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EARTH RESOURCES TECHNOLOGY SATELLITE
FINAL REPORT

# 13. GDHS STAFFING AND MATERIAL USAGE PLAN

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 13. GDHS Staffing and Material Usage Plan

April 17, 1970

prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center

Contract NAS5-11260

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# 1. GDHS STAFFING

## 1.1 INTRODUCTION

### 1.1.1 Purpose and Scope

This section presents the personnel requirements analyses, and resultant staffing requirements, and material usage requirements for the ERTS GDHS. A description of the positions required, the manning requirements, the training program, and the technical manuals are also included. A manpower cost estimate for the operation and maintenance of the GDHS is also provided.

### 1.1.2 Summary of Results

The staffing requirements are based upon three separate work areas which functionally segregate the GDHS equipment and work stations into the OCC, the NDPF, and the ADPE portion of the NDPF.

The GDHS operational concept provides for the OCC and associated automatic data processing equipment (ADPE) to be manned 24 hours per day, 7 days a week. For Case A the NASA Data Processing Facility (NDPF) will be manned only on a normal work schedule, namely, 8 hours per day, 5 days a week. For Case B the NDPF will be manned 24 hours per day, 7 days a week.

The total manning for the GDHS is 180 personnel for Case A and 279 for Case B. This total is computed 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 |

In computing the total staffing requirements a manning factor of 1.0 was used for single-shift operations and 5.0 for those positions which absolutely require manning around the clock. The manning factor used was less than 5.0, for many positions in the NDPF, because of job level requirements.

Figure 1-1 illustrates the first organizational tier for the GDHS. The complement of personnel and their functions which make up the lower

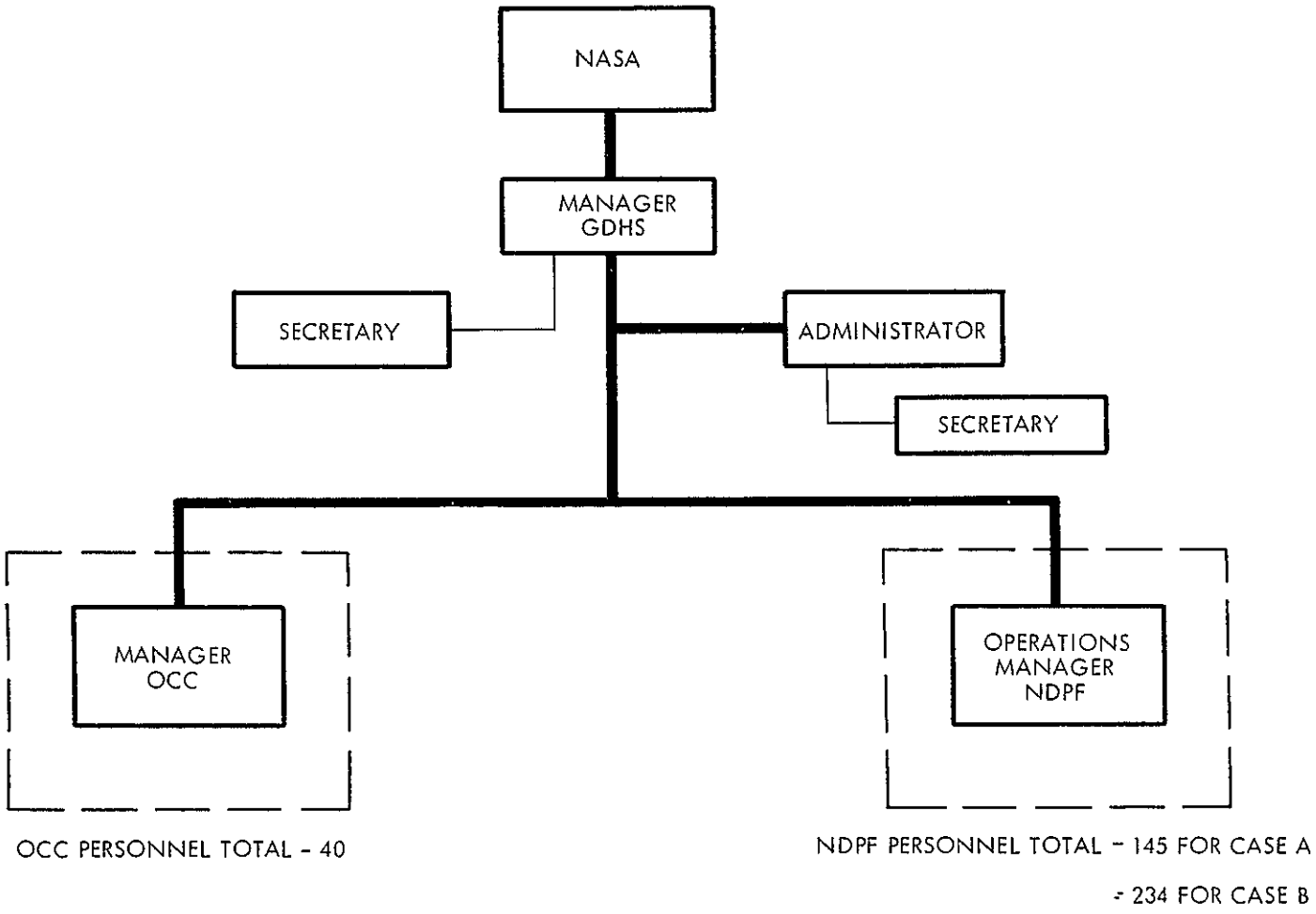


Figure 1-1
TOP LEVEL ORGANIZATION CHART FOR GDHS

tiers of the GDHS organization are discussed in the sections contained in this report. The yearly salary of the GDHS manager and his staff is estimated to be $52,000. The 40 personnel required to perform Operations Control Center functions include the OCC manager, 4 administrative personnel, 17 engineers, 3 programmers, and 15 technicians. These personnel are largely concerned with mission operations and their number is not necessarily influenced by the Case B situation. The cost per annum for these 40 personnel is estimated to be $467,000.

The Case A personnel complement of 136 personnel for the NDPF includes the NDPF manager, 70 personnel associated with the ADPE operations, 20 personnel associated with data management functions, and 45 personnel involved with image and photo processing operations. The Case A labor cost per annum for NDPF operations is estimated to be $1,217,000. For Case B, the NDPF staffing is 235 and the breakdown includes the NDPF manager, 78 personnel associated with ADPE, 40 personnel required for data management, and 116 personnel associated with image and photo processing. The Case B situation estimated yearly NDPF personnel cost is $1,909,200.

The annual cost of operations expendables, computer tape, film, chemicals, and photographic paper is estimated to be $1,486,358 for Case A and $3,963,371 for Case B. A summary of these costs are shown below.

| | Case A | Case B |
|---|---|---|
| Total yearly cost of personnel | $1,736,000 | $2,428,200 |
| Total yearly cost of GDHS material usage | 1,486,358 | 3,963,371 |
| Total yearly cost | $3,222,358 | $6,391,571 |

## 1.2 BACKGROUND MATERIAL

### 1.2.1 Summary of Operation and Maintenance Functional Requirements

Figure 1-2 is the top functional flow for GDHS as it appears in Volume 15A "Functional Flow Diagrams" of the ERTS Functional Requirements Analysis for Operations Control and Data Processing." Volume 15A "Requirements Allocation Sheets," shows the allocation of functional performance requirements to equipment, software and personnel.

### 1. 2. 2 Operational Characteristics of the Man-Machine System Design

The ground data handling system is required to monitor large volumes of information in both an on-line and an off-line mode of operations. The basic operational concept is that the machine will perform all routine, repetitive and high-speed computations, presenting data to the man for his use in making the necessary decisions. The man is given the capability of monitoring the machine activities, intervening as necessary to modify these activities, and to order new programs to handle unplanned conditions.

In implementation of this concept, the functions allocated to the machine are those requiring repetitive, programmed decision-making, or high-speed, routine activities. The man, on the other hand, has been assigned those tasks requiring decisions based on judgment, previous experience, or where syntheses of data is necessary. The system is designed so that man, at any stage of the mission, may intervene to alter programmed instructions, and, in fact, may operate the system without the computer should a malfunction occur. The primary purpose of the machine is to remove the routine tasks from the man, allowing him to function more effectively in the decision-making role.

The functions performed in the OCC differ widely from those required in the NASA Data Processing Facility. In the OCC, on-line operations are performed on a daily basis including observatory command and control, mission planning, and command generation. In the NDPF, the basic functions are image processing, data processing, and data management. The role of the operator is basically that of an inspector, quality control monitor, or equipment operator. However, the same basic concept is implemented in both areas, that of providing a machine capability to assist the operator in the performance of his activities.

#### 1. 2. 2. 1 Task Allocation

The allocation of tasks to the man and machine is based upon the decisions made during the function analysis and are recorded on the requirements allocation sheets. The allocation of tasks to man or machine is the result of trade-off studies conducted early in the program based on knowledge of the tasks to be performed and structured within the guidelines of the operations concept.

Man-Machine Allocation - OCC

The primary OCC functions to be performed in accomplishing its basic mission of observatory command and control are summarized in Table 1-1. The following information is presented on each function with a significant man-machine interaction:

a) Man-Machine Allocation. A function may be allocated to hardware, software, and/or the human operator (H, S/W, M)

b) Control Responsibility. Either of the three mentioned above, although the human operator can intervene at critical points.

c) Role of the Operator in the System. A classification of operator tasks; verifier, interactive with respect to the machine, determine status, etc.

d) Contribution to Major OCC Functions. The contribution of each subfunction to the major functions is tabulated.

Functions 7, 11, 14, and 16 illustrate the basic design approach to the man/machine interaction within the OCC. Since the basic task of the OCC is to provide command and control of the observatory, timely information must be presented to the operations personnel to make the appropriate decisions.

Function 7 requires a basic interaction between the operator and the display system. The effectiveness of the command list, in this case, will depend on not only the skill and knowledge of the operator, but also some effective means of portraying information and having the capability to modify it on an on-line basis.

Functions 11, 14, and 16 not only involve man-machine interaction, but also depend upon a high degree of analytical and evaluative ability in the human operator to make the necessary command decision.

A flexible, interactive software system is essential to optimize the designated man-machine combination. The use of CRT displays with fixed and variable function input keyboards gives the operator access to a flexible, interactive software system and provides him with a capability for on-line correction of anomalies in observatory performance. This capability exists because CRT's will display observatory telemetry data on a real-time basis permitting constant surveillance of system

# Table 1-1. OCC Man/Machine Allocation

| **Function No | OCC Functions | Man/Machine Allocation | Control Responsibility | Role of Operator in the System | Contribution to Major OCC Functions* |
|---|---|---|---|---|---|
| 2 | Request and process orbital data | S/W | | | 3 |
| 3 | Request and process weather data | S/W | | | 3 |
| 4 | Request and receive STADAN/ MSFN network data | S/W | | | 1, 2 |
| 5 | Receive and store narrowband data | Hardware | | | 1 |
| 6 | Transform user/operator requests to event list | H S/W M | Manual verification based on man/machine interaction | Interactive man/machine final decision maker | 1, 2, 3 |
| 7 | Transform event list to command list | S/W M | Manual verification based on man/machine interaction | Interactive man/machine final decision maker | 1, 2, 3 |
| 8 | Generate and transmit S/C commands | S/W M | S/W (manual backup) | Operator verifies commands as valid | 1, 2, 3 |
| 9 | Evaluate status of transmitted commands | H S/W M | Manual verification | Status determinations | 1 |
| 10 | Process and monitor observatory and DCS telemetry | H S/W M | Auto Limits Analysis Operator notified of out-of-tolerance conditions | Respond to out-of-tolerance condition | 1 |
| 11 | Perform satellite trend analysis and status prediction | S/W | S/W (manual backup) | Analyze and evaluate | 1 |
| 13 | Maintain and record operational status | S/W M | Manual | Status information | 1, 2 |
| 14 | Update coverage operator requests based on mission operations | S/W | Analysis/evaluation of information | Analyze/evaluate | 1, 2 |
| 15 | Receive and store real-time video data | H | N/A | N/A | 1 |
| 16 | Monitor real-time video | Quick Look | Analysis/evaluation of information | Analyze/evaluate | 1 |

**Based on ERTS Functional Analysis (See Figure 1-2)
*Major OCC Functions
1 - Command, Control Function
2 - Mission Planning
3 - Command generation

states. Further, it permits use of multiple displays for surveillance by several analysts who will be specialists in various subsystem operations. Selection and execution of commands can be transferred from one specialist to another when it is desirable to do so in order to facilitate selection of contingency procedures for correcting observatory performance anomalies. Ultimately, such a man-machine system design will prove to be most cost-effective, because after a nominal period of operational testing, debugging of the software programs, and improvement of operations (procedures, manning can be accomplished by the employment of qualified technicians rather than by highly qualified specialized engineering personnel.

Man-Machine Allocation - NDPF

The NDPF functions to be performed in order to accomplish the basic functions of image processing, data processing, and data management are presented in Table 1-2. The format of Table 1-2 is the same as in Table 1-1, but the information is specific to the NDPF.

A review of Table 1-2 confirms the fact that the operator's role in the NDPF is considerably different from that in the OCC. It is quite evident that the man is used primarily as an evaluator with little emphasis on interaction with the machine on an on-line basis. While the OCC operating tasks can be defined in terms of position descriptions, the basic personnel requirement for the NDPF can be described in terms of manning various equipment stations.

While man-machine interactions are limited, some are found in the NDPF. For example, Function 1 may require a fair degree of interaction. The role of the operator is to analyze and format user requests, structure processing requirements, retrieve data, and determine if requests are adequately filled. This function to be performed efficiently, will require a fair amount of interaction with the software and the display subsystem.

