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STUDENT STUDY GUIDE

AIR TRAINING COMMAND

MISSILE LAUNCH/MISSILE OFFICER (SM-65F)

SYSTEM CHECKOUT AND MAINTENANCE
BLOCK III

July 1961

COURSE OZR1821B/3121B-4
TECHNICAL TRAINING

FOR INSTRUCTIONAL PURPOSES ONLY

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Atlas Branch
Department of Missile Training
Sheppard Air Force Base, Texas

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SQUADRON ORGANIZATION AND MANNING

OBJECTIVE

This study guide is to help you become acquainted with the missile maintenance organization and the personnel that are needed to support this activity.

INTRODUCTION

The missile weapon system would be worthless without personnel. Highly skilled personnel are necessary to operate and maintain the various components of the missile weapon system. The squadron personnel have been highly trained in certain skills, making it necessary to have an organization to coordinate these skills into a united effort to accomplish the mission of the strategic missile squadron.

MAINTENANCE CONCEPTS

Maintenance is all actions for the retaining of material in, or restoring it to, a serviceable condition, or improving equipment, to meet programmed requirements, installation of fixed communications, electronics equipment and facilities. Maintenance also includes the function of servicing, troubleshooting, manufacturing, rebuilding, testing, reclaiming and the condition status clarification of material.

Maintenance Engineering function covers approximately 33% of the personnel resources and approximately 40% of the dollar resources of the Air Force. These resources are greater than any other one function with the Air Force. It is mandatory that the Air Force have the best management program that can be developed.

The operational requirement for ballistic missiles dictates less time in the maintenance area than has been experienced in other programs. This time element has necessitated the designing of organizational level logistic support tailored specifically to these operational needs. Systems and procedures are being developed to perfect the required support package as well as criteria for continuous evaluation of effectiveness.

Maintenance data collection will be greatly expanded because SAC has developed new maintenance forms. These forms will be used for reporting information on maintenance items.

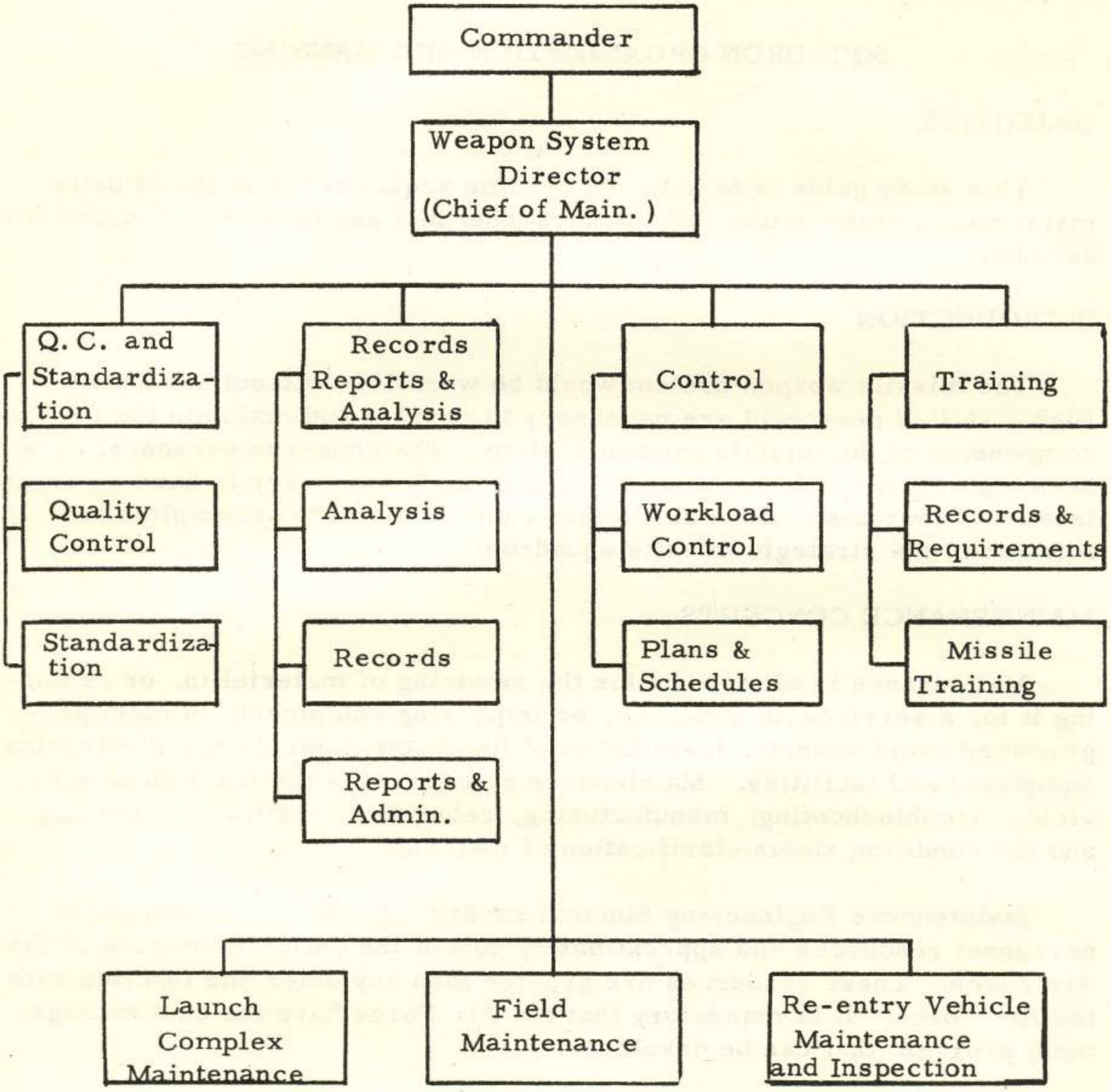


Figure 1 Maintenance Functional Chart

The fundamental responsibility of the maintenance section is to insure that a maximum number of launch installations are "In commission" at all times.

SAC has indicated a "Hands Off" policy in performing inspections and maintenance. Too frequent inspection and checkout will tend to decrease rather than increase reliability.

The differences in maintenance concept is due to changes in missile. These changes are:

1. Design simplification.
2. Increased reliability.
3. Changes in launcher configuration.

A maintenance functional chart is shown in Figure 1. The weapon systems director is the chief of maintenance. There are four staff sections under his direct supervision. They are (1) quality control and standardization, (2) records, reports, and analysis, (3) workload control, and (4) training. The launch complex maintenance, field maintenance and re-entry vehicle maintenance and inspection are also under the weapon systems director.

Maintenance Scheduling

When performing maintenance scheduling, five major points should be considered, they are:

1. What has to be accomplished.
2. Time required.
3. Personnel available.
4. Tools needed.
5. Parts required.

Types of Maintenance

There are two general types of maintenance; they are scheduled and unscheduled maintenance.

Scheduled (Periodic) maintenance can be predicted on an hourly, calendar or periodic basis; work load may be predicted to a high degree of accuracy.

Unscheduled or emergency maintenance is maintenance due to a failure of some system or subsystem that would prevent a launch; this type of maintenance cannot be predicted with any degree of accuracy but will be influenced by the caliber of scheduled maintenance that has been performed.

Levels of Maintenance

The ballistic missile concept is based on three levels of maintenance; organizational, field, and depot.

Organizational and field maintenance is that maintenance within the capability of the strategic missile squadron consistent with skills, equipment and/or facilities authorized.

Depot maintenance is that maintenance beyond the capability of the strategic missile squadron which will be accomplished at contractor or AF facilities or at the SMA by mobile depot teams.

The maintenance requirements are such that there should be a minimum interference with the readiness of the missile. The equipment should be designed for maintainability, and maximum use should be made of plug in units.

During the early stages of operation, missile units will depend heavily upon airframe and associate contractors to provide technical assistance in repairing equipment and calibrating test equipment and to furnish mobile maintenance teams to augment maintenance capability in the forward area.

The maintenance concept is designed to do as much maintenance, as far forward as is economically and technically possible. Missile organizations will be equipped and manned to perform maximum repair consistent with time and technical capability.

Organizational Maintenance Limitations

1. No repair of sealed or potted units.

2. No repair of precisely machined parts.

3. No repair of gyros or other finely machined, delicate tolerance items.

4. No repair of motor armature and stator windings.

5. No repair of items whose calibration would be disturbed during maintenance and which would require "hot" operation to recalibrate.

Organization and field levels of maintenance functions, as described in maintenance technical orders, are the responsibility of the missile organization. This consists of the maintenance at launch complex and missile assembly building. Mobile Checkout and Maintenance (MOCAM) will accomplish maintenance, testing, troubleshooting and isolating malfunctions at the launch complex. Maintenance beyond their capability will be performed by specialists dispatched from the missile assembly building as required. Bench maintenance, consisting of checkout and repair of components received from the launch complex, will be accomplished in the squadron maintenance facility.

Maintenance beyond the capability of the missile organization consists of depot level maintenance. Depot level maintenance is the responsibility of the Air Materiel Command with the Weapon System Manager. Depot level maintenance of non weapon system items will be the responsibility of the AMA/depot designated by AMC in accordance with normal procedures.

SQUADRON MAINTENANCE ORGANIZATION

The Weapon System Director (chief of maintenance) manages the missile maintenance organization and is responsible to the wing/squadron commander. He provides direction and guidance for all maintenance activities, implements maintenance policies of higher authority, and develops plans and schedules for maintenance activities. The chief of maintenance must annually estimate and program facilities, equipment, manpower and training requirements. He has the authority to reassign and/or reallocate personnel to meet maintenance requirements, to assign job and work priorities, and to schedule the movement of missiles from one maintenance phase to another.

It is particularly important that qualified personnel be selected to fill the staff and supervisory positions in the maintenance organization. The WSD must select competent assistants who are willing to assume responsibility. A wise manager will delegate the detailed maintenance operation to his maintenance officers.

Responsibility must be clearly defined and assigned to specific activities of the maintenance organization. The selection of inefficient supervisory personnel or the failure to properly delegate authority and assign specific responsibility results in over control, which is always followed by inefficiency and confusion. A WSD who is required to continually make minor decisions and personally prepare detailed procedures will have poor organization. It is a responsibility of the WSD to insure, through frequent observations and personal interviews, that key supervisors have a thorough knowledge of their responsibilities, duties and authority. The importance of intelligent supervision and adherence to management principles cannot be over emphasized. It must be understood that the efficiency of the maintenance organization depends on centralized controls, decentralized authority, and clear delineation of responsibility.

The WSD will require maintenance personnel on his staff to plan and develop sound maintenance policies and procedures for the effective administration, supervision and operation of the maintenance organization. All SOP's, policies, and local maintenance directives will be signed by the WSD under the authority line of the wing/squadron commander. All SOP's, policies, and procedures will be thoroughly researched to prevent duplication of, or conflict with, the directives of higher headquarters. Publication of nonessential information will be avoided.

Planning and scheduling of the overall maintenance function is vital to the success of the organization. Every action, every decision, must be based on a careful analysis of facts. For this reason a sound administrative system is required to gather and correlate the information essential for management of the entire maintenance organization. Available information must be used in making decisions in order to realize economy and efficiency. Factual data on use, availability, and status of manpower, equipment, and material must be collated and studied before a plan or schedule is made firm.

Management and control of the maintenance organization is provided for by four staff sections under the direct supervision of the WSD. (Figure 1) These are:

1. Workload Control

2. Analysis, Records and Reports

3. Training

4. Quality Control and Standardization

The above-listed staff will be centrally located in relation to the other activities of the maintenance organization. They must be provided with an effective communications and transportation system to insure the rapid transmission of maintenance data, control of work in progress, and control and movement of specialist personnel and supplies. Concentration of these activities in a central area is important because all are interdependent and must be closely coordinated. Effective control of maintenance demands a constant flow of information between the operating activities and the four management sections of the wing/squadron maintenance organization.

Workload Control

The workload control unit will be constantly alert to the balance of work within the maintenance organization. When one activity fails to accomplish its required maintenance or depends too heavily on the assistance of another maintenance activity, the maintenance capability will not be adequate to meet operational requirements. The result will be felt throughout the maintenance organization, and immediate corrective action must be taken. Immediate action must be taken to forestall or correct any unbalanced situation. Particular emphasis will be placed on the analysis of maintenance data and action on the results of these analysis.

Workload control and quality control will review all quality inspection reports and all corrective action indorsements to determine the quality of maintenance accomplished, the operational readiness of assigned missiles, the adequacy of corrective action, and areas of weakness within the maintenance organization. These reports must be current or their value is lost. Positive action will be taken to eliminate the causes of recurring discrepancies, correct the areas of weakness, improve the quality of maintenance, and increase the operational readiness of the organization. Copies of all quality inspection reports and statements of corrective action taken will be forwarded to the wing/squadron commander through the WSD.

The scope of the Workload Control unit may be better understood by discussing the duties and responsibilities of supervisory personnel within the unit. This unit is important in our discussion because of its close relationship with launch site maintenance.

Maintenance Control Officer

The maintenance control officer (through workload control) plans, schedules, directs and controls all activities of the maintenance organization as follows:

1. Plans and schedules maintenance necessary to meet the operations requirements established by the wing/squadron scheduling committee
2. Directs the dispatch of specialists and AGE in accordance with established priorities
3. Monitors the performance of all missile and AGE maintenance by assigning jobs, priorities, and completion times and by checking

progress to insure compliance with the established schedules

4. Schedules and controls the movement of missiles and AGE through all phases of maintenance

5. Maintains data on the status and location of missiles and AGE

6. Keeps advised of maintenance capability and adherence to a schedule

7. Schedules munitions loadings in missiles

8. Publishes a wing/squadron missile location plan

9. Coordinates with the quality control activity in the selection of missiles, AGE, or maintenance activities for quality inspection

10. Assists the analysis, records, and reports activity in establishing performance standards necessary for planning and scheduling, obtaining accurate missile records, and evaluating maintenance performance

11. Establishes and controls an effective maintenance communications and transportation system to provide for immediate transmission of data and for movement of maintenance personnel and equipment

12. Recommends cannibalization when such action is deemed advisable

13. Verifies MNORP (Missile not operationally ready parts) requisitions and maintains by missile serial number, current data on NOR (Not operationally ready) and MNORM (Missile not operationally ready maintenance) status

14. Operates a production control unit

Workload Control Officer

Since the workload control activity is the pivotal point for control of maintenance, it must provide sound direction to maintenance supervisors in accordance with established procedures and policies. The requirement to develop maintenance plans and schedules dictates the need for a complete familiarization with the entire SAC missile maintenance system. This activity will use data from the analysis, records, and reports activity to evaluate strengths and weaknesses and correlate them to the maintenance plan and schedule. The workload control officer:

1. Will insure that his personnel are kept fully informed of policies, procedures, and directives peculiar to their operation

2. Will maintain a reading file containing wing/squadron standard operating procedures and other directives current and applicable to the functions of this unit

3. Should allow his subordinates to make decisions within the sphere of their operation

Planning and Scheduling Officer

The planning and scheduling officer will assume the following duties:

1. Use the training program developed by the wing/squadron program committee to prepare the monthly missile utilization and maintenance schedule

2. Make changes and program into the maintenance schedule all unscheduled maintenance, Missile Out of Commission for Parts (MOCP's), grounding TOC's, depot projects, etc., for individual missiles

3. Coordinate with operations on all changes that affect the training schedule and insure that appropriate coordination is accomplished with support agencies to obtain munitions loadings

4. Coordinate with the quality control section for accomplishment of inspections

5. Insure that technical order compliances are controlled and programmed into the maintenance schedule based upon information provided by the other maintenance activities

6. Be responsible for conducting the periodic inspection planning meetings

7. Have knowledge of the current requirements of the Emergency War Operation (EWO).

Plans will be developed beforehand to take care of the smallest detail connected with its execution. He must know at all times the condition of each missile and where and how it will fit into the EWO schedule of events.

Maintenance Planner

The maintenance planner is responsible to the planning and scheduling officer for establishing the hour-to-hour work of the following day's maintenance activities.

The maintenance planner, using the individual missile maintenance plans, equipment, personnel availability and maintenance requirements, will plan the missile maintenance schedule for the following day. He will plot the plan on the workload control board by missile serial number and on the specialist dispatch boards by shop/activity. He will insure distribution of the firm individual missile maintenance plans to the affected organizations prior to morning roll call.

Senior Controller

The workload control unit senior controller is a qualified missile maintenance supervisor responsible to the workload control officer for the efficient operation and functioning of the control unit. In his position, the controller is in ready and frequent contact with the maintenance supervisors via the maintenance communications net. The Controller will:

1. Transmit instructions from the workload control officer to the maintenance supervisors
2. Notify maintenance activities of changes to maintenance plans or schedules
3. Direct the physical movement of missiles and mobile ground power as required for maintenance and servicing
4. Coordinate maintenance schedules, operations and priority changes with affected supervisors
5. Insure that the current location of AGE is reflected on the missile and AGE locator board
6. Control use of vehicles
7. Post all pertinent information to the workload control board

Because the controller's sphere of activity includes the support maintenance activities, he should be familiar with their organization and operation and be fully aware of their capabilities. He must constantly balance specialist availability against work requirements and insure that affected maintenance supervisors are following the concept of "first things first".

Expediter

The workload control unit has an expediter, responsible to the senior controller. The expediter will:

1. Be in direct and constant contact with the specialist dispatch section of the maintenance organizations

2. Operate and maintain the prescribed specialist dispatch board

3. Upon notification from the controller of work requirements for specialist support, initiate appropriate action with the respective maintenance activity, confirm the time requirements, plot or adjust requirements on the dispatch board, accomplish prescribed documentation, and coordinate work requirements and equipment support. Work stoppages and other delays will be appropriately documented.

4. Continually monitor outstanding job requests and follow up with specialist dispatch section to insure that maintenance schedules are being adhered to

5. Monitor the availability and disposition of specialists at all times. Through direct communication, he will insure that personnel availability and the status of job requirements fully coincide between the control and specialist dispatch section

Scheduler

The scheduler is the senior noncommissioned officer in the planning unit and is responsible to the officer in charge for planning and scheduling wing/squadron maintenance requirements. He will:

1. Be thoroughly familiar with the provisions of applicable directives, the local performance standards, the capabilities of the maintenance organization, and the current and projected maintenance situation

2. Be familiar with management principles and be capable of applying these principles to the accomplishment of the wing/squadron mission

3. Be thoroughly familiar with the capabilities of the base support activities

4. Be responsible for the development and current maintenance of the monthly missile utilization and maintenance schedules

5. Coordinate with the quality control activity in the selection of missile AGE for quality inspections

6. Control and program technical order compliances

Quality Control

The quality control unit is set up to provide the commanders, directors of weapon systems (chiefs of maintenance) and maintenance supervisors with the information necessary for evaluating maintenance. Quality must be observed continuously through the inspection of missile and support equipment in all phases of maintenance. Personnel performance and proficiency must be measured through standardization checks and analysis of job methods, practices and procedures. The product improvement program can be obtained only if there is maximum support from the maintenance personnel.

The command action, derived from quality control inspection reports and analyzes studies and standardization reports, emphasizes the importance of the relationship between this section and the director of weapon systems (chief of maintenance) and supervisors responsible for accomplishing maintenance.

The responsibility for safe missile operation and the determination of serviceability of items produced by the maintenance shops lie directly with maintenance supervisory personnel. Work accomplished throughout the maintenance complex will be signed off by the technician. Production inspection will be accomplished by qualified and designated technicians or supervisors. Quality inspection will be used in this regard only upon specific request of a maintenance supervisor who, because of lack of knowledge or doubt of the tolerances, may seek advice from the quality inspector prior to making his decision.

Quality control performs inspections to determine the quality of maintenance accomplished. It provides the control and preparation of material deficiency reports as required by T. O. 00-35D-54. To merit the confidence and active support of all maintenance activities, quality control must render complete, accurate and impartial reports with sound recommendations which will aid in the correction of discrepancies or irregularities. Quality control will accomplish a quality inspection, when practicable, on missiles and direct support/real property installed equipment (DS/RPIE), aerospace ground equipment, trainers, and simulators after completion of heavy, or major, field maintenance.

The material deficiency reporting section will process all reports required by T. O. 00-35D-54. This activity will maintain files necessary for control of material deficiency reporting throughout the maintenance organization. This activity will keep the chief of maintenance informed on material deficiency reporting and unsatisfactory material conditions concerning assigned air vehicles, AGE, trainers, precision measurement equipment, and simulators.

Maintenance Standardization

Maintenance Standardization may be defined as the development of procedural standardization. It is primarily a "troubleshooting" activity for the maintenance function. The objective is to improve maintenance effectiveness. It is a research activity which begins where quality control leaves off, recommending improvements in work environment and manpower utilization. Standardization will make available, knowledge of experienced personnel who are well schooled in high quality maintenance performance. This activity will demonstrate recommended maintenance methods. Assignments of personnel to this section should be for a maximum length of time. When correcting malpractices in existing techniques, procedures, or methods, standardization will devote maximum emphasis to actual demonstration. Obviously, not all procedures can be demonstrated to all personnel. Where the malpractice is sufficiently widespread to require several or continuing demonstrations, the normal procedure will be to demonstrate the method to technically qualified supervisory personnel. These personnel will then be responsible for further demonstration to personnel under their direction.

Training Control

Training control is responsible for developing and administering maintenance proficiency tests, monitoring performance evaluation, determining training needs, scheduling and monitoring training of assigned personnel and maintenance of applicable training records for assigned organizations and/or personnel. Training control will coordinate with the personnel directorate to insure control of maintenance training records for incoming and outgoing personnel.

Maintenance proficiency tests will be administered by training control. Responsibility for administering the phase tests may be delegated to the squadron training NCO's but the end of course test will be administered by training control personnel.

Immediately following administration of a maintenance proficiency test the results will be analyzed by training control to determine what training may be required. Training control will then schedule a meeting with the squadron training NCO and the individual's supervisor. The training problem will be discussed and a remedial course of action agreed upon.

Transportation

The Weapon System Director (WSD) is primarily responsible for establishing an effective transportation system within the maintenance organization, and, once established, its use will be controlled and supervised. The workload control activity is the agency directly influenced by transportation inadequacies; therefore, the monitoring of support and utilization is placed in this section. The maintenance control officer must know the current status and availability of transportation assets and insure that vehicle maintenance scheduling does not interfere with the missile maintenance operation.

Vehicles

Maintenance radio vehicles will be in operation at all times when maintenance is performed and as directed by the maintenance control officer. The wing/squadron will use radio vehicles to:

1. Notify workload control of all work completions and delays and provide notification of specialist and transportation requirements for return to shop

2. Transmit missile status information and specialist requirements to the workload control unit

3. Provide immediate communication support in event of fire, alerts, and other emergencies

4. Maintain contact with assigned missiles undergoing maintenance

Communications

For the maintenance organization to operate efficiently, it is necessary that an effective communications system be provided and used intelligently. The WSD will coordinate closely with the communications officer to make sure that adequate communications are provided, the latest type of equipment and services are available, and the communications system is operated in the manner intended. The system must permit the immediate and rapid transmission of instructions and requests for movement of specialist personnel, parts, materials, and equipment. Once established, it will be constantly evaluated by the maintenance control officer to insure that maximum service is realized.

Landline Communications

Landline communications facilities will be established between all activities involved in the maintenance operation. Each missile organization is or will be, authorized a communications system in the Program Communications (PC) document to support maintenance. This system is capable of great flexibility. The positions may be equipped with any combination of receiver-transmitter instruments; i. e., telephone, intercom sets, headset/mike units, etc. The type of equipment to be installed in the various positions will be determined by local commanders. One circuit of the authorized system will be isolated to allow for a direct (hot) line between the expediter in workload control unit, field maintenance branch, and AFW supply. Each position will be equipped with a headset/mike unit allowing for continuous contact between parties.

Radio Communications

The communications officer will be consulted for specific squadron authorizations. The radio set will be used to:

1. Transmit missile and AGE maintenance status, requests for parts and equipment, specialist requirements, etc.

2. Control vehicles used for transporting specialists to and from the job, for transporting parts between missile, AGE and shops, and for control of specialist work in general

The maintenance control officer, with technical assistance provided by the communications officer, will insure that published procedures and instructions covering radio voice communications are observed. Local SOP's will be developed and published, outlining instructions for use of the equipment to insure maximum effectiveness. Items to be considered in these SOP's are: use of master lists for ordering parts, use of correct and brief transmissions, scheduling of installed radio maintenance, manning of radio vehicles, etc.

LAUNCH COMPLEX OPERATIONS

Personnel assigned to each launch complex will be responsible for the operation and limited maintenance of the missile weapon system. To insure efficient operation of this activity, the Missile Launch Officer of each launch crew will be responsible for operations concerning assigned missile, including the surveillance of missiles at launchers in a ready status, targeting, countdown and launch; for accomplishment of quality maintenance on assigned missiles and AGE to include prelaunch preparation, minor maintenance (preventive, remove and replace); and accomplishment of applicable forms. The Missile Launch Officer, with the assistance of assigned personnel, is responsible for the following functions:

1. Planning and scheduling launch maintenance according to instructions and priorities by the workload control activity
2. Insure efficient accomplishment of quality maintenance and inspection of assigned missiles and AGE
3. Supervising and controlling maintenance accomplished by launch crews and specialists on assigned missiles and AGE
4. Insure compliance with current directives and SOP's
5. Establish controls necessary to obtain maximum availability and use of assigned personnel
6. Assign specific duties and delegating commensurate authority to responsible personnel
7. Know the current status of assigned missiles, AGE, and all maintenance in progress
8. Inform workload control of all changes in status and work in progress
9. Insure that maintenance personnel submit failure report information on all unsatisfactory conditions occurring within the launch maintenance complex
10. Insure compliance with all safety directives
11. Insure that the workload control activity is notified or personnel availability at the beginning of each work shift

The launch complex is responsible for accomplishing scheduled inspections, TOC's, servicing, and minor maintenance of assigned missiles and AGE where feasible. Minor maintenance will include maintenance that can be performed in the launch area by launch personnel within their technical capabilities, with authorized equipment and facilities, and within the allowable working period. Specialist assistance will be requested from workload control when maintenance is beyond the technical capabilities of this activity or exceeds the available time.

The missile maintenance organization must function as a team. Specialist support is available to assist the launch activity, and this activity must request it when required. Successful operation depends upon recognition by all personnel that the launch activity is not, and is not intended to be, a self-sufficient maintenance unit. If the launch complex does not follow this procedure and attempts more maintenance than it can or should perform, the maintenance workload becomes unbalanced and schedules are disrupted.

Missiles/AGE represent the immediate combat potential of the organization. It is essential that every effort be directed to maintaining maximum potential by thorough and careful accomplishment of launch maintenance. When this activity depends too heavily on the assistance of the other maintenance activities, the production and effectiveness of the unit is reduced.

The Missile Launch Officer is the top manager of the launch complex. He will manage the complex to insure that a proper balance is maintained in the accomplishment of the mission. The Missile Launch Officer, with the assistance of assigned personnel, will monitor all launch maintenance accomplished. Emphasis will be given to quality of maintenance and adherence to good management practices. When friction exists between the launch complex and support activities and cannot be eliminated by personal contact, the problem should be referred to the maintenance control officer.

The Missile Launch Officer will decentralize authority by assigning responsibility and delegating authority; he will insure that specific responsibilities and authority are known, understood, and carried out by each individual. All incoming personnel will be briefed on the organization and informed of their specific duties, responsibilities, and authority.

The Missile Launch Officer will plan and schedule the activities of launch complex maintenance to meet the maintenance schedule established by workload control. He will constantly monitor the progress of maintenance to insure that the schedule is being met. He must anticipate delays, and take appropriate action to prevent disruption of the schedule. He will refer maintenance problems he cannot solve to the maintenance control officer for action. He must be constantly alert for safety hazards and accident conditions and take immediate action to remove the hazards.

Periodic/Mobile Maintenance

In the "F" series missile and AGE simplification and accessibility have been considerably increased over previous models. As confidence in missile and launch control subsystems increase, inspection and checkout requirements will decrease and maintenance tasks will be reduced.

Because of the rapidity with which the weapon system was developed, it has not been possible to conduct a reliability program on the operational system as a whole. This can be accomplished by the using command at all operational bases by a program of decreasing or sampling inspections. This program will in no way jeopardize the weapon system and will provide a rapid means of determining systems reliability.

