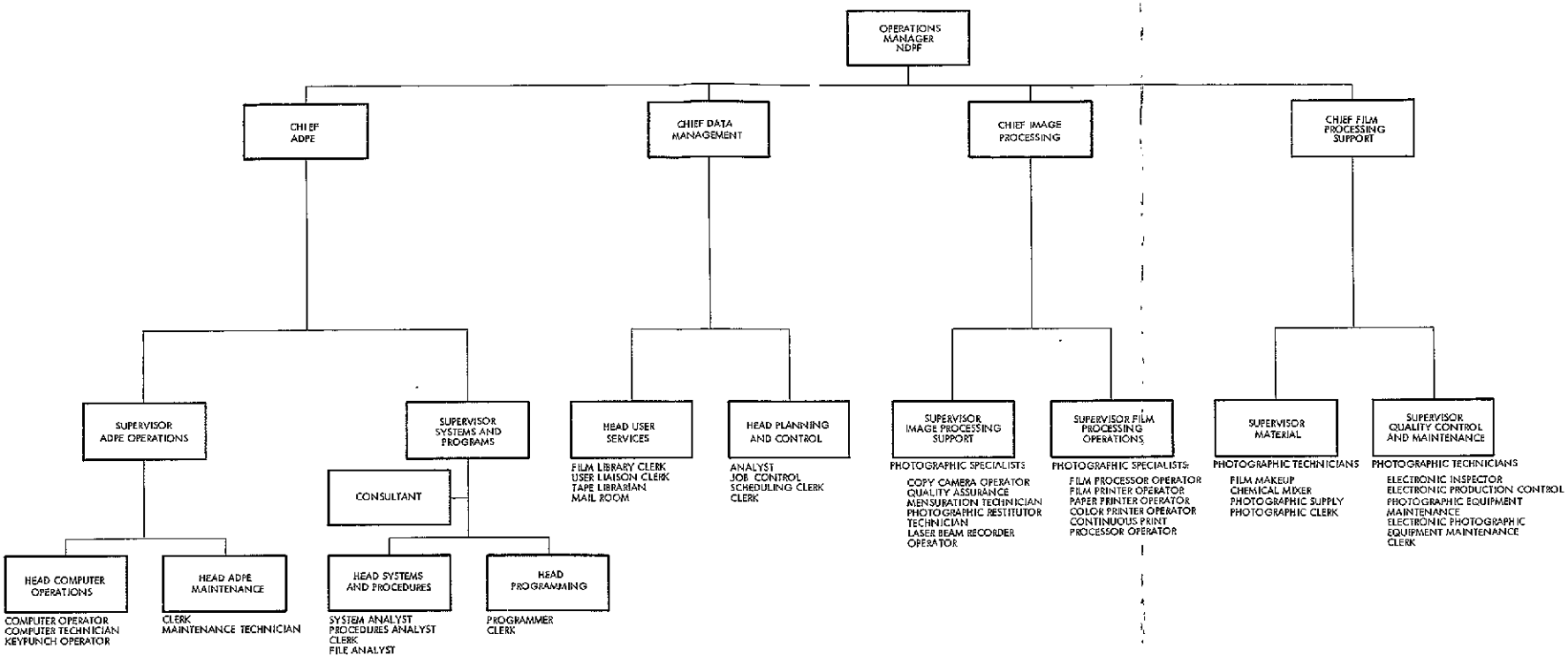

Figure 3. NDPF Organization Chart

FOLDOUT FRAME 1

FOLDOUT FRAME 2

3.3 Manning.

3.3.1 The total manning for the GDHS is 180 personnel for Case A and 279 for Case B. These totals are summarized as follows:

	Number of Personnel	
	Case A	Case B
GDHS Manager and Staff	4	4
OCC Manager and Personnel	40	40
NDPF Manager and Personnel	136	235
TOTAL	180	279

3.3.2 The manning requirements for the Operations Control Center shall be as shown in Table 1.

3.3.3 The manning requirements for the NASA Data Processing Facility shall be as shown in Table 2.

TABLE 1

OCC MANNING REQUIREMENTS

Position	Total No. of Personnel Required	Personnel Type
8 Hrs/day, 5 days/week		
Manager OCC	1	Engineer
Secretary	1	Secretary
Staff Analyst	1	Engineer
Secretary	1	Secretary
Staff Administrator	1	Administrator
Mission Planner	1	Engineer
Training Supervisor	1	Engineer
Computer Applications	1	Engineer
Subsystem Analyst	1	Engineer
Imagery Analyst	1	Engineer
ACS/Power Analyst	1	Engineer
Communications Analyst	1	Engineer
Computer Programmer Section Head	1	Engineer
Programmer	1	Technician
Programmer	1	Technician
24 Hrs/day, 7 days/week		
Data Analyst	5	Engineer
Operations Planner Controller	5	Engineer
PCM Technician	5	Technician
Command Generation Technician	5	Technician
Data Technician	5	Technician
TOTAL	40	

TABLE 2

NDPF MANNING REQUIREMENTS

Position	Personnel Type	Number of Personnel
8 Hrs/day, 5 days/week		
Operations Manager, NDPF	Operations Mgr. NDPF	1
Chief, Film Processing Support	Senior Photo Specialist	1
Supervisor, Qual Control and Maint.	Photo Specialist	1
Photo Inspector	Photo Technician	2
Photo Production Control	Photo Technician	2
Photo Equipment Maintenance	Photo Technician	2
Electronic Photo Equip. Maint.	Photo Technician	2
Clerk	Clerk, General	3
Supervisor, Material	Photo Specialist	1
Film Makeup	Photo Technician	3
Chemical Mixer	Photo Technician	2
Photo Supply	Photo Technician	3
Photo Clerk	Photo Technician	2
Chief, Image Processing	Senior Photo Specialist	1
Supervisor, Film Processing Operations	Photo Specialist	1
Film Processor Operator	Photo Specialist	3
Film Printer Operator	Photo Specialist	2
Paper Printer Operator	Photo Specialist	4
Color Printer Operator	Photo Specialist	3
Supervisor, Image Processing Support	Photo Specialist	1
Copy Camera Operator	Photo Specialist	1
Quality Assurance	Photo Specialist	2
Mensuration Technician	Mensuration Technician	1
Photo Restitutor Technician	Photo Restitutor Tech.	1
Laser Beam Recorder Operator	LBR Operator	1

TABLE 2

NDPF MANNING REQUIREMENTS (CONTINUED)

Position	Personnel Type	Number of Personnel
Chief, Data Management	Chief, Data Mgt.	1
Head, User Services	Head, User Services	1
Library Clerk	Library Clerk	2
User Liaison Clerk	Clerk, User Liaison	1
Clerk	Clerk, General	1
Tape Librarian	Clerk, General	2
Clerk, Mail Room	Clerk, General	2
Head, Planning and Control	Head, Planning & Control	1
Scheduling	Clerk, General	3
Job Control	Clerk, General	2
Analyst	Analyst	4
Chief, ADPE	Chief, ADPE	1
Supervisor, Systems & Programs	Supvr, Sys. & Programs	1
Consultant	Consultant	1
Head, Programming	Head, Programming	1
Programmer	Programming Analyst	8
Clerk	Clerk, General	1
Head, Systems and Procedures	Head, Sys. & Procedures	1
System Analyst	System Analyst	5
Procedures Analyst	Procedures Analyst	5
File Analyst	File Analyst	4
Clerk	Clerk, General	2
Head, ADPE Maintenance	Head, ADPE Maintenance	1
Head, Computer Operations	Head, Computer Operations	5
Computer Operator*	Computer Operator	20
Computer Technician**	Computer Technician	5
Keypunch Operator	Keypunch Operator	2
Maintenance Technician***	Maintenance Technician	6
Supervisor, ADPE Operations	Supervisor, ADPE Operations	1

* 4 per shift, 24 hours/day/7 days/week
** 1 per shift, 24 hours/day/7 days/week
*** 2 per first shift, 1 per other shifts, 24 hours/day/7 days/week

3.4 Position Descriptions

3.4.1 Operations Control Center. The principle duties of positions required to staff the Operations Control Center shall be as follows:

a) OCC Manager

1) Responsible for the operation of the OCC and the performance of the operations and support personnel.

2) Plans, supervises and coordinates operations and maintenance activities within the OCC.

3) Represents command and control operations to top ERTS management.

4) Interprets NASA policies and activities for OCC personnel.

5) Determines optimum personnel practices, manpower levels, budget requirements and training programs.

6) Establishes schedules and manning necessary to meet operating requirements and determines alternate sources of action as schedules change.

7) Reviews and approves the OCC daily activities schedule.

b) Staff Analyst

1) Reviews accomplishment of daily schedules and reports deviations.

2) Prepares daily OCC activity schedules.

3) Prepares inputs in the form of prioritized maintenance tasks for inclusion in the OCC daily schedule.

4) Prepare reports.

c) Staff Administrator

1) Insures that administrative requirements of OCC Staff and Operational personnel are satisfied.

2) Prepares required management and administrative reports in conjunction with other staff members.

d) Mission Planner

1) Provide weather predictions to operating personnel.

2) Provide on-the-job training to Operational Planner-Controller for around the clock weather predictions.

3.4.1 (Continued)

3) Generates operating procedures for STADAN stations to support ERTS passes.

4) Establishes schedules of activities required to generate and distribute command lists for each observatory revolution.

5) Establishes schedules and manning necessary to meet operating requirements, and determines alternate courses of action as schedules change.

6) Reviews the OCC Daily Schedule in order to determine position related assignments.

7) Provides master schedule, long term planning; coordinates with all shifts to insure continuity of operations.

8) Prepares reports.

e) Training Supervisor

1) Provides simulated training exercises to newly assigned OCC personnel utilizing script material and as hardware and software become available (2 months before launch), utilize the CRTS for presented simulated magnetic tape exercises.

2) Train all personnel including NASA and TRW.

3) Coordinate with Operations Controller, Planners and Systems Analysts in obtaining training material and teaching assistance.

4) Provide refresher training to experienced personnel and/or cross training in the case of equipment procedures.

f) Secretary

1) Provide clerical/secretarial support as required.

2) Type technical and administrative reports.

g) Subsystem Analysts (Imagery, ACS/Power, Communications)

1) Review pass schedule for RBV operating times.

2) Receives RBV video data and selects 1 of 3 video signals for display.

3.4.1 (Continued)

3) Evaluate RBV sensor performance. Examine video images for quality and cloud cover. Confirm basic data quality.

4) Evaluate mission performance. Compare sensor coverage against effected coverage.

5) Analyze subsystem telemetry data and evaluate for impact upon sensor performance.

6) Specify corrective measures. Determine actions required to improve image quality.

7) Add annotation comments to video data.

8) Generate quick-look report including unfulfilled sensor coverage report.

h) Computer Programmer

1) Maintainsall OCC applications programs.

2) Coordinates work with NDPF Programming Head.

3) Writes programs, routines, and prepares flow charts and diagrams as required.

4) Checks equipment and performs readiness tests to insure OCC data processing and display equipment are in an operational mode.

5) Assists Training Supervisor during simulated training sessions. Operate tape decks and insure equipment is operating properly.

i) Operations Planner Controller

1) Coordinate OCC activities.

2) Coordinate station support schedule with OPSCON.

3) Coordinate the establishment of voice and data links required for ERTS operations.

4) Communicates with STADAN stations during pre-pass activities.

5) Requests orbital data, weather data, STADAN/MSFN support.

6) Forward messages and instructions necessary to support ERTS passes to STADAN/MSFN stations.

7) Verifies receipt of command messages by STADAN/MSFN.

3.4.1 (Continued)

8) Review assignment of observatory acquisition opportunity versus users requests.

9) Review observatory command list; insure compatibility with observatory status, orbit corrections required, user requirements, observatory. Predicts track, power budgets, and weather data.

10) Review support schedule.

11) Monitor observatory command status.

12) Monitor stored command programmer status/contents.

13) Check observatory command sequence against event and resolved conflicts.

14) Transmit commands to spacecraft as required.

15) Review observatory command history.

16) Checks observatory telemetry for parameter values and equipment status changes associated with verification of command execution.

17) Reviews and modifies command lists for each observatory review.

18) Provide weather predictions on a periodic basis.

19) Perform long term trend analysis in office space, on time available basis.

j) Data Analyst

1) Monitor and evaluate current observatory and sensor health.

2) Perform trend analysis on required observatory and payload data.

3) Perform subsystem engineering utilizing CRTS/strip charts.

4) Recommend corrective action to improve observatory and payload performance.

5) Maintain history of utilization of critical observatory and payload items.

6) Perform long term trend analysis in office space, on time available basis.

3.4.1 (Continued)

k) PCM Technician (M&O)

1) Maintains and operates PCM tape recorders, PCM DHE, and strip chart recorders, scopes.

2) Implements requested strip chart and tape recorder channel assignments and prepares an updated list of channel allocations.

3) Configures and monitors telemetry DHE prior to pass related activities.

4) Labels, packages and stores tape and strip chart recorder outputs.

l) Command Generation Technician

1) Monitor command encoder.

2) Compare systems analyst requests against payload and observatory status to maintain observatory continuity.

3) Input item #1 to computer; computer will fit in request with payload event list.

4) Review computer generated event list for:

a. Accuracy.

b. Conflicts.

c. Additions, deletions.

5) Review SCP preliminary command sequence, command history.

6) Communicates with NDPF user.

m) Data Technician

1) Reviews ephemeris and orbit data versus station pass time.

2) Prepares and distributes daily OCC time sequence activity to support ERTS operations.

3) Maintains surveillance of OCC consumables.

4) Prepares ground support schedules.

5) Generates station pass check list.

3.4.2 NASA Data Processing Facility. The principle duties of positions required to staff key management and supervisory positions (including GDHS management) on the NASA Data Processing Facility shall be as follows:

3.4.1 (Continued)

a) Manager, GDHS

1) Responsible for the operation of the Ground Data Handling System including the Operations Control Center and the NASA Data Processing Facility.

2) Provides ground system liaison to the ERTS top management team, and with the appropriate NASA agencies.

3) Coordinates and integrates the various activities relating to the ground system.

4) Responsible for budgetary planning, functional management and contract management of the equipment and personnel of the GDHS.

b) Staff Administrator

1) Assures that administrative requirements of the NDPF and OCC Staff and Operational personnel are satisfied.

2) Prepares required management and administrative reports in conjunction with other staff members.

c) Operations Manager, NDPF

1) Responsible for the operation of the Telemetry Image Data Processing activities and the functions of the Data Services Laboratory.

2) Represents NDPF operations to top level ERTS management.

3) Interprets NASA policies and activities for NDPF personnel.

4) Determines optimum personnel practices, manpower levels, budget requirements and training programs.

5) Reviews and approves the NDPF activity schedules.

6) Plans, supervises and coordinates operation of the imagery, photo processing and data services activities.

7) Motivates personnel to the accomplishment of established objectives.

8) Maintains or approves contacts with GSFC offices and agencies.

9) Evaluates imagery, film processing and data services, performance against plans and goals.

10) Determines optimum personnel practices, manpower levels, budget requirements and training programs.

11) Evalutes feasibility of potential applications and approves of the amount and type of equipment required to perform the applications.

3.4.2 (Continued)

d) Secretary

1) Provides secretarial/clerical support as required.

2) Type technical and administrative reports.

e) Chief, Film Processing Support

1) Responsible for establishing the procedures to assure that the products delivered to the user are of uniformly excellent quality.

2) Responsible for the maintenance of the photo and electronic photo equipment required in the TIDP.

3) Responsible for providing the necessary material to the operations department and for supporting the film processing activities.

f) Supervisor, Quality Control and Maintenance

1) Responsible for implementing the quality control program for the film processing activities.

2) Supervise the activities of the quality control inspectors and develop the method of determining that all processes are being conducted in accordance with established standards and specifications.

3) Responsible for the scheduling of all maintenance activities in the TIDP and for assuring that all equipment is in operating condition.

4) Supervise maintenance technicians as shown in Figure 2, and arrange for contracted maintenance assistance as required.

g) Supervisor, Material

1) Supervises the activities of the personnel assigned to the material section.

2) Responsible for all chemical handling processes to assure that procedures are used which do not endanger personnel.

3) Responsible for all supply activities required to support the film processing operations.

4) Responsible for the preparation and implementation of personnel and equipment schedules to provide the necessary materials to the operations section.

5) Supervises personnel as shown in Figure 2.

h) Chief, Imagery Processing

1) Responsible for the operations of the film processing activities in converting the RBV and MSS data into photographs required by the users.

3.4.2 (Continued)

2) Responsible for the personnel assigned to the film processing section to assure that schedules are met.

3) Responsible for the development of the procedures used by the film processing personnel and for the adherence to safe and efficient methods.

i) Supervisor, Film Processing Operations

1) Plans and administers the operation of the activities performed in the film processing department.

2) Maintains efficient utilization of film processing equipment and personnel resources.

3) Establishes schedules to meet operating requirements and determines alternate courses of action as schedules change.

4) Verifies adherence to prescribed operating rules and regulations.

5) Provides supervision and proper training for operating personnel as shown in Figure 2.

6) Evaluates quality of personnel and procedures and makes adjustments.

j) Supervisor, Imagery Processing Support

1) Plans and administers the operation of the activities performed in the film processing support department.

2) Establishes schedules to meet operating requirements.

3) Reviews and establishes prescribed operating rules and regulations and verifies that these are followed by all department personnel.

4) Provides supervision and proper training of personnel as shown in Figure 2.

5) Evaluates quality of personnel and procedures and makes all necessary changes.

k) Chief, Data Management

1) Responsible for the job control activities necessary for the proper handling of all user requests.

2) Responsible for the maintenance and updating of the film library.

3) Responsible for the scheduling of user requests and the satisfaction of user requirements.

4) Supervises the photo handling activities to assure proper forwarding of data to users on a timely basis.

5) Supervises the personnel as shown in Figure 2.

3.4.2 (Continued)

l) Chief, ADPE

1) Plans and administers the operations of the personnel assigned to the ADPE departments.

2) Maintains efficient utilization of computing equipment and personnel resources.

3) Establishes schedules to meet operating requirements, and determines alternate courses of action as schedules change.

4) Verifies adherence to prescribed operating rules and regulations.

5) Determines internal report requirements (for example, machine utilization).

6) Sets acceptance standards for production programs and documentation received from the methods group.

7) Provides proper training for operating personnel.

8) Evaluates quality of personnel and procedures and makes adjustments as necessary.

m) Supervisor, Systems and Programs

1) Interprets broad areas to be investigated, general aims of the methods group, and proves feasibility of application projects.

2) Supervises planning, design, coding and documentation of projects to insure their proper execution.

3) Reviews and coordinates procedures employed in implementing and maintaining the data system and recommends appropriate procedures to support job completion on schedule.

4) Endorses application of the latest machine programming systems and systems techniques.