The human operator plays an important role in the performance of bulk processing of RBV and MSS tapes (Functions 19 and 20). In these cases, the man-machine interaction is minimum, but the operator is required to perform difficult tasks, such as evaluating imagery and determining if the customer's request has been satisfied or whether the photos must be retaken.

# Table 1-2. NDPF Man-Machine Allocation

| Function No | NDPF Function* | Man-Machine Allocation | Control Responsibility | Role of the Operator in the System | Contribution to Major GDHS Functions** |
|---|---|---|---|---|---|
| 1 | Perform production control | Manual with software assistance | Manual | Analyze and format requests, structure processing requirements, data withdraw request, file request | 1, 2, 3 |
| 12. | Make initial attitude determination | Software | Software data | Select software program | |
| 17 | Prepare frame annotation data | Software with manual verification | Software data | Receive data | 1, 2, 3 |
| 34 | Process user queries | Software/Manual | Manual | Manage, schedule, monitor, receive | 1, 2, 3 |
| 18 | Determine precise spacecraft attitude | Software | Software data | Select software program | |
| 19 | Bulk process RBV tapes | Hardware with manual monitor | Manual | Receive, monitor the preparation of corrected separation negatives, and,<br>19 6 Visual check of the processed files<br>19 10 Imagery checked for cloud cover, other special criteria<br>19 14 Visual check and adjust - color processor | 1 |
| 20 | Bulk process MSS tapes | Hardware with manual monitor | Manual | Receive, screen and select same as 19 10 | 1, 2, 3 |
| 21 | Process DCS data and generate master digital tapes | Hardware | Manual | Manual control of tape playback, review and make final decision regarding automatic DCS data quality check Specify corrections, and prepare master tapes | 1, 2, 3 |
| 22 | Process user inputs to archival files | Software/manual | Manual | Analyze and classify user inputs, determine handling requirements, abstract user inputs for storage, | 2, 3 |
| 23 | Generate and maintain archival files | Hardware/software/manual | Manual | Log and identify data, service data requests, maintain data record and update associated data | 2, 3 |
| 24 | Prepare precision frame annotation data | Software | Software | Not applicable | 2 |
| 25 | Process in photo laboratory | Hardware/manual | Manual | Manual control of photographic processing | 1 |
| 26 | Precision process RBV data | Hardware with manual backup | Manual override | Retrieve copies, visual check of processed files, deliver<br>Select tape, playback tape, process files, prepare file copies | 1, 2, 3 |
| 27 | Precision process MSS data | Hardware with manual backup | Hardware/Manual | Select photos | 1, 2, 3 |
| 28 | Monitor facility status | Not applicable | Not applicable | Not applicable | Not applicable |

*Based on ERTS functional analysis (See Figure 1-2)

**NDPF major functions
Image Processing (1)
Data Processing (2)
Data Management (3)

In the NDPF, as in the OCC, the machine is given the task of supporting the man in the performance of his duties. Highly skilled personnel will be required because a great deal of emphasis must be placed upon each individual exercising a high degree of personal quality control in the performance of his tasks.

### 1. 2. 3 Summary of GDHS Maintenance Concept

The GDHS maintenance concept is consistent with current NASA/ GSFC maintenance practices and constraints and conforms with existing GFSC facilities, equipments, and internal management policies and procedures.

The key factors of the overall GDHS maintenance concept common to the OCC, and the NDPF, including the ADPE, which impact upon staffing are as follows:

a) The electronics technicians assigned to the OCC maintenance area will accomplish diagnostics and repair of both OCC and NDPF equipments which are within station level maintenance capability.

b) The operator personnel within the OCC facility area are assigned the responsibility for maintenance activities to be performed in-between satellite passes.

c) Maintenance job descriptions and the attendant personnel training requirements for OCC, and NDPF equipment maintenance have purposefully been combined and centralized to minimize the number of maintenance personnel for each work shift.

#### 1. 2. 3. 1 Operation Control Center

The principal element of the OCC maintenance concept is the minimization of equipment downtime through system design provisions for closed test loops for the major subsystems which permit utilization of rapid self-test, fault detection, and fault isolation capabilities.

The pulse code modulation (PCM) stored-program simulator and the DCS IF simulator interface with the ADPE to provide test and fault isolation capabilities of the PCM terminal rack and the PCM and DCS data handling equipment.

The PCM format generator can be utilized, in various combinations, to test the PCM terminal rack, PCM data handling equipment, DCS IF

simulator, OCC data handling equipment, ADPE, and the data interface buffer. In addition, the command interface simulator provides a built-in self-test feature in the data interface buffer.

All OCC maintenance activity is under the cognizance of the Operator/Planner Controller for each work shift.

### 1.2.3.2 NASA Data Processing Facility

The NDPF maintenance concept relies principally on the use of subcontractors' experience and existing (off-the-shelf) tools, such as diagnostic software, maintenance manuals, and training courses.

Test tapes are utilized with the ADPE to provide self-test and fault isolation capabilities for the equipment and processes of the wide band telemetry and photo processing facility. All items in the photographic laboratory must be tested manually by operator and maintenance personnel.

The supervisor of quality control and maintenance is responsible for all maintenance activities within the NDPF.

### 1.2.3.3 Automatic Data Processing Equipment

For the ADPE computers no more than six hours per week downtime for preventive maintenance will be required during the prime shift. The initial nine months of preventive maintenance will be procured as part of the computer basic purchase agreement.

Unscheduled computer and peripheral equipment maintenance will be provided by call contract with either the hardware manufacturer or a commercial service organization, or by development of a NASA housekeeping contractor maintenance capability. Routine maintenance of displays, display drives, line printers and card read/punch, and the normal servicing of these units will be the responsibility of ADPE maintenance head. The periodic maintenance requirement for the complete station will be printed out by the NDPF computer. The ADPE maintenance head will be responsible for coordinating the work load and posting completed preventive maintenance events for the OCC/ADPE and NDPF equipment.

### 1. 2. 4 Maintenance Characteristics of Man-Machine System Design

Maintenance of electronic equipment will be facilitated because of its design characteristics which provide readily accessible instrumentation pickoff points, software and manual test routines which permit isolation of malfunctions to replaceable equipment units. Maintenance of electro-mechanical and optical equipment will consist of periodic servicing, in-line repair of failed components, and bench repairs which require routine disassembly and reassembly of equipment items. In those instances where major maintenance activity necessitates the unavailability of certain equipments, there will be switchover and substitution of other equipment items for the failed ones and reassignment of personnel functions will be necessary to temporarily support satellite pass events. Contractor factory maintenance will be required for some equipment failures which cost-effectively cannot be justified as a station repair function.

## 1. 3 OCC STAFFING REQUIREMENTS

### 1. 3. 1 Introduction

The determination of staffing requirements is an iterative process. The following presents the products of the major steps taken to develop position descriptions and manning requirements for the OCC.

Functional flow diagrams and requirements allocation sheets were analyzed to identify those functions and tasks requiring human intervention. Further analysis of the functions/tasks, related equipment, and operational procedures required to meet mission objectives led to the identification and categorization of tasks in generic terms. The tasks were reviewed and assigned to manned positions based on task flow information, task criticality, amount of time required to perform each task, task frequency and schedule, task commonality, and the equipment associated with the task performance. Task and equipment requirements were then reviewed to determine the number of personnel and operational shifts required, during routine orbital operations, to accomplish the tasks at each manned position, and, in turn, the organizational structure of each operating area.

Results of the analyses indicate that, during routine orbital operations, several positions require manning for a 8-hour day, 5-day week, and others for a 24-hour day, 7-day week. In computing the total staffing requirements, a manning factor of 1. 0 was used for single shift operations, and 5. 0 for those positions requiring manning around the clock.

### 1. 3. 2 Task Identification/Allocation

Functions and tasks allocated to manual processing in the Requirements Allocation Sheets, Volume 15A, were itemized and assigned to positions. Positions were selected on the basis of operational aspects required to accomplish command and control of the observatory, i. e., 24 hours a day, 7 days a week operation. The operational aspects selected and positions assigned were as follows:

| Position Identification | | Operational Aspects of the Positions |
|---|---|---|
| M | Operations Planner Controller | Serves as operations crew chief and coordinates and communicates with ground tracking stations and with spacecraft commander, data analysts, and ground equipment operations. |
| N | Data Analyst | Monitor and evaluate spacecraft and payload performance. |
| O | Command Generation Technician | Provides manual backup for the commanding and preliminary preparation of spacecraft command. |
| P | PCM Technician | Operates and maintains telemetry ground handling equipment. |
| Q. | Data Technician | Prepares schedules, plans, and related activities. |

Figure 1-3 illustrates the OCC organization and Table 1-3 is a listing of selected tasks and their assignment to positions.

In order to support the operational group, management, staff personnel, and clerical support is required on a routine basis. The management structure with the associated operational group (which includes position titles and alphabetic identifiers) is depicted in the organization

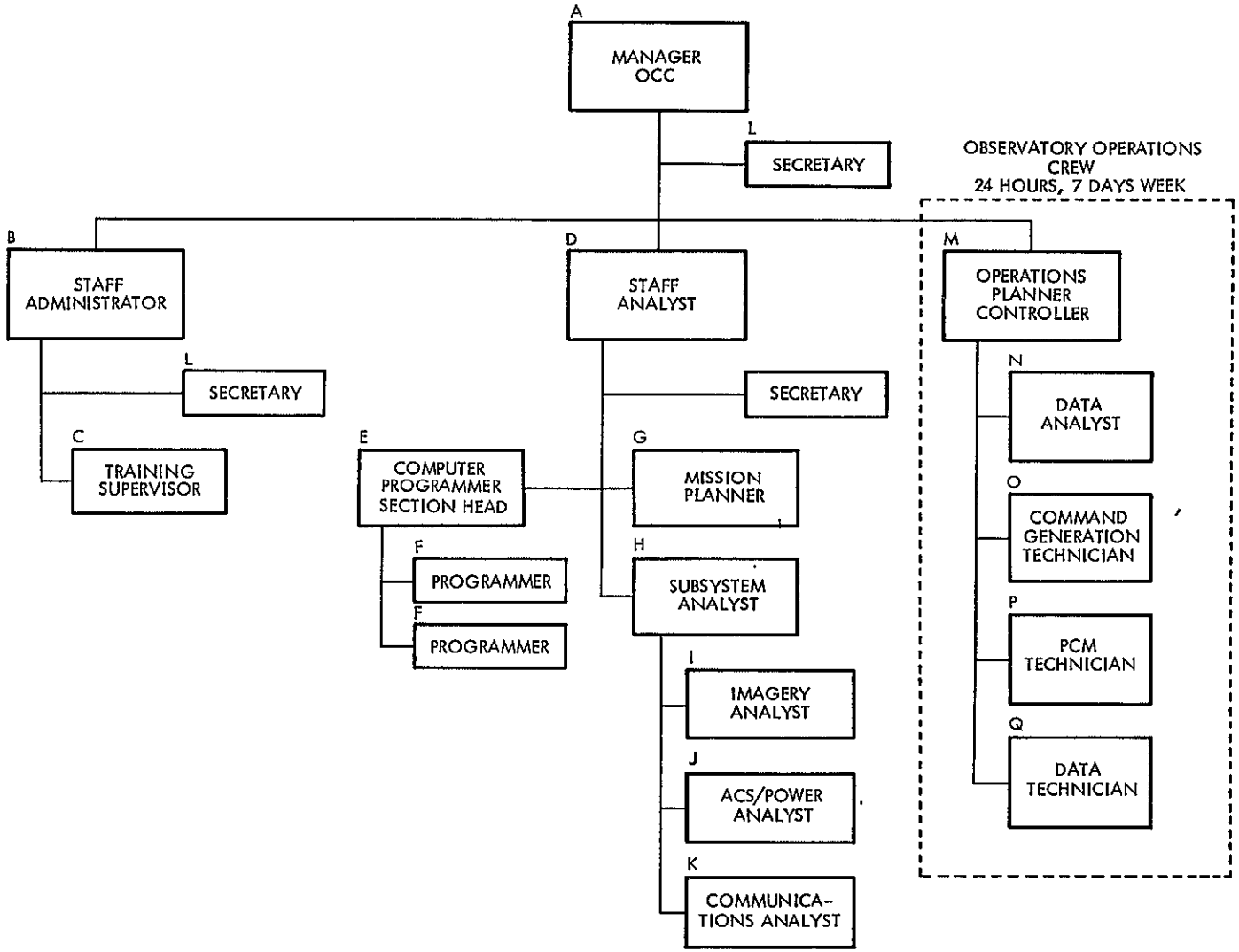


Figure 1-3

OCC ORGANIZATION CHART

Table 1-3. Allocation of Tasks to Operational Positions* within the OCC

| Function/Task | M Operations Planner Controller | N Data Analyst | O Command Generation Technician | P PCM Technician | Q Data Technician |
|---|---|---|---|---|---|
| Responsible for command activity | x | | | | |
| Provide weather predictions | x | | | | |
| Request orbit data | x | | | | |
| Evaluate observatory health | | x | | | |
| Perform trend analysis | | x | | | |
| Review history on critical items | | x | | | |
| Coordinate station support | x | | | | |
| Estimate links with station | x | | | | |
| Communicate with station | x | | | | |
| Request orbit data | x | | | | |
| Verify receipt of CMD messages | x | | | | |
| Operate PCM Data Handling Equipment | | | | x | |
| Operate PCM tape recorder | | | | x | |
| Operate Strip Charts | | | | x | |

Table 1-3. Allocation of Tasks to Operational Positions* within the OCC

| Function/Task | M Operations Planner Controller | N Data Analyst | O Command Generation Technician | P PCM Technician | Q Data Technician |
|---|---|---|---|---|---|
| Maintain PCM DHE T/R and strip charts | | | | x | |
| Handle recorder outputs | | | | x | |
| Maintain observatory continuity | | | x | | |
| Review generated list | | | x | | |
| Review Stored Command Program information | | | x | | |
| Communicate with NDPF user | | | x | | |
| Prepare schedules | | | | | x |
| Monitor OCC consumables | | | | | x |
| Generate station pass checklist | | | | | x |

*Operational positions are manned 24 hours/day, 7 days a week in contrast to management and staff positions which are manned 8 hours/day, 5 days per week.

chart, Figure 1-3. Table 1-4 provides the overall planning estimates for the OCC manning including time required of personnel, personnel classifications and allocation of CRT display consoles to positions.

