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MANAGEMENT PLAN FOR PROCUREMENT AND EVALUATION OF HIGH RELIABILITY SEMI CONDUCTOR DEVICES FOR THE UHF SATELLITE PROJECT

COMTECH CANADA LTD.

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Prepared by

T.A. Eastland

HiTech Canada Ltd.

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HITECH CANADA LIMITED

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1 INTRODUCTION

A. Scope and Objectives of the Study

The purpose of this Plan is to provide the UHF Satellite Project with the basis for management of a program to procure, evaluate and screen flight semiconductors, and to supply these devices as GFE to its subsystem contractors.

The Plan will support this concept with a summary of studies, proposals and experience to date, chiefly the experience with such a program by the CTS Satellite Project.

This study will not deal with the technical aspects of semiconductor evaluation, as these have been comprehensively presented in earlier work [1], but rather will deal with the overall management of the program. The Plan will highlight technical aspects only as they affect this overall management.

The Plan will discuss advantages and disadvantages of a government-managed program, and will include discussions of problems which have occurred in similar undertakings.

If the decision is made by the UHF Satellite Project to undertake the management of semiconductor procurement for its subsystem contractors, sufficient detail and guidance is presented herein to carry out this task.

1. Most notably, R.F. Haythornthwaite, A.R. Molozzi, and D. V. Sulway; "Reliability Assurance of Individual Semiconductor Components". IEEE Proceedings, Feb. 1974.

The management plan is flexible enough to be adapted to several modes of implementation: with the work being done by a government agency; by a subcontractor; or most likely, by a combination of the two. Where one alternative is specifically favored over another, an appropriate recommendation is made.

B. Historical Background

The original proposal establishing the basis for the CTS Parts Procurement Program was presented to CTS by the CRC Reliability Analysis Section during the Project Development Phase. Technical justification for the proposal was contained in a report to CTS Project management which was later expanded in the previously referenced IEEE paper.

The essential elements of this proposal included:

- the establishment of a controlled parts list by the Design Authority through circuit analysis and component comparison.

- the selection of approved semiconductor manufacturers by experience with and study of their applicable technological capabilities.

- the control of the manufacturing process by initial specification and subsequent inspections.

- the elimination of defective semiconductor devices through established screening methods.

- the selection, testing, and analysis of sample devices at various stages throughout the production cycle from initial wafer selection through final inspection.

The program actually used by CTS was based on the above elements with one major variation. It became clear early in the program that delivery schedules and availability of interested manufacturers would severely limit the application of this technique for all devices. For approximately half of the device types, chiefly diodes and simple transistors, an alternate procurement route was used: an independent testing laboratory was contracted to purchase these devices "off-the-shelf" to manufacturers' specifications and then subject the devices to the same level of mechanical, electrical, and environmental screening as required by the original CTS procurement specifications. In most cases, these screening specifications were derived from MIL-STD-750 and MIL-STD-883, modified as appropriate for specific devices.

A summary of CTS experience to date is better understood with some insight into the complexity of the problems which faced CTS in the management of its centralized procurement program.

The CTS Project contracted manufacture of its subsystems to several contractors, four of whom had major electronic assemblies requiring high reliability semiconductors. As an additional complication, there were several additional subcontractors involved in the final end use of the devices.

These semiconductors were required in 23 "black-boxes" (IMU's). The original parts list contained over 225 different device types, which after negotiation with the contractors, was reduced to approximately 180 types. Rough breakdown of these device types by generic group is as follows:

60 Diodes
47 Transistors
60 Integrated Circuits
13 Custom Hybrid Microcircuits

Required quantities of these device types for the various IMU's ranged from two to several hundred. The total number of devices, including spares, approached 12,000. These devices were procured from 20 specialized manufacturers, and the independent testing laboratory, under 35 different contracts. The average number of IMU's which used any given type was six; however, a few device types were required in over twice that many boxes.

Since the IMU's were being manufactured by several companies on both sides of the border, to varying schedules for each assembly, it became clear that, irrespective of any technical problems, there existed a major management problem in the procurement, evaluation, and timely delivery of the GFE semiconductors to the CTS contractors. In late 1973, a special task team was formed to deal with this management problem.

Early results indicate that the program has been successful. Sufficient numbers of the high reliability devices for flight buildup were procured, screened, and delivered with no major schedule perturbations, and perhaps most importantly, no delays attributed to late semiconductor delivery by CTS.

Of the total number of devices, almost 7000 have been installed and initially checked out; almost all have been subjected to continual operation through environmental qualification of the flight and flight-spare IMU's. To date, there have been 34 failures reported. Of these, almost half appear to be the result of improper handling or mounting, and the remainder have been replaced with success. Only three "unresolved" problems remain: in one series of TTL integrated circuits, pin-holes in the oxide coating have been discovered as the cause of two failures; in one type of hybrid, a suspected degradation of a beam-lead chip has caused three failures; and in one type of linear integrated circuit, thin oxide coating has caused three more failures.

It is interesting to note that all these devices were procured from selected, qualified vendors, and subjected to the optimum rigid inspections idealized in the original technical proposal. On the other hand, none of the large number of devices procured off-the-shelf and screened through the independent testing laboratory have failed to date.

C. Application and Justification

It seems clear that the presentation of the CTS history can lend perspective to the problem facing the UHF Satellite Project. The extent to which the history applies directly is dependent on a number of unknowns:

- the selection of the UHF management agency
- the selection of the Design Authority
- the decision of the Design Authority regarding prime and/or sub-contractors for the satellite
- the complexity of design of UHF subsystems (state-of-the-art, or off-the-shelf)
- weight and budgetary restraints on the satellite
- the time phasing of the development - design - manufacture cycle
- the state of the semiconductor industry.

Considering the above unknowns, this study is directed to a Management Plan for procurement of high reliability semiconductors similar to that used by CTS; that is, the Design Authority will set the standards for, and manage the procurement of, all semiconductors for the UHF satellite, and supply them to the contractors as GFE.

The advantages of a centralized procurement organization under Design Authority control include:

- early visibility into design/device type reliability considerations
- reduction of numbers and standardization of device types
- greater design authority control over suppliers
- economies of scale in purchasing
- greater technical advantages of traceability, lot homogeneity, statistical sampling techniques with larger purchases
- efficient use, through centralization, of scarce technological resources
- the "clout" of the Canadian government in dealing with suppliers and other government agencies (e.g. US and Canadian customs)
- objectivity of evaluation.

The concept of having the Design Authority supply semiconductors to the contractors as GFE is a double-edged sword, and not without substantial disadvantages. Perhaps the greatest of these is the simple fact that the Design Authority has inserted itself into the critical paths of its own contractors' assembly processes. In a contractual arrangement where schedule delays invoke penalties on the contractors, the Design Authority has provided the contractors with a possible method of avoiding such penalties. Other disadvantages are:

- A centralized procurement and evaluation program, no matter how effective, introduces delays. There is reason to believe that the design-to-approval-to-production cycle is already too short

for the procurement of any but the most common type of semiconductor. A procurement agency that keeps the circuit designer one step further from his device supplier adds to this problem.

- Standardization is, in a sense, antithetical to state-of-the-art design. A designer on the threshold of a new technology needs greater latitude in the choice of specialized components. Custom hybrid microcircuits, required chiefly because of weight and power restraints, are a case in point. To the extent that the UHF satellite uses "off-the-shelf" components and does not suffer from excessive weight limitations, this factor may not be present.

- With standardization, any change in specification by a supplier or user must go through the approval cycle for all users, often introducing unacceptable delays.

- For those cases where designers are forced to standardize, they must specify the highest performance device, to meet their most stringent requirements. This will increase cost and procurement time for those cases where an alternate, lower performance device could have been substituted.

- Finally, the government procurement cycle, in imposing necessary controls, lacks the responsiveness and flexibility that is absolutely vital if a procurement agency is to effectively deal with continuing design changes, test failures, and the unavailability of certain device types. Had the CTS Project been forced to use the normal procurement cycle on every purchase, their GFE semiconductor supply program would in all probability have delayed the CTS launch.

In summary, the advantages to the proposed procurement method are real and evident. The ensuing Management Plan is designed to minimize or eliminate the negative features of a centralized, government-managed semiconductor procurement program.

II MANAGEMENT PLAN

The Management Plan for the UHF Satellite semiconductor procurement program is divided into three basic sections:

- Work Breakdown Structure - The systematic breakdown of the overall project into Work Packages, and the listing in each package of the appropriate tasks.

- Organization Structure - The organization structure recommended to manage the effort, and the description of resources, including profiles of people, required to carry out the Work Package tasks.

- Systems and Procedures - The work flow for the entire procurement and evaluation of the devices, the management information system used, and the control documentation required.

The details of each of these portions of the Management Plan are contained in the following sections.

A. Work Breakdown Structure

The Work Breakdown Structure (WBS) is a tool used to divide work into separate packages for ease of management. It is, in a phrase, "managerial systems engineering" applied to an overall project. It is a pyramid approach, wherein at each level, the sum of the packages below equals all the work of the package above. This makes the Work Packages an exhaustive and exclusive compilation of total project activity. The WBS of a large project contains five or six levels for scheduling and control purposes. The attached WBS (Figure 1) shows three levels of Work Packages.

The WBS should not be (but frequently is) confused with an organization chart. The organization chart is shown in Section II B following, and is quite different.