5) Maintains liaison between methods and each of the operating groups.

n) Head, Programming

1) Plans, schedules and supervises preparation and maintenance of all NDPF applications programs.

2) Assigns, outlines and coordinates work of programmers. (See Figure 2).

3) Trains subordinates to prepare and write programs, routines, flow charts, and diagrams.

4) Reviews, evaluates and reports performance.

5) Collaborates with supervisor of systems and procedures on schedules and NDPF support.

6) Updates and maintains programming systems, and evaluates new programming languages and documentation techniques as they become available.

3.4.2 (Continued)

o) Head, Systems and Procedures

1) Supervises assigned personnel and coordinates work of the analysts. (See Figure 2).

2) Works with the manager of programming to determine project completion dates and personnel requirements.

3) Establishes documentation standards and recommends techniques and methods to secure adequate and consistent documentation.

4) Checks all data generated within his operation for correctness and for adherence to set data formats and editing procedures.

5) Communicates with other departments on NDPF requirements.

6) Prepares Standards instructions on such subjects as record formats, routines, labels audit and machine controls.

p) Supervisor, ADPE Operations

1) Responsible for the operations of the computer equipment and for the personnel assigned to the section.

2) Responsible for the maintenance of the equipment to assure ADPE support of OCC and NDPF activities.

3) Responsible for the scheduling of ADPE personnel and equipment to support the implementation of all operating schedules.

q) Head, ADPE Maintenance

1) Plans, supervises and coordinates the maintenance activities on the automatic data processing equipment in the NDPF.

2) Responsible for maintaining the ADPE in proper operating condition and for the performance of testing necessary to prevent or correct equipment malfunction.

3) Responsible for scheduling the activities of the maintenance technicians of the section. (See Figure 2).

4) Responsible for the coordination of contractor furnished maintenance and the scheduling of maintenance activities.

r) Head, Computer Operations

1) Supervises the operations of the computer room, including computer operators and keypunch operators. (See Figure 2)

2) Communicates with other departments on NDPF requirements.

3) Trains subordinates in computer room operations.

4) Supports both OCC and TIDP personnel as necessary in the performance of their duties.

3.5 Training Requirements

3.5.1 Training Program. A training program shall be developed and implemented for Contractor/NASA personnel who will operate and maintain the GDHS equipment at GSFC. The major phases of the Training Program shall be as follows and will occur, in general, in the sequence listed:

a) Develop detailed GDHS position descriptions.
b) Conduct personnel selection process.
c) Perform detailed training requirements analysis.
d) Accomplish tutorial training.
e) Provide work experience learning activity.
f) Conduct classroom (theory) training.
g) Conduct on-the-job training (OJT).

3.5.1.1 Position Description Drafting. Detailed GDHS position descriptions shall furnish the basis for that part of the training requirements analysis which deals with the operational and maintenance requirements as defined in TRW Document EBC-G086, ERTS Functional Requirements Analysis for ERTS Operations Control and Data Processing. Associated with each of the position descriptions will be experience prerequisites which will provide basic guidelines for the initial evaluation of candidate suitability.

3.5.1.2 Personnel Selection Process. TRW project management shall make the selection of candidates deemed qualified (through past experience and future training) to assume specific M&O positions as identified herein.

3.5.1.3 Training Requirements Analysis. The training requirements analysis shall involve the analysis of what each position requires for satisfactory performance in support of allocated operations and maintenance functions and will be employed to evaluate the skills and knowledge of personnel selected to fill the various positions specified herein. Individual training requirements shall be determined on the basis of comparing individual skills and knowledges with position task requirements.

3.5.1.4 Tutorial Training. Individualized training packages shall be developed and updated as required for each individual selected to fill given GDHS positions as defined herein.

3.5.1.5 Work Experience Training. Each GDHS staff specialist, initially, shall be assigned to such special work assignments as shall best meet the individual's learning needs for undertaking his designated GDHS position assignment.

3.5.1.6 Classroom Training. Formal classroom training shall be conducted as necessary to properly prepare GDHS personnel to operate and maintain OCC and NDPF equipment.

3.5.1.7 On-The-Job Training (OJT). The final phase of the training program shall involve OJT activity to provide personnel with instruction on actual hardware. The first part of OJT shall be concerned with position training for crew members that interface with operating station consoles. The second part of OJT shall be concerned with team training where the total crew performs exercises/scenarios in preparation for launch readiness activity. The position/team training shall encompass all aspects of ERTS operations including prelaunch, initial, orbit, and routine on-orbit operations.

3.5.2 Training Aids. Training aids shall include course outlines, lesson plans, technical manuals, position manuals, graphic aids, deliverable equipment, and guides to engineering documentation. No special training equipment or computer software programs will be developed.

3.6 Technical Manual Requirements

3.6.1 General. Technical manuals shall be generated to support GDHS operation and maintenance in accordance with TRW Systems Group Document, D-00001, Technical Manual Preparation Guide. Preliminary copies of the manuals shall be available in sufficient time to support GDHS compatibility testing and training activities. The preliminary copies of the manuals shall be updated during the compatibility testing period to reflect any changes made to equipment prior to launch and to incorporate any field feedback comments. Final copies of the manuals shall be furnished to NASA at the time of equipment turnover.

3.6.2 Types of Manuals. The following types of manuals shall be required to support the GDHS operation and maintenance, and training activities:

a) Subsystem Manuals.
b) Equipment Maintenance Manuals.
c) Position Checklists.
d) Software Operations Manual.

3.6.2.1.1 Subsystem Manuals. Subsystem manuals shall be furnished for the OCC and NDPF subsystems of the GDHS. The subsystem manuals shall tie in the operation and maintenance of all the units comprising a subsystem from a total system viewpoint.

3.6.2.2 Maintenance Manuals. Maintenance manuals shall be furnished for all drawer/unit equipment requiring periodic/corrective maintenance at GDHS facility. Commercial manuals on maintenance of off-the-shelf equipment shall be provided where they meet the intent and purpose of this specification.

3.6.2.3 Position Checklist. The position checklists shall be used by ground station operations during ERTS operations. Each checklist shall be designed to a particular position (ground station operation) and shall specifically instruct the operator in regard to what tasks he is to accomplish and their time sequencing during all ERTS mission operations (prelaunch, initial operations, routine operations). Each position checklist shall be keyed to a particular position manual which describes how to accomplish the tasks contained in the checklist.

3.6.2.4 Software Operations Manual. The software operations manual shall contain a complete description of the ADPE man-machine interface in the GDHS. It shall contain philosophy and details concerning usage of the ADPE computer program subsystem, interpretation of output, and

the operator interface functions for both the OCC and the NDPF. Since the manual addresses operational timelines and operator interface, it shall be used by GDHS operations personnel in support of training and planning.

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection and Test

4.1.1 Training. The performance of all operations and maintenance personnel shall be monitored throughout the training program.

4.1.1.1 Classroom Training. During formal classroom courses examinations will be given to monitor student progress and areas of weakness. These may be in the form of daily quizzes, laboratory worksheet problems, or formal course examinations. Students will be evaluated and class performance will be monitored as a means of determining individual and class comprehension or areas requiring additional emphasis.

4.1.1.2 On-the-Job Training. Since performance on the job is paramount, the contractor shall provide quality assurance of the training program by measuring its results in terms of job performance. This will require setting up performance testing procedures. Students' assimilation of material and understanding of their console position will be determined from evaluation of student response and progress in comparison with peers. Students who do not demonstrate acceptable progress will be given additional assistance in the form of tutorial or specialized guidance, or will be replaced.

4.1.2 Technical Manuals. The contractor shall verify the accuracy of all manuals produced or provided as commercial manuals for off-the-shelf equipment items prior to GDHS turnover.

5. PREPARATION FOR DELIVERY

Technical manuals, other than commercially procured manuals, shall be delivered as final typed copy with finished illustrations.

6. NOTES

(Not applicable)

10. APPENDIX

TRW Systems Group, D00001, Technical Manual Preparation Guide.

Commercial-Quality Technical Manual Preparation Guide

This document has been checked for technical content and is complete and accurate as of the date of publication.

Prepared by: Frank V. Hale, Jr. Date: March 14, 1967

Approved by: J. A. Griswold Date: March 14, 1967
Technical Publications and Training Dept.
Product Support and Logistics Laboratory

TRW SYSTEMS
ONE SPACE PARK · REDONDO BEACH CALIFORNIA 90278

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES, DESTROY SUPERSEDED PAGES

NOTE, The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page

Page No.	Issue
Title	Original
A	Original
i thru iv	Original
1-1	Original
1-2 Blank	Original
2-1 thru 2-2	Original
3-1 thru 3-21	Original
3-22 Blank	Original
4-1 thru 4-6	Original
5-1 thru 5-19	Original
5-20 Blank	Original
6-1	Original
6-2 Blank	Original

*The asterisk indicates pages changed, added, or deleted by the current change

TABLE OF CONTENTS

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LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I

INTRODUCTION

1-1. SCOPE AND PURPOSE.

1-2. This document provides content, format, and procedural instructions that shall be followed when preparing commercial manuals for TRW Systems. These instructions shall be used by TRW Systems and its vendors as the governing specification for the preparation of support data in the form of commercial-quality technical manuals whenever no other specification is cited by the applicable contract.

1-3. COMPLEX AND INTERRELATED EQUIPMENT.

1-4. A commercial manual shall be prepared for each major end item of equipment (including supporting special-purpose test and maintenance equipment) for which installation, operation, checkout, or maintenance instructions are required. When an end item consists of several complex components, or auxiliary equipment is required for use with an end item that is common to two or more end items, separate manuals may be prepared for such components or auxiliary equipment. When separate manuals are prepared for these types of components or auxiliary equipment, the commercial manual covering the major end item shall contain appropriate references to the supporting commercial manuals on components or auxiliary equipment.

SECTION II

REQUIRED DATA SUBMITTALS

2-1. TYPES OF DATA

2-2. Three different types of data submittals are required for each commercial manual prepared: an outline, a draft copy; and the final, finished manual. Each of these data submittals is subject to the review, acceptance, and written approval of TRW Systems.

2-3. OUTLINE.

2-4. An outline of each proposed commercial manual shall be prepared and submitted to TRW Systems for approval. This outline shall list the proposed manual coverage by section number and title, first and second order (as a minimum) paragraph numbers and titles within each section, figure number and title of each illustration proposed within each section, and table number and title of each grouping of tabular material proposed within each section. This outline shall be prepared with sufficient forethought and division to serve as a preliminary table of contents, list of illustrations, and list of tables for the proposed commercial manual. In addition, each entry in the outline (paragraph, figure, and table) shall be followed by a brief description of the information proposed for inclusion at that point in the commercial manual.

2-5. DRAFT COPY

2-6. A draft copy of each commercial manual shall be prepared based on the contents of the approved outline, and shall be submitted to TRW Systems for approval prior to starting preparation of the final, finished manual. The draft copy shall contain all text, tables, and figures intended for inclusion in the final, finished manual. This draft copy shall be 100-percent complete (including the table of contents, list of illustrations, and list of tables preceding Section I); shall contain copies of all illustrations reduced to final size and integrated within the draft copy approximately where they will appear in the final, finished manual, and shall be prepared to comply with all content, illustration, style, format, and quality assurance requirements of this document

2-7. FINAL, FINISHED MANUAL

2-8. The final, finished manual shall be prepared based on the contents of the approved draft copy. The final reproducible copy for each commercial manual shall be prepared in accordance with all requirements of this document Contractual acceptance of the final commercial manual is contingent upon review and written approval of that document by TRW Systems. The originals of all final typed copy and finished illustrations prepared for and/or included in the final commercial manual shall automatically become the property of TRW Systems. These originals shall be retained and safeguarded by the preparing vendor for purposes of revision until such time as they are called for by TRW Systems.

2-9. REPRODUCTION REQUIREMENTS.

2-10. The required number of copies per reproduction process (printed, Ozalid, reproducible, etc.) and the reproduction format (one-side or two-side printed) for each data submittal shall be as specified in the applicable contract.

SECTION III

DETAILED CONTENT REQUIREMENTS

3-1. MAJOR DIVISIONS OF MANUAL

3-2. Each commercial manual shall be separated into the following major divisions and presented in the sequence shown. Each division will be titled as indicated, and shall comply with the overall coverage requirements, as a minimum, cited in the paragraph referenced after each division.

	TITLE PAGE (para 3-5)
	LIST OF EFFECTIVE PAGES (para 3-5)
	TABLE OF CONTENTS (para 3-7)
	LIST OF ILLUSTRATIONS (para 3-7)
	LIST OF TABLES (para 3-7)
SECTION I	GENERAL DESCRIPTION (para 3-9)
SECTION II	THEORY OF OPERATION (para 3-12)
SECTION III	PREPARATION FOR USE (para 3-15)
SECTION IV	TEST EQUIPMENT AND SPECIAL TOOLS (para 3-18)
SECTION V	CHECKOUT AND OPERATION (para 3-20)
SECTION VI	PREVENTIVE MAINTENANCE AND CALIBRATION (para 3-25)
SECTION VII	CORRECTIVE MAINTENANCE DATA (para 3-28)
SECTION VIII	PARTS LIST (para 3-33)

3-3. DEPTH OF COVERAGE.

3-4. The minimum acceptable information within each major division of the commercial manual is specified in the following subparagraphs. If specific topics of information are not applicable to the equipment being documented they may be deleted; conversely, if topics of information not specified below are considered desirous or mandatory to fully understanding the equipment being documented they shall be added to the applicable major division. If sections are added or deleted the remaining sections shall be renumbered accordingly.

3-5. TITLE PAGE AND LIST OF EFFECTIVE PAGES.

3-6. A commercial manual title page and list of effective pages shall comply with the content and format requirements of figures 3-1 and 3-2, respectively If a document control number is assigned to the commercial manual, either at the request of TRW Systems or at the discretion of the preparing vendor, this number shall appear in the upper, right-hand corner of the title page as shown on figure 3-1 and be centered at the top of the list of effective pages as shown on figure 3-2.

3-7. FRONT MATTER.

3-8. The table of contents, list of illustrations, and list of tables for each commercial manual shall comply with the layout and format of figures 3-3, 3-4, 3-5, respectively. Information listed within the table of contents shall consist of all section numbers and titles, all first and second order paragraph numbers and titles within each section, and the page number on which each first and second order paragraph begins. The list of illustrations shall contain the section numbers and titles in which figures appear, the figure numbers and titles that appear within each section, and the page number on which each figure begins. The list of tables shall contain the section numbers and titles in which tables appear, the table numbers and titles that appear within each section, and the page number on which each tables begins. If a document control number is assigned to the commercial manual, this number shall appear centered at the top of each page of the front matter as shown on figures 3-3 through 3-5.

3-9. GENERAL DESCRIPTION

3-10. This section shall provide operation and maintenance personnel with sufficient general background information to enable them to understand the primary purpose and use of the equipment, and its basic functions and operation. The following types of information, as applicable to the specific equipment, shall be presented in this section in the order listed: (1) scope of the material presented within the commercial manual; (2) general function and use of the equipment; (3) leading particulars (as shown by the format sample of table 3-1) including principle features and characteristics such as dimensions, weight, speed, capacity, inputs, outputs, working voltages, working pressures, etc; (4) general physical description of the equipment and its major assemblies; (5) general functional description of the equipment as a whole, of the major assemblies, of the interrelationship between the major assemblies, and of any relationship between the overall equipment and auxiliary or interconnecting equipment; (6) differences between models; and (7) a glossary of new or unusual words and terms used in the commercial manual.

3-11. The information presented in this section shall be sufficient to portray a fundamental understanding of the equipment, its intended use, operation, function, and limitations; and shall be presented at such a level as to be readily understood by personnel untrained in this equipment. This section shall also contain sufficient equipment illustrations to portray to the reader a true sense of the equipment configuration. A list of equipment supplied, stating the nomenclature, part number manufacturer, and quantity of overall equipment and major assemblies comprising this equipment, shall be included in this section at the beginning of the physical description. In addition, if auxiliary equipment is required for normal operation that is not covered in detail by this commercial manual, a list of the nomenclature,