1. 3. 3 Pre-Launch Staffing

The build-up of the OCC operations team will proceed over a period of 12 months as shown in Figure 1-4. Beginning with a nucleus of the OCC Manager, Staff Analyst, and one Secretary, personnel will be added incrementally until the full complement of 40 personnel required for routine orbital operations is reached at a point two months prior to launch.

The concept of on-the-job training will be utilized from the start. The functions of the OCC Manager and Staff Analyst are to update job descriptions, select personnel, arrange contract labor support if required, and review training requirements of all personnel based upon their working knowledge of spacecraft, payload, and GDHS operations requirements and design. The Training Supervisor will be among the personnel added nine months prior to launch and will be responsible for developing and implementing a training program for all personnel whose responsibility it is to operate and maintain the control center. After approval of the plan by the OCC Manager, he will coordinate and implement the training program to produce operational personnel capable of performing all aspects of their stated job assignments.

The staff administrator will be responsible for preparing and maintaining daily personnel, facilities, and activities schedules during the training period.

The remaining operating personnel will be added in stages. This will permit the original nucleus to train the first group which, after completing its training, will in turn assist in training the next group to be brought in. This process of using personnel who have completed their training to assist in training newcomers will be used until the entire OCC operating staff is fully trained.

Table 1-4. Planning Estimates

| | Position | Total Number of Personnel Required | Personnel Type |
|---|---|---|---|
| | 8 hours/day, 5 days/week | | |
| A | Manager OCC | 1 | Engineer |
| L | Secretary | 1 | Secretary |
| D | Staff Analyst | 1 | Engineer |
| L | Secretary | 1 | Secretary |
| B | Staff Administrator | 1 | Administrator |
| L | Secretary | 1 | Secretary |
| G | Mission Planner | 1 | Engineer |
| C | Training Supervisor | 1 | Engineer |
| H | Subsystem Analyst | 1 | Engineer |
| I | Imagery Analyst | 1 | Engineer |
| J | ACS/Power Analyst | 1 | Engineer |
| K | Communications Analyst | 1 | Engineer |
| E | Computer Programmer Section Head | 1 | Engineer |
| F | Programmer | 1 | Technician |
| F | Programmer | 1 | Technician |
| | 24 hours/day, 7 days/week | | |
| N | Data Analyst* | 5 | Engineer |
| M | Operations Planner Controller* | 5 | Engineer |
| P | PCM Technician | 5 | Technician |
| O | Command Generation Technician | 5 | Technician |
| Q | Data Technician | 5 | Technician |
| | TOTAL | 40 | |

*These positions are manned during an observatory pass.

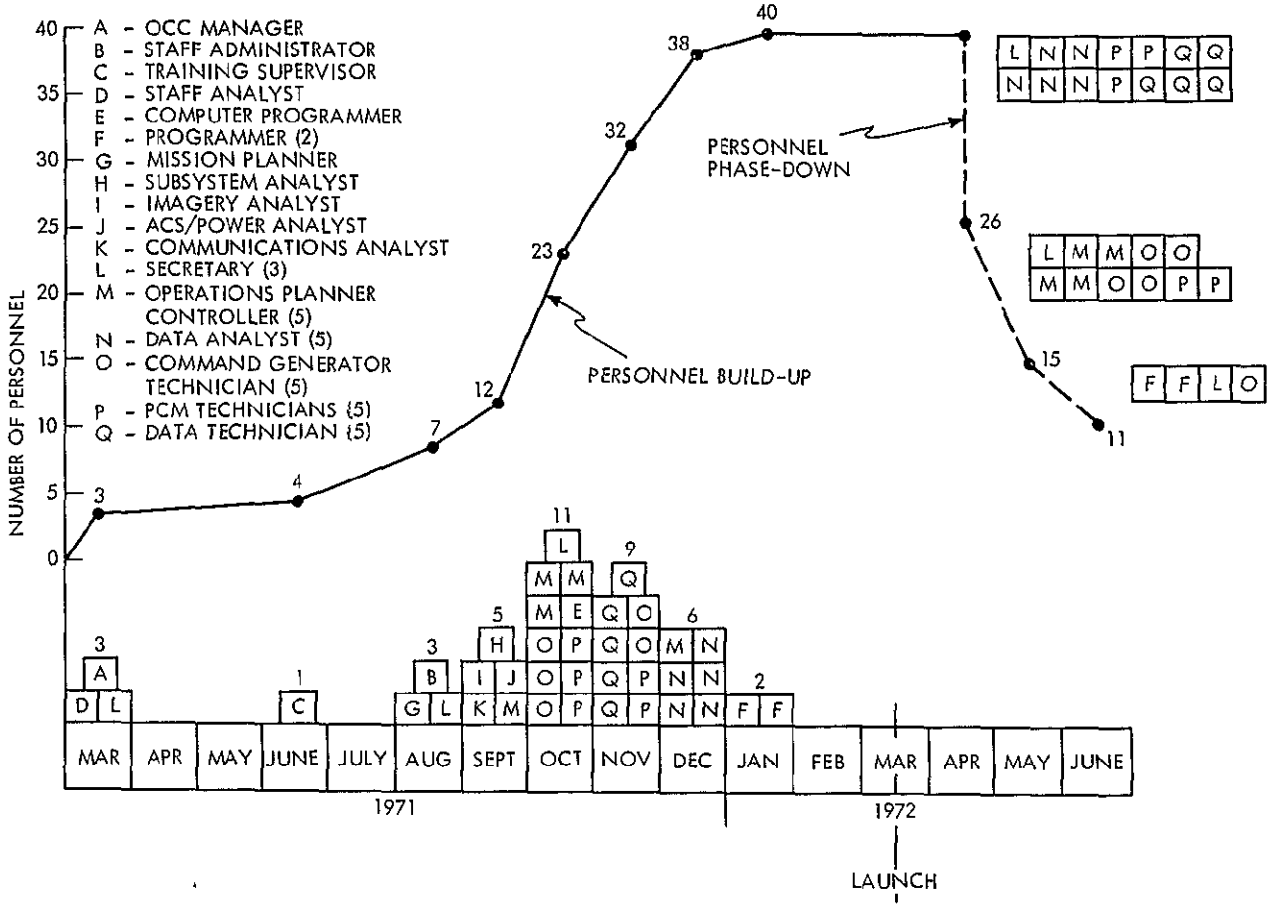


Figure 1-4

OCC STAFFING PHASING

Eighteen of the forty OCC personnel are appropriately skilled to allow TRW to hire them from the local Goddard labor market. These personnel include secretaries, data analysts, command generation technicians, PCM, and data technicians. TRW has investigated the possibility of utilizing contract labor for these personnel during the compatability test and post-launch operations.

1. 3. 3. 1 Position Descriptions

The duties for the positions depicted in Figure 1-3, OCC Organization Chart are presented below:

| Position | Title and Duties |
|---|---|
| A | OCC Manager |

- Responsible for the operations of the OCC and the performance of the operations and support personnel
- Plans, supervises, and coordinates operations and maintenance activities within the OCC.
- Presents command and control operations to ERTS project management.
- Interprets NASA policies and activities for OCC personnel.
- Determines optimum personnel practices, manpower levels, budget requirements, and training programs.
- Establishes schedules and manning necessary to meet operating requirements and determines alternate sources of action as schedules change.
- Reviews and approves the OCC daily activities schedule.

B Staff Administrator

- Insures that administrative requirements of OCC staff and operational personnel are satisfied.
- Prepares reports in conjunction with other staff members.

C Operations Training Supervisor

- Provides simulated training exercises to newly assigned OCC personnel utilizing script material. Utilizes hardware and software in training exercises as they become available.
- Responsible for the training of all personnel.
- Coordinates with operations controller-planners and systems analysts in obtaining training material and training assistance.
- Provides refresher training to experienced personnel and cross-training in the case of equipment procedures.

D Staff Analyst

- Reviews accomplishment of daily schedules and reports deviations.
- Prepares daily OCC activity schedules.
- Prepares inputs in the form of prioritized maintenance tasks for inclusion in the OCC daily schedule.
- Prepare spacecraft and payload operational reports.
- Coordination activities of subsystem analysis.

E, F Computer Programmer

- Maintains all OCC application programs.
- Coordinates with NDPF Programming Head.
- Writes programs and routines and prepares flowcharts and diagrams as required.
- Checks equipment and performs readiness tests to ensure OCC data processing and display equipment are in an operational mode.
- Assists training supervisor during simulated training sessions. Operates tape decks and ensures equipment is operating properly.

G Mission Planner

- Provides weather interpretations and predictions to operating personnel.
- Provide on-the-job training to Operations Planner-Controller for around-the-clock weather predictions.
- Generates operating procedures for STADAN stations to support ERTS passes.
- Establishes schedules of activities required to generate and distribute command lists for each observatory pass.
- Establishes schedules and manning necessary to meet operating requirements, and determines alternate courses of action as schedule changes.
- Reviews the OCC Daily Schedule to determine position-related assignments.
- Provides master schedule and long term planning; coordinates with all shifts to ensure continuity of operations.
- Prepares reports.

H, I, J, K Subsystem Analysts

The following duties are typical of those performed by each analyst:

- Review pass schedules for payload activity.
- Receives payload data and selects video signals for display.
- Evaluate sensor performance. Examines video images for quality and cloud cover. Confirm basic data quality.
- Evaluates mission performance. Compares sensor coverage against effected coverage.
- Specifies corrective measures. Determines actions required to improve image quality.
- Add annotation comments to video data.
- Generate quick-look report including unfulfilled sensor coverage report.

L Secretary

- Provide clerical/secretarial support as required.
- Type technical and administrative reports.

M Operations Planner Controller

- Coordinates OCC activities.
- Coordination of station support schedule with OPSCON.
- Coordinates the establishment of voice and data links required for ERTS operations.
- Communicates with STADAN stations during pre- and post-pass activities.
- Requests orbital data, weather data, and STADAN/ MSFN support.
- Forwards messages and instructions necessary to support ERTS passes to STADAN/MSFN stations.
- Verifies receipt of command messages by STADAN/ MSFN.
- Reviews assignment of observatory acquisition opportunities versus users requests.
- Reviews command list, event list, orbit corrections, power budget, and weather data.
- Reviews support schedule.
- Monitors observatory command status.
- Monitors stored command programmer status and contents.
- Checks observatory command sequence against user requests and resolves conflicts.
- Transmits commands to spacecraft as required.
- Reviews observatory command history.
- Checks observatory telemetry for parameter values and equipment status changes associated with verification of command execution.
- Reviews and modifies command lists for each station pass.

- Alters command list based upon weather predictions.
- Performs long-term trend analysis.
- Coordinates required equipment maintenance between observatory passes.

N Data Analyst

- Monitors and evaluates current observatory and sensor health.
- Perform trend analysis on required observatory and payload data.
- Perform subsystem engineering utilizing displays and strip charts.
- Recommends corrective action to improve observatory and payload performance.
- Maintain history of utilization of critical observatory and payload items.
- Performs long-term trend analysis.

O Command Generation Technician

- Compares systems analyst requests against payload and observatory status to maintain observatory continuity.
- Inputs user requests from NDPF to computer.
- Review computer generated event list for accuracy, conflicts, additions, and deletions.
- Review SCP preliminary command sequence, command history.
- Communicates spacecraft and sensor events to NDPF.
- Maintains OCC historical file.

PCM Technician (M and O)

P
- Maintains and operates PCM tape recorders, PCM DHE, and strip chart recorders and scopes.
- Implements requested strip chart and tape recorder channel assignments and prepares an updated list of channel allocations.

- Configures and monitors telemetry DHE prior to pass related activities.
- Labels, packages and stores tape and strip chart recorder outputs.

Q Data Technician

- Reviews ephemeris and orbit data versus station pass time.
- Prepares and distributes daily OCC time sequence activity to support ERTS operations.
- Maintains surveillance of OCC consumables.
- Prepares ground support schedules.
- Generate station pass check list.

1.3.4 Launch Staffing

The OCC personnel manning is supplemented by spacecraft subsystem engineers during the late pre-launch and early orbit operations. These engineers are not considered part of the GDHS operational personnel complement shown in Figure 1-3.

The spacecraft subsystem engineers will be available for assignment to the OCC or to any remote ground station to monitor and assist in spacecraft earth and sun acquisition sequences. During the three month post-launch period they will return to their normal TRW assignments but will be available for further OCC activity upon demand.

1.3.5 Post Launch Staffing

A gradual replacement of TRW operations personnel by government or NASA contract personnel will commence approximately six weeks following launch and will continue throughout the remaining post-launch support period. Initially, those personnel replaced will represent the relatively lower skilled levels required for GDHS operations. The staggered phase of technical personnel and their training is planned to produce a fully integrated and trained NASA team at the time the 90-day support period terminates. The TRW training supervisor will remain throughout the post-launch support period to conduct specialized training exercises. It is required that only eleven of the forty integration contractor personnel initially required to operate the OCC will be on-station at contract termination.

