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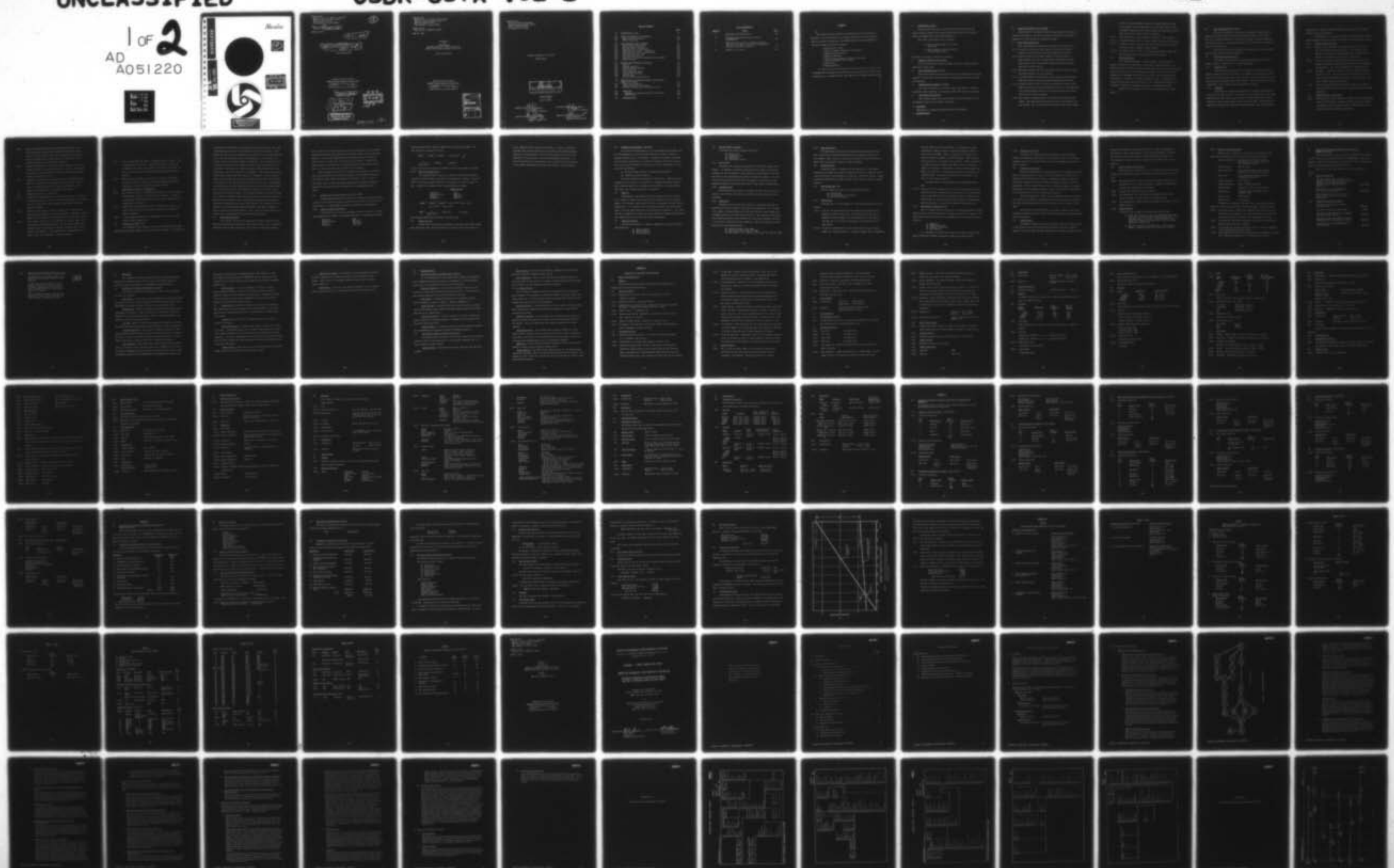

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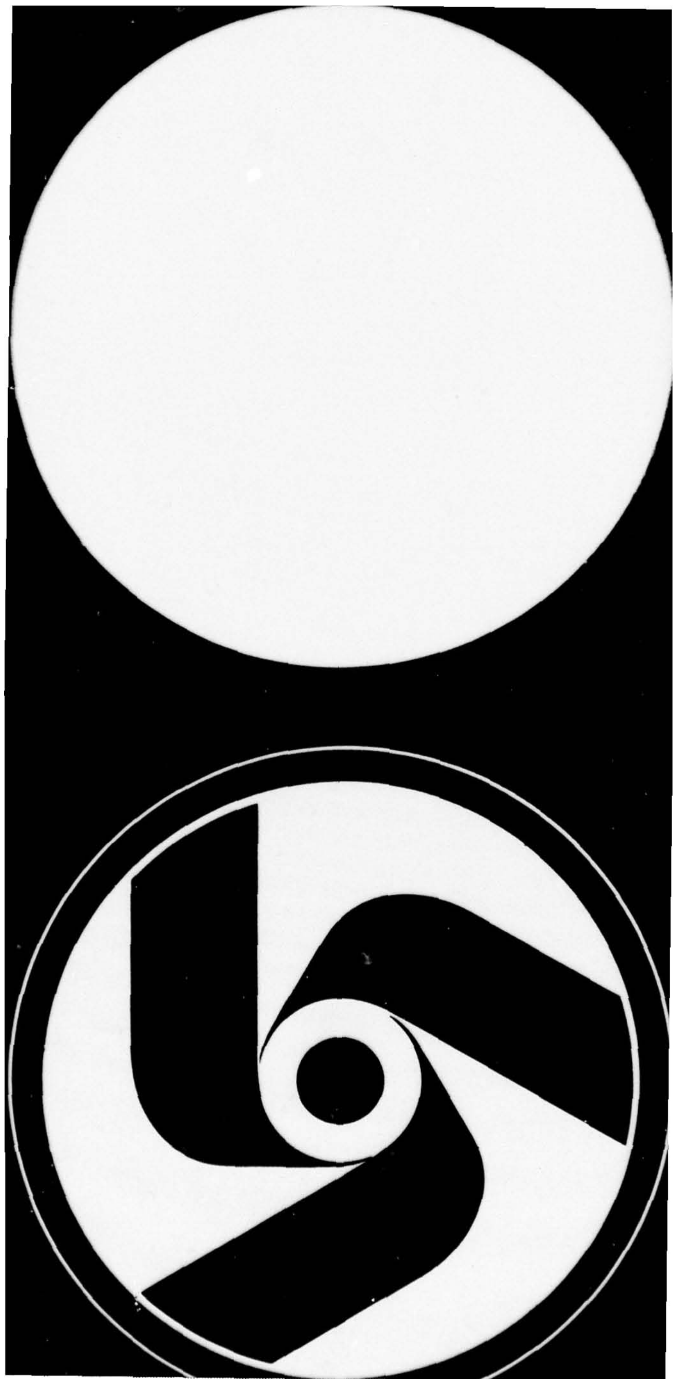

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VOLUME 2.
APPENDICES.

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APPENDIX A
TO
FINAL REPORT
ADVANCED PRODUCTION ENGINEERING (APE)
NIGHT VISION SIGHT INFRARED, AN/TAS-3()

CATS STUDY REPORT

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COMPUTER AUTOMATIC TEST SYSTEM

STUDY REPORT

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GSDR No. 569

June 20, 1973

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FOREWORD

This report has been prepared in compliance with the contractual requirements for an investigation of a Computer Automatic Test System (CATS), that can be used in production of the DRAGON Night Vision Sight AN/TAS-3( ). The report consists of several sections;

(1) Introduction to CATS,
(2) Theory of Computer Automatic Test Systems,
(3) Hardware Instrumentation,
(4) Computer Subsystem,
(5) Time and Cost Analyses of a Manual Test System versus an Automatic Test System,
(6) Conclusions,
(7) Recommendations;

It should be noted that although this report describes a system to test the DRAGON NVS the hardware described herein can be used for other night viewing systems (i.e., Handheld Viewer, TOW, FIRTI) with a minimum software effort.

1. INTRODUCTION TO CATS

The purpose of this report is to cover all the salient facts concerning computer automatic test equipment which can be used in the production of the DRAGON Night Vision Sight AN/TAS-3( ).

This report concentrates on the following:

a) Multi station computer driven test instruments.

b) Source programs that shall consist of End-to-End testing.

Sections 2.0 through 7.0 discuss the following.

2. THEORY OF AUTOMATIC TEST SYSTEMS

A brief introduction to the philiosphy of automatic testing and the definition of some terms.

3. TEST INSTRUMENTATION (HARDWARE)

This section specifies the requirements for the measurement and stimulus equipment and discusses trade-offs between a dedicated system and a building block approach.

4. COMPUTER AND PERIPHERALS (SOFTWARE)

This section specifies the minimum computer requirements, including peripheral support equipment, and provides insight into software programming.

5. TIME VERSUS COST ANALYSIS

This section compares the time and costs to perform systems tests on an Automatic System versus a Manual Test System.

6. CONCLUSION

Advantages of a Computer Automated Test Set are discussed.

7. RECOMMENDATIONS

2.0 THEORY OF AUTOMATIC TEST EQUIPMENT

A CATS system is a grouping of modified measurement and stimulus instruments configured so that they are remotely programmable and capable of responding to a Test Program Set (Software package).

2.1 Basic CATS Configuration

Basic requirements for configuring an Automatic Test System are:

2.1.1 A computer or controller that directs and controls the testing process, as well as interpreting and evaluating test results.

2.1.2 Stimulus devices such as power supplies, signal generator, or pulse generator that can be automatically programmed to provide required amplitudes, pulse widths, frequencies, and other inputs required to perform testing.

2.1.3 Measurement devices that can be programmed over the required ranges and scales needed to carry out testing.

2.1.4 A switching device to interconnect (under program control) the Unit Under Test (UUT) to the proper stimulus and measurement devices.

2.1.5 Peripheral devices such as printers and displays to provide a man-machine interface to the degree required by the user. The sophistication of the peripheral device will depend greatly upon the use for which the test system is planned.

2.1.6 Tape reader or equivalent device for loading the UUT program into memory. The requirements placed upon this unit also depend on the test system's use. If the system is required to test a small number of units it may be possible to keep all the UUT programs resident in core memory. As the number and size of the UUT's become larger it becomes necessary to store these programs on some medium and read them into the test system as they are required.

2.1.7 Test program set. A test program set consists of the following:

2.1.7.1 A computer program, such as a tape, to direct the testing operations.

2.1.7.2 A booklet or manual that describes to the station operator (production tester) how to operate the test station.

2.1.7.3 An interface device. This is a unique piece of hardware that mates the Unit Under Test to the patch panel of the computer.

2.2 CATS, Constraints

As in manual operations, a testing procedure must be devised to monitor the functions or parameters of a UUT under automatic testing. The additional constraints that automatic testing imposes are that the software package must implement this testing procedure, keeping in mind that the software package must be debugged and verified as an entity. This verification must take place on a station or a computer simulated station. It should also be noted that these tapes must be verified on a test station whose hardware configuration is capable of supplying the stimuli, measurements and loads.

Therefore, true automatic testing is not just automating a manual test set.

3.0 TEST INSTRUMENTATION (HARDWARE)

The test instrumentation represents the equipment/subsystem that is required to stimulate and measure the Unit Under Test (UUT). This section will not investigate hardware for the computer subsystem, switching subsystem, and interface devices. These three subsystems will be discussed in Section 4.0, Computer and Peripherals.

The several stimulus and measurement instruments with their respective specifications are described in Appendix A.

3.1 CATS Hardware Configuration

The testing instrumentation is generally configured as one of two types of systems: building block or a dedicated system.

3.1.1 Building Block

A building block configuration is comprised of separable functional elements joined to operate as a system. For example, if the test system multimeter were removed from the system, the multimeter could still perform its function of making measurements under manual control. Thus each element can operate independently of the remaining system elements as an entity.

3.1.2 Dedicated

A dedicated or integrated configuration is designed specifically for a given task or class of tasks. The elements of this type of system, when separated from the system itself, cannot be used to provide characteristic system functions as they do when connected within the test system. The dedicated configuration is usually built about some selected computer that provides control and analysis; it contains standard man-machine interfaces such as visual display, printer and keyboard.

The following is a comparison between the building block and dedicated hardware configurations, with the advantages and disadvantages of both.

3.2 Building Block Advantages

3.2.1 There is a wide selection of vendors from whom to select the test system building block components. This allows the user-developer, configuring a building block CATS, to select the components of the system to meet the test requirements.

3.2.2 By its very nature, a building block automatic test system is capable of extensive modification (through addition and deletion of components). This is not possible with a dedicated system.

3.2.3 Purchasing functional elements eliminates system design and development costs. The price paid for off-the-shelf components contains vendor development costs that are distributed over many units, thereby reducing the unit cost.

3.2.4 For any given building block component a vendor can usually be chosen whose expertise in design and development exceeds all other competitors.

3.3 Building Block: Disadvantages

3.3.1 Development of building block CATS includes an initial engineering outlay for integration. Among the problems that can be expected are grounding, EMI, timing and loading. These problems are not difficult to solve, but must be considered.

3.3.2 Since the building blocks selected are designed for general purpose application, they will have capabilities beyond the requirements of the test system itself. This inefficiency of unused capability invariably leads to reduced system reliability due to the presence of unnecessary failure mode candidates.

3.3.3 Because building blocks are not specifically packaged for use in a system environment, a great deal of space is required. In addition, by placing the building blocks in an enclosed environment, special cooling requirements may arise.

3.3.4 Maintenance requirements are increased because most building block CATS are not designed to be automatically self checked. Usually, once a fault has been identified within a building block, only manual test techniques exist to complete the diagnosis.

3.4 Dedicated Test Systems: Advantages

3.4.1 A dedicated or integrated system is generally smaller in size than a building block system. Also, since the dedicated modules are designed for their enclosed environment, thermal considerations have been taken into account.

3.4.2 Efficiency of a dedicated system is high because it contains only those functions required for the testing process. Therefore, since unneeded circuit functions are eliminated, system reliability increases.

3.4.3 By its nature, the design of the dedicated test system lends itself to automated maintenance techniques. This is because modular design inherently has a large number of internal monitoring points available for self-diagnosis. The availability of these additional test points allows for the design of a self-test program.

3.4.4 Time to troubleshoot and repair a dedicated system is shorter. This is due not only to the greater precision with which a failure can be identified but the system's modular, self-check nature lends itself to rapid removal and replacement of the suspected element or elements.

3.4.5 When testing requirements are unique (i.e., optical or infrared testing) or when it is necessary to check uncommon UUT parameters, a dedicated system may be the only automatic solution.

3.5 Dedicated Test System: Disadvantages

3.5.1 The development cost of a dedicated CATS requires broader experience and knowledge in the area of automatic test equipment. Improperly or inadequately specified equipment will eventually reduce the cost effectiveness of the CATS.

3.5.2 Modification of the dedicated system is possible but redesign is expensive and sufficient space may not be available to incorporate necessary changes.

3.5.3 If the computer subsystem of a dedicated system fails, the station becomes totally inoperative.

3.6 Test Accuracy Ratio (TAR)

The integration of an automatic test system (building block or dedicated) presents special problems to the Automatic Test Engineer. All stimulus or measurement specifications are usually only valid at the output of the module of building block and not at the interface of the CATS and the UUT. Consequently the accuracy of the measurement or stimulus can be seriously degraded due to the interconnecting cables and switching path. To circumvent this problem a Test Accuracy Ratio (TAR) is established. This specifies the ratio of testing tolerances at the interface to those testing tolerances at the instruments. The object is to obtain parameters, from the interface to the instruments, that are as close to 1:1 as possible. This should be taken into account while preparing the Test Program Set (software). The test accuracy ratio of any stimulus instrument can be improved by providing remote sensing of the output at the interface of the CATS and the UUT. This is accomplished by running a wire from the interface junction back to a high impedance amplifier in the stimulus which will automatically adjust the output to compensate for line losses and loading. An alternative method of improving the TAR is to return the stimulus remote sense lines back to a measurement instrument. The value of the stimulus is then verified by a measuring instrument whose accuracy and precision exceeds that of the stimulus. This capability is customized in the building block system integration, while this is usually a built-in feature of a dedicated system. In any event the remote sensing procedure must be incorporated while preparing the test program.

3.7 Self Check Definition

It is logical to assume that measurement as well as stimulus instruments are periodically calibrated to ensure their accuracy. It is, therefore, imperative that the CATS incorporate an auto check or self check procedure.

Prior to the start of each day's work or of a particular test run the measurement instruments will check themselves to ascertain whether they are operating properly. If some gross malfunction exists diagnostics will be performed, either on-line as a self test, or off-line on a test bench. If minor disparities exist, calibration can be performed either by using external equipment or by inserting a reference standard at the interface.

Once functional integrity of the measurement instruments is verified, the system now monitors the functional integrity of the stimulus instruments utilizing the proper operating measurement instruments. This is known as self check. Minor or major functional disparities of stimulus instrumentation will be treated similarly to disparities in the measurement instruments.

3.8 Calculation of Mean-Time-Between-Failures (MTBF)

As mentioned previously, two complete test stations provide flexibility such that in the event one station is down the other station can continue testing assemblies. A sample MTBF calculation is presented in the following.

3.8.1 MTBF for Building Block CATS

The probability of the system expressed for CATS in terms of the Mean-Time-Between-Failures (MTBF), for Building Block CATS is calculated as follows:

Subsystem	MTBF
Instrumentation	885 hours
Computer	1690 hours
Peripheral	1370 hours

The total system MTBF is found by adding the reciprocal of the MTBF's and then taking the reciprocal of the sum

$$(885)^{-1} + (1690)^{-1} \times (1370)^{-1} = 2.451 \times 10^{-3} \quad \frac{1}{hr}$$

$$\frac{1}{2.45 \times 10^{-3}} = 408 \text{ hrs} \qquad 2.56 \text{ month}$$

It can be seen that the Instrument subsystem has the lowest MTBF in the CATS.

3.8.2 MTBF for Dedicated CATS

If a dedicated CATS is used (i.e., PC board instrumentation)instead of discrete building blocks, the quantity of components is reduced. This will result in an instrumentation MTBF that is increased by at least a factor of two. The MTBF for a dedicated CATS is approximately as follows:

	Dedicated CATS
Subsystem	MTBF
Instrumentation	3000 hrs
Computer	2500 hours
Peripheral	2000 hrs

$$(3000)^{-1} + (2500)^{-1} + (2000)^{-1} = 0.33 \times 10^{-3} + 0.4 \times 10^{-3} + 0.5 \times 10^{-3} = 1.23 \times 10^{-3}$$

$$\text{MTBF} = \frac{1}{1.23 \times 10^{3}} = 815 \text{ hours} \qquad 5.1 \text{ months}$$

The calculated MTBF figures represent the average case.

3.9 Vendor Services

In the event a test station does become inoperative, most local vendors have stated that their service personnel can reactivate the station within 24 hours, depending on the nature of the problem. It shall be required of any CATS vendor that he include as a part of his total software package a thorough self check program. This self check program can be run at the beginning of the work shift if any of the subsystems are marginal. If marginal subsystems are detected they can be replaced (with the exception of the computer subsystem) by storing spare modules or building blocks.

4.0 COMPUTER AND PERIPHERALS (SOFTWARE)

It can be stated that whatever can be accomplished with hardware and its interconnections can also be accomplished with software, providing a suitable switching matrix is available. A purchaser is usually constrained to the hardware configuration of a particular Automatic Test System vendor. For a user to alter the CATS to satisfy his particular requirements, he must do one of the following:

- Have the vendor customize the hardware configuration.
- Expand the software compiler.

The first alternative was examined in Section 3.0. Software will be discussed in this section. The compiler is a language translation program that transforms symbols (i.e., Alpha-numeric) meaninful to a human operator into codes (i.e., binary) meaningful to a computer.

4.1 Compiler

The programmer must operate within the constraints of the compiler. It is resident in either the core memory of the computer or in its storage memory. An infinitely large compiler will give a programmer infinite software capabilities. It is obvious, from a practical standpoint, that since memory space is limited, some constraints are placed upon the programmer. As a guide, the cost of expanding the software to offset hardware configuration deficiencies will range from 0.3 to 3.0 times the cost of the hardware.

4.2 Computer Subsystem

The integral sections of a computer subsystem for a typical Automatic Test System are:

1) Digital Computer
2) Switching Matrix
3) Test Program Set.

4.3 Digital Computer Hardware

Practically all digital computers consist of:

a) Control Unit
b) Arithmetic Unit
c) Memory Unit
d) Input/Output device.

4.3.1 Control Unit

The control unit governs the operation of the overall computer subsystem. It translates instructions obtained from the memory into specific sequences of internal commands. These commands are distributed to all units and initiate their appropriate operations or information transfer. The control unit also ensures that the timing of commands is compatible with the operational speed and the operational status of the testing instrumentation.

4.3.2 Arithmetic Unit

The arithmetic unit consists of a number of electronic circuits connected in such a manner that certain arithmetic and logic operations can be performed.

4.3.3 Memory Unit

The memory stores instructions, operants, results and any other information which may be needed in the course of a computation. It is divided into a number of storage locations or cells each having a unique address and a storage capacity of one word (usually 16 bits). The circuitry of the memory will perform essentially three functions with the stored information therein; it will select, read and write the information. Memory can usually be classified as one of the following types:

a) Hard core random access (RAM)
b) Integrated circuit read only (ROM)
c) Mass storage (i.e., magnetic tape, punch tape, disk or drum).

4.3.4 Input/Output Unit

The Input/Output unit provides communication paths between the computer and external or peripheral equipment such as magnetic tape units or card readers. Much of this unit such as the teletype printers and video keypunch panel are physically located in separate consoles.

4.4 Switching Matrix

A switching matrix is connected to the patch panel or the computer subsystem and provides the connection paths between the unit under test interface and the stimuli and measurement instruments. The several types of switching matrices available are crossbar scanner, relay trees, or hard wire general purpose.

4.5 Test Program Set (TPS)

The test program set consists of the following elements:

a) Program tape
b) A test booklet of instruction
c) An interface device.

4.5.1 Program Tape

A program tape is the end product of a test specification or test procedure.

4.5.1.1 From the test specification and its supporting documentation (i.e., schematics, theory of operation, interconnection diagram, etc.) a Diagnostic Flow Card (DFC) will be generated which is the testing strategy that is to be coded, programmed, and implemented on the test station.

4.5.1.2 A coder or a programmer will then take the DFC and prepare coding sheets for a keypunch operator. A testing language that is compatible with the computer must be established. Two languages are under consideration, BASIC and ATLAS. Of the two languages, ATLAS is a higher level than BASIC. (Define a higher level language to be closer to English as opposed to machine language). Both languages have found wide use in automatic test equipment. BASIC is primarily a standard scientific language while ATLAS is directly oriented toward test equipment. Since ATLAS is a higher level language than BASIC, less time will be required by the engineer or programmer to implement ATLAS. This ease of implementation is achieved at the cost of a more complex compiler.

A program tape will be generated from the keypunched source deck.

4.5.1.3 Concurrent with the coding effort, will be the determination of what switching paths are required by the test program. This information, vital to the fabrication of the interface device, is called a Test Diagram (TD). It must also be coded and included in the keypunched source deck which, in turn, will be placed on the program tape.

4.5.2 Test Program Instruction (TPI)

This is a manual (usually generated by a technical publications group) that instructs a station operator how to conduct a specific test program. The source documentation required for the development of the test program instructions are:

1) Schematics
2) Theory of Operation
3) Diagnostic Flow Chart
4) Test Diagram.

It is pertinent to mention that accurate and complete documentation must be maintained throughout development stages of any CATS program.

4.5.3 Interface Device (ID)

This piece of hardware connects the UUT pins to the appropriate stimulus and measurement instruments via the switching matrix. The important documents required for the fabrication of ID are the assembly pin layout and the test diagram.

4.6 Program Tape Validation

Once the program tapes are generated they must be validated on station. The time required to verify a tape is directly related to the level of the language and the complexity of the test. Assuming the syntax and semantics are correct, parameter values can either be changed by on-line or off-line programming. On-line is much faster in that it allows the engineer to adjust the program at the Input/Output console. This is accomplished at the expense of utilizing station time and a more complex compiler.

Off-line programming is slower and more expensive because more people are involved in the change. The advantages are better control over changes in that they are documented and that the test stations are not needed to verify tapes.

As with the test instrumentation, the computer subsystem will have a self-check capability that will monitor internal test points to determine proper functional operation.

4.7 Testing Speed

It should be noted that the speed of testing a UUT is directly related to the response time of the stimulus and measurement instruments. While a computer can retrieve data and make comparisons in the order of tenths of microseconds the response time (settling time) may be in order of thousands of milliseconds. This is particularly true of analog measurements. Therefore, the limiting factor in determining the speed of automatic testing is the time sequences in digital tests and response time in analog tests, not the computer.

4.8 Digital Computer Specification

The following is a specification of the requirements for the computer subsystem with sufficient capacity to expand the memory and test instrumentation.

4.8.1 Mini Computer with a minimum of 16K words, either in hard core or in storage memory (i.e., tape, disk) must be capable of time sharing at least four independent test stations.

4.8.2 A teleprinter, BCS driver and test routine.

4.8.3 The input/output must have keyboard arrangement with CRT Alphanumeric display. This can be panel or console mounted.

4.8.4 The software shall include either an ATS BASIC interpreter or an ATS ATLAS interpreter.

4.8.5 Memory Capacity

The system must be capable of incorporating these options:

a) Punch tape or magnetic tape reader (500 bytes/sec) with interface, test routine and interface diagnostics. Punch tape must have as a minimum a packing density of ten bytes/inch. Magnetic tape must have a minimum packing density of 70 bytes/inch.

b) Dual disk memory with approximately 5 million bytes of memory. Included will be power supply and interface.

4.8.6 Modular Switching Subsystem

This must have a capacity of at least 16 relay switching cards.

Each relay switching card will have the following characteristics:

Switching Capability:	16 relays, with one Form-A and one Form-C switch per relay. Each relay has independent storage.
Maximum Voltage:	200 volts peak
Maximum Current:	2 amps switched with resistive load, 3 amps carry current after switching.
Cross talk:	40 dB typically measured at 100 kHz on adjacent switch line.
Signal Frequency:	DC to 100 kHz.
Contact Resistance:	400M at 100,000 operations.
Thermal Offset:	Typically 50 volts or less at 25°C.
Contact Life:	1,000,000 cycles at 28 VDC, 100 mA resistive load.
Operate Time:	20 ms maximum.
Release Time:	5 ms maximum.

In addition an "Electronic confirm" line on each storage element, which may be used to operate switch closing indicators, shall be included.

4.8.7 An interface panel or panels for interconnections between the unit under test and the automatic test system patch panel. At least one interface panel shall be used for self check and/or self test.

4.8.8 All cables and accessories required to interconnect the ATS and all cables between time shared stations.

4.8.9 In the event the computer subsystem is "down", it must be capable of being circumvented via manual control.

4.8.10 As an option the Automatic Test System should be compatible to operate with a heavy duty teleprinter or a high speed line printer.

5.0 TIME AND COST OF COMPUTER AUTOMATIC TEST SYSTEM VS. MANUAL TEST SYSTEM

This section analyses the time to run an automated test versus the time to perform the same test manually for the DRAGON NVS. Each type of testing is compared to determine the optimum point in time a computer automated test system becomes economically feasible.

The estimated cost data shown is extracted from Appendices B and C.

5.1 Manual Test Stations

The cost of labor plus overhead to produce 60 systems a month on a manual basis is \$38,900. To test 5000 DRAGON NVS (approximately 84 months) the labor cost is	\$3,344,778
The total cost to test 5000 DRAGON NVS at 60 systems a month is	\$3,344,778

Not included in this price is the test instruments which exist in the APE Pilot line)

5.2 Computer Automatic Test System

The price of two computer Automatic Test Systems is	\$244,400
The cost to install two CATS systems	40,000
The cost per Test Program Set is \$28,920. The cost of eight TPS's is	\$260,000
The cost of labor and overhead to produce 5000 DRAGON NVS at 60 systems a month is	\$327,103
The total cost to test 5000 DRAGON NVS utilizing CATS	\$871,503

5.3 Comparison Between CATS and Manual Stations

The difference in cost between CATS and a manual test station will result in a cost saving of

	$3,344,778
-	871,503
	$2,473,275

As seen from the graph (Figure 1 of Appendix C) the point in time for which a computer automated test system becomes more economically feasible than a manual system is 15 months.

After 15 months a computer automated test system will accrue a cost saving over the manual systems of $36,600.00 a month.

6.0 CONCLUSION

This conclusion summarizes the important facts concerning Computer Automated Test Systems and describes the type of system that would best serve the testing requirements for the DRAGON Night Viewing System.

6.1 ADVANTAGES OF COMPUTER AUTOMATED TEST SYSTEMS

The following delineates the advantage of using a CATS as opposed to manual test stations.

Cost Saving - As per section 5.0 and Appendix C a Computer Automated Test System will accrue a cost savings of 2.47 million dollars after testing 5000 DRAGON Night Viewing System. (84 months at a 60 per month rate)

Repeatability - Computer Automated Test Systems will provide precise repeatability of testing. Since the computer will control the testing all assemblies are tested exactly the same. This will reduce inconsistent test conditions inherent in manual operations.

Accuracy - CATS will improve the accuracy of the testing. Marginal operation can be more easily detected with CATS than by visual interpretation.

Incoming Inspection - As the rate of assembly and testing of Night Viewing Systems increases additional need for Automated Testing of components will arise. It will be possible, with only software development, to use the CATS as described for incoming inspection of electronic components.

Other Programs - Since other night viewing systems such as Handheld Viewer and Tow have similar functional electronics to DRAGON only a minimum of software development would be required to implement these systems on CATS. The hardware specified for the DRAGON CATS will encompass all stimulus and measurement instruments for the Handheld Viewer, TOW, FIRTI, etc. Once the software has been developed for DRAGON the cost of generating a Test Program Set for a similar project will be about (25% to 50%) of the DRAGON software cost.

Fault Diagnosis - If, as per Appendix C, diagnostic programs become desirable CATS will provide all the necessary computer and test equipment hardware for fault diagnostic investigation. Diagnostic programs are very similar to the End to End (GO-NO/GO) tests and can therefore be added at a later date with relative ease.

6.2 Proposed CATS - Section 3.1 through 3.5 discussed the advantages and disadvantages of a Building Block and a Dedicated system. This section describes why a Building Block system is more desirable for DRAGON Production testing.

Lead Time - Less lead time is required to deliver and install a building block system.

CATS Fault Location - Building Blocks require a shorter self checking program. A dedicated system, with its complex interconnections, requires a very sophisticated and long self check program to isolate down to faulty components. It is more advantageous to use a short self check program devised for the building block system and then replace the faulty building block once it has been identified.

Vendor Service - Vendor service can be provided not only by the CATS vendor but also by the individual building block vendors.

Modification of CATS - If any change in the operational performance of CATS is necessary, it is easier to implement them on building block system. This is due to its hardware versatility and relative interconnection simplicity.

Manual Mode - In the event the computer subsystem is out of service testing can be continued in a manual mode with the building block system.

7.0 RECOMMENDATIONS

7.1 Two Complete Computer Automated Test Systems

It is recommended that a two complete CATS stations be implemented for the DRAGON NVS dividing the number of assemblies to be tested between each system. The justification for this is the following:

Redundant Capability - In the event one computer subsystem is out of service, testing can be continued on the other system. The down time of the computer subsystem will vary from 24 hours to 48 hours.

Work Shifts - A single CATS station will necessitate two work shifts if 60 NVS's a month is required. (Refer to Appendix C.)

Other Programs - Two CATS stations will enable testing for programs such as TOW, Handheld Viewer AN/PAS-7 and TIRS (Thermal Imaging Rifle Sight) with the use of a second shift.

Incoming Inspection - Two CATS stations will provide computerized quality control for incoming inspection of components with additional software and a second work shift.

Fault Diagnosis - A second work shift can also use the CATS stations for troubleshooting or Diagnostic Programs for DRAGON assemblies.

7.2 One Complete Computer Automated Test System

One complete CATS station will be less costly than two CATS stations, and can be used as a building block for the two system approach, but it is less desirable for these reasons.

Two Work Shifts - Two work shifts will be required to test 60 units a month.

Manual Testing - In the event the computer subsystem is out of service both work shifts must implement manual testing.

Limited Capacity - There is little potential for available capacity to test other Night Viewing Systems or to assist Incoming Inspection without additional computer and test equipment hardware being added.

7.3 Time Shared Systems

In this scheme two hardware stations are time shared with a single computer subsystem. No degradation of testing performance will occur using a time shared system but it is less desirable than two complete CATS stations for the reasons listed and therefore not recommended.

Not Cost Effective - The decreasing cost of mini computer subsystems makes their purchase more economically feasible than purchasing a single computer time shared subsystem.

Additional Software - A time shared computer subsystem would require an executive routine that would almost double the memory allocations needed for the compiler. This will necessitate more software development and memory capacity.

Increased Hardware - The increased memory capacity required of a time shared computer subsystem may mean that disk memory must be used as opposed to tape memory. Disk memory is about $10,000 more than tape memory and the cost to develop the expanded compiler will be approximately $20,000.

Down Time - If the time-shared computer subsystem is out of service both hardware stations cannot be operated automatically.

Excess Capacity - Two CATS stations cannot justify the increased hardware integration and memory that a time-shared computer subsystem will require. Time sharing justifies itself only if there are many test stations all requiring high speed digital functions.

APPENDIX A

DEDICATED TEST EQUIPMENT SPECIFICATIONS

1. Dual Trace Oscilloscope

1.1 General

All functions must be remotely programmable and compatible with TTL/DTL logic utilizing 8421 BCD coding.

1.2 Vertical Section

1.2.1 Bandwidth and rise time - DC to at least 60 MHz, 5.8 NS at 5 mV/cm, 3 dB down.

1.2.2 Deflection factor -- 5 mV/cm to 10 V/cm.

1.2.3 Display modes - Channel 1 only: channel 2 only (may be inverted); Alternate - chopped (approximately 500 kHz): added.

1.2.4 Input R and C - 1 megohm, 24 pf.

1.2.5 Maximum input voltage - 600V (DC + peak AC), AC coupled and 300V (DC - peak AC), DC coupled.

1.2.6 Internal trigger source - composite or channel 1 only.

1.2.7 DC balance - the volts /cm vernier may be varied without baseline shift independent of screen position.

1.3 Horizontal Section

1.3.1 Main and delayed time bases - 0.1 sec/cm in 22 calibrated steps, 1, 2, 5 sequence; ±3% accuracy.

1.3.2 X10 magnifier - increases sweep speed by a factor of 10.

1.3.3 Horizontal display modes - Normal or main sweep, main sweep with intensified delayed sweep portion, delayed sweep portion, delayed sweep, main sweep with triggered delayed sweep intensified portion, triggered delayed sweep, and external horizontal input for X-Y display.