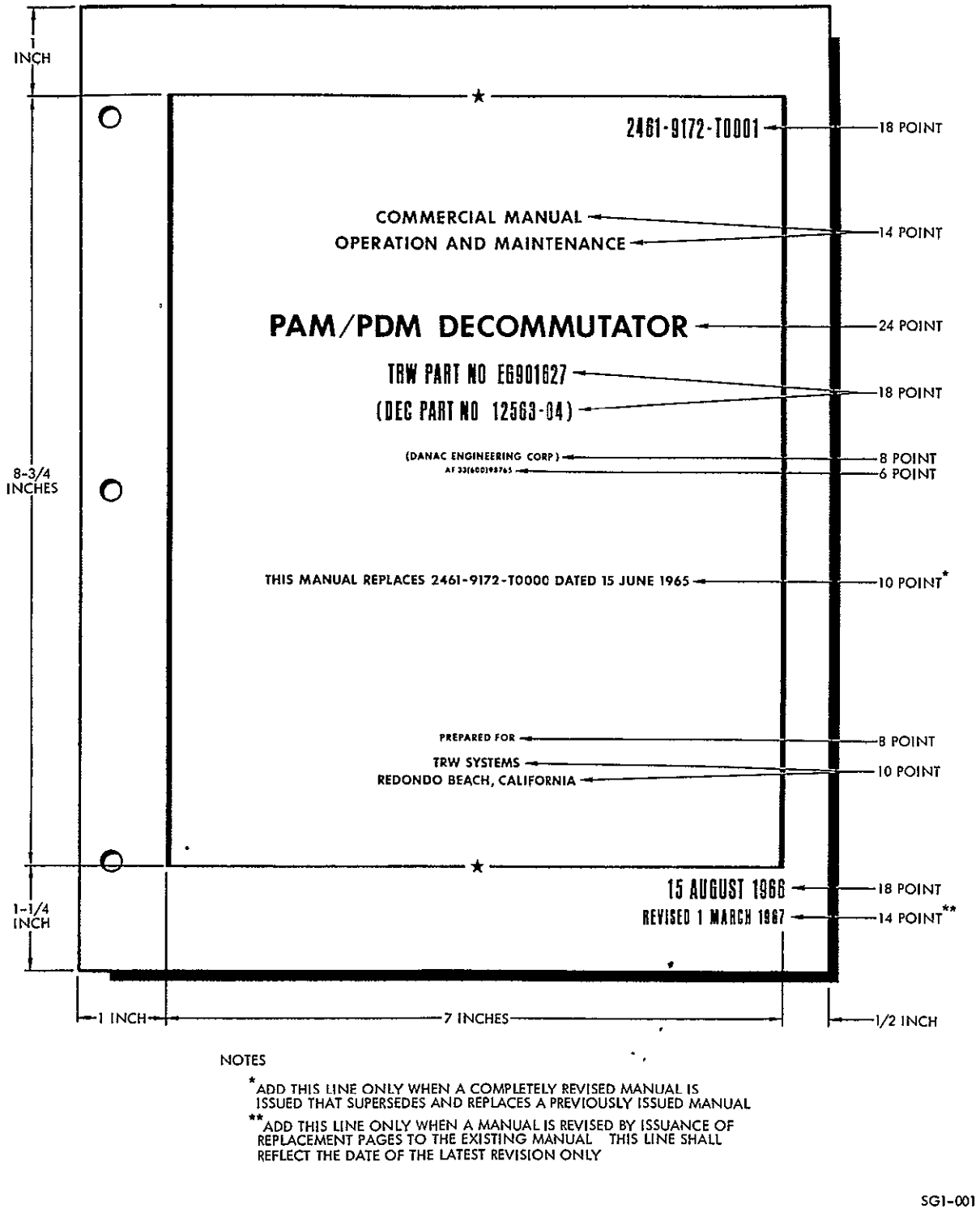


Figure 3-1. Basic Title Page (Reduced) with Revision Title Page Options

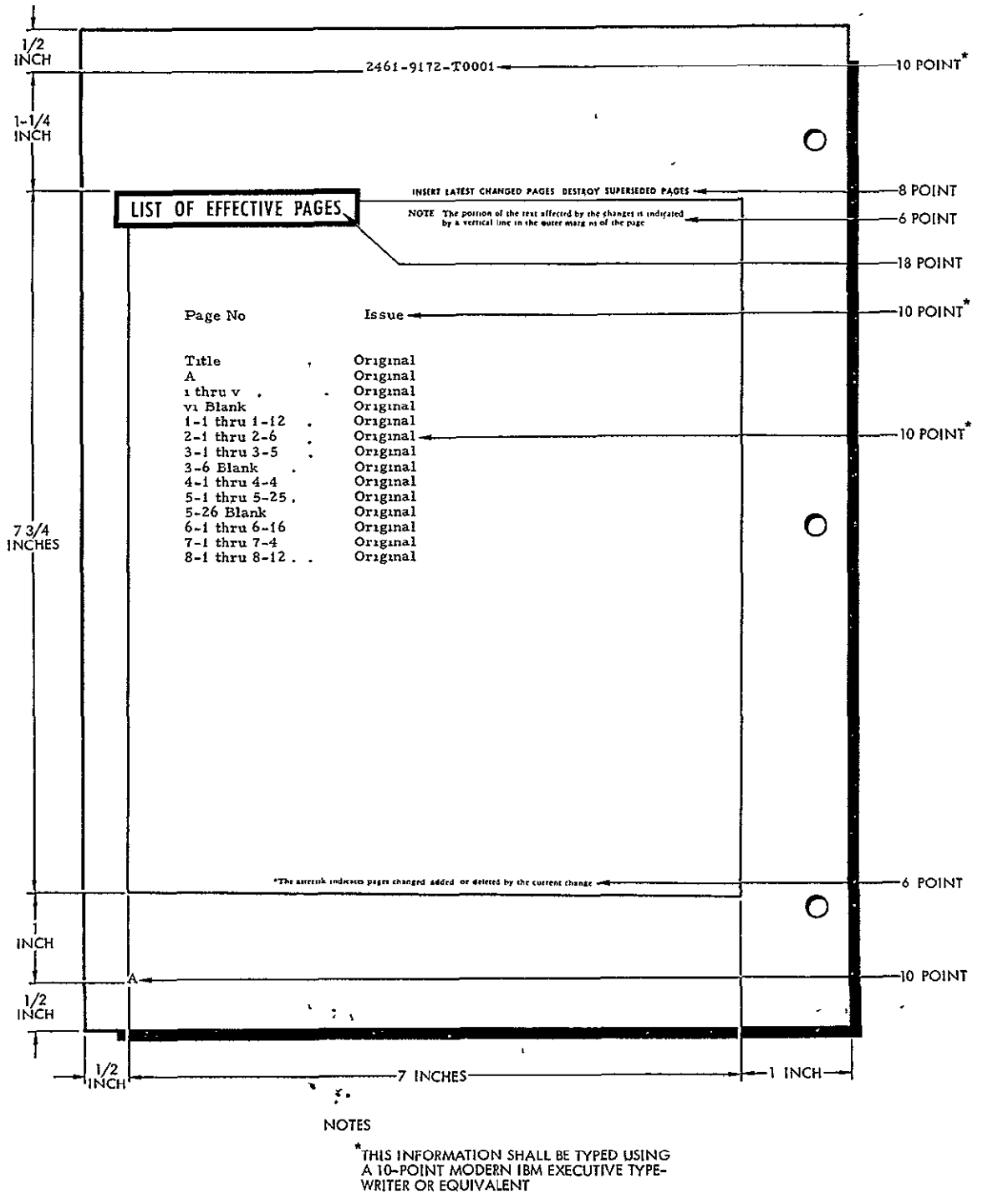
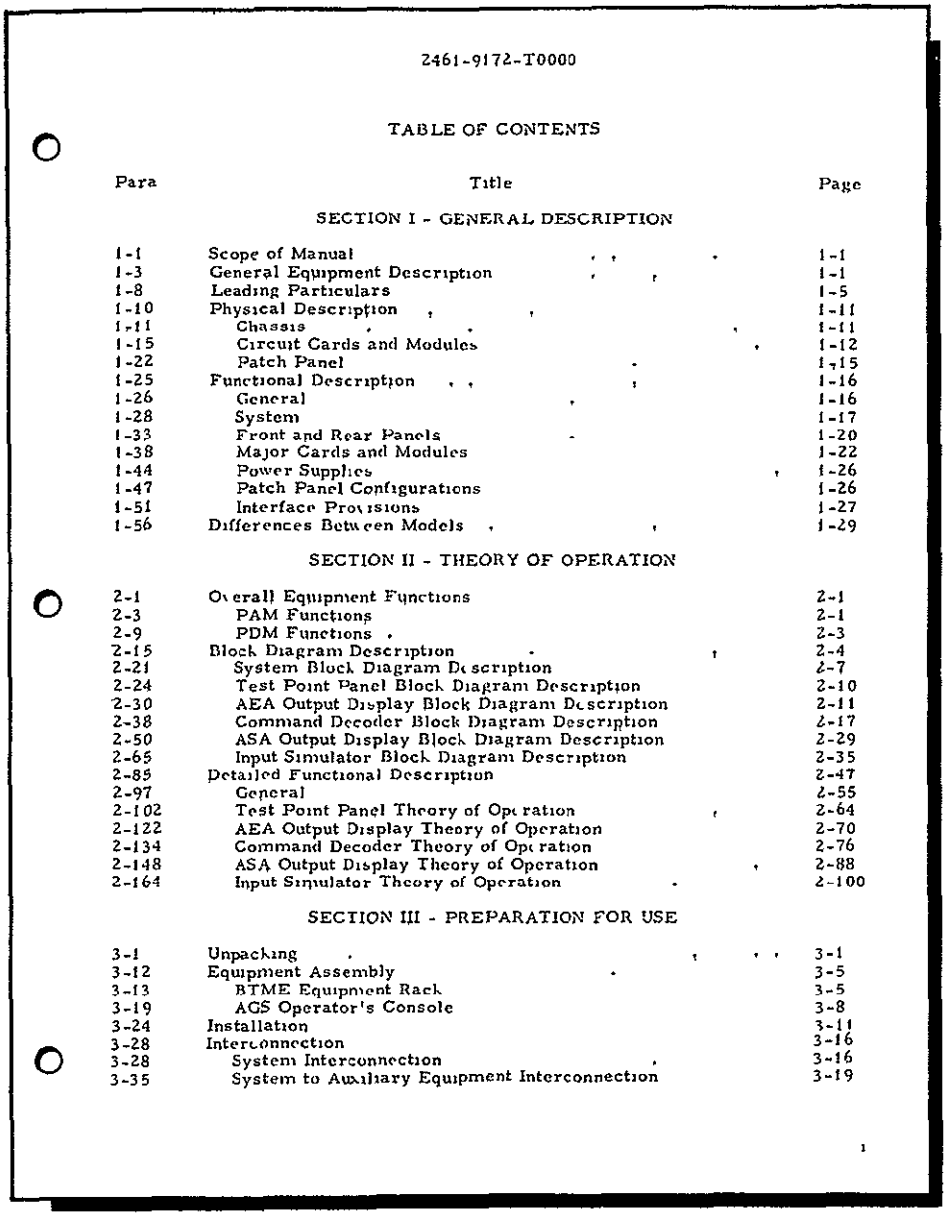


Figure 3-2. List of Effective Pages Standard Format (Reduced)



2461-9172-T0000

TABLE OF CONTENTS

1

NOTES

1. THE TABLE OF CONTENTS SHALL BE STARTED ON A NEW RIGHT-HAND PAGE
2. THE FIRST PAGE OF THE TABLE OF CONTENTS SHALL ALWAYS BE PAGE NUMBER 1.
3. ALL COPY IN THE TABLE OF CONTENTS SHALL BE TYPED USING A 10-POINT MODERN IBM EXECUTIVE TYPEWRITER OR EQUIVALENT

SG1-003

Figure 3-3. Table of Contents Standard Format (Reduced)

R042680-11-C

LIST OF ILLUSTRATIONS

NOTES

1. THE LIST OF ILLUSTRATIONS SHALL BE STARTED ON A NEW PAGE (EITHER LEFT- OR RIGHT-HAND) IMMEDIATELY FOLLOWING THE LAST PAGE OF THE TABLE OF CONTENTS
2. ALL COPY IN THE LIST OF ILLUSTRATIONS SHALL BE TYPED USING A 10-POINT MODERN IBM EXECUTIVE TYPEWRITER OR EQUIVALENT

SG1-004

Figure 3-4. List of Illustrations Standard Format (Reduced)

R042680-11-C

LIST OF TABLES

NOTES:

1 THE LIST OF TABLES SHALL BE STARTED ON A NEW PAGE (EITHER LEFT- OR RIGHT-HAND) IMMEDIATELY FOLLOWING THE LAST PAGE OF THE LIST OF ILLUSTRATIONS.

2 ALL COPY IN THE LIST OF TABLES SHALL BE TYPED USING A 10-POINT MODERN IBM EXECUTIVE TYPEWRITER OR EQUIVALENT

SG1-005

Figure 3-5. List of Tables Standard Format (Reduced)

Table 3-1. Format and Content Sample of Leading Particulars Table

GENERAL	
System Input Power Requirements	120/208 vac, 60 ± 3 cps, 3-phase, 5-wire. Each phase requires 115 ±10 vac at 34 amperes maximum
Temperature Range:	
Operating	15.4 to 46.4°C
Non-operating	-27.5 to 70.4°C
Altitude Range:	
Operating	Sea level to 6000 feet
Non-operating	Sea level to 6000 feet
System Overall Weight	7500 pounds (approx)
System Pneumatic Characteristics:	Four rack-mounted blowers each providing up to 600 cfm of fan-cooled air against a back-pressure of 0.5 inch of water. Density is 0.075 pound per cfm
BTME EQUIPMENT RACK	
BTME Equipment Rack Overall Dimensions:	
Height	75.5 inches
Width	96 inches
Depth	32 inches
BTME Equipment Rack Weight:	
Empty	1950 pounds (approx)
Loaded	3325 pounds (approx)
AGS Power Amplifier:	
Input Power Requirements	+28 ±2.8 v at 4 amperes
Power Outputs	115 ±2.3 vac, 400 ±20 cps, at 0.7 ampere

part number, manufacturer, and quantity of such equipment required but not supplied shall be included in the physical description of this section. The list of equipment supplied and the list of equipment required but not supplied shall comply with the format and content sample requirements of table 3-2.

Table 3-2. Format and Content Sample of Equipment List Tables

Qty	Nomenclature	Model or Part No.	Manufacturer
1	BTME Equipment Rack	EG227551-1	TRW Systems
1	Oscilloscope Assembly	EG221229-2	TRW Systems
1	Test Point Panel	EG227523-1	TRW Systems
1	Perforated Tape Reader	2500	Digitronics
1	Perforated Tape Handler	4566	Digitronics
1	Block Reader	EG221232-2	Digitronics
4	Blower	600031	Kenneth C. Holloway
1	AEA Output Display	EG227433-1	TRW Systems
1	AEA Input Output Control	EG227434-1	TRW Systems
1	Command Decoder	EG227435-1	TRW Systems
1	Power Control and Monitor	EG227436-1	TRW Systems
1	AC Power Panel	EG227438-1	TRW Systems
1	-15 VDC Power Supply	EG221211-2	TRW Systems
1	-3 VDC Power Supply	LH118	Lambda Electronics
1	+28 VDC Power Supply	EG221212-2	TRW Systems
1	AGS Operator's Console	EG227844-1	TRW Systems
1	Postion Control	C230212-1	TRW Systems
1	Rate and Acceleration Control	305C	Inland Controls
1	Precision Speed Control	302A	Inland Controls
1	Rate Servo Amplifier	401A	Inland Controls
1	Patch Panel	EG227958-1	TRW Systems

3-12. THEORY OF OPERATION.

3-13. This section shall contain a detailed description and discussion of the electronic, electrical, mechanical, pneumatic, and hydraulic (as applicable) theory of operation of the entire equipment. This information shall be presented in such detail, and divided in such a manner (major assemblies, major functions, etc.) as to allow operating and maintenance personnel to gain a complete understanding of the equipment and its functions. Basic theory of operation (information which technician-level personnel would normally possess) shall not be presented in this section, however, all circuits or applications which are not generally well understood, are unusual or new functional applications or arrangements, are special types of components not widely employed, or are special methods or complicated mechnical features shall be clearly explained using illustrations to supplement the text.

3-14. Information presented within this section shall be divided into three major categories and presented in the following order: overall equipment functions, block diagram level description (with accompanying block diagrams), and detailed functional theory of operation (employing such supplemental illustrations as full and partial schematic diagrams, logic diagrams, timing diagrams, mechnical diagrams, and pneumatic and hydraulic flow diagrams). The electronic, electrical, mechnical, pneumatic, and hydraulic (as applicable) descriptions shall be discussed separately.

3-15. PREPARATION FOR USE

3-16. This section shall define all actions that must be taken prior to initially energizing the equipment. Information shall be included specifying unpacking procedures (if complicated, uncommon, or potentially hazardous to personnel or equipment) and equipment assembly procedures (if applicable) When the equipment is intended to be anchored or mounted in a fixed location instructions shall be given for installation (including wiring and cabling diagrams showing equipment and assembly interconnections, if applicable), power source connections, and plumbing layouts and connections (if applicable). Also, a table (per table 3-3) shall be included in this section stating any precautionary control and adjustment settings that must be made prior to initially connecting the equipment to its external power source.

3-17. Any additional information deemed necessary to ensure the safe and proper pre-operation preparation of the equipment (such as operator and equipment precautions) shall be included in this section.

3-18. TEST EQUIPMENT AND SPECIAL TOOLS.

3-19. This section shall list, and illustrate as necessary, all standard test equipment, special test equipment, and special tools required for use during testing, troubleshooting, calibration, and repair of the equipment. All test equipment and special tools required shall be fully described (per the format and content sample of table 3-4) by stating the item nomenclature, complete manufacturer's name and part number, and the application and use of each item. Standard test equipment, special test equipment, and special tools shall be listed in separate tables. Common tools, found in any well-stocked tool box, shall not be listed.

Table 3-3. Format and Content Sample of Precautionary Control Settings Table

Unit	Control	Position
Perforated tape reader	POWER ON	Off
Perforated tape handler	POWER	OFF
Block reader	Power	OFF
Power control and monitor	Power circuit breaker	OFF
AC power panel	Power circuit breaker	OFF
Digital printer	POWER ON	Off
Angle position indicator	Power (all three switches)	OFF
-15 vdc power supply	Power	OFF
-3 vdc power supply	Power	OFF
+28 vdc power supply	POWER ON	Off
Digital voltmeter	POWER	OFF
Phase angle voltmeter	Power	OFF
Bidirectional counter	POWER	OFF
Temperature monitor	Power	OFF
Universal Counter	POWER	OFF
+15 vdc power supply	POWER	OFF
Test point panel	ASA SELF TEST	OFF
	COUNTER/ UTILITY	UTILITY
	SCOPE CHAN/ UTILITY	UTILITY
ASA output display	TEST MODE	OFF

Table 3-4. Format and Content Sample of Test Equipment and Special Tools Tables

Nomenclature	Manufacturer and Model No.	Usage
Oscilloscope Time Base Unit Vertical Pre-Amplifier	Tektronix Type 561 Tektronix Type 2B67 Tektronix Type 3A75	Observe waveshapes and adjust timing relationships throughout system
Pulse Generator	E H. Research Model 139	Adjust perforated tape reader and provide driving signals for individual unit tests
Frequency Generator	Hewlett-Packard Model 202A	Test AGS power amplifier
Distortion Analyzer	Hewlett-Packard Model 330B	Verify operation of AGS power amplifier
Theodolite and Transformer	Wild Model T3A	Check alignment of inertial test equipment
Multimeter	Simpson Model 270	Check continuity and voltage levels throughout system
Calculator	Friden Model STW-10	Calculation of ASA coefficients during ASA and AGS testing
Drawer Assembly Test Equipment (DATE)	TRW Systems EG227621	Test all functional circuits within the BTME equipment rack
Card Tester	TRW Systems EG214853	Test all circuit cards in system
Precision Bubble Level	Starrett Model 199	Checks alignment of bubble level on precision holding fixture
ASA Mock-Up	TRW Systems F228122	Used in conjunction with theodolite to check axmuth and elevation of dividing head and rotational axis

3-20. CHECKOUT AND OPERATION.

3-21. This section shall be divided into three major areas: operating controls and indicators; preliminary adjustment and alignment; and operation.

3-22. OPERATING CONTROLS AND INDICATORS All controls, indicators, adjustments, test points, and test connectors involved in normal operation or preventive maintenance of the equipment shall be illustrated and listed in tabular form (as shown in table 3-5) in the operating controls and indicators portion of this section. This tabular format will state the actual placarded nomenclature (or assigned nomenclature if not placarded) of each operating device, the reference designator of each device, the type of device, and the purpose, use, and operating interrelationship (function) of each device.

3-23. PRELIMINARY ADJUSTMENT AND ALIGNMENT. The preliminary adjustment and alignment portion of this section shall fully describe all procedures required to ensure that the equipment is properly adjusted and aligned prior to being initially turned over to operating personnel. These procedures shall be designed to ensure that the equipment meets its minimum performance standards when installed in its normal or simulated operating and functional environment. Preliminary adjustment and alignment procedures shall define the actual step-by-step sequences that must be performed, methods of connecting monitoring and test equipment (illustrated whenever possible), indications to be observed during these procedures, and instructions (when applicable) for readjusting or realigning out-of-tolerance indications. A list of tools and test equipment required to perform each preliminary adjustment or alignment procedure shall be stated at the beginning of the procedure.