## 1.4 NDPF STAFFING REQUIREMENTS

### 1.4.1 Task Identification/Allocation

Functions and tasks allocated to manual processing in Requirements Allocation Sheets, Volume 15A were itemized and assigned to positions. Positions were selected on the basis of data and image processing aspects required to support observatory operations. Table 1-5 presents a listing of tasks and their assignment to positions within the NDPF.

### 1.4.2 Position Identification

In order to support the typical data and image processing positions within the NDPF, management, staff personnel and clerical support is required on a routine basis. The management structure for the NDPF portions of the GDHS is depicted in the organization chart, Figure 1-5. The ADPE organization is incorporated within the NDPF.

Table 1-6 provides the overall planning estimates for the NDPF manning including:

a) Position Title. Each position within the NDPF will have a position title.

b) Location. Primary duty position.

c) Job Classification. A classification of jobs was established to cover all NDPF (including ADPE) positions.

d) Number of Personnel. The number of personnel for each position within the NDPF which are listed by title on the table for Case A and Case B.

### 1.4.3 Manning Requirements and Number of Personnel

An analysis was performed of the number of images to be received from the MSS and RBV sensors. This data was then used to determine the amount of time required for each subprocess (bulk and precision modes) and associated human functions for telemetry image data processing and data services. Number of individuals required per shift and number of shifts were determined considering such factors as customer time requirements for the processed film and data.

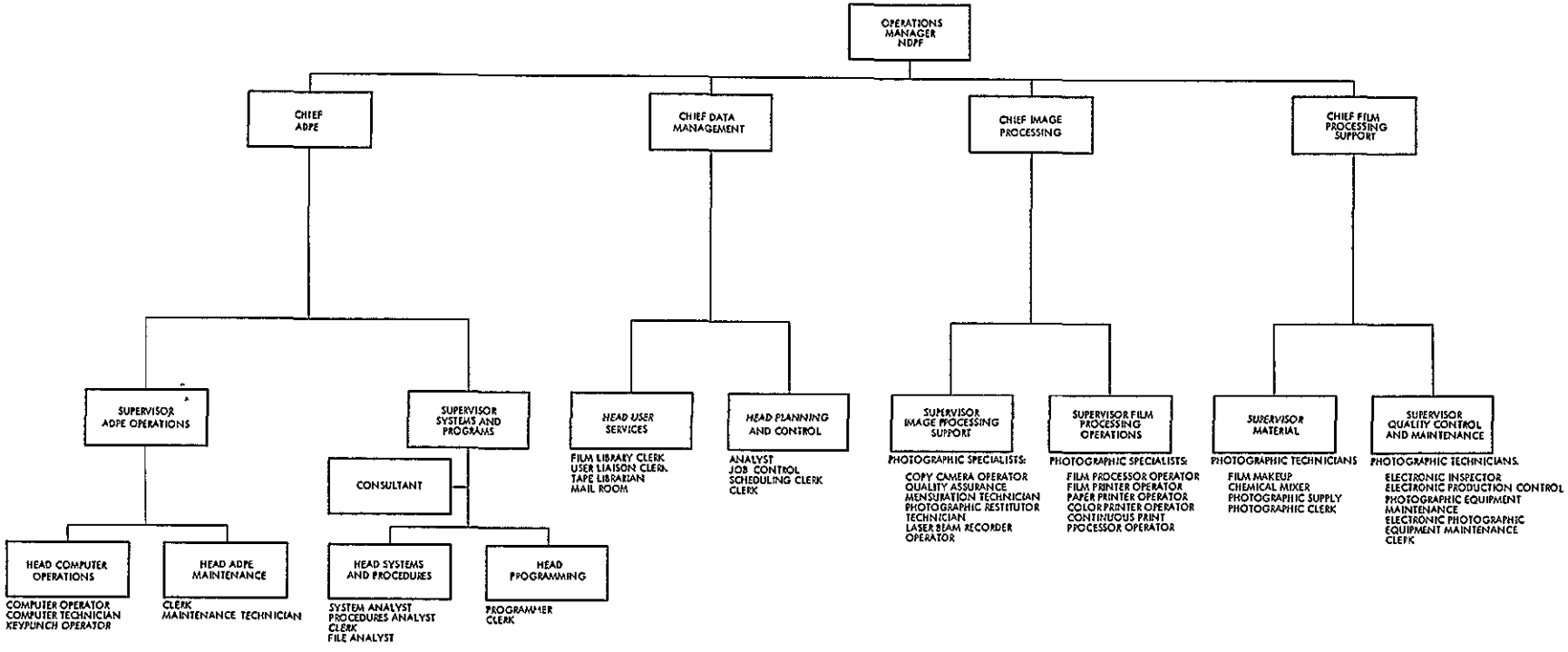


Figure 1-5

NDPF ORGANIZATION CHART

Table 1-5. Allocation of Tasks to Manned Positions in NDPF

| | Functions/Tasks | Positions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Photo Inspector | Chemical Mixer | Film Processor Operator | Copy Camera Operator | Maintenance Photo Equipment | System Analyst | Procedures Analyst | Computer Operator | Computer Technician |
| 1 | PERFORM PRODUCTION CONTROL | | | | | | | X | X | X |
| 17 | PREPARE FRAME ANNOTATION DATA | | | X | | | | | X | X |
| 34. | PROCESS USER QUERIES | | | | | | X | X | X | X |
| 19 | BULK PROCESS RBV TAPES | | | X | | | | X | X | X |
| 20 | BULK PROCESS MSS TAPES | | | X | | | | X | X | X |
| 21 | PROCESS DCS DATA AND GENERATE MASTER DIGITAL TAPES | | | | | | X | | X | X |
| 22 | PROCESS USER INPUTS TO ARCHIVAL FILES | | | | | | | X | X | X |
| 23 | GENERATE AND MAINTAIN ARCHIVAL TAPE FILES | | | | | | X | | X | X |
| 24 | PREPARE PRECISION FRAME ANNOTATION DATA | | | | | | | | X | X |
| 25 | PROCESS IN PHOTO LABORATORY | | X | | | | | | | |
| 26 | PRECISION PROCESS RBV DATA | X | | | | | | X | X | X |
| 27 | PRECISION PROCESS MSS DATA | X | | | | | | X | X | X |
| 28 | MONITOR FACILITY STATUS | | | | | X | | | | |

Table 1-6. NDPF Manning Requirements

| Position Title | Room Number | Job Classification | Number of Personnel Case A | Case B |
|---|---|---|---|---|
| Operations Manager, NDPF | W221 | Operations Manager NDPF | 1 | 1 |
| Chief, Film Processing Support | E205 | Senior Photo Specialist | 1 | 2 |
| Supervisor, Quality Control and Maintenance | C2212A | Photo Specialist | 1 | 3 |
| Photo Inspector | C2212A | Photo Technician | 2 | 3 |
| Photo Production Control | E209 | Photo Technician | 2 | 3 |
| Photo Equipment Maintenance | C2208 | Photo Technician | 2 | 3 |
| Electronic Photo Equipment Maintenance | W226 | Photo Technician | 2 | 3 |
| Clerk | C2212A | Clerk, General | 3 | 9 |
| Supervisor, Material | C2206 | Photo Specialist | 1 | 3 |
| Film Makeup | E214A | Photo Technician | 3 | 3 |
| Chemical Mixer | C2206A | Photo Technician | 2 | 3 |
| Photo Supply | C2206 | Photo Technician | 3 | 9 |
| Photo Clerk | C2206 | Photo Technician | 2 | 3 |
| Chief, Image Processing | E203 | Senior Photo Specialist | 1 | 3 |
| Supervisor, Film Processing Operations | E216 | Photo Specialist | 1 | 3 |

Table 1-6. NDPF Manning Requirements (Continued)

| Position Title | Room Number | Job Classification | Number of Personnel Case A | Case B |
|---|---|---|---|---|
| Film Processor Operator | E216 | Photo Specialist | 3 | 9 |
| Film Printer Operator | E216 | Photo Specialist | 2 | 6 |
| Paper Printer Operator | C2203 | Photo Specialist | 4 | 12 |
| Color Printer Operator | C2203 | Photo Specialist | 3 | 9 |
| Supervisor, Image Processing Support | E203 | Photo Specialist | 1 | 3 |
| Copy Camera Operator | E216 | Photo Specialist | 1 | 3 |
| Quality Assurance | C2212 | Photo Specialist | 2 | 6 |
| Mensuration Technician | C2007 | Mensuration Technician | 1 | 3 |
| Photo Restitutor Technician | C2008 | Photo Restitutor Technician | 1 | 5 |
| Laser Beam Recorder Operator | C2008 | Laser Beam Recorder Operator | 1 | 5 |
| Chief, Data Management | W217 | Chief, Data Management | 1 | 1 |

Table 1-6. NDPF Manning Requirements (Continued)

| Position Title | Room Number | Job Classification | Number of Personnel Case A | Case B |
|---|---|---|---|---|
| Head, User Services | W204 | Head, User Services | 1 | 1 |
| Library Clerk | C2106 | Library Clerk | 2 | 9 |
| User Liaison Clerk | W202 | Clerk, User Liaison | 1 | 1 |
| Clerk | W202 | Clerk, General | 1 | 2 |
| Tape Librarian | C2106 | Clerk, General | 2 | 5 |
| Mail Room Clerk | E215 | Clerk, General | 2 | 6 |
| Head, Planning and Control | W215 | | 1 | 1 |
| Scheduling Clerk | W213 | Clerk, General | 3 | 9 |
| Job Control | W213 | Clerk, General | 2 | 3 |
| Analyst | W211 | Analyst | 4 | 4 |
| Chief, ADPE | W219 | Chief, ADPE | 1 | 1 |
| Supervisor, Systems and Programs | W209 | Supervisor, Systems and Programs | 1 | 1 |
| Consultant | W209 | Consultant | 1 | 1 |
| Head, Programming | W203 | Head, Programming | 1 | 1 |
| Programmer | W203 | Computer Programmer | 8 | 8 |

Table 1-6. NDPF Manning Requirements (Continued)

| Position Title | Room Number | Job Classification | Number of Personnel Case A | Case B |
|---|---|---|---|---|
| Clerk | W203 | Clerk, General | 1 | 1 |
| Head, Systems and Procedures | W207 | Head, Systems and Procedures | 1 | 1 |
| System Analyst | W207 | System Analyst | 5 | 5 |
| Procedures Analyst | W205 | Procedures Analyst | 5 | 5 |
| File Analyst | W205 | File Analyst | 4 | 9 |
| Clerk | W208 | Clerk, General | 2 | 2 |
| Head, ADPE Maintenance | W208 | Head, ADPE Maintenance | 1 | 1 |
| Head, Computer Operations | W208 | Head, Computer Operations | 5 | 5 |
| Computer Operator* | W208 | Computer Operator | 20 | 20 |
| Computer Technician** | W208 | Computer Technician | 5 | 5 |
| Keypunch Operator | W201 | Keypunch Operator | 2 | 5 |
| Maintenance Technician*** | W208 | Maintenance Technician | 6 | 6 |
| Supervisor, ADPE Operations | W208 | Supervisor, ADPE Operations | 1 | 1 |
| | | Total | 136 | 235 |

*Four per shift, 24 hr/day/7 days/wk.
**None per shift, 24 hr/day/7days/wk.
***Two on first shift, one on other shifts, 24 hr/day/7 days/wk.

## 1.4.4 Position Descriptions

The duties of the key supervisory positions shown in Figure 1-11, NDPF Organization Chart are presented below.

| Position | Title and Duties |
|---|---|

NDPF Operations Manager

- Responsible for the operation of telemetry imaging and data processing activities and the functions within the data services area.
- Represents NDPF operations to top level ERTS management.
- Interprets NASA policies and activities for NDPF personnel.
- Determines optimum personnel practices, manpower levels, budget requirements and training programs.
- Reviews and approves the NDPF activity schedules.
- Plans, supervises and coordinates operation of the imager/photo processing and data services activities.
- Motivates personnel to the accomplishment of established objectives.
- Maintains or approves contracts with GSFC offices and agencies.
- Evaluates imagery film processing, and data services performance against plans and goals.
- Determines optimum personnel practices, manpower levels, budget requirements and training programs.

- Evaluates feasibility of potential applications and approves of the amount and type of equipment required to perform the applications.

Chief, Film Processing Support

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

- Responsible for the maintenance of the photo and electronic photo equipment.

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

Supervisor, Quality Control and Maintenance

- Responsible for implementing the quality control program for the film processing activities

- 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

- Responsible for the scheduling of all maintenance activities and for assuring that all equipment is in operating condition

- Supervise the maintenance technicians and arrange for contracted maintenance assistance as required

Supervisor, Material

- Supervises the activities of the personnel assigned to the material section.

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

- Responsible for all supply activities required to support the film processing operations

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

Chief, Image Processing

- Responsible for the operations of the film processing activities in converting the RBV and MSS data into photographs required by the users.
- Responsible for the personnel assigned to the film processing section to assure that schedules are met.
- Responsible for the development of the procedures used by the film processing personnel and for the adherence to safe and efficient methods.

Supervisor, Film Processing Operations

- Plans and administers the operation of the activities performed in the film processing department.
- Maintains efficient utilization of film processing equipment and personnel resources.
- Establishes schedules to meet operating requirements and determines alternate courses of action as schedules change.
- Verifies adherence to prescribed operating rules and regulations.
- Provides proper training for operating personnel.
- Evaluates quality of personnel and procedures and makes adjustments.