1.3.4 Trigger Mode - Automatic mode should provide a base line in the absence of A signal, useful above 20 Hz. Triggered mode should override automatic mode and should be used below 20 Hz.

1.3.5 Variable Hold-Off - Variable, to allow synchronous triggering on tone bursts, frequency or amplitude modulated signals or digital word lengths.

1.3.6 Trigger sensitivity - Flat triggering on 0.5 cm internally and 50 mV externally through 60 MHz from DC when DC coupled and from 4 Hz when AC coupled. LF REJ rejects signals below 30 kHz. HF REJ rejects signals above 50 kHz.

1.3.7 Trigger sources - Internal, picked off from CH1 and CH2 preamplifiers prior to DC offset from position controls. External, from BNC connector, External ÷ 10 line. Input RC-1 megohm, 24 pf, maximum input voltage 600 AC coupled and 300 DC coupled - peak AC plus DC. Level adjustment through ±1.5V in external or ±1.5V in external ÷ 10.

1.3.8 X-Y operation - Full sensitivity X-Y (CH 1 horizontal CH 2 vertical) -5 mV/cm to 10V/cm in 11 calibrated steps 1-2-3 sequence. Bandwidth is at least 4 MHz with about 1° phase difference at 50 kHz.

1.3.9 Horizontal amplifier - Bandwidth at least 4 MHz, 3 dB down; deflection factor is 120 mV/cm variable to 1.2V/cm external, 1.2V/cm to 12V/cm in external ÷ 10, X10 magnifier increases sensitivity to 12 mV/cm.

1.4 <u>Display Section</u>

1.4.1 CRT - 5 inch rectangular tube, 8 x 10 centimeter display area. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 phosphor. Accelerating potential is 10 kV.

DC couple Z-axis intensity modulation. +2V signal blanks trace at normal intensity from DC to 5 MHz, input R is 5K ohms.

1.4.2 Graticule - internal, no parallax; variable edge lighting.

1.4.3 Delay time jitter - less than 1 part in 20,000 of 10 x main sweep time/cm setting.

1.4.4 Calibrator - 1 kHz square wave. 0.6V and .06V peak-to-peak ±1%. Rise time less than 1 μs.

1.5 Environmental

1.5.1	Temperature:	Operating	+5° to +45°C
		Nonoperating	-20°C to +50°C
1.5.2	Humidity:	Operating and Nonoperating to 95% Relative Humidity at +55°C	

2. Power Supplies

2.1 Programmable Operation

2.1.1 All DC voltage levels must be remotely programmable and compatible with TTL/DTL logic utilizing 8421 BCD coding.

2.2 DC Output Voltages

2.2.1	+5.0 volts	2.0 amperes min.
2.2.2	-6.0 volts	1.0 ampere min.
2.2.3	-20.0 volts	0.5 ampere min.
2.2.4	+100 volts	0.1 ampere min.

2.2.5 Line regulation - 0.01% +1 millivolt for AC line variation from 105 to 125 volts.

2.2.6 Load regulation: 0.01% +1 millivolt for 0 - 100% changes in rated output current at the junction of load and remote sense leads.

2.2.7 Ripple and noise: less than one millivolt peak-to-peak over a 1 MHz band at an input line frequency of 60 Hz.

2.2.8 Source impedance: less than 5 milliohms at DC, 100 milliohms at 20 kHz, one ohm to 1 MHz.

2.2.9 Recovery time: output voltage will return to within a 15 millivolt band of the original voltage setting within 50 microseconds for a step change (1 microsecond rise time) in rated load of 10 - 100%.

2.2.10 Stability: Better than 0.02% +3 millivolts per 24 hours at constant line, load and ambient temperature, after warmup. Better than 0.01% +1 millivolt with external low temperature coefficient programming resistance.

2.2.11	Temperature:	Operating: +5°C to 45°C Storage: -20 to +50°C
2.2.12	Temperature coefficient:	Output voltage change less than 0.02% per °C.

2.3 <u>Over-voltage Crowbar</u>

2.3.1 Crowbar shall short circuit the output of the supply in less than 500 microseconds at any output voltage in excess of a preset level.

2.4 <u>Current Limiting</u>

2.4.1 All power supplies must be current limited to a preset level.

2.5 <u>Remote Sensing</u>

2.5.1 One-half volt drop per load lead.

2.6 <u>Remote Programming</u>

2.6.1	Ohms/Volt	1000
2.6.2	Accuracy	0.3% +1 mV

2.7 Environment

2.7.1 Temperature — Operating Range: +5°C to +45°C; Storage: -20°C to 50°C

2.7.2 Humidity: 80% maximum relative humidity at 40°C.

3. Digital Multimeter

3.1 Frequency Response: ±1.0 dB from 10 Hz 100 kHz

3.2 Readout

4.5 digits including over-range into a printer using 8421 BCD coding that is TTL/DTL compatible.

3.3 DC Volts

Range (volts)	Resolution	Input Impedance (M)	Maximum Voltage (volts)
1.0000	100 µV	1000	1000
10.000	1 mV	1000	1000
100.00	10 mV	10	1000
1000.0	1000 mV	10	1000

3.3.1 Over-range

Forty (40) percent all ranges at rated accuracy (except on 1000 Volt range).

3.3.2 Accuracy

±0.01% rdg., ±0.01% FS ....24 hours 23°C ±5°C

±0.03% rdg., ±0.01% FS ....90 days 23°C ±5°C

3.3.3 Measurement Time

1.5 second to rated accuracy

3.3.4 Reading Rate

5 readings/second

3.3.5 Normal Mode Rejection

60 dB at 60 Hz increasing at a rate of 6 dB/octave (or 20 dB/decade).

3.3.6 Common Mode Rejection

100 dB DC to 60 Hz with 1K source imbalance.

3.4 <u>AC Volts</u>

3.4.1

Range	Resolution	Input Impedance
1.0000V	100 µV	1M, 75 pf
10.000V	1 mV	1M, 75 pf
100.00V	10 mV	1M, 75 pf
1000.0V	100 mV	1M, 75 pf

3.4.2 Over-range

Forty (40) percent all ranges at rated accuracy (except on 1000V range)

3.4.3 Accuracy

100 Hz to 10 kHz ±0.1% RDG, ±0.03% FS

50 Hz to 30 kHz ±0.25% RDG, ±0.05% FS

30 kHz to 100 kHz ±1.0% RDG, ±0.1% FS

3.4.4 Maximum Input Voltage Vs. Frequency

50 Hz to 5 kHz 750V
5 kHz to 10 kHz 500V
10 kHz to 50 kHz 250V

3.4.5 Measurement Time

3 seconds to rated accuray.

3.4.6 Step Response Time

3 seconds.

3.5 <u>OHMS</u>

3.5.1

Range (K)	Resolution (ohms)	Output Current (uA)	Max. Open Circuit Voltage (volts)
1.0000	100M	1	18
10.000	1	100	18
100.00	10	10	18
1000.0	100	1	18
10000.	1K	100	18

3.5.2 Over-range

40% all ranges at rated accuracy (except on 10000K range)

3.5.3 Accuracy (90 days, 15 - 35°C)

1K to 100K	±0.02% RDG, ±0.02% FS
1 milliohms	±0.05% RDG, ±0.02% FS
10M	±0.2% RDG, ±0.02% FS

3.5.4 Measurement Time

2.0 second to rated accuracy.

3.5.5 Step Response Time

1K to 100K	200 ms
1M	300 ms
10M	3 sec

3.6 <u>DC Current</u>

3.6.1 Ranges ±100 µA, (20% over-range, all ranges to ±1999 mA)

3.6.2 Resolution 0.01% of range (10 nA on 100 µA range, maximum)

3.6.3 Accuracy (all ranges)

90 days, 15° to 35°C (±0.1% of input, +0.02% of range)

3.6.4 Burden 100 mV at 100 µA increasing to 300 mV, 1200 mA

3.6.5 Response Time to Rated Accuracy 1.5 seconds

3.6.6 Overload Protected to 2 amperes on any range.

3.7 AC Current

3.7.1 Ranges (auto) 100 uA to 1999 mA (20% over-range, all ranges)

3.7.2 Resolution

0.01% of range (10 nA on 100 uA range, maximum)

3.7.3 Accuracy (all ranges)

50 Hz - 5 kHz	30 - 50 Hz and 5 - 100 kHz
±(0.3% of input +0.05% of range)	±(0.6% of input +0.05% of range)

90 days, 15°C - 35°C

3.7.4 Burden 100 mV at 100 uA increasing to 300 mV, 1200 mA

3.7.5 Response Time to Rated Accuracy 3 seconds.

3.7.6 Overload Protected to 2 amperes on any range.

3.8 Environment

3.8.1 Temperature: Operating Range: +5°C to +45°C
Storage: -20°C to +50°C

3.8.2 Humidity: 80% maximum relative humidity at 40°C.

3.9 Auto Check

The unit must be capable of performing a quick self-check of all its functions.

4.0 Pulse Generator

4.1 Programmable Operation

4.1.1 The frequency and amplitude ranges must all be remotely programmable and compatible with TTL/DTL logic utilizing 8421 BCD coding.

4.2 Frequency Data

4.2.1 Internal clock: 0.1 Hz to 50 MHz.

4.2.2	Delay (single) Pulse	0.1 Hz to 50 MHz prf
4.2.3	Double (pairs) Pulse	0.1 Hz to 50 MHz effective prf
4.2.4	External Trigger	DC to 50 MHz
4.2.5	Frequency Jitter	0.1% of period +0.3 ns

4.3 Operating Modes

4.3.1 Current Source

4.3.2 Voltage Source

4.3.3 Single Pulse

4.3.4 Double Pulse (pairs)

4.3.5 Normal-Inverted (Complemented)

4.3.6 Positive or Negative Output

4.4 Output Data

4.4.1 Output Amplitude (positive): Continuously variable from 0V to +10V across high impedance; 0V to +5V across 50 ohms (with independent control).

4.4.2 Output Amplitude (negative): Continuously variable from 0V to -10V across high impedance: 0V to -5V across 50 ohms.

4.4.3 Current Mode: ±2 mA to +200 mA (±10V into 50 ohms) from 1K ohm source impedance.

4.4.4 Voltage Mode: ±50 mV to ±5V into 50 ohms from 50 ohms.

4.4.5 Source Impedance: 50 ohms or 1K ohms, switch selected.

4.4.6 Pulse Duration: 15 ns to 1 second.

4.4.7 Duration Jitter: 0.1% +0.4 ns.

4.4.8 Pulse Delay: 15 ns to 1 second.

4.4.9 Delay Jitter: 0.1% +0.4 ns.

4.4.10 Duty Cycle: to 100%.

4.5 Baseline Offset Data

4.5.1	Current Mode:	0 to ±40 mA (0 to ±2V into 50 ohms)
4.5.2	Voltage Mode:	0 to ±2V into 50 ohms.
4.5.3	Overload Protection:	Short and open circuit protected.

4.6 Pulse Shape Data

4.6.1 Rise/fall time/4 ns typical, 5 ns max. fixed.

4.6.2 Distortion: Less than 5% total (preshoot, overshoot, undershoot, droop) at full output.

4.7 Sync Output Data

4.7.1	Amplitude:	+2V minimum into 50 ohms.
4.7.2	Rise Time:	Less than 5 ns
4.7.3	Duration:	50% of minimum period of prf range.
4.7.4	Delay:	10 ns max., referred to trigger input.

4.8 Trigger/Gate

4.8.1	Trigger Frequency:	DC to 50 MHz.
4.8.2	Gate Frequency:	DC to 25 MHz, sync or async.
4.8.3	Sensitivity:	±100 mV, 10 ns or greater duration.
4.8.4	Slope:	Positive or negative.

4.9 Environment

4.9.1	Temperature: Operating Range:	+5°C to +45°C -20°C to +50°C
4.9.2	Humidity:	80% maximum relative humidity at 40°C.

5. Function Generator

5.1 Programmable Operation

5.1.1 The frequency and amplitude ranges must all be remotely programmable and compatible with TTL/DTL logic utilizing 8421 coding.

5.2 Frequency Range

5.2.1	Main Generator:	0.0001 Hz to 10 MHz.
5.2.2	Stability:	0.05% of setting for 10 minutes, 0.35% of setting for 24 hrs.
5.2.3	Accuracy:	±(2% set +2% range) 0.0001 Hz to 10 MHz.

5.3 Amplitude

5.3.1 Main Output

5.3.1.1	Output Amplitude:	15V p-p into 50 ohms, 30V p-p open circuit.
5.3.1.2	Output Attenuator:	80 dB attenuation in 10 dB steps and 200 dB continuously variable.
5.3.1.3	Stability:	0.05% of max p-p amplitude for 10 min.
5.3.1.4	Output Impedance:	50 ohms
5.3.1.5	DC Offset:	±7.5V into 50 ohms, ±15V open circuit, variable.

5.3.2 Sync Outputs

5.3.2.1	Output Amplitude:	20V p-p square
5.3.2.2	Output Impedance:	100 ohms

5.3.3 External Input

5.3.3.1 Voltage controlled frequency approximately 5V input for 1000 frequency ratio.

5.3.3.2	Sync:	5V p-p to lock.
5.3.3.3	DC Offset:	1.1 inverting.

5.4 Waveforms

Sine, square, triangle, sync, ±square, ±sine, triangle, ±ramp, ±pulse.

5.4.1 Sine

5.4.1.1	Frequency Response:	0.1 dB to 100 kHz, 2 dB to 10 MHz
5.4.1.2	Distortion:	0.5% to 0.001 Hz to 100 kHz. No harmonics 30 dB down from fundamental 100 kHz to 10 MHz.

5.4.2 Triangle

5.4.2.1	Linearity:	99% to 100 kHz, 95% to 10 MHz.

5.4.3 Square Wave

5.4.3.1	Rise and Fall:	20 ns (500V/sec slew rate limitation into 50 ohms)
5.4.3.2	Overshoot and Ringing:	5%

5.5 Environment

5.5.1	Temperature:	Operating Range:	+5°C to 45°C
		Storage:	-20°C to +50°C
5.5.2	Humidity:	80% maximum relative humidity at 40°C	

6. Counter/Timer

6.1 Readout

6.1.1 7 digits including overrange into a printer using 8421 BCD coding that is TTL/DTL compatible.

6.2. Modes of Operation

6.2.1	Count:	Frequency:	100 MHz
		Counter Range:	1 to 10^7 count
		Input:	Channel A
		Gate Time:	Automatically selected
		Accuracy:	Absolute
		Readout:	Dimensionless.

6.2.2	Frequency:	Range:	100 MHz
		Input	Channel A
		Gate Time:	A
		Accuracy:	±1 count ±time-base accuracy
		Readout:	kHz or MHz, with automatically positioned decimal point.
6.2.3	Period:	Range:	100 ns to 10^7 sec
		Input:	Channel A
		Clock Frequency:	100 ns to 1 second in decimal steps, automatically selected
		Resolution:	0.1 sec to 1 sec
		Accuracy:	±1 count ±time-base accuracy ±trigger error.
		Readout:	Sec, msec, or usec, with automatically positioned decimal point.

6.2.4 Positive or Negative Pulse Width:

Range:	0.1 usec to 10 sec
Input:	Channel A
Clock Frequency:	100 ns to 1 sec in decimal steps
Slope Selection:	Programmable
Resolution:	0.1 sec to 1 sec, automatically selected for maximum resolution
Accuracy:	± count ±time-base accuracy ±trigger error
Readout:	Usec, msec or sec, with automatically positioned decimal point.

6.2.5 Period Average

Range:	100 Hz to 1 MHz, 4-digit resolution 10 Hz to 1 MHz, 5-digit resolution 1 Hz to 1 MHz, 6-digit resolution 0.1 Hz to 1 MHz, 7-digit resolution
Input:	Channel A
Periods Averaged:	1 to 1000, automatically selected for maximum resolution.
Clock Frequency:	1 MHz
Accuracy:	±count ±time-base accuracy ±trigger error
Readout:	Usec, msec or sec with automatically positioned decimal point.

6.2.6 Time A B

Range:	0.1 sec to 10^7 sec
Input:	Start Signal: Channel A. Stop Signal: Channel B. Can be common or separate.
Clock Frequency:	100 ns to 1 second in decimal steps

Resolution:	0.1 sec to 1 sec
Accuracy:	±1 count ±time-base accuracy ±trigger error of ±trigger error of B.
Readout:	Usec, msec or sec, with automatically positioned decimal point.

6.2.7 Ratio A/B

Range:	Channel A: 0 - 100 MHz. Channel B: 0 - 10 MHz
Input (F1):	Channel B
Measures:	F1/F2
Number of Cycles of F2 averaged:	1 to 1000 automatically selected for maximum resolution
Accuracy:	±1 count of F1 ±trigger error of F2
Readout:	Dimensionless, with automatically positioned decimal point.

6.2.8 Time Interval

Range:	0.2 usec to 10^7 sec
Clock Frequency:	100 ns to 1 second in decimal steps
Resolution:	0.1 usec to 1 sec
Accuracy:	±1 count ±time-base accuracy ±gate error
Readout:	Usec, msec or sec, with automatically positioned decimal point.

6.2.9 Input Channels A & B

Range:	Channel A
DC Coupled:	DC - 70 MHz
AC Coupled:	20 Hz - 100 MHz
HF Rejection:	Attenuates signals above 1 kHz approx.
Range:	Channel B
DC Coupled:	DC - 10 MHz
AC Coupled:	20 Hz - 10 MHz
HF Rejection:	Attenuates signals above 1 kHz approx.
Impedance:	1 megohm shunted by 25 pf approx.
Sensitivity:	25 rms sine wave 0 - 2 MHz 50 rms sine wave 2 - 10 MHz 100 rms sine wave 10 - 100 MHz (Channel A only)
Channel A	0.3V peak-to-peak pulse, 7 ns min pulse width
Channel B	0.3V peak-to-peak pulse, 50 ns min pulse width
Preset:	Sets trigger reference to 0 volt
Attenuation:	X1, X10, X100
Trigger Level:	Automatically adjustable ±1V, ±100V, dependent upon setting of attenuator
Slope	Independent selection of positive or negative slope
Overload Protection:	250V rms on X10 and X100 attenuator settings, 120V rms on X1 attenuator setting up to 1 kHz, decreasing to 10V rms above 10 MHz.

6.3	Environment	
6.3.1	Temperature:	Operating Range: +5°C to +45°C Storage: -20°C to +50°C
6.3.2	Humidity:	80% maximum relative humidity at 40°C
6.4	Auto Check	
6.4.1	The unit must be capable of performing a quick self check of all its functions.	
7.	True RMS Voltmeter	
7.1	Programmable Operation	
	All voltage ranges must be remotely programmable and compatible with TTL/DTL logic using 8421 BCD coding.	
7.2	Voltage Range:	100 uV to 330V
7.3	Decibel Range:	-70 dB to +50 dB, referred to 1V
7.4	Frequency Range:	10 Hz to 20 MHz (-3 dB; 4 Hz and 50 MHz)
7.5	Accuracy:	50 Hz, -2 MHz: 1% FS or ±2% rdg, whicher is better, increasing to +5% at ends of range (±10% above 100V on upper ranges)
7.6	Input Impedance:	2 megohms shunted by 15 pf (25 pf, 1 - 30 mV FS ranges)
7.7	Crest Factor:	5:1 at full scale, increasing to 15.1 at 1/3 full scale. Overload protection: 500V peak on all ranges.
7.8	CMRR:	120 dB, DC to 1 kHz: 80 dB at 1 MHz
7.9	Environment	
7.9.1	Temperature:	Operating Range: +5°C to +45°C Storage: -20°C to +50°C
7.9.2	Humidity:	80% maximum relative humidity at 40°C.

8. Volt-Ohmmeter

8.1 Programmable Operation

All measurement ranges must be remotely programmable and compatible with TTL/DTL Logic using 8421 BCD coding.

8.2 DC Volts

Range	Accuracy	Temp. Coefficient (0°C to 50°C)	Input Impedance
199.9 mV	0.05% rdg ±1 digit	0.0075% rdg/°C	100M ohms
1.999V	0.05% rdg ±1 digit	0.0075% rdg/°C	1000M ohms
19.99V	0.1% rdg ±1 digit	0.0075% rdg/°C	10M ohms
199.9V	0.1% rdg ±1 digit	0.0075% rdg/°C	10M ohms
1000V	0.1% rdg ±1 digit	0.0075% rdg/°C	10M ohms

8.3 AC Volts

Range	Accuracy	Freq. Range	Temp Coefficient (0°C to 50°C)	Input Impedance
199.9 mV	0.3% rdg ±	40 Hz to 10 kHz	0.0225% rdg/°C	1M ohm @ 150 pf
1.999V	1 digit			1M ohm @ 150 pf
19.99V				1M ohm @ 150 pf
199.9V				1M ohm @ 150 pf
1000V	0.5% rdg ±1 digit	40 Hz to 2 kHz	0.0225% rdg/°C	1M ohm @ 150 pf
199.9 mV	0.6% rdg ±1 digit	10 kHz to 20 kHz	0.0225% rdg/°C	1M ohm @ 150 pf
1.999V				1M ohm @ 150 pf
19.99V				1M ohm @ 150 pf
199.9V				1M ohm @ 150 pf
1000	1% rdg ±1 digit	2 kHz to 10 kHz	0.0225% rdg/°C	1M ohm @ 150 pf

8.4 DC Current

Range	Accuracy	Temp Coefficient
199.9 uA	0.2% rdg ±1 digit	0.01% rdg/°C
1.999 mA	0.2% rdg ±1 digit	0.01% rdg/°C

8.5 AC Current

Range	Accuracy	Freq. Range	Temperature Coefficient (0°C to 50°C)
199.8 uA 1.999 mA	0.4% rdg ± 1 digit	40 Hz to 10 kHz	0.025% rdg/°C
199.9 uA 1.999 ma	0.75% rdg ± 1 digit	10 kHz to 20 kHz	0.025% rdg/°C

8.6 Ohms

Range	Current Flow Accuracy	Temp. Coefficient (0°C to 50°C)
199.9 ohms 1 mA 0.2V	0.25% rdg +3 -1 digit	0.012% rdg/°C
1.999K ohms 1 mA 2V	0.25% rdg ±1 digit	0.012% rdg/°C
19.99K ohms 10 uA 0.2V	0.1% rdg ±1 digit	0.012% rdg/°C
199.9K ohms 10 uA 2V	0.1% rdg ±1 digit	0.012% rdg/°C
1.999M ohms 1 uA 2V	0.2% rdg ±1 digit	0.025% rdg/°C
19.99M ohms 0.1 uA 2V	0.5% rdg ±1 digit	0.025% rdg/°C

8.7 Environment

8.7.1 Temperature: Operating Range: +5°C to +45°C
Storage: -20°C to +50°C

8.7.2 Humidity: 80% maximum relative humidity at 40°C

APPENDIX B

1.0 Electronic Functional Parameters that must be tested on the DRAGON NVS.

All test time shown are based on large volume production at a rate of 60 DRAGON NVS Systems per month.

1.1 Detector and Bias Assembly (SM-D-770215)

1.1.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	DC level	64	Millivolts
2	AC level	64	Millivolts 4 Hz
3	Noise	64	Millivolts
4	Continuity	3	Short Circuit
		195	

1.1.2 Necessary Instrumentation

Digital Multimeter
True RMS Voltmeter
Oscilloscope
Filter (Low Pass)
Infrared Source
Power Supplied -20V, -6V, +5V
Mechanical Chopper

1.1.3 System Comparison

Manual System		Auto System	
Set-up Time	0.5 hr	Set-up Time	10.0 minutes
Test Time	3.0 hr	Test Time	19.1 minutes
	3.5 hr		29.1 minutes 0.485 hour

1.2 Preamplifier/Multiplexer Assembly (SM-D-770177)

1.2.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	DC Offset	64	MVDC
2	Time Interval	20	480 sec max.
		84	

1.2.2 Necessary Instrumentation

Oscilloscope
Digital Multimeter
Function Generator
Pulse Generator
Counter/Timer
Power Supplies, -20V, -6V, +5V

1.2.3 System Comparison

Manual System		Auto System	
Set-up Time	0.5 hr	Set-up Time	10.0 minutes
Test Time	3.0 hrs	Test Time	16.8 minutes
	3.5 hrs		26.8 minutes
			0.48 hour

1.3 Electrical Scanner Assembly (SM-D-770205)

1.3.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	Time/Frequency	4	300 kHz
2	DC Level	5	+5 volts max.
3	AC Level	3	13.8 rms max.
		12	

1.3.2 Necessary Instrumentation

Counter/Timer
Pulse Generator
Digital Multimeter
Oscilloscope
Power Supplies -20V, -6V, +5V

1.3.3 System Comparison

Manual System		Auto System	
Set-up Time	0.3 hr	Set-up Time	9.0 minutes
Test Time	1.0 hr	Test Time	9.4 minutes
	1.3 hrs		18.4 minutes
			0.306 hr

1.4 Defl. Amp/Hi Voltage Multi/CRT/Reticule Subassembly (DM-D-770171)

1.4.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	DC Level	13	1000 volts
2	AC Level	7	25 volts pf
3	Time Interval	1	133 ms max.
4	Visual Alignment	9	
		30	

1.4.2 Necessary Instrumentation

Digital Multimeter
Counter/Timer
Oscilloscope
Power Supply +6V

1.4.3 System Comparison

Manual System		Auto System	
Set-up Time	0.4 hr	Set-up Time	10.0 minutes
Test Time	2.0 hrs	Test Time	13.5 minutes
	2.4 hrs		23.5 minutes 0.383 hr

1.5 Power Supply Assembly (SM-D-770179)

1.5.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	Time Interval	2	4 kHz
2	DCV Monitor	5	Full Load +5V +100V
3	DCV Monitor	5	Half Load +5V +100V
4	AC Level	1	12.5 Vrms
5	DCV Monitor	5	High Output +5V +100V
6	Ripple Noise	10	Millivolt p-p
7	Current	5	mA 1 amp max
8	AC Level	1	150 Vrms
		34	

1.5.2 Necessary Instrumentation

Pulse Generator
Counter/Timer
Oscilloscope
Digital Multimeter
Power Supplies +5V, +6V

1.5.3 System Comparison

Manual System		Auto System	
Set-up Time	0.5 hr	Set-up Time	10.0 minutes
Test Time	2.0 hrs	Test Time	15.7 minutes
	2.5 hrs		25.7 minutes 0.428 hr

1.6 Preamplifier and Multiplexer Assembly (SM-D-770204)

1.6.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	Visible Distortion of Sine Wave	8	-
2	Low Frequency Roll-off	$\frac{8}{16} \times 8 = 128$	-

1.6.2 Necessary Instrumentation

Digital Multimeter
Counter/Timer
Function Generator
Power Supplies +5 VDC, -6 VDC, -20 VDC

1.6.3 System Comparison

Manual System		Auto System	
Set-up Time	0.5 hr	Set-up Time	16 minutes
Test Time	2.0 hrs	Test Time	8 minutes
	2.5 hrs*		24 minutes* 0.4 hour

*Total Time for 8 PC Assemblies.

1.7 Logic Board Assembly (SM-D-770202)

1.7.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	Time Inverval	45	240 sec
2	DC Level	2	+5V
		47	

1.7.2 Necessary Instrumentation

Function Generator
Counter/Timer
Power Supplies +5V, -6V
Oscilloscope
Digital Multimeter

1.7.3 System Comparison

Manual System		Auto System	
Set-up Time	0.2 hr	Set-up Time	2.0 minutes
Test Time	1.0 hr	Test Time	6.4 minutes
	1.2 hrs		8.4 minutes 0.14 hour

1.8 Bias Board Assembly (SM-D-770175)

1.8.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	AC Gain	64	150 mV
2	DCV Level	128	-3.0 VDC
3	Resistance	4	0.0 ohm
		196	

1.8.2 Necessary Instrumentation

Functional Generator
Frequency Counter
Oscilloscope
Digital Multimeter

1.8.3 Power Supplies

Manual System		Auto System	
Set-up Time	0.2 hr	Set-up Time	12.0 minutes
Test Time	0.4 hr	Test Time	7.5 minutes
	0.6 hr*		19.5 minutes*
			0.325 hour

*Total Time for 6 PC Assemblies.

1.9 Min Resolvable Temperature (MRT) (SM-D-770170)

1.9.1 Functional Parameters

Test No.	Type of Test	Number of Tests	Approx. Value
1	Time Varying DC	8	Characteristic Curves

1.9.2 Necessary Instrumentation

Scanning Microphotometer
Off-axis Collimating Mirror
IR Thermal Source & Target Masks
X-Y Recorder
Power Supplies
Filters

1.9.3 System Comparison

Manual System		Auto System	
Set-up Time	1.0 hr	Set-up Time	16.0 minutes
Test Time	4.0 hrs	Test Time	120.0 minutes
	5.0 hrs		136.0 minutes
			2.26 hours

APPENDIX C

1.0 Time and Cost of Computer Automatic Test System Vs. Manual Test System

This section analyzes the time to run an automated test versus the time to run the same test manually for the DRAGON NVS. Each type of testing is compared to determine at what point in time a computer Automated Test System becomes economically feasible.

1.1 Assemblies and Testing Time for a Manual Station

The present DRAGON APE pilot line utilizes manual procedures to test the electrical parameters on the following assemblies:

Assemblies	Set-up Time* (Hrs)	Testing Time* (Hrs)
1. Detector and Bias Assemblies	0.5	3.0
2. Preamp/Multi/Logic/Intercon Assy	0.5	3.0
3. Electrical Scanner Assembly	0.3	1.0
4. Defl. Amp/Hi V Multi/CRT/RET Subassy	0.4	2.0
5. Power Supply Assembly	0.5	2.0
6. Preamplifier and Multiplexer Assembly of 8 cards	0.5	2.0
7. Logic Boards	0.2	1.0
8. Bias Board (6 pcs)	0.2	0.4
9. Minimum Resolvable Temperature	1.0	4.0
Total	4.1	18.4

The total time to test all the electronic functions on these assemblies is:

Set-up Time	4.1 hrs
Testing Time	18.4 hrs
Total Testing Time	22.5 hrs

*The times shown are extracted from Appendix B and are based on large volume production at a rate of 60/month.

1.2 Manual Test Station

The following delineates the instrumentation of each manual test station used to test the aforementioned assemblies:

- Printer
- Oscilloscope
- Digital Multimeter
- Power Supplies
- Counter/Timer
- Function Generator
- Pulse Generator
- Rack Stand
- Interconnecting Cabling
- MRT Test Station Increment

1.3 Number of Manual Systems Required

As previously mentioned the time required for a manual test station to complete all the electronic functional tests for one DRAGON system is 22.5 hours. Assuming 160 hours a month, the longest manual test time is 5 hours, which yields a production rate of 32/month considering a single shift. At this rate to produce 60 systems per month one will need more than a single shift on this station.

1.4 Cost to Operate Manual Testing Stations

The cost to operate nine manual test stations with 2 shifts or eight and 3 shifts on one can be calculated as follows:

2 shifts x 10 stations x 40 hours = 800 hrs/week

800 hrs/week x 4.3 weeks = 3440 hrs/month

Direct Labor Rate $11.32 hour.

The total cost in man hours per month is
(3440 hrs/month) x($11.32/hr) = $38,940/month

A production of 5000 systems at 60 systems a month will extend to 84 months. The total labor cost to operate the manual test stations for 84 months is
($38,940/month) x (84 months) = $3,270,960.00.

1.5 Total Cost for Manual Test Stations

The total cost of operating eight manual on two shifts to test 60 systems a month for 84 months (5000 systems) is:

Labor	$3,270,960.00

1.6 Assemblies on Testing Time for CATS

Assemblies to be tested are the same as for manual test. Testing time is directly related to the response time of the instrumentation.

Assemblies	Set-up Time	Testing Time
1. Detector and Bias Assemblies	10.0 min.	19.1 min.
2. Preamp/Multi/Logic/Intercon Assembly	10.0 min	16.8 min.
3. Electrical Scanner Assembly	9.0 min.	9.4 min.
4. Defl. Amp/Hi V Multi/CRT/ RET Subassembly	10.0 min.	13.5 min.
5. Power Supply Assembly	10.0 min.	15.7 min.
6. Preamplifier and Multiplexer Assembly of 8 cards	16.0 min.	8.0 min
7. Logic Boards	2.0 min.	6.4 min.
8. Bias Boards (6 pcs)	12.0 min.	7.5 min.
9. Minimum Resolvable Temperature	16.0 min.	120.0 min.
Total	95.0 min.	216.4 min.
	1.59 hrs	3.61 hrs.

The total time to test all the electronic functions on these assemblies utilizing CATS is:

Set-up Time	1.59 hrs
Testing Time	3.61 hrs

Total CATS Testing time for one system is 5.2 hours. This compares to 22.5 hours for manual test.

As before these figures are extracted from Appendix B. It should be noted the decrease in set up time is due to the increased capabilities of the more sophisticated Interface Devices.

1.7 Cost Per Computer Automated Test System

The following delineates the cost of computer Automated Test System.

Mini Computer, which includes:

a) Teleprinter
b) 16K words of core
c) Punch tape reader
d) Control panel
e) Patch panel
f) ATLAS interpreter
g) Tape Drive

Power Supplies

Digital Multimeter
Counter/Timer
Function Generator
Pulse Generator
CRT Display
Switching Subsystem
Interface Devices
Special IR Test Equipment

The approximate computer and test equipment hardware cost of one CATS is $138,000. Equivalent cost for two CATS is $244,000.

It should be noted that a programmable oscilloscope was not included because the speed of the CATS negates visual parameter interpretation. In those instances where the oscilloscope was used in the manual stations, the CATS will modify its software to implement other measuring instruments.

1.8 Number of CATS Required

The time required to complete the functional electronic testing of one DRAGON NVS utilizing CATS is 5.2 hours. Assuming 160 hours a month, one CATS will test

$$\frac{160 \text{ hrs/month}}{5.2 \text{ hrs}} = 30.0 \text{ systems a month.}$$

To test 60 systems a month requires 2 systems.

Two Computer Automated Test Systems will cost approximately $285,000. This would include the cost of in-house set up, operator training, special test fixtures and Quality Control inspection.

1.9 Cost to Operate CATS

The time required to test 60 systems a month utilizing two stations is

(2 men) x (40 hrs/wk) x (4.3 wks) = 344 hrs/month.

Assuming direct labor and overhead at the rate of $11.32/hour then the cost to test 60 systems a month is

(344 hrs) x ($11.32) = $3894/month.