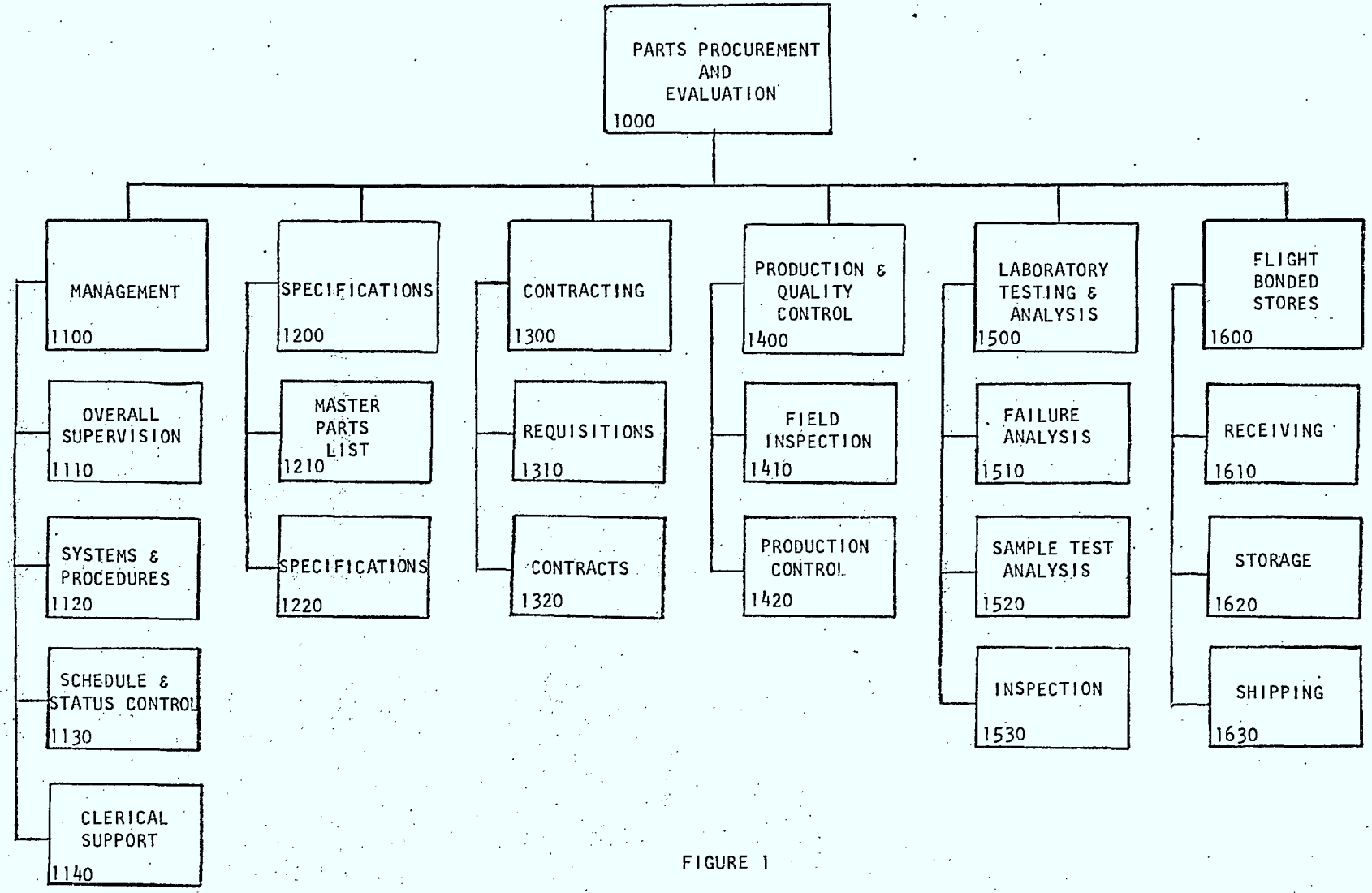


FIGURE 1

UHF SATELLITE PROJECT
GFE SEMICONDUCTOR PROCUREMENT AND EVALUATION
WORK BREAKDOWN STRUCTURE

The Level 3 Work Packages are listed on the following pages, with the essential content of each package broken down to the task level.

1100 MANAGEMENT

1110 Overall Supervision

1111 - approval and control
1112 - resource assignment, organization changes, priority determination
1113 - problem analysis and solution
1114 - conflict resolution
1115 - reporting to higher management
1116 - budgeting, financial management

1120 Systems & Procedures

1121 - management systems analysis
1122 - operational procedures, instructions
1123 - form design, control
1124 - management information system design

1130 Schedule & Status Control

1131 - overall operational coordination of group activities, including procurement, inspection, receiving, shipping
1132 - control of data base
1133 - scheduling inspections, pickups, deliveries
1134 - single point of contact with vendors, contractors for all schedule matters
1135 - expediting deliveries, tracking device status
1136 - priority enforcement
1137 - management information system operation, status reports

1140 Clerical Support

1141 - data base manipulation and maintenance
1142 - producing, distributing computer sorts
1143 - status, location of field personnel
1144 - correspondence control
1145 - report preparation
1146 - Parts Review Board record keeping
1147 - technical typing, filing, charting

1200 SPECIFICATIONS

1210 Master Parts List

1211 - coordination with contractors for parts requirements
1212 - Design Authority approval of circuit design, parts requested
1213 - rationalization of common parts
1214 - control of Master Parts List
1215 - assignment of part numbers, cross-indexing for other identification numbers

1220 Procurement Specifications

1221 - preparation of family tree for procurement specifications by generic type
1222 - coordination with contractors for component performance specifications
1223 - incorporation of accepted MIL, NASA, manufacturing and screening standards into performance specifications
1224 - publication and control of final procurement specifications
1225 - technical negotiations with vendors during contract negotiations
1226 - coordination of changes, waivers to specifications

1300 CONTRACTING

1310 Requisitions

1311 - grouping of device types for appropriate source selection
1312 - contractual accreditation of vendors
1313 - preparation of requisitions, supporting documentation for procurement

1320 Contracts

1321 - negotiations with vendors through contract consummation
1322 - contract waivers, amendments
1323 - contractual budget control
1324 - negotiations with vendors on price, schedule changes

1400 PRODUCTION & QUALITY CONTROL

1410 Field Inspection

1411 - selection and qualification of vendors
1412 - enforcement of controlled assembly specifications
1413 - technical negotiations with vendors, contractors for any modifications to procurement specifications
1414 - pre-encapsulation inspection
1415 - pre-shipping inspection

1420 Production Control

1421 - changes in priorities of manufacturing
1422 - overall technical single point of contact with vendors
1423 - tracking of status of devices in field for scheduling inspections, pickup of devices
1424 - maintenance of vendor log books

1500 LABORATORY TESTING AND ANALYSIS

1510 Failure Analysis

1511 - mechanical, electrical, microphotographic testing and examination of failed parts

1512 - analysis and reporting of type, cause, and implications of failures

1513 - inter-agency notification and coordination for failed components

1520 Sample Testing and Analysis

1521 - electrical, mechanical, optical inspections on samples of procured devices

1522 - destructive testing on appropriate samples

1523 - reports on results of tests

1530 Inspection

1531 - analysis of read-and-record data and X-rays

1532 - Bonded Stores inspection

1600 FLIGHT BONDED STORES

1610 Receiving

1611 - customs clearance

1612 - pickup and hand carry of devices from vendors

1613 - receipt, unpacking, quarantine of incoming shipments

1614 - reconciliation with expected types, quantities of each incoming shipment

1615 - verification of receipt for contractual purposes and invoice processing

1620 Storage

1621 - transfer from quarantine of inspected devices
1622 - separation of Bonded Stores devices from rejects and quarantined devices
1623 - cataloguing and indexing of all stored parts
1624 - maintenance of stock record cards
1625 - issue of bonded devices for shipping, with Certificates of Compliance

1630 Shipping

1631 - preparation of shipping documentation
1632 - receipt of devices from Bonded Stores and packing for shipment
1633 - notification of carrier, customs arrangements

B. Organization Structure

The Organization Structure for the procurement and evaluation program consists of a blend of technical and managerial expertise. The key concept of the organization is an adversary system which places responsibility for meeting the operational schedule demands on a Schedule and Status Controller while retaining the checks and balances necessary for adequate quality control under alternate supervision. This can be done in two ways.

- If a subcontractor is chosen to administer procurement, handling, storage and shipping, the government agency would retain management control over specifications, vendor selection and all quality control functions.

- If the government agency retains responsibility for the total procurement program, a system of checks and balances must exist within the organization. This latter method was used by CTS.

The organization structure shown in Figure 2 can be adapted to either method. Below are listed each of the groups shown on the organization chart, with the resources indicated within each group. Each function has been identified, but the exact number of people for each function depends on the scope of the program and the time available. The text also indicates where a specific responsibility should be subcontracted or, alternately, retained by the government agency, when this division is important.

1. Parts Review Board

The Parts Review Board consists of the Chairman (Senior Manager on the procurement program), the Schedule & Status Controller, the Production/QC Manager, the Specification Control Officer and a Secretary. Among ad hoc members are: specialists in micro-circuitry physics, circuit applications, semiconductor manufacture, and Field Project Engineers as required for special problem resolution. Should the semiconductor procurement program be subcontracted, the government agency must be represented on this Parts Review Board.

The Board reports operationally to the Project Manager, and is technically responsible to the Configuration Control Authority on the Project.

The Board has two main functions:

- overall management of the program (WP 1100, 1110)

- resolution of technical problems and high impact schedule perturbations.

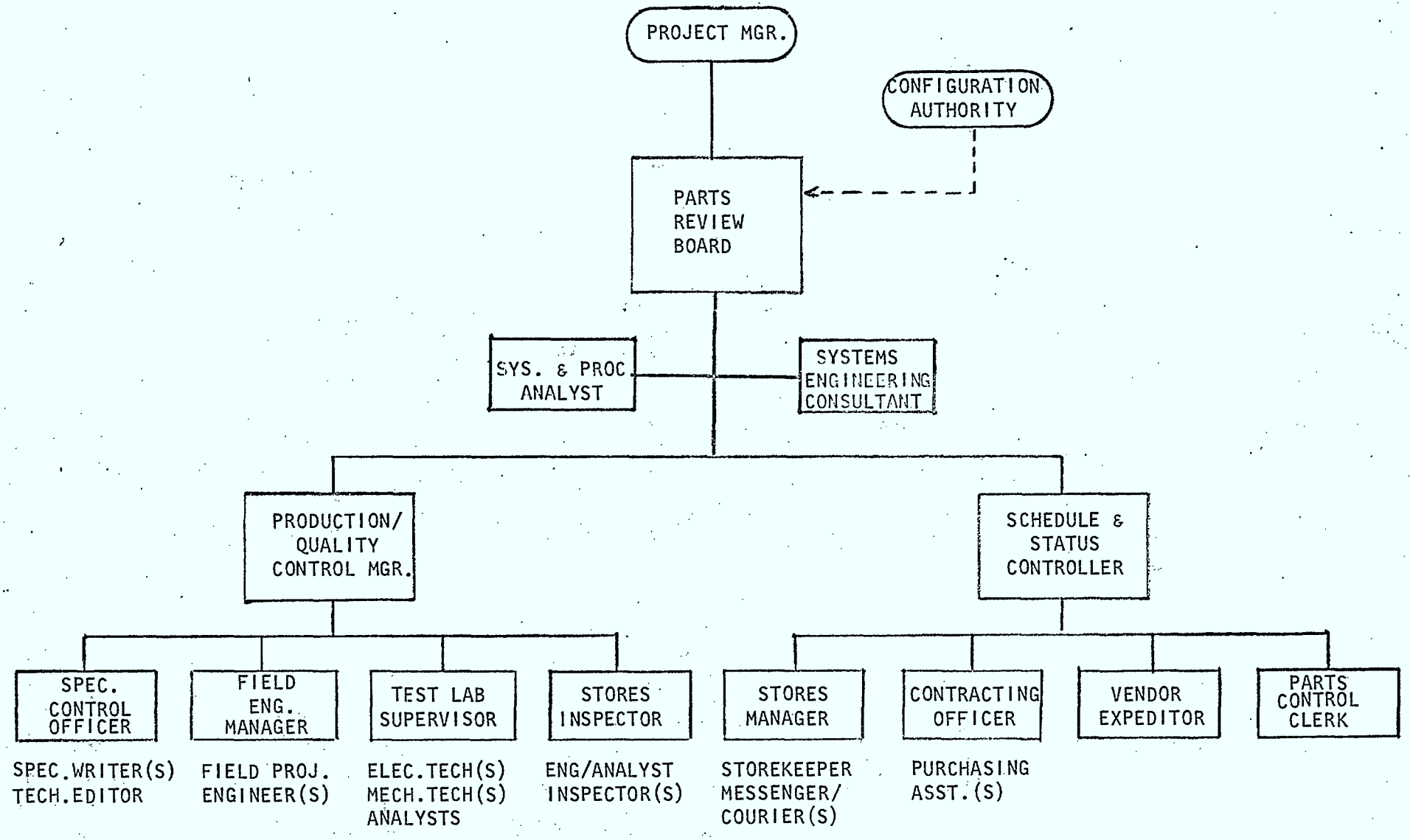


FIGURE 2
ORGANIZATION CHART FOR THE UHF SATELLITE PROJECT
SEMICONDUCTOR PROCUREMENT AND EVALUATION PROGRAM

Any change in contractor purchase orders, procurement specifications, or the Master Parts List must be referred to the Board for approval. All group instructions and procedures are issued over the Board's signature and changes to them concurred in by the Board.