The desirable objective is to accomplish all checkout and maintenance at the SMA where facilities and environment are superior and costly test equipment can be reduced to a minimum. This objective can be obtained when it becomes evident through programmed inspections that missile and launch control subsystems will remain "In commission" for a period of six months or more. It then becomes more practical, from a standpoint of time consumed and equipment required, to replace the missile every six months than to accomplish programmed checkout and maintenance at the launcher. Under this plan, it is believed possible to maintain 11 of the 12 launch sites "In commission" 24 hours a day. The twelfth would be inoperable only for the time required to actually remove, replace, and validate the missile once every six months. This would also enable each missile, on its rotation cycle, to remain 20 days, if necessary, in the SMA for complete revalidation.

Many components and parts of a missile subsystem require virtually no inspection or checkout. They are protected from environmental damage and because they do not operate until the missile is fired, no wear is induced unless it be from unnecessary functional checkout. Other subsystems or components contain parts that may deteriorate or change characteristics with time. A complete functional checkout of the entire missile subsystem at too frequent intervals may tend to induce malfunction. It is desirable to reduce these system checkouts to the absolute minimum compatible with confidence in the operational status of the missile.

The following program will prove the reliability of missile and AGE subsystems and will pinpoint critical items.

1. When the missile is installed in the launcher, a complete missile and launch control subsystems check will be made and the site validated "In commission".

2. Thereafter, a daily monitoring inspection will be made of missile and launcher control subsystems.

3. Every 90 days from the time of installation in the launcher a systems checkout will be made by the mobile checkout and maintenance section, and a record will be kept of the malfunction of any single unit. During these 90 day checkouts, malfunctioning components will be removed and returned to the SMA, and a new

component will be installed. A record will be kept of the date of installation of the new unit.

4. After six months on the launcher, the missile will be returned to the MAMS for required maintenance and/or modification. During this six month period those units showing a tendency toward periodic malfunction will be analyzed and improved through redesign.

5. When record indicate that the major part of the subsystems shows no indication of malfunction over a test period of six months, complete systems checkout will be extended and spot checks will be made on questionable units until reliability of such units can be brought to a parallel with the balance of the system.

6. A continuation of this program of decreasing systems checkout in 90 day increments and spot checking of critical items can conceivably be extended beyond the present design goal of six months. Critical items will be brought up to the standard of endurance or will establish their own maximum endurance point when they must be periodically replaced.

SQUADRON ORGANIZATIONAL STRUCTURE IDENTIFICATION AND FUNCTION

Personnel

The importance of personnel cannot be over emphasized. The utilization of automatic equipment does not diminish the importance of people in the weapon system program.

The following tables give the positions of the different personnel under each section followed by a brief job summary of each position.

Periodic Inspection (Tables 1 and 2)

AFSC ALL INCORRECT

1. GST/M311X0P Guidance System Technician/Mechanic. This technician is responsible for the isolation and replacement of malfunctioning modules of the inertial guidance system and associated test equipment. He operates the alignment-countdown set to perform checkout of the missile guidance set and/or the missile-guidance-set modules.

2. MSAT/S314X0P Missile Systems Analyst Technician/Specialist. This specialist is responsible for checkout and maintenance, and operational surveillance of integrated missile systems. As an analyst, he is responsible for missile systems checkout during

LAUNCH SITES																		
Periodic Inspection (MOCAM)								R/V and Expl			COMM			Launch and Surveillance				
GST/M 311X0P	MSAT/S 314X0P	MPRT/R 421X2	MFS 541X0	MERT/R 423X0	MMT/M 433X0	MET/M 433X1	ES/E 561X0	LFSMT/S 568X0B	NWT/S 331X0B	MDT/S 461X1	GCEMT/R(L)304X2	TI-R 361X2	DCOET/S 36270/51	MLO 1824 (2)	MSAT/S 314X0P	MGSERT/R 421X3	EPPT/S 567X0	MFS 541X0

Table 1

MISSILE ASSEMBLY AREA																
Missile Periodic Inspection						Maintenance of Support Equipment								R/V Assy C/O		Expl Dspl
GST/M 311X0P	MSAT/S 314X0P	MPRT/R 421X2	MERT/R 423X0	MMT/M 433X0	MET/M 433X1	MSAT/S 314X0P	MPRT/R 421X2	MFS 541X0	MERT/R 423X0	MMT/M 433X0	MET/M 433X1	ES/E 561X0	LESMT/S 568X0B	NWT/S 331X0B	MDT/S 461X1	NWT/S 331X0B

Table 2

MISSILE ASSEMBLY AND MAINTENANCE SECTION																			
Propulsion				Pneudraulics		Cleaning		Guidance	Electronic and Electrical		Other Facility and GSE Maintenance						Comm.		
MET/M 433X1	MPRT/R 421X2	MET/M 433X1	LFSMT/S 568X0B	MPRT/R 421X2	LFSMT/S 568X0B	GST/M 311X0P	CST/M 312X0P	MTET/S(AP) 315X0P	MERT/R 423X0	MFS 541X0	MST/M 531X0	MPT/S 532X0	ART/R 534X0	ES/E 561X0	RS/S (EC) 566X0B	EPPT/S 567X0	GCEMT/R(L)304X2	TI-R 361X2	DCOET/S36270/51

Table 3

periodic inspections and diagnosis of unscheduled missile systems malfunctions.

3. MPRT/R 421X2 Missile Pneudraulic Repair Technician/Repairman. The Missile Pneudraulic Repair Technician/Repairman is responsible for organizational maintenance which includes inspection, checkout, and repair of the hydraulic and pneumatic distribution systems of the missile, aerospace ground equipment, and direct support facilities equipment. He also performs field maintenance of hydraulic/pneumatic components.

4. MFS 541X0 Missile Facilities Specialist Technician/Repairman. He operates and maintains mechanical and selfpowered aerospace ground equipment and facilities equipment not specifically identified by the work of subsystem technicians and assists in missile mating to the launcher and missile erection operations. He assists the MSAT in conducting command/response tests between logic units and specific AGE.

5. MERT/R 423X0 Missile Electrical Repair Technician/Repairman. This technician is primarily responsible for missileborne electrical equipment and AGE which serves to carry power and electrical signals to the missile. Within the missile, the Missile Electrical Repair Technician/Repairman is responsible for missile electrical power and electrical components which activate and control other missile equipment. This does not include missileborne electrical equipment which are integral components of the autopilot, the propellant utilization system, or the engine.

6. MMT/M 433X0 Missile Maintenance Technician/Mechanic is responsible for maintenance of missile airframe and mechanical fittings thereon. He provides assistance in missile handling including launcher installation and removal, re-entry vehicle mating and demating. He is also responsible for overall missile corrosion control. He assures that all susceptible parts are inspected for signs of corrosion and that preventative or corrective action is carried out as required by the appropriate directives.

7. MET/M 433X1 Missile Engine Technician/Mechanic
He schedules the work, maintains records, and coordinates maintenance activities associated with the rocket engine system. He has primary responsibility in ascertaining and establishing the operational capability of the rocket engine propulsion system, propulsion operating ground equipment, and rocket engine spares.

8. ES/E 561X0 Electrician Supervisor/Electrician
He is responsible for the maintenance of all facility equipment which is concerned with electrical power conversion, transmission, and distribution. Also included is field and organizational maintenance of electrical components of real property installed equipment (RPIE) which are primarily hydraulic, pneumatic or mechanical.

9. LFSMT/S 568X0B Liquid Fuel Systems Maintenance Technician/Specialist (Unconventional Fuel and Oxidizers)
This position encompasses overall responsibility for ground fluid storage, transfer, and control equipment. Periodic inspection to determine serviceability of propellant storage and transfer systems and their included pressurization systems. He may be called upon to repair or modify components of the missileborne liquid propellant system while they are mounted on the missile.

R/V and Explosive (Table 1)

1. NWT/S 331X0B Nuclear Weapons Technician/Specialist (Re-entry Vehicle)
This position is responsible for the coordination of the activities involved in the installation of the re-entry vehicle to the missile airframe, and for all checkout, maintenance, and troubleshooting procedures performed on the re-entry vehicle.

2. MDT/S 461X1 Munitions Disposal Technician/Specialist
He is responsible for the proper storage, handling, monitoring, installation and disposal of all explosive devices for the missile. These devices include the retarding rockets, turbin spin cartridges, hypergol packages, and squib valves. He is directly responsible for the safe handling, visual inspection, and checkout of all explosive devices used in support of the missile. He renders safe all explosive hazards including warheads destruct explosives, and incendiary munitions. He is responsible for area and equipment decontamination after exposure to toxic agents or radio active materials. He maintains accurate records of all explosives received and installed.

Communications (Tables 1 and 3)

1. GCEMT/R (L) 304X2 Ground Communications Equipment Maintenance Technician/Repairman (Light)
This position installs maintains, and repairs low powered ground radio equipment. Familiarity with single-sideband and microwave equipment is required for checkout and isolation of malfunctions.

He maintains records, and may supervise or assign work to subordinate maintenance personnel, or perform repair duties by maintenance chief. He checks out and repairs the Launch Enable System and such equipment as LF, MF, HF, VHF, and UHF transmitters and receivers, using hand tools and specialized test equipment.

2. TI-R 361X2 Telephone Installer-Repairman
He replaces, and maintains telephone and interoffice voice communications systems. He installs inside telephone wiring, connector blocks, telephones, etc. He maintains all telephone and interpanel equipment. During routine inspections of equipment he assists the central office Equipment Technician/Dial Central Office Equipment Specialist in the performance of his duties.

3. DCOET/S 36270/51 Dial Central Office Equipment Technician/ Specialist
He carries out maintenance schedules and procedures for the performance of checkout and maintenance of dial central office equipment within the missile complexes and the Missile Assembly Building. He directs and/or observes such activities as ground communication equipment transportation and handling, installation and testing, inspection, and periodic maintenance. He provides advice on interpretation of maintenance policies and procedures, technical manuals, and other source materials, and maintains ground communications system records.

Launch and Surveillance (Table 1)

1. MLO 1824 Missile Launch Officer (2).
His primary responsibility is to maintain the degree of launch crew proficiency and missile operational readiness necessary to fulfill any strategic operational commitment. He reports status of launch site readiness for countdown. He is immediately responsible for the intricate network of facilities and equipment at the launch site and for the surveillance and conduct of all personnel having business at the launch site. He is prepared at all times to conduct instantaneous countdown, including emergency and abort procedures. He participates in the planning of all scheduled maintenance and insures prompt action on all unscheduled maintenance at the launch site. His responsibilities cover a wide range of activities, including maintenance procedures, operational concept, Engineering Work Order (EWO) status, training, leadership, security, assessment of nuclear effects, and electrical engineering. Due to the complex nature of the communication equipment, it will be necessary to provide the launch crew

with special instructions in the operation and checkout of equipment.

2. MSAT/S 314XOP Missile Systems Analyst Technician/Specialist
This technician is responsible for checkout, maintenance, and operational surveillance of integrated missile systems. As an analyst, he is responsible for missile systems checkout during periodic inspections and diagnosis of unscheduled missile systems malfunctions. As a member of the launch crew, the Missile Systems Analyst Technician/Specialist is a technical assistant to the Missile Launch Officer (MLO)

3. MFS 541X0 Missile Facilities Specialist
This technician provides a major portion of the operations and surveillance capability necessary to maintain missile readiness. Major areas of surveillance include:

   a. Launcher and Utilities Assembly

   b. Heating, Ventilating and Air Cooling Systems

   c. Power Distribution Systems and Controls

   d. Pneumatic and Hydraulic Systems

   e. Fluid Storage Facilities

   f. Propellant Transfer System

   He inspects and determines deviations from normal equipment operating characteristics. He assists the Missile Systems Analyst Technician/Specialist in conducting command/response tests between logic units and specific Aerospace Ground Equipment.

4. EPPT/S 567X0 Electrical Power Production Technician/Specialist
He is responsible for the operation and maintenance of the diesel engine generators. He is on alert duty with each launch crew to insure that the launch site electrical power requirements are continuously available and reliable. He performs all organizational and field maintenance on diesel engine systems. This involves heavy mechanical repair on the engines themselves and maintenance of associated systems for fuel oil, lube oil, intake and exhaust, cooling and controls. He services and repairs the 500-KW electric generators and generator switchgear. He also conducts scheduled checks on this equipment and maintains the necessary logs and engine history records.

Missile Assembly and Maintenance Section

Electronic and Electrical (Table 3)

1. CST/M 312X0P Control System Technician/Specialist
   He is responsible for detailed field maintenance of flight control subsystem components. He inspects, removes, tests, repairs, and modifies these components on a bench-maintenance basis. He also provides for repair of nonprogrammed missile electrical/electronic test equipment. This does not include the electrical checkout vehicle, prelaunch monitor set, or guidance system test equipment, which are automatic. Utilizing special bench test equipment and electrical circuit schematic diagrams, the Control Systems Technician/Mechanic diagnosis malfunctions in missile systems test apparatus. He removes defective components, installs replacements, adjusts equipment, and performs major repair.

2. MTET/S 315XOP Missile Test Equipment Technician/Specialist (Launch control and APCHE).
   This position performs field maintenance of the squadron mobile electrical checkout vehicles and launch control equipment. He analyzes Electrical Checkout Vehicle (ECV) and launch control equipment circuitry to isolate malfunctions to a particular module. This procedure can be as complex as isolating an individual malfunctioning part in a nonmodularized system. He uses scopes, meters, and special test equipment to verify circuit integrity, thereby isolating a defective module. He replaces defective modules and checks the system to verify its return to good operating condition. He makes adjustments when subsystems are out of alignment. He makes mechanical repairs in the card feed system.

Other Facility and AGE Maintenance (Table 3)

1. MST/S 531XO Machine Shop Technician/Specialist
   This technician inspects in progress and completed machine work for quality of workmanship and serviceability, instructs in metals machining techniques and maintenance of machinery and equipment, and also supervises machine shop personnel.

2. MPT/S Metals Processing Technician/Specialist 532XO
   This specialist welds metals by oxyacetylene welding process. Welds metals and alloys by electric arc welding process. Forges small tools and miscellaneous items. Cleans, tests, and repairs coolant and oil temperature regulators, radiators and associated parts. He maintains welding equipment and cleans metals.

Supervises metal-processing personnel.

3. ART/R Airframe Repair Technician/Repairman 534XO
This repairman prepares sheet metal layouts and designs templates; performs difficult sheet metal forming operations and designs forming dies. Also, designs and constructs special sheet plastic-forming jigs and dies and performs complex sheet plastic forming operations. He troubleshoots missile structural inspection and repair situations. Performs staff level inspections. He also supervises airframe repair personnel.

4. Refrigeration Supervisor/Specialist (Equipment Cooling) RS/S 566XOB
This specialist is responsible for inspection, modification, repair, and test of refrigerant systems utilized for missile and AGE cooling. He performs unscheduled field maintenance, on request, and conducts leak tests and tests pressure and temperature of systems using pressure recorders and thermometers. After he makes adjustments to thermostats and valves he must operate the system for several hours to insure proper control of cooling action.

SUMMARY

It is mandatory that the Air Force have the best maintenance program that can be developed. Maintenance data will assist in developing an efficient maintenance organization.

The maintenance organization consists of four maintenance divisions: Analysis, Records and Reports; Maintenance Control; Training Control; and Quality Control and Standardization. These divisions are managed by the Weapon System Director.

The maintenance control officer (through workload control) plans, schedules, directs and controls all activities of the maintenance organization.

Systems reliability will be determined at the operational bases. When this is determined the inspection and checkout requirements will decrease and maintenance tasks will be reduced.

There are nine positions on the MOCAM section. The Missile System Analyst Technician (MSAT) will be in charge of this team.

There are five positions on the launch crew. There will be two Missile Launch Officers on this crew. The Missile Launch Officer will be the manager at the launch site. He will direct and coordinate the activities of the MOCAM crew and unscheduled maintenance repairmen during the period when they are at the launch site performing maintenance operations.

REVIEW QUESTIONS

1. What is the fundamental responsibility of the maintenance section?

2. What are the levels of maintenance?

3. What are the major maintenance divisions?

4. List the purpose and function of each of these maintenance divisions.

5. What is the purpose of the maintenance control officer?

6. What are some of the duties of the planning and scheduling officer?

7. What are some of the functions of the Missile Launch Officer and his assigned personnel?

8. What are the duties of the MSAT?

9. How many positions are assigned to the MOCAM crew?

MAINTENANCE MANAGEMENT AND MAINTENANCE CONCEPTS

INTRODUCTION

T. O. 00-20E-1 will be supplied with this study guide to give you the necessary information that is needed for the first part of this training project. This T. O. will give you knowledge on the planned inspection concept of maintenance, the inspection work cards, inspection sequence charts and maintenance forms and records.

Since all missile equipment will change from its original condition, it will be necessary to perform certain inspections. In determining the frequency and extent of inspections, some thought must be given to the function of the item or equipment and to what extent use and environment will effect this function. This study guide will give you the management tools that are needed to perform these inspections and the type of inspections that will be performed.

The last part of this training project will give you information on logistics which is the supply and transportation of weapon system items.

INSPECTION REQUIREMENTS

Definite periods of inspection, checkout, and servicing are established to insure the operational status of the weapon system. These periods have been determined on the basis of the minimum number and type of inspections or checkouts presently needed to meet the operational requirements. It can be readily understood that if each squadron were to specify a different time period for each phase of preventive maintenance, the work load on the squadron maintenance organization would be insurmountable with the available manpower. Each type of scheduled inspection requires a separate card file and processing system, and these must be kept to a workable minimum. The following authorized inspection and servicing periods are listed in their normal sequence. A flow chart of the maintenance sequence and configuration is shown in Figure 2.

Receiving (Assembly) Inspection

This inspection is made on the complete missile as received from the factory, rocket engines (not installed), and the re-entry vehicle (not installed) when they are first received by the squadron. The inspection does not apply to AGE or components becuase these are handled under a different system. The following tasks will be accomplished during the receiving inspection:

1. Transport protective covers and security fixtures removed
2. Noninstalled equipment unpacked and inspected
3. Inventory inspection and document examination
4. Missile cleaned and inspected for transport damage
5. Vernier engines installed
6. Missile guidance system installed
7. All missile subsystems checked and verified by MAPCHE
8. Missile prepared for transport to launcher or ready storage

Ready Storage Inspection

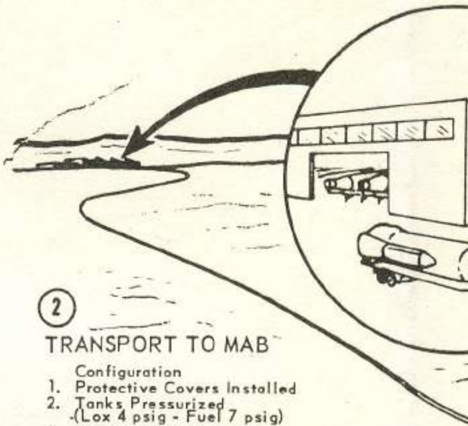
The missile is positioned on the missile handling trailer in a designated area at the MAMS. The tanks are pressurized, and the missile is in partial stretch as a safety measure. Protective covers, caps, seals, desiccants, etc., are installed. Tank pressures are monitored daily. Once every 90 days, the protective cover is removed and a superficial examination is made of the exterior surfaces of the missile for possible damage. The condition of seals and desiccants is checked.

Equipment canisters will be purged and pressurized. A systems checkout by the MAPCHE survey deck will be accomplished, the protective covers reinstalled, and the missile returned to ready storage.

Prelaunch Inspection

This inspection consists of those tasks required to insure that the missile and launch essential equipment are in commission, or ready to launch. It is actually a missile-to-launcher installation procedure and does not necessarily occur immediately prior to launch as the name might indicate. The launch control center and silo facilities are monitored daily and presumed to be in readiness. The following tasks will be accomplished during prelaunch inspection.

1. Transport cover removed and missile inspected for damage that may have occurred during transport from the MAMS to the launch area



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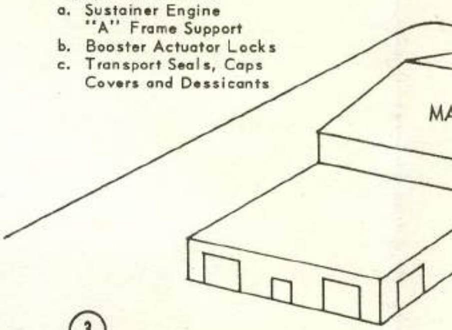
TRANSPORT TO MAB

Configuration
1. Protective Covers Installed
2. Tanks Pressurized (Lox 4 psig - Fuel 7 psig)
3. Equipment Not Installed
   a. Vernier Engines
   b. Aft Nacelle
   c. Missile Guidance Set
   d. Ordnance Items
4. Transport Security Equipment Installed
   a. Sustainer Engine "A" Frame Support
   b. Booster Actuator Locks
   c. Transport Seals, Caps Covers and Dessicants



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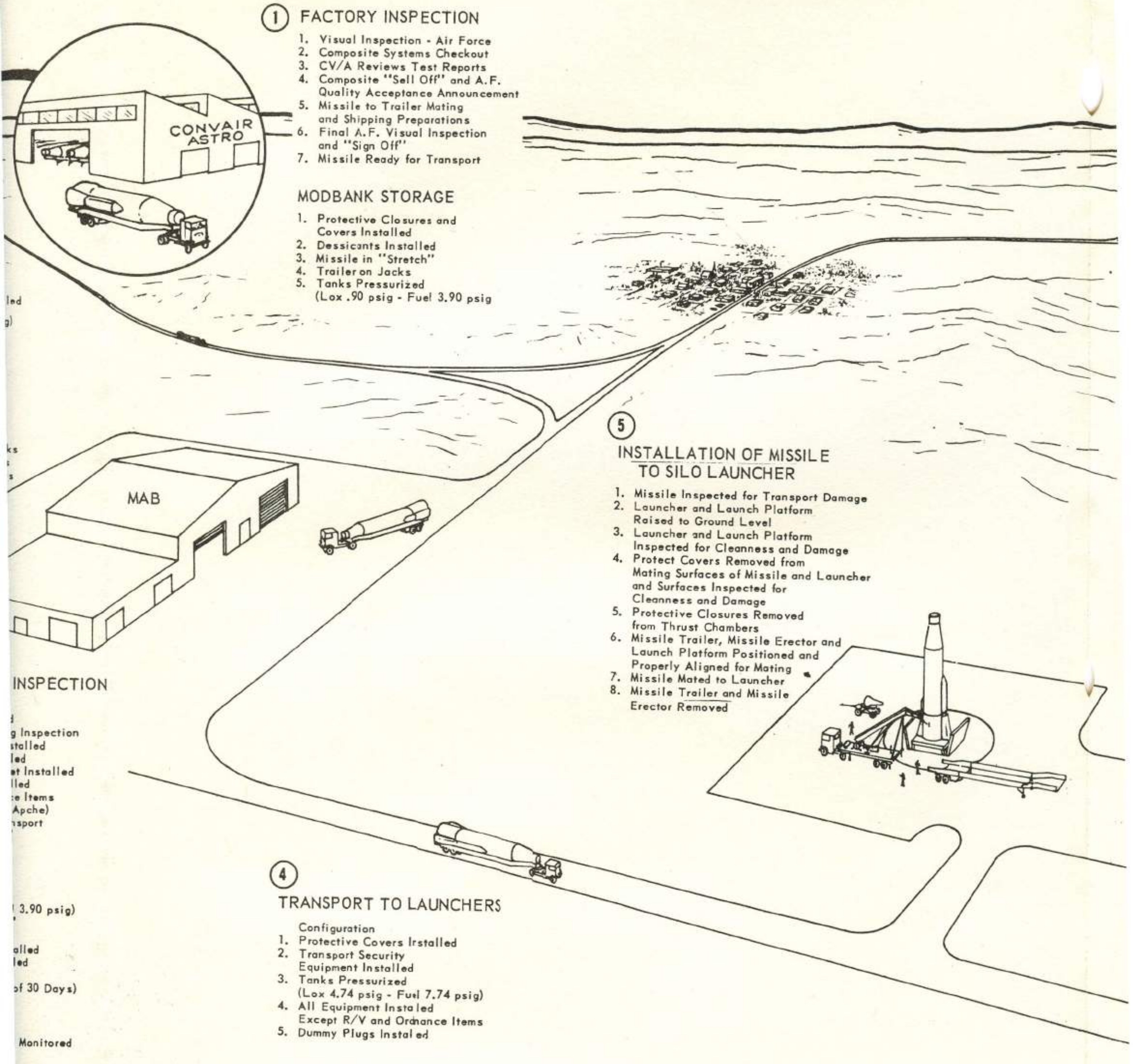
MAMS RECEIVING INSPECTION

1. Transport Security Equipment Removed
2. Assembly Receiving Inspection
3. Vernier Engines Installed
4. Aft Nacelles Installed
5. Missile Guidance Set Installed
6. Dummy Plugs Installed in Place of Ordnance Items
7. Systems Checkout (Apche)
8. Preparation for Transport or "Ready Storage"

READY STORAGE

Configuration
1. Tanks Pressurized (Lox .90 psig - Fuel 3.90 psig)
2. Missile in "Stretch"
3. Protective Covers and Dessicants Installed
4. Dummy Plugs Installed
5. Trailer on Jacks (Periods in Excess of 30 Days)

Inspection
1. Daily
   Tank Pressurization Monitored



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INSPECTION

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Monitored

① FACTORY INSPECTION

1. Visual Inspection - Air Force
2. Composite Systems Checkout
3. CV/A Reviews Test Reports
4. Composite "Sell Off" and A.F. Quality Acceptance Announcement
5. Missile to Trailer Mating and Shipping Preparations
6. Final A.F. Visual Inspection and "Sign Off"
7. Missile Ready for Transport

MODBANK STORAGE

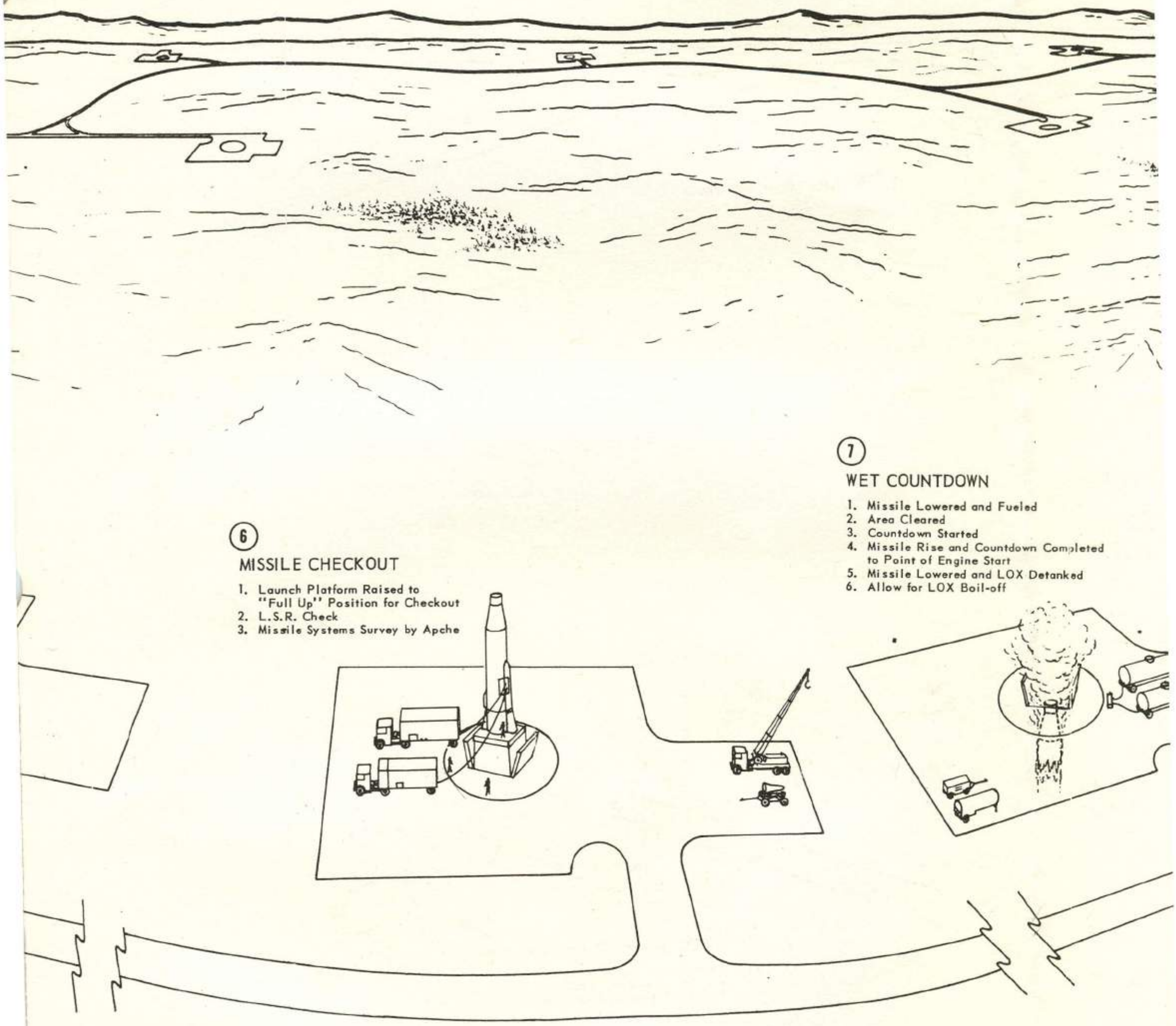
1. Protective Closures and Covers Installed
2. Dessicants Installed
3. Missile in "Stretch"
4. Trailer on Jacks
5. Tanks Pressurized (Lox .90 psig - Fuel 3.90 psig