A production of 5000 systems at 60 systems a month will extend to 84 months. The total labor cost to operate the CATS for 84 months is

($3894/months) x (84 months) = $327,103.

2.0 Software

The cost to generate the software is now calculated.

2.1 Test Program Tape

A typical end-to-end test program, for any of the aforementioned assemblies, will consist of approximately 250 test statements. There are 5 - 10 computer instructions per statement and there are 1 - 3 computer words per instruction. Therefore, a typical test program will amount to

(250 statements) x (8 comp. inst.) x (2 words) = 4000 words per test program

The memory capacity of each CATS is 16K words, hard core, plus 100K words in the tape drive. An ATLAS language compiler will consume approximately 32K words.

The average cost to develop a tape, assuming nine tapes are developed is $13,600.

2.2 Test Program Instruction TPI

The cost per each Test Program Instruction will be approximately $5,120.

2.3 Interface Device

Assume that the cost of each ID will be approximately 55 percent of the sum of the tape and the instruction manual.

Therefore, the cost of each ID is estimated to be

($13,600 + $5,120) x 55% = $10,200.

2.4 Total Software Costs

The total cost of a Test Program Set (TPS) for each assembly will be as follows:

Test Program Tape	$13,600.
Test Program Instructions	5,120.
Interface Device	10,200.
Cost per TPS	$28,920.

For nine Test Program Sets the total cost will be approximately:

(9 TPS's) x (28,920) = $260,000.

3.0 Test and CATS Cost

Total cost for 2 CATS systems and the cost of testing 5000 DRAGON NVS over a period of 84 months (60/month) is as follows:

Test Labor Cost		$327,103.
Hardware (2 systems)		$244,400.
In-house Set-up (2 systems)		$ 40,000.
Software (9 TPS's)		$260,000.
	Total Cost	$871,503.

4.0 System Cost Comparison

In comparing the two testing methods the cost of hardware in the manual stations is excluded since they exist as operational units in the APE pilot production line.

The difference in using manual test stations, for 5000 systems over a period of 84 months, and an automatic test system is:

Manual Test Stations	$3,344,778.	Labor
Automatic Test System	871,503.	Labor & CATS Cost
Savings using CATS 5000 systems	$2,473,275.	

From Figure 1 it is seen that the break even point between the two is approximately 960 DRAGON systems or 15 months. The cost savings thereafter using CATS is $36,500 a month.

5.0 Diagnostic Programs

The automatic testing outlined in this report concerns itself primarily with end-to-end testing. Under the present philosophy if an assembly has a malfunction it is taken off the CATS and given to a technician who will conduct a manual procedure to isolate the fault. It may, at some point, be desirable

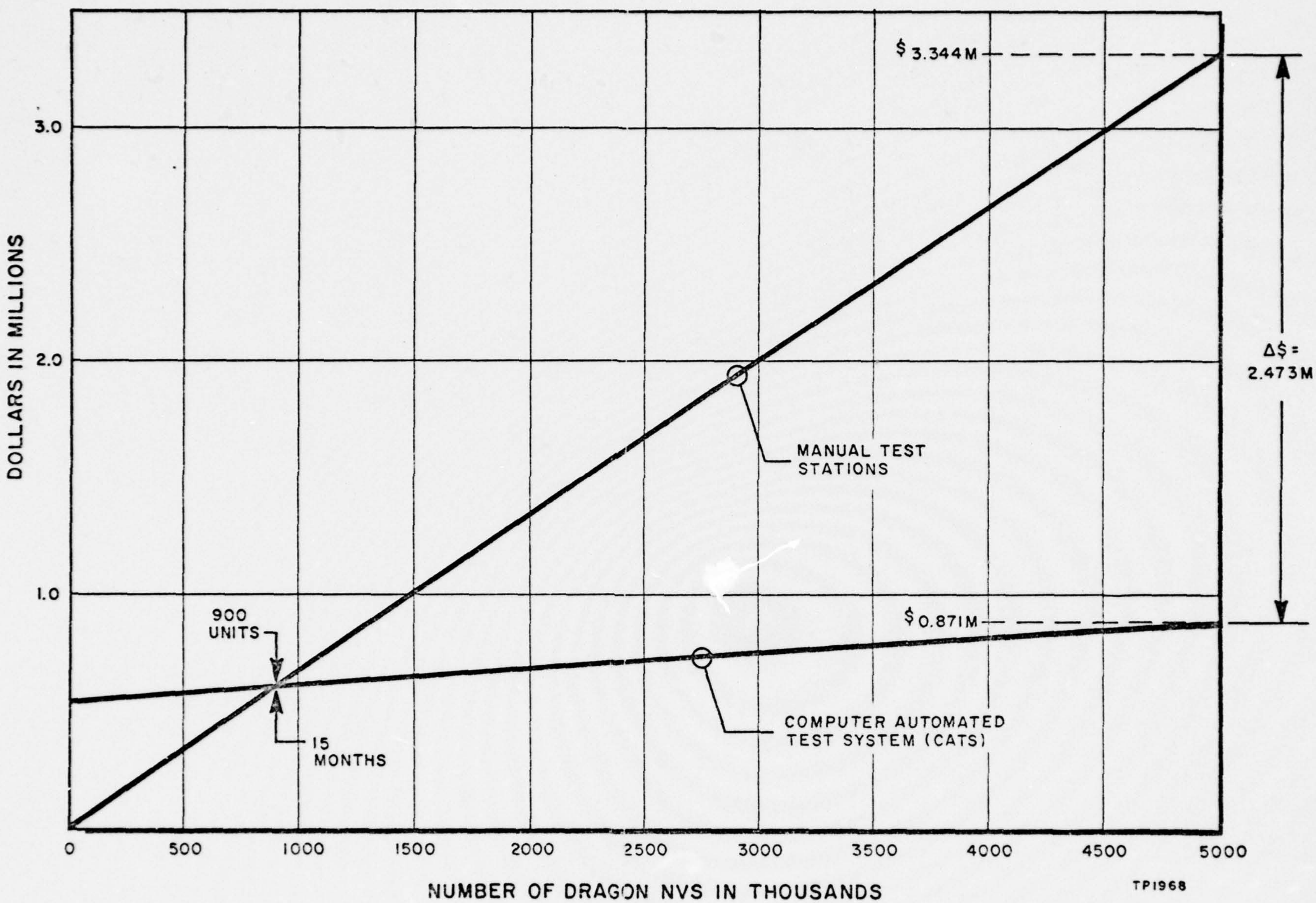

Figure #1 - Cost to test DRAGON Night Sight versus number of systems for manual stations and CATS (at 60 units a month) (station time permitting) to diagnose to the faulty components automatically. To implement this diagnostic procedure diagnostic programs must be developed. The scope of this report will not cover the details of a Diagnostic program, but some general observation will be stated.

A Diagnostic program consists mainly of two parts, an end-to-end test and a fault isolation sub routine.

5.1 The end-to-end test is similar to the end-to-end conducted on the production CATS except that more parameters are checked with constricted tolerances.

5.2 If any test in the end-to-end procedure fails, the program automatically enters into a fault isolation diagnosis. This diagnosis will eventually locate the faulty component (or group of faulty components usually 3 or less) and indicate this to the operator via video display or teleprinter.

5.3 The cost of developing a Diagnostic Test Program Set is approximately:

Test Program Tape	$25,000
Test Program Instruction	8,000
Interface Device	7,000
Cost for one self test TPS	$40,000

The time required to identify the faulty components will vary from 1 - 15 minutes per assembly as a worse case.

To date, no accurate estimate exists that can indicate the time to trouble shoot faulty assemblies manually.

APPENDIX D

TABLE 1

TEST INSTRUMENTATION REQUIRED TO TEST EACH ASSEMBLY

Equipment Required Per Test	Necessary Instrumentation
1. Detector and Bias Assembly	Digital Multimeter True RMS Voltmeter Oscilloscope Filter (Low Pass) Infrared Source Power Supplies -20V, -6V, +5V Mechanical Chopper
2. Preamplifier/Multiplexer Assembly	Oscilloscope Digital Multimeter Function Generator Pulse Generator Counter/Timer Power Supplies -20V, -6V, +5V
3. Electrical Scanner Assembly	Counter/Timer Pulse Generator Digital Multimeter Oscilloscope Power Supplies -20V, -6V, +5V
4. Defl. Amp/HiV Multi/CRT/ RET Subassembly	Digital Multimeter Counter/Timer Oscilloscope Power Supply +6V
5. Power Supply Assembly	Pulse Generator Counter/Timer Oscilloscope Digital Multimeter Power Supplies +5V, +6V
6. Preamplifier and Multiplexer Assembly	Digital Multimeter Counter/Timer Function Generator Power Supplies +5 VDC, -6 VDC, -20 VDC

TABLE 1 (CONT)

Equipment Required Per Test (Cont)	Necessary Instrumentation
7. Logic Board Assembly	Function Generator Counter/Timer Power Supplies +5V, -6V Oscilloscope Digital Multimeter
8. Bias Board Assembly	Function Generator Frequency Counter Oscilloscope Digital Multimeter
9. Min. Resolvable Temperature (MRT)	Scanning Microphotometer Off-axis Collimating Mirror IR Thermal Source & Target Masks X-Y Recorder Power Supplies Filter

TABLE 2

TABLE 2 DESCRIBES THE FOLLOWING PARAMETERS OF EACH ASSEMBLY TO BE TESTED

Types of Test per Assembly

1. Type of Tests
2. Number of Tests
3. Approximate Value

1. Detector and Bias Assembly

Type of Test	Number of Tests	Approx. Value
DC Level	64	Millivolts
AC Level	64	Millivolts at 4 Hz
Noise	64	Millivolts
Continuity	3	Short Circuit
	195	

2. Preamplifier/Multiplexer Assembly

Type of Test	Number of Tests	Approx. Value
DC Offset	64	mV DC
Time Interval	20	480 sec max
	84	

3. Electrical Scanner Assembly

Type of Test	Number of Tests	Approx. Value
Time/Frequency	4	300 kHz
DC Level	5	+5V max
AC Level	3	13.8 rms max
	12	

4. Defl. Amp/HiV Multi/ CRT/RET Subassembly

Type of Test	Number of Tests	Approx. Value
DC Level	13	1000V
AC Level	7	25V pf
Time Interval	1	133 msec max
Visual Alignment	9	
	30	

TABLE 2 (CONT)

5. Power Supply Assembly

Type of Test	Number of Tests	Approx. Value
Time Interval	2	4 kHz
DCV Monitor	5	Full Load +5V +100V
DCV Monitor	5	Half Load +5V +100V
AC Level	1	12.5 Vrms
DCV Monitor	5	High Output +5V +100V
Ripple Noise	10	Millivolt p-p
Current	5	mA 1 amp max
AC Level	1	150 Vrms
	34	

6. Preamplifier and Multiplexer Assembly

Type of Test	Number of Tests
Visible Distortion of Sine Wave	8
Low Frequency Roll-off	8
	16 x 8 = 128

7. Logic Board Assembly

Type of Test	Number of Tests	Approx. Value
Time Interval	45	240 sec
DC Level	2	+5V
	47	

TABLE 2 (CONT)

8. Bias Board Assembly

Type of Test	Number of Tests	Approx. Value
AC Gain	64	150 mV
DCV Level	128	-3.0 VDC
Resistance	4	0.0 ohm
	196	

9. Min. Resolvable Temperature (MRT)

Type of Test	Number of Tests	Approx. Value
Time Varying DC	8	Characteristic Curve

TABLE 3

TEST PARAMETERS OF EACH ASSEMBLY

1. Number of Tests
2. Stimulus
3. Stimulus Instrumentation
4. Measurement
5. Measurement Instrumentation
6. Number of Pins required.

Detector Bias Assembly

Test	Stimulus	Instrumen.	Meas.	Meas. Instrumen.	Pin Conn.
1-64	500°C	IR Source	AC Gain	RMS VM	72
1-64	500°C	IR Source	DC Level	DMM	72
1-64	Room Temp	Blackbody	Interference	RMS VM	72
1-64	Room Temp	Blackbody	Noise	DMM	72

Preamplifier/Multi Logic Interconnection

Test	Stimulus	Instrumen.	Meas.	Meas. Instrumen.	Pin Conn.
1-10	Square Wave	Pulse Gen	Timing	Oscilloscope Counter/Timer	95
11-20	Square Wave	Pulse Gen	Multiplexing	Oscilloscope Counter/Timer	95
	Sine Wave	Function Gen	Multiplexing		
21-29	DCV	Power Supply	DC Offset	DMM	16
30-40	Resistance	-	OHMS	DMM	16

Scanner Assembly (Electrical)

Test	Stimuli	Instru	Meas.	Meas.Instru	Pin Conn
1	300 kHz	Scanner Mirror Switch Simulator	Frequency	Counter/Timer	6
2	300 kHz	"	Square Wave	Oscilloscope	6
3	300 kHz	"	VRMS	DMM	6
4	300 kHz	"	Freq	Counter/Timer	6
5	300 kHz	"	Freq	Counter/Timer	6
6	300 kHz	"	VRMS	DMM	6
7	DCV	PS	DCV	DMM	4
8	ACV	Scanner Simulator	ACV	Oscilloscope	6
9	Pulses	Pulse Gen	VRMS	DMM	6

TABLE 3 (CONT)

Deflection Amp/HV Multi

Test	Stimuli	Instru	Meas.	Instru	Pin Conn
1	DCV	PS	DCV	DMM	4
2	DCV	PS	DCV	DMM	4
3	DCV	PS	DCV	DMM	4
4	DCV	PS	DCV	DMM	4
5	DCV	PS	DCV	DMM	4
6	DCV	UUT	Freq	Counter/Timer	6
7	DCV	UUT	V p-p	Oscilloscope	6
8(64 Tests)	DCV	UUT	VDC	DMM	6
9	DCV	UUT	V p-p	Oscilloscope	6
10	DCV	UUT	V p-p	"	6
11	DCV	UUT	V p-p	"	6
12	DCV	UUT	V p-p	"	6
13	DCV	UUT	V p-p	"	6
14	DCV	UUT	V p-p	"	6
15	DCV	UUT	V p-p	"	6
16	DCV	UUT	V p-p	Visual	6
17	DCV	UUT	V p-p	Visual	6
18	DCV	UUT	V p-p	"	6
19	DCV	UUT	V p-p	"	6
20	DCV	UUT	V p-p	"	6
21	DCV	UUT	V p-p	"	6
22	DCV	UUT	V p-p	"	6
23	DCV	UUT	V p-p	"	6
24	DCV	UUT	V p-p	"	6
25	DCV	PS	DCV	DMM	4
26	DCV	PS	DCV	"	4
27	DCV	PS	DCV	"	4
28	DCV	PS	DCV	"	4
29	DCV	PS	DCV	"	4

Power Supply Assembly

Test	Stimuli	Instru	Meas.	Instru	Pin Conn
1-4	DCV	Power Supplies	DCV	DMM	13
5-9	Square Wave	Pulse Gen	DCV	DMM	13
10-14	DCV	PS	Current	DMM	13
15	Square Wave	Pulse Gen	Timing	Counter/Timer	5
16-17	DCV	Power Supplies	Current	DMM	5

TABLE 3 (CONT)

Preamplifier Assemblies

Test	Stimulus	Instru	Meas	Meas Instru	Pin Conn
1-8	Sine Wave	Pulse Gen	Spectrum Distortion	Oscilloscope	18
	Square Wave	Function Gen	"	Counter/Timer	
9-16	Sine Wave	Function Gen	Low Freq Roll-off	Oscilloscope	18

Logic Board Assembly

Test	Stimulus	Instru	Meas	Meas Instru	Pin Conn
1-3	Square Wave	Pulse Gen	Timing	Counter/Timer	10
4-18	Sine Wave	Function Gen	Timing	Counter/Timer Oscilloscope	24
19-20	DVC	Power Supplies	DVC	DMM	5

Detector Bias Network

Test	Stimulus	Instru	Meas	Meas Instru	Pin Conn
1-11	DCV	Power Supplies	DCV	DMM	24
12-31	ACV	Function Gen	ACV	DMM Oscilloscope	24

Min. Resolvable Temperature (MRT)

Test	Stimulus	Instru	Meas	Meas Instru	Pin Conn
1	Temp	IR Source	Charac-teristics	Microphotometer	9

TABLE 4

TOTAL PIN CONNECTIONS REQUIRED FOR EACH ASSEMBLY

	Assembly	Input Pins	Output Pins	Total Pins
1.	Detector Bias Assembly	8	64	72
2.	Preamplifier/Multiplexer Assembly	71	24	95
3.	Electrical Scanner Assembly	9	9	18
4.	Defl. Amp/Hi V Multi/CRT/RET Subassembly	2 + (64)	12	14
5.	Power Supply Assembly	3	10	13
6.	Preamplifier and Multiplexer Assembly	17	1	18
7.	Logic Board Assembly	7	17	24
8.	Bias Board Assembly	13	11	24
9.	Min. Resolvable Temperature (MRT)	8	1	9

Prepared for:
United States Army Mobility Equipment
Research and Development Center
R&D Procurement Office
Fort Belvoir, Virginia 22060

Authorization:
Contract No.: DAAK02-73-C-0047

CDRL No. A022

APPENDIX B
TO
FINAL REPORT
ADVANCED PRODUCTION ENGINEERING (APE)
NIGHT VISION SIGHT INFRARED, AN/TAS-3()

VOLUME 1
OF
SBRC FINAL PRODUCTION PLAN

GOVERNMENT SYSTEMS DIVISION
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SANTA BARBARA RESEARCH CENTER

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75 COROMAR DRIVE • GOLETA • CALIFORNIA

VOLUME I - FINAL PRODUCTION PLAN

DETECTOR ASSEMBLIES AND CRYOSTAT ASSEMBLIES

ADVANCE PRODUCTION ENGINEERING MODEL
AN/TAS-3 INFRARED NIGHT VISION SIGHT

Contract No. PBEC 09772
Prime Contract No. DAAK02-73-C-0047

SBRC W/A 4625 - Dragon-APE

for

Philips Broadcast Equipment Corporation
Government Systems Division
One Philips Parkway
Montvale, New Jersey 07645

16 June 1975

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C. S. Tallman
Project Manager

This is Volume 1 of three volumes. Volume 2 contains the Planning and Procedures for the Detector Assembly. Volume 3 contains the Planning and Procedures for the Cryostat Assembly.

CONTENTS

CONTENTS (Cont)

FINAL PRODUCTION PLAN

I. PURPOSE

This Final Production Plan is submitted in response to the requirements for Contract Line Item 0011/A009. This plan, when implemented, will establish a single shift production capability of 60 Dragon Detector Assemblies and Dragon Cryostat Assemblies per month.

This production plan is intended to supplement the initial pilot production capability which was established for 20 Detector Assemblies and Cryostat Assemblies per month on a single shift basis and 35 per month on a double shift basis. The initial pilot production capabilities are described in the Preliminary Production Plan previously submitted under Contract Line Item 0011/A008.

II. CONFIGURATION

This production plan is based on implementing production capability for the product described as follows:

Detector Assembly

Drawings

SM-D-770349E	Detector, Infrared
SM-A-649902AA	Detector Array (U)

Specifications

C2a 2302-01011010A-1	Critical Item Product Function Specification for Detector

Cryostat Assembly

Drawings

SM-D-649252AB	Cryostat Assembly

Specifications

C2a 2302-01011020A-1	Critical Item Product Function Specification for Cryostat

III. MANUFACTURING PLAN

A. Manufacturing Implementation

1. Major Tasks - Project Network Chart (Figure 1)

This chart shows the major tasks to be performed in providing manufacturing implementation for the Dragon production program at a maximum rate of 60 Detector Assemblies and Cryostat Assemblies a month. The chart also shows the interdependency of each task that is required to accomplish this program. Make or Buy decisions for additional tooling requirements and facility layout decisions will be dependent on the particular conditions at the time of contract award.

2. Work Statement Requirement Summary

The following series of items describes the approach to be used in providing the necessary manufacturing implementation, and details the format that has been used to provide the necessary information. This information follows the outline established in the contract work statement requirements.

a. Production Engineering Design

SBRC reviewed the design for the Dragon Detector Assembly and the Cryostat Assembly and incorporated the changes necessary to make them producible items. The design changes have been documented on the drawings and specifications submitted under Contract Line Item 0011/A018. A discussion of the design changes may be found in the Final Technical Report, Contract Line Item 0011/A014.

b. List of Component Parts and Materials

Manufacturing planning sheets have been prepared to describe all the component parts and materials used to fabricate the detector assembly and cryostat assembly. These manufacturing planning sheets, including a list of component parts, are arranged so that they facilitate the release of Work Orders that will be used on the production program. The manufacturing planning sheets may be found in Volumes 2 and 3.

c. Make or Buy Determinations

SBRC has reviewed each part used on this program to determine whether the items should be made at SBRC or purchased from a supplier. Manufacturing Planning and Supplier Planning have been prepared for each of these

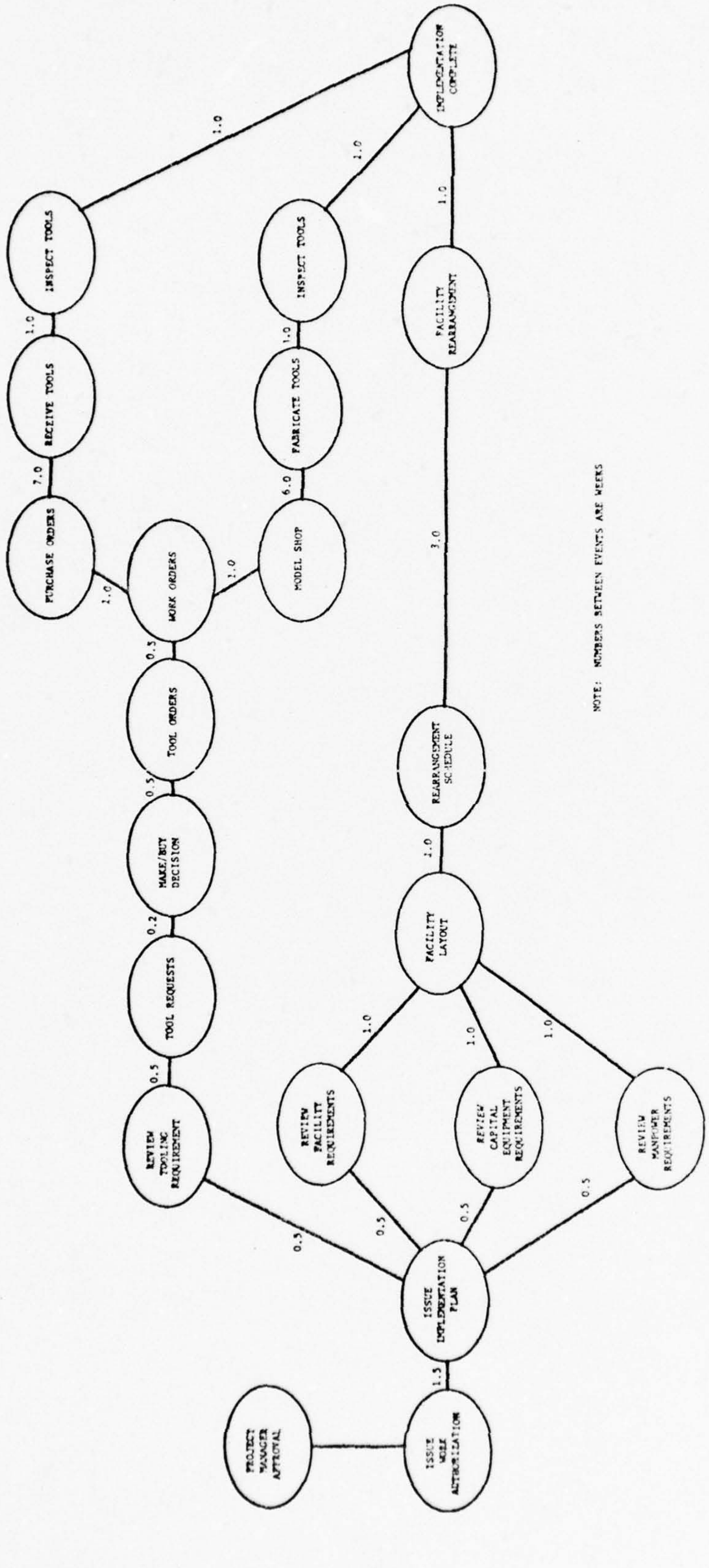


Figure 1. Project Network Chart

items. The items with Manufacturing Planning are considered make items and parts with Supplier Planning are considered buy items. Consolidated parts lists which include the make or buy decision for each part may be found in Attachments J and K.

d. Lead Time Determination

Each item in this program has been reviewed to determine the lead time necessary to produce the item or to buy the item if it is a purchased part. This information is summarized on the Manufacturing Planning or Supplier Planning documents and is also contained in the Manufacturing Setback Chart (Attachment B).

e. Production Methods and Processes

SBRC has developed the production methods, sequence of manufacture, processes and complete documentation of the manufacturing methods for all the parts used on the Dragon Detector Assembly and Cryostat Assembly. This information is documented on the Manufacturing Planning, Supplier Planning, Manufacturing Procedures, Standard Manufacturing Procedures and Manufacturing Purchase Descriptions. This information has been prepared and released at SBRC and is considered a necessary part of the manufacturing implementation for this program. The detailed Manufacturing Procedures may be found in Volumes 2 and 3.

f. Production Plan

This Final Production Plan describes the items of implementation that have been prepared to provide the pilot production capability described in the Preliminary Production Plan. This basic pilot production capability can easily be increased to the single shift production capability for 60 Detector Assemblies and Cryostat Assemblies a month by providing the additional tools and implementation described herein.

g. Production Line Yields and Rework Procedures

All the manufacturing operations used on this program have been reviewed and the yield for each operation has been estimated. This information may be found in Attachments J and K under the column titled "Attrition Factor." Rework procedures are incorporated as part of the Manufacturing Procedures contained in Volumes 2 and 3.

h. Establish Production Line

An initial production capability meeting the pilot production requirements of 20 units per month on a single shift basis and 35 units per month on a double shift basis has been established as part of this Advance Production Engineering program. This capability is described in the Preliminary Production Plan and includes the tooling and equipment described in Attachment D.

i. Fabrication of Advance Production Engineering (APE) Models

Two validation units and two APE units have been fabricated utilizing the production methods, tooling and equipment that were created for the Advance Production Engineering program. All the operations have been validated and are considered ready for the production program.

j. Production Drawings

A complete set of engineering drawings, specifications, and an Assembly Configuration List which adequately describes the product to be produced has been released and provides the configuration identification for the APE models that were produced under this contract. These documents have been submitted as a seperate data item (CLI 0011/A018).

k. Engineering Drawings for Special Tooling and Test Equipment

All the tools used to fabricate the APE models are described on Engineering Drawings which have been submitted under a separate data item in this contract (CLI 0011/A006). Test equipment drawings have been submitted to show the configuration of the SAIE Test Set which is funded under this program (CLI 0011/A019).

l. Special Tooling and Test Equipment

A complete set of tooling and test set equipment has been fabricated to carry out the pilot production objectives described in the Preliminary Production Plan. Attached is a list of special tooling and test equipment that has been fabricated for use on this program (Attachment D). SBRC also requires the use of the Government Owned Tooling and Test Equipment described in Attachment F on a rent free, noninterference basis. These two lists summarize a complete list of the in-house special tooling and test equipment necessary to carry out the pilot production program, except that SBRC owned tools are not included in the list. Lists of SBRC owned tooling needs may be found in the Manufacturing Procedures in Volumes 2 and 3. Attachment G lists the vendor tooling fabricated for the APE contract.

B. Final Production Line Description

SBRC has established the pilot production line required for the Advance Production Engineering contract. The following information summarizes and describes the basic concept for this implementation plan.

1. Operation Process Chart (Attachment A)

This chart indicates the manufacturing and inspection operation sequence for the assembly of the Dragon Detector Assembly and the Dragon Cryostat Assembly. The flow chart also shows the flow of parts for all purchased and manufactured items. Operation numbers may be found on the Manufacturing Planning documents given in Volumes 2 and 3.

2. Manufacturing Setback Chart (Attachment B)

This chart is intended to show the critical path relationship and the time sequenced events that are necessary to produce this product in accordance with the predetermined schedule. It is also intended that this chart will be the basis for a line-of-balance chart that can be used to control the production program. Setback times are given on the Manufacturing Planning documents found in Volumes 2 and 3.

3. Production Line Layout (Attachment C)

This line layout defines the primary areas that will be used for the Production Program defined. (Some auxiliary supporting areas comprising general purpose manufacturing facilities are not shown; i.e., PbSe detector deposition, preparation, and photoetch facilities.) This layout also describes the facilities and equipment that will be allocated for this production program. The general work areas are shown in Attachment C. This layout includes processing and assembly areas subject to change at the time of contract award.

4. Pilot Production Special Tooling and Test Equipment (Attachment D)

This list summarizes the items of special tooling and test equipment that were fabricated on the Dragon APE program and are required for use on initial production programs. Additional lists of standard tools and equipment are given in the Manufacturing Procedures contained in Volumes 2 and 3.

5. Production Special Tooling and Test Equipment (Attachment E)

This list identifies the special tooling and test equipment that is necessary to increase the production rate capability from the pilot production status to the production rate capability of 60 Dragon Detector Assemblies and Cryostat Assemblies per month.

6. Government Owned Special Tooling and Test Equipment (Attachment F)

This list contains all the government owned special tooling and test equipment that is required on a rent free, noninterference basis for the pilot production or production programs.

C. Production Methods and Planning

The following is a very general discussion of methods and processes that have been developed to fabricate and assemble the detector package, detector array and cryostat. Detailed documentation of the methods and processes is given in Volumes 2 and 3.

1. Detector Package

The detector package consists of a linear array of 64 photoconductive PbSe elements packaged in a glass/metal dewar. The dewar consists of three major subassemblies which are: the Window Section, the radial feedthrough or Sunburst Assembly, and the Stem Assembly.

The Window Section is manufactured by first beading a metal flange with a glass whose coefficient of expansion nearly matches that of the metal. A piece of glass tubing with a slightly different coefficient of expansion is then attached to the glass on the flange. These operations are performed using special holding fixtures and standard glass lathe equipment. To this assembly, the sapphire window is attached by heating the assembly on a fixture mounted in an RF Generator coil. The tubulation is then added to the side of the Window Section for use in later evacuation of the Dewar Detector Assembly. Finally an evaporated aluminum coating is applied to the inside walls of the Window Section.

The radial feedthrough or Sunburst Assembly is manufactured by first beading two flanges with glass. These glass beaded flanges along with metal pins are mounted in a carbon mold. The parts are then fused together by means of induction heating in an RF Generator coil.

The Stem Assembly consists of a glass beaded metal flange to which a precision bore glass tube is attached. The glass tube is subsequently sealed off at one end and ground to tight tolerances using a fine diamond grinding wheel. To provide conductive leads from the Detector Array, which is mounted onto the closed end of the Stem Assembly, silver paint is sprayed onto the tube and fused to the glass by heating in an oven. The paint is then covered with a masking material. The masking material is scribed through to allow an etching solution to remove silver paint in these areas. The masking material is then removed leaving the delineated stripe pattern.

The Detector Assembly is assembled by first heliarc (tungsten inert gas atmosphere) welding the Stem Assembly flange to one of the Sunburst Assembly flanges. At this point, wire connections are made from the Sunburst pins to the Stem Assembly silver stripes. Next, the Detector Array is mounted on the end of the Stem Assembly and another set of wire connections is made. Following the attachment of the Detector Array wires to the Stem Assembly silver stripes, the Filter Holder is attached. For final assembly considerations, the Filter Holder is oriented very precisely to the Detector Array. The Filter is then mounted to the Filter Holder. After the Detector Assembly is tested, the Window Section is heliarc welded to the Sunburst Assembly Flange. The Detector Assembly is then placed on a vacuum system, vacuum baked, barium getter fired, and the tubulation is sealed off. Bonding the mounting flange, potting the radial feedthroughs, and painting complete the assembly operations.

2. Detector Array

To fabricate the 64-element linear Detector Array, basic manufacturing process procedures used on other manufacturing programs are used. These steps include substrate preparation, chemical deposition of PbSe film, delineation of the array elements using photolithographic techniques, film sensitization, vacuum deposition of metal electrodes to the detector elements, and bonding lead wires to the electrode pads. These arrays are tested in test dewars prior to mounting on Stem Assemblies.

3. Cryostat

The demand flow Cryostat used in the Dragon Detector Assembly is very similar to one that was produced in production quantities at SBRC for another application. In fact, some of the component subassemblies are identical. This allows manufacture of the Dragon demand flow Cryostat with a minimum of special tooling. Extensive use is made of SBRC and Government owned special tooling. Except for the gas line Filter Assembly, all Cryostat Assembly operations are performed at SBRC. The Filter Assembly is a subcontracted part to a supplier having furnace brazing capability. This allows a low cost Filter Assembly with minimum risk of contamination.

D. Configuration Control

The configuration control is obtained by the Assembly Configuration List (ACL), Manufacturing Planning and Manufacturing Procedures. The ACL is an indentured drawing list that includes drawing revision letters of all subassemblies and parts to reflect the current status of released drawings. For each manufactured part, a Manufacturing Planning document and a Fabrication/Assembly Record form are issued with the work order. The Manufacturing Planning document carries the current revision letter of the applicable engineering drawing, and lists the sequence of operations with operation numbers and the responsible performing department. Each operation number is entered on the Fabrication/Assembly Record (Assembly History Record) when performed and initialed by the operator or inspector as appropriate. Each operation is controlled by a manufacturing or inspection procedure. Manufacturing Planning and Procedure documents are controlled by the Production Engineering Section. Prior to release of these documents, signature approval is obtained from the Engineering, Quality Assurance, and Manufacturing Project representatives. A Configuration Management Plan is given in Attachment H.

IV. QUALITY ASSURANCE PLAN

A. Documentation

The Quality Assurance Procedures and Inspection Instructions have been prepared to support the manufacturing and inspection sequence flow described herein. The Quality Assurance Procedures and Inspection Instructions are contained in Volumes 2 and 3.

B. Special Tooling

All the special inspection tools and fixtures of the type necessary to support a production rate of up to 60 units per month have been built and checked out. This tooling and the operation or item for which it is used are included in Attachment D.

C. Supporting Requirements

The established SBRC operating procedures and tasks applicable to high rate production programs are included as Attachment I. Quality Assurance Practices approved by the Director, Quality Assurance, promulgate the policies governing all operations affecting product quality.