Supervisor, Image Processing Support

- Plans and administers the operation of the activities performed in the film processing support department.
- Establishes schedules to meet operating requirements.
- Reviews and establishes prescribed operating rules and regulations and verifies that these are followed by all department personnel.
- Provides proper training of department personnel.
- Evaluates quality of personnel and procedures and makes all necessary changes.

Chief, Data Management

- Responsible for the job control activities necessary for the proper handling of all user requests.
- Responsible for the maintenance and updating of the film library
- Responsible for the scheduling of user requests and the satisfaction of user requirements
- Supervises the photo handling activities to assure proper forwarding of data to users on a timely basis

ADPE Chief

- Plans and administers the operations of the personnel assigned to the ADPE departments
- Maintains efficient utilization of computing equipment and personnel resources.
- Establishes schedules to meet operating requirements, and determines alternate courses of action as schedules change.
- Verifies adherence to prescribed operating rules and regulations
- Determines internal report requirements (for example, machine utilization).
- Sets acceptance standards for production programs and documentation received from the methods group.
- Provides proper training for operating personnel
- Evaluates quality of personnel and procedures and makes adjustments as necessary

Supervisor, Systems and Programs

- Interprets broad areas to be investigated, general aims of the methods group, and proves feasibility of application projects.
- Supervises planning, design, coding and documentation of projects to insure their proper execution.
- Reviews and coordinates procedures employed in implementing and maintaining the data system and recommends appropriate procedures to support job completion on schedule.

- Endorses application of the latest machine programming systems and systems techniques.

- Maintains liaison between methods and each of the operating groups.

Head, Programming

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

- Assigns, outlines and coordinates work of programmers.

- Trains subordinates to prepare and write programs, routines, flowcharts, and diagrams.

- Reviews, evaluates and reports performance

- Collaborates with supervisor of systems and procedures on schedules and NDPF

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

Head, Systems and Procedures

- Supervises assigned personnel and coordinates work of the analysts.

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

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

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

- Communicates with other departments on NDPF requirements

- Prepares standards instructions on such subjects as record formats, routines, labels audit, and machine controls

Head, ADPE Maintenance

- Plans, supervises and coordinates the maintenance activities on the automatic data processing equipment in the NDPF
- Responsible for maintaining the ADPE in proper operating conditions and for the performance of testing necessary to prevent or correct equipment malfunction
- Responsible for scheduling the activities of the maintenance technicians of the section
- Responsible for the coordination of contractor furnished maintenance and the scheduling of maintenance activities

Head, Computer Operations

- Supervises the operations of the computer room, including computer operators and keypunch operators.
- Communicates with other departments on NDPF requirements
- Trains subordinates in computer room operations
- Supports both OCC and image processing personnel as necessary in the performance of their duties.

Supervisor, ADPE Operations

- Responsible for the operations of the computer equipment and for the personnel assigned to the section
- Responsible for the maintenance of the equipment to assure ADPE support of OCC and NDPF activities
- Responsible for the scheduling of ADPE personnel and equipment to support the implementation of all operating schedules.

## 1.5 TRAINING REQUIREMENTS

A training program will be developed and implemented for Contractor/NASA personnel who will operate and maintain the GDHS equipment at GSFC. An overall training plan will be generated by the OCC training supervisor describing methods and procedures required to conduct the training program on all GDHS hardware/software equipment (OCC, NDPF, and ADPE). The training supervisor will receive training program planning from IBM/ITEK personnel, evaluate this information and integrate

it into the training plan. After approval of the training plan the training supervisor will coordinate and implement the training program at GSFC to produce trained Contractor/NASA personnel who can perform all required aspects of their stated job assignments.

The major phases of the training program are identified as follows and will occur, in general, in the sequence listed:

a) Develop detailed GDHS position descriptions

b) Establish 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)

### 1.5.1 GDHS Position Descriptions

The description of the staffing arrangement and descriptions of each designated position at GSFC will furnish the basis for that part of the training requirements analysis which deals with the operational and maintenance requirements in support of the mission objectives. Associated with each of the position descriptions will be experience prerequisites which will provide basic guidelines for the initial evaluation of candidate suitability.

### 1.5.2 Establish Personnel Selection Process

Project management will make the selection of candidates deemed qualified (through past experience and future training) to assume specific maintenance and operations positions. Upon the identification of candidates for each position, interviews with each candidate will be held by the training supervisor. The purpose of such interviews will be to determine:

a) The technical experience background, skills and knowledge that the individual is bringing with him.

b) His present technical assignment on the project.

c) General assessment of his technical strengths and weaknesses with respect to such an assignment.

Maintenance and operations personnel will be selected by project management from the group of candidates after the processes of screening, interviewing, and evaluating have been completed.

The interview data, together with the training requirements analysis evaluation, will comprise an individualized training package for each candidate. Such material will provide the necessary administrative guidelines which will determine the type, extent, and timing of training activities for each candidate. The training packages will be consolidated in a separate reference document and will be periodically reviewed and revised as required.

### 1.5.3 Perform Detailed Training Requirements Analysis

The process of determining the training needs of each of the designated candidates for maintenance and operation assignments is generally known as a training requirements analysis (TRA). The first part of this procedure will involve the analysis of what each position requires for satisfactory performance in support of all mission objectives. The second part of the analysis will be concerned with the evaluation of the skills and knowledge which the maintenance and operation candidate brings with him. Such data is then compared with the position requirements. The substance of training will then be identified as the difference between the above two evaluations (the "training gap"). The third part of this analysis will proceed with the determination of the following:

a) What is the appropriate and/or necessary means for training the given individual? What can be provided through tutorial training? What will require formal classroom training?

b) Is there a prerequisite course requirement (i. e., attendance at an IBM training center)?

c) To what equipment should the individual be exposed as part of his on-the-equipment training needs?

### 1.5.4 Accomplish Tutorial Training

Tutorial training is defined as that learning situation which occurs when a trainee is assigned to a resource person for the purpose of promoting the orderly, controlled and quick development of the trainee's knowledge in much the same way that a good tutor in a foreigh language would do

The training plan can only provide generalized guidelines for the direction, scope and administrative characteristics of the tutorial training activity. However, the individualized training packages, which are being developed for each maintenance and operations candidate, will provide the necessary detail and direction. They will be revised and refined as more information concerning each candidate becomes available and is programmed into his own training package.

### 1.5.5 Provide Work Experience Training

This type of training can be categorized as work experience learning activity. It is the most informal of the various types of training. Such learning activity will be characterized by the fact that what distinguishes it from purely work activity is the following: It is a direct assignment of the maintenance and operations candidate to a work activity to which he probably would not have been directed if there were not a training need involved. Since this particular need has been diagnosed in his individual training package, the decision will be made that a special work assignment will best meet the individuals' learning needs in this instance.

### 1.5.6 Conduct Classroom (Theory) Training

This type of training will be the most formal type of the four. It will be characterized as standard theory of operation training; however, the following distinguishing features will be stressed in these courses:

a) System familiarization

b) Operating procedures

c) Maintenance procedures

d) Hardware interfaces

e) Software interfaces

f) Self-test routines

### 1.5.7 Conduct On-The-Job-Training (OJT)

The final phase of the training program will involve OJT activity to provide maintenance and operations personnel with instruction on actual hardware. The first part of OJT is concerned with position training for crew members that interface with operating station consoles. Use will be made of position checklists to ensure that all crew members are intimately familiar with all aspects of their console operations. The second part of OJT is concerned with team training where the total crew performs exercises/scenarios in preparation for launch readiness activity. The position/team training will encompass all aspects of ERTS operations including prelaunch, initial, orbit, and routine on-orbit operations.

The performance of all operations and maintenance personnel will be monitored throughout the training program. 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.

Since performance on the job is paramount, the Contractor will 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.

## 1.6 TRAINING AIDS

Training aids to be provided are based on the concept of total training. They include course outlines, lesson plans, technical manuals, position checklists, graphic aids, deliverable equipment, and guides to engineering documentation.

### 1.6.1 Course Outlines

A course outline will be prepared for each course that will be presented at GSFC. The course outline will include the course description, and a detailed outline describing the content of each lecture, each lesson, laboratory worksheets, training aids to be used, the length of time to be spent on each lecture and lesson, and the scheduled examination to be given.

### 1.6.2 Lesson Plans

Lesson plans will be prepared based on the course outlines. These plans are prepared to assist the instructor in presenting and scheduling his course material. The lesson plans define, describe, and present exercises and examinations which constitute course instruction for personnel. The lesson plan will describe in a concise manner the nature of the particular presentation which the instructor will provide for a given span of instruction. Included will be memory triggers and/or sources of technical information that may be researched by the instructor to better prepare him for his instruction. Each major instructional topic will be allocated consistent with its relative importance to the instructional objective of which it is a part. The type of lesson plan (i.e., lecture, demonstration, laboratory exercise, troubleshooting or maintenance task, examination, etc.) will be stated. A concise statement of the lesson objectives will be included as part of the scope of instruction.

### 1.6.3 Technical Manuals

Preliminary copies of technical manuals will be available early in the program for training purposes. Students will be trained as to the complete content of these manuals and how to use them in operating and maintaining the GDHS equipment.

### 1.6.4 Graphic Aids

Graphic aids will be used in the classroom and in self-study sessions. Projection transparencies will show diagramatic sketches, simplified schematics, functional block diagrams, logic diagrams, and descriptive photographs or line drawings of console operating positions showing controls and indicators, simplified functional diagrams of the system, and operational checklists.

### 1.6.5 Deliverable Equipment

Deliverable equipment will be used, where possible, to acquaint the student with the equipment and to demonstrate operational and maintenance procedures.

### 1.6.6 Guide/Index to Engineering Documentation

A guide/index to selected engineering documentation will be prepared and distributed to students. The guide will contain a list of engineering drawings, selected technical reports, test procedures, software programs and other documentation pertaining to the GDHS equipment.

## 1.7 TRAINING PLAN AND MILESTONE SCHEDULE

A training plan will be generated describing the total training program required for Contractor/NASA personnel to ensure successful operation and maintenance of the GDHS equipment. The content of the training plan will be essentially what is presented below:

| Section | Title | Content |
|---|---|---|
| 1 | Introduction | Training plan scope |
| 2 | Training Program Objectives | Training objectives, concepts, approach |
| 3 | Training Program Development/Phases | Development of major training program events - types of training |
| 4 | Curriculum | Outline of courses |
| 5 | Training Aids | Materials and equipment to be used in support of training |
| 6 | Training Facilities | Facilities required in support of training |
| 7 | Personnel | Training staff requirements |
| 8 | Schedule | Detailed schedule for all training activities |

A preliminary training plan will be submitted to NASA for approval 1 May 1971. The training supervisor will coordinate with NASA personnel on the plan, incorporate their comments, and publish an approved final

plan 1 August 1971. These milestones along with other major training program milestones are shown in Figure 1-6. The training program milestones have been scheduled to dovetail other related project activities both at the contractor's plant and at GSFC.

## 1.8 TECHNICAL MANUAL REQUIREMENTS

Technical manuals will be generated to support operation and maintenance of the GDHS equipment. Preliminary copies of the manuals will be available in sufficient time to support compatibility testing and training activities. The preliminary copies of the manuals will 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 will be furnished to NASA at the time of equipment turnover.

The technical manuals required will be furnished by the technical publications department within the System Support and Logistics (SS&L) Laboratory. The responsibility of the technical publications department is to accomplish the following:

a) Identify type, format, and contents of all technical manuals required to support GDHS equipment.

b) Schedule and provide for technical manual development in consonance with project requirements.

c) Generate manuals and coordinate their development with applicable areas of project office and engineering subprojects.

d) Procure, receive, review, accept, and approve the required number of vendor manuals; vendor manuals shall include both off-the-shelf hardware manuals and manual prepared for hardware designed uniquely for the project.

e) Provide project office with a distribution list covering contact quantities plus local and residual quantities desired.

f) Provide and maintain a complete listing of all technical manuals.

g) Obtain and incorporate engineering and user comments as well as the effects of formal engineering changes (E. O.'s) into released manuals through a change page and/or revision program.