⑤ INSTALLATION OF MISSILE TO SILO LAUNCHER

1. Missile Inspected for Transport Damage
2. Launcher and Launch Platform Raised to Ground Level
3. Launcher and Launch Platform Inspected for Cleanness and Damage
4. Protect Covers Removed from Mating Surfaces of Missile and Launcher and Surfaces Inspected for Cleanness and Damage
5. Protective Closures Removed from Thrust Chambers
6. Missile Trailer, Missile Erector and Launch Platform Positioned and Properly Aligned for Mating
7. Missile Mated to Launcher
8. Missile Trailer and Missile Erector Removed

④ TRANSPORT TO LAUNCHERS

Configuration
1. Protective Covers Installed
2. Transport Security Equipment Installed
3. Tanks Pressurized (Lox 4.74 psig - Fuel 7.74 psig)
4. All Equipment Installed Except R/V and Ordnance Items
5. Dummy Plugs Installed



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MISSILE CHECKOUT

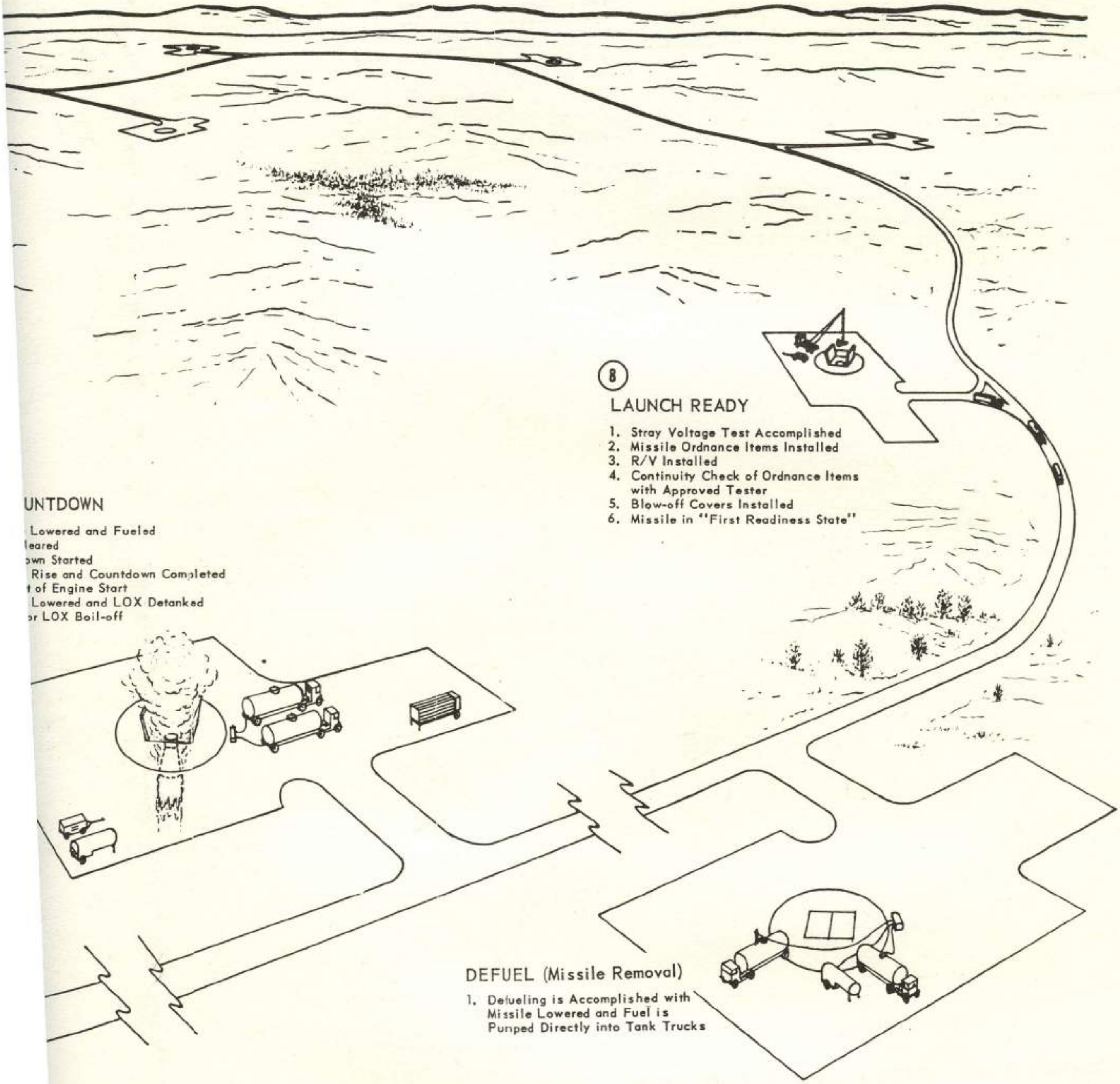
1. Launch Platform Raised to "Full Up" Position for Checkout
2. L.S.R. Check
3. Missile Systems Survey by Apche

⑦

WET COUNTDOWN

1. Missile Lowered and Fueled
2. Area Cleared
3. Countdown Started
4. Missile Rise and Countdown Completed to Point of Engine Start
5. Missile Lowered and LOX Detanked
6. Allow for LOX Boil-off

INTENANCE SEQUENCE AND CONFIGURATION, SILO SQUADRON



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LAUNCH READY

1. Stray Voltage Test Accomplished
2. Missile Ordnance Items Installed
3. R/V Installed
4. Continuity Check of Ordnance Items with Approved Tester
5. Blow-off Covers Installed
6. Missile in "First Readiness State"

UNTDOWN

Lowered and Fueled
leared
own Started
Rise and Countdown Completed
t of Engine Start
Lowered and LOX Detanked
or LOX Boil-off

DEFUEL (Missile Removal)

1. Defueling is Accomplished with Missile Lowered and Fuel is Pumped Directly into Tank Trucks

Figure 2

2. Launcher inspected for cleanliness, possible damage and security

3. Launcher exercised to assure proper operation

4. Missile and trailer positioned and properly aligned for mating

5. Protective covers removed from mating surfaces of missile and launcher and surfaces inspected for cleanliness and possible damage

6. Missile mated to launcher

7. Missile is checked in raised position

8. Missile systems survey accomplished by MAPCHE

9. Missile lowered and raised

10. Protective closures removed from thrust chambers

11. Stray voltage test accomplished using test points on dummy plugs

12. Re-entry vehicle installed

13. Missile explosive assemblies (pyrotechnics) installed

14. Continuity check of explosive assemblies with igniter tester

15. Blowoff covers installed

16. Missile in commission

Daily Inspection

This is primarily a monitoring function and should not take the missile out of commission. It can be stopped in case of an alert and should in no way affect the launching of the missile. It does not normally require critical or detailed inspection or the use of special tools. The following general tasks will be accomplished:

1. A "walk around" visual inspection, by area, will be made of the entire launch complex, including facilities, missile and related AGE. This is an inspection to detect obvious signs of contamination, corrosion, or damage and visible or audible signs of leakage.

2. All launch essential gages will be read and logged. The log will be kept to determine any change in daily readings that might indicate impending malfunction.

3. All indicator panels and consoles in the launch control center will be monitored. (This is normally done at every shift change).

4. Communications facilities will be verified "in order".

5. Main and auxiliary power supplies will be verified "operational".

6. Running equipment (motors, generators, compressors, etc.) will be observed for normal operation.

7. Transport equipment will be verified "ready for use".

First Periodic (Every 90 Days)

This is primarily a functional checkout of missile and launch essential AGE to determine launch capability. Missile systems will be verified by the MAPCHE ~~survey~~ SYSTEMS CHECKOUT deck which will indicate GO/NO-GO status to the subsystem level only. Before running the MAPCHE systems survey, the electrical connectors will be disconnected from the explosive assemblies of the re-entry vehicle separation, first stage separation and the retrorockets, and shorting clips will be installed. After systems checkout and before reconnecting, a stray voltage test will be made. The balance of the missile explosive assembly circuit will be rendered inactive by use of the maintenance mode.

~~Individual subsystem troubleshooting decks will not normally be~~ used ~~unless the survey deck indicates a malfunction within a specific subsystem.~~ Launch control will be checked by the launch signal responder and relay logic units. This periodic will also include functional verification of that AGE not checked by the automatic equipment. A visual inspection of missile, AGE and facilities will be made for damage, cleanliness, corrosion, lubrication, cleaning, adjustment, etc.

The first periodic is performed to determine that the missile and associated AGE remain in commission. It will not include detailed inspection, or checkout of individual components for alignment, calibration, or known operating characteristics, unless indicated by the overall systems checkout.

Second Periodic (Every 180 Days)

At the completion of 6 months on the launcher, a wet countdown is performed and the missile will be removed and returned to the MAMS for major inspection, servicing and maintenance. A replacement missile from ready storage will be installed in the launcher and a prelaunch inspection accomplished. During this recycle period, the missile will remain in the MAMS for approximately 20 days. It is estimated that normal maintenance action on the missile should not require more than 5 days unless major modification is scheduled. The balance of the time, the missile will be in ready storage and available for unscheduled missile replacement. The second periodic is established to provide adequate time for detailed missile maintenance, with the proper environmental conditions and required test facilities, and the minimum out-of-commission time on the launcher. The following general tasks will be accomplished during the second periodic:

1. A detailed visual inspection will be made of the entire missile for damage, corrosion, deterioration and contamination.
2. The missile will be cleaned and all traces of corrosion removed in accordance with specified procedures.
3. All missile subsystems will be checked and the components removed for bench maintenance and test when required.
4. Required leak checks will be performed on hydraulic and pneumatic subsystems and components.
5. Electrical components will be adjusted or calibrated as required.
6. Time significant items will be replaced.
7. General repair and servicing actions will be accomplished.
8. Scheduled modifications and retrofit will be accomplished.
9. Calibration requirements will be complied with.
10. A systems checkout will be made and all subsystems verified by MAPCHE.
11. Missile will be placed in ready storage.

The following tasks will be accomplished on AGE and technical facilities:

1. Visual inspection for damage, corrosion and general condition
2. Replacement of time significant items

3. Required cleaning and servicing

4. General repair and maintenance as required

5. Functional verification

Special Inspections

These inspections are required for specific circumstances or conditions not covered by other established inspection periods. They will usually occur as a result of an unscheduled condition such as an aborted firing or a Time Compliance Technical Order and will usually be limited to a specific rather than a general type of inspection. They will also be used to cover inspection requirements or operational checks that have an interval or frequency that does not coincide with established numbered periodics. Examples would be a preoperation or post-operation inspection, an inspection based on accumulated operating time, or an operational check required at an interval not covered by a numbered periodic.

The "Why" and "When" of Visual Inspection

Because all equipment starts out as new and operative, it is inspected for a change from the original condition. This may occur as a result of one or more of four basic conditions.

1. Elemental damage (contamination, corrosion, rust, deterioration, etc.) depending on material and environment

2. Physical damage, (cracks, dents, scratches, breaks, etc.) caused by contact, impact or stress

3. Security (security of mounting, torque, etc) because of vibration stress, or deterioration of material

4. Wear, caused by accumulated operating hours

In determining frequency and extent of inspection, some thought must be given to the function of the item or equipment and to what extent use and environment will affect this function. Obviously, equipment that is operating for long periods of time under adverse environmental conditions will require more frequent or detailed inspection than equipment that is operated infrequently and under protective environment. Conversely, a static state of operation on certain types of equipment, such as electronic or hydraulic, often tends to increase the hazard of corrosion or deterioration. Normally, inspection as frequently as daily or monthly is considered a light or surface inspection for obvious signs of change. Detailed inspection that requires examination of interior components or disassembly is usually scheduled at longer intervals to coincide with major maintenance.

LOGISTICS AND SUPPLY

The general objective of weapon system management is to provide a single point agency for Air Force using commands to refer all logistics support matters for a given air vehicle. It contains all functions and processes directly related to support: programming, initial provisioning, item identification, requirements, inventory management, transportation, cataloging, distribution and redistribution of stocks.

Logistics support for ballistic missile is a relatively new development for the Air Force which requires a flexible logistics system to accomplish the assigned mission. The necessity for missiles to be kept ready for firing on extremely short notice dictates a logistics system capable of immediate action.

The Ballistic Missile Logistics Program has been streamlined for the more stringent war plan and the major advance in weapons. This program has not been constrained by precedents or organizations, physical facilities, techniques or procedures when there is a better way. However, the pattern of past years developments has fitted nicely into the basic solutions.

Objective of Advanced Logistics System

The advanced logistics system management concept is designed to improve material management and support of complex advanced weapon systems. This concept is based upon three fundamental objectives:

1. Rapid and positive response to the logistic demands of weapon squadrons irrespective of geographical locations to which deployed.

2. Precision in the management of material.

3. Economy in the inventory investment.

The USAF'S Ballistic Missile Logistics Program

In the immediate future, the ballistic missile area offers the opportunity to design a logistics support structure, based on most advanced principles.

This study guide sets forth distinctive and essential features of the USAF'S Ballistic Missile Logistics Program as planned at this time.

Additional missiles entering the system will cause some changes.

To understand the complexity of logistically supporting ballistic missiles, it is necessary to examine certain facts regarding the magnitude and diversity of commodities involved. For example, the Atlas is divided into five major subsystems embodying the full range of commodities which are composed of some 300, 000 parts. To support the Atlas, the Air Force must procure and manage some 77, 000 different spare parts, components and Aerospace Ground Equipment AGE items: 32, 000 missile items and 45, 000 AGE items.

Spares required by major subsystem are:

Subsystem	Missile Spares Items	AGE Spares Items
Airframe	8, 000	30, 000
Propulsion	4, 300	2, 900
Accessory Power Supply	850	5, 000
Guidance	6, 500	4, 200
Computer	12, 000	2, 650
Re-entry Vehicle	260	400
Total	31, 910	45, 150

Air Force policy is to formulate logistics plans for support of new weapon systems concurrent with that development and production. The Ballistic Missile Logistics Program is an outstanding example of a highly tailored and flexible logistics system, developed to parallel the development, production and operation phases of missiles.

First, the program is built around a relatively complete Weapon System Support Concept. This concept integrates all functions required to produce totally operational and completely supported weapon systems. For no other weapon has the Air Force gone so far in applying this principle of weapon support management. Second, "Hi-Value" or selective management philosophy has been, and is being, incorporated in the Ballistic Missile Logistics Program. Third, the program employs, for the first time, a completely integrated Automatic Data Processing System.

The Ballistic Missiles Logistics Program involves the application and use of concepts and methods to a degree not previously attainable.

Responsibilities of Weapon System Manager

A Weapon System Manager (WSM) has been assigned the responsibility for providing integrated logistic support for each advanced weapon system. The integration of this system includes directing and/or coordinating the actions of each activity involved in providing logistic support to the weapon system complex (Figure 3).

The Weapon System Manager has been given prime responsibility for all peculiar types of equipment required to support a ballistic missile. "Prime" responsibility includes all essential management tasks from initial determination of requirements to ultimate expenditure or disposal. It also requires management of the complete range of commodities in the aerospace ground equipment area, as well as in the airborne missile area. In addition, responsibility for common items "primed" at the other Air Materiel Area is vested in the manager in so far as support of ballistic missile is concerned.

The operational advanced weapon squadron is responsible for organization and field level maintenance support.

The principal advanced weapon contractors are responsible for producing, storing, issuing and repairing items which are peculiar to the contractor's design. These functions are performed by the following contractor operated facilities:

1. Production facility.
2. Contractor storage site (CSS)
3. Contractor overhaul facility

Responsive Commodity Management

This is being supported by consolidating at lower management levels the functional area of supply and maintenance. The ultimate objective would be to combine these functions within an individual management area. In Missile Management, decisions pertaining to supply and maintenance functions are being made at levels much lower than normally employed in the Air Materiel Area.

There are two types of support items, the direct and indirect support items. The direct support item which when temporarily not available, retards the planned rate of launching. These items are listed in the

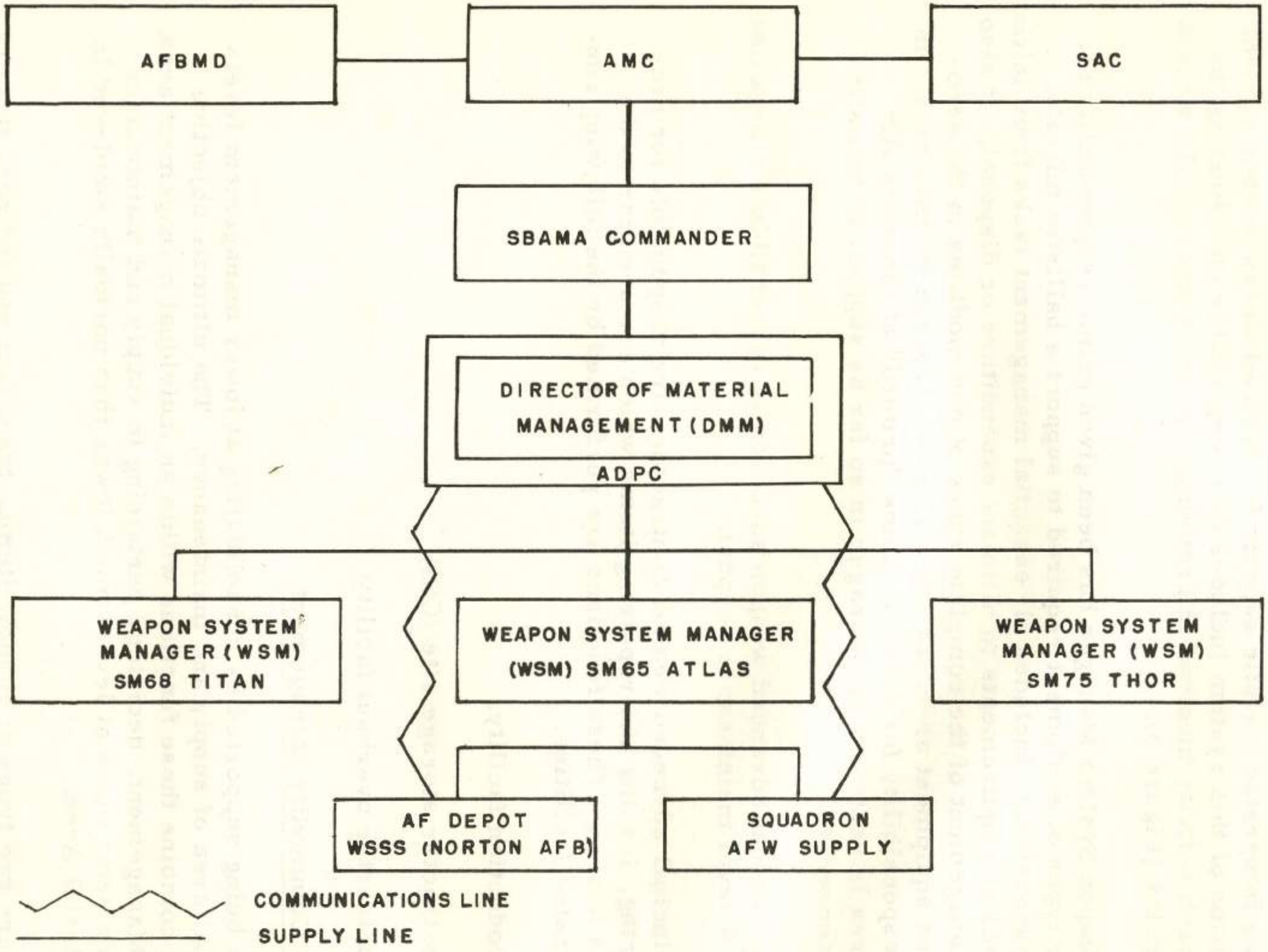


Figure 3 Missile Supply Structure

Weapon System Stock Control List (WSSCL) and are controlled by the Director of Materiel Management of AMC. The indirect support items are those items which are necessary and indirectly effect missile launching and when temporarily not available do not delay the planned launch. Indirect item support is provided by the support base supply activity to the missile squadron Unit Supply Section.

The designated stockage site for weapon system items, at the squadron is the Air Force Weapons Supply (AFW Supply). All transaction information is conducted through a transceiver linkage between the Air Force Weapons Supply section and the Weapon System Manager (WSM) at Norton AFB. This communications system is called comlognet which means combat logistics network. (Figure 4)

Transportation

The reduced stock levels, which are an integral part for ballistic missile support, are in turn dependent on a quick reaction of customer needs. The limited pipeline time objectives noted above demand a high degree of transportation capability with constant emphasis on minimum transit times.

Within the continental United States, the most effective transportation will be used which will meet the limited pipeline time factors built into the initial support and resupply phases of the program. Other modes may be used provided need dates are met.

Prime efforts will be used to assure that the advantages for long haul traffic are fully developed in the day to day support of the ballistic missile program. The Automatic Data Processing Center (ADPC) will be used for evaluating and establishing valid pipeline times for the traffic patterns used in maintaining logistic support. It will be used in the scheduling of shipments and maintaining suspense on all shipments in transit. Precise reporting of transit times and immediate analysis of carrier performance will be an outstanding feature of this system.

The support base transportation organization is responsible for: (1) the delivery of material to the missile unit, and (2) off base shipment of missile material. The strategic missile unit will move missiles between the missile assembly building and launch sites. Support services including medical, mortuary, laundry, dry cleaning, clothing repair, exchange service, food service, vehicle transportation, purchasing and contracting, commissary and subsistance will be provided by the support base.

Advantages of ADPE Use

Some of the advantages made possible through the use of Automatic

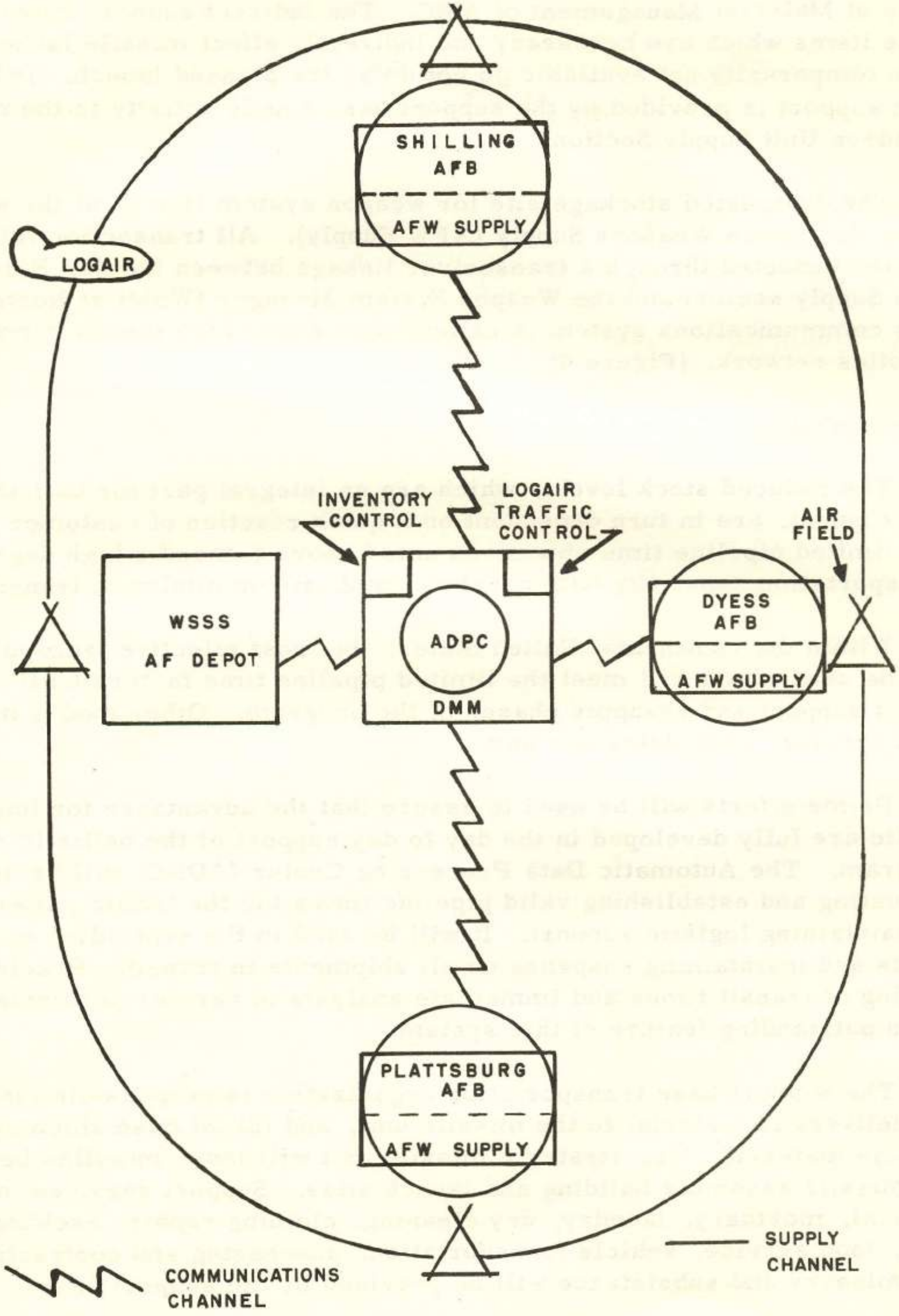


Figure 4 Supply Communications Channels Supply Support Flow Chart for Direct Support Items

Data Processing Equipment (ADPE) are:

1. Central accountability for all stocks within each weapon system.
2. Complete records of all weapon system stocks by location.
3. Immediate reaction too all requirements for advanced weapon direct support items.
4. Automatic computation of optimum stock levels and requirements.
5. Automatic initial supply and resupply of stock levels.
6. Suspense and necessary followup on outstanding shipping orders and intransit shipments.
7. Transportation scheduling for storage sites of high priority shipments.
8. Minimum intransit time.
9. Up to date configuration records.
10. Central inventory accounting monetary (IAM)-reporting.
11. Central UAL in Unit Support Equipment (USE) reporting.

A sample transaction report is shown in figure 5.

Importance of Accurate Data

Utilization of Automatic Data Processing Equipment (ADPE), does not diminish the importance of people in the logistic program. The potential advantages of automatic processing and central control can be realized only through great attention to accuracy by all data contributors. The instructions on the preparation of data to be transmitted to the ADPE; internal formats, documentation accompanying shipments, overhaul procedures, quality control and inspection procedures, technical order notification and completion, and other information required to assure efficient and effective support of this system. These instructions must be complied within the most minute detail to assure efficient processing by ADPE and to insure adequate logistics support of the advanced weapon program.