2. Systems Engineering Consultant

A systems engineer from the Project Staff is required to advise the Parts Review Board on the systems/circuit implications of any problem or change in semiconductor performance specifications.

3. Systems & Procedures Analyst

A systems and procedures consultant is required by the Parts Review Board for the period of time necessary to accomplish the tasks of WP 1120. This period will vary from several weeks to several months, depending on the extent to which elements of this proposal are adopted.

4. Production/Quality Control Manager

A senior engineer experienced in all phases of semiconductor manufacture and familiar with aerospace procurement standards is required for management of the functions 5 through 9 following.

5. Specification Control Officer

This position requires an expert in aerospace standards for semiconductor procurement as well as a wide knowledge of semiconductor circuit applications. The position supervises a staff of technical

specification writers and associated clerical, editing, and publication assistance. The function contains all elements of WP 1210 and WP 1220 listed in Section II A, and is also responsible for WP Task 1311 and assistance on 1313.

Should the program be subcontracted, the Specification Control Officer should be a member of the UHF Project Staff, with the tasks of specification approval (WP Task 1212) and control of the Master Parts List (WP Task 1214).

6. Field Engineering Manager

This position requires a senior engineer familiar with a wide range of semiconductor manufacturing techniques. His responsibilities include the coordination and cross-pollination of a staff of Field Project Engineers, below.

7. Field Project Engineer

One of the most important positions of the semiconductor procurement group because of the high level of professional, technological and field operations skills required. This function carries out all the tasks in WP 1410, WP Task 1422 and 1424, and requires an engineer/scientist with detailed knowledge of semiconductor physics, manufacturing techniques, circuit applications and aerospace manufacturing standards.

In the concept of dividing contractor-government agency functions, if these positions are filled by a contractor, the government agency should retain one inspector for spot checks of vendor assembly lines, and consultation with the contractor's Field Project Engineers.

8. Test Laboratory Supervisor

This function is responsible for all tasks in WP 1510 and WP 1520. The supervisor should be an engineer with extensive knowledge of inspection and testing techniques to aerospace standards. His function is to route samples and failed devices through the test facility and determine the type and order of testing on each device. He will coordinate the data gathered during testing and produce reports for the Parts Review Board. Support needed by the Test Laboratory Supervisor include senior electrical and mechanical technicians, engineer/scientist specialists in SEM analysis, semiconductor physics, and associated technology. This capability presently exists at CRC and could be utilized as such by the UHF Satellite Project; however, if these functions are contracted out, access to the body of knowledge and scientific staff of the Failure Analysis Section of CRC must be available to the contractor. The full-time employment of such specialized technology is not cost-effective.

9. Stores Inspector

This function is a key control point in the flow of semiconductors from the vendor to the contractor end user. It is responsible for all elements of WP 1530, and requires a senior engineer for analysis of device screening data (read-and-record, and X-ray) and selection of optimum devices based on this analysis and the results of final pre-shipping inspection. The senior engineer also confirms the necessary technical information for the Certificate of Compliance under WP Task 1625.

An assembly line inspector for external visual inspection is required for accomplishment of WP Task 1532.

Although the Bonded Stores Inspector(s) report operationally to the Schedule and Status Controller, they are functionally under the control of the Production/Quality Control Manager to prevent schedule demands from diluting the effectiveness of this final pre-shipping inspection.

10. Schedule & Status Controller

The Schedule and Status Controller is the key operational manager of the ongoing procurement and delivery operations. This position requires a technical manager knowledgeable of Project activities and objectives, considerable depth in state-of-the-art production control techniques, and familiarity with procurement and store-keeping activities.

This position is directly responsible for all tasks in WP 1130 and 1140, assisted by the Vendor Expeditor and the Parts Control Clerk.

11. Vendor Expeditor

The Vendor Expeditor requires skill and familiarity with expediting delivery from vendors, coupled with a knowledge of semiconductor manufacturing and Project schedule requirements. Responsible for WP Tasks 1134, 1135, 1423, and assistance in 1421 and 1424.

12. Parts Control Clerk

This position requires a technical clerk familiar with on-line manipulation of a computer data base, technical typing and filing, and travel arrangements. Responsible for all elements of WP 1140.

13. Contracting Officer

An experienced purchasing agent with knowledge and experience in the semiconductor industry is required for this position. This responsibility should definitely be subcontracted for maximum flexibility in procurement activities. Control can be exercised by government agency audit and overall budgetary control. This position carries out all tasks in WP 1320 plus WP Tasks 1312 and 1313.

14. Stores Manager

An experienced manager of secure, bonded storage of delicate instruments and devices is required for this position. Extensive knowledge of record keeping, packing and shipping procedures is required as well as familiarity with customs clearance procedures. This position oversees the required number of couriers and storekeepers and carries out all tasks in WP's 1610, 1620, and 1630.

This foregoing section of the Management Plan has shown the recommended Organization Structure for the UHF Project parts procurement program. It has also identified and described the resources necessary to fill the positions in the Organization Structure. Finally, by a system of coded cross-references, it has indicated the responsibility for all WP Tasks identified in Section II A, WORK BREAKDOWN STRUCTURE.

The final section of the Management Plan shows, by various management systems and procedures, how the work is to be accomplished.

C. Systems and Procedures

As stated above, the "what" and "who" of the parts procurement program have been identified. "How" the work will be done is described below by:

- an overall flow chart showing the relationship of all major tasks
- the description of a Management Information System including computerized printouts, a documentation tree, and suggested sample forms and charts
- a list of recommended management instructions for communicating procedural rules.

1. Flow Chart

Figure 3 is a flow chart showing each step in the procurement and evaluation cycle, from conceptual design, through manufacture and testing, to final inspection and shipment to the hardware subcontractors.

The flow chart omits certain off-line functions and internal loops, and some detailed technical steps; however, all phases necessary for identification of control functions have been presented.

An understanding and application of the flow chart requires the knowledge of what unit is flowing through the process. For a project such as the UHF satellite, the unit being "tracked" or controlled by the process flow must be the "device-IMU", which is the number of a given device type required at a certain time for a particular assembly.

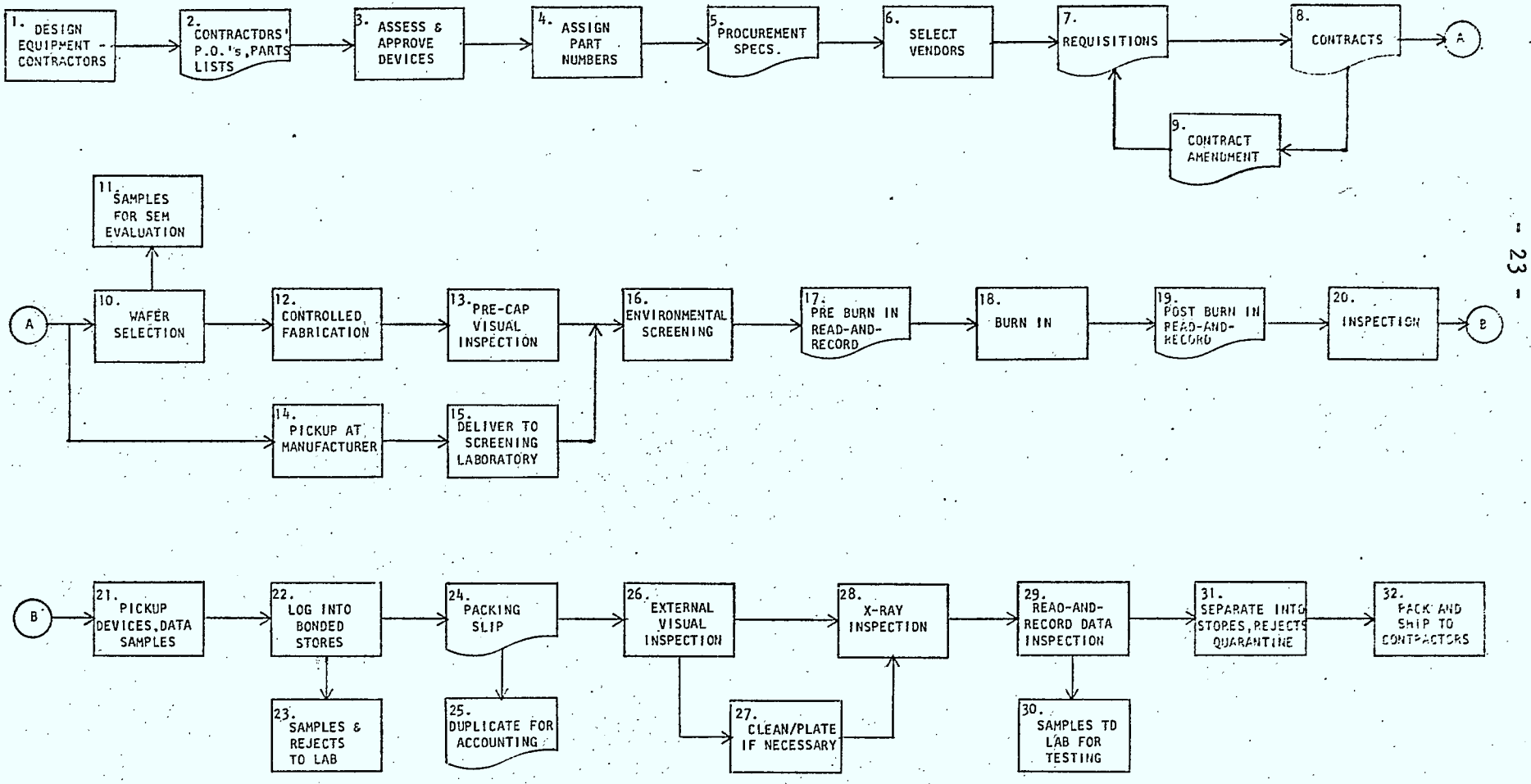


FIGURE 3

FLOW CHART FOR THE UHF SATELLITE PROJECT
SEMICONDUCTOR PROCUREMENT AND EVALUATION PROGRAM

To illustrate, consider an example in which a total of 40 of a certain hybrid microcircuit (device) is required in five different assemblies (IMU's). These assemblies are subcontracted to three of the Project subcontractors. All IMU's have different assembly sequences, and the required delivery date for the hybrids for each IMU varies from two weeks to several months.

Given enough lead time, the procuring agency would take delivery on all 40 devices, analyze the data, select the best eight for each application, and deliver them in three shipments to the three subcontractors.