SBRC

Attachment A

OPERATION PROCESS CHARTS

SANTA BARBARA RESEARCH CENTER

OPERATION PROCESS CHART

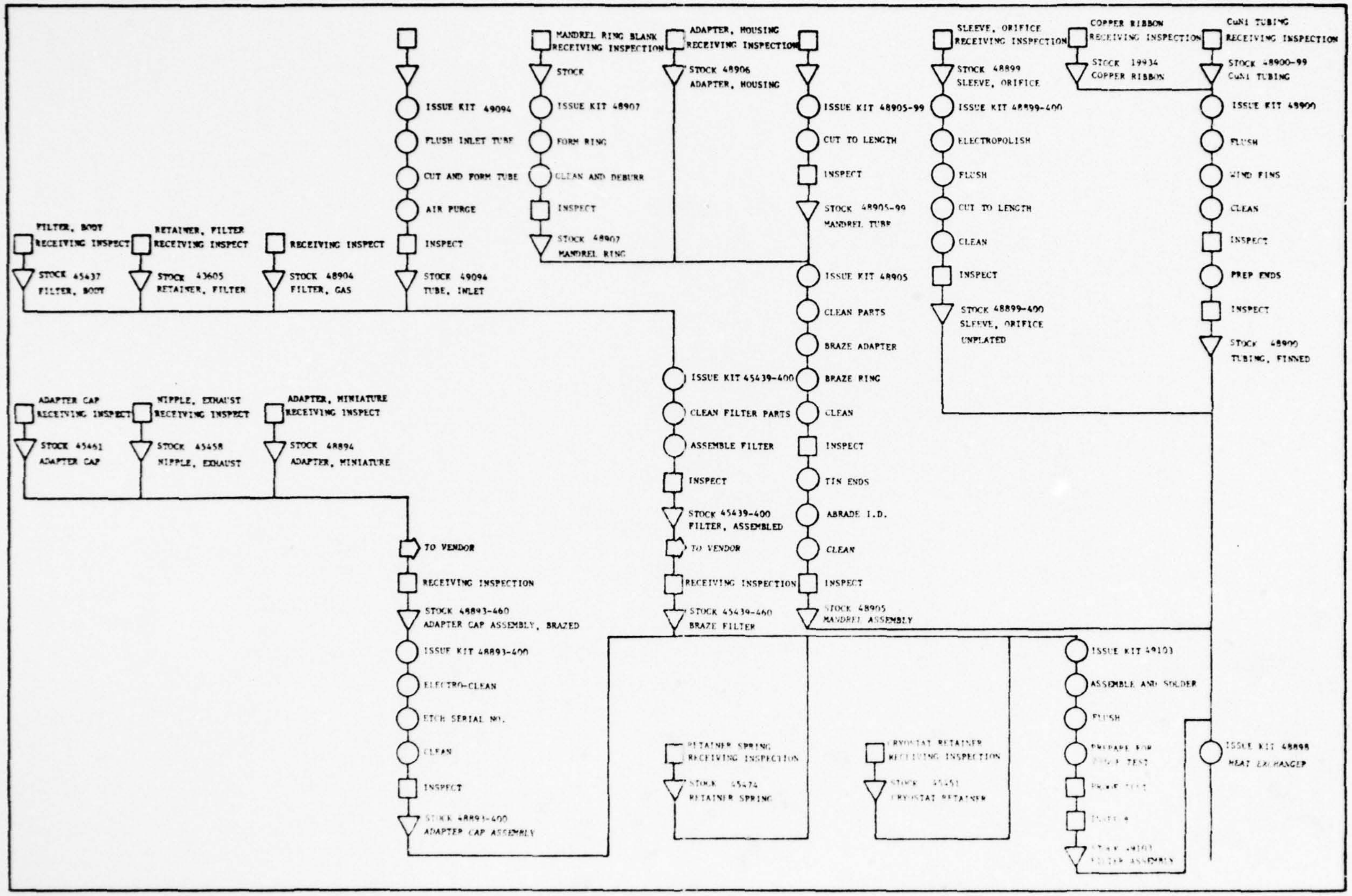
SBRC
SANTA BARBARA RESEARCH CENTER

DATE- DEC. 12, 1974

PAGE 1 OF

PREPARED BY- J. B. CONNORS

DESCRIPTION- DRAGON CRYOSTAT ASSEMBLY 45438



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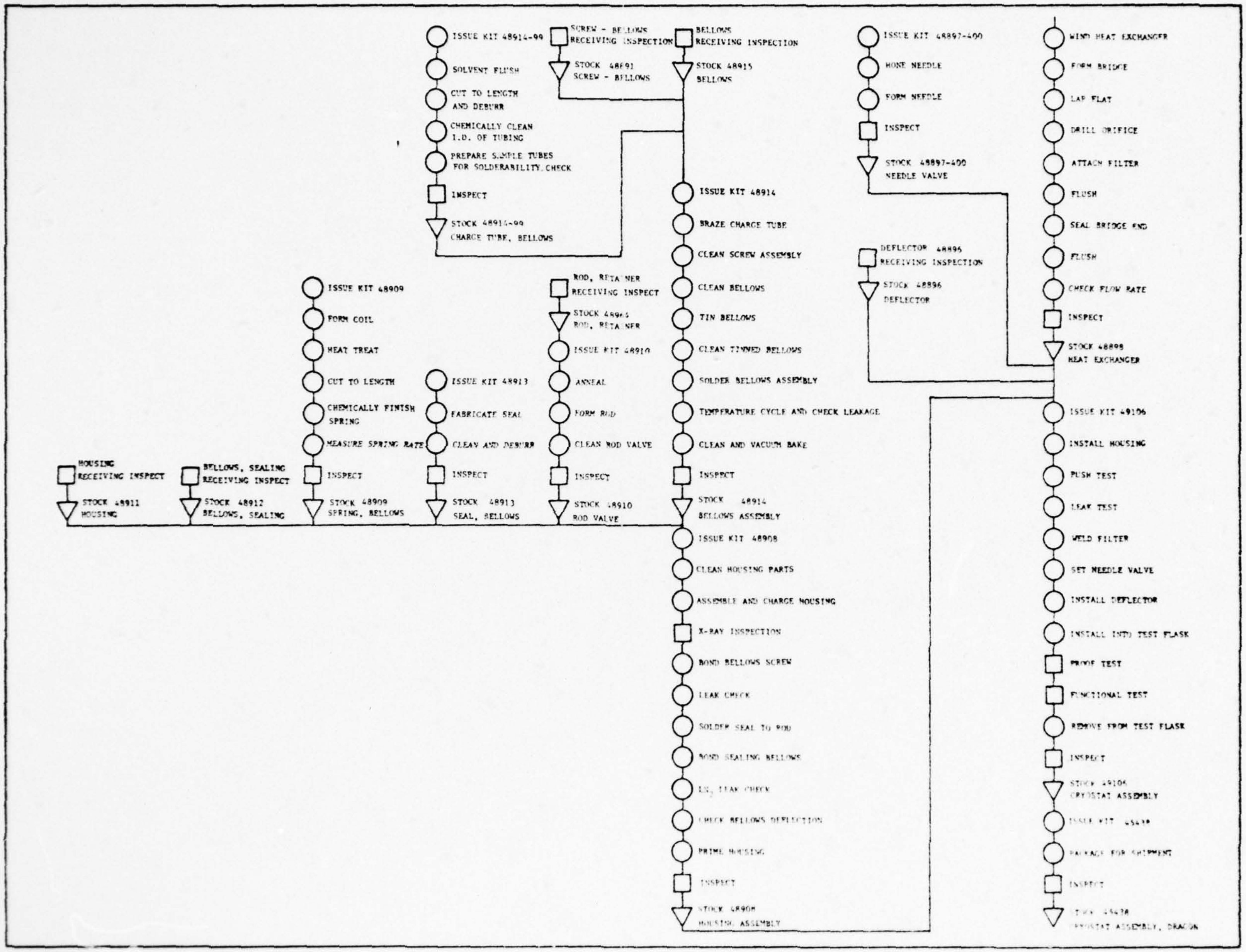
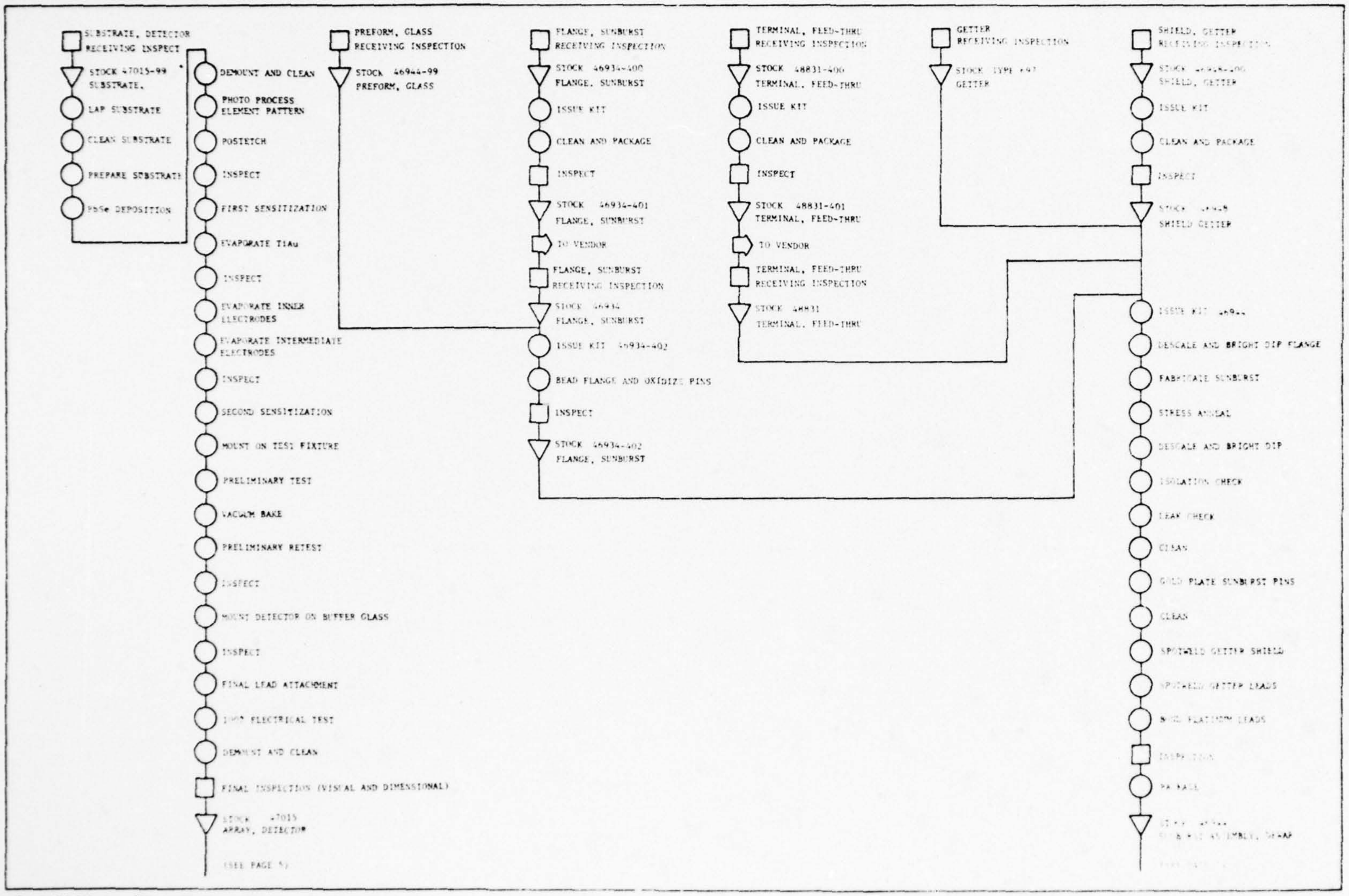


OPERATION PROCESS CHART

SBRC

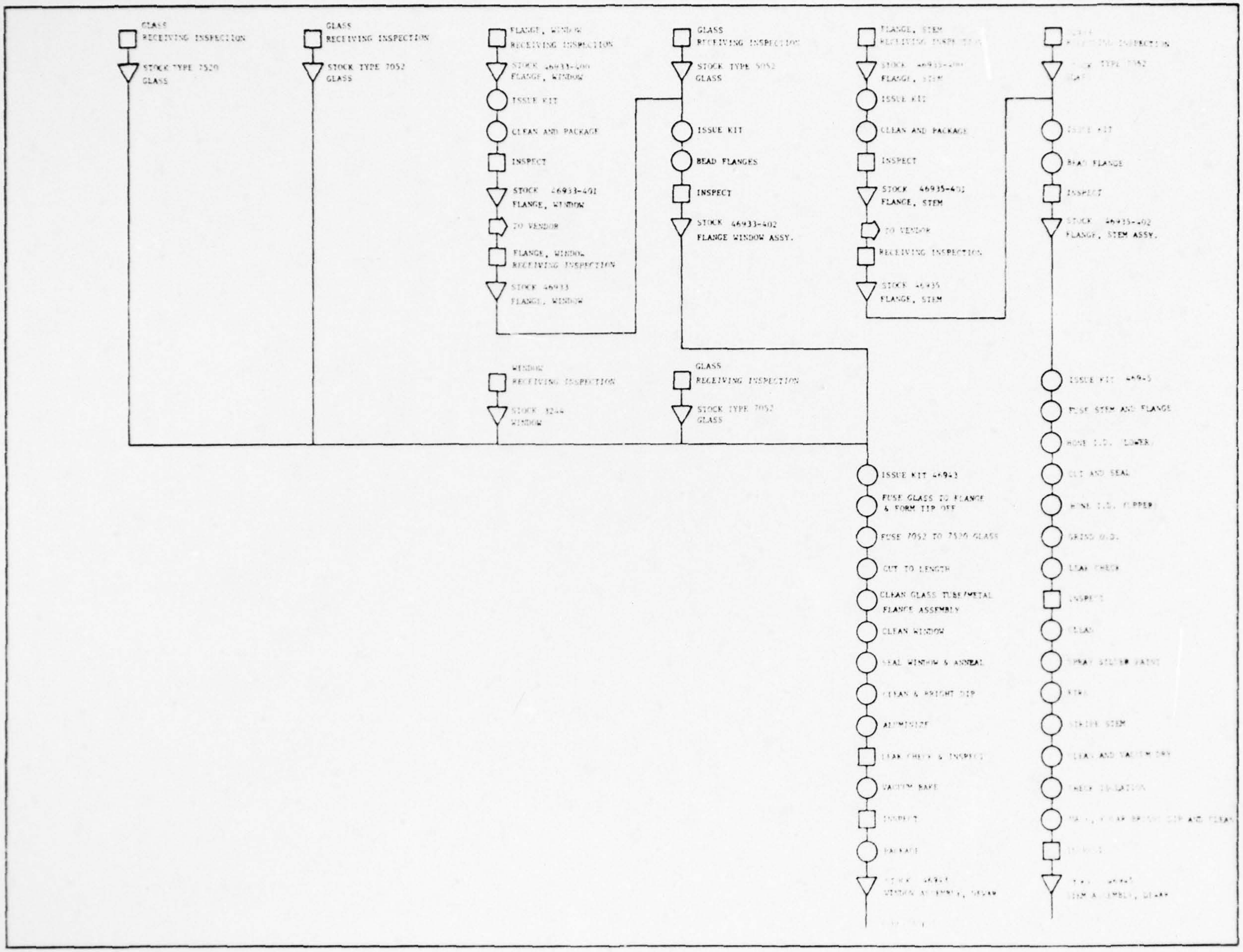
DATE-
PAGE OF
PREPARED BY-

DESCRIPTION- DRAGON DETECTIVE ASSEMBLY 46951

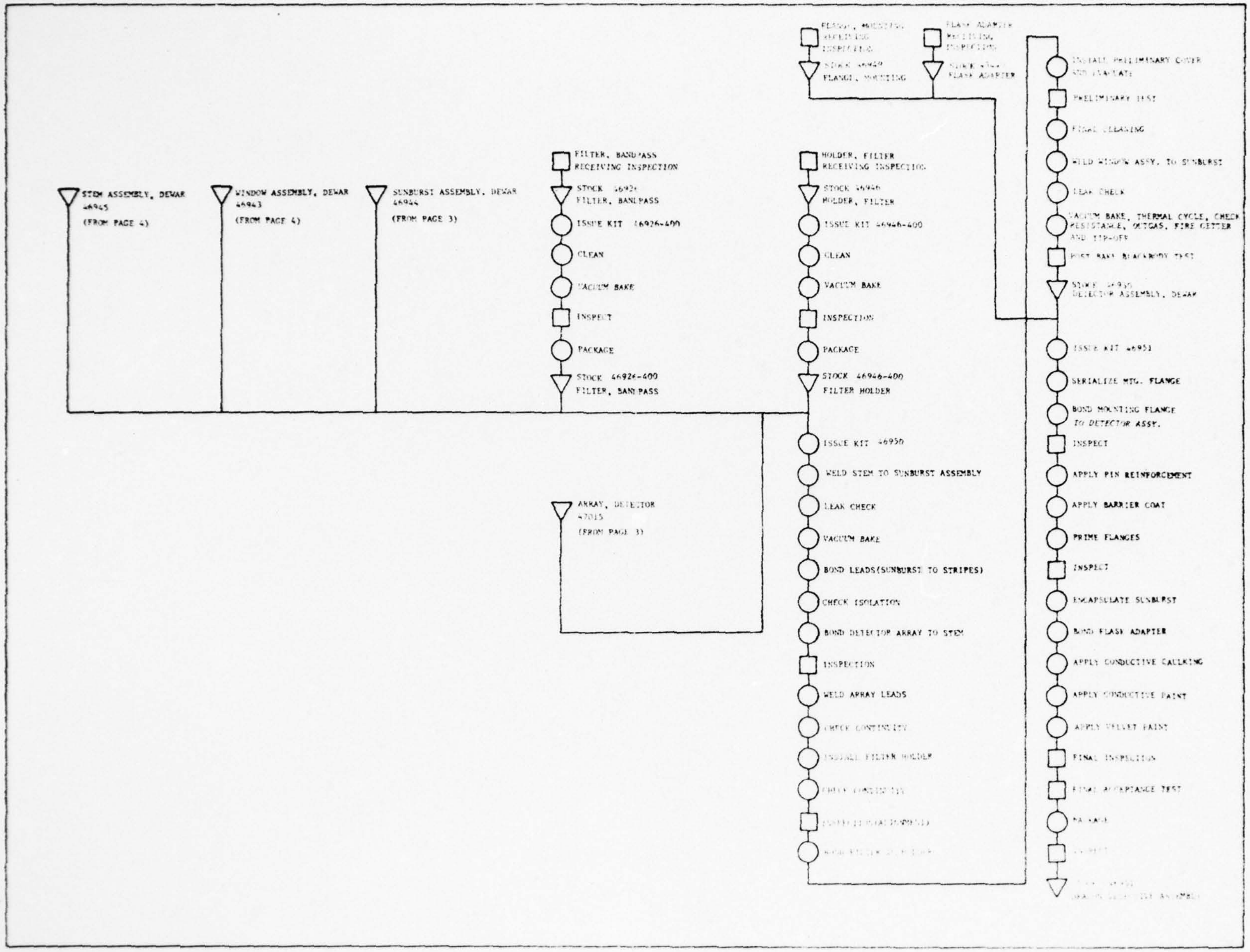


SANTA BARBARA RESEARCH CENTER

DATE-
PAGE OF


GLASS
RECEIVING INSPECTION
STOCK TYPE 7520
GLASS
GLASS
RECEIVING INSPECTION
STOCK TYPE 7052
GLASS
FLANGE, WINDOW
RECEIVING INSPECTION
ISSUE KIT
CLEAN AND PACKAGE
INSPECT
STOCK 46933-401
FLANGE, WINDOW
TO VENDOR
STOCK 46933
FLANGE, WINDOW
GLASS
ISSUE KIT
BEAD FLANGES
INSPECT
STOCK 46933-402
FLANGE WINDOW ASSY.
FLANGE, STEM
ISSUE KIT
CLEAN AND PACKAGE
INSPECT
STOCK 46935-401
FLANGE, STEM
TO VENDOR
RECEIVING INSPECTION
STOCK 46935
FLANGE, STEM
BEAD FLANGE
STOCK 46935-402
FLANGE, STEM ASSY.
WINDOW
RECEIVING INSPECTION
WINDOW
GLASS
RECEIVING INSPECTION
STOCK TYPE 7052
GLASS
ISSUE KIT 46943
FUSE GLASS TO FLANGE
& FORM TIP OFF
FUSE 7052 TO 7520 GLASS
CUT TO LENGTH
CLEAN GLASS TUBE/METAL
FLANGE ASSEMBLY
CLEAN WINDOW
SEAL WINDOW & ANNEAL
CLEAN & BRIGHT DIP
LEAK CHECK & INSPECT
VACUUM BAKE
INSPECT
PACKAGE
FUSE STEM AND FLANGE
CUT AND SEAL
GRIND O.D.
LEAK CHECK
CLEAN
CLEAN AND VACUUM DRY

DATE-
PAGE OF



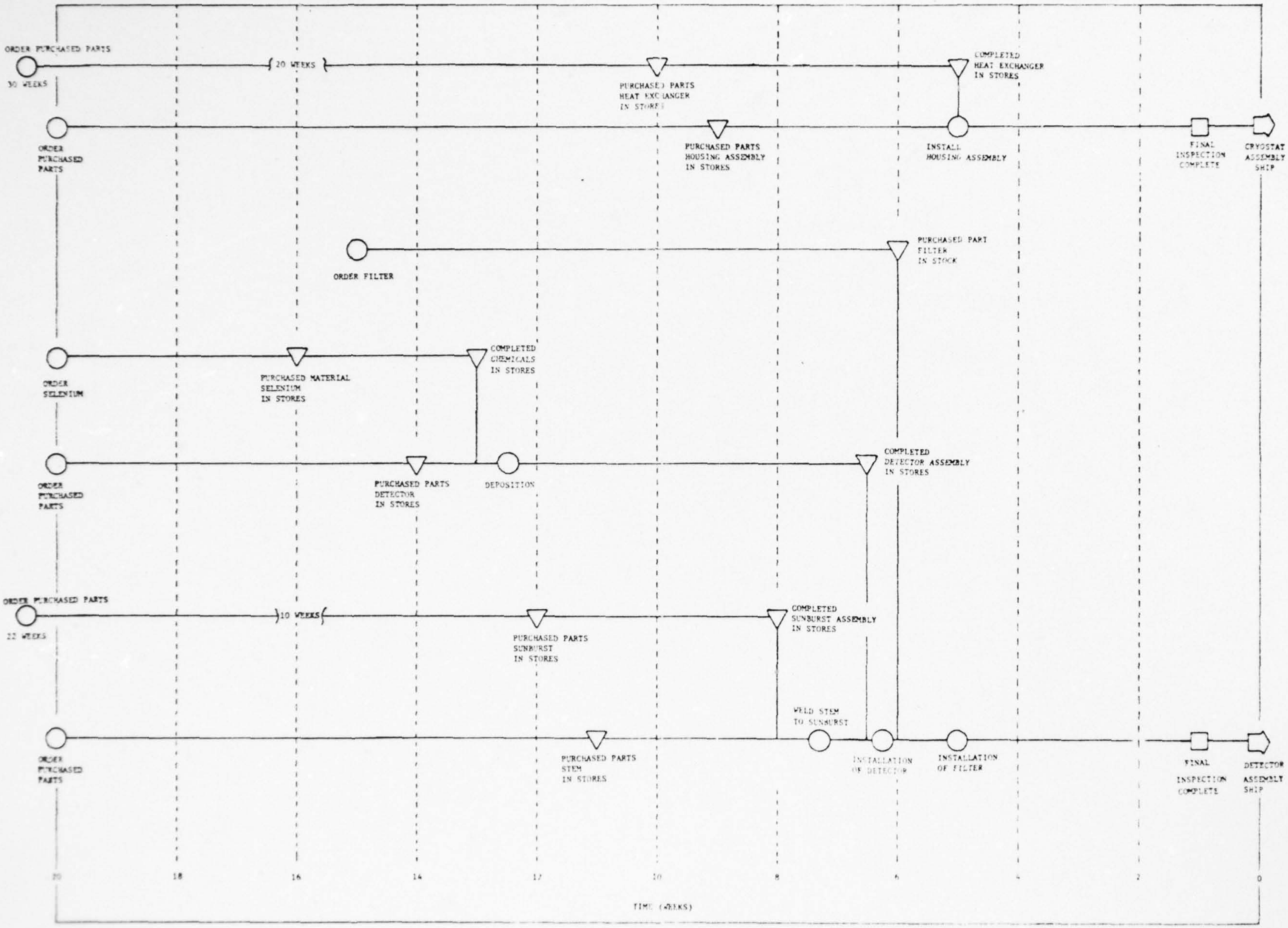
STEM ASSEMBLY, DEWAR
46945
(FROM PAGE 4)
WINDOW ASSEMBLY, DEWAR
46943
(FROM PAGE 4)
SUNBURST ASSEMBLY, DEWAR
46944
(FROM PAGE 3)
FILTER, BANDPASS
RECEIVING INSPECTION
FILTER, BANDPASS
ISSUE KIT 46926-400
CLEAN
VACUUM BAKE
INSPECT
PACKAGE
STOCK 46926-400
FILTER, BANDPASS
ARRAY, DETECTOR
(FROM PAGE 3)
HOLDER, FILTER
RECEIVING INSPECTION
STOCK 46946
HOLDER, FILTER
ISSUE KIT 46946-400
CLEAN
VACUUM BAKE
INSPECTION
PACKAGE
STOCK 46946-400
FILTER HOLDER
ISSUE KIT 46950
WELD STEM TO SUNBURST ASSEMBLY
LEAK CHECK
VACUUM BAKE
BOND LEADS(SUNBURST TO STRIPES)
CHECK ISOLATION
BOND DETECTOR ARRAY TO STEM
INSPECTION
WELD ARRAY LEADS
FLANGE, MOUNTING
STOCK 46949
FLANGE, MOUNTING
FLASH ADAPTER
FLASH ADAPTER
INSTALL PRELIMINARY COVER
PRELIMINARY TEST
FINAL CLEANING
WELD WINDOW ASSY. TO SUNBURST
LEAK CHECK
VACUUM BAKE, THERMAL CYCLE, CHECK
RESISTANCE, OUTGAS, FIRE GETTER
AND TIP-OFF
POST BAKE BLACKBODY TEST
DETECTOR ASSEMBLY, DEWAR
ISSUE KIT 46951
SERIALIZE MTG. FLANGE
BOND MOUNTING FLANGE
TO DETECTOR ASSY.
INSPECT
APPLY PIN REINFORCEMENT
APPLY BARRIER COAT
PRIME FLANGES
INSPECT
ENCAPSULATE SUNBURST
BOND FLASH ADAPTER
APPLY CONDUCTIVE CAULKING
APPLY CONDUCTIVE PAINT
APPLY VELVET PAINT
FINAL INSPECTION
FINAL ACCEPTANCE TEST
PACKAGE

Attachment B

MANUFACTURING SETBACK CHART

DESCRIPTION- DRAGON SETBACK CHART

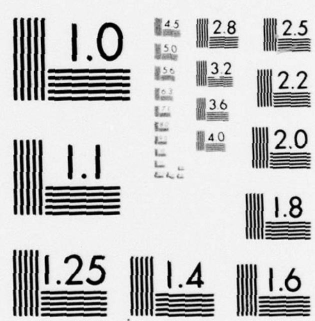
DATE- 10 DECEMBER 197-



ATTACHMENT 8

AD-A051 220 PHILIPS AUDIO VIDEO SYSTEMS CORP MAHWAH NJ GOVERNMEN--ETC F/G 17/5
ADVANCED PRODUCTION ENGINEERING (APE) NIGHT VISION SIGHT INFRAR--ETC(U)
DEC 75 DAAK02-73-C-0047
UNCLASSIFIED GSDR-817A-VOL-2 NL

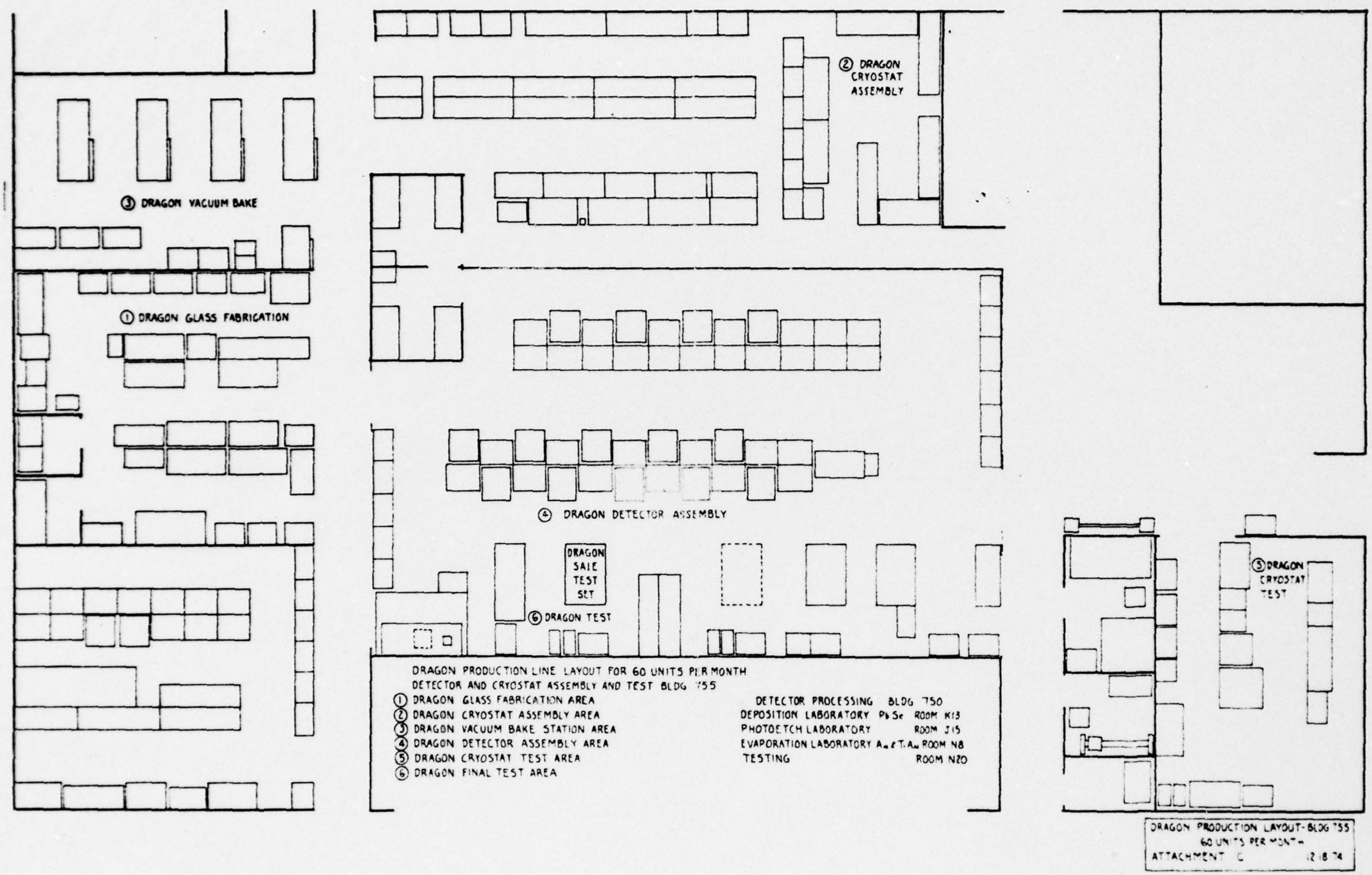
2 OF 2
AD
A051220



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Attachment C

PRODUCTION LINE LAYOUT



SCALE: 1 INCH = 13.7 FT.