3-24. OPERATION. The operation portion of this section shall contain complete instructions for normal and emergency operation of the equipment. Information such as power turn-on sequence and indications, power turn-off sequence and indications, emergency power turn-off sequence and indications, and normal operating precautions shall be included. In addition, if the sequence and method of operations is essentially the same each time the equipment is used, a normal sequence of operations for the equipment shall be presented including representative indications that would be observed during this operation. A table shall also be included in the operation portion of this section defining the types of indications that should be obtained from the equipment during normal operation, and an explanation (if applicable) of what these indications mean to the operator.

3-25. PREVENTIVE MAINTENANCE AND CALIBRATION.

3-26. This section shall contain procedures allowing skilled maintenance personnel to perform preventive maintenance and calibration of the equipment. All procedures shall be preceded by a list of required tools and test equipment. Preventive maintenance shall include instructions for performing systematic inspections and procedures at regularly scheduled intervals for the detection and correction of minor faults before they develop into equipment failures.

3-27. Preventive maintenance procedures shall present instructions for performing periodic inspection, cleaning, lubrication, and tests and adjustment which will verify that the equipment is functioning properly. If certain test and adjustment procedures appearing earlier in the commercial manual are to be performed during preventive maintenance exactly as previously presented, they shall be referred

Table 3-5. Format and Content Sample of Controls and Indicators Table

Nomenclature	Type	Function
UNITS 0 through 9 (S1 through S4)	Four 10-position rotary switches	Selects various system ac and dc signal and voltage levels, in conjunction with TENS switches S5 through S8, for application to switches S9 and S10
TENS 0 through 9 (S5 through S8)	Four 10-position rotary switches	Selects various system ac and dc signal and voltage levels, in conjunction with UNITS switches S1 through S4, for application to switches S9 and S10
DVM/UTILITY (S9)	2-position rotary switch	In DVM position, routes signal and voltage levels selected by UNITS and TENS switches to digital voltmeter. In UTILITY position, routes signal and voltage levels selected by these switches to UTILITY connectors (AC or DC as applicable) under S9
COUNTER/UTILITY (S10)	2-position rotary switch	In COUNTER position, routes signal and voltage levels selected by UNITS and TENS switches to universal counter. In UTILITY position, routes signal and voltage levels selected by these switches to UTILITY connectors (AC or DC as applicable) under S10
ASA SELF TEST ON/OFF (S11)	2-position toggle switch	ASA unit under test placed in self-test mode of operation when this switch set to ON position
POWER ON (S12)	Switch-light	Lights switch-light green and applies +28 v, +15 v, +6 v, -15 v, and -3 v to test point panel when pressed
DVM (J1)	BNC connector	External connection to digital voltmeter

to by paragraph number rather than actually repeated within this section. Calibration procedures shall provide maintenance personnel with information necessary to check and determine the reliability of equipment indications and reading, and shall provide instructions for restoring the equipment to its original accuracy. Data and procedures for preventive maintenance and calibration shall be presented in tabular form whenever possible.

3-28. CORRECTIVE MAINTENANCE DATA.

3-29. This section shall provide corrective maintenance procedures and data allowing skilled maintenance personnel to troubleshoot and bench test the equipment, isolate equipment malfunctions to a major stage or component within the equipment, and determine remedial actions. Step-by-step procedures (not "trouble, probable cause, remedy" type troubleshooting tables) using illustrated test set-ups shall be presented allowing isolation of a malfunction first to a major assembly (if applicable), and then to a subassembly, stage, or component. These procedures shall state normal indications that will be observed if the equipment is operating properly, and shall state the major assembly, subassembly, stage, or component (as applicable) that can be proven to be or can be reasonably suspected of malfunctioning as a result of an improper indication during this procedure.

3-30. For electronic equipment, data such as normal tube socket voltages, transistor pin voltages, input and output parameters and waveforms, and power requirements shall be presented within this section to allow skilled maintenance personnel to isolate malfunctions to specific components. Data shall also be presented stating indications that will normally be observed at selected interstage monitoring points and at normal equipment monitoring outlets such as test points and connectors. Equipment that is mechnical in nature shall have strict component tolerance data presented to allow determining if a mechanical component should be replaced. Equipment that is pneumatic or hydraulic in nature shall have complete tolerance data presented for all critical parameters (such as flow requirements, pressure requirements, temperature requirements, etc.). Disassembly and reassembly procedures shall be included and illustrated if the procedure is uncommon or complicated.

3-31. Test, adjustment, and alignment procedures that must be performed before, during, and after corrective maintenance to ensure proper equipment operation shall be included in this section. If certain test, adjustment, and alignment procedures appearing earlier in the commercial manual are to be performed during corrective maintenance exactly as previously presented, they shall be referred to by paragraph number rather than actually repeated within this section.

3-32. Diagrams, schematics, and wire interconnection data not appearing in other sections of the commercial manual which will aid in performing corrective maintenance shall be included in this section.

3-33. PARTS LIST

3-34. This section is intended for use by maintenance personnel during identification and replacement of detailed parts, and for illustrating the physical location of these replaceable parts. Standard hardware, structural parts, or other parts which have no maintenance significance shall not be listed.

3-35. This section shall consist of a brief introduction, a tabular list (per table 3-6) of equipment and major assemblies supplied, a tabular list (per table 3-7) of the names and codes for all vendors of replaceable parts (in accordance with DOD Cataloging Handbooks H4-1 and H4-2), and the replaceable parts list and identification illustrations. Identification illustrations in this section shall be exploded only to the extent necessary to locate and identify the replaceable parts (figures 3-6 and 3-7). Replaceable part key (index) numbers appearing on identification illustrations shall be Arabic numerals.

3-36. The replaceable parts list shall list the end item equipment, major assemblies and subassemblies, and the detailed replaceable components applicable to each of these disassembly levels. Replaceable parts list information shall be presented in seven columns, with column headings as shown in table 3-8. Information contained in the description column shall be indented to show the next higher assembly. If differences between models exist, a code letter shall be included in the usable on code column designating the model applicability of each part. Each usable on code letter employed shall be defined in the introduction portion of this section.

3-37. EXISTING MANUALS

3-38. Existing manuals which generally conform to the requirements of this section shall be acceptable as commercial manuals. Minor deviations shall not invalidate use of existing manuals, but final determination of the adequacy and conformity of supplied existing manuals shall be subject to the review and written approval of TRW Systems prior to final acceptance.

3-39. If additional information is required to adopt an existing manual to the use intended, such information shall be prepared in accordance with paragraphs 3-5 through 3-36 (as applicable), and issued as a basic commercial manual with the existing manual appended thereto. This method will provide the necessary supplementary information and existing manual in a single volume, whenever possible.

3-40. REVISIONS

3-41. Revised commercial manual data (text and illustrations) shall be provided to reflect those changes in configuration which have occurred since delivery of the final commercial manual or the last revision. Revised data shall also be supplied to eliminate any omissions or deficiencies in the final commercial manual or previous revisions.

3-42. Revisions shall be prepared in the form of replacement change pages. Each time a commercial manual is revised, a revised title page (with revision date specified thereon) and list of effective pages shall be included in the revision. If more than 60 percent of the pages contained in a commercial manual require revision, a new manual superseding the previously released manual shall be prepared and forwarded to TRW Systems in lieu of replacement change pages.

3-43. The commercial manual shall be revised, either partially or totally, at least every 90 days for a period of at least one year (unless otherwise specified in the contract), and shall include any TRW Systems comments received during that period. If a revision is not required, the preparing vendor shall notify TRW Systems in writing.

Table 3-6. Format and Content Sample of Equipment Supplied Table

Qty	Nomenclature	Model or Part No.	Manufacturer	Fig. Ref
1	BTME Equipment Rack	EG227551-1	TRW Systems	8-2
1	Oscilloscope Assembly	EG221229-2	TRW Systems	8-3
1	Test Point Panel	EG227523-1	TRW Systems	8-4
1	Perforated Tape Reader	2500	Digitronics	8-5
1	Perforated Tape Handler	4566	Digitronics	8-6
1	Block Reader	EG221232-2	Digitronics	8-7
4	Blower	600031	Kenneth C. Holloway	8-2
1	AEA Output Display	EG227433-1	TRW Systems	8-8
1	AEA Input Output Control	EG227434-1	TRW Systems	8-9
1	Command Decoder	EG227435-1	TRW Systems	8-10
1	Power Control and Monitor	EG227436-1	TRW Systems	8-11
1	AC Power Panel	EG227438-1	TRW Systems	8-12
1	-15 VDC Power Supply	EG221211-2	TRW Systems	8-13
1	-3 VDC Power Supply	LH118	Lambda Electronics	8-14
1	+28 VDC Power Supply	EG221212-2	TRW Systems	8-15
1	AGS Operator's Console	EG227844-1	TRW Systems	8-16
1	Position Control	C230212-1	TRW Systems	8-17
1	Rate and Acceleration Control	305C	Inland Controls	8-18
1	Precision Speed Control	302A	Inland Controls	8-19
1	Rate Servo Amplifier	401A	Inland Controls	8-20
1	Patch Panel	EG227958-1	TRW Systems	8-21
1	AEA Test Panel	EG227847-1	TRW Systems	8-22

Table 3-7. Format and Content Sample of Vendor Identification Table

Code	Vendor	Code	Vendor
00656	Aerovox Corp. New Bedford, Mass.	82768	Phillips-Advance Control Co., Div. of Phillips-Eckardt Electronic Corp. Joliet, Ill.
02111	Spectrol Electronics Corp. San Gabriel, Calif.	83594	Burroughs Corp., Electronic Tube Div. Plainfield, N. J
02660	Amphenol-Borg Electronics Corp. Broadview, Chicago, Ill.	85604	Kepco, Inc. Flushing, N Y
02979	Computer Measurements Co., Div. of Pacific Industries, Inc. San Fernando, Calif	87034	Marco Industries Co. Anaheim, Calif
03611	Weston Instruments, Div. of Daystrom, Inc. Monterey Park, Calif.	90002	Hubbell Harvey, Inc. New York, N Y.
04062	Elmenco Products Co. New York, N Y.	90439	McIntosh Laboratory, Inc. Binghamton, N Y
04387	Dale Electronics, Inc., Pacific Division Burbank, Calif.	91141	Davidson Optronics, Inc West Covina, Calif.
04643	Digitronics Corp. Albertson, N Y	91662	Elco Corp. Willow Grove, Pa.
04713	Motorola, Inc., Semiconductor Products Div. Phoenix, Ariz.	91737	Gremar Mfg. Co., Inc Wakefield, Mass.
05172	Auto-Control Laboratories, Inc. Los Angeles, Calif.	91812	Janco Corp. Burbank, Calif.
05277	Westinghouse Electric Corp., Semiconductor Dept. Youngwood, Pa	91929	Honeywell, Inc., Micro Switch Div. Freeport, Ill.
05571	Sprague Electric Co., Pacific Division Los Angeles, Calif.	93490	Lab Tronics, Inc. Chicago, Ill
81312	Winchester Electronics Co , Inc. Norwalk, Conn.	94412	Dressen Barnes Electronic Corp Pasadena, Calif.
		95077	General RF Fittings Co. Boston, Mass.

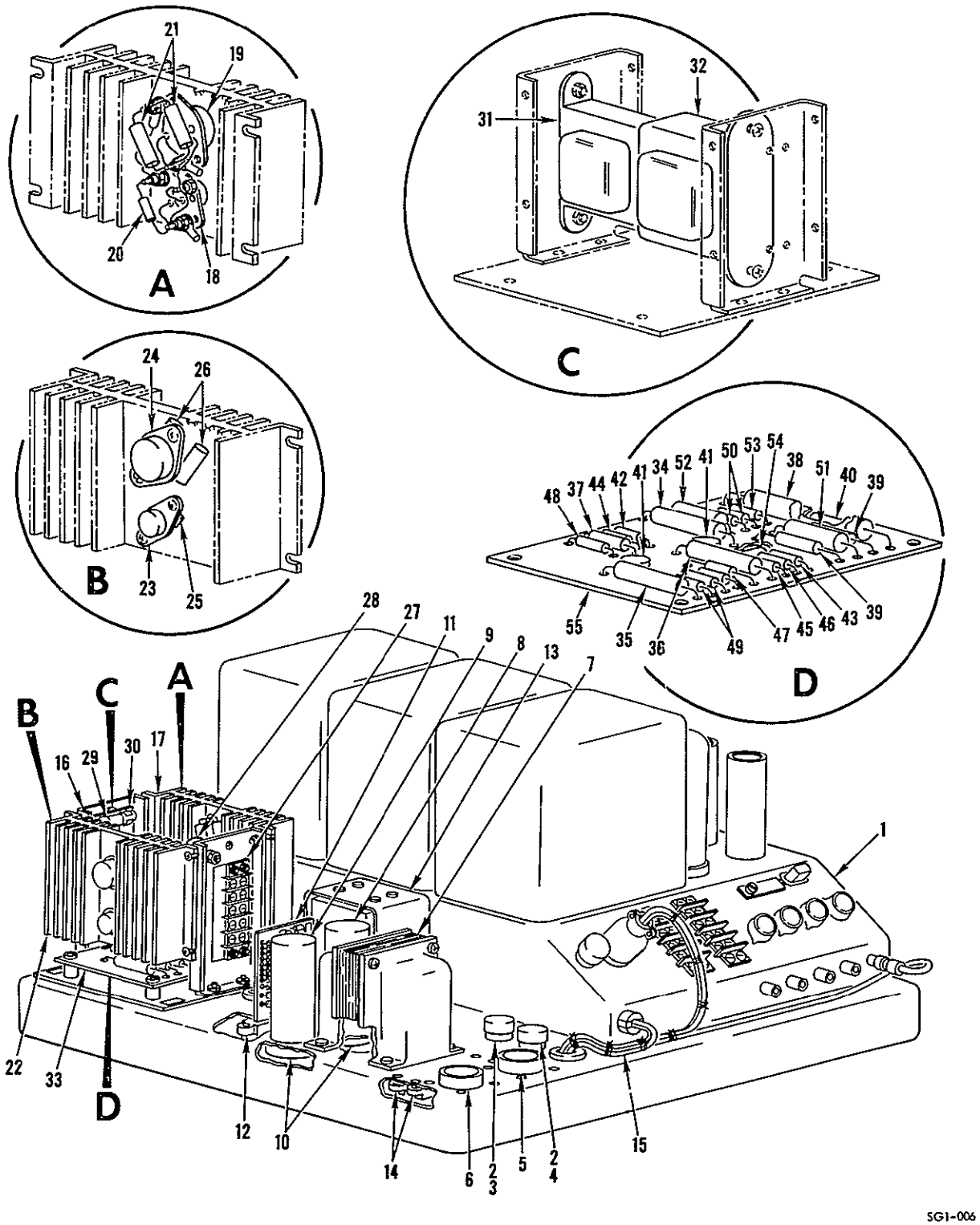


Figure 3-6. Line Drawing Sample of Parts List Identification Illustration

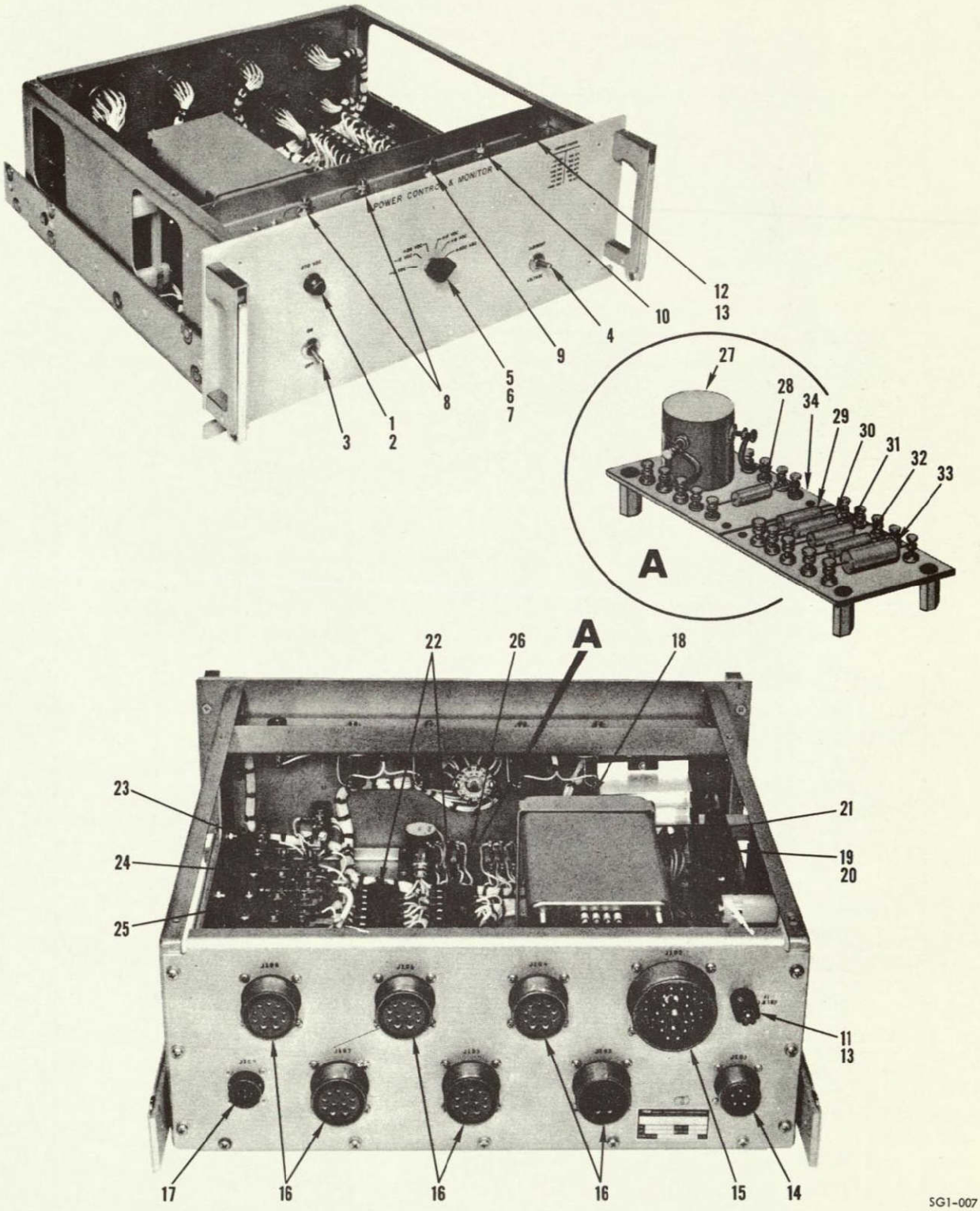


Figure 3-7. Photograph Sample of Parts List Identification Illustration

Table 3-8. Format and Content Sample of Replaceable Parts List

Fig. & Index No.	Part No.	Description 1234567	Vendor Code	Ref Des	Units Per Assy	Usable on Code
8-4-	EG227523-1	. . TEST POINT PANEL (see. figure 8-2 for nha)		A2	Ref	
-1	MS91528-3F2B	. . . Knob, Black			12	
-2	2205-4010-1500-3102	. . . Switch, Rotary, 2-Deck, . 10-pos	71471	S1 thru S4	4	
-3	1801-2010-1500-3100	. . . Switch, Rotary, 3-Deck, . 10-pos	71471	S5 thru S8	4	
-4	1401-2002-2250-3100	. . . Switch, Rotary, 4-Deck, . 2-pos	71471	S9 thru S12	4	
-5	UG657/U	. . . Connector, Receptacle . .		J301 thru J308	8	
-6	105-601	. . . Jack, Tip, White	74970	TP1 thru TP66	66	
-7	8363K7	. . . Switch, pb, spdt	15605	S13	1	
-8	184A	. . . Connector, Receptacle . .	95077	J309	1	
-9	10E-A1C1F3J3L(G)N1R1V13	. . . Switch, Display (power . . on), pb, dpdt	13904	S15	1	
-10	10E-A1C1F3J3L(G)N1R1V13	. . . Switch, Display (simu-. . lated 1K pps), pb, dpdt	13904	S16	1	
-11	MS25237-327	. . . . Lamp (used on each . . of index nos. 9 and 10)			4	
-12	MS33058-30	. . . Switch, Toggle, 3pdt . . .		S14	1	
-13	0143	. . . Resistor, ww, variable . .	44655	R15	1	
-14	CLU5001	. . . Resistor, ww, variable . .	44655	R16	1	
-15	10-141	. . . Terminal Board.	71785	TB1	1	A
-16	105-601	. . . Jack, Tip, White	74970	TP201	1	B
-17	BR7X300D7-26	. . . Relay, Armature	09026	K1, K2, K3	3	
-18	1N3062	. . . Diode	07263	CR1	1	
-19	313002	. . . Fuse, 2 Amp	75915	F1	1	
-20	3136.25	. . . Fuse, 6.25 Amp	75915	F2	1	
-21	313001	. . . Fuse, 1 Amp	75915	F3	1	
-22	313.500	. . . Fuse, 0.5 Amp	75915	F4, F5	2	
-23	342004	. . . Fuse Holder	75915	XF1 thru XF5	5	
-24	PT02A14-12P	. . . Connector, Receptacle . .	12143	J201	1	

SECTION IV

ILLUSTRATION REQUIREMENTS

4-1. GENERAL.