AFW Supply Organization

The Air Force Weapons Supply section is required to receive, store,

SAMPLE TRANSACTION REPORTING

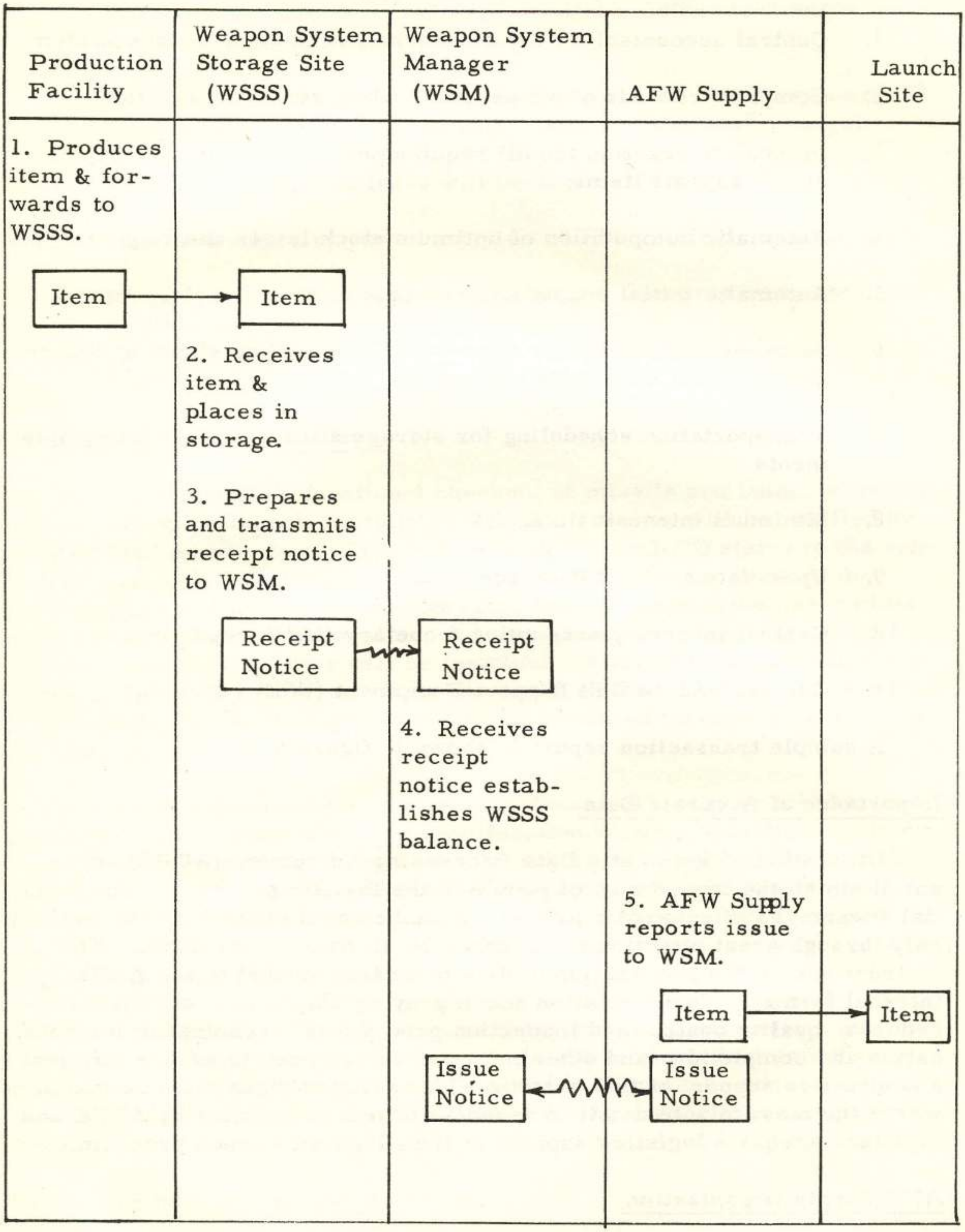
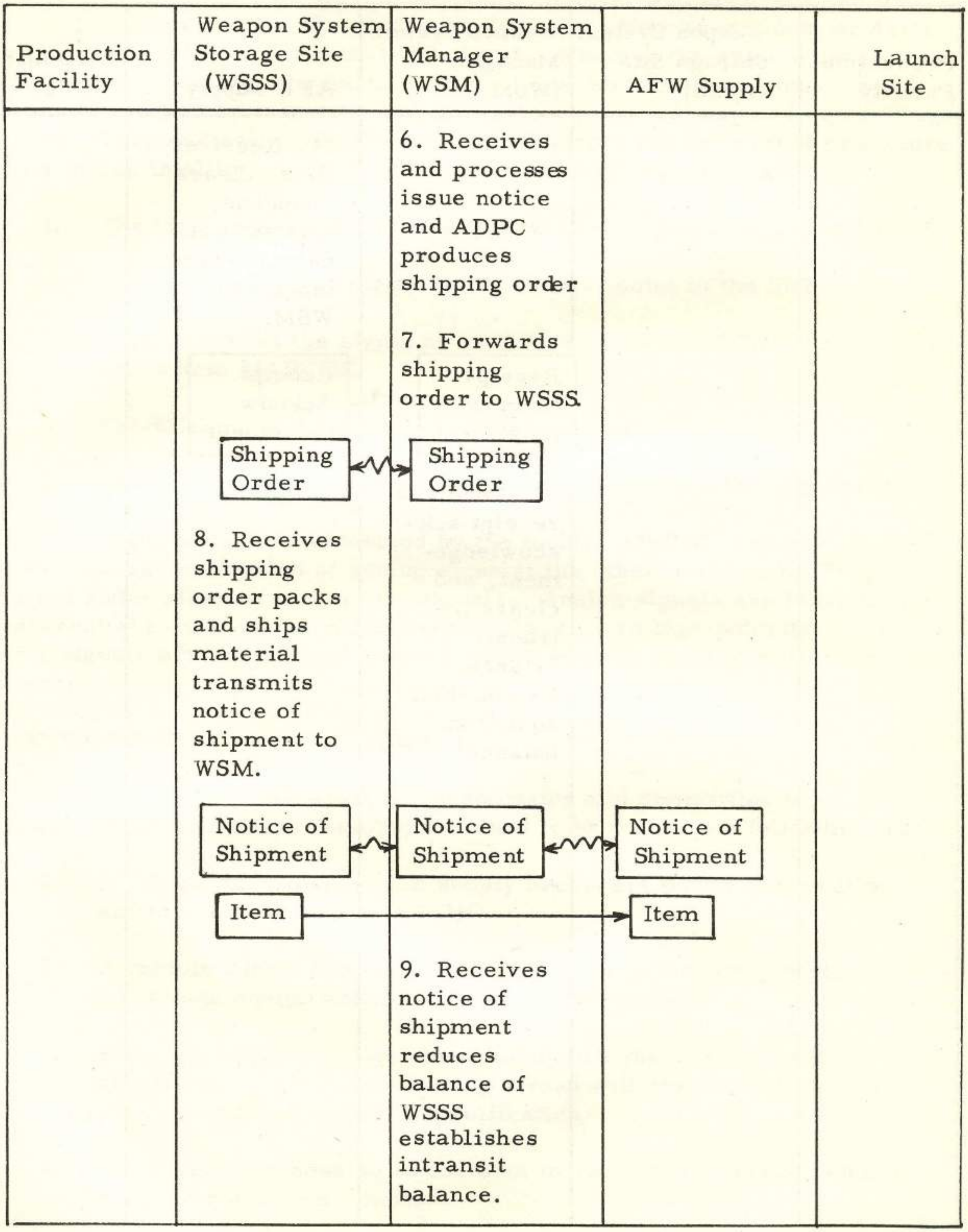


Figure 5 (Sheet 1 of 3)

SAMPLE TRANSACTION REPORTING Cont.



6. Receives and processes issue notice and ADPC produces shipping order

7. Forwards shipping order to WSSS.

8. Receives shipping order packs and ships material transmits notice of shipment to WSM.

9. Receives notice of shipment reduces balance of WSSS establishes intransit balance.

Figure 5 (Sheet 2 of 3)

SAMPLE TRANSACTION REPORTING Cont.

Production Facility	Weapon System Storage Site (WSSS)	Weapon System Manager (WSM)	AFW Supply	Launch Site
			10. Receives item, clears suspense, forwards receipt acknowledgement to WSM.	
		Receipt Acknowledgement	Receipt Acknowledgement	
		11. Receives receipt acknowledgement, and clears in-transit balance. Establishes squadron balance.		

Figure 5 (Sheet 3 of 3)

issue, deliver, and control stocks within the squadron by maintaining locator files, distributing assets and reporting transactions through the transceiver network to the Director of Materiel Management.

The Accounting Section will perform the following operations:

1. Report all missile supply transactions to WSM. Operate electrical accounting machine and comlognet equipment (Machine Unit).
2. Maintain document control file and Delivery Control Register
3. Make inventory comparison on WSM directed inventories.
4. File and account for all documents pertaining to AFW supply.

The Materiel Facilities Section (Figure 6), will receive, store, and issue supplies which includes:

1. Determining distribution.
2. Maintaining due out file.
3. Forwarding all property due out to the squadron.
4. Perform minor packing.
5. Perform proper functions for reparable and damaged parts.

The Storage Section (Figure 6), will perform the following operations:

1. Store and care for all stock.
2. Notify machine unit and expediter of location changes.
3. Issue property to delivery.
4. Perform required inspections on shelf life items.
5. Perform count on inventories directed by the WSM.

The Expediter Section (Figure 6), will perform the following operations:

1. Deliver items to user.
2. The maximum delivery time of 1 hour is mandatory. Average time of 30 minutes will be maintained.

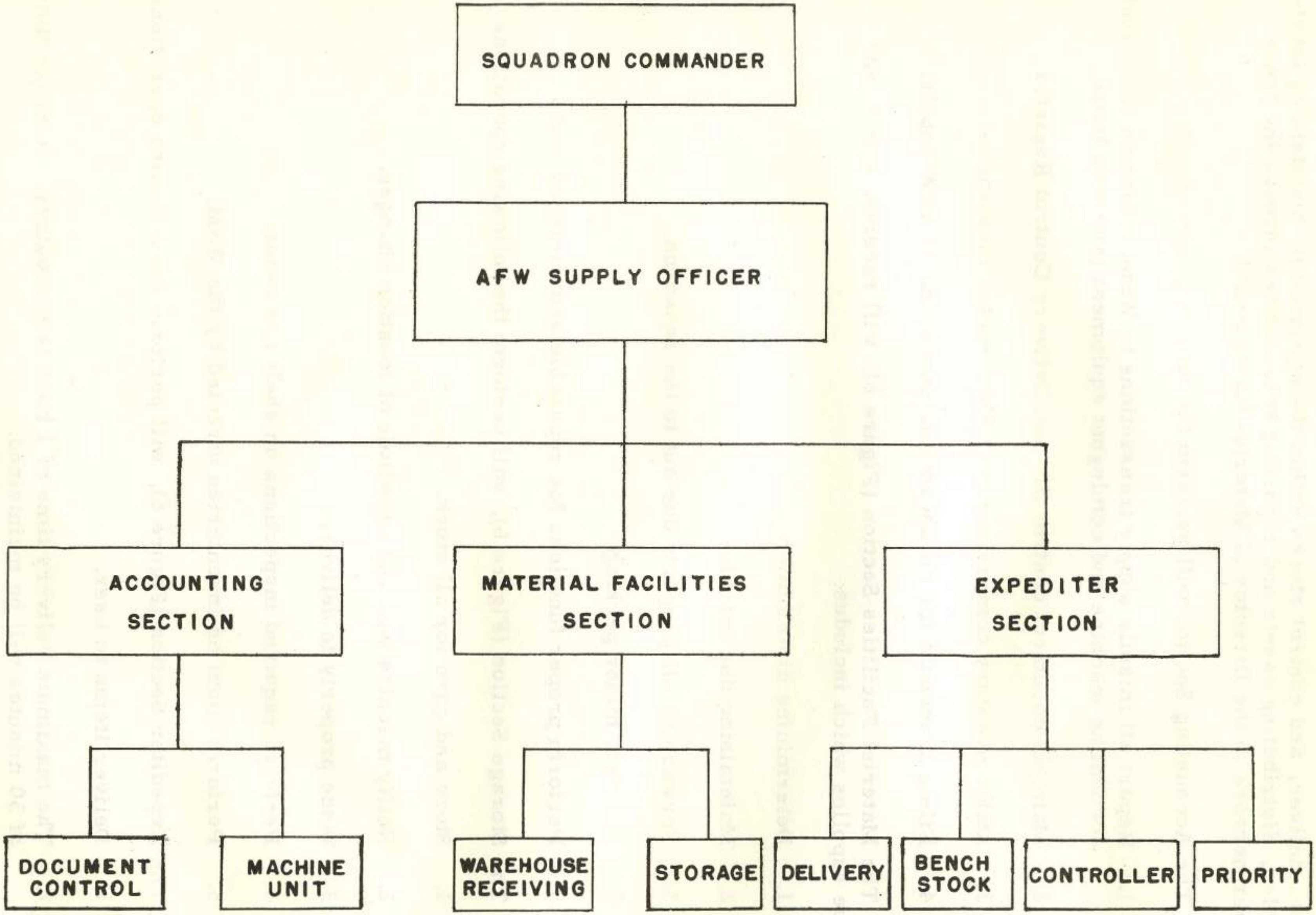


Figure 6 Air Force Weapons Supply Organizational Chart

3. Reporting of supply actions to Weapon System Manager after completing supply actions.

The Controller Section will perform the following operations:

1. Receive requests from maintenance organization.

2. Maintain Missile Out of Commission for parts (MOCP) status board. Control and know the whereabouts of delivery drivers at all times. Will maintain the controller file (requests from maintenance squadron).

The Priority Section will perform the following operations:

1. Establish priority on all back orders.

2. Perform followup on all outstanding requisitions.

3. Maintain limited Technical Order (TO) file, Weapon System Stock List and Provisioning Parts breakdown.

4. Assist in research to identify items not in WSSL.

5. Perform research to identify items not in WSSL.

6. Process all requests for establishment of AFW levels.

The Delivery Section will perform the following operations:

1. Makes deliveries to requesting activities.

2. Return completed issue notices to controller.

3. Pick up and deliver all reparables processed in the squadron except intershop work orders.

The Bench Stock is responsible for operation of squadron bench stocks for day to day use in maintenance work.

SUMMARY

The purpose of T. O. 00-20E-1 is to prescribe for missile weapons systems:

1. A planned inspection of maintenance with supporting forms.

2. The historical and maintenance forms that will be maintained for recording status, operational time, inspections due or completed, technical order compliance and schedules for time replacement items.

3. A system for recording basic information required for logistics, product improvement, engineering, and development purposes.

This technical order prescribes forms and procedures to assist the using organizations in maintaining the highest possible percentage of missiles and aerospace ground equipment in a state of readiness at all times and to provide essential information for development and supporting organizations of the Air Force.

Definite periods of inspection, checkout, and servicing are established to insure operational status of the weapon system.

Daily and periodic NO. 1 inspections are considered light or surface inspections for obvious signs of change. Detailed inspection that requires examination of interior components or disassembly is usually scheduled at longer intervals to coincide with major maintenance.

The Air Force has developed a single management agency for a logistics support structure which is built around a complete weapon system support concept. The Weapon System Manager is the support manager of ballistic missiles. The comlognet communications system is the linkage between AFW Supply Organization and the WSM.

REVIEW QUESTIONS

1. Why are symbols used on maintenance forms?

2. What do the following symbols indicate:

   a. Red X

   b. Circled Red X

   c. Red horizontal dash

   d. Red diagonal

3. How are red symbols on the AFTO Forms cleared?

4. How are symbols changed after original entry?

5. What is the purpose of the following forms?

   a. AFTO 26

   b. AFTO 26A

   c. AFTO 26B

   d. DD Form 829-1

   e. AFTO 2A

   f. AFTO 2B

   g. AFTO 2D

   h. AFTO 2E

6. At which inspection are the vernier engines installed?

7. When are the pyrotechnics installed?

8. When will all launch essential gages be read?

9. What are some of the advantages in using automatic data processing equipment to support the logistics program?

10. Which AFW supply section will receive requests for parts from other maintenance organizations?

Missile Launch/Missile Officer (SM-65F)
Atlas Branch
Department of Missile Training
Sheppard Air Force Base, Texas

OZR1821B/3121B-4-III-2
Student Study Guide

CHECKOUT EQUIPMENT

OBJECTIVE

To aid the student in understanding the physical description and operation of mobile APCHE, pneumatic checkout unit, and maintenance vehicle.

INTRODUCTION

The "F" series missile, due to simplification of design, reduction of components, and increased reliability resulted in the utilization of the 1 x 12 silo concept. Under this concept, a missile will remain on the launcher for a period of not less than 12 ~~6~~ months in commission. At no time, barring malfunctions, will the missile be out of commission for a period of more then 11 ~~4~~ hours and then only while undergoing regularly scheduled checkout. The design of the aerospace ground equipment (AGE) is greatly simplified over previous models, resulting in a reduction of the testing frequency. As confidence in missile and launch control subsystems increase, inspection and checkout requirements will decrease. The goal is to have the missile remain in commission without further checkout, except for daily monitoring, for 12 ~~6~~ months or longer.

Many components and parts of a missile subsystem require virtually no inspection or checkout because they are protected from environmental damage and are only operated when the missile is fired. Therefore the only deterioration or wear would come from unnecessary functional checkout. Other components or subsystems, because of their construction, contain parts that may deteriorate or change characteristics with time, necessitating regularly scheduled checkout. A complete functional checkout of the entire missile subsystems at too frequent intervals may tend to induce malfunctions and thereby defeat the ultimate objective. It is desirable to reduce these system checkouts to the absolute minimum compatible with confidence in the operational status of the missile.

Automatic programmed checkout equipment, (APCHE) will be utilized at the organizational level to evaluate operations of installed missile subsystems and to isolate malfunctions to specific components in minimum time. The equipment will be mobile and will accomplish missile system checkout at both the launcher and the MAMS. Additional checkout equipment will be available at the MAMS for component checkout.

The launch control console will continuously indicate the readiness of the launch control system and, in conjunction with the launch signal responders and the relay logic units, will be self-checking. The equipment will also be capable of simulating countdowns and malfunctions to comply with unit proficiency requirements.

MAINTENANCE CONCEPT

Basis for MOCAM Concept

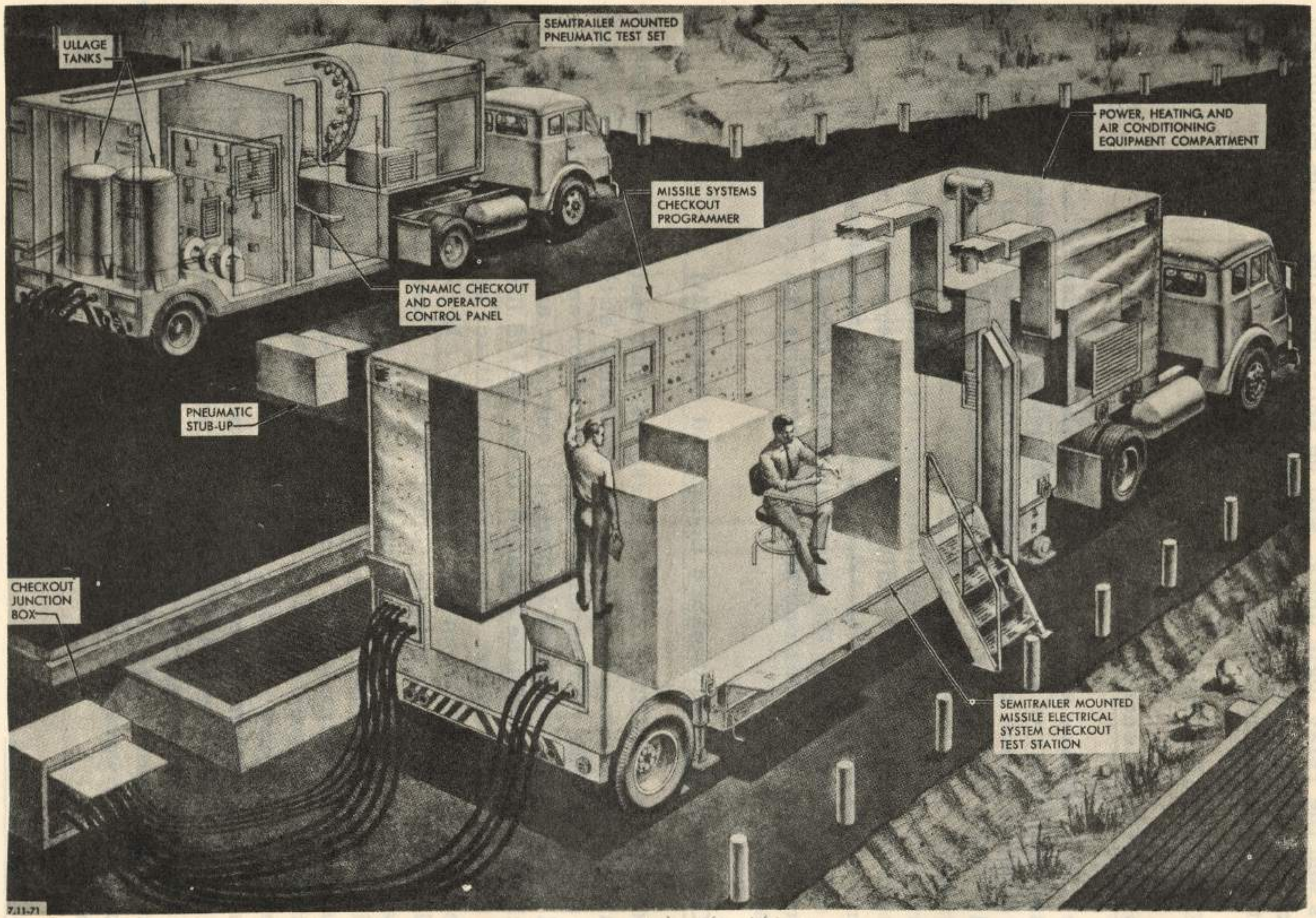
The 1 x 12 unitary silo concept is possible because of increased reliability and simplicity of the "F" series missile. This concept permits tactical dispersion and allows all missiles of the complex to be fired simultaneously. The "F" series missile squadron includes 12 strategically dispersed missiles, 15 to 18 miles apart surrounding a centralized MAMS. Distances between individual launchers and the MAMS dictate the use of mobile test equipment units to fully support the operational plan. An important aspect of this configuration is the utilization of one highly skilled crew to do the checkout for the entire squadron, thereby placing the most proficient specialists under one unit and increasing the overall reliability of the checkout crew.

Mobile Checkout and Maintenance Equipment (MOCAM)

MOCAM is a mobilized team of personnel and equipment required to perform weapon system checkout and maintenance at the dispersed launchers and at the MAMS. Three units are planned for each squadron. One unit will be normally occupied in periodic checkout and maintenance at the 12 launchers, another will be engaged at the MAMS for checkout of missiles in the rotational cycle. The third unit will act as a backup unit for unscheduled launcher maintenance. A unit of MOCAM (Figure 7) will consist of one electrical checkout vehicle, one pneumatic checkout vehicle, and one maintenance vehicle, which will contain critical spare parts, tools and special handling equipment. The complete checkout and maintenance crew will consist of approximately 12 men. A unit of MOCAM should be capable of checking out a complete launch site and validate it as operational in a maximum of four hours excluding any maintenance action. Periodic checkout and necessary maintenance will be accomplished by MOCAM once every 90 days at each launcher and will be available on a 24 hour per day basis for unscheduled maintenance. It should be stressed here that the maintenance at an operational site should encompass the integrated weapon system as a whole, which would include the missile, AGE and all technical facilities as well.

Checkout Procedures

An automatic programmed checkout determines the operational status



E PICTURE BUT SAME

Figure 7 Mobile Checkout and Maintenance Vehicles of a large group of circuits in a short period of time. Test procedures are predetermined so that the human variables in speed and accuracy can be reduced or eliminated. The circuits tested are either operational or defective as indicated by a GO or NO-GO signal. Whether the system under test is simple or complex, the basic method of operation is the same. The circuits are checked by inserting test data into a programming and controlling device. This unit called the programmer controls the entire test procedure by receiving intelligence from a punched card and determining:

1. The type of test signal to be applied to the system under test (SUT)
2. Distribution of that signal to the correct point in the SUT
3. Distribution of the signal or response from the SUT to the correct unit within MAPCHE
4. Establishment of upper and lower test limits
5. Operation of devices that will display and record the test results

Two basic tests are performed by the mobile APCHE: one test is the generation and evaluation of analog signals; the other pertains to the generation and evaluation of discrete signals. Analog signals are those which represent absolute values of frequency, phase or voltage polarity. Discrete signals are those which convey intelligence by their presence or absence.

TRANSPORTABLE APCHE (Figure 7)

To make the APCHE system transportable and compatible to the unitary configuration certain requirements had to be met in the following areas:

1. A vehicle to transport and supply necessary power distribution and air conditioning to APCHE
2. A vehicle with a shock isolation system to adequately protect electronic equipment from shock and vibration
3. Mounting of APCHE equipment to absorb shock and vibration created by a vehicle traversing a road with the rugged mobility requirements of military specifications
4. Equipment and housing to conform to radio interference requirements for electronic units.

5. Personnel able to operate the equipment entirely from within the trailer after connections were made at the stubup, and at the umbilical junction box.

6. Vehicle that can be towed with an Air Force type M-52 tractor, the same type tractor that hauls the missile

7. Air-transportable vehicle

All of these requirements have been met in mobile APCHE, the electrical checkout vehicle.

Trailer Design

The semitrailer is designed to contain, protect, and transport APCHE electronic equipment and to provide shelter and working facilities for personnel. Environmental control is provided for the trailer interior.

The shell of the aluminum trailer body is rigidly fastened to a rugged chassis frame, and structural members have a high strength/weight ratio.

The trailer van is 32 FT long, 8 FT wide and over 12 FT high. Weight of the trailer, with equipment, is 25, 000 LBS. The slightly crowned roof of the trailer is water tight and can withstand a static snow load of 40 LB/ FT^2 and a dynamic load imposed by a walking man. A side door entrance located on the curb side of the trailer body, serves as the main entrance for personnel, and is equipped with a boarding stairway. An inner vestibule with a sliding door protects the trailer interior from weather exposure. A door, located at the front of the trailer body, permits limited access to the forward utility compartment.

Suspension System

The suspension system is designed to absorb total road shock. The rear suspension system is an air-ride type, while the front suspension is a torsion-bar type known as "soft ride". Assuming the wheels never leave the ground the trailer will not bottom over a 4 IN obstacle at 20 MPH. The chassis are rigidly mounted to the cabinets which are in turn bolted to the trailer body. The principle is that all shock will be absorbed by the larger mass, and therefore individual chassis need not be shock mounted.

Air Loading and Transporting

Mobile APCHE is air transportable in the Air Force C-133A and C-133B, and all necessary tie-down fittings are installed on the trailer. Tie-down fitting designations and allowable loads are indicated by markings.

To fit aircraft requirements, the semitrailer has four tie-down fittings on each side designed for crash landing conditions. Hoist fittings are identified, and the required hoisting capacity marked. Fork lift locations are also marked.

Trailer Details

A winterized, rectangular metal box is rigidly mounted on the trailer underbody for storage of cables, including umbilical cables and others required for operation of mobile APCHE. A gasoline heater prevents freezing of the cables and storage box door in sub-zero weather. Leveling jacks are provided in four places beneath the trailer and the forward leveling jacks are equipped with wheels and pivoting pads which provide trailer leveling and support.