SBRC

Attachment D

PILOT PRODUCTION SPECIAL TOOLING AND TEST EQUIPMENT

Attachment D

PILOT PRODUCTION SPECIAL TOOLING AND TEST EQUIPMENT

Item	Part Number	Description	Quantity	Application
1	MD32275C	Fixture, Stem Grinding	1	46945
2	MD32276C	Gauge, Stem	1	46945
3	MD32277A	Gauge, Run-Off	1	46945
4	MD32278C	Gauge, Length	1	46945
5	MD32301B	Fixture, Flange Holding	2	46945
6	MD32302A	Fixture, Stem and Closing	1	46945
7	MD32315A	Fixture, Stem Forming	1	46945
8	MD32316B	Fixture, Tip-Off Installation	1	46943
9	MD32317A	Die: Blank Shield	1	46948
10	MD32318A	Form Die-Shield	1	46948
11	MD32320A	Fixture, Leak Check	1	46943 46945, 46944
12	MD32324A	Fixture, Aluminize Window Assembly	1	46943
13	MD32325B	Fixture, Stem Assembly Striping	1	46945
14	MD32328B	Fixture, Heli-Arc Weld	1	46950
15	MD32344A	Flushing Station, Portable	1	45439 48898, 49106
16	MD32345A	Fixture, Trim Deflector	1	49106
17	MD32346A	Spot Weld Electrodes	1	49106
18	MD32347A	Adapter 5121 Connector to Disconnect	20	48898
19	MD32349A	Fixture, Lap Sleeve	1	48898
20	MD32350A	Fixture, Form Bridge	1	48898
21	MD32352A	Adapter Miniature Fitting to Purge Gland	4	48900
22	MD32354B	Form Die	1	48907
23	MD32355A	Fixture, Form Inlet Tube	1	49094
24	MD32357C	Fixture, Braze Charge Tube to Bellows Screw	1	48914

PILOT PRODUCTION SPECIAL TOOLING AND TEST EQUIPMENT

Item	Part Number	Description	Quantity	Application
25	MD32358 B	Fixture, Braze Mandrel Ring to Tube	1	48905
26	MD32359 B	Fixture, Swage Filter to Retainer	1	45439
27	MD32363 B	Window Sealing Block	1	46943
28	MD32364 B	Masking Disk	29	46943
29	MD32365 A	Fixture, Firing Rack	1	46945
30	MD32366 B	Fixture, Form Getter Wires	1	46944
31	MD32367 C	Fixture, Weld Shield to Flange	1	46944
32	MD32370 B	Fixture, Weld Platinum Wires to Feed Thru Pins	1	46944
33	MD32373 B	Fixture, Solder Wires to Stripes	2	46950
34	MD32374 A	Fixture, Weld Detector Leads to Stripes	1	46950
35	MD32377 A	Tubulation Mask, Aluminize Window	24	46943
36	MD32379 B	Fixture, Mount and Align Detector Array	1	46950
37	MD32381 C	Cover, Preliminary Window Assembly	3	46950
38	MD32382 B	Protective Cover, Sunburst Flange	31	46944
39	MD32383 C	Fixture, Pot Mounting Flange	5	46951
40	MD32384 D	Fixture, Potting Sunburst	5	46951
41	MD32385 C	Fixture, Mount Flask Adapter	5	46951
42	MD32386 A	Fixture, Mask Detector Assembly for Painting	1	46951
43	MD32388 A	Fixture, Check Isolation and Resistance	1	46944
44	MD32392 A	Fixture, Plate Feed Thru Pins	1	46944
45	MD32393 B	Fixture, Braze Adapter to Mandrel Tube	1	48905
46	MD32396 A	Fixture, Align Flange to Filter Holder	1	46951

PILOT PRODUCTION SPECIAL TOOLING AND TEST EQUIPMENT

Item	Part Number	Description	Quantity	Application
47	MD32398C	Fixture, Position and Solder Valve	1	49106
48	MD32402A	Mold, Pin Feed Thru	1	46944
49	MD32404B	Fixture, Press Filter Holder on Stem	1	46950
50	MD32411B	Fixture, Detector Height	1	46950
51	MD32412A	Fixture, Paint Mask	1	46951
52	MD32429A	R. F. Generator Coil	1	46944
53	MD32432A	Shroud, Inert Gas	1	46944
54	MD32434B	Spot Weld Electrodes	1	46944
55	MD32443B	Extension Split Electrode Welder	1	46950
56	MD32447A	Fixture, Solder Sleeve	1	48898
57	MD32448B	Protective Cover, Sunburst Stem Assembly	56	46950
58	MD32453A	Fixture, Hold Detector Assembly on Comparator	1	46950
59	MD32454A	Comparator Overlay, Detector Dewar Assembly	1	46950
60	MD32455A	Fixture, Hold Sunburst on Comparator	1	46944
61	MD32456A	Comparator Overlay, Sunburst Lead Position	1	46944
62	MD32458A	Ring Gage	1	46950
63	MD32461A	Go Gage I.D. 3 Places	1	48911
64	MD32462B	Fixture, Hold Housing on Comparator	1	48911
65	MD32463A	Comparator Overlay	1	48911
66	MD32465A	Fixture, Vacuum Holding	1	48964
67	MD32466A	Comparator Overlay	1	48964

PILOT PRODUCTION SPECIAL TOOLING AND TEST EQUIPMENT

Item	Part Number	Description	Quantity	Application
68	MD32467B	Fixture, Hold Flange on Comparator	1	46949
69	MD32468A	Comparator Overlay, Flange Mounting	1	46949
70	MD32469A	Fixture, Leak Check	1	45439
71	MD32470A	Fixture, Flow Rate	1	45439
72	MD32472A	Gauge, True Position	1	45461
73	MD32473B	Gauge, True Position	1	45440
74	MD32474A	Fixture, Inspect Runout	1	46944
75	MD32475A	Fixture, Check True Position	1	46943
76	MD32476A	Fixture, Vacuum Bake, Sunburst	6	46944
77	MD32477A	Fixture, Vacuum Bake Stem	6	46945
78	MD32478A	Fixture, Vacuum Bake, Window Housing	6	46943
79	MD32481A	Fixture, Final Leak Test	1	46950
80	MD32483A	Test Fixture	1	46951
81	MD32498A	Plug Gage, Outer Glass	1	46943
82	MD32503A	Hand Lap	6	47015
83	MD32504A	Glass Cleaning Rack	6	47015
84	MD32505A	Intermediate Electrode Mask	*	47015
85	MD32506A	Inner Electrode Mask	*	47015
86	MD32507A	Outer Electrode Mask	*	47015
87	MD32508A	Substrate Holder Metal Evaporation	60	47015
88	MD32510A	Inner Mask Holder	180	47015
89	MD32512A	Fixture, Bond Lead Wires	1	47015
90	MD32513A	PbSe Deposition Glass Ware	4	47015

*Consumable Tool

PILOT PRODUCTION SPECIAL TOOLING AND TEST EQUIPMENT

Item	Part Number	Description	Quantity	Application
91	MD32514A	Mask Aligner	1	47015
92	MD32515A	Photomask 66 Element	*	47015

*Consumable Tool

SBRC

Attachment E

PRODUCTION SPECIAL TOOLING AND TEST EQUIPMENT

Attachment E

PRODUCTION SPECIAL TOOLING AND TEST EQUIPMENT

Item	Part Number	Description	Quantity	Application
1	MD32275C	Fixture, Stem Grinding	1	46945
2	MD32302A	Fixture, Stem and Closing	1	46945
3	MD32315A	Fixture, Stem Forming	1	46945
4	MD32316B	Fixture, Tip-Off Installation	1	46943
5	MD32347A	Adapter 5121 Connector to Disconnect	20	48898
6	MD32352A	Adapter Miniature Fitting to Purge Gland	4	48900
7	MD32374A	Fixture, Weld Detector Leads to Stripes	1	46950
8	MD32381C	Cover, Preliminary Window Assembly	7	46950
9	MD32382B	Protective Cover, Sunburst Flange	31	46950
10	MD32383C	Fixture, Pot Mounting Flange	5	46951
11	MD32384D	Fixture, Potting Sunburst	5	46951
12	MD32385C	Fixture, Mount Flask Adapter	5	46951
13	MD32448B	Protective Cover, Sunburst Stem Assembly	56	46950
14	MD32476A	Fixture, Vacuum Bake, Sunburst	18	46944
15	MD32477A	Fixture, Vacuum Bake Stem	26	46945
16	MD32478A	Fixture, Vacuum Bake, Window Housing	36	46943
17	MD32503A	Hand Lap	6	47015
18	MD32504A	Glass Cleaning Rack	6	47015
19	MD32512A	Fixture Bond Lead Wires	1	47015

Attachment F

GOVERNMENT OWNED SPECIAL TOOLING AND TEST EQUIPMENT

Attachment F

GOVERNMENT OWNED SPECIAL TOOLING AND TEST EQUIPMENT

Primary ID Number	Item Description	Accountable Contract No.
93879000073	Fume Hood, Double	N00017-72-C-5506
USN 5648-74	Station, Lead Acetate Preparation	N00017-72-C-5506
USN 5648-80	Panel, Deposition Control	N00017-72-C-5506
USN(3090)19058	Tin Building (315)	N00017-72-C-5506
SA2197304	Station, Deposition	N00017-72-C-5506
USA 2490-A	Test Set, Hi-Low Temp	NAS 7-100 (JPL-953273)
MD31272	Test Station, High Pressure	PO 05-457073
MD31274	Test Station, Life and Thermal	PO 05-457073
MD31275	Test Station, Functional	PO 05-457073
MD30592-1	Fixture, Grind Spring to Length	PO 05-457073
MD31004-1	Gage, Indicator	PO 05-457073
MD31005-1	Gage, G-No-Go	PO 05-457073
MD31007-1	Fixture, Slotting	PO 05-457073
MD31008-1	Fixture, Winding	PO 05-457073
MD31009-1	Chart, Comparator	PO 05-457073
MD31012-1	Gage, Depth	PO 05-457073
MD31015-1	Gage, Concentricity	PO 05-457073
MD31016-1	Chart, Comparator	PO 05-457073
MD31019-1	Chart, Comparator	PO 05-457073
MD31021-1	Gage, Plug	PO 05-457073
MD31024-1	Chart, Comparator	PO 05-457073
MD31040-1	Fixture, Forming	PO 05-457073
MD31041-1 & -2	Fixture, Positioning	PO 05-457073
MD31042	Fixture, Positioning	PO 05-457073
MD31044-1 & -2	Fixture, Positioning	PO 05-457073

GOVERNMENT OWNED SPECIAL TOOLING AND TEST EQUIPMENT

Primary ID Number	Item Description	Accountable Contract No.
MD31046-1 & -2	Fixture, Positioning	PO 05-457073
MD31059-1	Fixture, Forming	PO 05-457073
MD31065-1 & -2	Fixture, Soldering	PO 05-457073
MD31067-1	Fixture, Tube Bending	PO 05-457073
MD31070-1	Fixture, Flow Rate	PO 05-457073
MD31072-1	Gage, Slot Position	PO 05-457073
MD31074-1	Fixture, Trim	PO 05-457073
MD31078-1	Fixture, Hone	PO 05-457073
MD31079-1	Fixture, Surge and Purge	PO 05-457073
MD31080-1	Heating Tube	PO 05-457073
MD31083-1	Fixture, Spring Winding	PO 05-457073
MD31087-1 & -2	Fixture, Vibration	PO 05-457073
MD31090-1	Fixture, Cutting	PO 05-457073
MD31099-1 & -2	Fixture, Soldering	PO 05-457073
MD31109-1	Fixture, Expanding	PO 05-457073
MD31110-1	Gage, Croystat	PO 05-457073
MD31111-1	Fixture, Pull	PO 05-457073
MD31113-1	Gage, Push Test	PO 05-457073
MD31119-1	Fixture Assembly	PO 05-457073
MD31129-1	Fixture, Gage	PO 05-457073
MD31144-1	Fixture, Purge and Flush	PO 05-457073
MD31147-1 & -2	Fixture, Bakeout	PO 05-457073
MD31149-1	Chart, Comparator	PO 05-457073
MD31165-1	Fixture, Solder	PO 05-457073

GOVERNMENT OWNED SPECIAL TOOLING AND TEST EQUIPMENT

Primary ID Number	Item Description	Accountable Contract No.
MD31166-1	Fixture, Test	PO 05-457073
MD31173-1	Fixture, Vacuum Manifold	PO 05-457073
MD31179-1	Fixture, Bubble Test	PO 05-457073
MD31197-1	Guide, Wire (1 pair)	PO 05-457073
MD31199-1	Fixture, Braze	PO 05-457073
MD31432-1	Gage, Spring	PO 05-457073
USAF-400283	Cryostat Cool (SBRC #49A)	05-457073-D-30
USAF-38106-52774	Optical Micrometer Fixture	05-457073-D-30
USAF-3512-31735	Vacuum Bake Station	F-34601-71-C-3333
USAF-3530-A	Vacuum Bake Station	F-34601-71-C-3333

SBRC

Attachment G

VENDOR TOOLING

Attachment G

LIST OF VENDOR TOOLING

Item	Property Identification No.	Description	Quantity	Application
1	SBRC-4625-46933-1	Draw Die	1	46933
2	SBRC-4625-46933-2	First Trim Fixture	1	46933
3	SBRC-4625-46933-3	Second Trim Fixture	1	46933
4	SBRC-4625-46933-4	Pilot Trim Die	1	46933
5	SBRC-4625-46934-1	Draw Die	1	46934
6	SBRC-4625-46934-2	First Lathe Fixture	1	46934
7	SBRC-4625-46934-3	Second Lathe Fixture	1	46934
8	SBRC-4625-46935-1	First Draw Die	1	46935
9	SBRC-4625-46935-2	Second Draw Die	1	46935
10	SBRC-4625-46935-3	Pilot Trim Die	1	46935
11	SBRC-4625-46935-4	First Lathe Fixture	1	46935
12	SBRC-4625-46935-5	Second Lathe Fixture	1	46935
13	SBRC-4625-48896	Insert Cavity Mold	1	48896

Attachment H

CONFIGURATION MANAGEMENT PLAN

Attachment L

SANTA BARBARA RESEARCH CENTER

A Subsidiary of Hughes Aircraft Company

75 COROMAR DRIVE • GOLETA, CALIFORNIA 93017

TELEPHONE: 968-3511

CONFIGURATION MANAGEMENT PLAN

FOR

DETECTOR ASSEMBLIES

AND

CRYOSTAT ASSEMBLIES

For Use In The

ADVANCE PRODUCTION ENGINEERING MODEL

OF THE

AN/TAS-3 INFRARED NIGHT VISION SIGHT

15 APRIL 1974

PBEC Contract No. 09772

Prime Contract No. DAAK02-73-C-0047

SBRC W/A 4625 - Dragon APE

Revised 5/23/74

Prepared by J. B. Watson
J. B. Watson
Configuration Management Office

Approved by C S Tallman
Charles S. Tallman
Project Manager

Configuration Management Plan
PBEC Contract No. 09772
Prime Contract No. DAAK 02-73-0047
SBRC W/A 4625 - Dragon APE

REVISION NOTICE

REVISION	DATE	DESCRIPTION	APPROVAL
1	5/23/74	Added marked paragraph to section 5.4 per PBEC TWX MV 2008	[signature]

1. INTRODUCTION

This plan describes the Santa Barbara Research Center (SBRC) configuration management organization, and establishes the configuration management requirements and practices for the Dragon Night Sight Detector and Cryostat Assemblies.

2. APPLICABLE DOCUMENTS

The following documents of the exact issue shown form a part of this plan to the extent specified herein:

SPECIFICATIONS

USAECOM

C2a2302-01011010A-1	Critical Item Product Function Specification for Detector of Night Vision Sight, Infrared AN/TAS-3
C2a2302-01011020A-1	Critical Item Product Function Specification for Cryostat of Night Vision Sight, Infrared AN/TAS-3

DRAWINGS

USAECOM

SM-D-770349E	Detector, Infrared
SM-A-649902AA	Detector Array (U)
SM-D-649252AB	Cryostat Assembly, Specification Control Drawing

The following SBRC documents of latest approved issue form a part of this plan to the extent specified herein:

Dragon Night Sight Detector Assembly Configuration List (ACL-46951)

Dragon Night Sight Cryostat Assembly Configuration List (ACL-45438)

3. ORGANIZATION AND RESPONSIBILITIES

The Configuration Management Office (CMO) at SBRC is an administrative office within the Mechanics Section of the Santa Barbara Laboratory. The CMO has the responsibility for configuration management of SBRC projects in accordance with the SBRC Configuration Management Directives (CMD) Manual, the SBRC Engineering Procedures (EP) Manual, and requirements defined by the SBRC Project Manager and established by Customer approval of the SBRC Configuration Management Plan.

Instructions for implementation of the SBRC Configuration Management Plan are prepared by the CMO and approved by the Project Manager. The CMO monitors all project activities for proper implementation of approved configuration management instructions.

4. CONFIGURATION IDENTIFICATION

4.1 Configuration Baselines

The configuration baselines for the Dragon Night Sight Detector and Cryostat Assemblies are established by the USAECOM specifications and drawings called out in paragraph 2. These configuration baselines are further defined by SBRC prepared and controlled engineering drawings, specifications and assembly configuration lists (ACL). Acceptance of the Validation Models by PBEC shall establish the Product Baselines for the Detector and Cryostat Assemblies.

4.2 Identification Numbers

Engineering documentation prepared by SBRC shall be assigned identification numbers in accordance with established SBRC drafting room practice (SBRC drafting room practice satisfies the essential requirements of MIL-STD-100A). The Detector and Cryostat Assemblies manufactured by SBRC shall be identified as required by USAECOM drawings. SBRC components and other SBRC hardware shall be identified by the corresponding SBRC engineering drawing numbers. Commercial/vendor equipment shall be identified by the commercial/vendor numbers when used as is, and by SBRC assigned numbers when modified or screened by SBRC. Government and industry standard items shall retain their standard identification numbers.

4.3 Documentation Preparation and Release

SBRC drawings for the Detector and Cryostat Assemblies shall be prepared in accordance with SBRC standard practice (USAMC DI-E-1118 will be used as a guide). Marked up ET/EST (Ref. PBEC P.O. 4626 & 6200) drawings may be used to define the validation model configurations. Each item of SBRC engineering documentation and each item of customer furnished engineering documentation shall be controlled in accordance with established SBRC engineering data control procedures. The Engineering Document Control Center (EDCC) at SBRC shall release and maintain records of release of all engineering documentation including initial release, release of change information, and release of revised documentation.

Regular and reproducible copies of all engineering documentation and revisions shall be furnished to PBEC per requirements specified in sequence numbers A017 and A018 of the DRAGON/APE Contract Data Requirements List (CDRL), except for proprietary processes.

SBRC will utilize processes and procedures proprietary to SBRC. Therefore, SBRC will not provide any data or information concerning the following items.

1. The process procedures and chemistry utilized to fabricate the lead salt film detectors, including chemicals used, photoetching, electroding and sensitizing of lead salt films.

2. The process for producing miniature finned heat exchanger tubing such as that used in the Joule-Thomson cryostat.

5. CONFIGURATION CONTROL

Each proposed engineering change to the Detector and Cryostat Assemblies shall be reviewed, evaluated, and classified by SBRC as a Class I or Class II change in accordance with the following change classification criteria. This review and classification by SBRC applies to changes proposed by PBEC as well as to changes proposed by SBRC. Changes classified as Class I by SBRC are subject to reclassification as Class II changes by PBEC with concurrence of the SBRC Project Manager.

Attached is an SBRC Change Flow Diagram which graphically describes the basic procedure for processing requested changes to Engineering documentation.

5.1 Class I Engineering Change

Proposed engineering changes shall be classified as Class I by SBRC whenever one or more of the following is affected:

a) Increase in Costs and/or Delay in Schedules

b) USAECOM Specifications, C2a2302-01011010A-1 and C2a2302-01011020A-1

c) USAECOM Drawings SM-D-770349, SM-A-649902, and SM-D-649252

5.2 Class II Engineering Changes

Engineering changes not classified as Class I in accordance with Class I criteria shall be classified as Class II engineering changes.

5.3 Class I Change Procedure

Proposals for changes classified as Class I by SBRC shall be processed in accordance with established SBRC engineering data control procedures and shall be submitted to PBEC along with estimated cost and schedule data for further evaluation and disposition. After this evaluation, PBEC shall direct one of the following courses of action:

a) Continued processing of the change as a Class I change and coordination of ECP preparation with SBRC: Incorporation of Class I changes shall be held in abeyance by SBRC pending approval of the ECP by PBEC and authorization of funding and schedule adjustments.

b) Reclassification and approval of the change for processing and incorporation as a Class II change.

c) Rejection of the change.

d) Modification of the proposed change to accomplish approval.

Unless otherwise directed by PBEC within 15 calendar days after submittal of a Class I change, SBRC will assume the change to be acceptable as a Class I change and will initiate further ECP processing action.

5.4 Class II Change Procedure

Class II changes shall be processed in accordance with established SBRC engineering data control procedures. Processing and incorporation of Class II engineering changes shall be the responsibility of the SBRC Project Manager.

PBEC shall be advised of all Class II changes by copy of the SBRC Engineering Change Notice. Copies of the revised drawings shall also be submitted to PBEC in accordance with CDRL items A017 and A018. (1)

6. CONFIGURATION ACCOUNTABILITY

6.1 Assembly Configuration List (ACL)

SBRC shall prepare and maintain a Detector Assembly Configuration List (ACL) and a Cryostat ACL. The ACL is an indentured drawing list that includes drawing revision letters to reflect the current status of released drawings. ACL's shall be prepared in accordance with established SBRC procedures.

6.2 Assembly History Record Sheets (AHRS)

For each manufactured unit, SBRC shall prepare a Manufacturing Planning Sheet which consists of a list of material (part numbers with revision status), a list of operations with operation numbers, responsible department and a brief description of each operation. Inspection operations are included. Each operation is controlled by a Manufacturing or Inspection Procedure. The reverse side of the Manufacturing Planning Sheet is the Assembly History Record Sheet. Each operation is entered on the AHRS when performed and signed by the operator or inspector as appropriate. An analogous record is maintained by Receiving Inspection.

Each Inspection operation is controlled by a procedure describing (as appropriate) the part numbers with revision status, which parameters are to be measured and what the acceptable parameter values must be.

These records will be preserved at SBRC for a period of not less than two years.

6.3 Audit

A Functional Configuration Audit (FCA) and/or a Physical Configuration Audit (PCA) is a comparison of the ACL and AHRS data packages discussed above. SBRC will assist PBEC in conducting these audits of the APE models. Five working days notice is required.

SBRC

EP NO. 1 PAGE 5

SUBJECT: ENGINEERING DATA CONTROL

DATE 10-11-61 REVD. 7-7-70

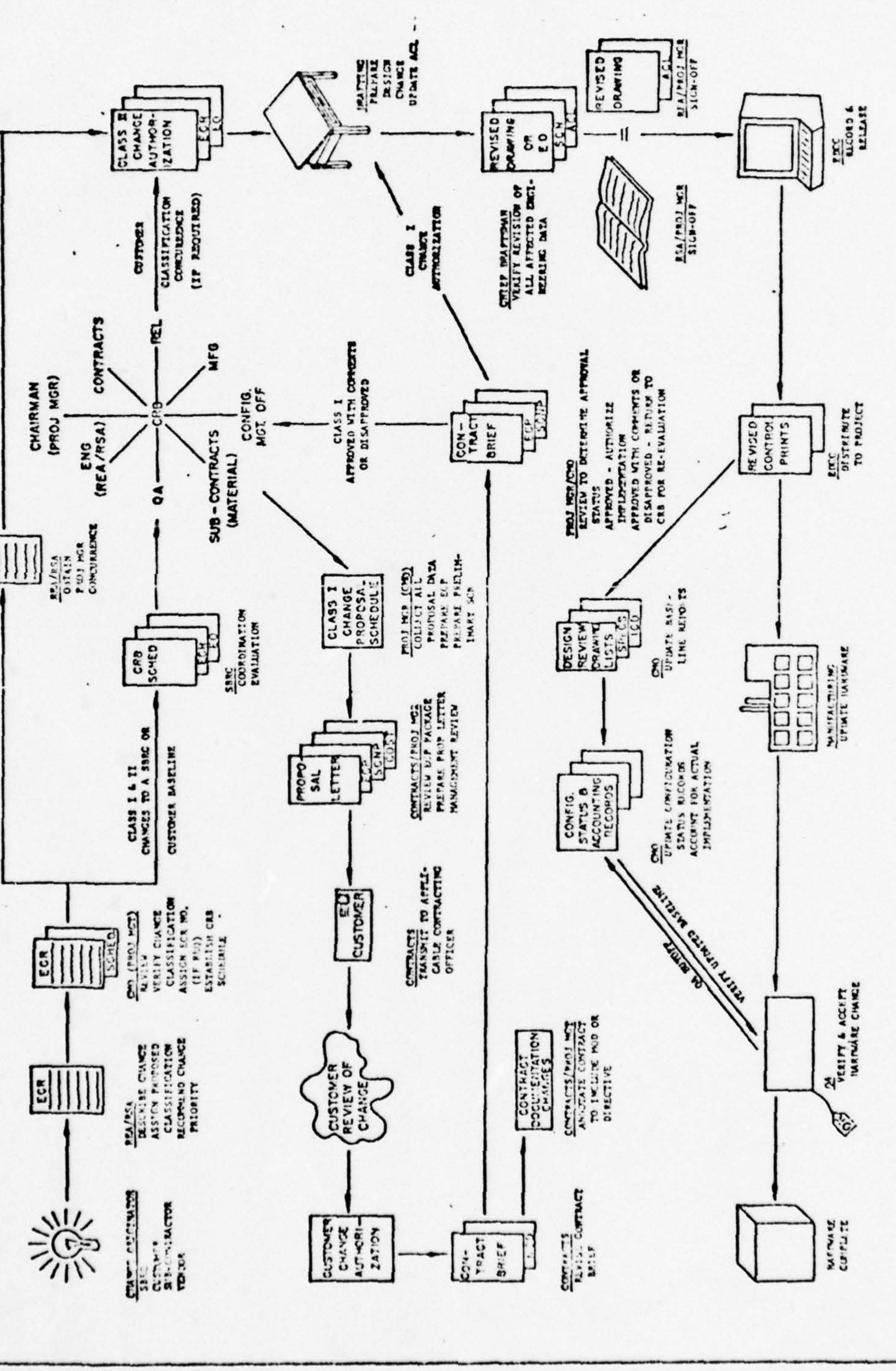


FIGURE 1 - SBRC CHANGE FLOW

Attachment I

APPLICABLE CODE 7 QUALITY TASKS SUMMARY

Attachment I

HUGHES

HUGHES AIRCRAFT COMPANY

SBRC

NO 7/SYS

QUALITY

DATE January 1974

SANTA BARBARA RESEARCH CENTER

SUBJECT QUALITY CODE LEVEL SBRC 7/SYS - Hughes PRD/SYS
RELATED TO PHASE OF DESIGN DEVELOPMENT AND APPLICABLE QUALITY SYSTEM
IN ACCORDANCE WITH QUALITY ASSURANCE PRACTICE 1.7

Production Model - (MIL-STD-280A)

An item in its final form of final production design made by production tools, jigs, fixtures and methods. It employs standard parts (or nonstandard parts approved by the agency concerned).

Quality Code Level 7/SYS complies with ASPR 14-101.3 and MIL-I-45208.

Applicable Quality Tasks (as established by SBRC Quality Assurance Practices)

Documented quality system and organization.
Test equipment calibration to MIL-C-45662.
Procurement document screening for quality requirements.
Final acceptance and shipping inspection.
Internal audits of quality system.
Supplier evaluation/control based on quality history.
Process controls to applicable specifications.
Liaison with customer Quality Assurance.
Control/protection of customer furnished property.
Quality program planning (requirements summary).
Receiving inspection and test.
Maintenance of inspection and test records.
Identification of inspection status for work in process.
Obtain customer quality acceptance as required.
Assure applicable data used for fabrication/inspection/test.
Assure that standard parts, or nonstandard parts approved by the agency concerned are employed (final advanced development and later models only).
Prepare inspect/test instructions and accept/reject criteria.
Fabrication, assembly, test and inspection to released engineering data.
Material and process control. Utilize control procedures if process inspection is required.
Control of nonconforming supplies by MRB.
Submit sampling plans not specified by contract for customer approval.

For NHB 5300.4 (1C) add:

Control of production tooling used as media of inspection.
Training and certification.
Configuration verification.
Screening of manufacturing work instruction.

SBRC

Attachment J

MANUFACTURING INDENTURED PARTS LIST -
DETECTOR ASSEMBLY

ATTACHMENT J

PREPARED BY	DATE		DOCUMENT NO.
W.E. Sauer	6/13/75	[SBRC] SANTA BARBARA RESEARCH CENTER A SUBSIDIARY OF HUGHES AIRCRAFT CO. MANUFACTURING INDENTURED PARTS LIST	MIPL 46951
APPROVED, ENG.	DATE		DWG. REV. C / PROC CODE 43 / DIST. CODE - / M.I. -
D.D. Lindhm	6/13/75		DOC. REV. 1 / REL. DATE / REL. BY
APPROVED, Q.A.	DATE	TITLE	PLANNING EFFECTIVITY
R.W. McCollum	6/13/75	Detector Assembly	46951 SER NO. 101 and SUBQ.
APPROVED, MFG.	DATE		
R.E. Wood	6-13-75		

ITEM	PART NUMBER	IND.	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC. CODE	Attrition Factor	STD. COST PER 100 MAT. COST & HRS.		CLASS	CAT
	46951	1	Detector Assembly	1	ea	Make	1.0				
	46949	2	Flange, Mounting	1	ea	Buy	1.15				
	46950	2	Detector Assembly, Dewar	1	ea	Make					
	46943	3	Window Assembly, Dewar	1	ea	Make					
		4	Glass, Type 7520, .73 ± .01 O.D. x .66 ± .01 I.D.	.5	in	Buy	2.5				
		4	Glass, Type 7052, .73 ± .01 O.D. x .66 ± .01 I.D.	.5	in	Buy	2.5				
	3244	4	Window (Insaco)	1	ea	Buy	1.15				
		4	Glass, Type 7052, .16 ± .01 OD. x .03 ± .01 Wall	1.5	in	Buy	2.5				
	46933-402	4	Flange, Window Assembly	1	ea	Make	1.30				
	46933	5	Flange, Window	1	ea	Buy	1.30				
		5	Glass, Type 7052, .73 + .01 O.D. x .65 + .01 I.D.	1	in	Buy	2.5				
	46933-401	6	Flange, Window	1	ea	Make	1.30				
	46933-400	7	Flange, Window	1	ea	Buy	1.30				
		4	Aluminum, Pure	A/R		Buy					

SBRC – 0186-1

ITEM	PART NUMBER	NO.	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC. CODE	Attrition Factor	STD. COST PER UNIT MAT COST & HRS		CLASS	CAT
	46944	3	Sunburst Assembly	1	ea	Make	1.40				
	46934-402	4	Flange, Sunburst	2	ea	Make	1.40				
		5	Glass, Corning, 22 mm I.D. Std Wall, Type 7052	2	in	Buy	2.5				
	46934	5	Flange, Sunburst	2	ea	Buy	1.40				
	46934-401	6	Flange, Sunburst	2	ea	Make	1.40				
	46934-400	7	Flange, Sunburst	2	ea	Buy	1.40				
	48831	4	Terminal, Feedthru	68	ea	Buy	1.75				
	48831-401	5	Terminal, Feedthru	68	ea	Make	1.75				
	48831-400	6	Terminal, Feedthru	68	ea	Buy	1.75				
		4	Immersion Gold Plating Solution	A/R		Buy					
	46948	4	Getter Shield	1	ea	Make	1.25				
	46948-400	5	Getter Shield	1	ea	Buy	1.25				
	Type 697	4	Getter (Union Carbide)	1	ea	Buy	1.60				
		4	Wire, .002 Dia Platinum	41	in	Buy	1.60				
	46945	3	Stem Assembly, Dewar	1	ea	Make	1.40				
		4	Glass, Type 7052, .43 $\pm$ .01 O.D. x .3258/.3262 I.D.	3	in	Buy	2.5				
	46935-402	4	Flange, Stem	1	ea	Make	1.40				

[SBRC] MANUFACTURING INDENTURED PARTS LIST

DOCUMENT No. MIPL 46951 | DOC. REV. 1 |

ITEM	PART NUMBER	NO.	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC CODE	Attrition Factor	STD COST PER ... MAT COST & HRS		CLASS	CAT
		5	Glass, Type 7052, 18 mm	1	in	Buy	2.5				
			± .3 mm O.D., Std. Wall								
	46935	5	Flange, Stem	1	ea	Buy	1.40				
	46935-401	6	Flange, Stem	1	ea	Make	1.40				
	46935-400	7	Flange, Stem	1	ea	Buy	1.40				
	No. 7713	4	Paint, Silver, Conductive	1	oz	Buy					
			(E.I. Dupont Denemours								
			& Co., Inc.)								
	46946-400	3	Filter Holder	1	ea	Make	1.10				
	46946	4	Filter Holder	1	ea	Buy	1.10				
	46926	3	Filter, Bandpass	1	ea	Buy	1.15				
	No. 7031	3	Varnish (General Electric	A/R		Buy					
			Co., Code Ident. 08800)								
	47015	3	Array, Detector	1	ea	Make	1.10				
	47015-99	4	Substrate, Detector	1	ea	Buy	2.25				
			(Crystal Quartz, .375 +								
			.002 Dia., .006 + .004-								
			.001 Thick, Main Surfaces								
			cut perpendicular within								
			± 5 Degrees to Z axis,								
			free of seed interfaces,								
			crystal Twinning or other								
			physical irregularities)								
		4	Wire, Gold, .002 Dia.,	3.5	ft	Buy	2.0				
			99.99% Pure, 0.5% to								
			1.5% Elongation								

[SBRC] MANUFACTURING INDENTURED PARTS LIST	DOCUMENT No. MIPL 46951	DOC. REV. 1	PAGE 4 OF 5

ITEM	PART NUMBER	NO	DESCRIPTION	END ITEM		PROC CODE	Attrition Factor	STD COST PER 100			
				QTY	UNIT			MAT COST & HRS		CLASS	CAT
	47015-98	4	Substrate, Buffer	1	ea	Make					
	No. 0211	5	Cover Glass, .030 Thick (Corning Glass Works, Code Ident 14674)	.25	in	Buy					
	No. 7031	4	Varnish (General Elect. Co., Code Ident. No. 08800)	A/R		Buy					
	No. 3	3	Solder, Indalloy	.1	oz	Buy					
	45440	2	Flask, Adapter	1	ea	Buy	1.10				
	1332	2	Barrier Coating (Dow Corning)	A/R		Buy					
	No. 92-019	2	Primer (Dow Corning)	.1	oz	Buy					
	Epon 828	2	Epoxy Resin (Shell Chem Co.)	.1	oz	Buy					
	No. 140	2	Polyamide Resin, Versamide (Gen Mills)	.1	oz	Buy					
		2	Colloidal Silica, Cab-O-Sil, (Cabot Corp Boston)	A/R		Buy					
	72-0005	2	Adhesive, Conductive (Technical Wire Products)	A/R		Buy					
	72-00025	2	Paint, Conductive (Technical Wire Products)	A/R		Buy					
	No. 101-C10	2	Black Air Dry Enamel (3M Co.)	A/R		Buy					

[SBRC] MANUFACTURING INDENTURED PARTS LIST	DOCUMENT No. MIPL 46951	DOC. REV. 1	PAGE 5 OF 5

ITEM	PART NUMBER	NO.	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC CODE	Attrition Factor	STD. COST PER UNIT MAT COST $/HRS		CLASS	CAT
	90-072	2	Potting Material (Dow Corning Corp.)	A/R		Buy					

SBRC 0186-2

SBRC

Attachment K

MANUFACTURING INDENTURED PARTS LIST - CRYOSTAT ASSEMBLY

ATTACHMENT K

PREPARED BY	DATE		DOCUMENT NO.
W.D. Sauer	6/13/75	[SBRC] SANTA BARBARA RESEARCH CENTER, A SUBSIDIARY OF HUGHES AIRCRAFT CO	MIPL 45438
APPROVED, ENG.	DATE	MANUFACTURING INDENTURED PARTS LIST	DWG. REV: G; PROC CODE: 43; DIST. CODE: -; M.I.: --
[signature]	6/13/75		DOC. REV.: 1; REL. DATE: ; REL. BY:
APPROVED, Q.A.	DATE	TITLE	
R.W. McCollum	6/13/75	Cryostat Assembly, Dragon	PLANNING EFFECTIVITY
APPROVED, MFG.	DATE		
[signature]	6-13-75		S/N 1001 & Up