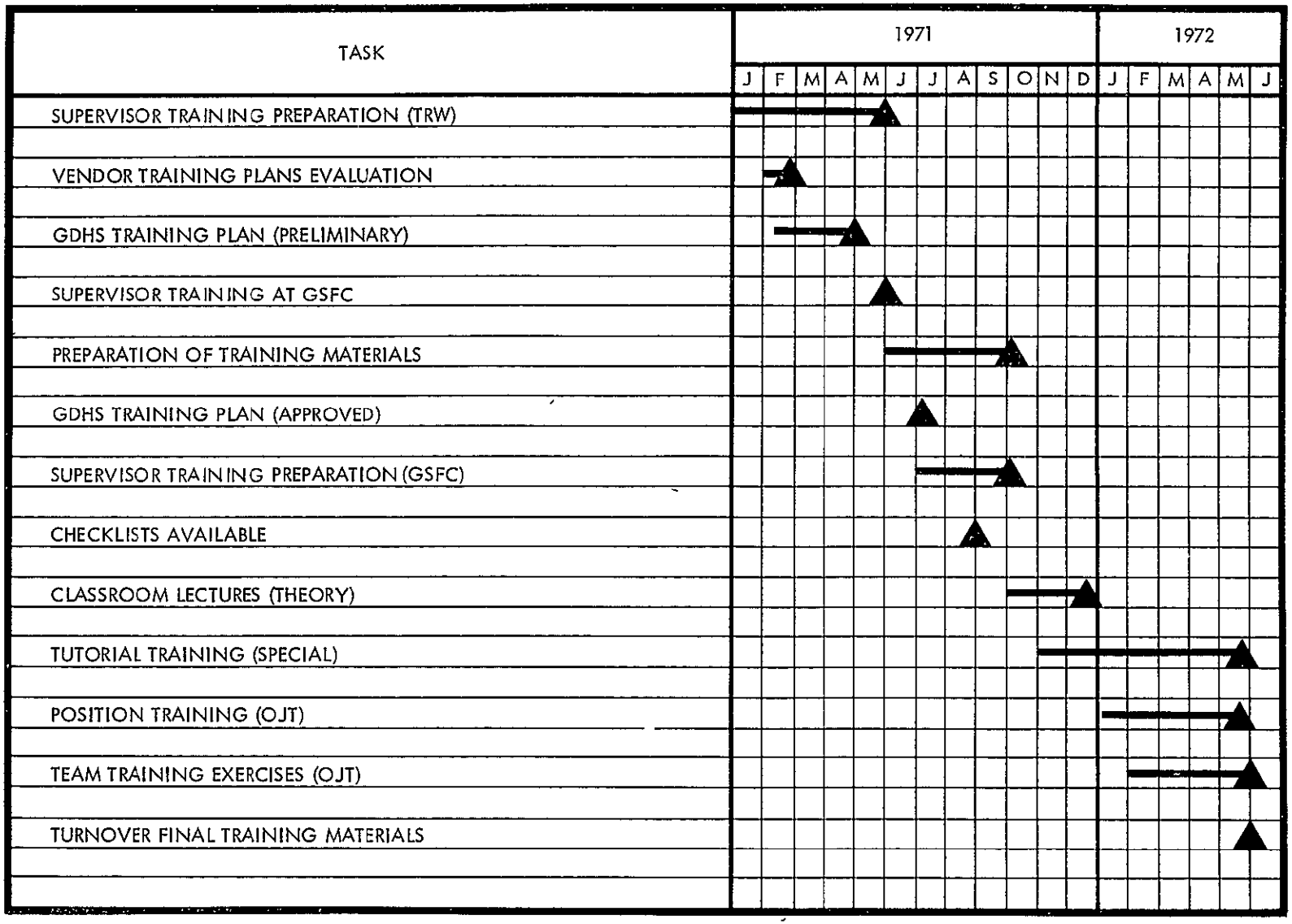


Figure 1-6
TRAINING PROGRAM MILESTONES

The above sequence of events briefly identifies the technical manual background development, coordination areas and responsibilities, initial release, point of control, and process of revision. This procedure is applicable to all technical manual release and change activity up to the time of final acceptance of the composite equipment (GDHS) for which the manuals are prepared.

The following types of manuals will, in general, be required to support the GDHS equipment and training activities:

a) Subsystem manuals

b) Equipment maintenance manuals

c) Position checklists

d) Software operations manual

Subsystem manuals will be furnished for the major subsystems of the GDHS equipment (OCC and NDPF). The subsystem manuals will tie in the operation of all the units comprising a subsystem from a total system viewpoint. Major loop self tests available in major equipment components will be contained in these manuals to enable M&O personnel to quickly isolate to a drawer/major unit in the equipment

Maintenance manuals will be furnished for all drawer/major unit equipment requiring periodic and/or corrective maintenance at GSFC. The maintenance manuals will be separated into the following major divisions and presented in the sequence shown below:

| Section | Contents |
|---|---|
| 1 | General description |
| 2 | Theory of operation |
| 3 | Preparation for use |
| 4 | Test equipment and special tools |
| 5 | Checkout and operation |
| 6 | Preventive maintenance and calibration |

The position checklists will be used by ground station operators during ERTS operations. Each checklist will be designed to a particular position (ground station operation) and will instruct the operator as to what tasks he has to accomplish and the time sequence they are to be accomplished in during all ERTS mission operations (prelaunch, initial operations, routine operations). Each position checklist is keyed to a particular position manual which describes how to accomplish the tasks contained in the checklist.

The software operations manual contains a complete description of the ADPE man-machine interface in the GDHS. It contains 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 time-lines and operator interface, it is used by GDHS operations personnel in support of training and planning.

## 1.9 GDHS PERSONNEL SPECIFICATION AND ITS CONFIGURATION CONTROL

### 1.9.1 Description

The GDHS Personnel Specification as it appears in Volume 19 sets forth the qualitative and quantitative operations and maintenance personnel requirements, including position definitions, organization charts, and manning levels for the OCC and NDPF. It also sets forth requirements for training and technical manuals in support of the operations and maintenance stuffing.

### 1.9.2 Interfaces With Hardware and Software Specifications

The GDHS Personnel Specification completes the trilogy subsystem specifications covering hardware, software, and personnel which are required to describe the total spectrum of performance/design requirements for implementation of the GDHS System performance requirements. If, therefore, sets forth the personnel skill, training and procedural requirements for effectively fulfilling the man-machine-software interfaces in the system functional design as described in Volume 2, Requirements Allocation Sheets, of the ERTS Functional Requirements Analysis.

### 1.9.3 Purpose of Configuration Control of Manning, Training Courses, and Technical Manuals

Staffing requirements, like hardware and software requirements, must be controlled in the engineering design and development process. Proposed changes in manning, whether qualitative or quantitative, can and often do have an impact on equipment design characteristics. For example, a proposed substitution of a technician which may occur concomitantly with changes in hardware and software requirements specifications, or which may be independently initiated because of some need to better optimize the performance characteristics of the overall man-machine-software design.

## 1.10 MANPOWER COST ESTIMATES

Table 1-8 presents the OCC and NDPF manpower cost estimates based upon typical estimates of yearly salaries anticipated for the job skills that are required.

### 1.10.1 NDPF "Case B" Cost Estimate

The "Case B" mode of operation would require manning certain job positions on a 3-shift/day basis, 5 days/week. These positions are identified in Table 1-5, which when related to the NDPF manpower cost estimates set forth in Table 1-7, and multiplied by the number required to provide the additional 2 shifts per day would increase the total manpower costs by an estimated $692,200 a year.

Table 1-7. GDHS Manpower Cost Estimates

| Functional Area | Position Title | Number per Work Shift Case A/Case B | Estimated Annual Wages (Dollars) | Total Annual Wages per Function (Dollars) |
|---|---|---|---|---|
| GDHS Staff | Manager, GDHS | 1/1 | 25,000 | 25,000 |
| | Administrator, GDHS | 1/1 | 15,000 | 15,000 |
| | Secretary, GDHS Manager | 1/1 | 7,000 | 7,000 |
| | Secretary, GDHS Administrator | 1/1 | 5,000 | 5,000 |
| | Total | | | 52,000 |
| Operations Control Center | OCC Manager | 1/1 | 24,000 | 24,000 |
| | Staff Administrator | 1/1 | 15,000 | 15,000 |
| | Training Supervisor | 1/1 | 18,000 | 18,000 |
| | Staff Analyst | 1/1 | 22,000 | 22,000 |
| | Computer Programmer | 1/1 | 19,000 | 19,000 |
| | Programmer | 2/2 | 12,000 | 24,000 |
| | Mission Planner | 1/1 | 18,000 | 18,000 |
| | Subsystem Analyst | 1/1 | 18,000 | 18,000 |
| | Imagery Analyst | 1/1 | 18,000 | 18,000 |

Table 1-7. GDHS Manpower Cost Estimates (Continued)

| Functional Area | Position Title | Number per Work Shift Case A/Case B | Estimated Annual Wages (Dollars) | Total Annual Wages per Function (Dollars) |
|---|---|---|---|---|
| Operations Control Center (cont) | ACS/Power Analyst | 1/1 | 17,000 | 17,000 |
| | Communications Analyst | 1/1 | 17,000 | 17,000 |
| | Secretary (Manager) | 1/1 | 7,000 | 7,000 |
| | Secretary (Staff Administrator) | 1/1 | 5,000 | 5,000 |
| | Secretary (Staff Analyst) | 1/1 | 5,000 | 5,000 |
| | Operations Planner Controller | 5/5 | 15,000 | 75,000 |
| | Data Analyst | 5/5 | 8,000 | 40,000 |
| | Command Generation Technician | 5/5 | 10,000 | 50,000 |
| | PCM Technician | 5/5 | 8,000 | 40,000 |
| | Data Technician | 5/5 | 7,000 | 35,000 |
| | Total | | | 467,000 |

Table 1-7. GDHS Manpower Cost Estimates (Continued)

| Functional Area | Position Title | Number per Work Shift Case A/Case B | Estimated Annual Wages (Dollars) | Total Annual Wages per Function (Dollars) | |
|---|---|---|---|---|---|
| | | | | Case A | Case B |
| NDPF | Operations Manager, NDPF | 1/1 | 22,000 | 22,000 | 22,000 |
| | Chief, Film Processing Support | 1/2 | 12,000 | 12,000 | 24,000 |
| | Supervisor, Q. C. and Maintenance | 1/3 | 9,000 | 9,000 | 27,000 |
| | Photo Inspector | 2/3 | 6,000 | 12,000 | 18,000 |
| | Photo Production Control | 2/3 | 10,000 | 20,000 | 30,000 |
| | Photo Equipment Maintenance | 2/3 | 9,000 | 18,000 | 27,000 |
| | Electronic Photo Equipment Maintenance | 2/3 | 8,000 | 16,000 | 24,000 |
| | Clerk | 3/9 | 5,000 | 15,000 | 45,000 |
| | Supervisor, Material | 1/3 | 8,000 | 8,000 | 24,000 |
| | Film Makeup | 3/3 | 6,000 | 18,000 | 18,000 |
| | Chemical Mixer | 2/3 | 6,000 | 12,000 | 18,000 |
| | Photo Supply | 3/9 | 4,600 | 13,800 | 41,400 |
| | Photo Clerk | 2/3 | 4,600 | 9,200 | 13,800 |

Table 1-7. GDHS Manpower Cost Estimates (Continued)

| Functional Area | Position Title | Number per Work Shift Case A/Case B | Estimated Annual Wages (Dollars) | Total Annual Wages per Function (Dollars) | |
|---|---|---|---|---|---|
| | | | | Case A | Case B |
| NDPF (cont) | Chief, Image Processing | 1/3 | 12,000 | 12,000 | 36,000 |
| | Supervisor, Film Processing Operations | 1/3 | 10,000 | 10,000 | 30,000 |
| | Film Processor Operator | 1/3 | 8,000 | 8,000 | 24,000 |
| | Film Processor Operator | 2/6 | 6,000 | 12,000 | 36,000 |
| | Film Printer Operator | 1/3 | 6,000 | 6,000 | 18,000 |
| | Film Printer Operator | 1/3 | 8,000 | 8,000 | 24,000 |
| | Paper Printer Operator | 1/3 | 8,000 | 8,000 | 24,000 |
| | Paper Printer Operator | 3/9 | 6,000 | 18,000 | 54,000 |
| | Color Printer Operator | 2/3 | 6,000 | 12,000 | 18,000 |
| | Color Printer Operator | 1/6 | 8,000 | 8,000 | 48,000 |

Table 1-7. GDHS Manpower Cost Estimates (Continued)

| Functional Area | Position Title | Number per Work Shift Case A/Case B | Estimated Annual Wages (Dollars) | Total Annual Wages per Function (Dollars) | |
|---|---|---|---|---|---|
| | | | | Case A | Case B |
| NDPF (cont) | Supervisor, Image Processing Support | 1/3 | 8,000 | 8,000 | 24,000 |
| | Copy Camera Operator | 1/3 | 8,000 | 8,000 | 24,000 |
| | Quality Assurance | 1/3 | 8,000 | 8,000 | 24,000 |
| | Quality Assurance | 1/3 | 6,000 | 6,000 | 18,000 |
| | Mensuration Technician | 1/3 | 8,000 | 8,000 | 24,000 |
| | Photo Restitutor Technician | 1/5 | 9,000 | 9,000 | 45,000 |
| | Laser Beam Recorder Operator | 1/5 | 9,000 | 9,000 | 45,000 |
| | Total Case A | | | 343,000 | |
| | Case B | | | | 848,200 |

Table 1-7. GDHS Manpower Cost Estimates (Continued)

| Functional Area | Position Title | Number per Work Shift Case A/Case B | Estimated Annual Wages (Dollars) | Total Annual Wages per Function (Dollars) | |
|---|---|---|---|---|---|
| | | | | Case A | Case B |
| NDPF (ADPE) | Supervisor, ADPE Operations | 1/1 | 22,000 | 22,000 | 22,000 |
| | Chief, Data Management | 1/1 | 18,000 | 18,000 | 18,000 |
| | Head, User Services | 1/1 | 8,000 | 8,000 | 8,000 |
| | Library Clerk | 1/3 | 6,000 | 6,000 | 18,000 |
| | Library Clerk | 1/6 | 5,000 | 5,000 | 30,000 |
| | User Liaison Clerk | 1/1 | 5,000 | 5,000 | 5,000 |
| | Clerk | 1/2 | 5,000 | 5,000 | 10,000 |
| | Tape Librarian | 2/5 | 5,000 | 10,000 | 25,000 |
| | Mail Room Clerk | 2/6 | 4,000 | 8,000 | 24,000 |
| | Head, Planning and Control | 1/1 | 12,000 | 12,000 | 12,000 |
| | Scheduling Clerk | 3/9 | 5,000 | 15,000 | 45,000 |
| | Job Control | 2/3 | 7,500 | 15,000 | 22,500 |
| | Analyst | 4/4 | 10,000 | 40,000 | 40,000 |