The most likely occurrence, however, is that the manufacturing cycle of the devices will introduce negative slack in the critical paths of several of the IMU's. Additionally, they will typically be completed by the vendor in several separate lots. Consequently the procuring agency is forced to take delivery of the devices as they become available, and deliver them to the most urgent need, as determined by overall Project priorities.

The above example requires that the unit being controlled is the device-IMU, which results in five separate lots of eight devices each. As one can readily see, the problem of controlling the flow of thousands of these device-IMU units defies traditional methods.

The entire thrust of the Management Plan, and, in particular, the systems and procedures described in this section, are designed to effectively manage this complex procurement process.

Another major point of elaboration required for the process shown in the flow chart concerns the off-line activity beginning at step 14. This activity marks the introduction of an alternate

procurement cycle to that shown on the main line of the chart. This main line contains all the steps of controlled fabrication from wafer selection through encapsulation described in the previously referenced technical paper. The alternate cycle, however, uses an independent testing laboratory to purchase off-the-shelf parts to the highest level of reliability available, and then screens these devices through the same rigid processes as shown by the main line.

Several factors contribute to the decision to use this alternate cycle: short lead times may preclude starting a new batch of required devices; manufacturers may be reluctant to participate in the controlled manufacture process; small numbers of parts may make the cost of a controlled line prohibitive.

The extent to which the UHF Satellite chooses either path depends on the cost-time-reliability tradeoffs for each device type and source. The CTS Project procured roughly half of its devices (mostly diodes and simple transistors) through this alternate cycle.

Other elements of the flow chart are adequately described in the preceding WBS section and in the systems and procedures following.

2. Management Information System

The term Management Information System (MIS) is used here to describe the computer data base, various printouts, control documents, and selected forms and charts used to report and control the status of system flow. The MIS, its outputs, and other management documents are shown on the Documentation Tree, Figure 4, and are described below. Several sample forms are included in Appendix A.

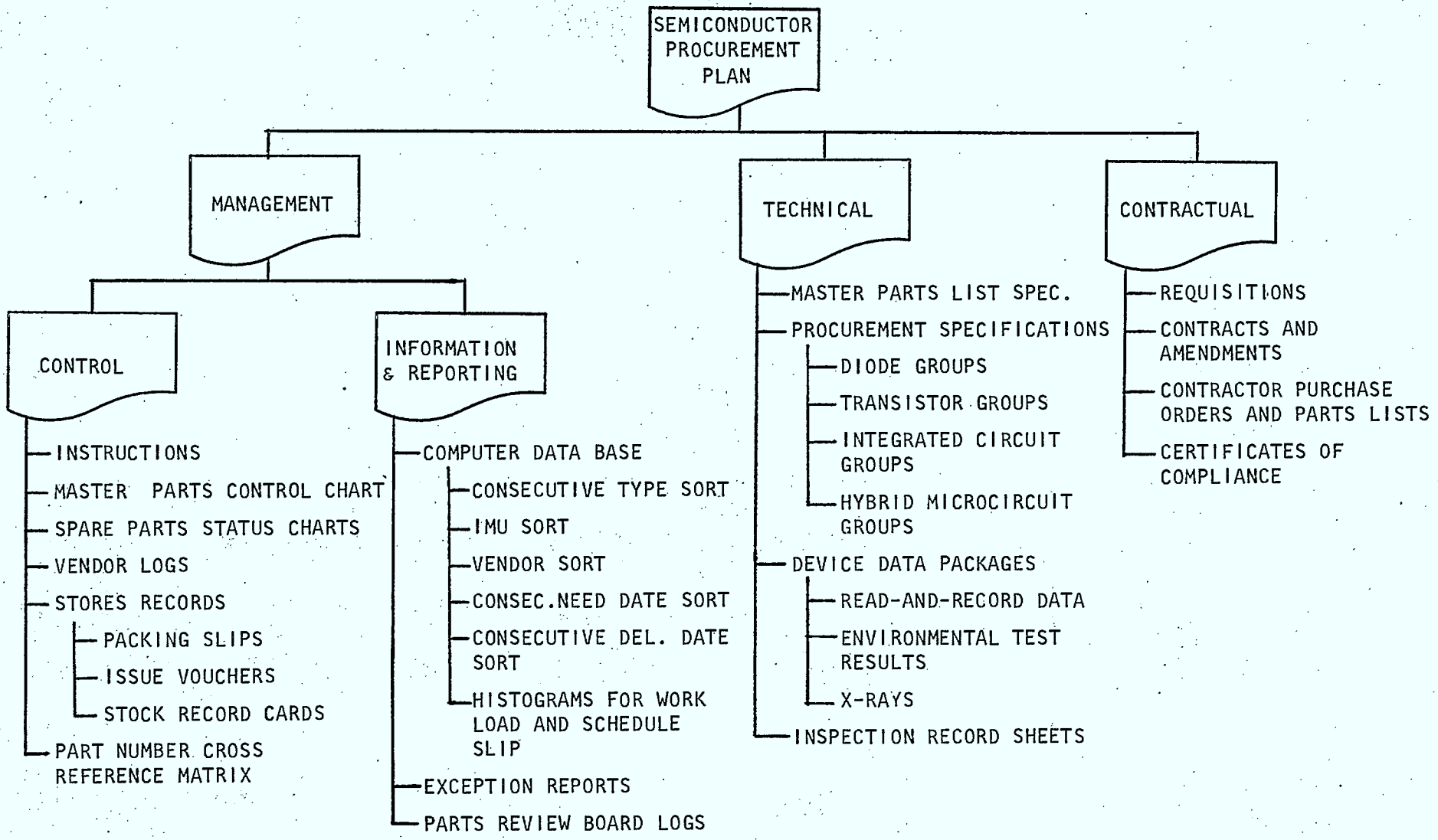


FIGURE 4

DOCUMENTATION TREE FOR THE UHF SATELLITE
PROJECT SEMICONDUCTOR PROCUREMENT AND EVALUATION PROGRAM

a) The computer data base requires the following information:

- device type (usually JEDEC code; e.g. 1N5811)
- part number
- vendor
- total quantity ordered
- expected delivery date from vendor
- IMU's requiring part
- number per IMU
- IMU required assembly date

Manipulation of the computer data base along various "sorts" provides the following printouts, used as indicated:

CONSECUTIVE TYPE SORT - the controlled master printout upon which current changes are made by the Schedule and Status Controller, and then used by the Parts Control Clerk to update the computer data base.

IMU SORT - used to provide information to the subsystem engineers about the status of their deliveries. This sort shows the number, type, need date, delivery date and "slack" for all devices in each IMU. Also used to provide data for exception reporting by subsystem.

VENDOR SORT - the same information as above but sorted by vendor rather than IMU. It is used by the Field Project Engineers as well as the Contracting Officer to provide current status by supplier.

NEGATIVE SLACK SORT - this sort provides an overview of "negative slack" for each device-IMU and is used as a management exception reporting tool.

CONSECUTIVE NEED DATE - this sort shows each device type rank-ordered by its most critical need time and is used to predict shipment demands on the system.

CONSECUTIVE DELIVERY DATE - this sort shows each device type-rank ordered by consecutive expected delivery date and is used to predict demands on device pickups for the group.

The last two sorts are used to produce a Histogram of inputs and outputs of the overall system flow for balancing work loads within the system and to provide upper management with a macroview of expected results.

b) Vendor Logs

These logs are records kept by the Vendor Expeditor and the Field Project Engineers of communications with each vendor on the status of production for each of his device types. The logs are used as regular inputs to the data base update and provide an informal record of changes in vendor commitment, as well as a regular tool for posting field inspections and device pickups.

c) Master Parts Control Chart

This chart is used by the Schedule and Status Controller to show the number of devices, by type, contracted for, required by each contractor, received, inspected (rejected, held, or placed in Bonded Stores) and delivered. It is an instantaneous reference to the status of commitment to each contractor.

d) Contractor Purchase Orders

These are controlled documents, in that they are the official requisitions by the contractors on the government agency for quantities of each device type. Once accepted, they represent a commitment to deliver by the government agency. No changes to these documents are permitted unless approved by the Parts Review Board and concurred in by the contracting authority (DSS).

e) Master Parts List Specification

An internal specification used to consolidate the requirements by the contractors for parts. A controlled document which is changed only as a result of the above approved action.

f) Procurement Specifications

These are the technical specifications which contain performance data, packaging requirements, lead forming specifications, manufacturing standards, and screening and inspection requirements. They are generated from contractor performance specifications and aerospace manufacturing standards mentioned earlier. Together with the contracts described below, they represent the official requirements on the semiconductor suppliers, and are controlled documents.

g) Contracts

These are the purchase orders placed on the suppliers which contain the device type(s), part number(s), delivery date(s), price(s), and associated contract boiler plate. They are controlled documents used in the standard fashion by the government procurement agency (DSS), or as recommended earlier, its delegated procurement agency.

h) Part Number Cross Reference Matrix

This is an internal document containing the generic type, JEDEC code, Master Parts List Part Number, and Manufacturer's Part Number for each type of device being procured. This is an essential tool used in stores management for positive identification of each device type.

i) Device Data Package

This is the package of test data (environmental tests, read-and-record, X-rays, etc.) which is delivered by the vendor with each lot of each device type. It is used by the Stores Inspector to analyze and select, by serial number, each device for shipment to the contractor.

j) Stores Documentation

This is the body of standard storekeeping documents (receiving reports, packing slips, issue vouchers, stock record cards) used to record the input, status, and output of all Bonded Stores transactions.

k) Inspection Records

These are internal records which become part of the Data Package after completion by the Stores Inspector. They contain the results of analysis and external visual inspection on each device type by serial number, and show the final disposition to Bonded Stores, quarantine, or reject.

l) Certificates of Compliance

These are certificates issued by the Stores Manager and Inspector with each shipment to the contractor, summarizing

the condition of all devices in the shipment. The Certificates are used to satisfy contractor Quality Assurance of the flight standards of each device supplied to him.

The above list describes the key documents necessary to provide system control, operational status, technical performance standards, contractual compliance, traceability, and, if properly used and filed, a comprehensive history of each device from design through final delivery and acceptance by the contractor.

3. Recommended Procedure List

A parts procurement program is a short-lived (6-18 months) part of a satellite project, with a large number of agencies and specialists brought together in multiple interfaces for ad hoc periods. The program also has a substantial impact on the project which overreaches its size and tenure. For these reasons, a body of specialized instructions is required to help the group carry out its tasks with a minimum of problems. A list of these instructions is included as a guideline. Actual instructions would vary with the final organization selected and resources assigned.