4-2. The preparation of all illustrations shall conform to commonly accepted standards of good technical illustrating techniques and professional workmanship. Illustrations shall be well planned and laid out, and shall be presented by any means available that will result in clear, legible artwork conveying an immediate and thorough comprehension of the subject.

4-3. The most desirable pictorial illustrations of mechanical details are line drawings or photographs in exploded or cutaway form. Line drawings and photographs shall be clean, with manufacturer's drawing numbers and other extraneous material omitted. Line weight on line drawings shall be sufficient to ensure good reproduction, and shall be reasonably consistent on all illustrations in the same commercial manual. The minimum nomenclature (reference designators, line functions, notes, callouts, key numbers, etc.) height on all final reproduced illustrations shall be 0. 06 inch, and the maximum nomenclature height shall be 0. 10 inch.

4-4. ILLUSTRATION CONTROL NUMBER.

4-5. All illustrations shall be identified by a control number in the lower, right-hand corner of the artwork, just within the cropped image area (figures,4-1 through 4-3). No two illustrations shall be identified by the same control number; however, each sheet of a multisheet illustration shall be identified by the same basic control number (for example: TRW-567) followed by a dash number corresponding to the sheet number (for example: TRW-567-1, TRW-567-2, etc.). A series of illustration control numbers to be used within each commercial manual shall be assigned to the preparing vendor by TRW Systems upon request.

4-6. USE OF MILITARY STANDARDS.

4-7. Abbreviations, reference designations, and symbols used on illustrations shall be in accordance with MIL-STD-12, MIL-STD-15, MIL-STD-17, USAS Y32.14 1962, and USAS Y32.16 1965.

4-8. LINE DRAWINGS.

4-9. Ink, pencil, or any other media capable of good photographic reproduction shall be used for preparing line drawings (figures 3-6 and 4-1). All finished line drawings shall be mounted on heavy illustration board, cropped and sized for final reproduction, and protected by both a tissue overlay and paper cover. The illustration figure number, figure title, and control number shall be marked in the upper, right-hand corner of the outer paper cover on each line drawing for ready identification of the artwork.

4-10. PHOTOGRAPHS.

4-11. Photographs shall be taken as clear, sharp, and shadow-free as possible so that a minimum amount of retouching is necessary to tonally separate planes,

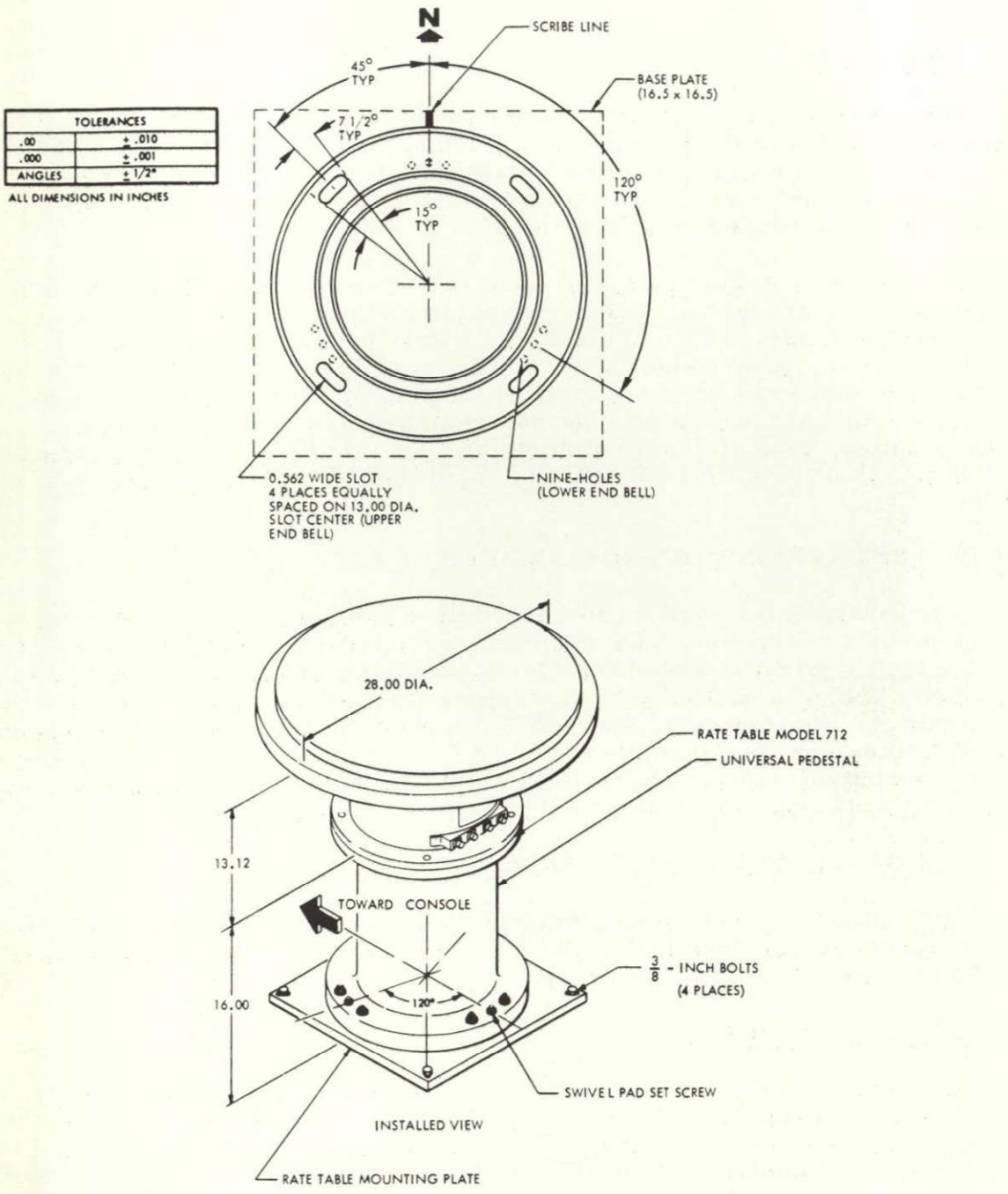


Figure 4-1. Sample of Acceptable Line Illustration

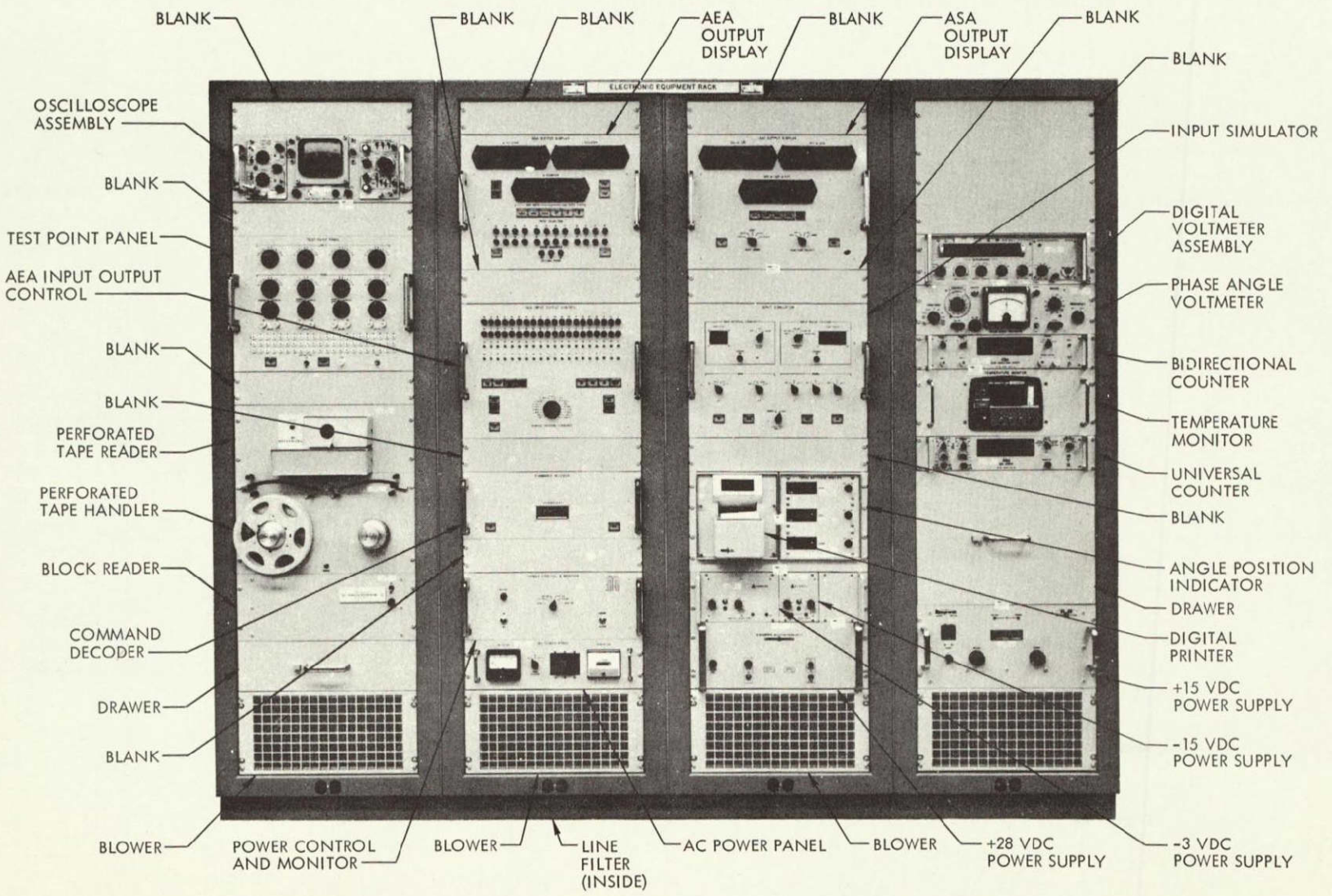


Figure 4-2. Sample of Acceptable Photographic Illustration

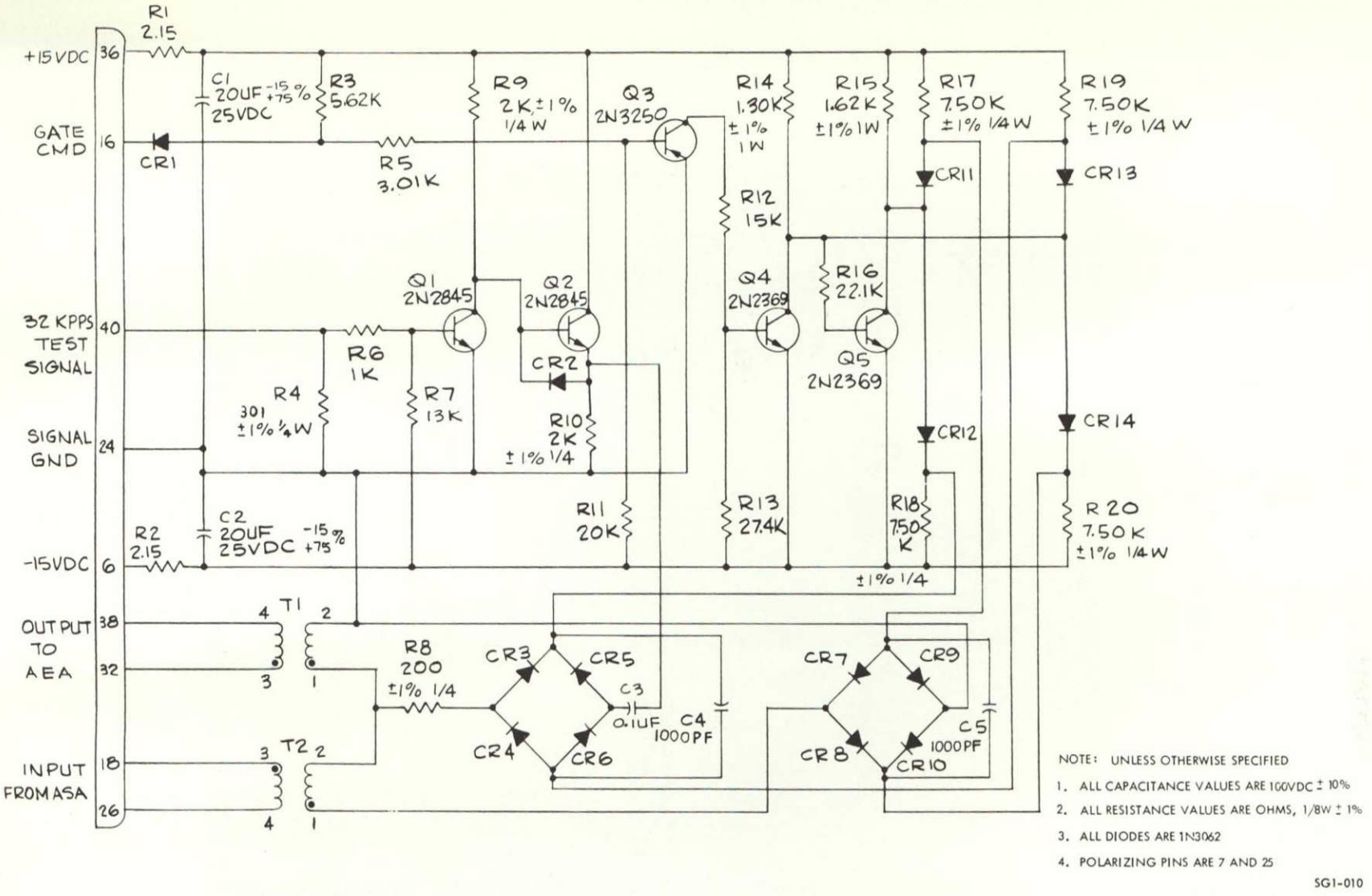


Figure 4-3. Sample of Acceptable Reduced Engineering Drawing

highlight essential details, and eliminate undesirable shadows (figures 3-7 and 4-2). Callouts and key numbers, when used, shall be applied to a clear acetate overlay with register marks keying the overlay to the photographic print. All finished photographs shall be mounted on heavy illustration board with associated acetate overlays affixed thereto, cropped and sized for final reproduction, and protected by both a tissue overlay and paper cover. The illustration figure number, figure title, and control number shall be marked in the upper, right-hand corner of the outer paper cover on each photograph for ready identification of the artwork.

4-12. ENGINEERING DRAWINGS.

4-13. Engineering drawings, or portions thereof, which contain information desired in support of the text may be photographically reduced in size for use as original line drawings in the commercial manual (figure 4-3). All lines and nomenclature on final reproduced engineering drawings used in the commercial manual shall be continuous and unbroken or they shall be considered unacceptable. Line weight consistency and nomenclature height on final reproduced engineering drawings shall comply with the requirements stated in paragraph 4-3. Photographically reduced engineering drawings used as original artwork shall be mounted, protected, and identified as specified in paragraph 4-9.

4-14. CHARTS AND GRAPHS.

4-15. Charts and graphs shall be included in the commercial manual as illustrations, and shall be assigned figure numbers, figure titles, and illustration control numbers. All general illustration requirements apply to the preparation of charts and graphs. Charts and graphs shall be mounted, protected, and identified as specified in paragraph 4-9.

4-16. CALLOUTS AND KEY NUMBERS

4-17. Callouts shall be used on illustrations only when they do not clutter and unduly obscure the illustrated object; otherwise, key numbers and an accompanying key list shall be used for item identification. When key numbers are used they shall start with Arabic numeral 1 and shall be placed at the end of a leader pointing to the item being identified (figures 3-6, 3-7, and 4-2) A key list, identifying the key numbers, shall be included either on the illustration itself or in the text immediately preceding the illustration.

4-18. A leader shall be used between the callout or key number and the item identified by that callout or number. An arrowhead shall be shown at the end of the leader nearest the item and shall just touch the item Leaders shall be in sharp contrast with other features of the illustration. Printed or plastic self-adhesive leaders, with one or both edges outlined in white, shall be used Leaders shall not cross or touch other leaders on an illustration.