Table 1-7. GDHS Manpower Cost Estimates (Continued)

| Functional Area | Position Title | Number per Work Shift Case A/Case B | Estimated Annual Wages (Dollars) | Total Annual Wages per Function (Dollars) | |
|---|---|---|---|---|---|
| | | | | Case A | Case B |
| NDPF (ADPE) (cont) | Chief, ADPE | 1/1 | 18,000 | 18,000 | 18,000 |
| | Supervisor, Systems and Programs | 1/1 | 16,000 | 16,000 | 16,000 |
| | Consultant | 1/1 | 17,000 | 17,000 | 17,000 |
| | Head, Programming | 1/1 | 16,000 | 16,000 | 16,000 |
| | Programmer | 8/8 | 14,000 | 112,000 | 112,000 |
| | Clerk | 1/1 | 5,000 | 5,000 | 5,000 |
| | Head, Systems and Procedures | 1/1 | 16,000 | 16,000 | 16,000 |
| | System Analyst | 2/2 | 14,000 | 28,000 | 28,000 |
| | System Analyst | 3/3 | 11,000 | 33,000 | 33,000 |
| | Procedures Analyst | 1/1 | 14,000 | 14,000 | 14,000 |
| | Procedures Analyst | 4/4 | 11,000 | 44,000 | 44,000 |
| | File Analyst | 1/3 | 15,000 | 15,000 | 45,000 |
| | File Analyst | 3/6 | 10,000 | 30,000 | 60,000 |

Table 1-7. GDHS Manpower Cost Estimates (Continued)

| Functional Area | Position Title | Number per Work Shift Case A/Case B | Estimated Annual Wages (Dollars) | Total Annual Wages per Function (Dollars) | |
|---|---|---|---|---|---|
| | | | | Case A | Case B |
| NDPF (ADPE) (cont) | Clerk | 2/2 | 5,000 | 10,000 | 10,000 |
| | Head, ADPE Maintenance | 1/1 | 10,000 | 10,000 | 10,000 |
| | Head, Computer Operations | 5/5 | 17,000 | 85,000 | 85,000 |
| | Computer Operators | 20/20 | 8,500 | 170,000 | 170,000 |
| | Computer Technician | 5/5 | 5,000 | 25,000 | 25,000 |
| | Keypunch Operators | 2/5 | 5,500 | 11,000 | 27,500 |
| | Maintenance Technicians | 6/6 | 5,000 | 30,000 | 30,000 |
| | Total Case A | | | 874,000 | |
| | Case B | | | | 1,061,000 |
| GDHS Total Manpower Cost | Case A | | | 1,736,000 | |
| | Case B | | | | 2,428,200 |

# 2. MATERIAL USAGE PLANNING

This section contains the results of the GDHS study task devoted to the compilation of material requirements for operation of the Operations Communication Center, Automatic Data Processing Equipment, and Image and Photo Processing. The material presented in the tables contained within this section represent items which are required initially to set-up station operations and expendables which are consumed as part of one year operation of the station.

Specifically, Tables 2-1, 2-2, and 2-3, contains the film, chemicals and paper consumed by the NDPF on the basis of one years operation. Table 2-4 lists the miscellaneous materials required for photo processing which are not necessarily expendable in one years operation except for attrition replacements. Table 2-5 are the expendables which represent major cost items utilized in one year for the ADPE. Table 2-6 similarly represents estimated expendables for one years operation of the OCC. Finally, Table 2-7 is simply a listing of miscellaneous materials which are required to support the maintenance and safety requirements for the station equipment and operation personnel.

The unit costs for all of the expendables itemized herein reflect estimated quantity discounts for the yearly estimates. However, the actual volume and method of procuring these expendable materials, particularly if purchased in very large bulk shipments can significantly influence the ultimate cost of operating the station during the year. Therefore, the summary material costs which are identified herein are useful only as planning estimates. Bulk purchases on the open market could vary the actual cost of these materials by as much as 10 percent.

The major expenditures for material during the year of GDHS operations is represented by magnetic tape, computer tape, data hard copy, film chemicals, and photographic paper. Administrative materials and the cost of services and materials for data copy reproduction also represent a moderately large expenditure. However, the ERTS user

demand upon the GDHS which obviously dictates the amount of this expenditure is difficult to anticipate. Therefore, the cost of administrative materials and services as well as the cost of copy reproduction are intentionally excluded from the yearly material cost estimates which have been computed for GDHS operation.

The summary for GDHS material costs for the year are listed below:

| Facility Area | Material Item | Case A Usage | Case B Usage |
|---|---|---|---|
| OCC | Magnetic tape, Strip chart paper, Printer paper, Hard copy paper, Teletype paper and tape, etc. | $ 39,683 | $ 39,683 |
| NDPF (ADPE) | Computer tape, Data film tape, RBV and MSS bulk, Storage tape, Printer paper, Punch card, etc. | 458,620 | 1,141,900 |
| NDPF (Image and Processing) | Film | 638,024 | 1,771,144 |
| | Paper | 322,715 | 908,164 |
| | Chemicals | 27,316 | 102,480 |
| | Total | $1,486,358 | $3,963,371 |

Table 2-1. Photo Processing Material and Costs - Film Requirements

| Case | Operational Mode | Daily Usage Rationale | | Estimated Cost per Day (Dollars) | Estimated Cost per Annum (Dollars) |
|---|---|---|---|---|---|
| A | Bulk Mode II | Frames per day (7-day week) | 315 (135/180) | | |
| | | Sets per day (7-day week) | 45 | | |
| | | Sets to be processed per day | 45 | | |
| | | Bulk records | 441 (375 ft) | 56 | 20, 531 |
| | | Masters (2 P) | 441 (375 ft) | 56 | 20, 531 |
| | | Copy negatives (3 N) | 4, 410 (3, 750 ft) | 562 | 205, 313 |
| | | Copy positives (4 P) | 4, 410 (3, 750 ft) | 562 | 205, 313 |
| | | Color negatives | 39 (35 ft) | 42 | 15, 242 |
| | | Color positive transparencies | 390 (350 ft) | 420 | 153, 300 |
| | | | Total | 1698 | 620, 230 |

Note: Bulk records costs based upon $120 per 500 feet

Cost based upon $75 per 500 feet

Masters/copy negatives/copy positives

Color negatives based upon $720 per 600 feet

Color positive transparencies based upon $300 per 250 feet

Table 2-1. Photo Processing Material and Costs - Film Requirements

| Case | Operational Mode | Daily Usage Rationale | | Estimated Cost per Day (Dollars) | Estimated Cost per Annum (Dollars) |
|---|---|---|---|---|---|
| B | Bulk Mode II | Frames per day (7-day week) | 1, 320 (495/825) | | |
| | | Sets per day (7-day week) | 165 | | |
| | | Sets to be processed per day | 165 | | |
| | | Bulk Records (1 N) | 1, 320 (1, 100 ft) | 165 | 60, 225 |
| | | Masters (2 P) | 1, 320 (1, 100 ft) | 165 | 60, 225 |
| | | Copy negatives (3 N) | 13, 200 (11, 000 ft) | 1650 | 602, 250 |
| | | Copy positives (4 P) | 13, 200 (11, 000 ft) | 1650 | 602, 250 |
| | | Color negatives | 99 (85 ft) | 102 | 37, 212 |
| | | Color positive transparencies | 990 (850 ft) | 1020 | 372, 300 |
| | | | Total | 4752 | 1, 734, 462 |

Note: Bulk records costs based upon $120 per 500 feet

Cost based upon $75 per 500 feet

Masters/copy negatives/copy positives

Color negatives based upon $720 per 600 feet

Color positive transparencies based upon $300 per 250 feet

Table 2-1. Photo Processing Material and Costs - Film Requirements

| Case | Operational Mode | Daily Usage Rationale | | Estimated Cost per Day (Dollars) | Estimated Cost per Annum (Dollars) |
|---|---|---|---|---|---|
| A | Precision Mode | Sets per day (7-day week) | 2.25 | | |
| | | Sets to be processed (1 day) | 4 | | |
| | | RBV masters (1 N) | 12 (15 ft) | 2 | 821 |
| | | MSS masters (1 N) | 16 (20 ft) | 3 | 1095 |
| | | Copy negatives (3 N) | 28 (25 ft) | 4 | 1369 |
| | | Copy positives (2 P) | 28 (25 ft) | 4 | 1369 |
| | | Color negatives | 12 (15 ft) | 18 | 6570 |
| | | Color positive transparencies | 12 (15 ft) | 18 | 6570 |
| | | | Totals | 49 | 17,794 |

Note: Bulk records costs based upon $120 per 500 feet

Cost based upon $75 per 500 feet

Masters/copy negatives/copy positives

Color negatives based upon $720 per 600 feet

Color positive transparencies based upon $300 per 250 feet

Table 2-1. Photo Processing Material and Costs - Film Requirements

| Case | Operational Mode | Daily Usage Rationale | | Estimated Cost per Day (Dollars) | Estimated Cost per Annum (Dollars) |
|---|---|---|---|---|---|
| B | Precision Mode | Sets per day (7-day week) | 2.25 | | |
| | | Sets to be processed (1 day) | 9 | | |
| | | RBV masters (1 N) | 27 (30 ft) | $ 5 | $ 1642 |
| | | MSS masters (1 N) | 36 (40 ft) | 6 | 2190 |
| | | Copy positives (2 P) | 63 (60 ft) | 9 | 3285 |
| | | Copy negatives (3 N) | 63 (60 ft) | 9 | 3285 |
| | | Color negatives | 27 (30 ft) | 36 | 13, 140 |
| | | Color positive transparencies | 27 (30 ft) | 36 | 13, 140 |
| | | | Totals | $101 | $36, 682 |

Note: Bulk records costs based upon $120 per 500 feet
Cost based upon $75 per 500 feet
Masters/copy negatives/copy positives
Color negatives based upon $720 per 600 feet
Color positive transparencies based upon $300 per 250 feet

Table 2-2. Photo Processing Materials and Costs - Chemical Requirements

| Case | Operational Mode | Daily Usage Rationale | | Estimated Cost per Day (Dollars) | Estimated Cost per Annum (Dollars) |
|---|---|---|---|---|---|
| A | Bulk Mode II | Bulk records | $ 5.06 x 365 | $ 5.06 | $ 1,847 |
| | | Masters | 3.00 x 365 | 3.00 | 1,095 |
| | | Copy negatives | 30.00 x 365 | 30.00 | 10,950 |
| | | Copy positives | 30.00 x 365 | 30.00 | 10,950 |
| | | Color negatives | $ .28 x 365 | 0.28 | 102 |
| | | Color transparencies | 3.50 x 365 | 3.50 | 1,277 |
| | | | Totals | 71.84 | 26,221 |
| B | Bulk Mode II | Bulk records | $14.85 x 365 | 14.85 | 5,420 |
| | | Masters | 8.80 x 365 | 8.80 | 3,212 |
| | | Copy negatives | 88.00 x 365 | 88.00 | 32,120 |
| | | Copy positives | 88.00 x 365 | 88.00 | 32,120 |
| | | Color negatives | 6.80 x 365 | 6.80 | 2,482 |
| | | Color transparencies | $68.00 x 365 | 68.00 | 24,820 |
| | | | Totals | $274.45 | $100,174 |

Note:
- Chemicals for bulk records based upon $6.75 per 500 feet
- Chemicals for masters/copy negatives/copy positives based upon $4.00 per 500 feet
- Chemicals for color negatives/color transparencies based upon $40.00 per 500 feet

Table 2-2. Photo Processing Materials and Costs - Chemical Requirements

| Case | Operational Mode | Daily Usage Rationale | | Estimated Cost per Day (Dollars) | Estimated Cost per Annum (Dollars) |
|---|---|---|---|---|---|
| A | Precision Mode | Masters | $ .28 x 365 | $ 0.28 | $ 102 |
| | | Copy negatives | .12 x 365 | 0.12 | 44 |
| | | Copy positives | .20 x 365 | 0.20 | 73 |
| | | Color negatives | 1.20 x 365 | 1.20 | 438 |
| | | Color transparencies | $1.20 x 365 | 1.20 | 438 |
| | | | Totals | 3.00 | 1,095 |
| B | Precision Mode | Masters | $ .56 x 365 | 0.56 | 204 |
| | | Copy negatives | .48 x 365 | 0.48 | 175 |
| | | Copy positives | .48 x 365 | 0.48 | 175 |
| | | Color negatives | 2.40 x 365 | 2.40 | 876 |
| | | Color transparencies | $2.40 x 365 | 2.40 | 876 |
| | | | Totals | $ 6.32 | $2,306 |

Note: ●Chemicals for bulk records based upon $6.75 per 500 feet
●Chemicals for masters/copy negatives/copy positives based upon $4.00 per 500 feet
●Chemicals for color negatives/color transparencies based upon $40.00 per 500 feet

Table 2-3. Photo Processing Materials and Costs - Paper Requirements

| Case | Operational Mode | Daily Usage Rationale | | Estimated Cost per Day (Dollars) | Estimated Cost per Annum (Dollars) |
|---|---|---|---|---|---|
| A | Bulk Mode II | Copy prints (4 P) | 4,410 (3,750 ft) | $ 683.00 | $249,112 |
| | | Color prints | 390 (350 ft) | 189.00 | 68,985 |
| | | | Totals | 872.00 | 318,097 |
| B | Bulk Mode II | Copy prints (4 P) | 13,200 (11,000 ft) | 2002.00 | 730,730 |
| | | Color prints | 990 (850 ft) | 459.00 | 167,535 |
| | | | Totals | 2461.00 | 898,265 |
| A | Precision Mode | Copy prints (2 P) | 28 (25 ft) | 5.00 | 1,661 |
| | | Color prints | 12 (15 ft) | 8.00 | 2,957 |
| | | | Totals | 13.00 | 4,618 |
| B | Precision Mode | Copy prints (2 P) | 63 (60 ft) | 11.00 | 3,986 |
| | | Color prints | 27 (30 ft) | 16.00 | 5,913 |
| | | | Totals | $ 27.00 | $ 9,899 |