The suggested instructions are listed below with no special emphasis on ordering:

a) an overall Work Breakdown Structure, including all tasks to the lowest level possible

b) an Organization Chart, clearly assigning responsibilities for each Work Package Task, and including staff and support agency functions.

c) a statement of the Parts Review Board charter, makeup, and authority

d) policy statements regarding system priorities, particularly in the use of scarce resources, and the necessary schedule - reliability tradeoffs, such as alternate procurement cycles or sources.

e) procedures for processing samples through the test laboratory, including the rapid feedback of analyses and failure reports to the Parts Review Board

f) establishment of the use of blanket purchasing authority for rapid turnaround, including appropriate restraints

g) assignment of Official Points of Contact for vendors and contractors to maintain control over external interfaces

h) correspondence control and establishment and use of special files; control on the official use of telephones, telexes and other means of communication

i) establishment of blanket customs clearance authority, and instructions on its use

j) special handling and packaging procedures, particularly for delicate devices or those with special sensitivities

k) inspection standards and procedures for Field Project Engineers and Stores Inspectors

l) specialized forms, procedures, and facilities for stores management

m) procedures for preparation, purpose, and control of all key documents

n) requirements, content and routing of status and exception reports

o) vendor expediting, tracking instructions

p) method for rapid referral and resolution of problems

4. Special Problems

While not an integral part of the design of a theoretical management system, the anticipation of problems is often the key to survival in a rapidly changing environment. For this reason, it seems appropriate to mention some of the problems drawn from the experiences of a similar organization. A list of several problems which the CTS Parts Procurement Group faced and dealt with are included in Appendix B.

III SUMMARY AND CONCLUSIONS

A. Summary

Section I of this Management Plan contains a list of advantages and disadvantages of a proposed procurement plan for high reliability semiconductors.

It seems clear in review, from the benefit of CTS experience, that the advantages far outweigh the disadvantages. Specifically:

- The ability to marshall the resources necessary to guarantee maximum reliability of the flight semiconductors in a schedule and cost-effective fashion is best accomplished under a centralized, government-managed organization.

- Most of the inherent disadvantages of the government-managed concept can be eliminated or minimized by careful application of the management system described in this Plan.

Key elements of the Management Plan are summarized below:

- a systematic breakdown of the work to be accomplished

- the careful selection of personnel assigned to the recommended Organization Structure

- the clear and unambiguous assignment of responsibilities

- the melding of technical and managerial expertise in a mechanism such as the Parts Review Board

- the separation of Quality Control functions from operational processing to maintain the proper balance between schedule and quality demands

- the early analysis and selection of components for maximum lead time

- the careful use of controlled technical and managerial documentation

- the use of established aerospace standards of manufacture for quality control

- the rapid feedback and resolution of problems

- the delegation of purchasing authority for maximum flexibility and rapid response to changing technical requirements and conditions

- the careful collection of records and files for ease of access during subsequent troubleshooting

- dogged persistence in the acceptance and discharge of responsibility by all members of the team

Most importantly, support is required from the highest level of Project management because of the priority demands on Project resources. In addition, immediate response in dealing with external agencies at highest levels is an indispensable contribution of Project management.

B. Recommendations

Based on the success of the CTS Project, it is recommended that the UHF Satellite Project adapt a similar program for the procurement of the required flight semiconductors, and supply them as GFE to their hardware contractors.

The program described in this Management Plan is an improved version of that used on CTS, and with its intelligent application, has a very high probability of success.

The precise method of implementing the Plan by the UHF Satellite Project depends on a number of factors yet unresolved, but the broad scope of this Plan will support a successful implementation whichever alternative is selected.

APPENDIX A

SAMPLE FORMS

DEVICE TYPE	VENDOR	CONTRACT	QTY ORDERED	QTY RECD	FQS	FBS	FBH	FQP	FQR	QTY REQUIRED / QTY SHIPPED												COMMENTS
										RCA		SPAR		ACEA		CRC		LAB		OTHERS		
1N82AG	DCA	OGE3-1063	15	10			1			9	9											
S1N649	DCA	OGK2-1410	41	39		32	3	8	10			10	10	36	36							
	DCA(SEM)	OGE3-1063	60	60																		
1N751A	DCA	OPL3-0108	23/75	23/75		46	2	9	18			15	15			4	4					3?
1N753A	DCA	OPL3-0108	23/50	23/50		29		1	35							5	5	3	3			
1N758A	DCA	OPL3-0108	3/50	3/50					21									6	6			
1N829A	DCA	OGE3-1063	52	52		4		6	11	0	4	15	20					7	7			
1N957B	DCA	OGE3-1063	20	20		11				7	9											
1N2977B	DCA	OGE3-1063	20	20		6	1	2	4	7	7											Ret'd 15
1N2979B	DCA	OGE3-1443	9	9			1		1	0	7											
1N2991B	DCA	OGE3-1063	25	25		6	7	5	0	7	7											Ret'd 7
1N3611	DCA	OGK2-1410	1000	990		288			106	470	470			114	114			12	12			
1N3826A	DCA	OGE3-1063	20	20	6		4		3	7	7											6 traded with FETA
1N3893	DCA	OPL3-0108	35	35		17		2	9	7	7											Ret'd 24 15 unscreened
1N3913	DCA	OPL3-0108	25	25			3		9	13	13											2 package types
1N4448	DCA	OPL3-0108	1445	1445		334	4		44													CSM
	FAR/DCA	OGE3-0969	200	200						880 +16	880 +16	20	20	172	172	75	75	65	65	35	35	FETA
1N4569A	DCA	OGE3-1063	43	43		13			4	25	26											Ret'd 5
1N4574A	DCA	OGE3-1063	11	11		2				9	9											
1N4579A	DCA	OGE3-1063	15	15		4			1							10	10					
1N4769A	DCA	OGE3-1063	30	14			3			15	11											37 rejects ret'd
1N4774A	DCA	OGE3-1063	28	28		8			4	9	9							7	7			
1N4782A	DCA	OGE3-1063	10	10			2		1	7	7											
1N4899A	DCA	OGE3-1063	50	50		27				23	23											Ret'd 38
1N4918A	DCA	OGE3-1063	15	15		2		1	4	8	8											
1N4924A	DCA	OGE3-1063	20	20	5	4				11	11											
1N4942	DCA	OGE3-1063	225	225		24	10		1			190	190									
1N4944	DCA	OGE3-1063	88	88		24	1		6	57	57											

APPENDIX A

MASTER PARTS CONTROL CHART (SAMPLE)

DEVICE TYPE

```
305.000  1E*  34*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
309.000  CD4011AK/ 170/ 65/7205-04/ 4841/RCA/   /   /   /   /   /   /
310.000  1E*  46*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
311.000  CD4013AK/ 173/140/7208-01/ 4841/RCA/   /   /   /   /   /   /
312.000  1E*  75*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
313.000  CD4014AK/ 170/ 30/7207-01/ 4841/RCA/   /   /   /   /   /   /
314.000  1E*   2*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
315.000  CD4015AK/ 171/ 30/7207-02/ 4841/RCA/   /   /   /   /   /   /
316.000  1E*   2*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
317.000  CD4016AK/ 175/140/7206-05/ 4841/RCA/   /   /   /   /   /   /
318.000  1E*  70*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
319.000  CD4018AK/ 171/ 40/7207-03/ 4841/RCA/   /   /   /   /   /   /
320.000  1E*   8*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
321.000  CD4021AK/ 170/ 60/7207-04/ 4841/RCA/   /   /   /   /   /   /
322.000  1E*  22*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
323.000  CD4022AK/ 173/ 85/7207-05/ 4841/RCA/   /   /   /   /   /   /
324.000  1E*  43*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
325.000  CD4023AK/ 170/ 40/7206-06/ 4841/RCA/   /   /   /   /   /   /
326.000  1E*  10*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
327.000  CD4024AK/ 174/ 45/7207-06/ 4841/RCA/   /   /   /   /   /   /
328.000  1E*  14*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
329.000  CD4025AK/ 171/ 35/7206-07/ 4841/RCA/   /   /   /   /   /   /
330.000  1E*   4*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
331.000  CD4049AK/ 170/ 55/7206-03/ 4841/RCA/   /   /   /   /   /   /
332.000  1E*  18*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
333.000  LH0002H/ 149/ 67/7227-01/ 4710/NAT/   /   /   /   /   /   /
334.000  A/D*  44*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
335.000  HA2-2700/ 169/230/7216-01/ 4945/HAS/   /   /   /   /   /   /
336.000  I/O*   4*SHP/ I/O*   6*SHP/ I/O*  12*SHP/PCU*  12*SHP/EHC*  12*SHP/
337.000  HA2-2720/ 169/DUP/7216-01/ 4945/HAS/   /   /   /   /   /   /
338.000  A/D*  12*SHP/ A/D*  10*SHP/EPC*  10*SHP/   *   *   /   *   *   /
339.000  LH0002/ 141/ 29/7201-02/ 4710/NAT/   /   /   /   /   /   /
340.000  EHC*   4*SHP/EHC*   2*SHP/EHC*   2*SHP/EHC*   2*SHP/   *   *   /   *   *   /
341.000  LH2104F/ 169/ 15/7201-03/ 4710/NAT/   /   /   /   /   /   /
342.000  1E*   2*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
343.000  LH103-5./ 165/ 30/7201-05/ 4710/NAT/   /   /   /   /   /   /
344.000  A/D*   6*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
345.000  LH105H/ 148/ 27/7221-01/ 4710/NAT/   /   /   /   /   /   /
346.000  1E*   2*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
347.000  LH106/ 160/144/7201-01/ 4251/NAT/   /   /   /   /   /   /
348.000  EHC*   4*SHP/A/D*   6*SHP/   *   *   /   *   *   /   *   *   /   *   *   /
349.000  LH107A/ 157/ 37/7201-04/ 4710/NAT/   /   /   /   /   /   /
350.000  LC*   6*SHP/EIA*   7*SHP/   *   *   /   *   *   /   *   *   /   *   *   /
351.000  LH111F/ 148/ 25/7221-02/ 4710/NAT/   /   /   /   /   /   /
352.000  1E*  16*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
353.000  LM565-/ 157/ 30/7222-01/ 4710/NAT/   /   /   /   /   /   /
354.000  1E*   2*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
355.000  LM747/ 160/ 37/7217-01/ 4710/NAT/   /   /   /   /   /   /
356.000  TD*   2*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
357.000  MCS /  154/ 10/7223-01/ 4794/MIJ/   /   /   /   /   /   /
358.000  1E*   4*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
359.000  MC1558G/ 169/ 15/7224-01/ 0544/DCA/   /   /   /   /   /   /
360.000  1E*   4*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
361.000  MC1561R/ 160/ 15/7221-03/ 0544/DCA/   /   /   /   /   /   /
362.000  1E*   2*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
363.000  MC1596/E156/ 15/7224-02/ 4765/RCI/   /   /   /   /   /   /
364.000  1E*  10*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
365.000  MC1596/ 170/ 30/7225-01/ 0544/DCA/   /   /   /   /   /   /
366.000  1E*   4*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
367.000  4RD/ 166/150/7302-01/ 4714/ TI/   /   /   /   /   /   /
368.000  INT*  1*SHP/ CO*   1*SHP/PSU*  14*SHP/PCU*   9*SHP/EHC*   7*SHP/ AB*  20*SHP/
369.000  4RD/ 166/DUP/7302-01/ 4714/ TI/   /   /   /   /   /   /
370.000  ACC*   6*SHP/EIA*  20*SHP/EPC*   1*SHP/EHC*   1*SHP/EHC*   1*SHP/   *   *   /
371.000  ANALOG/ 174/ 60/7303-01/ 4715/ TI/   /   /   /   /   /   /
372.000  1E*  44*SHP/   *   *   /   *   *   /   *   *   /   *   *   /   *   *   /
373.000  COAST/ 174/ 10/7305-02/ 5015/CRY/   /   /   /   /   /   /
```