4-19. REPRODUCTION SIZES

4-20. Quarter-page vertical illustrations shall be prepared for final reproduction within a cropped image area of 7 by 1-3/4 inches. Half-page vertical illustrations shall be prepared for final reproduction within a cropped image area of 7 by 4 inches. Quarter-page and half-page horizontal illustrations shall not be used within a commercial manual. Full-page vertical illustrations shall be prepared

for final reproduction within a cropped image area of 7 by 8-1/2 inches. Full-page horizontal (landscaped) illustrations shall be prepared for final reproduction within a cropped image area of 6-1/2 by 9 inches.

4-21. Foldout illustrations may be used if desired, but foldup illustrations shall never be used in a commercial manual. All foldout illustrations shall be reproduced with an 8-1/2 by 11 inch blank apron. Foldout illustrations shall be prepared for final reproduction at only three maximum overall trim sizes to produce either a two-fold, four-fold, or six-fold foldout illustration. Each fold of a foldout illustration shall be 6-1/2 inches wide, therefore a two-fold foldout illustration will have a trim size of 21-1/2 by 11 inches (8-1/2 inch blank apron plus two 6-1/2 inch folds), a four-fold foldout illustration will have a trim size of 34-1/2 by 11 inches, and a six-fold foldout illustration will have a trim size of 47-1/2 by 11 inches. The maximum overall cropped image area for foldout illustrations shall be: two-fold 12-1/2 by 8-1/2 inches, four-fold 25-1/2 by 8-1/2 inches; and six-fold 38-1/2 by 8-1/2 inches. Any illustration that will exceed the maximum overall cropped image area of a six-fold foldout illustration shall either be rearranged to fit these dimensions or physically divided (with proper cross-references) to form two or more foldout sheets.

SECTION V

STYLE AND FORMAT REQUIREMENTS

5-1. INTRODUCTION.

5-2. This section specifies general rules of writing that shall be observed when preparing commercial manuals. Procedures are specified that shall be adhered to when using the various elements of style and grammar. Information is also presented defining the format requirements of manual elements (paragraphs, tables, figures, sections, etc.), and the layout and composition requirements of various types of manual pages (text, illustration, front matter, etc.)

5-3. STYLE AND USAGE.

5-4. PERSON AND TENSE

5-5. Personal prounouns (I, you, we, they, us, etc) shall never be used in a commercial manual. The second person imperative shall be used for all procedural instructions (for example: "Set PWR switch to ON position. "), and the third person indicative shall be used for all descriptive material (for example: "Main power is applied by setting the PWR switch to the ON position. "). The present tense shall be used during presentation of both instructive and descriptive material.

5-6. PUNCTUATION AND GRAMMAR

5-7. All rules of good grammar and punctuation shall be followed to ensure the generation of clear, concise text which is readily understandable. The GPO Style Manual shall be adhered to for all rules of punctuation. Punctuation shall be used only to clarify the meaning of the material being presented Its use shall aid in reading and prevent misreading, therefore, if it does not clarify the material it shall be omitted. Webster's New Collegiate Dictionary and the GPO Style Manual, in that order, shall be adhered to for the proper spelling, prefixing, suffixing, hyphenating, and compounding of words.

5-8. ABBREVIATION

5-9. The only abbreviations that shall be used in a commercial manual are those specified in MIL-STD-12. Use of abbreviations in text shall be held to an absolute minimum, with only commonly used terms (such as units of measurement) being abbreviated. Use of common abbreviations in tabular material or on illustrations shall be governed by the necessity for conserving space, however, no abbreviation shall be used that might cause the reader to question what word or words have been abbreviated.

5-10. All abbreviations used in textual and tabular material shall be fully lowercase except when (1) the words represented by the abbreviation are normally initially capitalized, (2) the abbreviation is an exact replica of placarded or stamped equipment nomenclature, (3) the abbreviation represents a symbol, formula. or equation that is capitalized by definition, and (4) units of temperature measurement (centigrade, Fahrenheit. Kelvin. and Reaumur) are abbreviated Abbreviations for the four different units of temperature measurement shall always be capitalized (C, F, K, and R, as applicable).

5-11. CAPITALIZATION

5-12 Capital letters are required for certain specific purposes in commercial manuals. The general rules specified below, in addition to those specified in the GPO Style Manual, shall be followed when using capitalization:

a. Capitalize all letters of section headings and first, second, third, and fourth order paragraph headings in regular position in text.

b. When textual references are made to portions of a commercial manual the words "volume" and "section" shall be initially capitalized, and the words "paragraph, " "step, " "item, " "table, " and "figure" shall be fully lowercase.

c. Component nomenclature placarded or stamped on equipment panels or chassis shall be capitalized in text, in tables, and on illustrations exactly as capitalized on the equipment. If lowercase letters or symbols are placarded or stamped on the equipment, use lowercase in text, tables, and illustrations exactly as on the equipment.

d. Capitalize all letters of notation headings (NOTE, CAUTION, WARNING, etc.)

e. Capitalize the first letter of the first word and all other significant words used for (1) table and figure titles, (2) paragraph headings (fifth, sixth, and seventh order only), (3) column headings in tables, charts, and lists, (4) paragraph headings, table titles, and figure titles appearing in the front matter of a commercial manual, and (5) official nomenclature of a system, unit, assembly, subassembly, or module when the complete designator (including part number in proper sequence) is used in text or tables.

f. Initially capitalize trade names (Formica, Glyptal, etc.) used in a commercial manual.

5-13. WORDS AND PHRASES

5-14. Certain words and phrases are either not clearly defined or are too broad in their meaning to be usable in commercial manuals. Avoid the use of such words as "approximately, " "nearly " "excessive, " etc. Indefinite or loose expressions such as those listed below shall not be used:

Preferred	Indefinite
because	due to the fact that
based on	on the basis of
consider	give consideration to
before	prior to
after	subsequent to
most	the greatest part
must	is essential that
circular	circular in shape
estimate	make an approximation

5-15. Technical phraseology requiring a specialized knowledge shall be avoided except where no other wording will convey the intended meaning, in which case the technical term shall be defined Colloquialisms and jargon ("scope" for oscilloscope, "yo-yo" for tape measure, etc.) shall not be used in a commercial manual.

5-16. SENTENCES

5-17. Sentences in commercial manuals shall be as short and concise as the subject will allow. As a general rule, limit sentences to approximately 20 words. This short sentence structure will enable the reader to grasp quickly one thought before proceeding to the next. All types of meaningless expressions and strange or unusual words shall be avoided.

5-18. Every word and phrase in the commercial manual shall work at giving instructions or information to the reader. When a word or phrase can be crossed out of a sentence without changing the meaning or destroying the unity or completeness of that sentence, it is not working and shall be eliminated. Unnecessary words and phrases shall therefore be eliminated, and complex and cumbersome words replaced with clear, simple words. This practice will greatly increase the accuracy and usability of the manual.

5-19. USE OF NUMBERS

5-20. Two general rules shall be followed (except as specified below) when using numbers in a commercial manual. The first general rule states that the following items shall be spelled out: (1) numbers beginning a sentence; (2) numbers from zero through nine (except when used with units of measurement); and (3) numbers of less than 100 preceding a compound modifier containing a number. The second general rule states that the following items shall be expressed as Arabic numerals: (1) numbers 10 or greater, (2) age and date, (3) percentages. proportions, values. and mathematical equations, (4) units of temperature, electricity, tolerance, measurement, etc., (5) numbers in unit modifiers that combine a number and a unit of measurement, and (6) numbers in sequence within a phrase when one number is 10 or greater.

5-21. Specific exceptions to and clarifications of the two general rules stated above are as follows:

a. Any time a decimal number less than one is expressed, the decimal point shall be preceded by a zero (0.75 inch, 0.24 gram, etc.). The only exception to this rule is when expressing the caliber of a weapon (30 caliber, .357 Magnum, etc.).

b. Fractions occurring alone shall either be spelled out or converted to their decimal equivalents When fractions are spelled out they shall be hyphenated (one-third, twenty-three sixty-fourths, etc.)

c. Percentages shall be expressed in Arabic numerals followed by the word "percent" (23 percent). The symbol representing percent (%) shall never be used in textual material, and may be used in tabular material and on illustrations only when space requirements disallow use of the word "percent " Fractional percentages shall always be expressed in decimal form rather than as fractions (0 5 percent, 10.25 percent, etc.).

d. A comma shall be used to separate the thousands from the hundreds when expressing a number 10, 000 or greater. When expressing a number 9999 or less. a comma shall not be used to separate the thousands from the hundreds except in aligned tabular material. If tabular material contains numbers both above and below 10, 000, and these numbers are to be aligned in a column. commas shall be used to separate the thousands from the hundreds in every number above 999.

5-22. NOTES, CAUTIONS, AND WARNINGS.

5-23. All hazards to personnel and equipment safety related to tasks specified in the commercial manual shall be called to the attention of the reader by use of cautions and warnings. Notes. cautions. and warnings shall be used as specified below, and shall be employed only when conditions truly warrant their use

a. Notes shall be used to highlight procedural conditions, descriptive information, or definitive data in text. in tables, and on illustrations.

b. Cautions shall be used to specify operating procedures and practices which, if not strictly observed. may result in damage to or destruction of the equipment

c. Warnings shall be used to specify operating procedures and practices which, if not correctly followed, may result in injury to personnel or loss of life.

5-24. Cautions and warnings shall precede the step or procedure to which they apply. Notes may either precede or follow, depending upon the material that is to be highlighted. Notes. cautions and warnings are written as statements of fact. The statement shall give the reason for the notation, as well as the correct procedure or practice.

5-25. REFERENCES.

5-26. References shall be made to section, paragraph, procedural step, table, and figure numbers within a commercial manual as necessary, but references shall not be made to page numbers. References can also be made to other publications if (1) they contain supplemental information required to substantiate or support the commercial manual being prepared and (2) the referenced publication is known to be readily available to the reader. The word "see" shall be used in a reference phrase only when the referenced material is named (for example: "For further interface information see paragraph 2-37. "), otherwise the reference phrase shall consist of the location reference within parentheses only (for example: "(paragraph 2-37)")

5-27. REFERRING TO SECTIONS. References may be made from one section of a manual to another section in total. Section references shall be made to the section number only. the section title not being specified in the reference.

5-28. REFERRING TO PARAGRAPHS Paragraph references shall be made to the paragraph number, never to the paragraph number and title. References shall be made only to the main paragraph number when that paragraph contains a series of subparagraphs that are being referenced collectively and in total Reference shall be made to only a subparagraph number when a single, specific subparagraph is referred to. Reference to an unbroken series of paragraphs or subparagraphs shall be made only to the first and last paragraph numbers in that series (for example· "(paragraphs 3-47 through 3-52)")

5-29. REFERRING TO PROCEDURAL STEPS. Reference may be made from one step in a procedure to other steps in the same procedure, and from one step in a procedure to steps in a different procedure or a different procedure in its entirety. Such references, however, shall be kept to a minimum and shall be made only when the referenced material is extensive. It is considerably easier for a writer to repeat several steps while preparing a procedure than it is for the reader to refer back and forth between portions of a commercial manual while performing the procedure.

5-30. REFERRING TO TABLES. Tables shall be referenced by table number only, not by such phrases as "the following table" or "the table below." If the table referred to is defined in a paragraph, the paragraph number under which the table is explained or discussed may also be included in the reference (for example: "(table 3-4, paragraph 3-45)")

5-31. The first reference to each table within a section shall be in consecutive order. Table 3-3, for example, shall not be referred to before tables 3-1 and 3-2 in Section III. Once a table has been referred to in proper sequence within the section in which it appears, it may be referenced at any time thereafter. References to tables in other sections of the commercial manual need not be in consecutive order

5-32. REFERRING TO ILLUSTRATIONS. References to illustrations shall be by figure number only. An illustration shall never be referred to by (1) its figure title, (2) its figure number and title, or (3) its figure number and sheet number if it is a multi-sheet illustration. References to a particular sheet of a multi-sheet illustration generally necessitate changing figure references within the text. A five-page illustration all too often becomes a four-page or six-page illustration when finished

5-33. When repeated reference is made to only one illustration in a paragraph, the figure number reference shall be included in the paragraph heading rather than repeated several times throughout the text (for example: "1-18. POWER AMPLIFIER. (Refer to figure 1-4.)"). The first reference to each illustration within the section the illustration appears shall be in consecutive order. Once the illustration has been referenced in proper sequence, it may be referred to at any time thereafter. References to illustrations in other sections of a commercial manual need not be in consecutive order

5-34. References to sections, paragraphs, procedural steps, tables, or other illustrations shall not be made on an illustration. The only references allowed on an illustration are references from one sheet to another sheet of the same multi-sheet illustration.

5-35. NOMENCLATURE CONSISTENCY

5-36. Using inconsistent nomenclature is a sure way of making a commercial manual next to useless and thoroughly confusing to the reader If an equipment, component, or function is described in one section of a manual as ABC and then adjusted in another section as BAC, it is impossible to accurately correlate the description and adjustment information. Once a given item has been assigned nomenclature, it shall be referred to by that exact nomenclature throughout the remainder of the commercial manual.

5-37. EQUIPMENT NOMENCLATURE. The equipment name indicated on the equipment nameplate or otherwise designated by the manufacturer or procuring activity is the official equipment nomenclature. Certain equipment, however, may consist of two or more major units or contain one or more major assemblies, subassemblies, or modules that have not been assigned official equipment nomenclature by the manufacturer. When this occurs, the writer shall assign nomenclature that functionally describes the item This assigned nomenclature then becomes the official equipment nomenclature for the major unit, assembly, subassembly, or module with respect to and for the duration of the commercial manual project. Once the official equipment nomenclature has been used in a commercial manual it shall be used consistently thereafter unless a common name for the equipment is properly established and referenced.

5-38 Assigning and using common equipment names is sometimes desirable when the official equipment nomenclature is too long for convenient, repeated use in the text. As an example, the nine-channel data acquisition system might be referred to as the nine-channel recorder by common equipment name If a common name is assigned to an equipment, it must be used in place of the official equipment nomenclature for all references to the equipment throughout the remainder of the manual. A common equipment name, if used, shall be specified as early in a manual as possible, and shall be established by stating the official equipment nomenclature followed by a parenthetical phrase stating the common equipment name (for example: "The nine-channel data acquisition system (hereinafter referred to as the nine-channel recorder) is a . . ") If an equipment consists of several major units or assemblies that have been assigned common equipment names, a table shall be included in Section I of the manual cross-referencing the official nomenclature and common name of each major item

5-39 COMPONENT NOMENCLATURE All components (controls, indicators, test points, connectors, etc.) that have nomenclature placarded or stamped on their associated panel or chassis shall be referred to by that exact placarded or stamped nomenclature. Components that do not have placarded or stamped nomenclature shall either be assigned functional nomenclature (output load resistor, isolation capacitor, power control relay, etc) or descriptive nomenclature (resistor, capacitor, relay, etc.). Whenever a component is referred to that does not have placarded or stamped nomenclature, it shall be referred to by both its reference designator and its assigned functional or descriptive nomenclature (resistor R12, isolation capacitor C105, relay K42, etc.)

5-40. FORMAT AND LAYOUT.

5-41. SECTIONS.

5-42. Each section shall be started on a new, right-hand page. Sections shall be numbered using Roman numerals, starting with Roman numeral I and proceeding consecutively through the last section of the commercial manual. Section headings shall be centered at the top of the first page of each section, and shall be typed fully capitalized. The section number and section title shall be on different lines, with double-spacing between these two lines. Examples of this format can be seen on the first page of each section within this document.

5-43. PARAGRAPHS.

5-44. Text shall be logically arranged by paragraphs. Basically, a paragraph consists of a topic sentence and supporting sentences all relating to a single subject.

5-45. PARAGRAPH HEADINGS. The system of paragraph subordination through the use of paragraph headings that shall be followed to present related information in a logical manner is shown in table 5-1. If subordinate headings are used under a higher-order heading, at least two headings of the same subordinate order shall be used.

Table 5-1 Paragraph Heading Format

Order of Heading	Example
First	1-10. PHYSICAL DESCRIPTION. 1-11 First order headings shall be fully capitalized, underlined, and terminated with a period. First order heading shall not be run into the text, and shall be separated from other copy by double-spacing both before and after the heading.
Second	1-20. PATCH PANEL 1-21. Second order headings shall be fully capitalized and terminated with a period, but shall not be underlined. Second order headings shall not be run into the text, and shall be separated from other copy by double-spacing both before and after the heading
Third	1-30 GATING CIRCUITS. Third order headings shall be fully capitalized, underlined, and terminated with a period Text (except procedural steps) shall be run in with third order headings 1-31 If a third order heading is used to introduce procedural steps, it must be followed by text that the heading can be run in with, i e., no third order heading shall stand alone
Fourth	1-40 BUFFER AMPLIFIERS. Fourth order headings shall be fully capitalized and terminated with a period, but shall not be underlined. Text (except procedural steps) shall be run in with fourth order headings. 1-41 If a fourth order heading is used to introduce procedural steps, it must be followed by text that the heading can be run in with, i.e , no fourth order heading shall stand alone
Fifth	1-50. Input Monitoring. 1-51. Fifth order headings shall have each significant word initially capitalized, shall be underlined, and shall be terminated with a period.

Table 5-1. Paragraph Heading Format (cont)

Order of Heading	Example
Fifth (cont)	1-52. Fifth order headings shall not be run into the text, and shall be separated from other copy by double-spacing both before and after the heading.
Sixth	1-60. Data Time Sharing.
	1-61. Sixth order headings shall have each significant word initially capitalized, shall be terminated with a period, but shall not be underlined Sixth order headings shall not be run into the text, and shall be separated from other copy by double-spacing both before and after the heading
Seventh	1-70. Counter Synchronization. Seventh order headings shall have each significant word initially capitalized, shall be underlined and shall be terminated with a period Text (except procedural steps) shall be run in with seventh order headings
	1-71 If a seventh order heading is used to introduce procedural steps, it must be followed by text that the heading can be run in with, i e., no seventh order heading shall stand alone

5-46 PARAGRAPH NUMBERS All paragraphs shall be numbered consecutively within each section using Arabic numerals separated by a dash. The numeral preceding the dash shall indicate the section number in which the paragraph appears, and the numeral following the dash shall indicate the consecutive number of the paragraph within the section Commercial manuals shall not contain unnumbered paragraphs. If textual material is divided for any reason, the information both before and after the division shall be considered as separate paragraphs and assigned paragraph numbers.

5-47 PROCEDURAL STEPS

5-48. Procedural steps shall be direct and concise, and shall be written in the present tense using the second person imperative. Procedural steps can be preceded by either (1) a paragraph heading and supporting text, or (2) a first, second, fifth, or sixth order paragraph heading only as indicated in paragraph 5-45. Text which follows procedural steps, however, must be preceded by a paragraph heading

5-49 All procedures shall be as short and concise as possible. Short procedures are easier for the reader to understand and perform. Occasionally a procedure becomes so lengthy that the entire alphabet is run through several times in lettering the individual steps. Whenever this occurs, the procedure shall be examined to see if it can be divided into two or more separate procedures. The added descriptive paragraph titles required by the division will aid the reader by

informing him of the objective of each part of the overall procedure. A long procedure, however, shall not be divided if the division introduces complications such as excessive references between procedures.