ITEM	PART NUMBER	IND.	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC. CODE	Attrition Factor	STD. COST PER 100 MAT. COST & HRS.		CLASS	AT
1	45438-460	1	Cryostat Assy., Dragon	1	ea	Make	1.0				
2	5 - 134	2	O-Ring (Parker Seal Co., Code Ident No. 03818)	1	ea	Buy					
3	49106	2	Cryostat Assembly	1	ea	Make	1.0				
4		3	Thread, Star Ultra Dee, Polyester Fiber, Silicote Finish, #12 Left (Z) Twist, Natural	A/R	sp	Buy					
5		3	Thread, Star Ultra Dee Polyester Fiber, Silicote Finish, #16 Left (Z) Twist, Natural	A/R	sp	Buy					
6		3	Thread, Star Ultra Dee, Polyester Fiber, Silicote Finish, #24 Left (Z) Twist, Natural	A/R	sp	Buy					
7	48896	3	Deflector	1	ea	Buy	1.15				
8		3	Cement, Standard SUC 51645, Unbreakable Watch Crystals, Inc.	A/R	tu	Buy					
9		3	Solder, Sn63 WS per QQ-S-571	A/R	lb	Buy					
10		03	Allen Solder Paste	A/R	lb	Buy					

SBRC-0186-1

[SBRC] MANUFACTURING INDENTURED PARTS LIST	DOCUMENT No. MIPL - 45438	DOC. REV. 1	PAGE 2 OF 7

ITEM	PART NUMBER	NO	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC CODE	Attrition Factor	STD COST PER 100 MAT COST & HRS		LASS	CAT
11		3	Loctite Retaining Compound #75	A/R	oz	Buy					
12		3	Primer, Locquic Grade N	A/R	oz	Buy					
13	48897-400	3	Valve, Needle	1	ea	Make	1.50				
14		4	.010 Wire, 302 Cres, Condition B per QQ-W-42	A/R	lb	Buy					
15		4	Solder, Sn60 or 63 WS per QQ-S-571, .031 Dia	A/R	lb	Buy					
16		04	Flux, Kester #817	A/R	oz	Buy					
17	48908	3	Housing Assembly	1	ea	Make	1.20				
18	MPD 1003	4	Adhesive, GA47LV Epoxy	A/R	tu	Buy					
19	MPD 1004	4	Adhesive, Armstrong A-12 Epoxy, 3 parts A to 2 parts B, premixed, frozen, 1 cc tube	A/R	tu	Buy					
20		4	Gas Freon 14	A/R	cf	Buy					
21		4	Solder, Sn63 WS, .010 Dia. per QQ-S-571	A/R	lb	Buy					
22		04	Allen Solder Paste	A/R	lb	Buy					
23		4	Solder, Kester Sn63, 44 Resin Flux, Core 66, .010 Dia.	A/R	lb	Buy					
24	48912	4	Bellows, Sealing	1	ea	Buy	2.00				

ITEM	PART NUMBER	NO	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC. CODE	Attrition Factor	STD. COST PER 100 MAT COST $/HRS		CLASS	CAT
25	48910	4	Rod, Valve	1	ea	Make	1.40				
26	48964	5	Rod, Retainer	1	ea	Buy	2.00				
27	48909	4	Spring, Bellows	1	ea	Make	1.15				
28		5	Wire $.0120^{+.0000}_{-.0002}$ Dia. Cres 302/304 Condition B per QQ-W-423	A/R	lb	Buy					
29	48911	4	Housing	1	ea	Buy	1.85				
30	48913	4	Seal, Bellows	1	ea	Make	1.15				
31		5	Naval Brass, Alloy 464 or 485, 1/2 hard, .015 thick per QQ-B-637	A/R	lb	Buy					
32	48914	4	Bellows Assembly	1	ea	Make	1.40				
33	48891	5	Screw, Bellows	1	ea	Buy	2.45				
34	48915	5	Bellows	1	ea	Buy	3.00				
35	48914 - 99	5	Charge Tube	1	ea	Make	1.90				
36	MPD - 1046	6	Tube CuNi	A/R	ft	Buy					
37		5	Solder, Sn63 WS per QQ-S-571, .015 Dia	A/R	lb	Buy					
38		05	Flux, No. 30 Supersafe, Superior Flux and Manufacturing Company	A/R	oz	Buy					

[SBRC] **MANUFACTURING INDENTURED PARTS LIST**

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ITEM	PART NUMBER	NO	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC CODE	Attrition Factor	STD COST PER 1K MAT COST $		CLASS	CAT
39		05	Flux, Lonco #5170	A/R	oz	Buy					
40		5	Silver-Solder, Easy-Flo			Buy					
			45 .010 Dia	A/R	lb						
41		05	Silver Solder Flux,			Buy					
			Handy Flux Type B-1	A/R	16						
42	48898	3	Heat Exchanger Assy	1	ea	Make	1.20				
43		4	Solder, Ag 1.5 WS per								
			QQ-S-571, .032 Dia	A/R	lb	Buy					
44		4	Solder, Sn96 WS per								
			QQ-S-571, .032 Dia	A/R	lb	Buy					
45		4	Solder, Sn60 WS per								
			QQ-S-571, .015 Dia	A/R	lb	Buy					
46		4	Solder, Sn63 WS per								
			QQ-S-571, .015 Dia	A/R	lb	Buy					
47		04	Allen Solder Paste	A/R	lb	Buy					
48		04	Kester #817 Flux	A/R	oz	Buy					
49		4	Wire Per QQ-S-343, Type S								
			32 AWG, Tinned, Soft	A/R	in	Buy					
50		4	Thread, Star Ultra Dee,								
			Polyester Fiber, Silicote								
			Finish, #24 Left (Z)								
			Twist, Natural	A/R	sp	Buy					
51		04	.0115 Dia Aluminum Wire	A/R	lb	Buy					
52	48899-461	4	Sleeve, Orifice	1	ea	Buy	2.25				

SBRC 0186-2

[SBRC] MANUFACTURING INDENTURED PARTS LIST

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Item	Part Number	NO	Description	End Item Qty	End Item Unit	Proc Code	Attrition Factor	Std Cost Per Unit: Mat Cost & OHS		Labor	Cat
52.5	48899-460	5	Sleeve, Orifice, Unplated	1	ea	Buy	2.25				
53		6	Tube, .0310 ±.0005 O.D. x								
			.0215 ± .0005 I.D., 416								
			Cres Per QQ-S-764	A/R		Buy					
54	48900	4	Tube-Finned	1	ea	Make	1.43				
55		05	Allen Solder Paste	A/R	lb	Buy					
56		5	Eutec-Tin Weld #3	A/R	lb	Buy					
57	48900-98	5	Tinned Copper Ribbon	A/R	ft	Buy					
58	MPD-1046	5	Tubing, CuNi	A/R	ft	Buy					
59	48905	4	Mandrel Assy	1	ea	Make	1.25				
60	48905-99	5	Mandrel Tube	1	ea	Make	1.30				
60.1		6	Tube, CRES 304, seamless,	3	in	Buy	1.40				
			full hard .2448 +.0000/-.0020								
			O.D. x .2328 ±.0005 I.D.								
61	48906	5	Adapter, Housing	1	ea	Buy	2.25				
62	48907	5	Ring, Mandrel	1	ea	Make	2.40				
63	48907-400	6	Mandrel Ring Blank	1	ea	Buy	2.50				
63.5			Ag 1.5 Solder per	A/R		Buy					
			QQ-S-571, WS, .032 Dia.								
64		5	Silver Solder, Easy-Flo								
			#45, .010" Dia	A/R	lb	Buy					
65		5	Silver Solder, Easy-Flo								
			#45, .031" Dia	A/R	lb	Buy					
66		05	Brazing Flux, Handy								
			Brazing Flux, Type B-1	A/R	lb	Buy					
66.1			Solder, Sn 60 WS per	A/R	lb	Buy					
			QQ-S-571, .015 Dia.								
66.2			Flux, Kester #817	A/R	oz	Buy					
67	49103	4	Filter Assembly	1	ea	Make	1.10				

[SBRC] MANUFACTURING INDENTURED PARTS LIST	DOCUMENT No. MIPL 45438	DOC. REV. 1	PAGE 6 OF 7

ITEM	PART NUMBER	NO.	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC CODE	Attrition Factor	STD COST PER: MAT COST		CLASS	CAT
68	45441	5	Cryostat Retainer	1	ea	Buy	1.15				
69	45474	5	Retainer Spring	1	ea	Buy	1.80				
70		5	Solder, Sn63 WS								
			per QQ-S-571, .015 Dia	A/R	lb	Buy					
71		5	Solder, Sn96 WS per								
			QQ-S-571, .032 Dia	A/R	lb	Buy					
72		05	Flux, Kester #817	A/R	oz	Buy					
73	48893- 400	5	Adapter Cap Assy	1	ea	Make	1.15				
74	48893-460	6	Adapter Cap Assy,								
			Brazed	1	ea	Buy	1.20				
75	48894	7	Adapter	1	ea	Buy	1.20				
76	45461	7	Cap, Adapter	1	ea	Buy	1.20				
77	45458	7	Nipple	1	ea	Buy	1.20				
78	D2-093	7	Pin, Dowel (PIC Design	1	ea	Buy	1.20				
			Corp., Code Ident #00141)								
79	45439-460	5	Filter Sub-Assembly,								
			Brazed	1	ea	Buy	1.20				
80	45439-400	6	Filter Assy, Assembled	1	ea	Make	1.20				
81	49094	7	Tube, Inlet	1	ea	Make	1.20				
82		8	Tubing, Type 304 cres								
			Per Mil-T-8504, .0220								
			$^{+.0005}_{-.0000}$ O.D. x								
			.0120 $^{+.0000}_{-.0005}$ I.D.	A/R	ft	Buy					

[SBRC] MANUFACTURING INDENTURED PARTS LIST

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ITEM	PART NUMBER	NO.	DESCRIPTION	END ITEM QTY	END ITEM UNIT	PROC CODE	Attrition Factor	STD COST PER EA MAT COST $/HRS		CLASS	CAT
83	48904	7	Filter, Gas	1	ea	Buy	1.20				
84	43605	7	Retainer, Filter	1	ea	Buy	1.20				
85	45437	7	Filter, Body	1	ea	Buy	1.20				

Prepared for:
United States Army Mobility Equipment
Research and Development Center
R&D Procurement Office
Fort Belvoir, Virginia 22060

Authorization:
Contract No.: DAAK02-73-C-0047

CDRL No. A022

APPENDIX C
TO
FINAL REPORT
ADVANCED PRODUCTION ENGINEERING (APE)
NIGHT VISION SIGHT INFRARED, AN/TAS-3()

SBRC
SAIE OPERATION AND CALIBRATION MANUAL

GOVERNMENT SYSTEMS DIVISION
PHILIPS AUDIO VIDEO SYSTEMS CORP.
91 McKEE DRIVE, MAHWAH, N. J. 07430
TEL: 201-529-3800 TWX: 710-988-5343
A NORTH AMERICAN PHILIPS COMPANY

SANTA BARBARA RESEARCH CENTER

A Subsidiary of Hughes Aircraft Company

75 COROMAR DRIVE . GOLETA . CALIFORNIA

DRAGON
SPECIAL ACCEPTANCE INSPECTION EQUIPMENT
OPERATION AND CALIBRATION
MANUAL

SBRC P/N 15573

For Use with SAIE, SBRC P/N 29411, S/N 001

Contract No. DAAK02-73-C-0047

For

Purchase Order 09772

Philips Broadcast Equipment Corporation
Government Systems Division
One Philips Parkway, Montvale, New Jersey

28 March 1975
Revision A – 1 June 1975
Revision B - 18 July 1975

Prepared By R. W. Hilke
R. W. Hilke
Test Equipment Project Engineer

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H. K. Coulter, Head
Instrumentation Section

Approved By C S Tallman
C. S. Tallman
Program Manager

SBRC

SAIE Manual P/N 15573
PBEC Contract No. 09772
Prime Contract No. DAAK02-73-0047
SBRC W/A 4625 - Dragon APE

REVISION NOTICE

Revision	Date	Description	Approval
A	6/1/75	Revised extensively as a result of Demonstration and PBEC comments.	ST
B	7/18/75	Added Section 4.3, Cryogenic Residual Tank and Dryer.	RWH ST

CONTENTS

CONTENTS (Continued)

(B)

ILLUSTRATIONS

TABLES

Section 1
DESCRIPTION

1.1 GENERAL

The Special Acceptance Inspection Equipment (SAIE) Test Set, SBRC Part No. (P/N) 29411, is a special infrared and cryogenic station. The infrared portion of the station is designed to automatically measure bias current, dc bias voltage, and the rms value of signal and noise voltage of the Dragon Detector Assembly SM-D-770349. The cryostat portion of the station is designed to provide a source of high pressure, regulated Freon-14 gas to operate the Dragon demand flow cryostat SM-D-649252. The station is comprised of various pieces of hardware as shown in Figure 1-1 and in the block diagram in Figure 1-2, and as listed in Table 1-1.

The blackbody assembly contains two infrared sources, variable- and fixed-speed modulators, apertures, and shuttering mechanism. Infrared signals incident on the detector array are transferred to an external mechanical crossbar assembly for channel selection. Signals from the crossbar output are sent to a preamplifier located within the assembly housing. The preamplifier output is connected to an electrical bandpass filter. The bandpass filter output is connected to a digital voltmeter (DVM). The DVM reads positive or negative dc voltage, and true rms ac measurements. This instrument also performs as an A/D converter for the recording of digital information. Signals from either the preamplifier output or the bandpass filter output may be viewed on an oscilloscope if desired.

The SAIE Test Set instrumentation rack contains a rack power panel, an oscilloscope, DVM/TRUE rms voltmeter, scanner control, bandpass filter, bias power supply, sequencer, serializer, printer, tape punch, wave analyzer, blackbody temperature controller, pen recorder, and gas panel. Refer to Table 1-2, SAIE Test Set Equipment, and Table 1-3, Test Set Parameters. The serializer is a parallel-to-serial converter which accepts

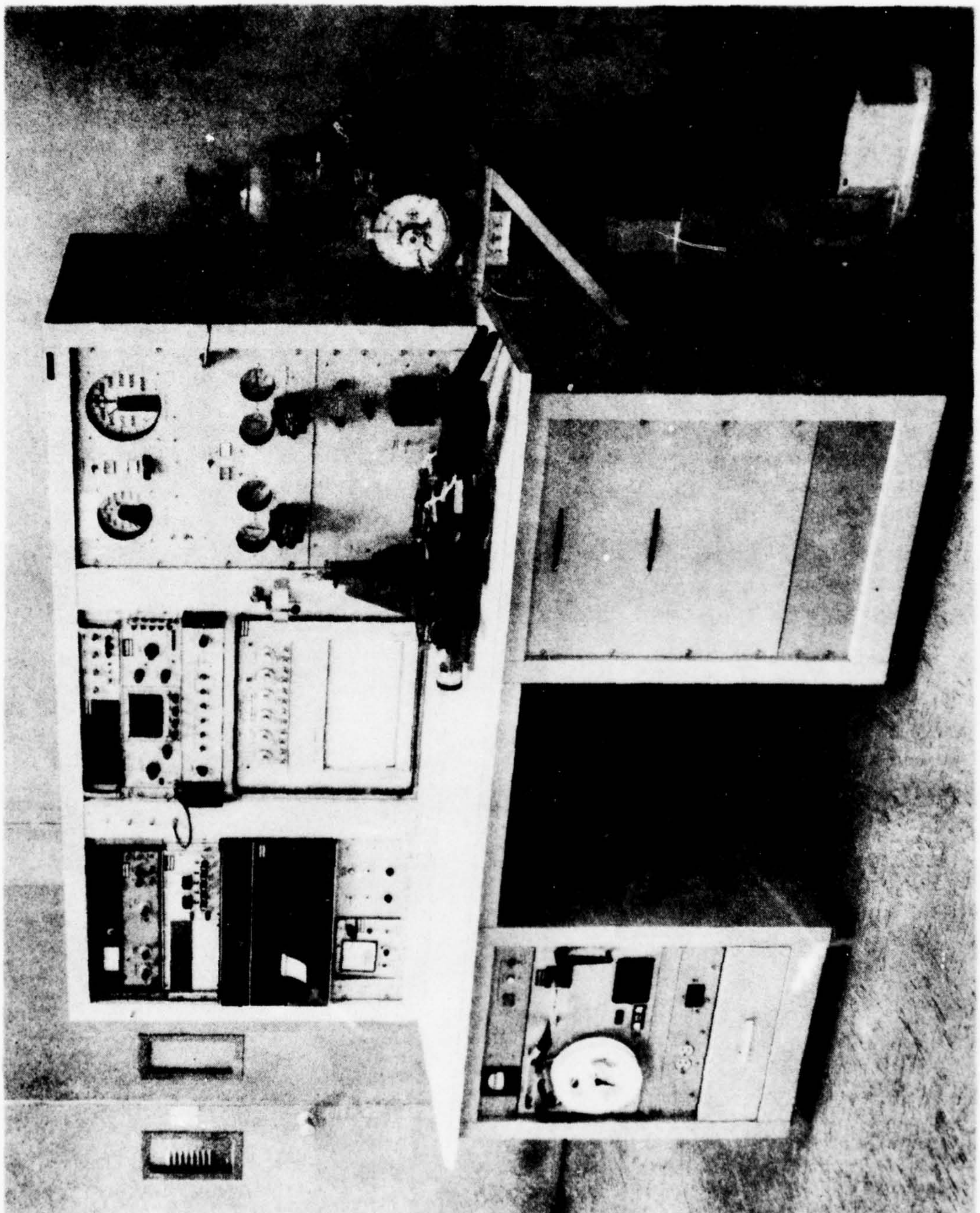

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Figure 1-1. SAIE Test Set

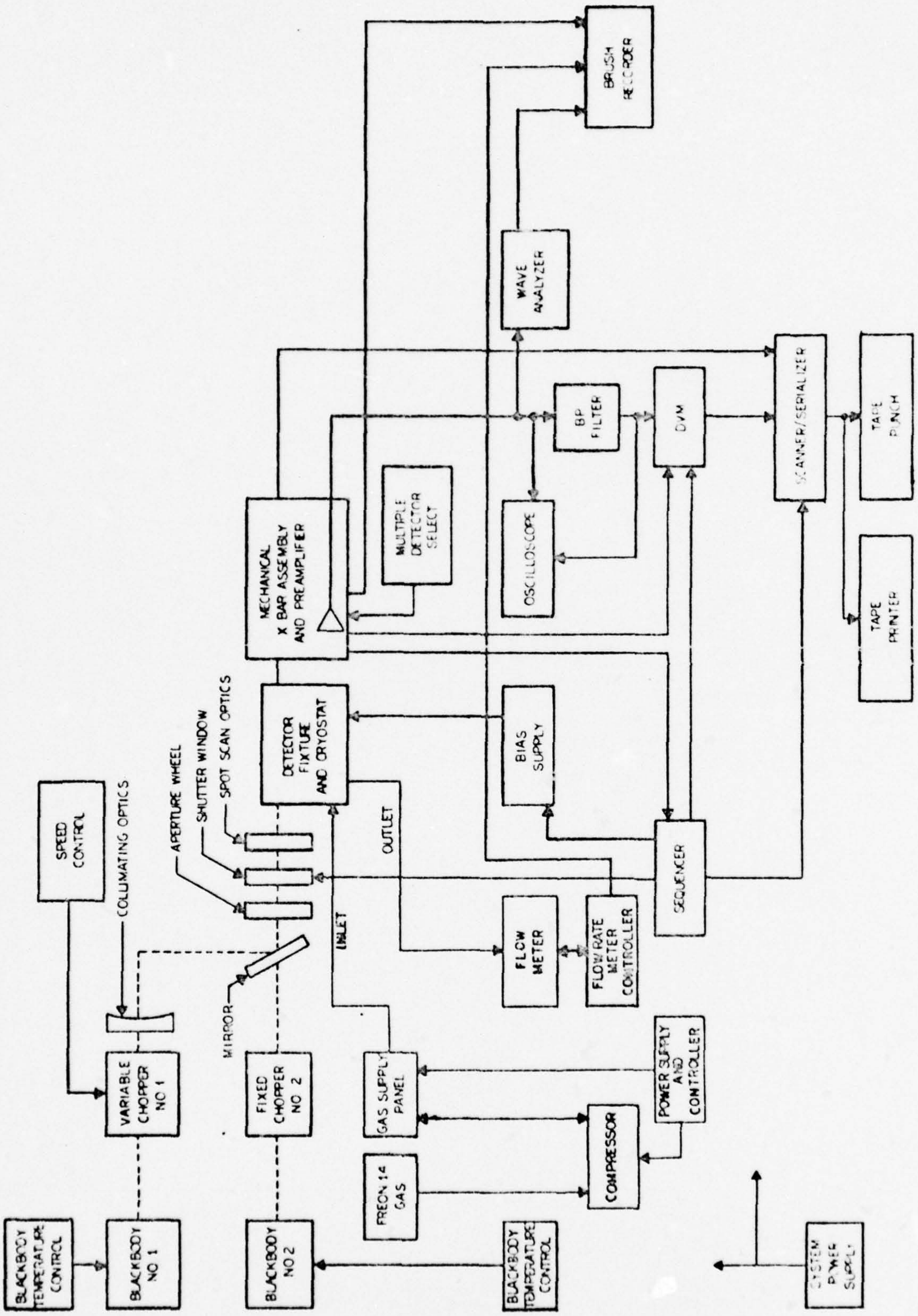

Figure 1-2. SAIE Block Diagram

Table 1-1. Set 163 Inventory USA-4625-A

DESCRIPTION	MANUFACTURER	MODEL	SERIAL NUMBER	IDENTIFICATION TAG
ANALYZER	QUANTEK	2449	1134	4625-560335
DIGITAL VOLTMETER	HEWLETT-PACKARD	3480D	1338A00245	4625-560233-1
MULTIFUNCTION	HEWLETT-PACKARD	3484A	1124A01526	4625-560233-2
OSCILLOSCOPE	TELEQUIPMENT	S54AR	E436157	4625-560214
SPEED CONTROL	ELECTRO-CRAFT	E650MSpec	S2423	4625-560472-2
RECORDER	BRUSH	260	03279	4625-560260E
PAPER PUNCH	REMEX	RPM1075BBX	59358	4625-560359
PAPER PUNCH	REMEX	RPS1075	59358	4625-560359
PAPER PUNCH	REMEX	BCI/550/H-U000	59358	4625-560359
PAPER PUNCH	REMEX	P/N 61914	59358	4625-560359
CROSS BAR	MONITOR LABS	MDL1200XBar	74	4625-56050-3
POWER SUPPLY 1	SCR DIVISION/MOXON	3567B	10340	------
POWER SUPPLY 2	LAMBDA	LSS-A-5	D161778	------
POWER SUPPLY 3	LAMBDA	LCD-A22	E91833	------
POWER SUPPLY 4	LAMBDA	LCS-A-5	D16857	------
POWER SUPPLY 5	LAMBDA	LK613DM	B1643	4625-560211
POWER SUPPLY 6	LAMBDA	LZS-11	------	------
BLACKBODY CONTROLLERS	SBRC	26994	16	------
BLACKBODY CONTROLLERS	SBRC	26994	18	------
DATA ACQUISITION SYSTEM	MONITOR LABS	9400/10368	74	4625-560450-3
GAS PANEL	SBRC	29485	------	------
FLOW METER	AMERICAN METER	AL17-1	P-231	4625-560959

Table 1-2. Special Acceptance Inspection Equipment (SAIE) Test Set

CRYOSTAT TEST

1. FREON GAS SUPPLY
2. COMPRESSOR
3. GAS SUPPLY PANEL
4. AVERAGE FLOW METER
5. FLOW RATE METER CONTROLLER
6. PEN RECORDER (EVENT)
7. POWER SUPPLY AND HIGH PRESSURE GAS CONTROLLER

DETECTOR TEST

1. BLACKBODY ASSEMBLY

   INFRARED SOURCES (500°K) (2)
   CHOPPER ASSEMBLIES (1 FIXED-SPEED, 1 VARIABLE-SPEED MOTOR AND CONTROL)
   COLLIMATING OPTICS
   MIRROR
   APERTURE WHEEL
   SHUTTER
   SPOT SCAN OPTICS

2. BLACKBODY TEMPERATURE CONTROLS (2)
3. DETECTOR AND CRYOSTAT UNDER TEST
4. MECHANICAL CROSSBAR AND MULTIPLE DETECTOR SELECTOR
5. PREAMPLIFIER
6. BANDPASS FILTER
7. OSCILLOSCOPE
8. WAVE ANALYZER
9. PEN RECORDER
10. DIGITAL VOLTMETER
11. SCANNER/SERIALIZER
12. PRINTER
13. PAPER TAPE PUNCH
14. PROGRAM CONTROL (SEQUENCER)

Table 1-3. SAIE Test Set Parameters

BLACKBODY TEMPERATURE (FIXED-SPEED CHOPPER)	ADJUSTABLE; INITIALLY SET TO 500°K
BLACKBODY TEMPERATURE (VARIABLE-SPEED CHOPPER)	ADJUSTABLE; INITIALLY SET TO 500°K
BLACKBODY APERTURE	0.003, 0.200, 0.300, 0.400 INCH
DISTANCE TO APERTURE FROM TABLE RING	11.53 INCHES
CHOPPER (PITCH) DIAMETER	10.0 INCHES
NUMBER OF TEETH (FIXED-SPEED CHOPPER)	17
NUMBER OF TEETH (VARIABLE-SPEED CHOPPER)	300
CHOPPING FREQUENCY (FIXED-SPEED CHOPPER)	510 Hz
CHOPPING FREQUENCY (VARIABLE-SPEED CHOPPER)	0 TO 25 kHz
EQUIVALENT NOISE BANDWIDTH (FIXED-SPEED CHOPPER)	50 Hz (BANDPASS FILTER)
EQUIVALENT NOISE BANDWIDTH (VARIABLE-SPEED CHOPPER)	7 Hz, 100 Hz, AND 1 kHz (WAVE ANALYZER)
CROSSBAR LOAD	1 MEGOHM OR 100 KΩ
GAIN: SIGNAL:	10, 100, 1000, AND 10,000
NOISE:	10, 100, 1000, AND 10,000
CRYOSTAT PRESSURES	3000, 2500, AND 800 PSIA (ADJUSTABLE)

the BDC information from the DVM, and presents it in proper form to a digital data printer and tape punch. The serializer also features a manual data entry capability. The scanner interfaces with the mechanical crossbars bringing each channel "on line" sequentially. Channel scan limits are established by manually selecting the first and last points on the front panel switches. The heart of the SAIE Test Set is a sequencer for program initiation and control of parameter selection. Provision is made for automatic sequencing of the desired program or manually selecting each parameter.

Delete switches allow desired parameters to be excluded from the automatic program sequencing. Each channel parameter can be recorded with either positive or negative polarity biases applied. Data recorded for each run may be presented on a tape punch for analysis and limit processing from an external computer system.

1.2 COMPONENT DESCRIPTION

1.2.1 Blackbody

Mounted beneath the detector test fixture are two blackbody sources preset to 500°K with fixed- and variable-speed chopper assemblies. The fixed-speed chopper disc is driven by a synchronous ac motor for fixed frequency D* and responsivity measurements. The variable-speed chopper disc is driven by a servo-controlled dc motor for varying the chopper rotation speed over the required frequencies when performing time constant measurements. Collimating optics are used during the time constant measurements to increase the irradiance level due to detector bandpass rolloff. Optical selection of the two blackbody systems is accomplished from the front panel (Figure 1-3) by positioning a mirror in the optical path for variable-speed chopper measurements and mechanically removing the mirror for measuring fixed-speed chopper measurements. The mechanical mirror assembly is designed to eliminate any spectral crosstalk from the unused blackbody source. Included in the blackbody housing are a shutter assembly to block irradiant energy when making narrow-band noise measurements, and four apertures, selectable from the front panel (Figure 1-3), for establishing the desired radiant power incident on the detector array surface for D*, responsivity, and time constant measurements. When measuring adjacent detector crosstalk, spot scan optics is used to focus all the radiant power incident on one desired detector while observing the adjacent detectors.

1.2.2 Blackbody Temperature Control

Each blackbody source has its own temperature control consisting of a heating element and core, a platinum resistance sensor, and a solid-state controller. The controller senses the change in blackbody temperature as a change in sensor resistance. The sensor is placed in one leg of a bridge circuit with reference potentiometers. The bridge is powered from an astable multivibrator and provides a comparison between the multivibrator frequency and the change in sensor resistance. A phase comparator senses the bridge lead or lag to the reference frequency, and controls the heating element power. Temperature control is better than ±2°K.

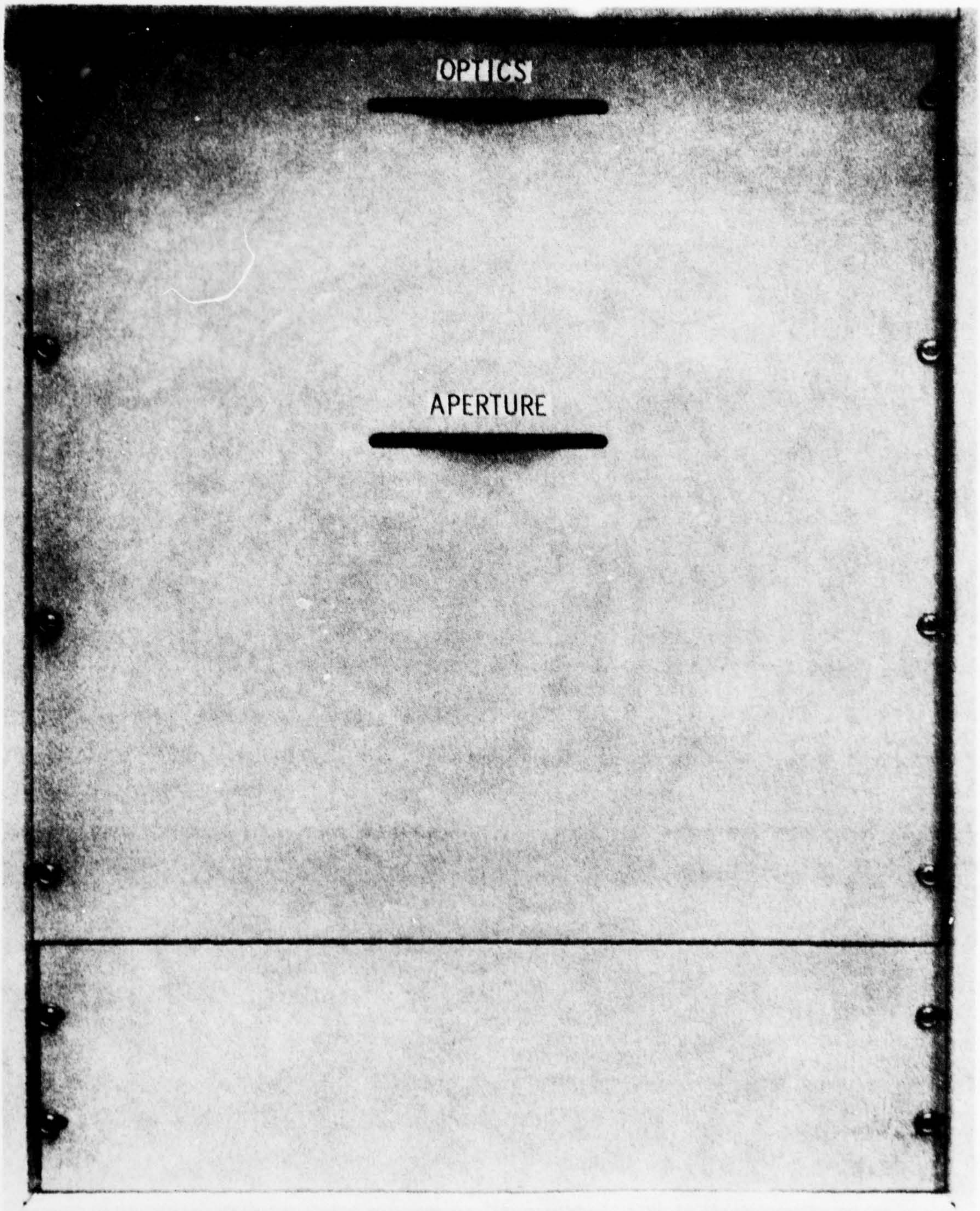

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Figure 1-3. SAIE Test Set, Bay No. 5

1.2.3 Scanner/Serializer/Tape Printer

A Monitor Labs 9400 Scanner/Crossbar System has the capability of scanning 100 preamplifier output channels. The channels to be scanned are determined by the FIRST POINT and LAST POINT switches (see Figure 1-3). Engaging the scanner START switch places each detector "in circuit" sequentially until the LAST POINT has been reached. The serializer is a general purpose parallel-to-serial converter which accepts up to 20 BCD characters in parallel and serializes them for the paper tape punch. The controls include thumbwheel switches for manual entry of tape header information. The paper tape printer is used to print data onto an 18-column printer. Like the paper punch, printing speed depends on the flow of data to the printer and can vary from 2 to 6 lines per second. Printing is accomplished by the 18-column keys striking pressure sensitive paper. The following is the Printer Recording Format.