CONSECUTIVE DEVICE TYPE COMPUTER SORT (SAMPLE)

MA4511[illegible]	200/	20/	7015-01/	4843/DCA/	/ / / / /	/	TT* 8*15[illegible]-	50	**
2N2222A/	158/	200/	7101-01/	1736/FAR/	/ / / / /	/FBS 80	TT* 10*150/-	8	
2N2857/	153/	25/	7104-05/	4945/DCA/	/ / / / /	/	TT* 4*150/-	3	
							~~TT* 4*150/-~~	~~10~~	DB
2N2907A/	116/	200/	7106-01/	3316/FAR/	/ / / / /	/FBS 79	TT* 4*150/	34	SHP
2N3810/	153/	10/	7106-04/	4880/DCA/			TT* 2*150/-	3	
2N4001/	155/	75/	7109-05/	4786/KER/	/ / / / /	/	TT* 2*150/-	5	PRC
2N5917/	161/	10/	7109-04/	4796/RCA/	/ / / / /	/	~~TT* 2*150/-~~	~~11~~	DB
							TT* 2*150/-	1	
CA3005/	157/	25/	7219-02/	0544/DCA/	/ / / / /	/	TT* 2*150/-	7	
CA3015A/	149/	20/	7219-03/	0544/DCA/	/ / / / /	/	TT* 2*150/	1	
SIN649 /	113/	10/	7001-01/	0060/DCA/	/ / / / /	/FBS 8	A0E* 8*160/	47	
SIN649 /	155/	50/	7001-01/	4843/DCA/	/ / / / /	/	~~A0E* 8*160/~~	~~5~~	DB
1N829A/	151/	50/	7013-10/	4843/DCA/	/ / / / /	FBS 6	A0E* 4*160/	9	
1N4448/	146/	DUP/	7006-01/	4945/DCA/	/ / / / /	/	A0E* 16*160/	14	
1N4942/	150/	250/	7008-08/	4843/DCA/	/ / / / /	/	A0E*168*160/	10	
2N2222A/	158/	DUP/	7101-01/	/ /	/ / / / /	/	A0E* 8*160/	2	
5400/	148/	41/	7226-01/	4710/NAT/	/ / / / /	/FBS 41	A0E* 4*160/	12	
54L00/	148/	480/	7215-01/	4710/NAT/	/ / / / /	/FBS 118	A0E* 26*160/	12	
5404/	148/	40/	7226-02/	4710/NAT/	/ / / / /	/FBS 40	A0E* 8*160/	12	
54L04/	148/	390/	7204-01/	4710/NAT/	/ / / / /	/FBS 140	A0E* 20*160/	12	
54L10/	148/	90/	7215-02/	4710/NAT/	/ / / / /	/FBS 90	A0E* 4*160/	12	
54L20/	148/	140/	7215-03/	4710/NAT/	/ / / / /	/FBS 43	A0E* 4*160/	12	
54L51/	148/	50/	7205-01/	4710/NAT/	/ / / / /	/FBS 24	A0E* 8*160/	12	
54L73/	148/	105/	7202-03/	4710/NAT/	/ / / / /	/FBS 41	A0E* 16*160/	12	
54L93/	149/	150/	7212-01/	4710/NAT/	/ / / / /	/FBS 22	A0E* 8*160/	11	
54121W/	147/	35/	7214-01/	4710/NAT/	/ / / / /	/FBS 21	A0E* 4*160/	13	
54121F/	157/	35/	7214-01/	4710/NAT/	/ / / / /	/	~~A0E* 4*160/~~	~~3~~	BU
DH0008H/	148/	60/	7228-01/	4710/NAT/	/ / / / /	/FBS 60	A0E* 36*160/	12	
LM103-5./	157/	36/	7201-05/	4710/NAT/	/ / / / /	/	A0E* 8*160/	3	
LM108/	118/	100/	7201-01/	4251/NAT/	/ / / / /	/FBS 64	A0E* 8*160/	42	
4RD/	162/	DUP/	7302-01/	4714/ TI/	/ / / / /	/	A0E* 6*160/-	2	PRC
LR/	146/	115/	7301-03/	3822/CTI/	/ / / / /	/FBS 22	A0E* 14*160/	14	SHP
1N751A/	160/	50/	7009-16/	4739/FAR/	/ / / / /	/	DAE* 3*163/	3	
UT4020/	156/	20/	7011-11/	4801/UNI/	/ / / / /	/	~~DAE* 6*163/~~	~~7~~	DB
							DAE* 6*163/	11	
UT8120/	152/	15/	7011-12/	4945/DCA/	/ / / / /	/	~~DAE* 6*163/~~	~~11~~	BU
UT8120R/	161/	20/	7011-12/	4801/UNI/	/ / / / /	/	DAE* 6*164/	3	
2N2222A/	158/	DUP/	7101-01/	/ /	/ / / / /	/	DAE* 3*163/	5	
MD2219A/	159/	100/	7119-01/	4739/FAR/	/ / / / /	/	DAE* 3*163/	4	
MD2905A/	151/	50/	7119-02/	4739/FAR/	/ / / / /	/	DAE* 3*163/	12	
MJ4211/	152/	25/	7115-02/	0544/DCA/	/ / / / /	/	DAE* 6*163/	11	
1N3611/	116/	990/	7004-01/	0060/DCA/	/ / / / /	FBS 564	EHC* 28*152/	36	SHP
1N4448/	146/	301/	7006-01/	4945/DCA/	/ / / / /	/	EHC*110*152/	6	SHP
1N4899A/	150/	50/	7013-04/	4843/DCA/	/ / / / /	/	EHC* 4*152/	2	

COMPUTING CENTRE

COMMUNICATIONS RESEARCH CENTRE

IMU COMPUTER SORT (SAMPLE)

IMU

APPENDIX A

APPENDIX A

NEED DATE (WEEK) →

[illegible]			/FBS [illegible]	[illegible]	12	
54L10/	148/ 90/7215-02/ 4710/NAT/	/ / / / /	/FBS 90	ADE* 4*160/	12	
54L20/	148/140/7215-03/ 4710/NAT/	/ / / / /	/FBS 43	ADE* 4*160/	12	
54L51/	143/ 50/7205-01/ 4710/NAT/	/ / / / /	/FBS 24	ADE* 6*160/	12	
54L73/	148/105/7202-03/ 4710/NAT/	/ / / / /	/FBS 41	ADE* 16*160/	12	
54L93/	149/150/7212-01/ 4710/NAT/	/ / / / /	/FBS 22	ADE* 8*160/	11	
54121[illegible]/	147/ 35/7214-01/ 4710/NAT/	/ / / / /	/FBS 21	ADE* 4*160/	13	
54121F/	157/ 35/7214-01/ 4710/NAT/	/ / / / /	/	~~[illegible]~~	~~3~~	BU
N.725A/	152/ 10/7215-01/ 4734/AMD/	/ / / / /	/	PCU* 2*160/	5	
DH0005F/	143/ 60/7228-01/ 4710/NAT/	/ / / / /	/FBS 60	ADE* 35*160/	12	
NA2-2700/	154/230/7216-01/ /DCA/	/ / / / /	/	PCU* 10*160/	6	
LM103-5./	157/ 35/7201-05/ 4710/NAT/	/ / / / /	/	ADE* 8*160/	3	
L[illegible]103/	113/100/7201-01/ 4251/NAT/	/ / / / /	/FBS 64	ADE* 8*160/	42	
[illegible]48D/	162/125/7302-01/ 4714/ TI/	/ / / / /	/	PCU* 9*160/-	2	
				ADE* 6*160/-	2	PRC
LM/	146/115/7201-03/ 3122/CTI/	/ / / / /	/FBS 22	ADE* 14*160/	14	SHP
[illegible]06S/	156/ 30/7304-01/ 4712/ TI/	/ / / / /	/	PCU* 4*160/	4	
[illegible]03D/	164/ 30/7304-02/ 4712/ TI/	/ / / / /	/	PCU* 4*160/-	4	
11[illegible]449/	146/299/700[illegible]-01/ 4945/DCA/	/ / / / /	/FBS 101	TE*144*161/	15	SHP
114539A/	150/ 40/7007-02/ 4843/DCA/	/ / / / /	/	TE* 2*161/	11	
114574A/	150/ 20/7007-04/ 4843/DCA/	/ / / / /	/	TE* 2*161/	11	
114774/	157/ 20/7013-02/ 4843/DCA/	/ / / / /	/	TE* 2*161/	4	
[illegible]	150/ 20/7013-03/ [illegible]/DCA/	/ / / / /	/	TE* 2*161/	11	
[illegible]	156/ 20/7013-0[illegible]/ [illegible]/DCA/	/ / / / /	/	TE* 10*161/	[illegible]	
1155250/	154/DUP/7012-04/ 4945/DCA/	/ / / / /	/	TE* 2*161/	7	
1155300/	155/ 20/7007-11/ 4843/DCA/	/ / / / /	/	TE* 2*161/	6	
2122223/	158/200/7101-01/ 1734/FAR/	/ / / / /	/FBS 80	TE* 44*161/	3	
2N3504/	164/ 70/7107-01/ 4701/FAR/	/ / / / /	/	TE* 44*161/-	3	
CD4[illegible]/	161/ 25/7205-01/ 4341/RCA/	/ / / / /	/	TE* 4*161/	[illegible]	
CD4[illegible]/	161/ 45/7205-02/ 4341/RCA/	/ / / / /	/ / /	TE* 34*161/	[illegible]	
CD4011AE/	161/ 75/7205-04/ 4341/RCA/	/ / / / /	/	TE* 44*161/	[illegible]	
CD4013AE/	161/100/7205-01/ 4341/RCA/	/ / / / /	/	TE* 75*161/	0	
CD4014AE/	161/ 20/7207-01/ 4341/RCA/	/ / / / /	/	TE* 2*161/	0	
CD4015AE/	161/ 20/7207-02/ 4341/RCA/	/ / / / /	/	TE* 2*161/	0	
CD4016AE/	161/100/7205-05/ 4341/RCA/	/ / / / /	/	TE* 70*161/	0	
CD4019AE/	161/ 30/7207-03/ 4341/RCA/	/ / / / /	/	TE* 8*161/	0	
CD4021AE/	161/ 50/7207-04/ 4341/RCA/	/ / / / /	/	TE* 24*161/	0	
CD4022AE/	161/ 75/7207-05/ 4341/RCA/	/ / / / /	/	TE* 44*161/	0	
CD4023AE/	161/ 30/7206-06/ 4341/RCA/	/ / / / /	/	TE* 10*161/	0	
CD4024AE/	161/ 35/7207-06/ 4341/RCA/	/ / / / /	/	TE* 14*161/	0	
CD4025AE/	161/ 25/7204-07/ 4341/RCA/	/ / / / /	/	TE* 4*161/	0	
CD4049AE/	161/ 45/7204-03/ 4341/RCA/	/ / / / /	/	TE* 16*161/	0	
NA2-2700/	154/230/7216-01/ /DCA/	/ / / / /	/	TE* 8*161/	7	
LM111F/	143/ 25/7221-02/ 4710/NAT/	/ / / / /	/FBS 25	TE* 16*161/	13	SHP
[illegible]AL20G/	164/ 55/7303-01/ 4715/ TI/	/ / / / /	/	TE* 44*161/-	[illegible]	PRC
CDAS1/	155/ 10/7303-02/ 5015/CRY/	/ / / / /	/	TE* 2*161/	5	
DIGITAL/	161/ 55/7303-02/ 4715/ TI/	/ / / / /	/	TE* 36*161/-	3	PRC
LF0022/	159/ 15/7201-02/ 4710/NAT/	/ / / / /	/	TE* 3*161/	2	
1N751A/	160/ 50/7009-16/ 4739/FAR/	/ / / / /	/	DAE* 3*163/	3	
				LC* 6*163/	3	
1N829A/	151/ 50/7013-10/ 4843/DCA/	/ / / / /	FBS 6	LC* 6*163/	12	
JT4020/	156/ 20/7011-11/ 4801/UNI/	/ / / / /	/	~~[illegible]~~	~~7~~	DB
				DAE* 6*163/	11	
				DB* 64*163/	6	
JTB120/	152/ 15/7011-12/ 4945/DCA/	/ / / / /	/	~~[illegible]~~	~~11~~	BU
2122224/	158/DUP/7101-01/ / /	/ / / / /	/	DAE* 3*163/	5	
1D2219A/	159/100/7119-01/ 4739/FAR/	/ / / / /	/	DAE* 3*163/	4	
1D2905A/	151/ 50/7119-02/ 4739/FAR/	/ / / / /	/	DAE* 3*163/	12	
MJ4211/	152/ 25/7115-02/ 0544/DCA/	/ / / / /	/	DAE* 6*163/	11	
LM108A/	156/ 22/7201-04/ 4710/NAT/	/ / / / /	/FBS 22	LC* 6*163/	7	
1N3611/	116/010/7004-01/ 0069/DCA/	/ / / / /	/	TD* 4*164/	43	SHP
114446/	146/999/7006-01/ 4945/DCA/	/ / / / /	/FBS 101	TD* 36*164/	13	SHP
114574A/	150/ 20/7007-04/ 4843/DCA/	/ / / / /	/	TD* 2*164/	14	
JTB120B/	161/ 20/7011-12/ 4801/UNI/	/ / / / /	/	DAE* 6*164/	3	
2122222A/	158/DUP/7101-01/ / /	/ / / / /	/	TD* 36*164/	6	
2124324/	155/ 25/7103-04/ 4945/DCA/	/ / / / /	/	TD* 4*164/	9	
						DB