5-50. Procedural steps shall be subordinated using the following numbering system:

a. Primary procedural steps shall be numbered consecutively using lowercase alphabetical letters (for example: a. Connect cable W1 at.....).

b. Secondary procedural steps shall be numbered consecutively using Arabic numerals within parenthesis (for example: (1) Observe oscilloscope.....).

c. Tertiary procedural steps shall be numbered consecutively using lowercase alphabetical letters within parenthesis (for example: (a) Set MON switch to.....).

5-51. TABLES.

5-52. Tabular material may be presented in either an open text format as shown in paragraphs 3-2 and 5-14 or a closed table format as shown by tables 3-1 through 3-8. The closed table format is preferred because the table can be separately referenced by its table number. Tabular material presented in the open text format (1) appears within the text and is usually part of the sentence that identifies it, (2) contains a simple body usually consisting of a stub heading and one to three columns, (3) does not have its columns and headings separated by ruled horizontal and vertical lines, (4) does not have an identifying table number and title assigned, and (5) is not listed in the List of Tables preceding Section I of the manual. Tabular material presented in the closed table format (1) appears separate from the text and the sentence that references or identifies it, (2) contains a body consisting of two or more columns and formal column headings, (3) has its columns and headings separated by ruled horizontal and vertical lines, (4) is completely enclosed by ruled lines, (5) has an identifying table number and title assigned, and (6) is separately listed in the List of Tables preceding Section I of the manual. Column headings used for both the open text format and closed table format shall be centered above the columns, and shall have each significant word initially capitalized. In addition, column headings used for the open text format shall be underlined.

5-53. Material contained in a table shall be presented in at least two columns. If the information can be presented in less than two columns it shall be prepared as textual material in sentence and paragraph form. Tables shall be arranged to be readable either (1) when the finished manual is viewed vertically or (2) is rotated one-quarter turn clockwise from its normal reading position. Tables shall be placed within the manual immediately following the paragraph in which they are introduced or initially referenced, whenever feasible.

5-54. Tables shall be identified by a table number (terminated with a period) and a table title as shown by tables 3-1 through 3-8. The table number shall always consist of two arabic numerals separated by a hyphen. The first of these two numerals shall correspond to the section in which the table appears, and the second shall be the sequential number of the table within that section. Each word in the table title, except conjunctions, shall be initially capitalized. The table number and table title shall be centered at the top of the table. If a table is continued on a

second or subsequent page (1) the table number and title shall be centered at the top of the table on each continuation page, (2) the abbreviation "cont" shall be placed within parentheses following the table title on each continuation page, and (3) only the last page of the table shall be closed at the bottom by a ruled line.

5-55. ILLUSTRATIONS

5-56. Illustrations shall be arranged to be readable either (1) when the manual is viewed vertically or (2) is rotated one-quarter turn clockwise from its normal reading position. Foldout illustrations may be used if required; however, foldup illustrations shall never be used in a commercial manual. If the information contained on an illustration is too tall, it shall be rearranged and elongated to fit a standard 11-inch-high page. Illustrations shall be placed within the manual immediately following the paragraph in which they are introduced or initially referenced, whenever feasible.

5-57. Illustrations shall be identified by a figure number (terminated with a period) and a figure title as shown on figures 3-1 through 3-7 and 4-1 through 4-3. The figure number shall always consist of two Arabic numerals separated by a hyphen. The first of these two numerals shall correspond to the section in which the illustration appears, and the second shall be the sequential number of the illustration within that section. Each word of the figure title, except conjunctions, shall be initially capitalized. If an illustration consists of two or more sheets, all sheets of the illustration shall be identified with the figure number and title followed by a parenthetical statement specifying the sequential number of each sheet of the illustration and the total number of sheets comprising the illustration (for example: (Sheet 3 of 5), (Sheet 1 of 7), etc.).

5-58. The figure number and title shall be centered below the illustration if the illustration if full-page size (either vertical or horizontal) or smaller. If an illustration is larger than full-page size (foldout), the figure number and title shall appear below the illustration centered within the last fold of the foldout illustration. Figures 5-1 through 5-5 shall be adhered to for page layouts of quarter-page vertical illustrations, half-page vertical illustrations, full-page vertical illustrations, full-page horizontal illustrations, and foldout illustrations (paragraph 4-21), respectively. Quarter-page and half-page horizontal illustrations shall not be used within a commercial manual.

5-59. PAGE NUMBERS.

5-60. Four different methods of page numbering shall be used within each commercial manual; the title page, list of effective pages, front matter, and sections each being page numbered using a different method. Page numbers used on the list of effective pages, front matter, and sections shall always be typed flush to the outside margin (either left- or right-hand margin depending upon whether the page is a left- or right-hand page.).

5-61. PAGE NUMBERING OF TITLE PAGE. The title page shall contain no page number, as shown on the format sample of figure 3-1.

5-62. PAGE NUMBERING OF LIST OF EFFECTIVE PAGES. The list of effective pages shall be page numbered using a capital alphabetical letter A, as shown on the format sample of figure 3-2.

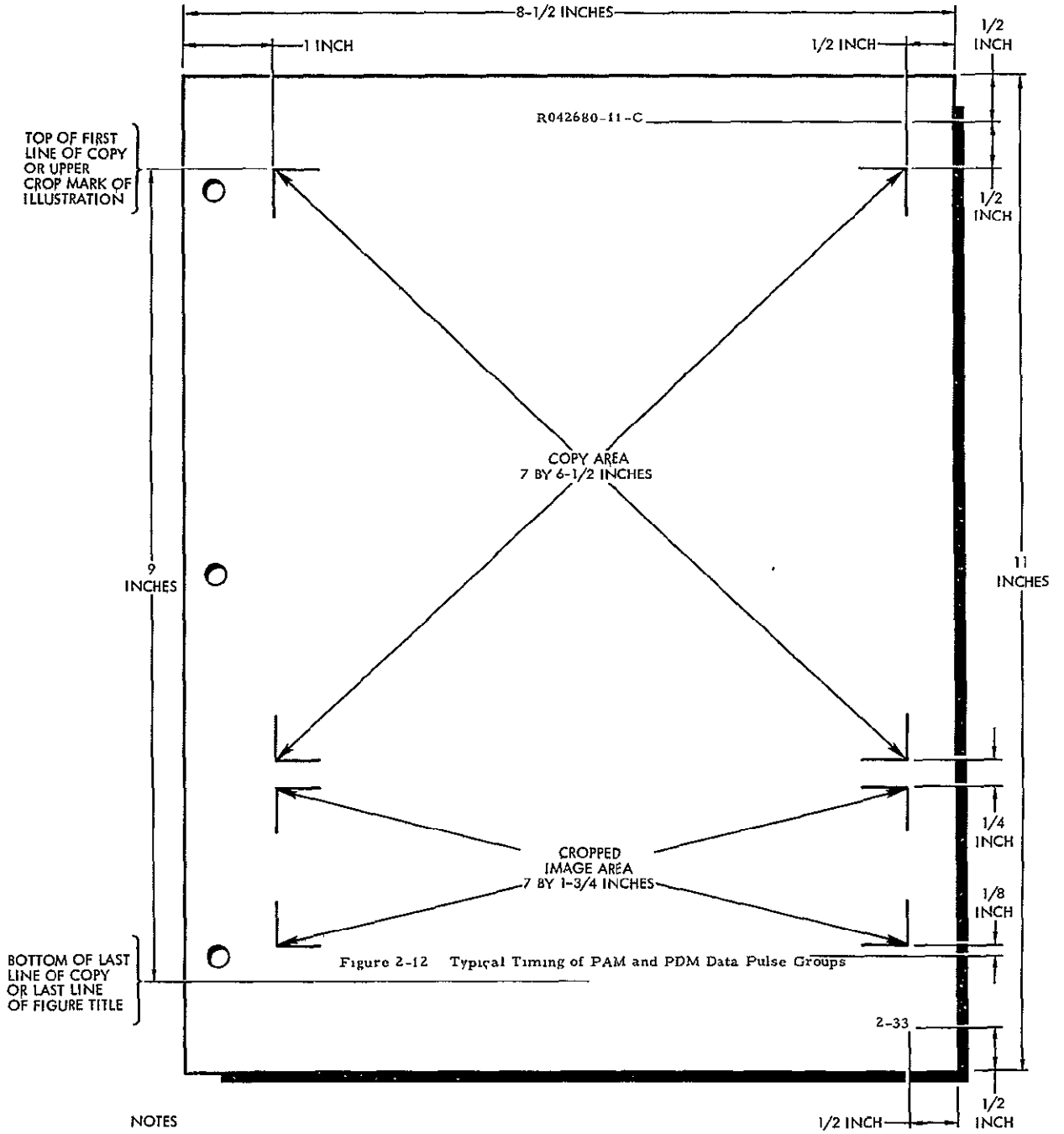


Figure 2-12 Typical Timing of PAM and PDM Data Pulse Groups

NOTES

1 QUARTER-PAGE ILLUSTRATIONS MAY APPEAR IN ANY OF THE FOUR VERTICAL QUARTERS OF A PAGE

2 ONE TO FOUR QUARTER-PAGE ILLUSTRATIONS MAY APPEAR ON THE SAME PAGE IF TWO APPEAR ON THE SAME PAGE THE COPY AREA SHALL BE 7 BY 4-1/4 INCHES IF THREE APPEAR ON THE SAME PAGE THE COPY AREA SHALL BE 7 BY 2 INCHES

3 ANY TEXT OR TABULAR MATERIAL IN THE COPY AREA, THE DOCUMENT CONTROL NUMBER CENTERED AT THE TOP OF EACH PAGE, THE FIGURE NUMBER AND TITLE CENTERED BELOW EACH ILLUSTRATION, AND THE PAGE NUMBER FLUSH TO THE OUTSIDE MARGIN SHALL BE TYPED USING A 10-POINT MODERN IBM EXECUTIVE TYPEWRITER OR EQUIVALENT.

SGI-011

Figure 5-1. Page Layout Sample of Quarter-Page Vertical Illustration (Reduced)

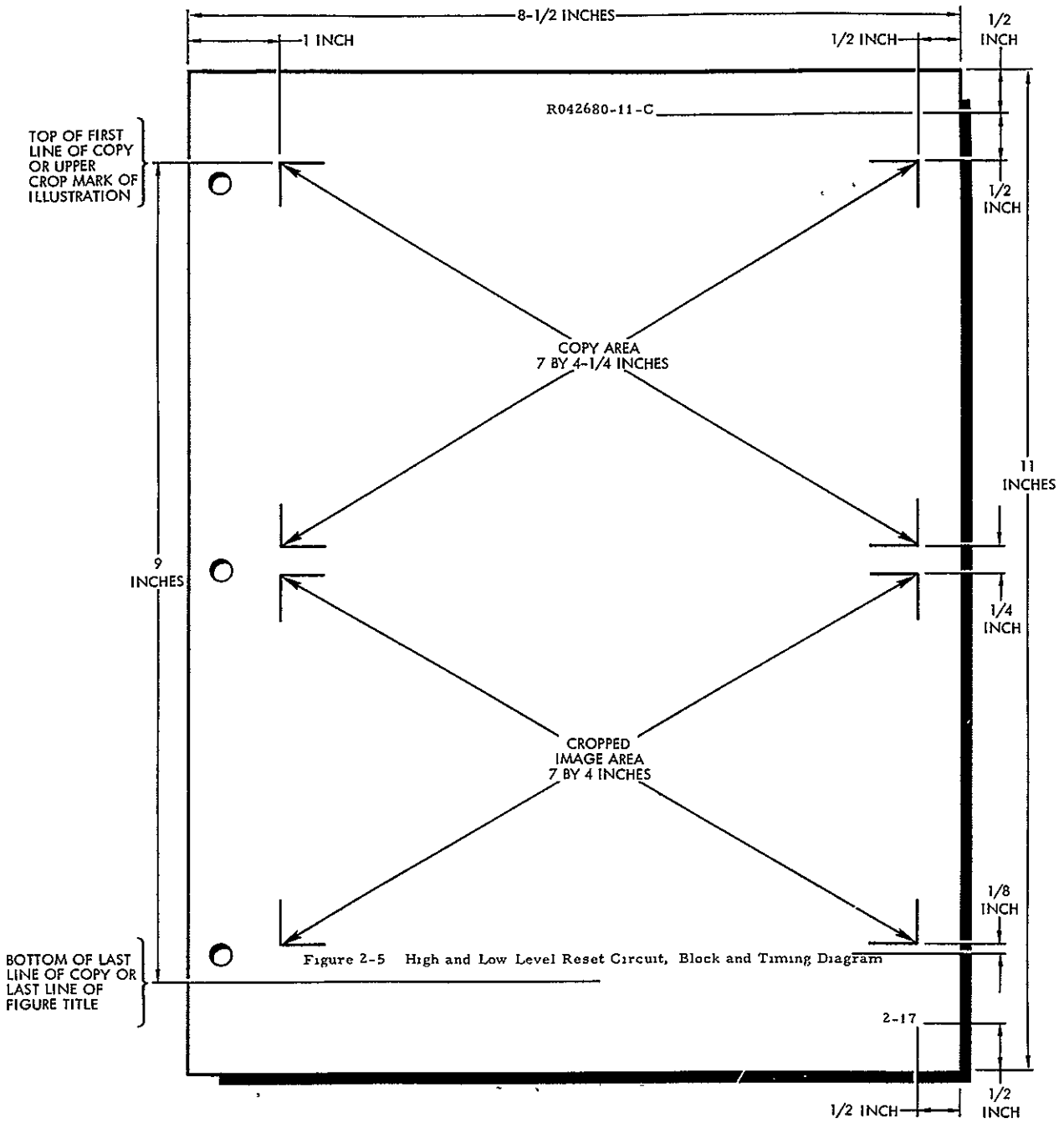


Figure 2-5 High and Low Level Reset Circuit, Block and Timing Diagram

Figure 5-2. Page Layout Sample of Half-Page Vertical Illustration (Reduced)

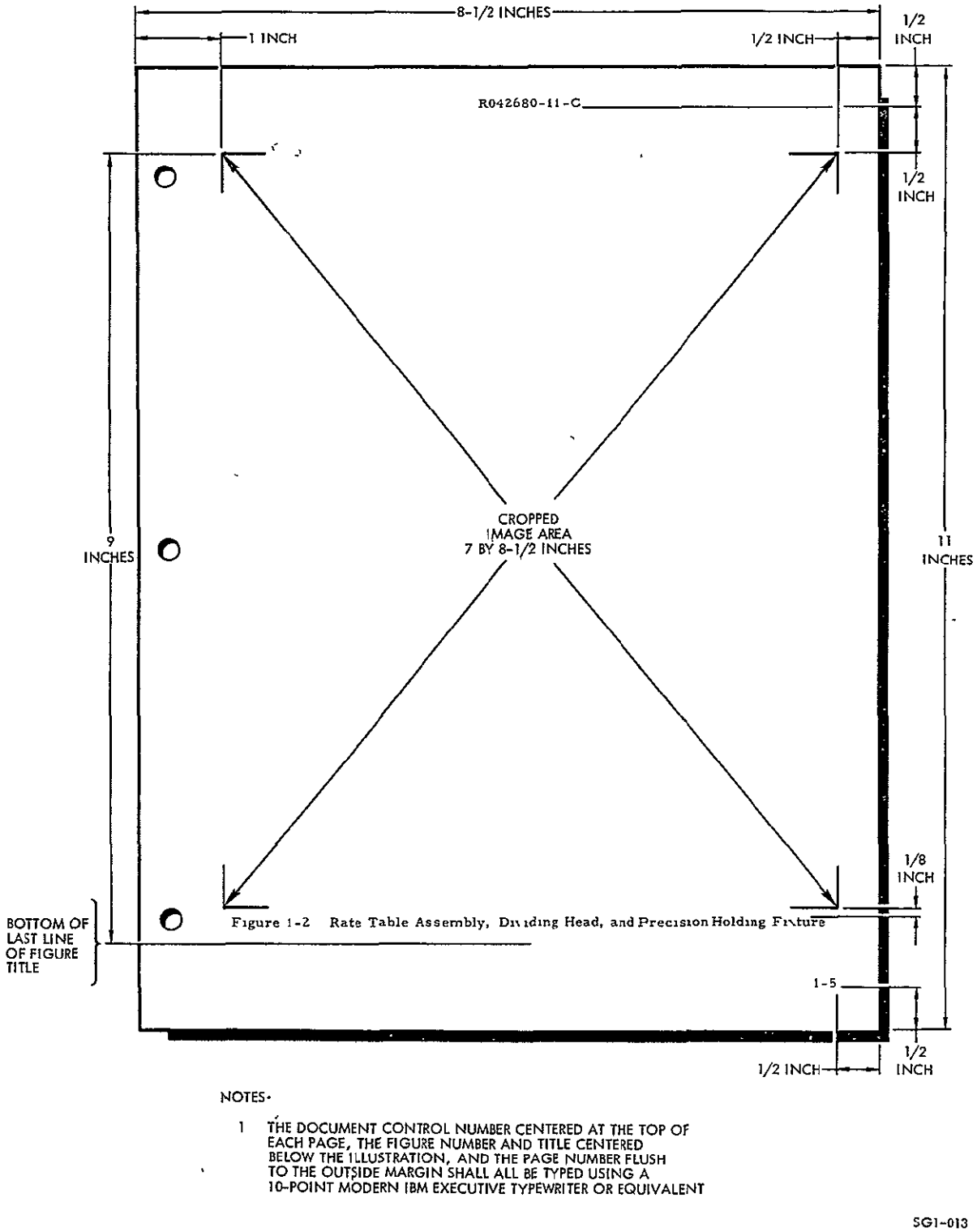


Figure 5-3. Page Layout Sample of Full-Page Vertical Illustration (Reduced)