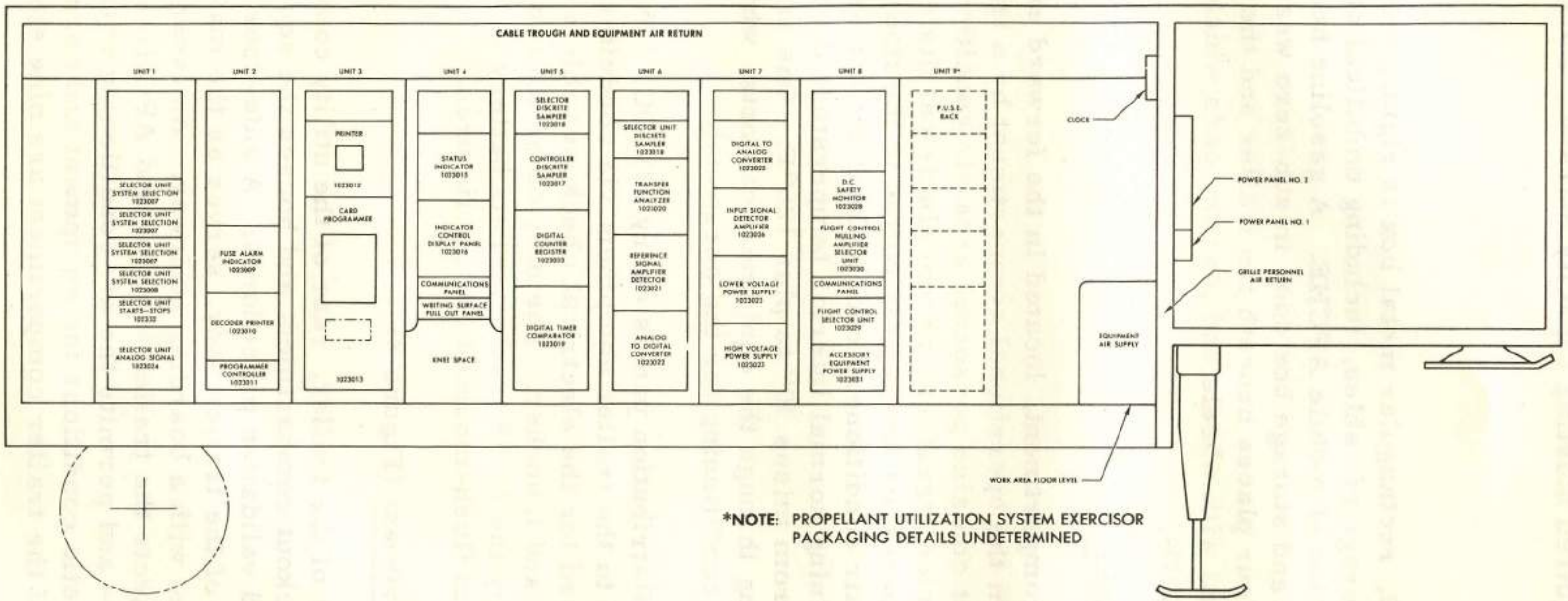
Utility Compartment

The utility compartment, located in the forward end of the trailer, is separated from the operational compartment by a transversial bulkhead. The compartment contains personnel area air conditioner, equipment air conditioner, service transformers and electrical distribution center. The air-conditioner packages are rigidly bolted to the floor of the utility compartment. The air conditioners cool or heat the air while controlling humidity and maintaining normal interior temperature during external temperature variation from minus 30° to plus 125°F. One air conditioner controls the air circulating through the equipment cabinets, while the other maintains proper air conditioning for the personnel.

Two power distribution panels carry 28V DC, 115V (60-CPS), 115V (400 CPS) power to the trailer equipment via conduit-enclosed lines. All normal power used for the electrical checkout vehicle is supplied by the AGE at the MAB and launcher. The only other source of power is the 24V battery carried by the M-52 tractor. This battery is used for emergency lights contained in flush-mounted ceiling fixtures.

Checkout Compartment (Figure 8)

The interior of the trailer, rear of the utility compartment, is designated as the checkout compartment and houses the equipment used in missile checkout and validation procedures. A side-door entrance, located on the curb side of the trailer body, serves as the main entry for personnel and is equipped with a boarding stairway. An inner vestibule with a sliding door protects the trailer interior and APCHE equipment from weather exposure and permits the air conditioning equipment to maintain the correct climatic conditions for equipment and personnel. Located on the street side of the trailer compartment are nine electrical cabinets,



***NOTE:** PROPELLANT UTILIZATION SYSTEM EXERCISOR PACKAGING DETAILS UNDETERMINED

Figure 8 Trailerized APCHE

Launch Site Facilities Electrical System which house the automatic checkout equipment.

The operating temperature of these cabinets is controlled by the air conditioning equipment located in the utility compartment, thereby reducing the change in operating characteristics of the equipment and increasing its overall efficiency.

The packaging concept of these cabinets and their chassis enables operation and maintenance of equipment by personnel having a minimum of specialized training. Panel indicators are designed to show clearly the status of systems tested. All parts, terminals, and wiring are readily accessible from the front for adjustment and maintenance with a minimum variety of special tools. Adjustments are kept to a minimum consistent with required performance, and sequential adjustments are physically arranged to facilitate adjustments in proper order. Parts are mounted so assemblies and subassemblies can be removed individually without disturbing other components or upsetting their adjustment.

Safety Features

Cabinet design includes features which prevent personnel from making accidental contact with hazardous voltages, including residual charges on capacitors. Closed cabinets provide safety for all personnel, and internal design features provide protection for trained service personnel. The following protective measures are taken in each cabinet as required:

1. Interlocks on access doors, covers or plates remove all potentials in excess of 600V when closures are opened.

2. Terminals having dangerous potentials are covered by metal shield covers.

3. Resistors are placed across filter capacitors to bleed off stored charges.

Storage

One standard 2 x 3 x 6 upright metal locker is used to store miscellaneous test equipment and tools. Two five-drawer file cabinets are provided to store a complete set of MAPCHE and associated equipment prints. An operator desk is provided for the MAPCHE operator's convenience and storage of test decks. The decks are stored in the drawers located on the left side of the desk where they are readily available for insertion into MAPCHE to conduct the tests.

Umbilical Connections (Figure 9)

Located externally on the rear of the trailer are two umbilical junction boxes utilized for connection of umbilicals between the checkout trailer, the J box and pneumatic checkout trailer. Umbilicals are connected to the left-hand connection box, and consist of the following: lines used in checking out the propellant utilization system, four umbilicals for transmitting and receiving intelligence, and a standard communication line. Situated on the right side, the other communication box receives the power input from the AGE.

The site connections for operation are:

1. Connect the umbilicals from the mobile APCHE to the checkout J box (Level 2 L/P)
2. ~~Connect the umbilical from the mobile APCHE to the pneumatic checkout vehicle.~~
3. Reconnect the eleven cables at the umbilical junction box (Level 2 L/P) which normally connect the launch control equipment to the missile.

PNEUMATIC CHECKOUT VEHICLE

Purpose

The pneumatic checkout vehicle is used to check out the missileborne and aerospace ground equipment pneumatic components. Checkout of this equipment is performed by simulating an actual missile pressurization schedule. Automatic programmed checkout equipment sends specific pressurization commands to the pneumatic checkout vehicle and monitors the results for GO/NO-GO condition. The components tested are the airborne helium bottles, airborne regulator valves, airborne relief valves, change-over valve and the associated hardware connected with their operation.

Physical Description

The pneumatic checkout vehicle (Figure 10) is a semitrailer capable of being towed by the Air Force type M-52 tractor over terrain and through environmental conditions that will exist at missile bases within the continental United States. The semitrailer is designed to house, protect and transport equipment necessary to test the pneumatic systems and protect personnel from weather conditions during actual operation.

The outside dimensions are: length, 21 FT ~~19 FT 8 IN~~; height, 10 FT 5 IN;

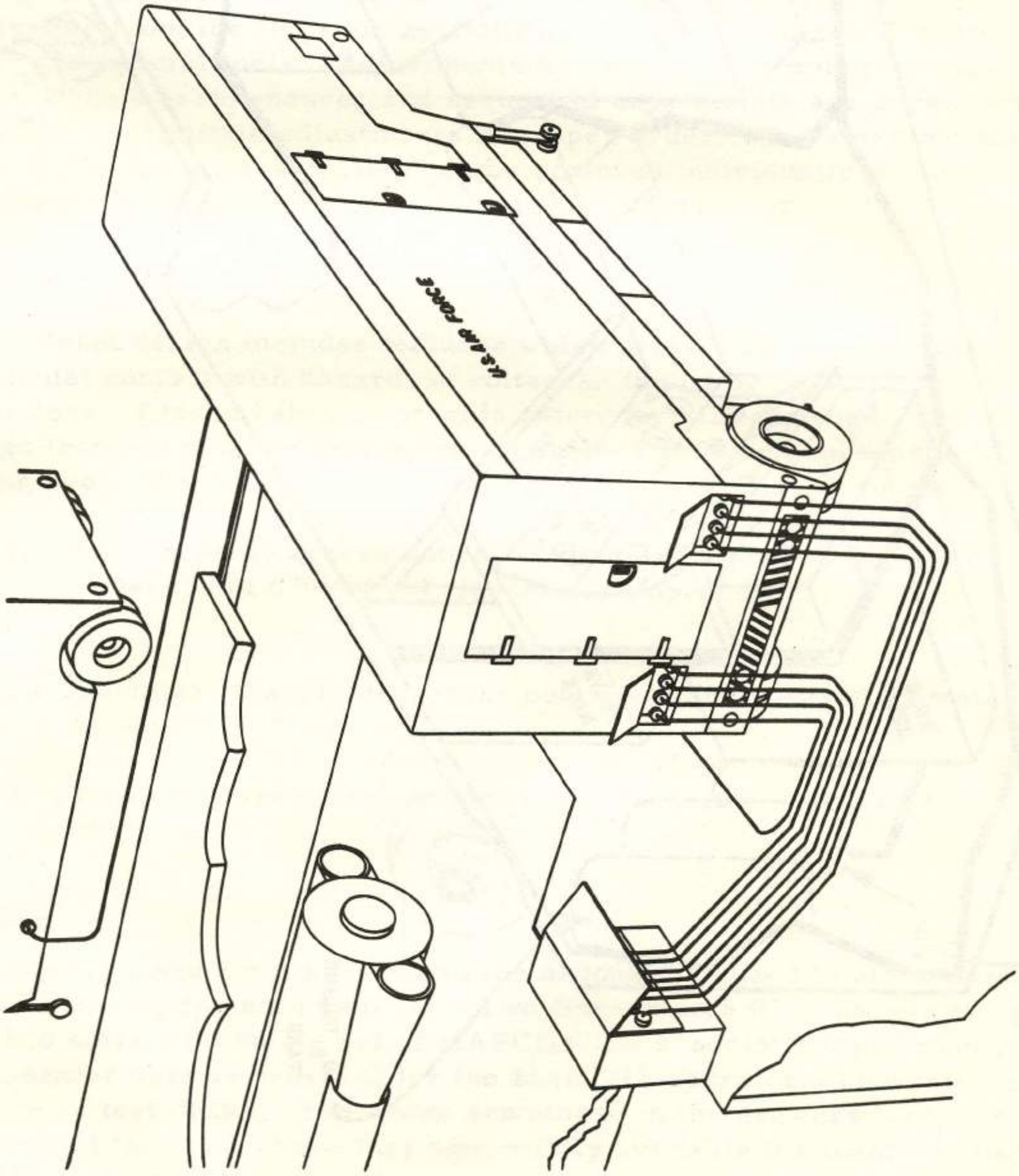


Figure 9 Rear View of APCHE Trailer

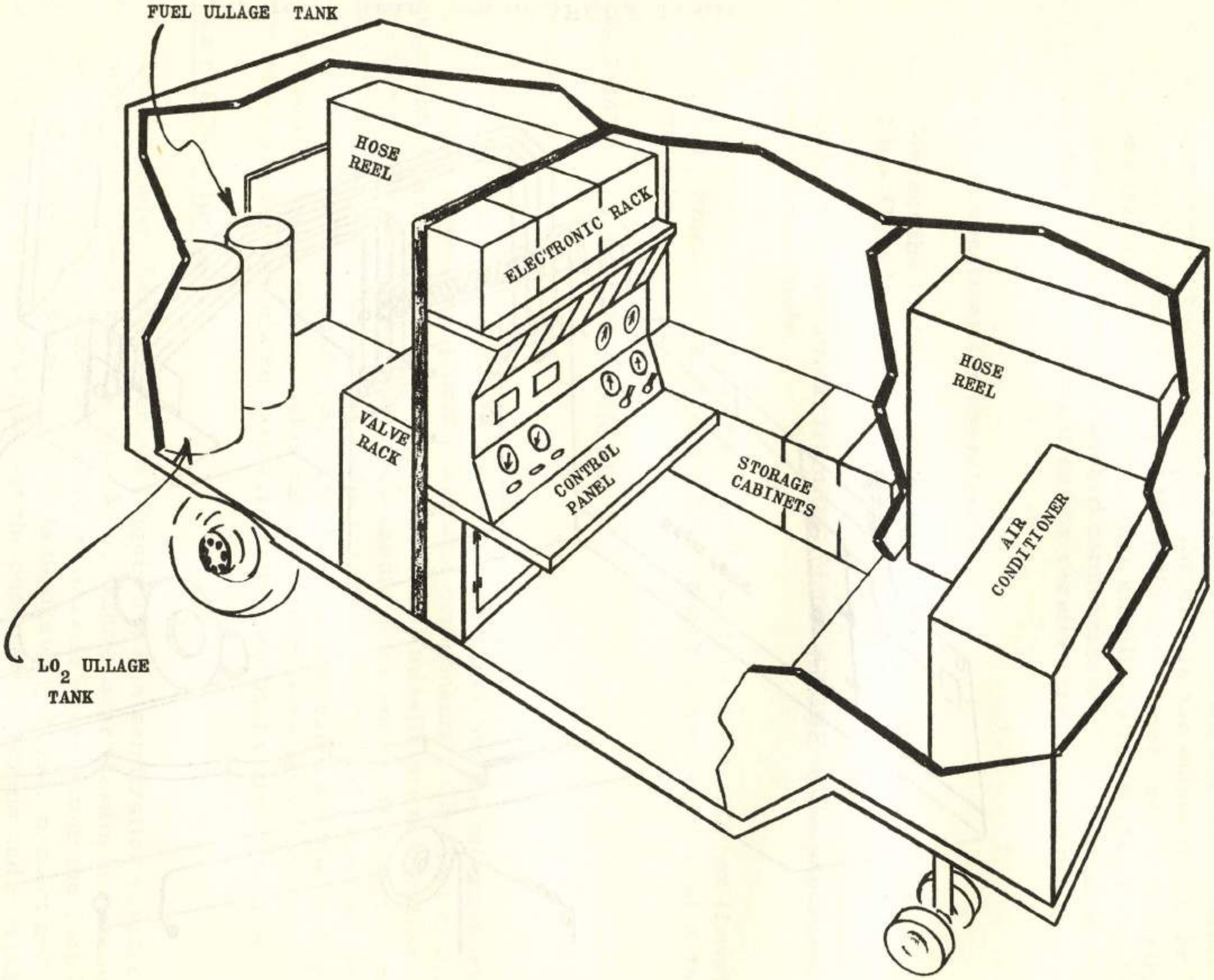


Figure 10 Pneumatic Checkout Trailer

and width, 8 FT. The trailer has three compartments. The storage area over the fifth wheel is 7 FT, 8 IN long and contains the air conditioner, hose reel, and spare tire. The center compartment is the operation compartment and is 5 FT long and contains the operator console and storage lockers for blueprints and technical manuals. The rear compartment, 7 FT in length, contains two ullage tanks, one for simulation of the LOX tank aboard the missile and one for the fuel tank. These tanks are in direct proportion to the actual tanks aboard the missile. Also located in this compartment are reels for the storage of hose and a valve rack. Near the top of the compartment is a motor-driven winch used to pull the umbilicals into storage.

External Connectors

Situated on the rear of the trailer are recepticals for attaching the hoses and necessary electrical cables utilized in checkout. These connections are between the mobile APCHE, AGE power supply, and ~~helium~~ NITROGEN stub-up. 440V, 3 phase 60 CPS, 20 AMPS; 28V DC 40 AMPS; and 115V, single phase, 400 CPS power is supplied to the APCHE from the AGE.

Air Conditioning

The operator compartment is air conditioned for personnel comfort, maintaining normal interior temperature during external variation from minus 30° to plus 160°.

Crew and Spare Parts Vehicle

The crew and spare parts vehicle is utilized in transporting critical spare parts, tools, and special handling equipment necessary to checkout the missile on regular scheduled maintenance and emergency repair.

This is a van-type trailer, capable of being towed by the Air Force M-52 tractor. It is 19 FT, 8 IN long; 8 FT wide; and 10 FT, 5 IN high. The interior is fitted with a combination of bins and cabinets along the full length of one side of the trailer; the opposite side is a collapsible work bench. It is ducted and equipped with a gasoline-fired, electronically controlled, forced-air heater. The main access is located on the rear, and an escape hatch is on the front. Recessed lighting and electrical receptacles are located in the work area. Limited shop capabilities are also included.

PERSONNEL REQUIREMENTS

The maintenance program is controlled by the Missile Officer.

Missile Officer Capabilities

The missile officer will provide overall direction of that portion of the squadron maintenance effort which maintains the operational readiness of the missile and AGE. Their prime responsibility is planning, establishing, and administrating performance standards for the squadron maintenance effort. They will control maintenance schedules, establish procedures, and continuously train mobile maintenance personnel for the most efficient support of missile readiness.

These officers observe such activities as assembly, installation, checkout, and component replacement and inspect the completed work to insure adherence to quality standards. They interpret technical publications applicable to installation, maintenance, and modification of the missile and equipment. They supervise the preparation and maintenance of logs, records, and reports incident to equipment inspection and system performance. They coordinate with supply activities to insure availability of test equipment, spare parts and tools. They prepare staff studies and correspondence on matters affecting maintenance procedures. The missile officer's have a "data flow" knowledge of the weapon system in order to properly evaluate and control the maintenance activities involved. Their maintenance officer background qualifies them to direct the scheduling of shop procedures, administrate personnel requirements, lay out and organize shop and field installation of equipment, and establish safety procedures and drills. In addition, they are responsible for receiving and transporting the missile in and about the squadron area as may be required.

The mobile APCHE team comes under the supervision of the missile officer at the MAMS and will be dispatched to the individual launcher sites on regular scheduled periodic checkout.

Specialist dispatch for unscheduled maintenance will be the joint responsibility of the missile officer and the launch officer, since bench area personnel may be used for such on-launcher repairs as may be required.

Mobile APCHE Crew

The basic MOCAM crew will consist of the following maintenance types. They will be augmented by other personnel depending upon the requirements of a particular job.

The crew consists of:

AFSC ALL INCORRECT

Missile System Analyst Technician, 31470P (MSAT)
Performs APCHE checkout of missile and AGE systems; analyzes results; recommends and directs modular replacement of other

maintenance based on his analysis.

Missile Electrical Repairman/Technician, 42350 (MER/T) performs checkout of all missileborne electrical equipment to include wiring harnesses, battery and inverter.

Guidance System Technician/Mechanic, 31150P (GST/M) assists in performing checkout of Inertial Guidance System; performs remove and replace maintenance on malfunctioning modules.

Missile Maintenance Technician/Mechanic, 43370 (MMT/M)
Coordinates and assists in maintenance functions involving missile airframe including installation, erection, booster demating and component replacement.

Missile Pneudraulic Repair Technician/Repairman, 42172 (MPRT)
Operates and maintains missile and operating ground hydraulic and pneumatic systems and components such as valves, pumps, gages, regulators, actuators, pneumatic motors and disconnects.

Missile Facilities Specialist 42153
Operates and maintains mechanical and self-powered aerospace ground equipment and facilities equipment not specifically identified with the work of subsystem technicians; assists in missile mating to the launcher and missile erection operations (includes checkout and repair of propulsion system. (AGE)

Electrician/Supervisor (Facility) 56170 (E/S(F))
Installs, maintains, troubleshoots and repairs facilities electrical systems and equipment; maintains all basic squadron electrical power supplying aerospace ground equipment.

Missile Engine Technician/Mechanic, 43351 (MET/M)
Maintains propulsion system to a modular replacement level.

Liquid Fuel Systems Maintenance Technician/Specialist 56870 (LFSMT/S)
Operates and maintains propellant transfer and storage system equipment.

Periodic Checkout

The basic mobile team will be increased for the 1st periodic checkout. The additional men will consist of communication types, AIG personnel, re-entry vehicle technicians, and three additional repair technicians.

Periodic NO. 2 (P2) Inspection at MAMS

For the P2 inspection the checkout crew will consist of a basic crew plus additional men from the MAMS.

Specialist Dispatch

A basic MOCAM team will be available 24 hours a day for unscheduled maintenance. In the event of a malfunction at one of the launcher sites, the crew will be dispatched from the MAMS area and will be supervised at the launcher by the missile launch officer.

Bench Level Maintenance

There will be three missile officers at the bench level: a major in charge of the missile maintenance branch, a captain in charge of the mobile maintenance phase, and a captain in charge of the electrical/electronic shop. The mobile maintenance section will be comprised of 83 men.

MOBILE APCHE OPERATION

The basic function of the weapon checkout equipment is to test missile systems and associated aerospace ground equipment (AGE). Test performed by the weapon checkout equipment originate in the MAPCHE card reader and the results are presented at the MAPCHE printer. A test generally involves a five part sequence of operations:

1. Generate a stimulus signal
2. Switch it to the test point
3. Detect a return signal
4. Evaluate the return signal
5. Display the result

The Atlas weapon system is a highly complex organization of electronic, hydraulic and pneumatic controls. It is highly desirable to minimize missile time in maintenance and eliminate the human error as much as possible. The MAPCHE is designed to fulfill these requirements.

An automatic programmed checkout automatically determines operational status of a large number of circuits in a short period of time. Test procedures are predetermined so that human variables in speed and accuracy can be reduced or eliminated. The circuits tested are either operable or defective as indicated by a GO or NO-GO signal. Whether the system under test (system tested) is simple or complex, the basic method of operation is the same. The circuits are checked by inserting test data into a programming and controlling device. This unit, called the card reader, controls the entire test procedure by receiving intelligence from a punched card and determining:

1. The type of test signal to be applied to the system-under-test.
2. The distribution of that signal to the proper point in the system-under-test.
3. The distribution of the output from the system-under-test to a comparison device.
4. The insertion of test limit signals into the comparison device.
5. The operation of devices to record and display test results.

To better understand the operation of the automatic programmed checkout equipment you can place all the separate components into three basic loops, control, analog, and discrete. These three loops have distinct functions although they are closely tied together. In other words you might say that the control loop is part of both the discrete and analog loops, but to better understand the functions of the different components we keep them separate.

The breakdown of the components into the three loops are as follows:

Control Loop

1. Card
2. Card Reader
3. Control Panel
4. Counter registers
5. Ring counter
6. Start/stop selector
7. Printer

Analog Loop

1. Reference signal amplifier detector (RSAD)

2. Digital-to-analog converter (DACON)

3. Analog switching

4. Input signal amplifier detector (ISAD)

5. Analog-to-digital converter (ADCON)

6. Digital comparator

Discrete Loop

1. Discrete sampler

2. System selector unit

3. System self-test selector unit.

MAPCHE data for test procedures is punched into business machine type cards (Figure 11) which are fed to the Card Reader to perform checkout of missile subsystems. The generator of test signals (stimuli) is the MAPCHE Analog system which produces various types of AC and DC analog signals upon command from the Card Reader (Analog signals are those which represent absolute values as to frequency, phase, polarity, or amplitude of voltage). Discrete signals are also employed to initiate commands and to evaluate discrete responses. As defined herein, a discrete signal is one which conveys intelligence by the presence or absence of that signal (GO/NO-GO).

Power required for the operation of MAPCHE is:

1. 440V, 60 CPS 3 Ø

2. 115V, 400 CPS 3 Ø

3. 28V DC

The source for these voltages is site power or another external source. MAPCHE does not contain its own power source. The Switching System provides means to connect the Mobile APCHE to the missile system under test. The analog stimuli, produced by the MAPCHE Analog System for a specific test, pass through the Switching System out to the desired test point. The selection of the system to be tested (an input test point) is accomplished by relay switching circuits in the Selector Switching System,

MAPCHE TEST PROGRAM CARD

	M	L	K	J	H	G	F	E	D	C	B		
46	SCALE	POS	2^9		DACON 1 OUTPUT							2^0	
47	SCALE	POS	2^9		DACON 2 OUTPUT							2^0	2
48				50V NEG		(1) DLTP (2)		D2 Φ	D1 STEP		D2 STEP		3
49		DACON 1 TEST POINT				PAR		DACON 2 TEST POINT				PAR	4
50	AC REF		DC REF		(1) AC (2)		RLTP						5
51	PAR	TFA SOURCE				TFA FREQ			QUAD	TFA PHASE			6
52	ADCON EXT SOURCE						ADCON INT SOURCE				LTP		7
53	1 MEG	START	ADCON FREEZE			ADCON SCALE				DETECT		DECK NUMBER	8
54	2" PRESET COUNTER A										FLTR		9
55						2^0	A-CT						10
56	A START			A STOP			A FREQ			A-SUB	A-IR		11
57													12
58	2" PRESET COUNTER B						B X-START				¬BO		13
59						2^0	B X-STOP						14
60	B START			B STOP			B FREQ			B-SUB	B-IR		15
61							PAR		B-IN	BX-IN	B13-R		16
62	2" PRESET COUNTER C						C X-START				¬CO	STP	17
63						2^0	C X-STOP					SUT NO	18
64	C START			C STOP			C FREQ			C-SUB	C-IR		19
65									C-IN	CX-IN	C13-IR		20
66		CAL	DND	NSTP	LTIP	DDS	DPCG	IC	DSNG	RNG	MA	PAR	21
67								1 PRINT MODE 4					22