CONSECUTIVE NEED DATE SORT (SAMPLE)

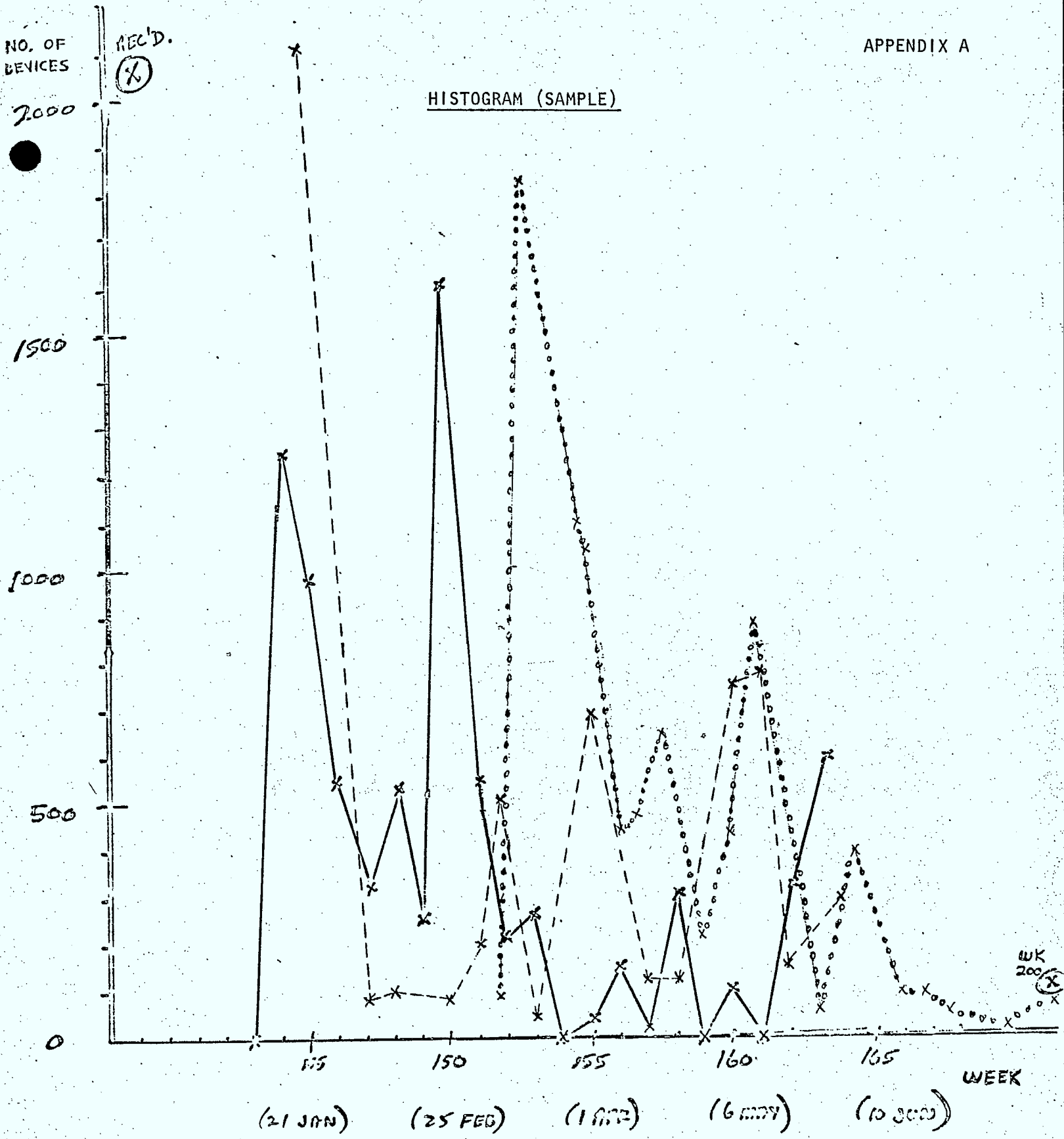
DELIVERY DATE (WEEK)

1N4918A/	149/	20/7013-05/	4843/DCA/	/	/	/	/	/	/		PCU*	3*160/	11
54L10/	149/	90/7215-02/	4710/NAT/	/	/	/	/	/	/		TD*	4*154/	15
											AB*	56*145/-	4
											ADE*	4*160/	11
54H20/	149/	20/7226-01/	0544/DCA/	/	/	/	/	/	/		TR*	2*147/-	2
93L11/	149/	25/7227-01/	0544/DCA/	/	/	/	/	/	/		TD*	4*154/	15
CA3002/	149/	20/7219-01/	0544/DCA/	/	/	/	/	/	/		TR*	2*147/-	2
CA3015A/	149/	30/7219-03/	0544/DCA/	/	/	/	/	/	/		TT*	2*150/	1
CA3023A/	149/	25/7219-04/	0544/DCA/	/	/	/	/	/	/		TR*	6*147/-	2
LM108/	149/3GP/7221-01/		4251/NAT/	/	/	/	/	/	/		ADE*	8*160/	11
LM108A/	149/	22/7221-04/	4710/NAT/	/	/	/	/	/	/	/FBS 56	LC*	6*163/	14
MC1590G/E	149/	45/7224-02/	4765/MOT/	/	/	/	/	/	/		TR*	10*147/-	2
SN7649 /	150/	50/7201-01/	4843/DCA/	/	/	/	/	/	/		AB*	28*145/-	5
											ADE*	8*172/	22
1N2979B/	150/	10/7209-05/	4880/ /	/	/	/	/	/	/		EPC*	2*155/	5
1N4569A/	150/	40/7207-02/	4843/DCA/	/	/	/	/	/	/		TE*	2*161/	11
											SA*	2*155/	5
											PCU*	5*160/	10
											MHC*	2*157/	7
											MHC*	3*158/	8
											EPC*	2*155/	5
											CD*	4*155/	5
1N4674A/	150/	30/7207-04/	4843/DCA/	/	/	/	/	/	/		TE*	2*161/	11
											TD*	2*154/	14
1N4679A/	150/	20/7213-11/	4843/DCA/	/	/	/	/	/	/		SR*	3*152/	2
1N4769A/	150/	30/7213-06/	4843/DCA/	/	/	/	/	/	/		MHC*	4*157/	7
											MHC*	4*158/	8
											EPC*	2*155/	5
1N4899A/	150/	50/7213-04/	4843/DCA/	/	/	/	/	/	/		EHC*	4*152/	2
											MHC*	4*157/	7
											MHC*	4*158/	8
											EPC*	4*155/	5
1N4924A/	150/	35/7213-07/	4843/DCA/	/	/	/	/	/	/		PCU*	4*160/	10
											EHC*	2*152/	2
1N5418/	150/	25/7208-09/	4843/DCA/	/	/	/	/	/	/		SR*	4*152/	2
1N5764/	150/	20/7209-07/	4843/DCA/	/	/	/	/	/	/		EHC*	2*152/	2
1N5303/	150/	50/7210-02/	4843/DCA/	/	/	/	/	/	/		PCU*	8*160/	10
											EHC*	6*152/	2
1N5308/	150/	20/7209-11/	4843/DCA/	/	/	/	/	/	/		TE*	2*161/	11
											EPC*	2*155/	5
1N5226B/	150/	20/7209-14/	4843/DCA/	/	/	/	/	/	/		EPC*	2*155/	5
2N2102/	150/	15/7109-01/	4736/KER/	/	/	/	/	/	/		EHC*	2*152/	2
MJ2955A/	150/	60/7119-02/	4739/FAP/	/	/	/	/	/	/		DAE*	3*163/	13
54L95/	150/375/7313-01/		4710/NAT/	/	/	/	/	/	/		TD*	20*164/	14
											AB*	320*145/-	5
1N829A/	151/	50/7013-10/	4843/DCA/	/	/	/	/	/	/		ADE*	4*160/	9
											LC*	6*163/	12
1N4944A/	151/	20/7008-07/	4843/DCA/	/	/	/	/	/	/		EHC*	8*152/	1
											EPC*	6*155/	4
1N4967/	151/	40/7009-08/	4843/DCA/	/	/	/	/	/	/		EHC*	4*152/	1
											MHC*	4*157/	6
											MHC*	2 *158/	7
HP-0243/	151/	15/7017-03/	4799/ HP/	/	/	/	/	/	/		LO*	4*148/-	3
											TR*	2*147/-	4
HP-2713/	151/	10/7016-01/	4799/ HP/	/	/	/	/	/	/		FT*	3*148/-	3
2N2857/	151/	25/7104-05/	/DCA/	/	/	/	/	/	/		LO*	12*142/-	9
											TT*	4*145/-	6
2N3570/	151/	/7105-01/	/DCA/	/	/	/	/	/	/		TR*	4*147/-	4
2N3635/	151/	20/7110-01/	0544/DCA/	/	/	/	/	/	/		SR*	3*152/	1
											INT*	2*151/	0
2N3799A/	151/	20/7107-02/	0544/DCA/	/	/	/	/	/	/		EHC*	2*152/	1
2N3810/	151/	10/7106-04/	4880/DCA/								TT*	2*150/-	1
2N5917/	151/	25/7109-04/	0544/DCA/	/	/	/	/	/			LO*	4*148/-	3
											TT*	2*150/-	1
5404/	151/	40/7226-02/	4710/NAT/	/	/	/	/	/	/		ADE*	8*160/	9
490/	151/3GP/7302-01/		4714/ TI/	/	/	/	/	/	/		ADE*	6*160/	9