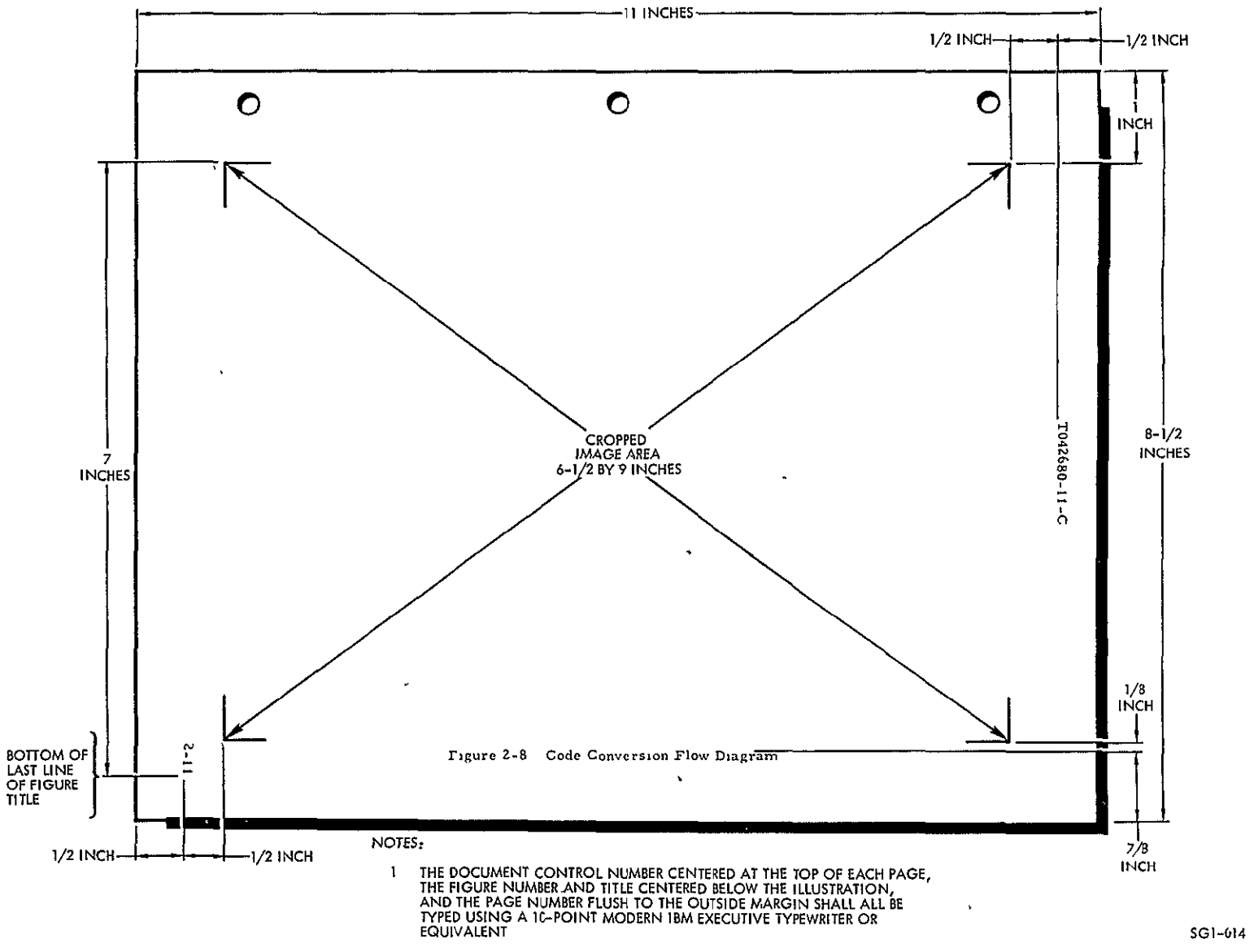
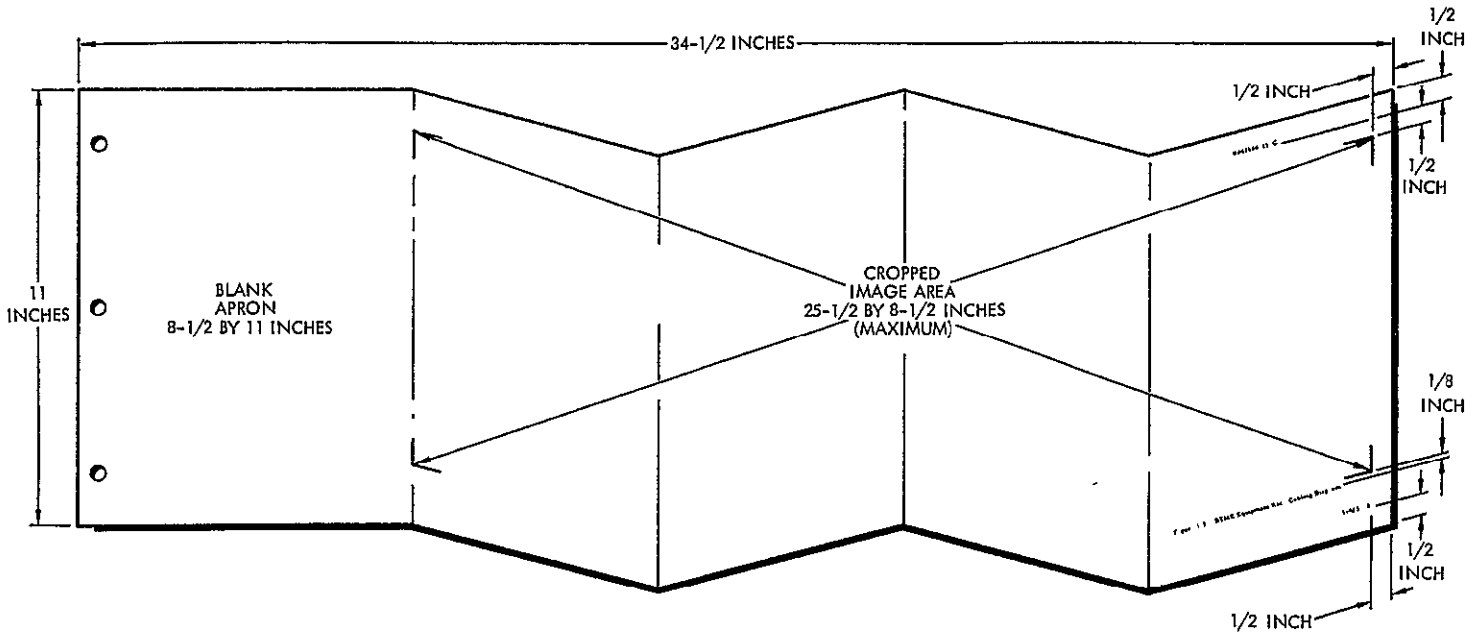


Figure 5-4. Page Layout Sample of Full-Page Horizontal Illustration (Reduced)



NOTES:

1 THE DOCUMENT CONTROL NUMBER CENTERED AT THE TOP OF EACH PAGE WITHIN THE LAST FOLD, THE FIGURE NUMBER AND TITLE CENTERED BELOW THE ILLUSTRATION WITHIN THE LAST FOLD, AND THE PAGE NUMBER FLUSH TO THE RIGHT-HAND MARGIN SHALL ALL BE TYPED USING A 10-POINT MODERN IBM EXECUTIVE TYPEWRITER OR EQUIVALENT

SG1-015

Figure 5-5. Page Layout Sample of Four-Fold Foldout Illustration (Reduced)

5-63. PAGE NUMBERING OF FRONT MATTER. All front matter (table of contents, list of illustrations, and list of tables) shall be page numbered using lowercase Roman numerals, as shown on the format samples of figures 3-3, 3-4, and 3-5. The first page of the table of contents shall be page number i, with each subsequent page of the front matter (through the last page of the list of tables) numbered consecutively using lowercase Roman numerals. If the front matter ends on a right-hand page (for example: page number vii), that page shall contain a dual page number separated by a slant mark (for example: page number vii/viii) indicating that the back-up page is intentionally left blank.

5-64. PAGE NUMBERING OF SECTIONS Every page (textual, tabular, and illustration) of each section shall be page numbered consecutively within each section using Arabic numerals separated by a dash. The numeral preceding the dash shall indicate the section number in which the page appears, and the numeral following the dash shall indicate the consecutive number of the page within the section. The first page of each section shall be a new right-hand page and shall be page number 1 (for example: the first page in Section III will be page number 3-1). If the last page of a section is a right-hand page (for example: page number 6-35), that page shall contain a dual page number separated by a slant mark (for example: page number 6-35/6-36) indicating that the back-up page is intentionally left blank.

5-65. Foldout illustrations shall be prepared as non-backed-up, right-hand pages. Each foldout illustration appearing within the commercial manual shall therefore contain a dual page number as shown on the format sample of figure 5-5

5-66. PAGE COMPOSITION.

5-67. TYPE FACE AND SIZE All copy appearing within each commercial manual (except on the title page, on the list of effective pages, and within the cropped image area of illustrations) shall be consistent in type face and size and shall be typed using a 10-point modern IBM Executive typewriter or equivalent. Copy appearing on the title page shall be in accordance with the format sample of figure 3-1, and copy on the list of effective pages shall be in accordance with the format sample of figure 3-2. Copy appearing within the cropped image area of illustration pages shall be in accordance with Section IV, and copy outside the cropped image area of illustration pages shall be in accordance with the format samples of figures 5-1 through 5-5.

5-68. PAGE LAYOUT DIMENSIONS The title page and list of effective pages shall be dimensionally arranged as shown on figures 3-1 and 3-2, respectively. Illustration pages shall be dimensionally arranged as defined in paragraph 4-19 and shown on figures 5-1 through 5-5. All other pages within each commercial manual (pages within the front matter and textual and tabular pages within each section) shall be dimensionally arranged as shown on figure 5-6.

5-69. SPACING. In general, all typewritten copy appearing within a commercial manual shall be typed single-spaced. Specific exceptions to this requirement apply to the title page (spaced per figure 3-1), list of effective pages (spaced per figure 3-2), front matter (spaced per figures 3-3, 3-4, and 3-5), copy within the image area of illustrations (spaced as required to clearly convey the intended information), and textual and tabular material within each section as stated below.

a. Double-spacing shall be used within the textual and tabular material of each section as follows:

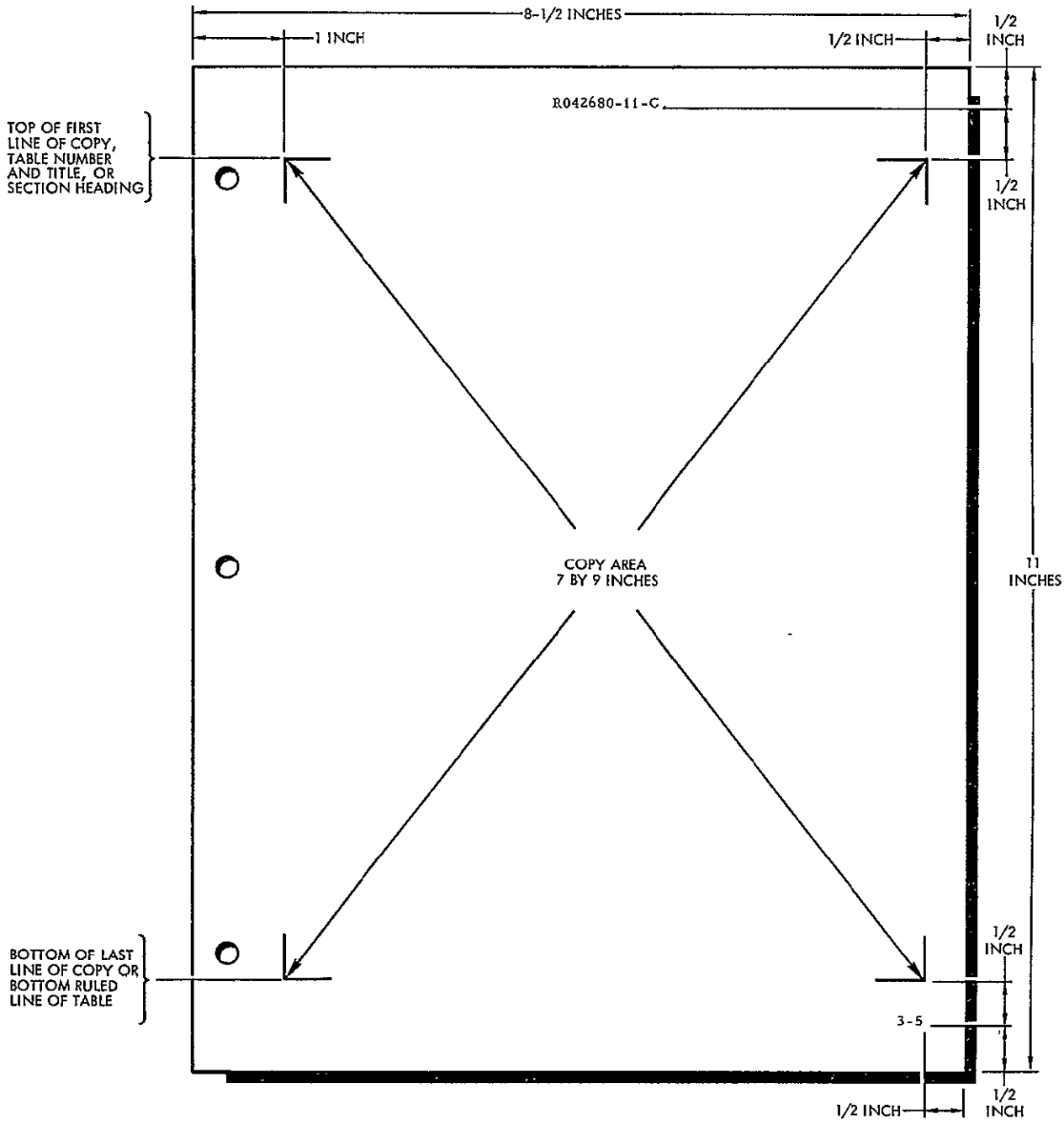


Figure 5-6. Page Layout Sample of Textual or Tabular Material Page (Reduced)

(1) Between the section number and title of section headings.

(2) Between paragraphs, and before and after each first, second, fifth, and sixth order paragraph heading.

(3) Between each numbered step of a procedure or numbered subitem within a paragraph.

(4) Before and after notation headings (note, caution, warning, etc.) and the indented notation copy following such headings.

(5) Between entries in all tables except replaceable parts listings (table 3-8).

(6) Between lines of copy that are separated by a ruled line (such as in tables)

(7) If desired, between items listed in open text format tabular material (paragraph 5-52).

b. Triple-spacing shall be used within the textual and tabular material of each section as follows:

(1) Between the section title and the first paragraph heading of each section.

(2) Between the last line of copy and a table number and title if copy precedes a table on the same page.

(3) Between the bottom ruled line of a table and the paragraph heading or line of copy immediately following the table if a table precedes copy on the same page.

5-70. INDENTING Tabular material within each section of the manual presented in the closed table format (paragraph 5-52) shall be indented from the left- and right-hand margins sufficiently to allow drawing a ruled line on these margins to fully enclose the table. Tabular material presented in the open text format (paragraph 5-52) within each section shall be indented at least 0.5 inch from the left- and right-hand margins. Textual material within each section shall be typed flush to the left-hand margin (ragged to the right-hand margin) except as specifically indicated below.

a. The commercial manual document control number (if assigned) shall be centered within the left- and right-hand margins of each page, except foldout pages, of each section. This control number shall be centered within the last fold of foldout pages (figure 5-5)

b. The section heading appearing on the first page of each section shall be centered within the left- and right-hand margins (paragraph 5-42)

c. Table headings shall be centered over the associated table (paragraph 5-54)

d Figure numbers and titles shall be centered below all illustrations except foldouts (figures 5-1 through 5-4) Figure numbers and titles shall be centered within the last fold of each foldout illustration (figure 5-5).

e. Notation headings (paragraph 5-22) shall be centered within the left- and right-hand margins. Notation copy following such headings shall be indented 1.5 inches from the left- and right-hand margins.

f. The first line of primary procedural steps (paragraph 5-50a) or numbered subitems within a paragraph shall be indented 0.25 inch (equivalent to 8 units on 10-point modern IBM Executive typewriter) from the left-hand margin. Second and subsequent lines of the step shall be typed flush to the left-hand margin, with all lines of the step ragged to the right-hand margin.

g. The first line of secondary procedural steps (paragraph 5-50b) or numbered subitems within a paragraph shall be indented 0.5 inch (equivalent to 16 units on 10-point modern IBM Executive typewriter) from the left-hand margin. Second and subsequent lines of the step shall be typed flush to the left-hand margin, with all lines of the step ragged to the right-hand margin.

h. The first line of tertiary procedural steps (paragraph 5-50c) or numbered subitems within a paragraph shall be indented 0.75 inch (equivalent to 24 units on 10-point modern IBM Executive typewriter) from the left-hand margin. Second and subsequent lines of the step shall be typed flush to the left-hand margin, with all lines of the step ragged to the right-hand margin.

SECTION VI

QUALITY ASSURANCE REQUIREMENTS

6-1. GENERAL.

6-2. The vendor preparing each commercial manual shall be responsible for the technical accuracy and completeness of all information appearing within that manual, and shall correct any deficiencies contained therein. The vendor shall also be responsible for establishing and maintaining adequate procedures for assuring the overall quality of the manual.

6-3. QUALITY ASSURANCE PROCEDURES.

6-4. The preparing vendor shall perform the quality assurance procedures listed below to assure the quality, integrity, and specification and contract compliance of each commercial manual.

a. Edit the outline, draft copy, final manual, and each revision thereto for clarity, consistency, grammar, punctuation, compliance with this specification, and compliance with the applicable contract.

b. Check all illustrations in the draft copy, final manual, and each revision thereto for completeness, accuracy, consistency, reproducibility, and compliance with this specification and the applicable contract.

c. Proofread all typed material in the outline, draft copy, final manual, and each revision thereto for typographical errors, duplications, and omissions

d. Authenticate the completeness and accuracy of all information (textual, tabular, and illustrations) in the outline, draft copy, final manual, and each revision thereto by having cognizant engineering personnel review and approve the information.

e. Verify all procedural instructions and numerical data in the draft copy, final manual, and each revision thereto using the end-item equipment (whenever possible) or authenticated design data as the verification source

f. Certify that all information in the outline, draft copy, final manual, and each revision thereto is complete, accurate, and in full compliance with this specification and the applicable contract by supplying a letter of certification attesting to this fact as in integral part of each commercial manual data submittal to TRW Systems.

SUBSYSTEM SPECIFICATION
OPERATION CONTROL CENTER SUBSYSTEM

1. SCOPE

1.1 Scope. This specification establishes the requirements for design, performance, qualification and acceptance test of the Operational Control Center Subsystem, hereinafter referred to as the Subsystem.

The Subsystem shall be a functional part of the ERTS GDHS. It shall provide a central command and control capability for the ERTS Observatory as well as providing the necessary capability for mission planning. The baseline definition is for a configuration that is collocated with the NDPF and the central computer facility.

The Subsystem will be located in Building 23, second floor at NASA/GSFC.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detail content of Sections 3, 4, and 5, the detail requirements of Sections 3, 4, and 5 shall be considered a superseding requirement. For TRW Systems documents, the latest issue shall apply.

SPECIFICATIONS

Military

MIL-D-1000 01 March 1965	Drawings-Engineering and Associated Lists

TRW Systems Group

D-13500	System Specification for Earth Resources Technology Satellites A and B
D-13590	Data Collection System, Earth Resources Technology Satellite
D-13700	Ground Data Handling System, Earth Resources Technology Satellite