Printer Recording Format

Column:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	L	L	L	L	L	L	L	L	L	L								
		Y	Y	Y		M	F		P	X_1	X	X	X	X			Z	

LLLLLLLLLL = Manual Data recorded only when MDE is depressed

YYY = Channel 000 to 099

M = Raw Data Mode
- 1 = Current
- 2 = Voltage
- 3 = Noise
- 4 = Signal

F = DVM Function Code
- 0 = dc volts
- 1 = ac(ac) volts
- 3 = ac(dc) volts

P = Polarity + or -

X_1XXXX = DVM Data Digits 00000 to 19999

Z = Range
- 1 = 1000 volts
- 2 = 100 volts
- 3 = 10 volts
- 4 = 1000 millivolts
- 5 = 100 millivolts

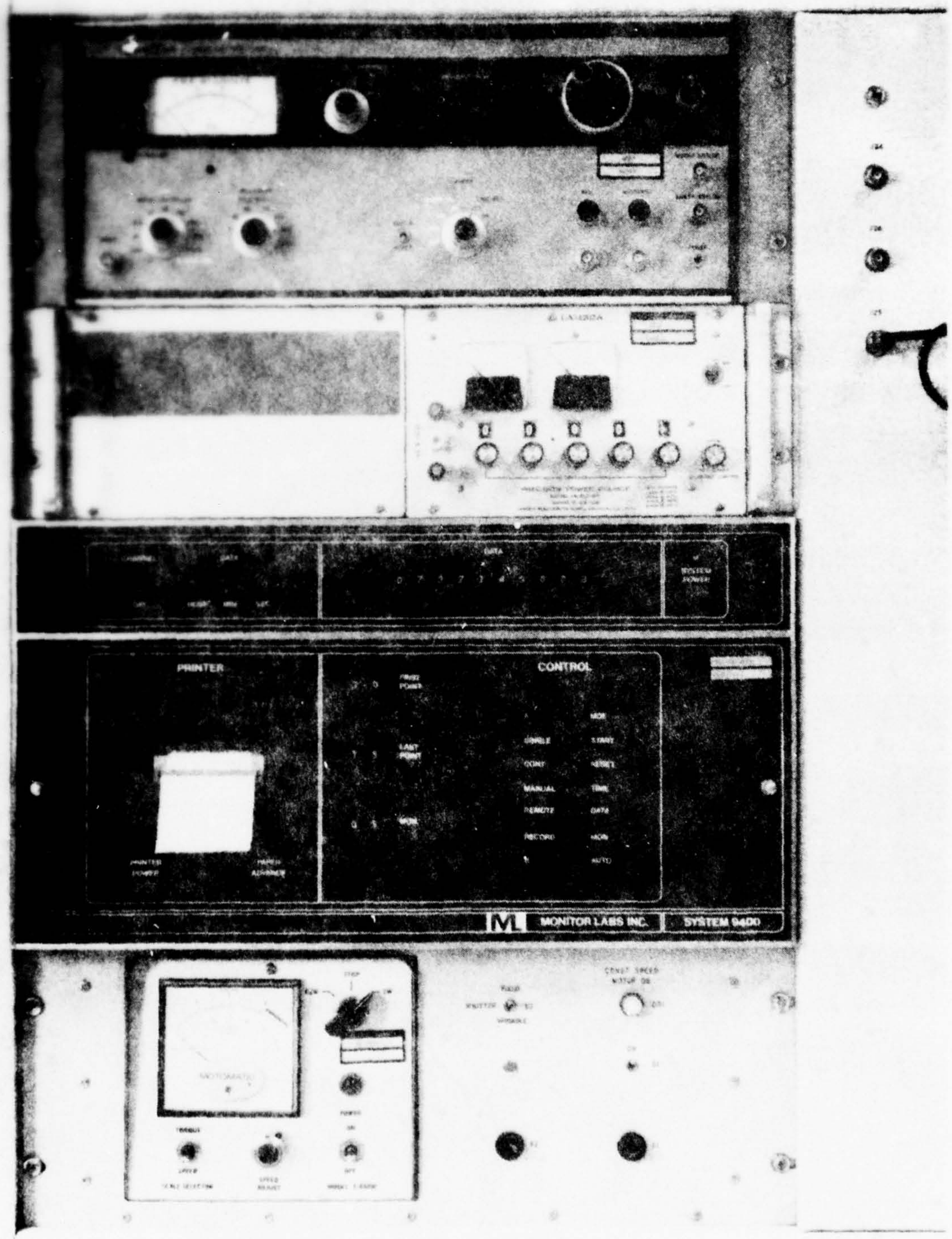

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Figure 1-4. SAIE Test Set, Bay No. 1

Front Panel Controls (See Figure 1-4)

Group	Control	Function
Channel Selection Controls	FIRST POINT	Thumbwheels determine the first channel of the scanner to be scanned when operating in the SINGLE, CONT (Continuous), or MANUAL mode with single speed selected. In the Dual Speed mode, the thumbwheels determine the last channel of the higher speed group of channels which begins at channel 00.
	LAST POINT	Thumbwheels determine the last channel to be scanned when operating in the SINGLE or CONT mode with single speed selected. In the Dual Speed mode, these thumbwheels determine the last channel of the slower speed group of channels which begins at the FIRST POINT channel number plus 1.
	MON	Thumbwheels that determine the MON (Monitor) channel to be displayed in either the DATA MON or MON display modes.
Scan Mode Controls	SINGLE	Places the scanner control in the SINGLE scan mode. In this mode, the analog channels selected, first point to last point and not skipped will be scanned once in sequence upon each manual START, External Start, or internal time pulse start. In the Dual Speed mode, channel 00 to first point will be scanned once in sequence upon each manual START, External Start, or internal time pulse start. Channel first point +1 to last point will be scanned once in sequence upon each internal time pulse start.
	CONT*	Places the scanner control in the CONT scan mode. In this mode, the analog channels selected first point to last point and not skipped will be scanned continuously in sequence upon receipt of one START, External Start, or internal time pulse start.

*Not used for the SAIE Detector Test Set

Front Panel Controls (Continued)

	Control	Function
Scan Mode Controls	MANUAL	Places the scanner control in the MANUAL scan mode. In this mode, the first point analog channel is selected and digitized upon receipt of the first start. Subsequent start commands advance the analog channel 1 channel for each start. The scanner will continue to advance as in the CONT scan mode as long as starts continue.
Manual Internal Control Disable	REMOTE*	Disables the Internal System Controller (ISC). This frees the internal data and command bus to be used by external control. This control slaves the 9400 to external control only as provided with the Computer Input/Output option card CIO.
Recording Enable	RECORD	Enables control and printout on the Printer (PRT) and external recording devices Teletype (TTO), Magnetic Tape (MTO), and Paper Tape Punch (PTP) if they are powered on, which are controlled in the standard control program.
Manual Label Control	MDE	Depressing this switch causes the Label switches to be recorded on all active recording devices.
Auto Time Start	AUTO*	When depressed, it enables the 9400 to start a scan on each output of time pulse interval 1 setting.
Manual Scan Start Control	START	Depressing this switch initiates the Analog scanner in all its modes - SINGLE, CONT, and MANUAL.
Master Reset	RESET	Provides a master reset to the control and all interface cards to clear the logic. For example, if a scan has started depressing, this switch terminates the scan and restarts the control

*Not used for the SAIE Detector Test Set

Front Panel Controls (Continued)

	Control	Function
Master Reset		logic at the beginning of the control program. If depressed with RECORD selected, normal end of scan output occurs to all output devices powered on.
Display Controls	TIME*	When depressed, the Clock time will be displayed in the readout and updated every second. The primary purpose is to allow setting the clock by observing the digital display. Secondary purpose is to display the time on the readout continuously during all operations of the system. DATA and MON must not be depressed.
	DATA	When depressed, with TIME and MON not depressed, the readout will display the analog channel number and the digitized reading during the scan modes of SINGLE, CONT, or MANUAL.
	MON (optional)	When depressed, with TIME and DATA not depressed, the readout will display the channel selected by the MON thumbwheels when the system is not scanning in the CONT mode. The channel selected will be displayed and continuously updated.
	MON and DATA*	When both depressed, the readout will display the channel selected by the thumbwheel switches every time that channel is scanned in either the SINGLE or CONT scan modes. The readout is updated on the fly, regardless of the system digitizer in use and the speed.
Special Control Applications	A* B*	Reserved for special programs. Not active in the standard program. Consult the special features described in your special system program manual if applicable.
Printer Controls	PRINTER POWER	Energizes the printer. If the RECORD button is not depressed, the printer will not operate. In systems with magnetic tape output or other

*Not used for the SAIE Detector Test Set

Front Panel Controls (Continued)

	Control	Function
Printer Controls		output recording devices, this switch allows disabling the printer while other devices are recording.
	PAPER ADVANCE	Advances the printer paper for loading or set-up purposes as desired.
Clock Setting Controls	PWR FAIL*	When depressed, this control extinguishes the POWER FAIL lamp and resets the recorded power fail flag logic.
	SET*	When depressed, the clock may be set to the desired time by the DAY, HOUR, MINUTE, and FAST controls.
		When released, the time will start updating. To allow synchronization with an external time source, this control should be released exactly with the minute setting.
	FAST*	Controls the rate at which the DAY, HOUR, or MIN counters of the clock are updated.
		Not Depressed: Rate = ~1.5 increments per second Depressed: Rate = ~10 increments per second
	DAY*	While depressed and enabled by the SET switch, the Days portion of the clock will update.
	HOUR*	While depressed and enabled by the SET switch, the Hours counter of the clock is updated.
	MIN*	While depressed and enabled by the SET switch, the Minutes counters are incremented.
Manual Data Entry	MDE	The switch settings of the 10-column manual data entry register are recorded in format when the front panel MDE switch is depressed.

*Not used for the SAIE Detector Test Set

1.2.4 Crossbar and Multiple Detector Selector

The crossbar, part of a Monitor Labs 9400 Scanner System (Figure 1-5), is electrically connected to the detector mounting fixture and preamplifier. Each detector is connected to a channel of the 100 × 1 wire crossbar which is controlled from a remote scanner. Exception to the above statement is during performing the crosstalk measurement. During this measurement, a front panel switch, S2, connects one of three predetermined detectors (10, 30, and 45) to the preamplifier and bias circuitry. The output from the crossbar is coupled to a preamplifier for signal and noise gain. A load switch provides selection of either a 1-meg resistive load for D* and responsivity measurements or a 100-KΩ resistive load for time constant measurements.

1.2.5 Preamplifier

The preamplifier is a capacitively coupled voltage-mode two-stage amplifier with selectable gains of 10, 100, 1000, and 10,000. The gain required for the signal and noise voltage modes can be selected from one of the four available settings located within the sequencer panel. Amplifier output signals are sent to a 50-Hz bandpass filter to provide narrow-band noise readings.

1.2.6 Electrical Bandpass Filter

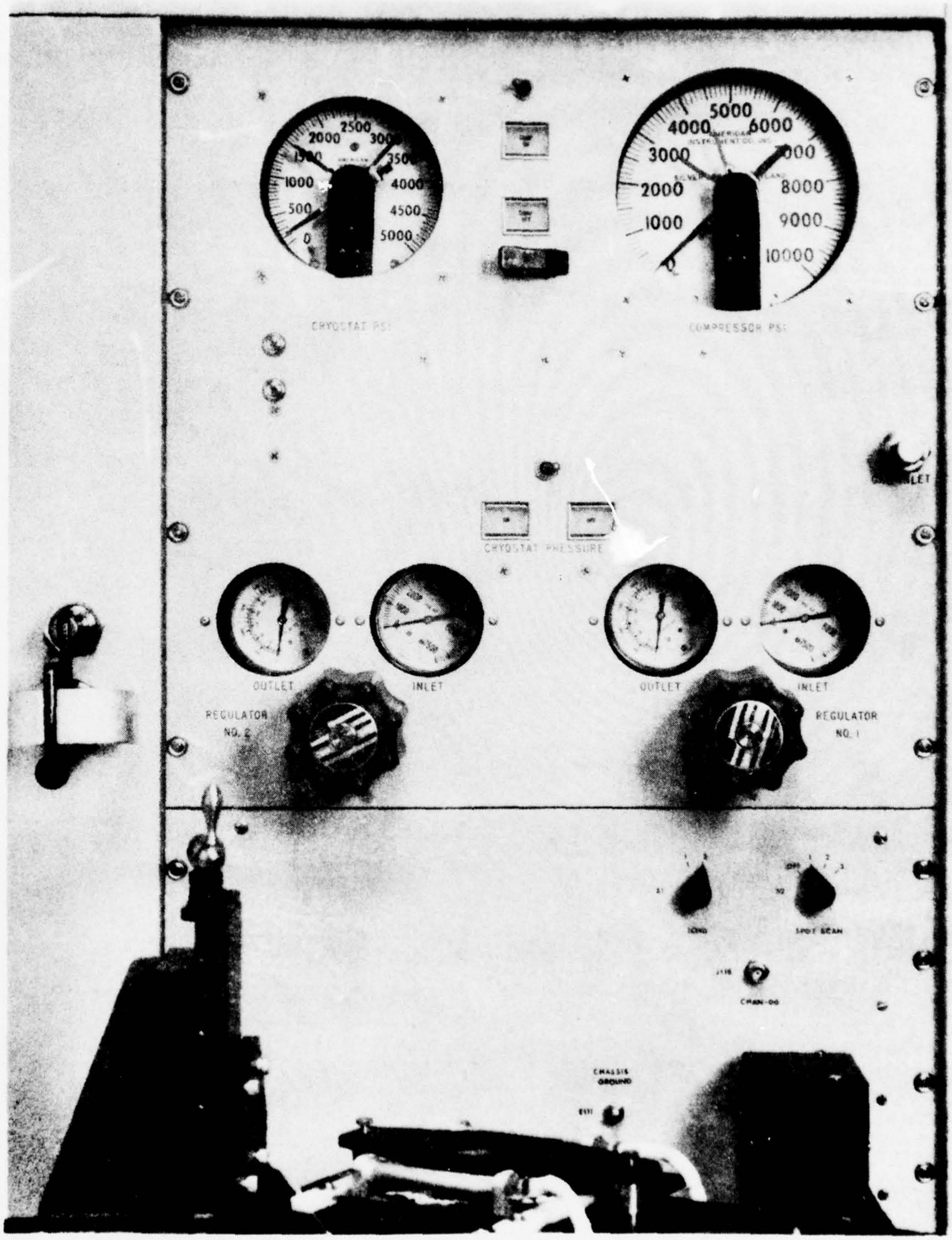
An active electrical bandpass filter having a center frequency of 510 Hz and an NEBW of 50 Hz is used to process the broadband detector noise signals. The filter center frequency corresponds to the required chopper frequency.

1.2.7 Oscilloscope (Figure 1-6)

The rack mounted Telequipment S54R oscilloscope has a bandwidth from dc to 10 MHz, sensitivity of 10 mv/cm to 50 v/cm, and a sweep range from 3 μsec/cm to 2 sec/cm.

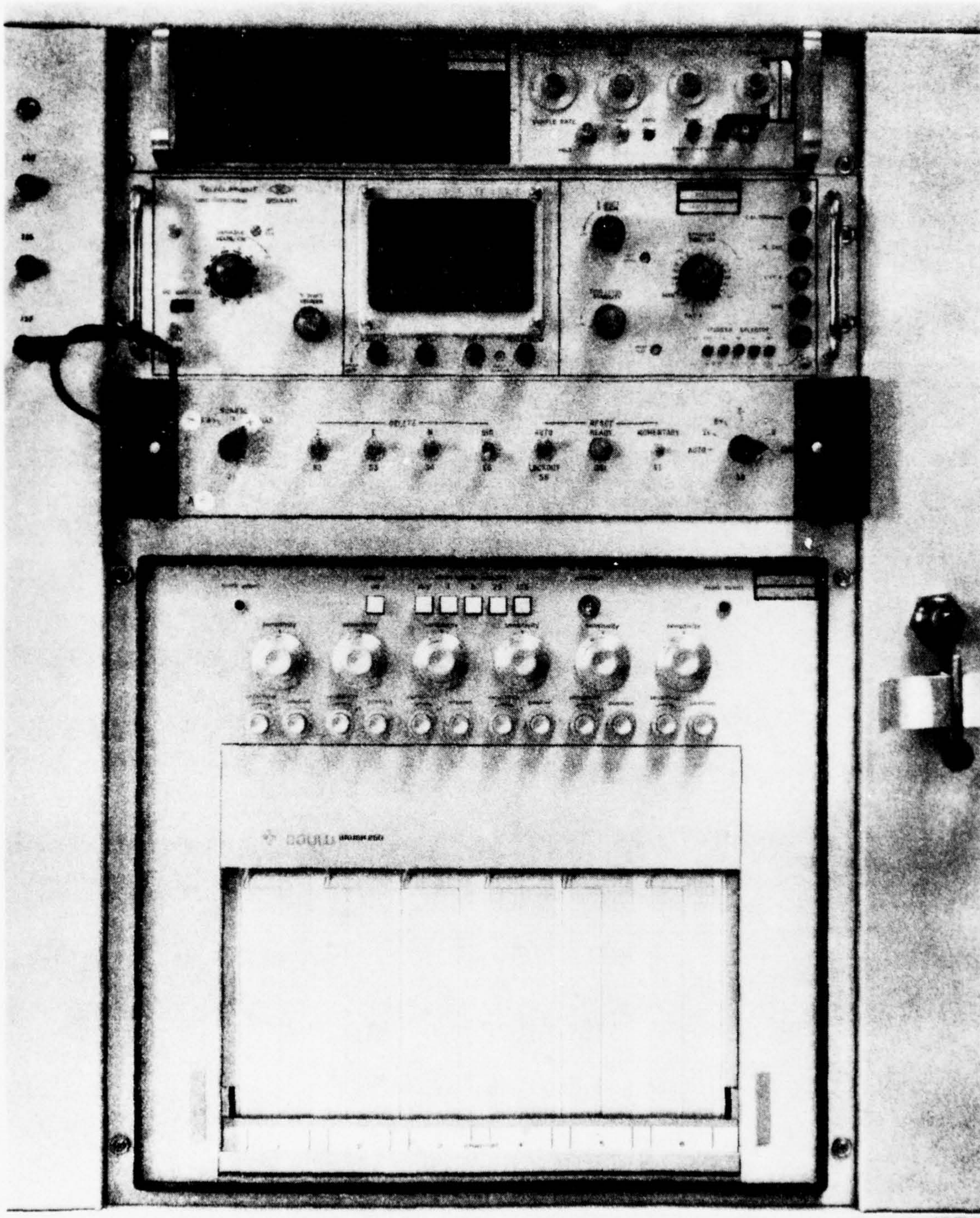
1.2.8 Digital Voltmeter (Figure 1-6)

The Hewlett Packard 3484 Digital Voltmeter makes 4-digit dc and true rms voltage measurements, with up to 50% overrange and 10% underrange capability. Full scale ranges of 100 and 1000 mv, 10, 100, and 1000 volts may be selected manually, automatically, or remotely. Polarity



75-3-26

Figure 1-5. SAIE Test Set, Bay No. 3



75-4-6

Figure 1-6. SAIE Test Set, Bay No. 2

selection and display are automatic. The degree of filtering desired may also be selected manually or remotely. The DVM also has provisions for BCD data output, 1-2-4-8 code.

1.2.9 Paper Tape Punch (Figure 1-7)

A Remex RPS 1075 paper tape punch is used to record data. Punching speed depends on the flow of data to the punch and can vary from 0 to 75 rows per second. The tape is fed by a nine-punch-pin tape-feed mechanism that operates independently of the feed holes. All nine-punch pins are solenoid-operated.

1.2.10 Wave Analyzer (Figure 1-4)

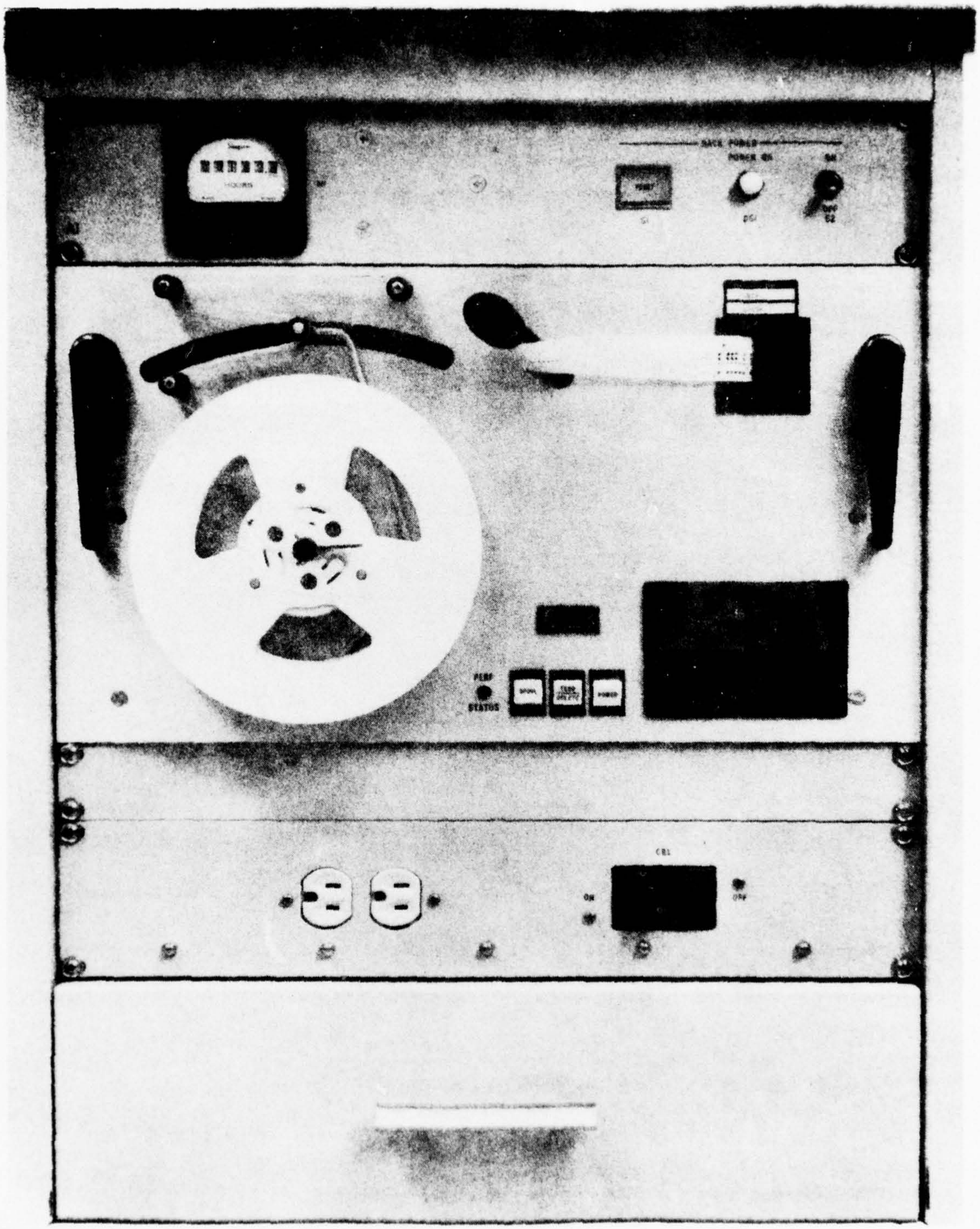
A Quantech 2449 wave analyzer provides frequency measurement over a range of 10 Hz to 50 kHz with a selectable bandwidth of 7, 100, or 1000 Hz. The frequency and meter displays, meter analog, sweep analog, beat frequency oscillator (BFO), and restored signals are all available from the front panel.

1.2.11 Pen Recorder (Figure 1-6)

A Brush recorder (Mark 260) is a six-channel analog recorder used to record time varying analog data. Channel functions are: channel 1 - wave analyzer output; channel 2 - temperature sensor 1; channel 3 - temperature sensor 2; channel 4 - flow rate meter output; channels 5 and 6 are not used. Four event markers, two on margins and two interchannel, are standard. The marginal event markers are activated by pushbuttons located on the front panel. A built-in 1-second timer operates the left interchannel marker. The right interchannel marker must be operated from an external source. Eight chart speeds are available: 1, 5, 125 mm/sec and 1, 5, 25, 125 mm/min. Measurement ranges are from 1 mv per chart division to 500 volts dc full scale (50 chart divisions).

1.2.12 Chopper Control (Figure 1-4)

The chopper control unit provides power to the constant-speed motor, power and speed adjust to the variable-speed controller, and selection of



75-3-27

Figure 1-7. SAIE Test Set, Bay No. 4

either the fixed-speed shutter or the variable-speed shutter. The variable-speed chopping (modulation) frequency is determined from the following formula:

$$\text{Modulation frequency} = \frac{(\text{No. of Chopper Blade Slots})(\text{Meter rpm Reading})}{60}$$

where No. of Chopper Blade Slots = 300

1.2.13 Bias Supply (Figure 1-4)

The detector bias supply is a 5-digit voltage selectable power supply. Voltage range is 0 to 40 vdc with an overvoltage limiter set to 15 vdc.

1.2.14 Program Control Sequencer (Figure 1-6)

The sequencer has the following front panel program controls: bias select, delete switches, mode of operation, program reset, lockout, and READY indicator. A seven-position MODE switch provides the following program selection: AUTO, +I, +E, -I, -E, N (Noise), and SIG (Signal). In the AUTO mode: current, voltage, noise, and signal are remotely programmed on each channel scanned. DELETE switches, labeled I, E, N, and SIG, are provided for deleting a desired parameter while in the AUTO mode. By positioning the mode switch to any one of the remaining six modes, a manual program is available. The RESET switch allows the program to be terminated during a scan cycle. The LOCKOUT switch, S6, is provided to prevent accidental program start. A three-position Bias switch (-BIAS, NORMAL, and +BIAS) provides both polarities of bias to each channel. -BIAS provides only negative bias programming per channel. NORMAL provides both negative and positive bias programming per channel. +BIAS provides only positive bias programming per channel. Located within the pullout rack sequencer are the preamplifier gain switches for signal and noise measurements, and the digital voltmeter range switches for I, E, N, and S raw data measurements.

1.2.15 Console Front Panel Connections

The following is a list of the console front panel connections and their functions:

J25	FILTER OUT
J26	PREAMP OUT
J27	WAVE ANALYZER INPUT
J28	ANALOG INPUT
DUMP VALVE	GAS SAFETY VALVE
GAS OUTLET	GAS CONNECTION TO CRYOSTAT
E111	UNI-POINT GROUND
J118	CHANNEL 000 FOR TEST PURPOSES

1.3 SEQUENCE OF OPERATION

Before issuing a START command to the scanner, the operator must position the required program control switches to obtain the desired program and establish the desired FIRST and LAST scan points. When the READY light (Figure 1-6) is illuminated, the system is ready to start a scan cycle. As the scanner start button is pushed, the scanner issues a Closure Complete pulse to the Control Unit (Sequencer). Depending on the selected program, integration times are established for the parameters to be measured. A 1-second for dc current and voltage measurements, 15 seconds for Noise measurements, and 2 seconds for Signal measurements. At the start of the integration times, a DVM ENABLE trigger is routed to the DVM via the serializer. During this time, function, filter, and range information are also sent to the DVM. At the end of the DVM digitizing time, a Print Command is generated. The Print Command is routed to the serializer where it becomes "serializer start." Having received a Start signal, the serializer synchronizes the Start signal with an Internal Clock and stores all incoming data including the First Point information, voltmeter data, and channel data. When this section is complete, the serializer issues a Storage Complete signal when it has received a Scanner Advance command from the control unit. At this moment of time, two parallel operations begin to take place. While the scanner advances to the next channel and subsequently issues another Closure Complete pulse, the serializer is causing data to be recorded by the tape punch and the printer. If the recording of all data is complete prior to the voltmeter completing a measurement, the Print Command simply causes the serializer to start again. If, however, the recording operation is still in process when the Print Command is given, the serializer will store the Print Command. When the recording process is completed, the stored Print Command will be utilized in synchronization with the serializer clock and a storage complete signal will be issued to advance the scanner. The above process continues until after the last channel has been recorded. An EOL operation is inserted after each recorded channel of data by issuing a serializer Last Point signal.

1.4 GAS PANEL (CRYOSTAT TESTING)

1.4.1 The Gas Panel (Figure 1-5) is used to provide a source of high-pressure Freon-14 to operate the Dragon demand flow cryostat. The Freon-14 gas is supplied to the system by a pressurized bottle (2000 psi) located at the rear right-hand side of the Dragon Test Set Console. This bottle feeds the AMINCO Compressor which further pressurizes the gas to about 6000 psi before introducing the gas into the Gas Panel for regulation. The AMINCO Compressor is located on the right-hand side, outboard of the Dragon Test Set Console. The Gas Panel provides three basic functions: 1) automatic control of the AMINCO Compressor to regulate the input gas pressure from 4000 to 6000 psi; 2) filtration and drying of the pressurized gas; and 3) pressure regulation of the gas for cryostat operation.

The Gas Panel consists of a compressor psi gauge with adjustable electrical limit settings; two circle seal relief valves and one AMINCO blowout valve for safety; an input pressure regulator; check valve; residual tank and dryer; output pressure regulator; solenoid valve, cryostat psi gauge and an output manually operated dump valve; as well as various switches and display lights.

1.4.2 The pressurized Freon-14 gas from the compressor is introduced into the Gas Panel through the gas inlet fitting and is applied to the compressor psi gauge. This gauge displays gas inlet pressure and provides automatic control of the compressor by the two adjustable limit switches. The limit switch controlled by the rotatable arm nearest the gauge is the UPPER LIMIT switch and should be set to around 6000 psi. When the pressure indicator exceeds the setting of the UPPER LIMIT switch, the compressor shuts off and the compressor OFF display illuminates. If the compressor ON display is lighted at this time, the RESET HOLDING relay switch should be momentarily thrown. This resets the display lights to the correct mode of operation. The RESET HOLDING relay switch will only operate if the dial pressure indicator is at a higher pressure then the UPPER LIMIT switch. Regardless of the lights, however, the compressor will shut off whenever the pressure indicator exceeds the setting of the UPPER LIMIT switch.

The limit switch controlled by the rotatable arm farthest from the gauge is the LOWER LIMIT switch and should be set to 3800 psi. When the gauge pressure indicator drops below this limit switch, the compressor starts and remains in operation until the UPPER LIMIT switch is exceeded by the pressure indicator. This is accompanied by the compressor ON display being illuminated. If, for some reason, the dial pressure indicator drops below the LOWER LIMIT switch without the compressor ON display being illuminated, the UPPER LIMIT switch and the LOWER LIMIT switch must be rotated below the dial pressure indicator and the RESET HOLDING relay switch must be toggled. The UPPER LIMIT switch must then be returned to the 6000 psi setting and the LOWER LIMIT switch to the 3800 psi setting.

The compressor ON/OFF switch provides a manual override to the compressor psi gauge's automatic control functions. When this switch is in the OFF position, the compressor will not start, regardless of the lights. This switch must be turned off when the operator leaves the console for any reason.

Two safety valves are provided after the compressor psi gauge and are located behind the front panel. The circle seal relief valve No. 1 is set to vent the compressed gas to atmosphere if an inlet pressure of 7000 psi is exceeded. The blowout valve, located behind the front panel, has a rupture disc set to 8500 psi and will vent to the atmosphere if this inlet pressure is exceeded and the relief valve is non-operational.

The Input Pressure Regulator (Regulator 1) provides the initial pressure regulation in the Gas Panel and should be set to 3600 psi with the Regulator 1 outlet pressure gauge.

When initially pumping up the system, the output pressure gauge will take at least 30 minutes to register this pressure because the residual tank and dryer takes time to be brought up to pressure.

A third safety feature is added to the system by the circle seal relief valve No. 2 past the Input Pressure Regulator. This valve is set to vent to the outside if the outlet pressure of Regulator 1 goes above 4000 psi. This is necessary because the residual tank and dryer is rated at 4500 psi.

A check valve is placed in the system between the relief valve No. 2 and the residual tank and dryer to prevent a backwash of pressure from the pressurized tank if the inlet pressure drops below the holding pressure of the residual tank and dryer.

Fine regulation of pressure is required in the second part of the Gas Panel requiring a constant pressure source to maintain this regulation. The residual tank and dryer performs this function as well as providing filtration and drying of the gas before the gas is applied to the cryostat. An analogy can be drawn between the residual tank and dryer and a capacitor in an electrical power supply. The dryer presents a relatively constant pressure source to its load and the capacitor presents a relatively constant voltage source to its load. The residual tank and dryer is kept "charged" at approximately 3600 psi by the Input Regulator and, due to the small flow rate of gas through the second part of the system, "discharges" through a long time constant.

The Output Pressure Regulator (Regulator 2) provides a means of finely adjusting the output (cryostat) pressure in the system. Both this regulator and Regulator 1 are self-dumping regulators which do not depend on gas flow rate to adjust their outlet pressure in the system. This allows a certain predetermined pressure to be set at the input of the cryostat before the solenoid valve allows gas flow to proceed through the cryostat. The operator should adjust the Output Pressure Regulator according to the outlet pressure gauge on the regulator before allowing gas flow through the rest of the system.

The solenoid valve acts as a switch, allowing either atmospheric pressure or Gas Panel pressure to be applied to the cryostat. The solenoid valve is controlled by the cryostat pressure switch located at the lower middle of the Gas Panel. The PRESSURE ON and PRESSURE OFF indicators provide easy visual indications of the state of the outlet pressure to the cryostat. When this switch is in the ON position, the solenoid valve will be energized allowing the pressure from the outlet part of Regulator 2 to be applied to the cryostat.

The cryostat psi gauge is active only when the solenoid valve is activated and provides an accurate visual scale for fine adjustments of cryostat pressure during test.

The manually operated dump valve is located to the left of and adjacent to the Gas Panel and allows pressurized gas to flow from the Gas Panel outlet connector to the cryostat assembly. This valve is installed to make absolutely sure that no pressure is applied to the cryostat line when disconnected from the cryostat assembly. To obtain access to the gas outlet connector, the operator lifts the valve handle shield surrounding the connector which activates the dump valve, venting pressure in the line to the atmosphere.

When disconnecting the cryostat gas inlet line at the cryostat assembly, the operator must visually check the cryostat pressure switch and the PRESSURE OFF indicator to assure that the solenoid valve is vented to the atmosphere. The operator must also check the cryostat psi gauge to see that this gauge reads zero psi before activating the dump valve by placing it in the lifted position.

The output gas flow from the cryostat is connected to a flow meter located on a cantilevered stand attached to the right side of the test console. The flow meter dial pointer engages a potentiometer shaft (part of the flow meter control) to produce a time display on pen recorder channel 4. The flow meter and the time dependent variable indicate average flow rate measurements.

Section 2

OPERATION PROCEDURE

2.1 GENERAL

The operating procedure for the SAIE Test Set describes equipment usage in testing the detector/cryostat assembly. Instructions are presented from assembly on the cryostat mounting fixture to the completion of a single-scan operation. The system upon receiving a START command will scan the channels selected once and stop automatically. Instructions are also given for loading of the tape punch and printer.

2.2 DEWAR/CRYOSTAT OPERATIONS

1. Position the dewar/cryostat on the test set mounting fixture with the locating hole in orientation with the black dot on the test set fixture.
2. Before placing the dewar in the mounting fixture, check the bias supply for 0.00 vdc. Secure the dewar/cryostat to the mounting fixture after alignment has been assured. Attach the sunburst connector to the test set interface cable. Note: A black dot denotes the number one end of the fixture.
3. Connect the cryostat coolant line to the test set coolant supply point. Remove the dust cover from the blackbody port and position the dewar over the port opening by means of the X-Y divider head. Raise or lower the mounting fixture to obtain the desired irradiance level by means of the Z divider head. See irradiance equations (Table 2-1) for computing H as a function of path length (L).

2.3 TEST CONSOLE PRETEST OPERATIONS

1. Set switch S2 located on the Power Panel (Figure 1-7) to the ON position; the indicator lamp in the RESET switch, S1, will illuminate. This indicates that ac power is applied on the rack connector, although ac power to the remaining equipment in the rack has not yet been applied. When switch S1 is actuated with S2 ON, the rack power relay will actuate via the diode bridge, POWER ON indicator DS1 will illuminate, and power will be applied to the remainder

of the equipment rack. At this time, the RESET indicator in switch S1 will extinguish. At the same time, the elapsed time meter, M1, will receive ac power and indicate the rack total elapsed operation time. Check that all component panel switches are in the ON position.