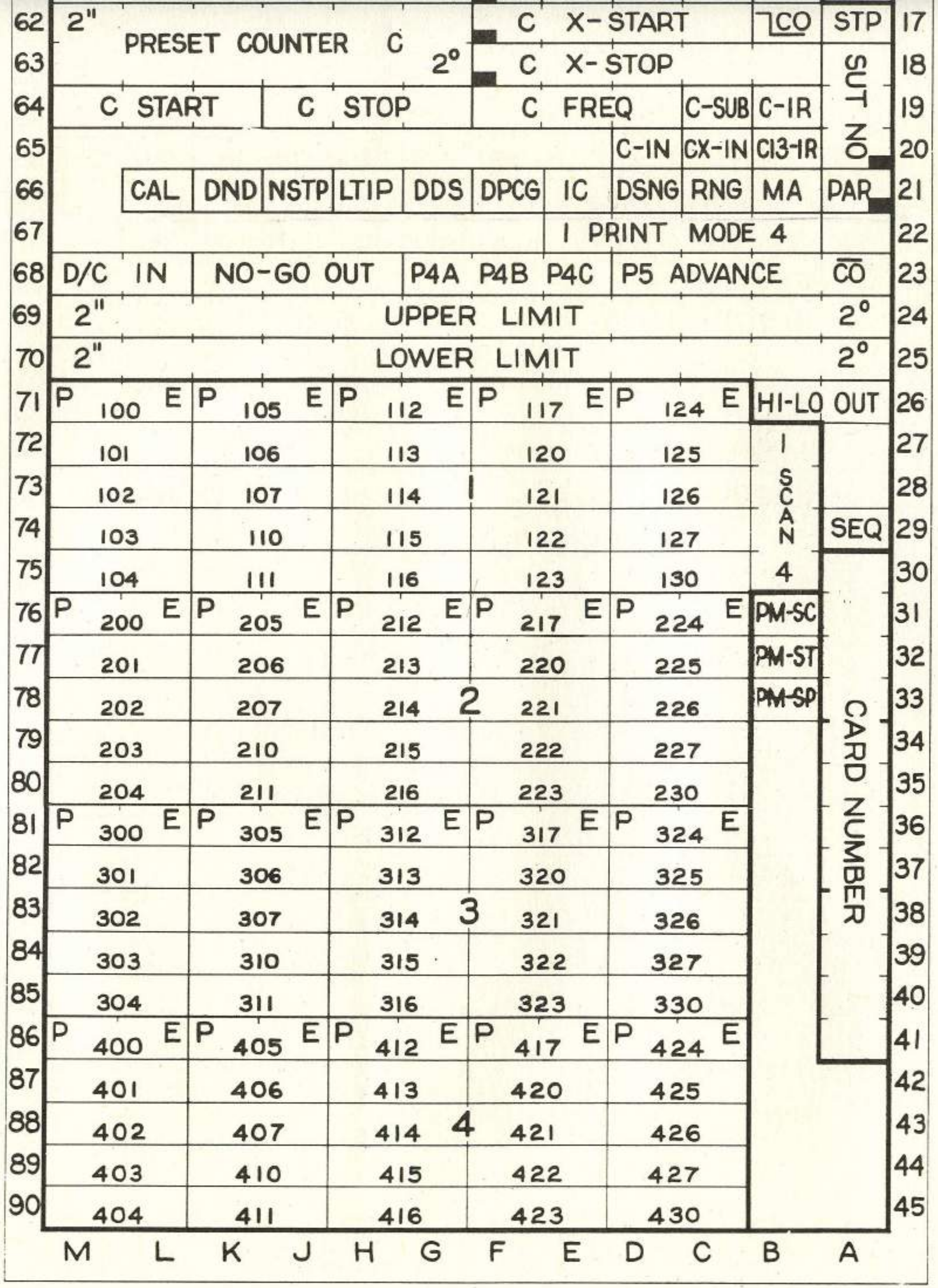


Figure 11

David Jenkins 556th SMS -scanned by Jeff Stephens- atlasbases.homestead.com

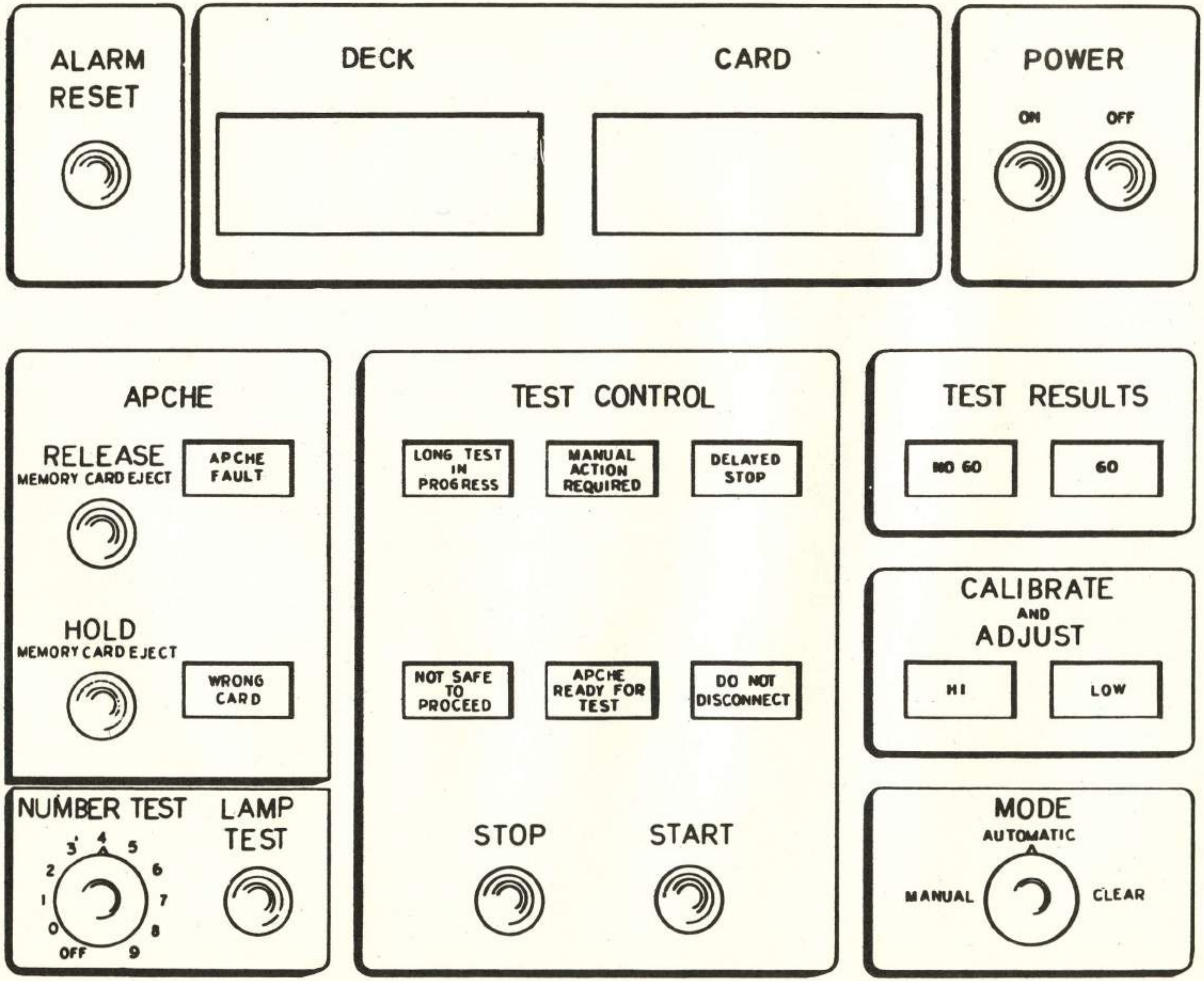
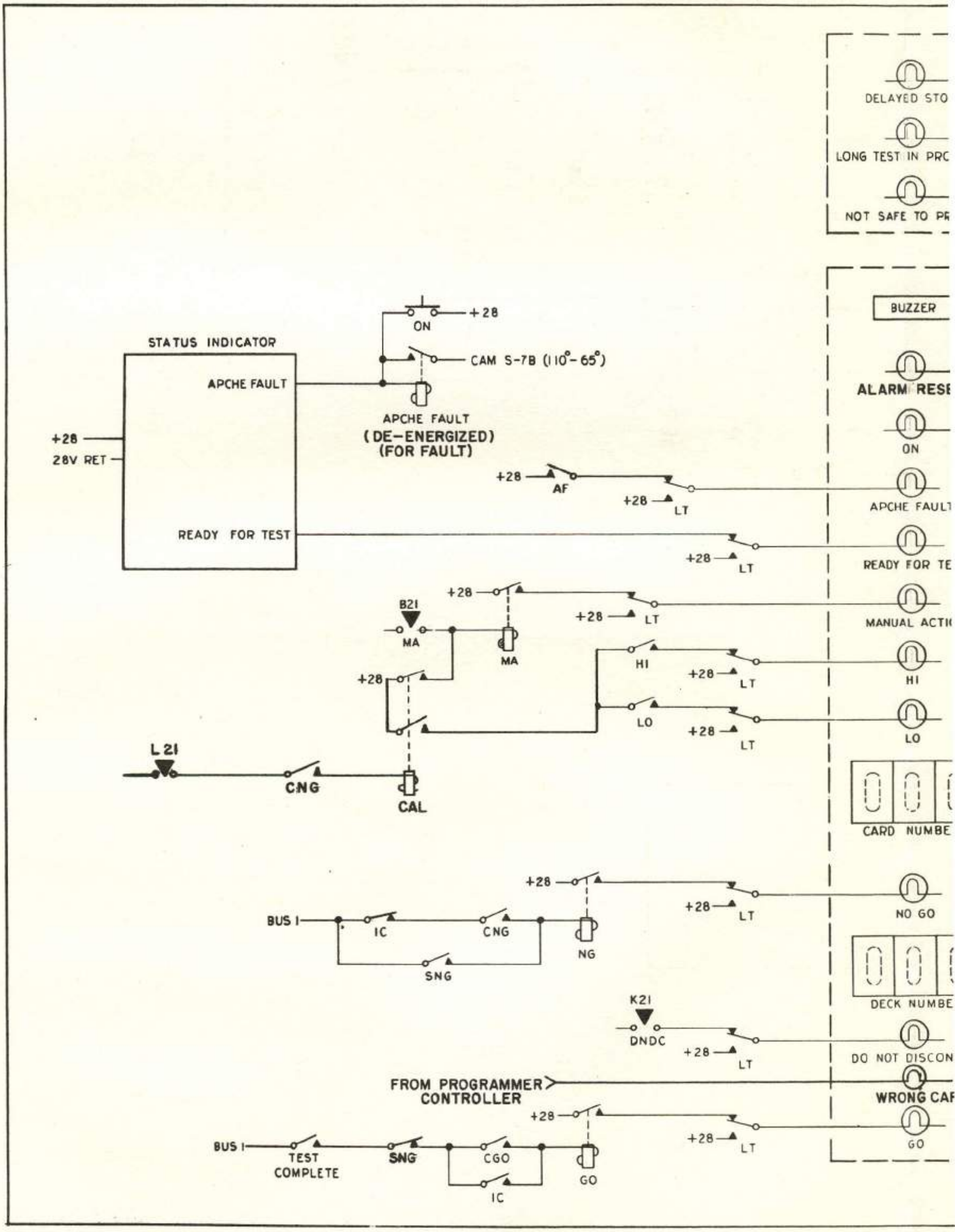


Figure 12 **INDICATOR-CONTROL DISPLAY PANEL**


DELAYED STO
LONG TEST IN PRC
NOT SAFE TO PR
BUZZER
ALARM RESE
ON
APCHE FAULT
READY FOR TE
MANUAL ACTI
HI
LO
CARD NUMBE
NO GO
DECK NUMBE
DO NOT DISCON
WRONG CAR
GO
ON
+28
CAM S-7B (110°- 65°)
STATUS INDICATOR
APCHE FAULT
APCHE FAULT
(DE-ENERGIZED)
(FOR FAULT)
+28
28V RET
+28
AF
+28
LT
READY FOR TEST
+28
LT
+28
B21
MA
MA
+28
LT
+28
HI
+28
LT
LO
+28
LT
L 21
CNG
CAL
+28
+28
LT
BUS I
IC
CNG
NG
SNG
K21
DNDC
+28
LT
FROM PROGRAMMER
CONTROLLER
+28
+28
LT
BUS I
TEST
COMPLETE
SNG
CGO
IC
GO

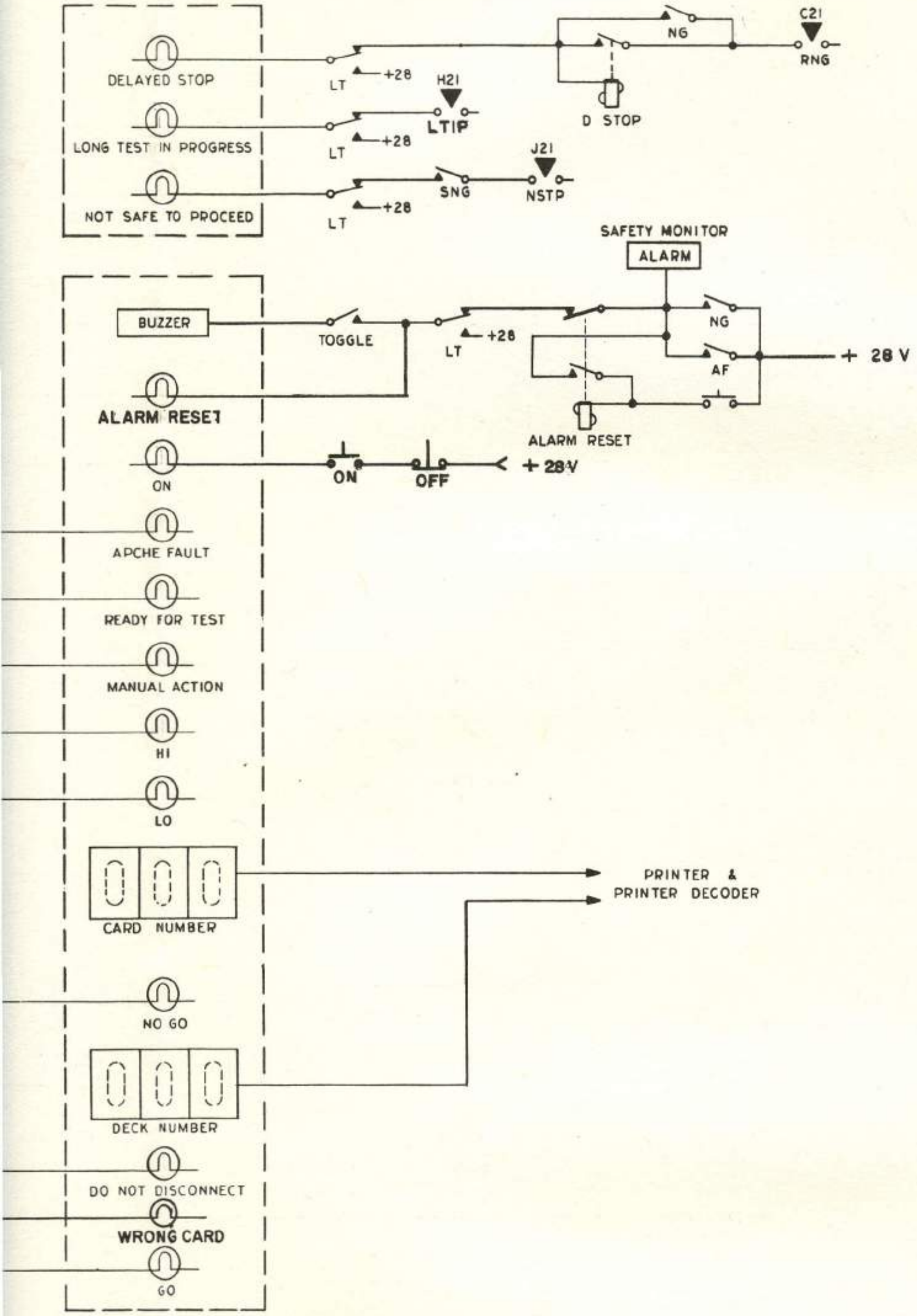


Figure 13 STATUS INDICATOR & INDICATOR CONTROL LOGIC

as programmed by the Card Reader.

The analog responses from the system-under-test return through the analog switching unit and are applied to the MAPCHE Analog System. Here the response signals are (scaled) and compared with reference signals whose limits have been programmed by the Card Reader. Results of the comparisons of the two signals are displayed on the Indicator-Control Display Panel as GO or NO-GO indications.

Control Loop

Indicator-Control Display Panel

The indicator-control display panel provides indications and controlling functions for mobile automatic programmed checkout equipment (MAPCHE) and is located in chassis A13 of the electrical checkout vehicle. The physical appearance of this panel is shown in Figure 12. The panel is organized into 9 subpanels.

1. Mode Subpanel

   The mode subpanel allows the APCHE operator to select the desired mode of operation. The mobile APCHE may be operated in any of 3 modes: manual, automatic or clear. In manual mode, APCHE can be stepped under manual control, one card at a time, through an entire test sequence or test deck. In automatic mode, APCHE proceeds normally through a test sequence and will stop only due to an APCHE fault, manual action card hole command, NO-GO command, or STOP button command. In clear mode, a card deck or part of a deck is sequenced through the card programmer without performing any tests. A 3-position switch provides selection of the mode desired.

2. Power Subpanel

   The power subpanel consists of pushbuttons providing an on-off control of primary power for mobile APCHE. A single pushbutton turns on all 3 types of primary power: 115V, 60 CPS; 115V, 400 CPS; and 27. 5V DC. When power is on, the ON pushbutton is illuminated white. When the OFF pushbutton is depressed, power is turned off and the white lamp behind the ON pushbutton extinguishes.

3. Test Control Subpanel

   The test control subpanel consists of 6 indicators and the START

STOP pushbuttons. Five of the 6 indicators on the test control subpanel have essentially self-explanatory labels: LONG TEST IN PROGRESS, NOT SAFE TO PROCEED, MANUAL ACTION REQUIRED, DELAYED STOP, and DO NOT DISCONNECT. The sixth indicator, labeled APCHE READY FOR TEST, is illuminated green by a contact closure from summary logic comprised of fuses all good, power supplies on plus 33 sec a delay for circuit stabilization, facility power on (440V, 60 CPS and 115V, 400 CPS and 27. 5V DC, and card READER RECEIVER magazine in position.

The START-STOP pushbuttons mounted on the test control subpanel provide manual start and stop of a checkout.

4. Test Results Subpanel

The test results subpanel consists of 2 indicators GO (green) and NO-GO (red).

5. Calibrate and Adjust Subpanel

The calibrate and adjust subpanel consists of 2 indicators, HI and LOW. These indications are controlled by outputs from the digital comparator and will function if the calibrate card hole has been punched. The HI indicator will illuminate red if the test valve is above the upper limit. The LOW indicator will illuminate red if the test valve is below the lower limit.

6. APCHE Subpanel

The APCHE subpanel has 2 indicators and 2 pushbuttons. APCHE fault logic causes the APCHE FAULT indicator to illuminate red if a fault occurs and simultaneously sets off the alarm buzzer. If automatic mode has been selected, APCHE fault logic will also stop the test sequence. The WRONG CARD indicator will illuminate red if a card or a deck is out of sequence. The wrong card must be ejected before proceeding with the test. The RELEASE MEMORY CARD EJECT control pushbutton permits (1) the ejection of a card without reading and (2) the memory of the previous card to be released. The HOLD MEMORY CARD EJECT control pushbutton permits the ejection of a card without reading but retains the memory of the previous card.

7. Deck and Card Subpanel

The deck and card subpanel consists of 2 in-line indicators that supply numbers of the deck and card in process, one window carrying deck numbers, the other window carrying card numbers.

8. Alarm Reset Subpanel

The alarm reset subpanel contains the ALARM RESET pushbutton. Upon activation of the alarm buzzer, the ALARM RESET display pushbutton is illuminated white. Depression of the pushbutton cuts off the buzzer and extinguishes the indicator lamp.

9. Number and Lamp Tests Controls

The last subpanel contains the NUMBER TEST switch and the LAMP TEST pushbutton. Deck and card display numbers can be tested by an 11-position rotary switch in the number test display. The positions are numbered 0-9, plus an OFF position. A separate circuit for conduction of a lamp test is provided. Depression of the LAMP TEST pushbutton activates all lamp circuits simultaneously, thereby providing means of checking indicator lamps for the entire indicator-control display panel.

The logic diagram for the indicator-control display panel is shown in Figure 13.

Card Familiarization

Test characteristics of MAPCHE are determined by instructions on punched programming cards. These precoded cards are of plastic composition and are similar to business machine punched cards.

The card contains 540 card hole locations in a configuration of 12 rows identified by letters and 45 columns identified by numbers. The presence of a hole at a card location causes a DC voltage to appear at the circuit assigned to the location as the card is "read" in the card programmer. A specific instruction may require one or more card locations to be punched. The presence or absence of holes at these locations determines the nature of the instructions. It is not possible to energize all 540 card hole switches at one time. Since all card holes are not assigned, and since no test requires the use of all card holes (usually a test precludes the use of certain card holes), no problem will be encountered.

A card layout is shown in Figure 14, which illustrates the grouping of card functions. The groups labeled A on the card are test controlling functions and programming controls. The 2 groups labeled B are used in conjunction with programming of the discrete sampler. The C groups are associated with analog test. Figure 11 shows a MAPCHE test program card, and Table 4 explains the specific use of each card hole location.

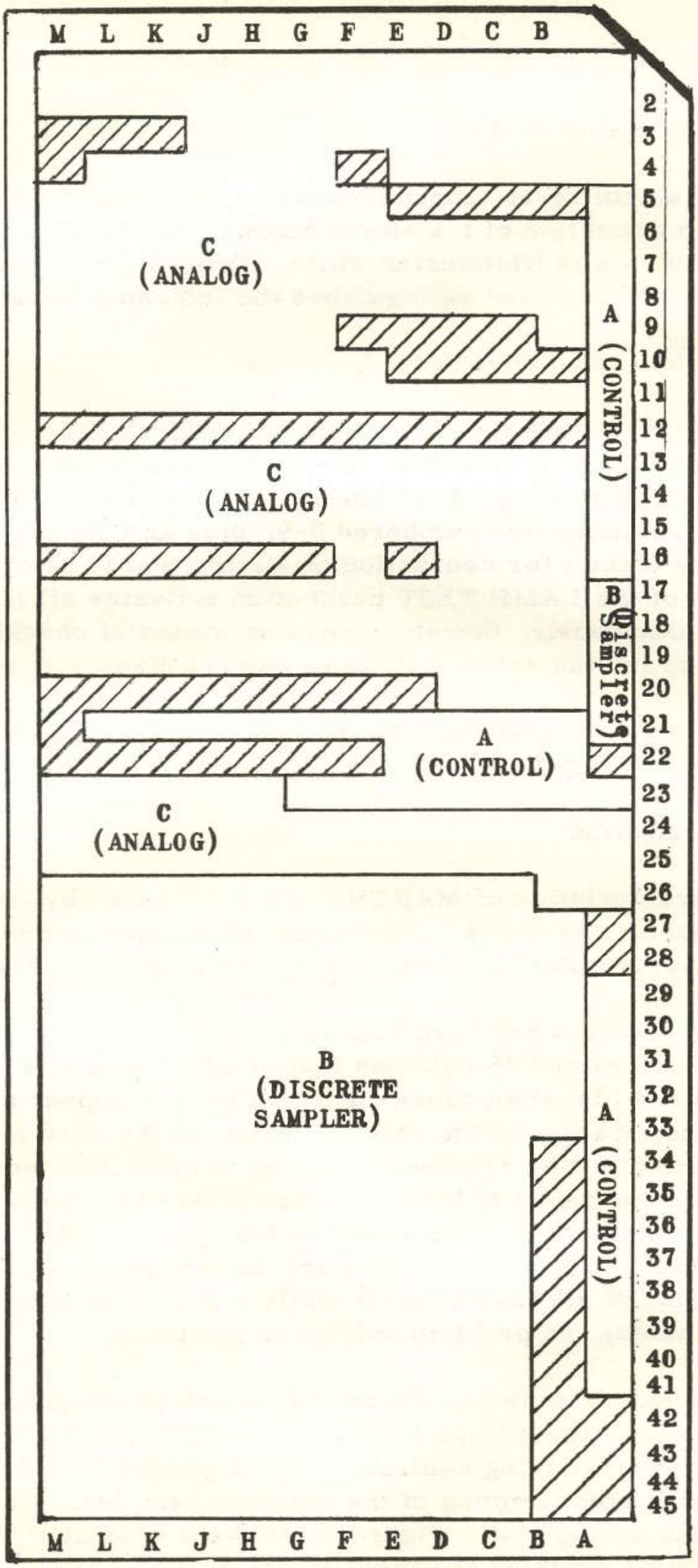


Figure 14 -Mobile APCHE Card Layout

Table 4

Card Hole Functions

Card Locations	Function	Abbreviation
A1-K1	Select DACON 1 output voltage	DACON 1 output
L1	Select positive DACON output	POS
M1	Select 50mv DACON 1 scale factor	Scale
A2-K2	Select DACON 2 output voltage	DACON 2 output
L2	Select positive DACON 2 output	POS
M2	Select 50-mv DACON 2 scale factor	Scale
A3-B3	DACON 2 stop to ground on B(C)13	D2 stop
C3-B3	DACON 1 stop to ground on B(C)13	D1 stop
N3	Select DACON 2-phase reversal of DACON 1 output	B2Ø
F3-G3	Apply DACON 1 (2) lock tree power	(1) DLTP (2)
H3-J3	Select ± 50V DC DACON output	50-Neg
A4	DACON 2 test point parity	PAR
B4-F44	Select DACON 2 test point	DACON 2 Test Point
G4	DACON 1 test point parity	PAR
H4-L4	Select DACON 1 test point	DACON 1 Test Point
A5-A16	Test deck number	Deck number
F5	Apply DACON reference voltage lock	RLTP
G5-H5	Select DACON 1 (2) AC output	(1) AC (2)

Table 4 (Cont'd)

Card Locations	Function	Abbreviation
J5-K5	Select DACON 1 and 2 DC reference	DC REF
L5-M5	Select DACON 1 and 2 AC reference	AC REF
B6-C6	Select TFA phase	TFA Phase
D6	Select TFA quadrature measurement	QUAD
E6-G6	Select TFA frequency	TFA FREQ
H6-L6	Select TFA source	TFA Source
M6	TFA source select parity	PAR
B7	ADCON internal and external test point lock tree power	LTP
C7-F7	ADCON internal source select	ADCON INT Source
G7-M7	ADCON external source select	ADCON EXT Source
B8-C8	ADCON detector select	Detect
D8-G8	ADCON scale select	ADCON Scale
H8-K8	ADCON freeze (stop) command select	ADCON Freeze
L8	Start ADCON	Start
M8	Insert 1-megohm ADCON input impedance	1 MEG
B9	Insert low-pass filter	FLTR
F-10	Use ADCON as the A counter	A-CT
G9-M9		Preset
G10-M10	Preset the A counter counting modules	Counter A
B11	Inhibit the reset of the A counter	A-IR

Table 4 (Cont'd)

Card Locations	Function	Abbreviation
C11	A counter subtract command	A-SUB
D11-F11	A counter operating frequency select	A-FREQ
G11-J11	A counter stop command select	A stop
K11-M11	A counter start command select	A Start
B13	B counter start on loss of external signal	BQ
C13-F13	Program B counter external start	B X-Start
B14-F14	Program B counter external stop	B X-Stop
G13-M13		
G14-M14	Preset the B counter	Preset Counter B
B15	Inhibit the reset of the B counter	B-IR
C15	B counter subtract command	B-SUB
D15-F15	Select B counter operating frequency	B-FREQ
G15-J15	Program B counter internal stop	B Stop
K15-M15	Program B counter internal start	B Start
B16	Inhibit the reset of the B13 module	B13-IR
C16	Select external preset to the B counter modules	BX-IN
D16	Select ADCON input to the B counter	B-IN
F16	Parity for B and C counters	PAR
A17	SUT select lock tree power	STP

Table 4 (Cont'd)

Card Locations	Function	Abbreviation
B17	C counter start on loss of external signal	CO
C17-F17	Select C counter external start	C X-Start
A18-A20	SUT select	SUT NO.
B18-F18	Select C counter external stop	C X-Stop
G17-M17		Preset
G18-M18	Preset the C counter	Counter C
B19	Inhibit the reset of counter C	C-IR
C19	C counter subtract command	C-SUB
D19-F19	Select C counter operating frequency	C FREQ
G19-J19	C counter internal stop select	C Stop
K19-M19	C counter internal start command	C Start
B20	Inhibit the reset of the C13 module	C13-IR
C20	Select external presets to the C counter module	CX-IN
D20	Select ADCON input to the C counter	C-IN
A21	SUT selection parity	PAR
B21	Program manual action	MA
C21	Retain NO-GO	RNG
D21	Don't stop on a NO-GO	DSNG
E21	Ignore comparator	IC
F21	Don't print comparator GO	DPCG

Table 4 (Cont'd)

Card Locations	Function	Abbreviation
G21	Delay discrete sampler	DDS
H21	Long test in progress	LTIP
J21	Not safe to proceed	NSTP
K21	Do not disconnect	DND
L21	Calibrate	CAL
B22-E22	Select print mode	1 Print Mode 4
A23	Advance to P5 on C counter not counting	CO
B23-D23	Advance to P5 selection	P5 Advance
E23-G23	Select advance to P4 on A, B and/or C counter counting	P4A, P4B, P4C
H23-J23-K23	Select NO-GO HI output	NO-GO HI Out
L23-M23	Select digital comparator input	B/C IN
A24-M24	Program digital comparator upper limit	Upper Limit
A25-M25	Program digital comparator lower limit	Lower Limit
A26-B26	Select digital comparator HI or LOW output to flight programmer	HI-LO OUT
A29	Make sequence check	SEQ
A30-A41	Card number	Card Number
B27-B30	Select discrete sampler scan, Groups 1 - 4	1 Scan 4
B31	Enable self-check of B (C) counter start on disappearance mode	PM-SC

Table 4 (Cont'd)

Card Locations	Function	Abbreviation
B32	Discrete sampler program monitor start to B or C counter	PM-ST
B33	Discrete sampler program monitor stop to B or C counter	PM-SP
C26-M26 C27-M27 C28-M28 C29-M29 C30-M30	Discrete sampler group I	100-130
C31-M31 C32-M32 C33-M33 C34-M34 C35-M35	Discrete sampler group II	200-230
C36-M36 C37-M37 C38-M38 C39-M39 C40-M40	Discrete sampler group III	300-330
C41-M41 C42-M42 C43-M43 C44-M44 C45-M45	Discrete sampler group IV	400-430

Punched card instructions may be commands that determine a particular operation of MAPCHE or may be coded decimal numbers representing data to be used in tests. Both types of commands contribute to establish the necessary test conditions. Table 1 lists the punched card instructions by card locations in an alphanumbered order. The function abbreviations are given in the table as an aid in identifying the standard abbreviations of the punched card shown in Figure 11.