Note: Copy prints costs based upon $91 per 500 feet

Color prints costs based upon $135 per 250 feet

Table 2-4. Photo Processing Miscellaneous Material Requirements

| Material Item | Quantity |
|---|---|
| Equipment for Quality Control Laboratory | |
| Top-loading balance, ±0.01 g, Mettler P-1200 | 1 |
| Refilling burets, one for each test desired plus spares | 6 |
| PH Meter, Orion 801 with PH electrode plus 2 spare electrodes | 1 |
| Silver billet electrode, Beckman | 2 |
| Magnetic stirrer: Gyratherm (stir plus heat) with stirring magnets | 1 |
| Stirring magnets | |
| Large, 2-7/8 inch | 1 |
| Medium, 1-9/16 inch | 3 |
| Small, 1 inch | 5 |
| Water still, 1/2 gallon | 1 |
| Pipet bulbs | 6 |
| Assorted clamps, rings, etc. | |
| Large buret stands for refilling burets | |
| Buret holder | 1 |
| Ring stand | 1 |
| Spatulas | 6 |
| Hydrometers | 1 |
| Separation funnels (teflon stopcocks) | |
| 500 milliliter | 6 |
| 250 milliliter | 3 |

Table 2-4. Photo Processing Miscellaneous Material Requirements (Continued)

| Material Item | Quantity |
|---|---|
| Funnels | |
| Diameter: 150 millimeter; stem length: 100 millimeter | 4 |
| Diameter: 125 millimeter; stem length: 35 millimeter | 4 |
| Diameter: 75 millimeter; stem length: 75 millimeter | 2 |
| Diameter: 40 millimeter; stem length: 50 millimeter | 2 |
| Diameter: 100 millimeter; stem length: 100 millimeter | 2 |
| Pipets | |
| 1 milliliter | 3 |
| 2 milliliters | 3 |
| 3 milliliters | 3 |
| 4 milliliters | 3 |
| 5 milliliters | 5 |
| 6 milliliters | 3 |
| 7 milliliters | 3 |
| 8 milliliters | 3 |
| 9 milliliters | 3 |
| 10 milliliters | 5 |
| 15 milliliters | 3 |
| 20 milliliters | 3 |
| 25 milliliters | 5 |
| 50 milliliters | 5 |
| 100 milliliters | 3 |

Table 2-4. Photo Processing Miscellaneous Material Requirements (Continued)

| Material Item | Quantity |
|---|---|
| Graduated pipets | |
| 1 milliliter | 2 |
| 5 milliliters | 2 |
| 10 milliliters | 2 |
| 25 milliliters | 2 |
| Glassware Needed for Quality Control Laboratory | |
| Beakers | |
| 50 milliliters | 12 |
| 100 milliliters | 12 |
| 150 milliliters | 12 |
| 250 milliliters | 12 |
| 400 milliliters | 12 |
| 600 milliliters | 6 |
| 1000 milliliters | 6 |
| 1500 milliliters | 3 |
| 2000 milliliters | 3 |
| 4000 milliliters | 3 |
| Iodine determination flasks, 500 milliliters | 6 |
| Erlenmeyer flasks | |
| 125 milliliters | 4 |
| 250 milliliters | 4 |
| 500 milliliters | 4 |
| One-liter glass brown bottles, screw-on caps | 24 |

Table 2-4. Photo Processing Miscellaneous Material Requirements (Continued)

| Material Item | Quantity |
|---|---|
| Tip-up pipets, number and size to depend upon individual test requirements | |
| Volumetric flasks | |
| 50 milliliters | 3 |
| 100 milliliters | 3 |
| 250 milliliters | 6 |
| 500 milliliters | 6 |
| 1000 milliliters | 6 |
| 2000 milliliters | 2 |
| Graduated cylinders | |
| 10 milliliters | 4 |
| 25 milliliters | 4 |
| 50 milliliters | 4 |
| 100 milliliters | 4 |
| 250 milliliters | 1 |
| 500 milliliters | 1 |
| 1000 milliliters | 1 |
| 2000 milliliters | 1 |
| Burets | |
| 50 milliliters | 2 |
| 10 milliliters | 2 |

Table 2-4. Photo Processing Miscellaneous Material Requirements (Continued)

| Material Item | Quantity |
|---|---|
| Film cleaner fluid | 1 gal/wk/ shift |
| Film wax | 1 lb/wk/ shift |
| Versamat skip-rack cross-over $525 | 2 |
| Versamat roll film adapter $1,150 | 5 |
| Versamat roll film take-up adapt $975 | 5 |
| Kodak reflection-transmission color densitometer $380 | 1 |
| Densitometer check plaque (Refl.) $16 | 1 |
| Densitometer check plaque (Trans.) $65 | 1 |
| Interval timers | 4 |
| Tray/Tank thermometers | 12 |
| Clean room uniforms | 20/week |
| Miscellaneous chemicals (QC, spec. proc., etc.) | As required |
| Rubber gloves | As required |
| QC instrumentation $4K/one time | |
| Film casettes | 24 |
| 12" print trimmers | 2 |
| Scissors | 20 |
| Print tongs | 12 |
| Versamat rollers | 100 |
| Lamps (printer) | As required |
| Graduates | 32 oz |
| Compressed nitrogen (every 3 weeks) | |

Table 2-5. ADPE Material Requirements

| Material Item | Usage Rationale | Quantity Per Year | |
|---|---|---|---|
| Computer Tape: | | Case A | Case B |
| Telemetry, analog, 1/2" x 10" | Case A 20 tapes per day at $20/reel | 7,300 reels | 7,300 reels |
| Ephemeris, dialog, 1/2" x 10" | Case A 1 tape per day at $20/reel | 365 reels | 365 reels |
| DCS, analog, 1/2" x 14" | Case A 6 tapes per day at $20/reel | 2,190 reels | 10,950 reels |
| RBV, analog, 2" x 14" | Case A 4 tapes per day at $75/reel | 1,460 reels | 4,380 reels |
| MSS, analog, 1" x 14" | Case A 4 tapes per day at $66/reel | 1,460 reels | 4,380 reels |
| Digital bulk, RBV, 1" x 16" | Case A 1 tape per day at $66/reel | 365 reels | 1,095 reels |
| Digital bulk, MSS, 1" x 16" | Case A 1 tape per day at $66/reel | 365 reels | 1,095 reels |
| Data file, 1/2" x 10" | | 100 reels | 300 reels |
| Programs, 1/2" x 10" | | 300 reels | 900 reels |
| Printer paper, IBM 1403, 1 ply | Annual quantity based upon comparable computer system requirement | 900 boxes | 900 boxes |
| Punch cards | Annual quantity based upon comparable computer system requirement | 100 cartons | 100 cartons |

Table 2-6. OCC Expendable Stock Annual Requirements and Costs

| Material Item | Usage Rationale | Quantity and Unit Cost | Annual Cost |
|---|---|---|---|
| Magnetic Tape — Reel Size | Attrition due to breakage - 10% | 100 tapes | |
| PCM-Telemetry (1000 tapes required for the OCC scratch tape inventory) — 10 inches x 1/2 inches | Replacement due to residual hysteresis | 50 tapes | |
| | Historical Retention - 5% | 50 tapes | |
| | Data Compaction | 150 tapes | |
| | Total | 350 tapes at $20 | 7,000 |
| Tape Cleaner | --- | As required | |
| Tape Cans | --- | As required | |
| Strip Chart Pens | 2 pens per day | 730 pens at $5.75 | 4,198 |
| Strip Chart Paper | 6 charts x 6 ft per pass x 14 passes per day (200 foot per roll) | 920 rolls at $19.75 | 18,170 |
| Line Printer | | | |
| Paper (4 per ply NCR - no carbon) | 1000 sheets per day (750 sheets per carton) | 486 cartons at $11.31 | 5,497 |
| Ribbons | Replacement every two days | 183 ribbons at $0.35 | 64 |

Table 2-6. OCC Expendable Stock Annual Requirements and Costs (Continued)

| Material Item | Usage Rationale | Quantity and Unit Cost | Annual Cost |
|---|---|---|---|
| Hard copy | 400 sheets per day (1000 sheets per box) | 146 cartons at $16.81 | 2,454 |
| Teletype | | | |
| Paper (5 per ply) | 2 ft per pass x 2 printouts per pass x 14 passes per day (458 ft per box) | 45 boxes at $16.81 | 756 |
| Mylar Tape | 2 rolls per week (1200 ft per roll) | 104 rolls at $14.50 | 1,508 |
| Ribbons | 1 replacement per week | 52 ribbons at $0.35 | 18 |
| Paper tape 8-level Baudot | 3 replacements per month 980 ft per roll | 36 rolls at at $0.50 | 18 |
| | | TOTAL | $39,683 |

Table 2-7. Maintenance Material

## Electronic Supplies

| | |
|---|---|
| Clips | Lamps |
| Insulators | Cable clamps |
| Connectors (T&C/B&C) | Test leads |
| Adapter converters | Resistors stock |
| Coaxial connectors | Terminal blocks |
| Fuses | Tubing and Sleeving |
| Jacks | Wire |

## Safety Equipment

| | |
|---|---|
| Boots, rubber, large | Safety goggles |
| Aprons, large and small | Hand cleaner |
| Safety glasses | Face shield |
| Protective gloves | |

## Tools

| | |
|---|---|
| Electric drill | Screwdriver set |
| Drill set H. S. S. | Tool boxes |
| Calipers | Connector insertion and extraction and crimp tools and accessories |
| Bench clamps | |
| Hole cutters | Wire strippers |
| Heat gun | Wrench set |
| Soldering tools and materials | Plier set |
| Chassis punches | File set |
| Brushes | Fastener hardware |

Table 2-7. Maintenance Material (Continued)

Shipping Materials

Boxes, corrugated packaging

Dessicant 4-unit bag

Packing material

Solvent

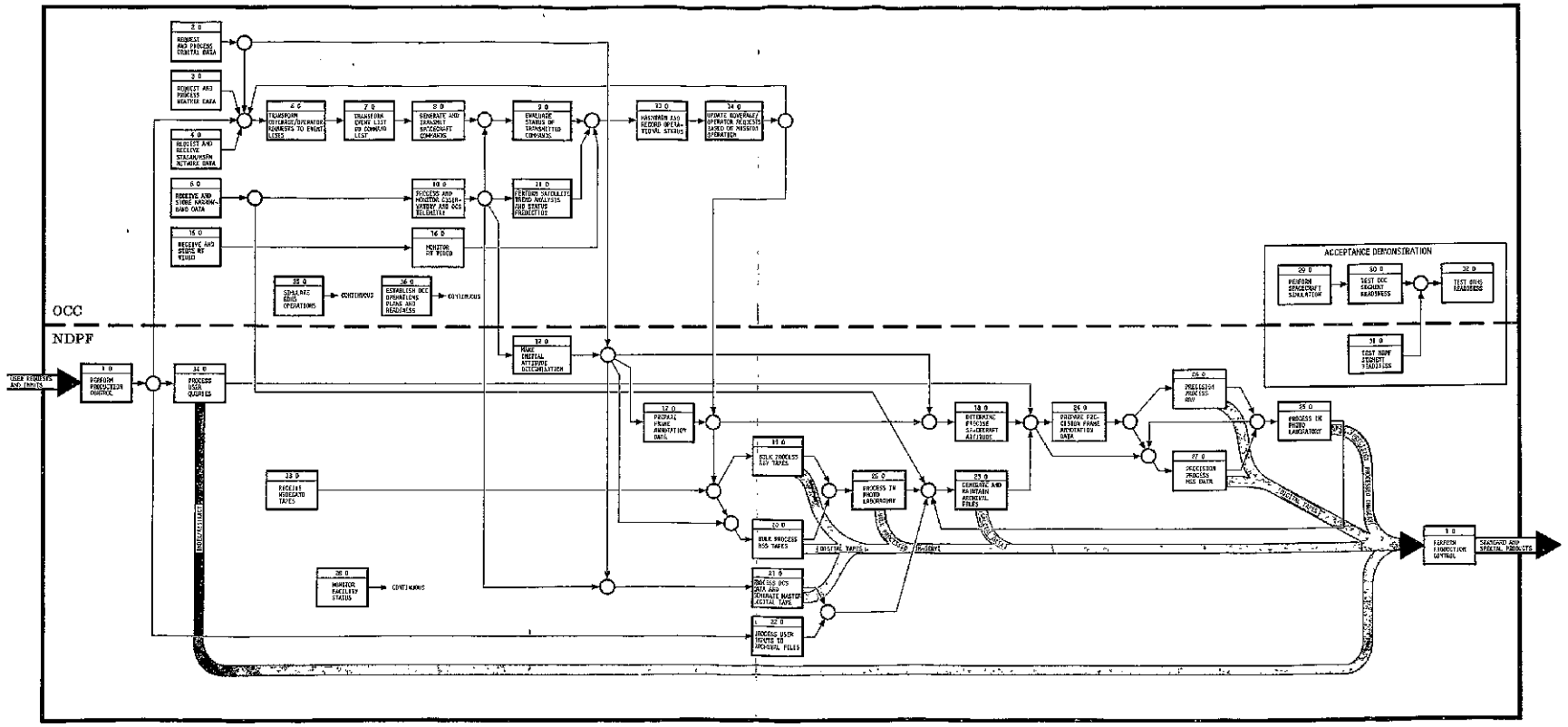


Figure 1-2
TOP FUNCTIONAL FLOW FOR GDHS



FOLDOUT FRAME 1

FOLDOUT FRAME 2

FOLDOUT FRAME