2. Load the paper punch as outlined in Calibration Procedure, Section 3, paragraph 3.8.

3. Open coolant bottle supply valve. Press COMP ON located on the coolant supply panel.

4. Adjust compressor pressure gauge upper trip point to 6000 psia and lower trip point to 3800 psia.

5. Adjust Regulator 1 outlet pressure to 3600 psia.

6. Adjust Regulator 2 outlet pressure to 3000 psia for initial testing. Additional pressure setting requirements are described later in the operating procedure.

7. Ensure that CRYOSTAT PRESSURE gauge reads 0 psia.

8. Test set front panel controls and switches used for single-scan operation are listed in Table 2-2, Single-Scan Operation Guide.

Table 2-1. Irradiance Equations for Various Aperture Sizes

1. 0.400-INCH APERTURE

$$H_{rms} = 5210.0/(132.25 + 23L + L^2) \text{ IN } \mu w/cm^2$$

2. 0.300-INCH APERTURE

$$H_{rms} = 3006.7/(132.25 + 23L + L^2) \text{ IN } \mu w/cm^2$$

3. 0.200-INCH APERTURE

$$H_{rms} = 1364.0/(132.25 + 23L + L^2) \text{ IN } \mu w/cm^2$$

4. 0.003-INCH APERTURE

$$H_{rms} = 0.310/(132.25 + 23L + L^2) \text{ IN } \mu w/cm^2$$

WHERE: L = DISTANCE FROM TABLE RING TO DETECTOR IN INCHES

NOTE: DISTANCE FROM APERTURE TO TABLE RING = 11.53 INCHES

Table 2-2. Single-Scan Operation Guide

INSTRUMENT	SWITCH	POSITION
1. DIGITAL VOLTMETER	POWER	ON
	SAMPLE RATE	HOLD
	FUNCTION	REMOTE
	RANGE	REMOTE
	FILTER	REMOTE
	ANALOG INPUT	REAR
2. SCANNER CONTROL	SYSTEM POWER	ON
	FIRST POINT	AS DESIRED
	LAST POINT	AS DESIRED (GREATER THAN FIRST POINT)
	SINGLE	PRESS IN
	RECORD	PRESS IN
	DATA	PRESS IN
	MDE	PRESS IN (TO INITIATE A MANUAL DATA ENTRY)
3. MANUAL DATA	ENTRY REGISTER	SELECT AS DESIRED
4. DATA PRINTER	POWER	PRESS IN
	PAPER ADVANCE	PRESS IN
5. CROSSBAR	LOAD	AS DESIRED (100 KΩ OR 1 MEG)
	SPOT SCAN	POSITION OFF, 1, 2, OR 3
6. WAVE ANALYZER	POWER	ON
	INPUT	CONNECT TO PREAMPLIFIER OUTPUT
	VAR. METER MULTIPLIER	AS DESIRED (X.01 - X300)
	MILLIVOLT FULL SCALE	AS DESIRED (3 - 300 MV)
	SINGLE/RESET	RESET
	SWEEP	NOT USED
	BFO	NOT USED
	RESTORED	NOT USED
	METER ANALOG	CONNECT TO PEN RECORDER, RECORDER INPUT
	SWEEP ANALOG	NOT USED
	METER TC	AS DESIRED (0.1, 1, AND 10 SECONDS)
	BANDWIDTH	AS DESIRED (7, 100, AND 1000 Hz)
7. FIXED-SPEED CHOPPER	POWER	ON FOR 510-Hz CHOPPING FREQUENCY
8. VARIABLE-SPEED CHOPPER	POWER	ON FOR TIME CONSTANT MEASUREMENT
	SCALE SELECTOR	SPEED
	ROTATION	CW
	SPEED ADJUST	AS REQUIRED
9. APERTURE/OPTICS	APERTURE INDEX	0.003, 0.200, 0.300, 0.400 INCHES
	OPTICS INDEX	NO. 1 NORMAL
		NO. 2 TC
		NO. 3 SPOT
10. SHUTTER	FIXED/VARIABLE	FIXED - D*, RESPONSIVITY, AND CROSSTALK MEASUREMENTS
		VARIABLE - TC MEASUREMENTS
11. PAPER PUNCH	POWER	ON
	SPOOL	ON
	FEED/DELETE	AS DESIRED FOR TAPE LEADER

Table 2-2. Single-Scan Operation Guide (Continued)

INSTRUMENT	SWITCH	POSITION
12. SEQUENCER	FUNCTION	AS DESIRED (AUTO, CURRENT, VOLTAGE, NOISE, OR SIGNAL)
	BIAS	AS DESIRED (+BIAS, -BIAS, OR NORMAL)
	DELETE	AS DESIRED (I, E, N, OR S)
	AUTO/LOCKOUT	LOCKOUT
	RESET	PRESS TO RESET PROGRAM
13. OSCILLOSCOPE	POWER	ON (ADJUST BRILLIANCE AND FOCUS FOR SHARP TRACE)
	INPUT	CONNECT TO BANDPASS FILTER, INPUT OR OUTPUT
	VERTICAL ATTENUATE	AS DESIRED
	SWEEP RATE	AS DESIRED
14. BIAS SUPPLY	POWER	ON
	VOLTAGE CONTROL	SELECT DESIRED DETECTOR BIAS VOLTAGE
15. COMPRESSOR PRESSURE	COMPRESSOR ON	ON
16. COMPRESSOR GAUGE PRESSURE LIMIT	MAX	6000 psi
	MIN	3800 psi
17. REGULATOR 1	INLET	3800 - 6000 psi
	OUTLET	3600 psi
18. REGULATOR 2	INLET	3600 psi
	OUTLET	AS DESIRED - a) 3000 psi b) 2500 psi c) 800 psi
19. CRYOSTAT/TEST SET INTERFACE	SAFETY VALVE	DOWN
20. CRYOSTAT GAUGE PRESSURE	MAX	AS DESIRED - a) 3000 psi b) 2500 psi c) 800 psi
21. CRYOSTAT PRESSURE	CRYOSTAT PRESSURE	ON (APPLY PRESSURE AFTER CONNECTION TO CRYOSTAT)
22. PEN RECORDER	POWER	ON
	CHART SPEED (mm/min)	AS DESIRED - a) 1 mm/min b) 5 mm/min 25 mm/min 125 mm/min
	CHART SPEED (mm/sec)	ON OR OFF AS DESIRED
	MARK EVENT	PRESS WHEN MARKER IS DESIRED
	SENSITIVITY	AS DESIRED - a) OFF b) 1, 2, 5, 10, 20, 50, 100, 200, 500 mv/div c) 1, 2, 5, 10 v/div

2.4 TEST SET DETECTOR SINGLE-SCAN OPERATIONS

2.4.1 Manual Data Entry

1. Position the 10-column data register for coding the program per computer program procedure.
2. Press the MDE switch on the scanner control to enter manual data.

2.4.2 I, E, N, and S Raw Data Parameter Tests

1. Position AUTO/LOCKOUT switch to AUTO; check that sequencer ready light is illuminated. Press RESET if not illuminated.
2. Check that all DELETE switches are in the down (OFF) position. Note: The ON position deletes a particular raw data test.
3. Ensure that the shutter switch is in NORMAL position.
4. Ensure that the shutter switch is in FIXED position. Position the fixed chopper motor switch to ON.
5. Rotate the crossbar load switch, S-1, to 1 meg.
6. Position the sequencer FUNCTION switch to AUTO.
7. Select the desired bias polarity: -BIAS, NORMAL, or +BIAS. Adjust bias supply for the desired detector bias voltage. Note: Allow the detector to cool at least 5 minutes before applying bias voltage to detector. Select the scanned FIRST and LAST points as desired.
8. Press the scanner RESET switch to "CLEAR" the scanner logic circuitry.
9. Press the scanner START switch. The test set will record the following data on both data printer and paper punch:
   a. Bias resistor voltage from which bias current can be calculated
   b. Bias voltage
   c. Signal and noise measurements from which S/N ratio may be calculated

$$\text{Bias Current} = \frac{\text{Bias Resistor Voltage}}{2000 \times 50}$$

$$S/N = \frac{\text{Signal Reading/Signal Gain}}{\text{Noise Reading/Noise Gain}}$$

where: 2000 is the current sensor resistor
50 is the amplifier gain

$$\text{Detector Resistance} = R_D = \frac{V_B}{I_B} - R_L$$

where: R_D = detector resistance

V_B = bias voltage

I_B = bias current

R_L = load resistance (1 meg)

10. After completing the program, position the chopper power switch to OFF and return the AUTO/LOCKOUT switch to LOCKOUT.
11. Remove the recorded data from the tape punch and/or tape printer.

2.5 SINGLE-SCAN OPERATION WITH DELETE

1. Test parameters may be deleted when operating the test set in the automatic mode.
2. If any of the test parameters (I, E, N, or S) are to be deleted, move the respective switches to the UP positions.
3. Proceed as outlined under Test Set Detector Single-Scan Operations, paragraph 2.4.

2.6 TIME CONSTANT MEASUREMENTS

1. Position the fixed/variable shutter to VARIABLE.
2. Rotate the optics index to TC.
3. Position the sequencer function switch to SIGNAL.
4. Ensure that the sequencer signal gain and range settings are as desired.
5. Set the scanner control first point and last point as desired.
6. Position the DVM SAMPLE RATE control to HOLD.
7. Press the scanner control MANUAL switch with all the scanner controls as stated in paragraph 2.4.
8. Rotate the crossbar load switch to the 100-KΩ position.
9. Press the scanner control RESET and then the START switch.

10. Position the variable-speed chopper motor switch to ON and the rotation switch to CW.

11. Rotate the speed knob to the desired frequency.

12. Tune the wave analyzer to the chopping frequency; adjust both the chopping frequency and the wave analyzer to obtain a signal level corresponding to 0.707 that of the signal level at 510 Hz.

13. After performing the time constant measurements, turn the variable-speed chopper motor to OFF; position the shutter switch to FIXED; and rotate the crossbar load switch to 1 meg.

2.7 SPOT SCAN MEASUREMENTS (CROSSTALK)

1. Rotate the optics index to SPOT.
2. Rotate the aperture index to the 0.003-inch setting.
3. The sequencer, DVM, and scanner controls are the same as mentioned in the time constant measurements.
4. Position the fixed chopper motor switch to ON.
5. Rotate the crossbar spot scan switch to position 1 (Channel 10).
6. Viewing the scope or the wave analyzer (510-Hz frequency) adjust the X, Y, and Z divider heads for a maximum undistorted signal level.
7. View the signal levels of all elements while irradiating Channel 10 (position 1). For spot scan Channel 30 (position 2) and Channel 45 (position 3), repeat steps 6 and 7.
8. After completing spot scan measurements, turn chopper motor switch OFF; return optics index to NORMAL.
9. Return sequencer, DVM, and scanner controls as described in Table 2-2, Single-Scan Operation Guide.

NOTE

Spot scan (crosstalk) measurements discussed in paragraph 2.7 consist of three components:

V_{CA} = optical crosstalk within the detector array

V_{CB} = electrical crosstalk within the detector assembly

V_{CC} = electrical crosstalk within the test set switching matrix

The total crosstalk (V_{CT}) measured by the test set is the sum of $V_A + V_B + V_C$. To obtain the crosstalk contributed by the detector array ($V_{CD} = V_{CA} + V_{CB}$):

$$V_{CD} = V_{CT} - V_{CC}$$

The method for computing the electrical crosstalk within the test set switching matrix is discussed in Section 3, Calibration Procedure, paragraph 3.12.

Spot size shall be defined in the following manner: The spot shall be positioned on the center of an element, then moved toward one edge of the element until the signal is 90% of its value in the center of the element. Record spot position. Continue to move the spot away from the center of the element until the signal reaches 10% of its center (maximum) value. Record spot position. The distance between the two recorded positions is the nominal spot size.

2.8 CRYOSTAT MEASUREMENTS

2.8.1 Pretest Operation

1. Adjust the DVM controls as follows (see Figure 1-6):

   FUNCTION: VAC (ac)
   RANGE: AUTO
   FILTER: OUT
   TERMINAL: REAR

2. Adjust the sequencer controls as follows (see Figure 1-6):

   S6: LOCKOUT
   S8: SIG

3. Adjust the scanner controls as follows (see Figure 1-4):

   FIRST POINT: As desired
   LAST POINT: Same as above
   MANUAL: Press in
   RESET: Press in
   START: Press in

4. Adjust the pen recorder controls as follows (see Figure 1-6):

SENSITIVITY:	10 mv/div (Channels 1-3); 20 mv/div (Channel 4)
POSITION:	As desired
CHART SPEED:	25 mm/sec

5. Adjust the wave analyzer controls as follows (see Figure 1-4):

METER MULT.:	x1
MV FULL SCALE:	300
METER TC:	0.1
BANDWIDTH:	100
FREQUENCY:	510 Hz
METER ZERO:	Per paragraph 3.3.1

6. Mount the cryostat/detector assembly to the holding fixture, connect inlet cryostat gas line to the gas panel outlet connector, and connect the cryostat outlet gas line to the flow meter.
7. Pull down dump valve handle after connection has been made to the gas panel.
8. Energize compressor COMP ON switch to ON (see Figure 1-5).
9. With Regulator 1 control, adjust OUTLET pressure to 3600 psi.
10. With Regulator 2 control, adjust OUTLET pressure to 3000 psi.

2.8.2 Initial Cooldown Measurement

1. Press the pen recorder (Figure 1-6) CHART SPEED switch to 25. Cooldown time is a function of the responsivity level recorded on recorder Channel 1, the selected detector element as in paragraph 2.8.1, step 3. Bias desired detector element at 5 vdc.
2. Simultaneously press the pen recorder MARK EVENT switch (located on the right side of the recorder front panel) and position the gas panel CRYOSTAT PRESSURE switch to ON (Figure 1-5).
3. After the recorder has run for approximately 15 seconds, lower the recorder to 5 mm/sec (press CHART SPEED switch 5).

2.8.3 Steady State and Average Flow Rate Measurement

1. Let the recorder run at 5 mm/sec with a cryostat pressure of 3000 psi for approximately 15 minutes.
2. Press pen recorder MARK EVENT switch.
3. With Regulator 2 control, adjust CRYOSTAT pressure to 2500 psi (Figure 1-5).

4. When 2500 psi gas pressure has been reached, press pen recorder MARK EVENT switch (Figure 1-6).

NOTE

Pen recorder Channels 2 and 3 are recording resistance of temperature sensors 1 and 2, and Channel 4 is recording average flow rate.

5. Let the recorder run at 5 mm/sec with a cryostat pressure of 2500 psi for at least 10 minutes.

6. After 10 minutes have elapsed, press pen recorder MARK EVENT switch.

7. With gas panel Regulator 2 control, adjust CRYOSTAT pressure to 800 psi.

8. When 800 psi gas pressure has been reached, press pen recorder MARK EVENT switch.

9. Let the recorder run at 5 mm/sec with a cryostat pressure of 800 psi for at least 15 minutes.

10. After 15 minutes have elapsed, turn pen recorder CHART SPEED switch to STOP.

11. Return sequencer, DVM, and cryostat pressure switch to OFF; lift the DUMP VALVE handle and adjust scanner controls as described in Table 2-2, Single-Scan Operation Guide.

Section 3
CALIBRATION PROCEDURE

3.1 GENERAL

The calibration procedure for the SAIE Test Set describes overall system calibration and individual equipment calibration where applicable. The test equipment described in this calibration procedure has traceability to the National Bureau of Standards.

3.2 PREAMPLIFIER CALIBRATION

3.2.1 Test Equipment Requirement

1. Test oscillator HP-204B or equivalent.
2. Attenuator HP-350D or equivalent.
3. Items 1 and 2 may be substituted by a frequency synthesizer HP-3320B.
4. True rms voltmeter, HP-3400 or equivalent.

3.2.2 Procedure

1. Connect a 510-Hz, 1-volt rms signal having a source resistance of 300 ohms through an internal or external attenuator (14 db) to Channel 00 on the crossbar (J118).
2. Position the sequencer function switch (located within the sequencer panel) to NOISE and the NOISE GAIN to 1000.
3. Rotate the DVM SAMPLE RATE control to HOLD.
4. Adjust the scanner FIRST POINT to 00, press the MANUAL switch, the DATA switch, and the START switch.
5. Remove the preamplifier cover (located on crossbar housing rear panel) and connect the rms voltmeter across output state No. 1 (A1-6) and ground.
6. Adjust R19 for a gain of 5 (1-volt rms).
7. Replace the preamplifier cover and adjust the attenuator to 60 db.
8. Connect rms voltmeter to the preamplifier output, J115, and adjust R24 for a gain of 1000 (1-volt rms).

9. Position the sequencer NOISE GAIN to 10,000 and adjust the attenuator to 80 db.

10. Adjust R23 for a gain of 10,000 (1-volt rms).

11. Position the sequencer NOISE GAIN to 100 and adjust the attenuator to 40 db.

12. Check that the preamplifier gain is 100 (1-volt rms).

13. Position the sequencer NOISE GAIN to 10 and adjust the attenuator to 20 db.

14. Check that the preamplifier gain is 10 (1-volt rms).

15. Position the sequencer FUNCTION switch to SIGNAL and check the preamplifier gain with the following attenuator settings:

SIGNAL GAIN	ATTENUATOR
10	20 db
100	40 db
1,000	60 db
10,000	80 db

16. Remove the true rms voltmeter from the preamplifier output and connect to the bandpass filter output (J25).

17. Position the sequencer FUNCTION switch to NOISE, the NOISE GAIN to 1000, and the attenuator to 60 db.

18. Adjust the filter gain, R10, for a 1-volt rms output level.

3.3 BANDPASS FILTER CALIBRATION

3.3.1 Test Equipment Requirement

1. Use the same laboratory equipment as outlined in paragraph 3.2.1.

3.3.2 Procedure

1. Connect a 510-Hz, 1-volt rms signal having a source resistance of 300 ohms through an internal or external attenuator (14 db) to Channel 00 on the crossbar (J118).

2. Position the sequencer function switch (located within the sequencer panel) to NOISE and the NOISE GAIN to 1000.

3. Rotate the DVM SAMPLE RATE control to HOLD.

4. Adjust the scanner FIRST POINT to 00, press the MANUAL switch, the DATA switch, and the START switch.

5. Connect rms voltmeter to console front panel connector FILTER OUT (J25), and adjust bandpass filter gain control R10 for a gain of 1000 (1-volt rms).

6. Rotate signal generator to obtain the following output signal levels, and read the frequency at these signal levels:

SIGNAL LEVEL (db)	
0	
Lower -3	Upper -3
Lower -6	Upper -6
Lower -10	Upper -10
Lower -20	Upper -20
Lower -30	Upper -30

7. From the tabulation of signal levels versus frequency, compute the noise equivalent bandwidth (NEBW) and record.

3.4 WAVE ANALYZER

3.4.1 Meter Zero

1. Disconnect signal from INPUT connector.
2. Turn the MILLIVOLTS switch to maximum CCW.
3. Turn the METER MULTIPLIER switch to X.01.
4. Alternately adjust the METER ZERO controls for a minimum meter reading.

3.4.2 Internal Calibration Check

1. Disconnect signal INPUT connector.
2. Adjust frequency control for 10,000 Hz on the LED display (frequency in Hz).
3. Set MILLIVOLTS FULL SCALE switch to CAL position.
4. Adjust CAL ADJ (located on rear panel) for a full scale meter reading (1.0 ± 2%).

3.5 POWER SUPPLIES VOLTAGE ADJUST

Connect a digital multimeter (dc) to the following system power supplies (accessible from rear of console) and check or adjust voltage.

SUPPLY	VOLTAGE ADJUST
PS1	±15 vdc (±5%)
PS2	± 5 vdc (±5%)
PS3	±12 vdc (±5%)
PS4	+ 5 vdc (±5%)
BIAS	±1% of setting
PS6	+12 vdc (±5%)

3.6 OSCILLOSCOPE

This instrument is calibrated per Tektronix TLS 54AR maintenance manual.

3.7 DVM

This instrument is calibrated per Hewlett Packard 3480D/3484A maintenance manual.

3.8 PAPER PRINTER LOADING

1. Remove scanner front panel by turning locking screws maximum CCW.
2. Turn printer locking screw maximum CCW and pull printer outwards.
3. Remove paper roll and spindle.
4. Insert spindle in paper roll and load in printer so that paper will unwind from the top up.
5. Feed paper between paper guide plates until it will go no further.
6. Press PAPER ADVANCE until paper exits front of printer.

3.9 PAPER PUNCH

1. Pull the punch outwards on its slides.
2. Place the POWER switch in the OFF position.

3. Place the RUN/LOAD switch in the LOAD position. This is accomplished by moving the lever to the left until it engages the stop.

4. Place a spool of tape on the supply reel; thread it through the punch and out the opening in the front panel. The threading path is shown in diagram on punch chassis. A decal is mounted on each RPS 1075 adjacent to the punch illustrating the tape path.

5. Place the POWER switch in the ON position.

6. For Model RPS 1075, thread the tape leader under the post, through the rollers, and onto the take-up reel.

7. Place the RUN/LOAD switch in the RUN position.

8. On Model RPS 1075, place the SPOOL switch in the lighted position.

9. If a leader of tape with feed holes only is required, press FEED switch until the required amount of tape is punched.

10. If a leader of tape with code holes only is required, press DELETE switch until the required amount of tape is punched.

3.10 BLACKBODY/TEMPERATURE CONTROLLER CALIBRATION

1. Test equipment required for blackbody/controller calibration:

   a. Standard thermocouple

   b. Millivolt potentiometer, Leeds and Northrup, Model 8686 or equivalent

2. Prior to test set installation, check the internal thermocouple against a Blackbody Standard. A curve of temperature versus controller must be plotted and recorded. This procedure mates the blackbody with the controller.

3. Adjust the millivolt potentiometer controls for the blackbody external thermocouple (platinum, 13% rhodium).

4. Using the millivolt potentiometer conversion tables supplied with the instrument, convert the millivolt readings to degrees Centigrade (°C) or degrees Kelvin (°K), as desired.

5. Adjust both blackbody controller dials to provide a 500°K temperature reading and record.

6. After temperature stabilization (meter zero), check that controller dial reading corresponds to the desired temperature ±2°.

3.11 PEN RECORDER CALIBRATION

Perform pen recorder calibration as outlined in Brush Recorder, Model 1900 A, Instruction Manual.

3.12 TEST SET (SWITCHING MATRIX) CROSSTALK MEASUREMENT

1. Test equipment required is the same as described in paragraph 3.2.1.
2. *Connect a 1-volt rms signal source having a frequency of 510 Hz* and the internal or external attenuator (60 db for 1000 gain signal in the preamplifier) to detector "sun burst" connector pin 10.
3. Adjust the DVM controls as follows (see Figure 1-6):

   FUNCTION: VAC (ac)
   RANGE: AUTO
   FILTER: OUT
   TERMINAL: REAR

4. Adjust the sequencer controls as follows (see Figure 1-6):

   S6: LOCKOUT
   S8: SIG

5. Adjust the scanner controls as follows (see Figure 1-4):

   FIRST POINT: 01
   LAST POINT: 64
   SINGLE: Press in
   RESET: Press in
   START: Press in

6. Position the X-bar controls as follows:

   SPOT SCAN CHANNEL: 10
   LOAD: 1 meg

7. Record the DVM signal reading from all channels.
8. For measuring crosstalk from Channels 30 and 45, repeat steps 2 through 7 for the respective channels.
9. The channel crosstalk voltage reading is the voltage developed across the switching matrix (V_{CC}). The crosstalk percentage for a channel is:

$$\%V_{CC} = \frac{V_{MEAS}}{V_{SIG}} \times 100$$

where: V_{MEAS} = output voltage measured on each channel when a crosstalk calibration signal is injected on the referenced test channel (10, 30, or 45)

V_{SIG} = output voltage measured on referenced test channel (10, 30, or 45) while the crosstalk calibration signal is applied

See Table 3-1, Channel Signal/Test Signal Ratios in Percent.

3.13 GAS PANEL PRESSURE GAUGE CALIBRATION

3.13.1 Equipment Required

1. Master Pressure Gauge, Heise, Model 177 or equivalent.

3.13.2 Procedure

1. Use Freon 14 gas for performing gas panel calibration.
2. Position CRYOSTAT PRESSURE switch to OFF.
3. Attach master pressure gauge to cryostat inlet pressure line. The master pressure gauge should be in an upright position facing the operator.
4. Set the compressor high limit switch to 6000 psig and the low limit switch to 3800 psig.
5. Position the COMPRESSOR switch to ON allowing the system pressure to rise to 3200 psig on the compressor psi gauge. Position the COMPRESSOR switch to OFF. If the system is already above 3200 psig, disregard this step.
6. Do not adjust Regulator No. 1 unless outlet gauge of Regulator No. 1 reads less than 3200 psig after step 5.
7. Turn Regulator No. 2 fully CCW (closed).
8. Close the dump valve (down).
9. Position CRYOSTAT PRESSURE switch to ON.
10. Adjust Regulator No. 2 to 3100 psig on master pressure gauge.
11. Slowly bleed system to 3000 psig on the master pressure gauge by carefully lifting the dump valve handle. When 3000 psig is achieved, record and label all gauges.
12. Adjust Regulator No. 2 until the master pressure gauge reads 2500 psig.
13. Record and label the cryostat pressure gauge with the master pressure gauge adjusted to 2500 psig.

Table 3-1. Channel Signal/Test Signal Ratios in Percent

	CHANNEL	%V_{CC}	CHANNEL	%V_{CC}	CHANNEL	%V_{CC}	CHANNEL	%V_{CC}
CHANNEL 10	1	0.9	17	1.4	33	1.3	49	<0.8
	2	1.2	18	1.0	34	2.1	50	<0.8
	3	1.7	19	<0.8	35	1.4	51	<0.8
	4	2.0	20	<0.8	36	1.0	52	<0.8
	5	1.5	21	1.7	37	0.9	53	<0.8
	6	2.5	22	4.0	38	<0.8	54	<0.8
	7	1.3	23	2.8	39	0.9	55	<0.8
	8	3.8	24	1.6	40	<0.8	56	<0.8
	9	4.5	25	1.6	41	<0.8	57	<0.8
	10	-	26	<0.8	42	<0.8	58	<0.8
	11	4.7	27	1.3	43	<0.8	59	<0.8
	12	2.4	28	<0.8	44	<0.8	60	<0.8
	13	1.1	29	<0.8	45	3.0	61	<0.8
	14	1.7	30	2.7	46	1.0	62	<0.8
	15	1.6	31	<0.8	47	<0.8	63	<0.8
	16	1.0	32	<0.8	48	<0.8	64	<0.8
CHANNEL 30	1	1.1	17	3.0	33	2.8	49	1.1
	2	1.5	18	1.8	34	4.3	50	<0.8
	3	3.8	19	1.1	35	2.2	51	<0.8
	4	3.0	20	1.0	36	1.9	52	<0.8
	5	1.6	21	4.4	37	1.1	53	<0.8
	6	2.1	22	3.7	38	0.9	54	<0.8
	7	2.1	23	3.9	39	1.5	55	<0.8
	8	2.3	24	1.9	40	0.9	56	<0.8
	9	3.6	25	1.6	41	0.9	57	0.9
	10	2.8	26	1.2	42	1.2	58	<0.8
	11	2.0	27	2.8	43	1.1	59	<0.8
	12	2.0	28	1.6	44	1.3	60	<0.8
	13	1.6	29	1.4	45	3.2	61	<0.8
	14	1.8	30	-	46	1.4	62	<0.8
	15	2.2	31	1.3	47	<0.8	63	<0.8
	16	1.8	32	1.2	48	<0.8	64	<0.8
CHANNEL 45	1	<0.8	17	1.7	33	2.6	49	0.9
	2	0.9	18	1.4	34	4.4	50	<0.8
	3	1.7	19	1.0	35	4.1	51	<0.8
	4	1.6	20	1.1	36	2.5	52	<0.8
	5	1.1	21	2.8	37	1.7	53	1.2
	6	1.4	22	3.8	38	<0.8	54	<0.8
	7	1.7	23	2.2	39	0.9	55	1.0
	8	1.7	24	4.0	40	<0.8	56	1.3
	9	2.5	25	2.8	41	<0.8	57	1.6
	10	3.0	26	0.9	42	1.2	58	<0.8
	11	2.9	27	1.5	43	2.0	59	<0.8
	12	3.7	28	1.0	44	1.6	60	<0.8
	13	1.0	29	1.0	45	-	61	<0.8
	14	1.1	30	3.1	46	3.3	62	<0.8
	15	1.3	31	1.2	47	1.2	63	<0.8
	16	1.1	32	1.3	48	<0.8	64	<0.8

14. Adjust Regulator No. 2 until the master pressure gauge reads 800 psig.

15. Record and label the cryostat pressure gauge with the master pressure gauge adjusted to 800 psig.

16. Position CRYOSTAT PRESSURE switch to OFF.

17. Bleed the outlet system through the outlet dump valve to 0 psig.

18. Detach the master pressure gauge.

3.14 FLOW METER CALIBRATION

3.14.1 Equipment Required

1. Wet Test Meter, American Meter Co., Model AL18-3 or equivalent.

2. Needle Valve, Hoke Model 2PY281 or equivalent.

3.14.2 Procedure

1. Remove flow meter from test set to perform calibration.

2. Connect line of wet test meter to inlet of flow meter under test. Use identical size tubing as interfaces the cryostat with the flow meter.

3. Connect dry gas supply having the needle valve in line to the wet test meter inlet set to 3 liters/minute.

4. Set gas supply pressure to 250 psi.

5. Ensure all inlet water filler valves on flow meter are closed; do not exceed flow meter capacity of 5 liters/minute.

6. Open dry gas supply valve and run gas through the wet test meter for 15 minutes.

7. Close dry gas supply valve; connect outlet line of the wet test meter to the flow meter under test. Use identical size tubing as interfaces the cryostat with the flow meter.

8. Open dry gas supply valve; compare the readings between the wet test meter and the flow meter.

9. Record the flow meter reading; place calibration label on meter.

10. If error between the wet test meter and the flow meter is greater than 2%, meter must be sent to factory or authorized service center for adjustment.

11. Reinstall flow meter in SAIE Test Set and balance.

Section 4

PREVENTIVE MAINTENANCE

4.1 GENERAL

The following preventive maintenance procedure shall be performed at every calibration period (90-day calibration cycle).

4.2 PROCEDURE

1. Record the preventive maintenance procedures performed in a Preventive Maintenance Log.
2. Clean test set exterior and vacuum interior thoroughly.
3. Clean all fans and filters; oil motor if necessary.
4. Check all test set internal cables for good connection at their respective connectors. Correct where applicable.
5. Check blackbody controller meter for null.
6. Position sequencer READY switch to LOCKOUT, rotate FUNCTION switch to SIGNAL, and inspect blackbody cavity.
7. If further maintenance is required, perform the necessary repair and record in the Preventive Maintenance Log.

4.3 CRYOGENIC RESIDUAL TANK AND DRYER (B)

The residual tank and dryer is located at the back of the test set in the inlet side of Regulator No. 2. The tank and dryer provides a constant pressure source to assist in maintaining the regulation of the gas supply to the cryostat, as well as providing filtration and drying of the gas as required. The tank and dryer requires preventative maintenance at infrequent intervals depending on the volume processed and purity of the gas used.

As a guideline, replacement of the removable cartridge of the tank and dryer is recommended after use with twenty (20) K-size Freon 14 gas bottles. Spares may be purchased from Robbins Aviation, Inc., 3817 Sante Fe Avenue, Vernon, California 90058 as "Purifier Cartridge, RAF-SPTMS" at a cost (1975) of about $30.

4.3.1 Removal of Purifier Cartridge

The residual tank and dryer, together with the replaceable cartridge, shall be removed in accordance with the following procedure:

1. Close Regulator No. 1 (outlet pressure zero).
2. Close Regulator No. 2 (outlet pressure zero).
3. Set Cryostat Pressure Switch ON, Compressor Switch OFF.
4. Cautiously open Dump Valve to bleed system from Regulator No. 2. Leave Dump Valve open.
5. Cautiously open Regulator No. 2 to bleed residual tank and dryer. Leave Regulator No. 2 open.
6. At rear of test set (top door behind Cryogenic Panel) identify the residual tank and dryer, inlet and outlet gas lines, and mechanical mounting connections (reference Drawing 29485).
7. Disconnect inlet and outlet gas lines at tank.
8. Disconnect mechanical mounting connections and remove tank from the test set.
9. Unscrew top cover of tank.
10. Lift out purifier cartridge and set aside.

4.3.2 Replacement of Purifier Cartridge

1. Remove the sealed plastic bag in which the cartridge is packed. Remove the red plastic tape covering the vent holes at one end. Remove the plastic cap from the tube at the other end.

   If a spare cartridge is not available, the used cartridge may be refurbished by baking at 120°C in vacuum for at least one hour. Discontinue baking and purge with dry nitrogen as the cartridge returns to room temperature. This refurbishment is both more expensive and less efficient than the replacement of the cartridge.

   In handling the cartridge, use clean lint-free gloves to prevent contamination by body oils on the cartridge.

2. Insert the cartridge in the tank (with vent holes up). The tube at the bottom of the cartridge must be seated against the pressure of an o-ring at the bottom of the tank.

3. Replace the top cover of the tank and screw in place until well-seated and marks on the cover and tank body are aligned.

4. Install the tank in the test set and connect the inlet and outlet gas lines (reference steps 8 and 7 of 4.3.1).

5. Close Regulator No. 2.

6. Set Cryostat Pressure Switch OFF.

7. Close Dump Valve.

8. Confirm that Freon 14 gas supply bottle is properly connected and valve is open.

9. Confirm that Compressor Gauge Pressure Limit Switches are set at 6000 (High) and 3800 (Low).

10. Set Compressor Switch ON.

11. When pressure is indicated on inlet gauge of Regulator No. 1, slightly open Regulator No. 1 to allow pressure to begin to build up in residual tank.

12. Confirm that gas lines and fittings at the residual tank are properly installed.

13. When inlet pressure of Regulator No. 1 is at least 3800, adjust Regulator No. 1 for outlet pressure of 3600.

    CAUTION: Regulator No. 1 must be opened slowly, and the adjustment monitored carefully. Outlet pressure will drop rapidly to initially fill the residual tank. Regulator No. 1 must be opened only sufficiently so that the outlet pressure is 3600 when the residual tank is fully pressurized.

14. Set Cryostat Pressure Switch ON.

15. Slowly open Regulator No. 2 and maintain slow flow through cryostat outlet tube for fifteen minutes to purge system.

16. Set Cryostat Pressure Switch OFF, and proceed as further immediate use of the test set indicates.

END 4-78
DDC