Card Reader

The card reader (Figure 15) is the primary source of control and programming for all tests conducted by MAPCHE. Mobile APCHE cards contain the coded information used to perform the various test. The card reader feeds, senses and ejects these cards at a maximum rate of 2 cards per second. Reading of all holes is done simultaneously, and an electromechanical memory holds the reading of each card until the next card is read. In case of power failure, the memory is retained, thereby preventing loss of continuity for the deck when power is restored.

The card reader contains 540 card hole switches of which 270 may be used at one time; if memory circuits are maintained through relay logic, the number is increased to 300 for the first card retaining the memory. Each card hole switch has leads connecting to suitable interconnecting relay circuitry. Certain select relays have a memory capability that may be released on command of the ring counter; the majority of the memory capabilities, however, are released mechanically each time a new card is sensed.

Two cycles of operation are necessary to completely process a card through the card reader. During the first cycle, before the actual testing is commenced, the card reader will presense the card for sequence and feed it into the main sensing chamber. During the second cycle, the card is sensed and fed into the receiver magazine.

The card reader consists of 6 sections: the motor section, the input magazine section, the presensing section, the main sensing section, the memory unit section, and the receiver magazine section.

The feed and receiving magazines are each capable of containing 600 cards. Interlocks prevent card reader operation if the magazines are not properly inserted.

The motor section consists of a 115V, 60 CPS, 1/6-HP constant speed motor; a drive assembly, and a clutch and brake assembly, which control the operation of the cams in the card reader.

The presensing and main sensing section consists of a card chamber, pins to readout the information, the mechanism to move the pins, and relay contacts which allow the information to be distributed.

The memory section consists of the locking and release devices that hold pins in the "read" position until their release is programmed.

Programmer Controller

The programmer controller contains the relays, switches and associated electronic circuitry necessary to control the sequencing of operation

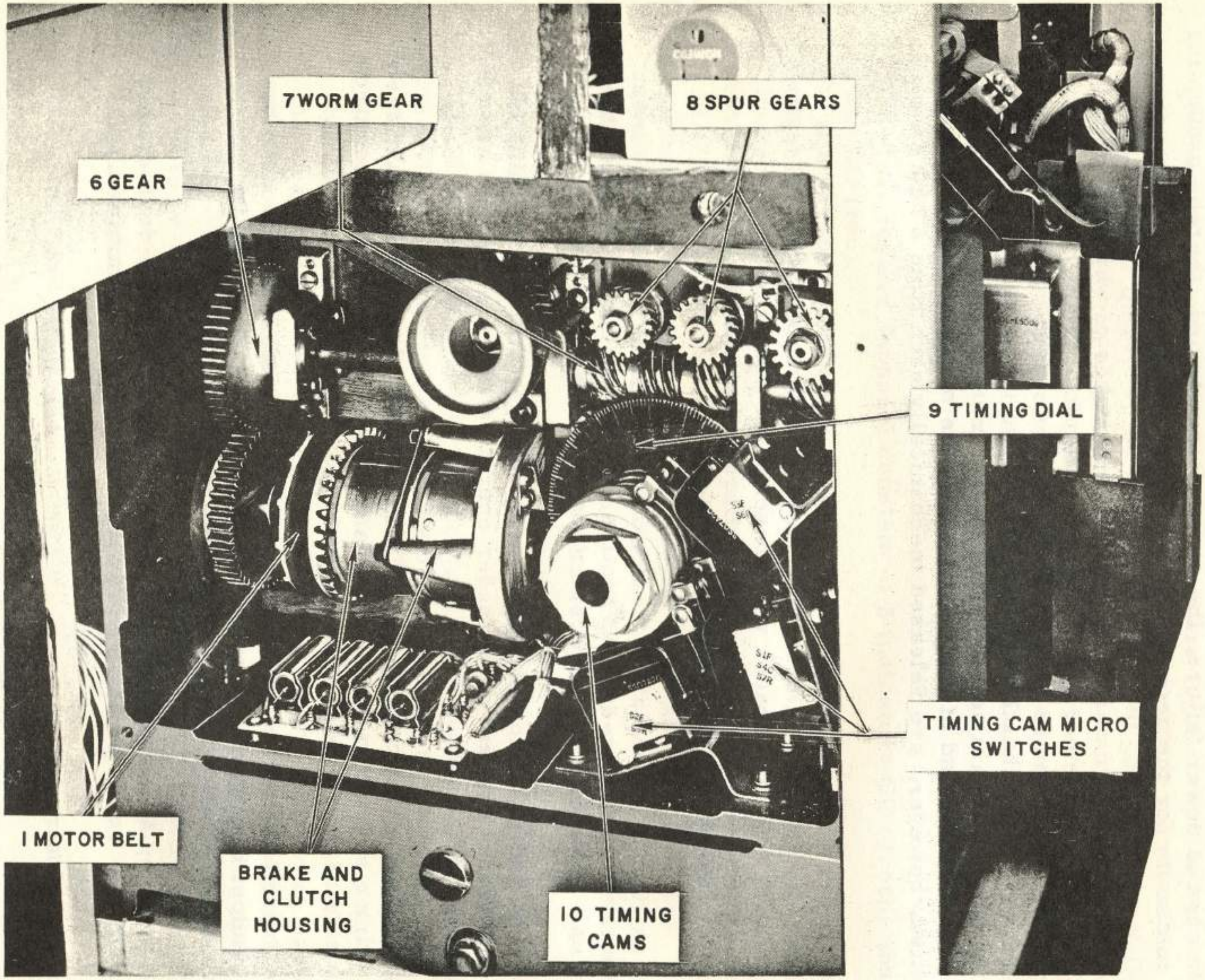


Figure 15 Card Reader, Drive Mechanism

of the card reader.

Theory of Operation

When the indicator-control display panel POWER ON pushbutton is depressed, the motor starts, and the motor belt transfers energy to the clutch pulley (Figure 15). The clutch pulley turns freely until a program is started by inserting cards into the input magazine and the START button on the control panel is depressed. The different modes of operation govern the method of feeding cards into the card reader. The cards can be fed automatically until a stop signal is received (MODE selector switch in AUTO position) or they can be fed individually as controlled by the APCHE operator (MODE selector switch in MANUAL position). The energized clutch solenoid engages the clutch pulley, and power is transmitted through the drive gear (Figure 15) on the main horizontal drive shaft to the worm gear. The worm gear turns the spur gears, which operate the feed rolls, intermediate feed rolls and eject rolls. When the clutch pulley is engaged, mechanical power is applied to the timing dial and the various cams that control the timing (Figure 15).

The first cycle of operation starts when the first start pulse is applied. The main horizontal drive shaft rotates at a constant speed. Consequently the timing dial mounted on this shaft and calibrated in degrees of rotation indicates the occurrance as timing of events during a card cycle. The timing dial indicates 238 to 244° at the start of a program. It is assumed that the timing dial is indicating 240° at the start of the following procedure. The timing dial rotates 15°, and the brake releases as the clutch engages. The dial rotates another 8° and the no card sensing pin detects a card in the main sensing section. The timing dial rotates another 30°, and the picker knife moves. The picker knife selects the bottom card from the feed magazine and moves the card toward the presensing section during 37° of timing dial rotation. Then the picker knife stops. The card is now in the presensing position. Six more degrees of rotation occur, and the presence control cam microswitch closes and energizes the presensing solenoid. The presensing pins move up to and through holes in the card and activate microswitches, which send information to the coincidence bridge circuit. The bridge balances when the deck number and the card number are correct. When the timing dial has rotated another 5°, the card leaves the presense position and moves toward the main sensing section. After an additional 25° of dial rotation, the no card sensing pin opens the circuit which deenergizes the energized memory hold solenoid. The card is fed through the intermediate feed rollers and into the main sensing section during the next 104° of dial rotation. Then the brake and clutch cam microswitch contacts open and deenergize the clutch solenoid, and other contacts close and energize the brake solenoid. The brake is applied and the card reader stops its operation within an additional 31° of rotation.

The timing dial indicates 240°, and one cycle of operation has been completed.

The second cycle of operation starts when a second start pulse is applied. This originates when the card reader selects another card from the feed magazine in either mode. Card operation is the same as that described for the first cycle of operation. The preceding card is in the main sensing chamber during this operation, and the card stop is closed to keep it there. As the timing dial begins to rotate, the sensing pins move upward under the preceding card. The dial rotates from 240 to 263° when the new card sensing pin moves up to and through holes punched in the card. Those pins that have moved through the holes in the card continue upward and engage pins in the locking pin box or memory unit. The pins, which have been pushed up in the locking pin box, close the sensing switches. The push pins continue to move upward, and the push pin release disengages the locking pins that contain the memory of previous cards. The memory of the card that is now in the main sensing chamber is locked up by the lock pins and retained. At this point the timing dial has rotated 85° and the sensing pins move downward toward their rest position. The timing dial rotates another 170° and the card stop is opened, allowing the eject roller to eject the card into the receiver magazine. The brake is applied and the clutch is disengaged when the dial indicates 209°. The second cycle is completed when the timing dial again indicates 240°.

The card reader continues to operate as long as a next card command signal is received. If the next card command is removed, the card programmer will stop at the end of a card reader cycle. It will start if the signal is reapplied.

The card reader and the programmer controller contain safety features, which stop a program when a malfunction occurs or stop a program automatically under normal conditions when the card deck has been fed successfully through the card reader. A program is also stopped when a test control STOP pushbutton is depressed, a card is not in correct sequence, or a CARD EJECT pushbutton is depressed.

The card reader ejects cards when the CARD EJECT MEMORY HOLD pushbutton or the CARD EJECT MEMORY RELEASE pushbutton is depressed or when the MODE selector switch is in the CLEAR position. The suppress card sensing relay insures that the out-of-sequence card will not be sensed, and the picker knife disengage relay prevents the picker knife from feeding a new card into the card reader. When the trip relay is energized, the card reader ejects the card from the main sensing section into the receiver magazine. Because of card reader operations, the mechanical trip relay release stops the card reader at the end of the cycle. After the cards have been arranged in proper sequence, the test control panel START button must be depressed to restart the operation of the card reader. Depressing the CARD EJECT MEMORY RELEASE pushbutton ejects the card into the receiver magazine. The card reader stops at the end of its cycle.

An "auto-interrupt stop" signal is developed when there is no card in the main sensing section. The no card sensing pin moves up through the main sensing section and closes a microswitch that operates auto-interrupter relay K20. (A card in the main sensing section would block the no card sensing pin from closing the microswitch.) When it is energized, the auto-interrupter relay K20 latches through its own contacts and energizes the picker knife disengage and suppress card sensing solenoids and the memory hold solenoid. The card reader stops at the end of its cycle. A manual restart is necessary to restart card reader operation. When the first card of the deck is in the presensing section, the main sensing section is normally empty and a no card indication is generated. This makes it necessary to provide a manual start for the second cycle of operation no matter which mode of operation is used. When the receiver magazine is inserted, it presses against and closes a microswitch. When the receiver magazine is not in place, the microswitch opens and the card reader will not operate.

Auto-interrupter relay action is included in the card reader circuit to protect the circuit. If a card does not enter the main sensing chamber properly, interlocks at the side of the main sensing chamber detect the dislocation of the card.

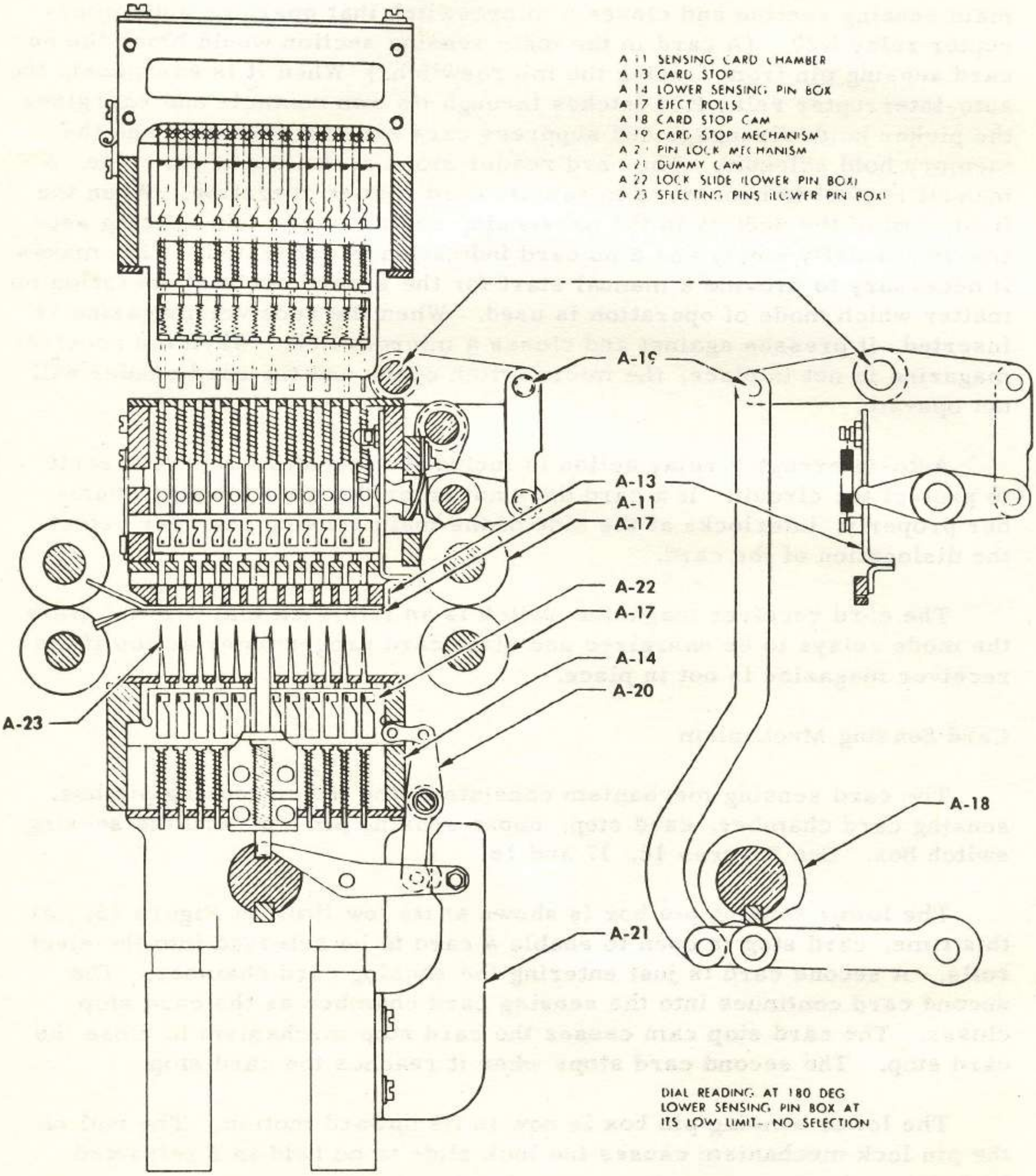
The card receiver magazine switch is an interlock that will not allow the mode relays to be energized and start card programmer action if the receiver magazine is not in place.

Card Sensing Mechanism

The card sensing mechanism consists of the lower sensing pin box, sensing card chamber, card stop, upper sensing pin box, and the sensing switch box. See Figures 16, 17 and 18.

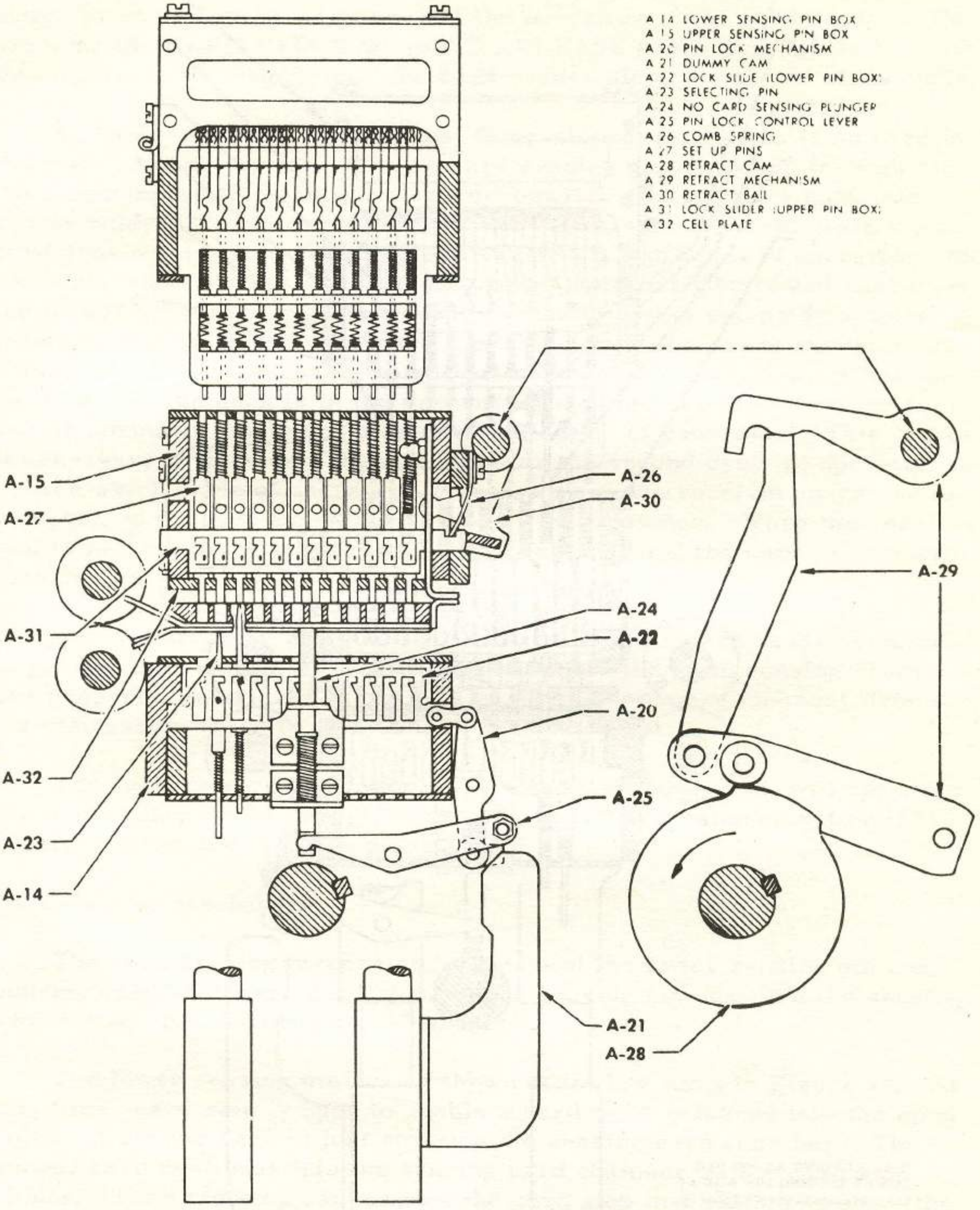
The lower sensing pin box is shown at its low limit in Figure 16. At this time, card stop is open to enable a card to be released into the eject rolls. A second card is just entering the sensing card chamber. The second card continues into the sensing card chamber as the card stop closes. The card stop cam causes the card stop mechanism to close the card stop. The second card stops when it reaches the card stop.

The lower sensing pin box is now in its upward motion. The roll on the pin lock mechanism causes the lock slide to be held in a retracted position.



DIAL READING AT 180 DEG
LOWER SENSING PIN BOX AT
ITS LOW LIMIT- NO SELECTION

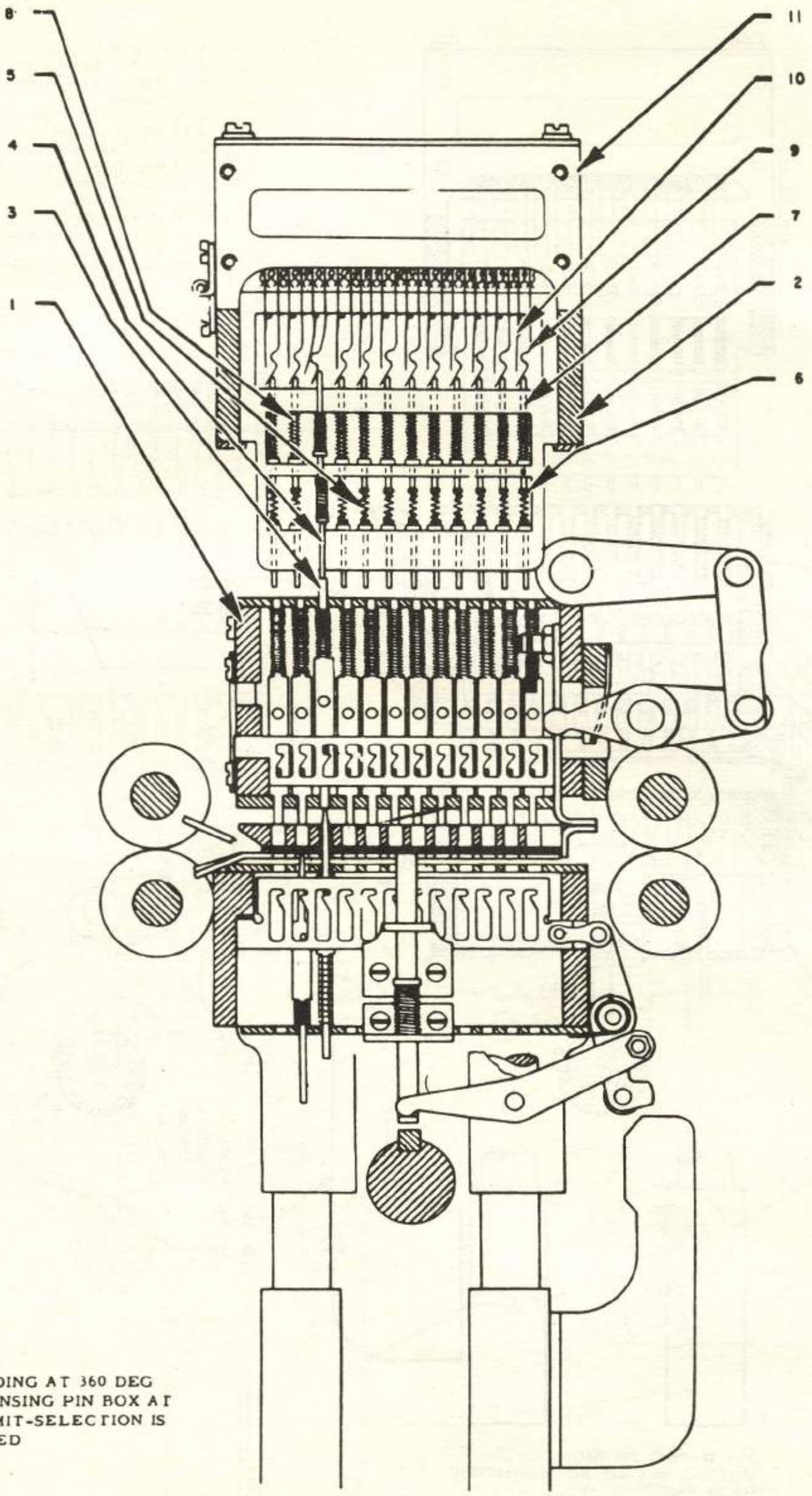
Figure 16 Sensing 180 Degrees



A 14 LOWER SENSING PIN BOX
A 15 UPPER SENSING PIN BOX
A 20 PIN LOCK MECHANISM
A 21 DUMMY CAM
A 22 LOCK SLIDE (LOWER PIN BOX)
A 23 SELECTING PIN
A 24 NO CARD SENSING PLUNGER
A 25 PIN LOCK CONTROL LEVER
A 26 COMB SPRING
A 27 SET UP PINS
A 28 RETRACT CAM
A 29 RETRACT MECHANISM
A 30 RETRACT BAIL
A 31 LOCK SLIDER (UPPER PIN BOX)
A 32 CELL PLATE

DIAL READING 293 DEG
SELECTING PINS ARE JUST CONTACTING
SET UP PINS

Figure 17 **Sensing 293 Degrees**



DIAL READING AT 360 DEG
LOWER SENSING PIN BOX AT
ITS UP LIMIT-SELECTION IS
COMPLETED

1.	Upper Sensing Pin Box	6.	Pin Cap
2.	Sensing Switch Pin Box	7.	Contact Pin
3.	Set Up Pins	8.	Contact Pin Spring
4.	Intermediate Sensing Pins	9.	Contact (RH)
5.	Compression Spring	10.	Contact (LH)
11.	Removable Connector		

Figure 18 Sensing 360 Degrees

When the lower sensing pin box continues to rise, it enables the selecting pins to contact the card held in the sensing card chamber as shown in Figure 17. From this point, a selecting pin penetrates a hole in the card; if there is no hole the pin is depressed. This action causes the pin lock control lever to release the pin lock mechanism so that the roll on the pin lock mechanism can follow the slope of the dummy cam. This motion of the pin lock mechanism moves the lock slide so the extrusion on the selecting pin contacting the card is depressed below the latch in the lock slide. The extrusions on the selecting pins that penetrate holes in the card are above the latch on the lock slide. Just before the latched selecting pins contact the setup pins, the selection in the upper sensing pin box (retained there from the first card) is retracted.

The retract cam operates the retract mechanism so the retract bail retracts the lock slides. The lock slides during retraction, are positioned so that the extrusions on the setup pins are free of the latch in the lock slide. The compression spring on each setup pin forces the pin down so the shoulder of the pin rests against the cell plate.

When the lower sensing pin box rises, its selected pins contact corresponding setup pins in the upper sensing pin box. The contacted setup pins are raised until the lower sensing pin box reaches the card stops. The selected setup pins are retained by removal of the retraction on the lock slides. The retract cam operates the retract mechanism so that the retract bail is in a position to enable the lock slides to move into a locking position. The tension of the comb spring moves the lock slide so the latch is positioned under the extrusion of the selected setup pins. The extrusion on the unselected setup pins are below the latch on the lock slides.

The selected setup pins and the contacting and operating pins in the sensing switch box are shown in Figure 18. A selected setup pin contacts the intermediate sensing pin. The motion of the intermediate sensing pin is transferred through the compression spring and pin cap to raise the contact pin. The raised contact pin compresses the contact pin spring and operates the contact. The selection in the sensing switch box is entirely controlled by the upper sensing pin box. The contacts connect to a removable connector to complete the electrical circuits used in reading the sensed valves in a card.

Ring Counter

Test timing and sequencing are controlled by cam position in the programmer controller just described and a 6-stage electronic counter called the ring counter. The ring counter is so constructed that only one stage is active at any given instant. Time periods are designated by counter outputs P_0 - P_5, inclusive. The counter rest or idle position is

P_5. The counters first 2 transitions in a test cycle are from P_5 to P_0 and from P_0 to P_1. These are controlled by the programmer controller mechanical cam position and are of fixed time duration. A 400-cycle trigger pulse normally controls transition time from P_1 to P_2 but this transition may be altered by card hole selection or by an external counter. The transition from P_2 to P_3 is controlled by a 400-cycle pulse. Transition of the last 2 stages is controlled by card holes and the duration of programmed events. Figure 19 shows the time relationship of the cam angle starting at 240° (the home position of the dial) through 360° of rotation plotted under the time relationship in milliseconds.

Located on the left of Figure 19 are the steps of a complete card cycle from presensing to P_5 "end of test" for one card. This chart (Figure 19) used in conjunction with Figure 20, the logic block diagram of the ring counter, will enable the reader to trace the condition of the ring counter, its inputs and control conditions. The control conditions can be traced step by step from the next card command, which initiates the start of the test to P_5 condition.