CONSECUTIVE DELIVERY DATE SORT (SAMPLE)

APPENDIX A

HISTOGRAM (SAMPLE)



- - - X IMU NEED DATES

——— X DEVICE DUE DATES (AT CDC)

..... X NEW DELIVERY DATES (4 MAR)

CTS FLIGHT BONDED STORE

DEVICE TYPE:

SUPPLIER:

DSS P/O Nº:

CRC PART Nº: 2507

MANUFACTURER:

QUANTITY RECEIVED:

MNF. PART Nº:

DATE CODE:

DATE RECEIVED:

DEVICE MARKING:

ITEM	SERIAL NUMBER	EXTERNAL VISUAL	X-RAY	READ & RECORD	STORE	SHIPMENTS			DEVICE COMMENTS
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
						Quantity			
						Date			

Dimensional Check

Solderability Check

GENERAL COMMENTS

Codes:

S: FB STORE

* H: FB HOLD

A: Acceptable

* D: Doubtful

R: Reject

* Decision required before shipment.

BONDED STORES INSPECTION AND SHIPMENT RECORD FORM (SAMPLE)

GFE SEMICONDUCTOR DEVICE RELIABILITY CERTIFICATION

REFERENCE: SR 01/07, 08, 09, 10 and Supporting Detailed Specifications.

This is to certify that device type _____ (serial numbers listed below) have met the high reliability requirements of the CTS Program. These requirements include:

(a) Product line certified to aerospace high-rel standards; or

(b) Procurement of highest level devices available and selection by stringent screening (CPL - equivalent), including the following:

- Lot serialization for traceability;
- Environmental testing;
- Burn-in including read and record data;
- Radiographic inspection where applicable;
- Hermeticity tests;
- Group B & C inspections;
- Post-cap visual.

Data supporting the above screening and testing is available in CRC Flight Bonded Stores Library.

Exceptions to the above are:

Serial No's.

Certified by: _____

Date: _____

CERTIFICATE OF COMPLIANCE (SAMPLE)

DEVICE TYPE	NO. AD CONTRACTORS FLT.	SPARES	TOTAL	CES SPARES REQ'D 15%	NO. IN STORES FDS	FBH	FQP	FQR	OVERAGE OR SHORTAGE	REL'S AND QTY PER ISU
1N82AG	4	5	9	2	0	0	1	0	-2	LO(4)
1N649	36	10	46	7	32	3	8	10	+25	AOE(8), AB(28)
1N751A	9	6	15	3	46	2	9	18	+43	DAE(9)
1N753A	4	1	5	1	29	0	1	35	+28	SB(4)
1N758A	4	1	5	1	17	0	0	21	+16	SB(4)
1N829A	10	5	15	3	4	0	6	11	+1	DAE(6), AOE(4)
1N957B	4	5	9	2	11	0	0	0	+9	LO(2)
1N2977B	2	5	7	2	6	1	2	4	+4	EPC(2)
1N2979B	0	7	7	0	0	1	0	1	0	EPC(2)
1N2991B	2	5	7	2	6	7	5	0	+4	EPC(2)
1N3611	484	59	543	82	288	0	0	104	+206	INT(62), SA(36), CD(22), PSU(34), PCU(62), EHC(30), MHC(10), MWC(10), EPC(36), AB(94), TD(4), EIA(84)
1N3826A	2	5	7	2	0	4	0	9	-2	EPC(2)
1N3893	2	5	7	2	17	0	2	9	+15	EPC(6)
1N3913	8	5	13	2	3	0	0	9	-2	MWC(4), MHC(4)
1N4448	1043	134	1177	177	334	4	0	44	+157	INT(84), TT(28), TR(4), TE(144), TD(42), CD(116), PCU(65), EHC(106), MHC(44), MWC(56), EPC(96), AB(156), SB(62), AOE(16), FET(24)
1N4569A	20	6	26	6	13	0	0	4	+7	TE(2), CD(2), PCU(5), MWC(3), MHC(2), EPC(2), INT(2), EHC(2)
1N4574A	4	5	9	2	2	0	0	0	0	TE(2), TD(2)
1N4579A	6	4	10	2	4	0	0	1	+2	SB(6)
1N4769A	10	0	10	3	2	0	1	0	-1	MWC(4), MHC(4), EPC(2)
1N4774A	4	5	9	2	8	0	0	4	+6	TE(2), TR(2)
1N4782A	2	5	7	2	0	2	0	1	-2	TE(2)
1N4899A	18	5	23	4	27	0	0	0	+23	MWC(4), MHC(4), EPC(6)
1N4918A	3	5	8	2	2	0	1	4	0	PCU(3)
1N4924A	6	5	11	2	9	0	0	0	+7	PCU(4), EHC(2)

SPARE PARTS STATUS CHART (SAMPLE)

APPENDIX A

APPENDIX B

LIST OF TYPICAL PROBLEMS/SITUATIONS ENCOUNTERED BY A SATELLITE PROJECT

LIST OF TYPICAL PROBLEMS/SITUATIONS ENCOUNTERED BY A SATELLITE PROJECT

Following is a list of possible problems similar to those encountered by a satellite project in undertaking a centralized parts procurement program. The situations described are not an official record of the program, but the subjective experience of a member of its parts procurement group.

They are presented here to help the UHF Satellite Project avoid or minimize the impact of similar problems which might arise.

1. The most important problem is the short lead time between crystallization of equipment design and the required delivery dates for the components for protoflight assembly. The effect of this short cycle can be minimized by early review and design approval, standardization of parts, resistance by the Design Authority to overspecification by the designer, early coordination with the manufacturers, and a quick response contracting method.

2. Most important to the solution of management problems is the support of Project Management in directing priorities and assigning scarce resources. The ability to short-circuit traditional recruiting sources is an allied and important factor.

3. In addition to the thousands of units (device-IMU's) being tracked on a day-to-day basis, it must be remembered that each device is uniquely identified, by serial number, for traceability. The importance of adequate recordkeeping of the movement and condition of each device, without proliferating tons of paperwork, cannot be overemphasized.

4. Related to the above, the text has mentioned a cross-index of device identification. A matrix is required to identify each device type by JEDEC code, CRC part number, manufacturer's part number, and specification number.

5. The density of communications between contractor and Design Authority regarding changes to device numbers and specifications is enormous in the early part of the procurement cycle. Likewise, there are many changes to the delivery commitments from the vendors throughout the program. The impact of an improper, uncontrolled change can be disastrous, and can be eliminated or minimized by:

   - identification of single official point(s) of contact with both contractors and vendors, and an enforced discipline recognizing these

   - rigid control of the Master Parts List, all contracts, and procurement specifications, by insistence that all changes be "hard-copied" at some point

   - required approval of a quorum of the Parts Review Board for all changes to the above

   - All official telexes, letters, other communications signed off by the Parts Review Board

6. Supplying critical parts to one's own contractor often results in a role reversal for the Design Authority. This must be mitigated by insistence on mutual respect for each party's role and a great deal of tact and diplomacy by the key members of the parts procurement group. The jobs of Vendor Expeditor and Schedule and Status Controller, for example, must be filled by competent professionals.

7. One potential technical management problem worth noting involves the control over materials used in the manufacture of hybrid microcircuits. Although contract boiler plate may require the use of high reliability components, Design Authority inspection of the hybrids would not normally begin until transistor chips were mounted on the substrate. Often the chips are "flip" mounted, and inspection of them at this point is not feasible.

The technical inconsistency introduced by this situation is that at the original chip manufacturer (e.g. Motorola, RCA), the Field Project Engineers maintain rigid quality at pre-cap inspections of required transistors and integrated circuits; however, the same type of chips, but a lower quality, could be procured and used by the hybrid manufacturer, and "passed" by the hybrid Field Project Engineer.

This problem can be avoided by Design Authority insistence on high reliability procurement standards by the manufacturer, and pre-mounting inspection by the Field Project Engineer. As a minimum, all "flip-chips" should be inspected prior to mounting, and to the same rigid standards imposed on the original manufacturer.

8. It must be clear that the manipulation of the large masses of data in the MIS can itself create a major problem. A suggested aid here is to have an independent technical editor review and "audit" the data base periodically, perhaps as often as every month in the early, more fluid stages of the program.

9. A most important and most difficult position to fill, is that of Field Project Engineer, who is a blend of diplomat, inspector, scientist, and production manager. Early selection, training, and continuing cross-pollination are necessary to solve this problem.

10. Care must be taken at each step in order that the adversary system designed by this Management Plan be recognized and enforced. Pressures to sacrifice reliability for schedule will build constantly, and the conflicts generated must be dealt with openly and firmly.

11. Although seemingly a minor item, speed of response by all parties concerned can be improved by some simple tools:

    - the use of teleconferencing for troubleshooting, problem solving and, followed by a quick telex, any change in specifications or contracts

- the elimination of distributors, jobbers, field representatives and and other "middle men". If it is not possible to establish direct contact with a responsible "project engineer" at the plant, find another supplier.

- personal pickup and hand carry of all parts to and from the suppliers/ contractors. Never hand flight devices over to a commercial carrier. It is a most false concept of economy, for both schedule and security reasons.

- the use of blanket customs clearance authority for all parts crossing any borders. This can be obtained by inter-agency agreement and is an invaluable short cut in the ritual at the border.

12. If using an independent testing laboratory as a procuring agency, ensure that the contractual arrangement is a "buy-sell", rather than fixed price type. When a fixed price contract is used, there are tremendous conflicts of interest generated within the laboratory which is, after all, trying to make a profit.

13. Be certain that all parameters for each device type are specified clearly. This sounds obvious, but in many cases essential indications of size, package, number of leads, lead forming profile, etc. can be overlooked.

14. Essential to the proper operation of the group is the rapid alerting of the Parts Review Board to any malfunction in any part type similar to those being procured. Firm reporting channels must be set up with contractors, suppliers, test laboratories, other users (NASA, DND, commercial firms) within the industry.

15. A final discussion of "people" problems is called for: the stresses on an ad hoc group under constant pressures of schedule and technical problems is significant. The stresses cannot be eliminated or ignored, but can be reduced by:

- recruiting, rather than assigning people to the team

- instilling an elitist team spirit in the group

- open recognition, discussion of conflicts; equal and fair support to all members

- reduction of anxiety by clear direction and problem resolution

- shifting of roles where possible to cross-train and breed understanding

- constant recognition by Project Management of high performance and individual achievement.