1. Card Cycle

At the beginning of a test cycle, time T_0, the ring counter is at the P_5 position, where it rests after test completion and cycle of each card. Upon the next card command the timing dial starts to rotate. When it reaches the 265° position (33 milliseconds from T_0) cam S6 combined with the next 400-cycle Z trigger, puts the ring counter in the P_0 condition. At the same time, the ground signal is applied to P_1 - P_4, which resets them to the disable condition. Upon the counter, assuming the P_0 condition, a signal is sent to reset P_5 to the disable condition. The counter remains in the P_0 condition for 223 milliseconds. During this time the card is being read and the dial has rotated to the 65 degree position enabling P_1. 256 milliseconds after the start of the cycle, the ring counter steps to the P_1 position. When P_1 sets it sends a reset signal to P_0 and enables counters B and C to be reset, provided that card holes B-15 and B-19 (reset inhibit commands) have not been punched. The A counter can be reset at this time by programming card hole F-10. Card hole B-11 inhibits reset of the A counter.

2. P_2 Position

On the next cycle pulse after P_1, the counter normally steps to P_2, but this transition may be delayed until a signal from an external counter appears. This function would be used if the B or C counter is conditioned to receive data from an external counter.

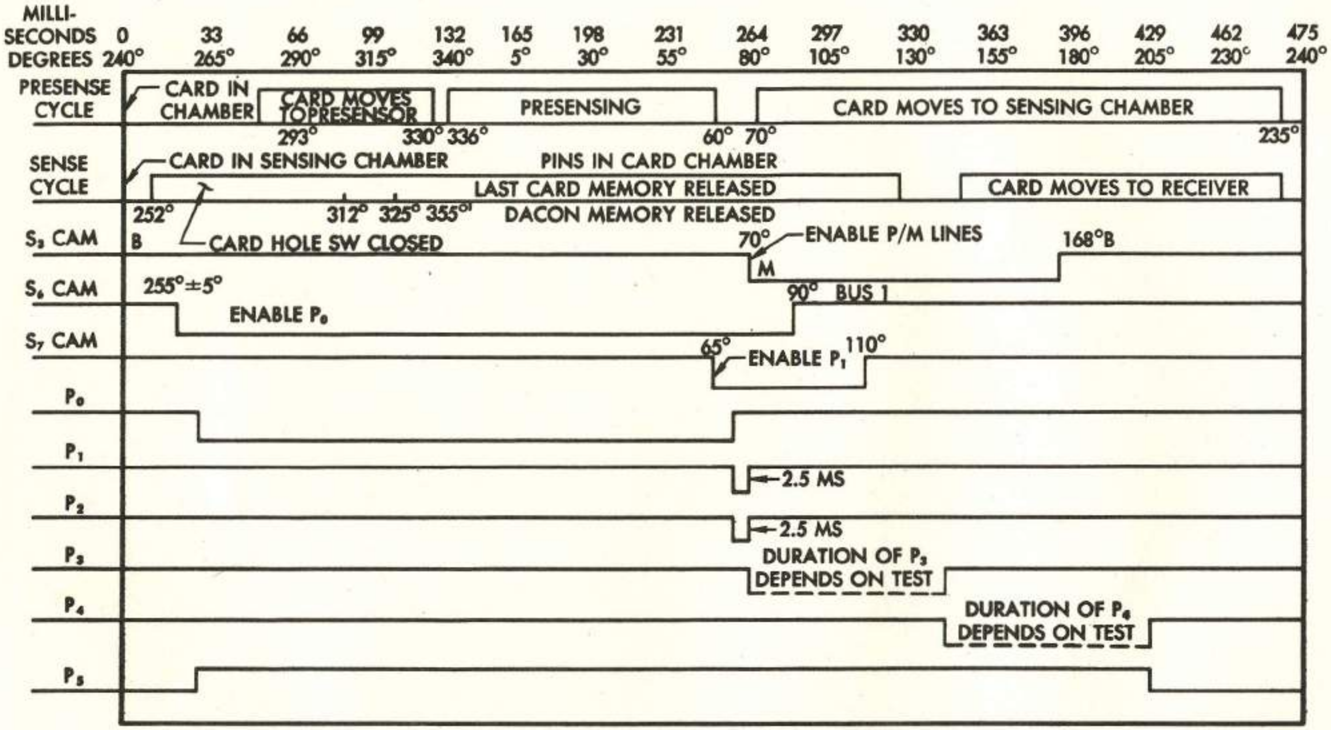


Figure 19 **MOBILE APCHE TIMING CHART**

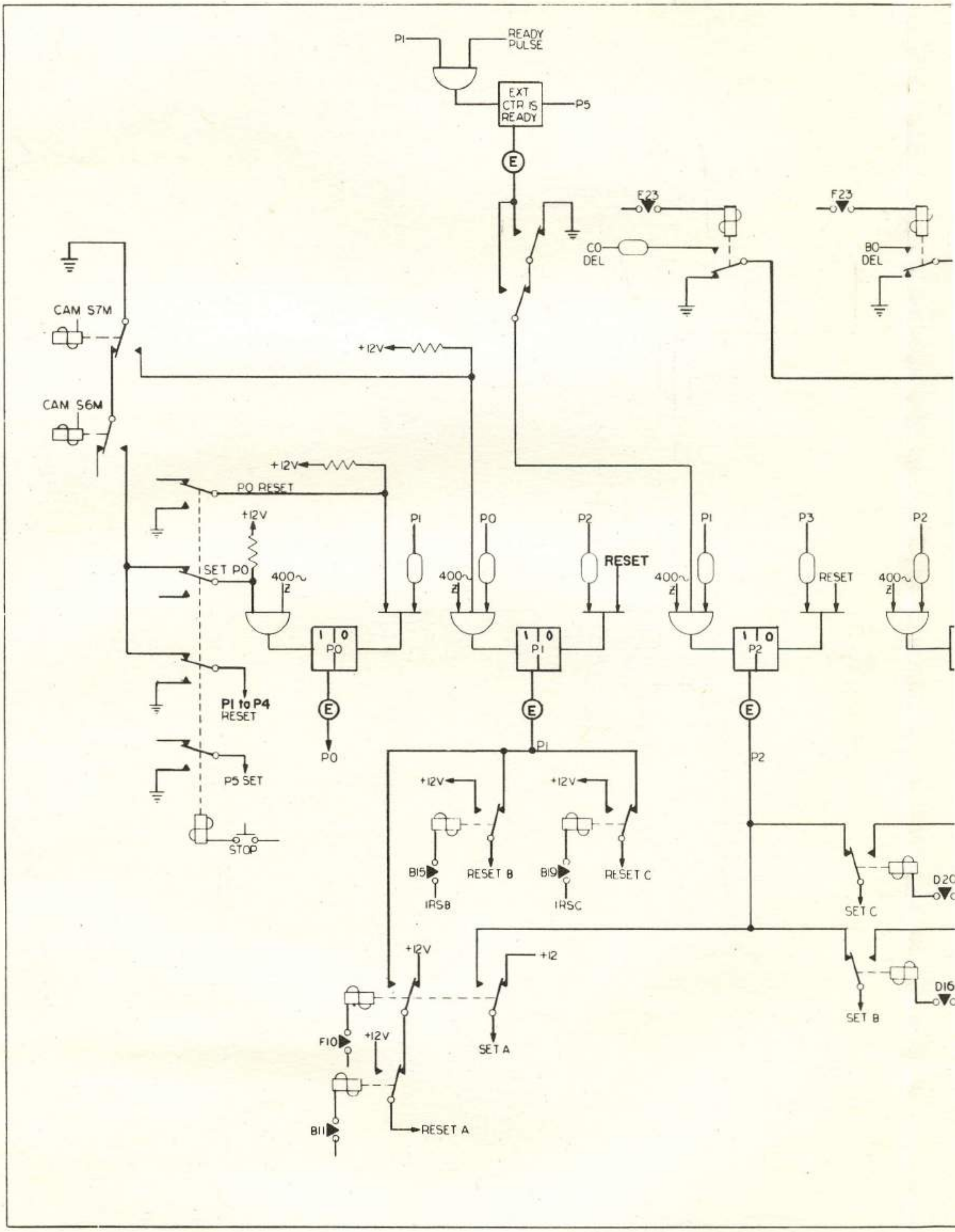
CONTROL

M L K J H G F E D C B

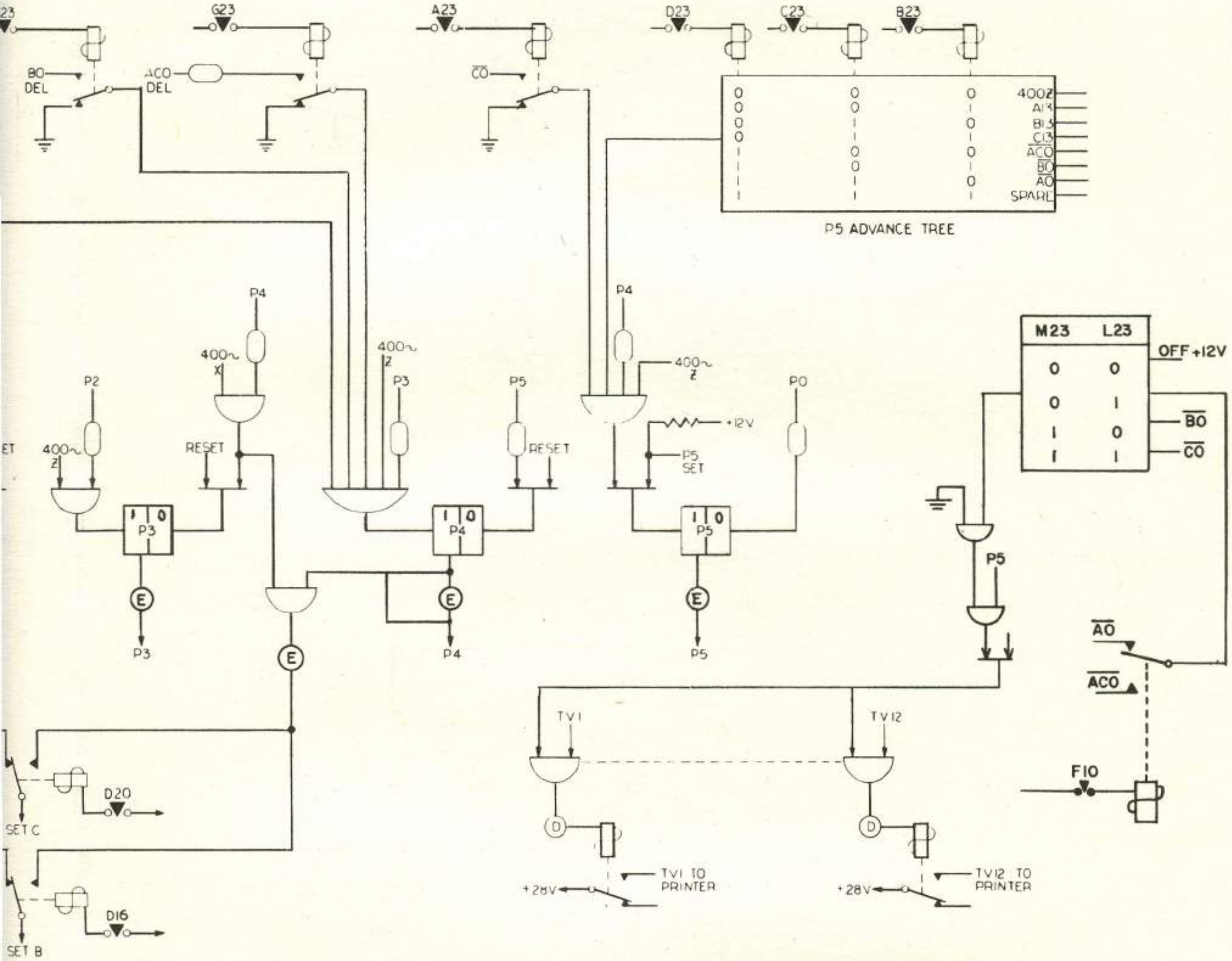
46	SCALE	POS	2^9 DACON 1 OUTPUT 2^0										
47	SCALE	POS	2^9 DACON 2 OUTPUT 2^0										2
48	[redacted]	50V	NEG	(1) DLTP (2)	D2ϕ	D1 STEP	D2 STEP						3
49	DACON 1 TEST POINT	PAR	[redacted]	DACON 2 TEST POINT	PAR								4
50	AC REF	DC REF	(1) AC (2)	RLTP	[redacted]	DECK NUMBER							5
51	PAR	TFA SOURCE	TFA FREQ	QUAD	TFA PHASE								6
52	ADCON EXT SOURCE	ADCON INT SOURCE	LTP										7
53	1 MEG	START	ADCON FREEZE	ADCON SCALE	DETECT								8
54	2^{11} PRESET COUNTER A 2^0	X 10	$\overline{F}$ IN	[redacted]	FLTR								9
55		A-CT	$\overline{F}$ MS										10
56	A START	A STOP	A FREQ	A-SUB	A-IR								11
57	[redacted]	D1 BP	D2 BP	A BP	X BP	S BP							12
58	2^{11} PRESET COUNTER B 2^0	B X-START	BO										13
59		B X-STOP											14
60	B START	B STOP	B FREQ	B-SUB	B-IR								15
61	[redacted]	PAR		B-IN	BX-IN	B13-IR							16
62	2^{11} PRESET COUNTER C 2^0	C X-START	CO	STP									17
63		C X-STOP	SUT NO										18
64	C START	C STOP	C FREQ	C-SUB	C-IR								19
65	[redacted]	C-IN	CX-IN	C13-IR									20
66	[redacted]	CAL	DND	NSTP	LTIP	DDS	DPCG	IC	DSNG	RNG	MA	PAR	21
67	[redacted]	1 PRINT MODE 4	[redacted]										22
68	D/C IN	NO-GO OUT	P4A	P4B	P4C	P5 ADVANCE	$\overline{CO}$						23
69	2^{11} UPPER LIMIT 2^0												24
70	2^{11} LOWER LIMIT 2^0												25
71	P 100 E	P 105 E	P 112 E	P 117 E	P 124 E	HI-LO	OUT						26
72	101	106	113	120	125	SCAN 4	C NG						27
73	102	107	114 1	121	126		S NG						28
74	103	110	115	122	127		SEQ						29
75	104	111	116	123	130		8 4 2 1						30
76	P 200 E	P 205 E	P 212 E	P 217 E	P 224 E	PM-SC							31
77	201	206	213	220	225	PM-ST							32
78	202	207	214 2	221	226	PM-SP							33
79	203	210	215	222	227	DECK PART #	CARD NUMBER						34
80	204	211	216	223	230								35
81	P 300 E	P 305 E	P 312 E	P 317 E	P 324 E								36
82	301	306	313	320	325								37
83	302	307	314 3	321	326								38
84	303	310	315	322	327								39
85	304	311	316	323	330								40
86	P 400 E	P 405 E	P 412 E	P 417 E	P 424 E								41
87	401	406	413	420	425								42
88	402	407	414 4	421	426								43
89	403	410	415	422	427								44
90	404	411	416	423	430								45

M L K J H G F E D C B A

David Jenkins 556th SMS -scanned by Jeff Stephens- atlasbases.homestead.com



P1
READY PULSE
EXT CTR IS READY
P5
E
F23
CO DEL
F23
BO DEL
CAM S7M
+12V
CAM S6M
+12V
PO RESET
+12V
SET PO
400~ Z
P1
PO
P2
RESET
P1
P3
RESET
P2
400~ Z
400~ Z
400~ Z
1 0 PO
1 0 P1
1 0 P2
P1 to P4 RESET
P5 SET
STOP
E
PO
E
P1
E
P2
+12V
+12V
B15
IRSB
RESET B
B19
IRSC
RESET C
SET C
D20
+12V
+12
SET A
SET B
D16
F10
+12V
B11
RESET A



M23	L23
0	0
0	1
1	0
1	1

Figure 20

RING COUNTER

Advance to P_2 is automatically disabled until a ready signal (ground closure) is received from the external source. An output from P_2 starts the A counter at this time if card hole F-10 has not been programmed. The B and C counters will be set at this time if card holes D-20 and D-16 have not been punched. If these card holes have been punched the B and C counters will be set at P_4. This is to allow the A counter or an external counter time to stabilize.

3. P_3 Position

On the next 400-cycle pulse the ring counter moves to P_3. At this time counter registers A, B and C are supplied with a "start counting" signal if so programmed. P_3 is reset by delayed P_4 signal and a 400-cycle X trigger.

4. P_4 Position

The P_4 position is enabled by the delayed P_3 signal, 400-cycle Z trigger and 2 ground signals or signals from the A, B or C counters that they have started counting. With card holes F-23, E-23 and G-23 not punched the counter will go to P_4 on the 1st 400-cycle trigger after P_3. The principal function of the P_4 output is to enable a set signal for the B and C counters to register information assimilated in the ADCON or an external source. This set signal occurs 1.25 milliseconds after P_4, allowing the transfer of information from the ADCON to a counter at any given time, while the ADCON is tracking a function.

5. P_5 Position

The ring counter advance to P_5 is conditioned by card hole switches A-23, B-23, C-23, and D-23. The P_5 output enables the summarizing of the test results and initiates the sequence of events leading to TEST COMPLETION and the next card command.

Counter Registers and Stop/Start Selector Unit

The counter registers used in the mobile APCHE are designated A, B and C counters. The B and C counters, identical, reversible, 12-state binary counters, are capable of digital timing, storage functions and measuring frequencies. The A counter normally provides a reversible, 11-stage, binary step-switching function for use with the ADCON. The A counter, however, may be conditioned to perform the function of a reversible 12-stage binary counter similar to the B and C counters, but it will have less flexibility.

Each counter register can be conditioned independently by enabling applicable card holes. These switches connect the trigger frequency and start/stop controls to the counters. Counters B and C can be preset to any 12-bit binary number from the program card, the A counter, or from an external counter. Presetting of the A counter is limited to information contained on the program card. Information contained in the counter may be transferred to the digital comparator for test evaluation by enabling card holes M-23 and L-23.

1. ADCON as a 12-Bit Counter

Card hole F-10 enables counter register A to be used independently of the ADCON unit. Counter A is programmed to any 12-bit binary number by 12 card hole switches, G10 - M10, and G9 - M9. Card hole G10 represents the least significant bit, and M9 represents the most significant bit. A punched hole on the card in any of these locations sets the corresponding stage to a ONE. The absence of a hole causes the corresponding stage to remain at ZERO, providing that the counter has been reset by ring counter output P_1. The binary number represented by the configuration of punched card holes is set into the counter on occurrence of the set A pulse from ring counter output P_2. The resetting of counter A can be inhibited by enabling card hole switch B11.

2. B Counter Programming (Figure 21)

Counter register B is programmed to any 12-bit binary number by the 12 card hole switches, G14 - M14, and G13 - M13. Card hole G14 represents the least significant bit. Counter B is reset to all ZERO'S by ring counter output P_1 and is set on the occurrence of P_2. The resetting of counter B can be inhibited by enabling card hole switch B15. Counter register B is also capable of storing any 12-bit number transferred from the ADCON (A counter) or an external counter. The transfer of a binary number from the A counter is enabled by card hole D16. This switch has the added function of changing the transfer time from P_2 to the next 400-cycle pulse after P_4, because information is not available until the P_4 condition is reached. A combination of enabled card holes, D16 and C16, allows the transfer of a 12-bit binary number from an external source. Although both the B anc C counters can store external information, no more than one external source can be connected to APCHE for storage at a given time.

3. C Counter Programming (Figure 21)

The programming of counter register C is identical to that of counter B in every respect, except for the location of card holes. The C counter is preset from the card by holes G10 - M18, and G17 - M17. The least significant digit is G18. The transfer of information from the A counter to the C counter is enabled by hole D20 and from an external counter by a combination of card holes D20 and C20. Reset is inhibited bv enabling card hole switch B19.

4. Frequency Selection (Figure 22)

The selection of a trigger frequency for the 3 counter registers is furnished by relay trees. The selected input is formed into pulses, which are used to control the counter and the rate of counting. Counters B and C can be operated by an external frequency source. The input signal amplifier-detector is connected directly to the external frequency input of the counter frequency selection tree. The input signal amplifier-detector must be programmed to provide attenuation of the frequency voltage to a nominal 4.5V peak, minimum 2.26V peak. External frequencies must be between 20 cycles and 40 kilocycles because of the frequency limits of the counter.

5. Series Connection

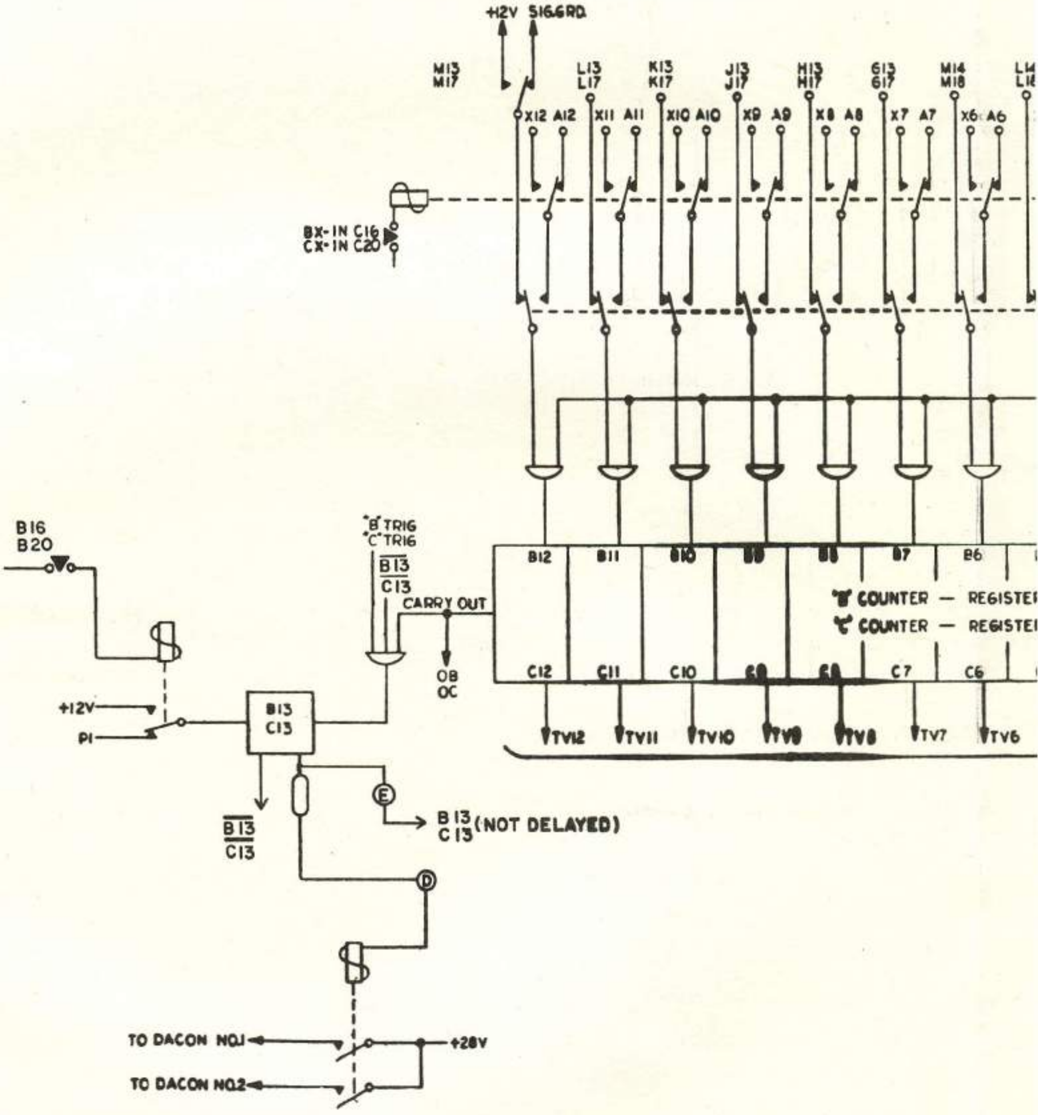
If 2 counters are connected in a series sequence (not tandem - the B13 output of one counter providing the start control for the second), one trigger pulse is lost. The second counter of a series connection overflows after 4096 + 4096 + 1 (or 8193) pulses from a RESET condition of all ZERO'S.

A START signal cannot change the state of a counter from a RESET to a set condition if a stop signal exists. A STOP signal cannot change the state of a counter from SET to RESET if a START signal exists.

6. Tandem Operation (Figure 22)

Counters B and C may be combined to form a 24-stage counter. If TANDEM is programmed into the B counter frequency selection tree, the start and stop signals and frequency selection must be made on the C counter selection trees. With this connection, counter register B supplies the 12 most significant bits. Tandem operation also may be programmed using counter C as the most significant counter.

When counters are being operated in tandem, the start/stop module of the counter furnishing the 12 most significant bits is


+12V
516 GRD
M13
M17
L13
L17
K13
K17
J13
J17
H13
H17
G13
G17
M14
M18
X12
A12
X11
A11
X10
A10
X9
A9
X8
A8
X7
A7
X6
A6
BX-IN C16
CX-IN C20
B16
B20
"B" TRIG
"C" TRIG
B13
C13
CARRY OUT
OB
OC
B12
B11
B10
B9
B8
B7
B6
"B" COUNTER — REGISTER
"C" COUNTER — REGISTER
C12
C11
C10
C9
C8
C7
C6
TV12
TV11
TV10
TV9
TV8
TV7
TV6
+12V
P1
B13
C13
E
B13
C13
(NOT DELAYED)
B13
C13
D
TO DACON NO.1
TO DACON NO.2
+28V

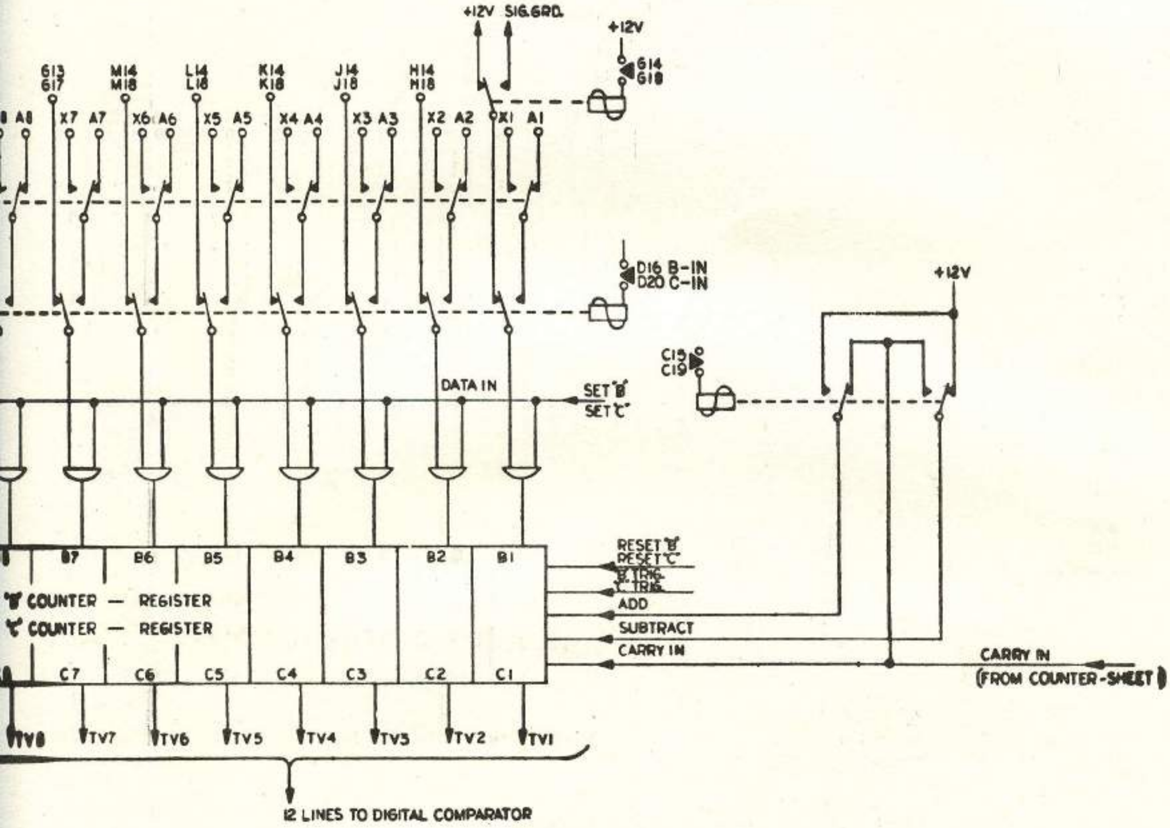
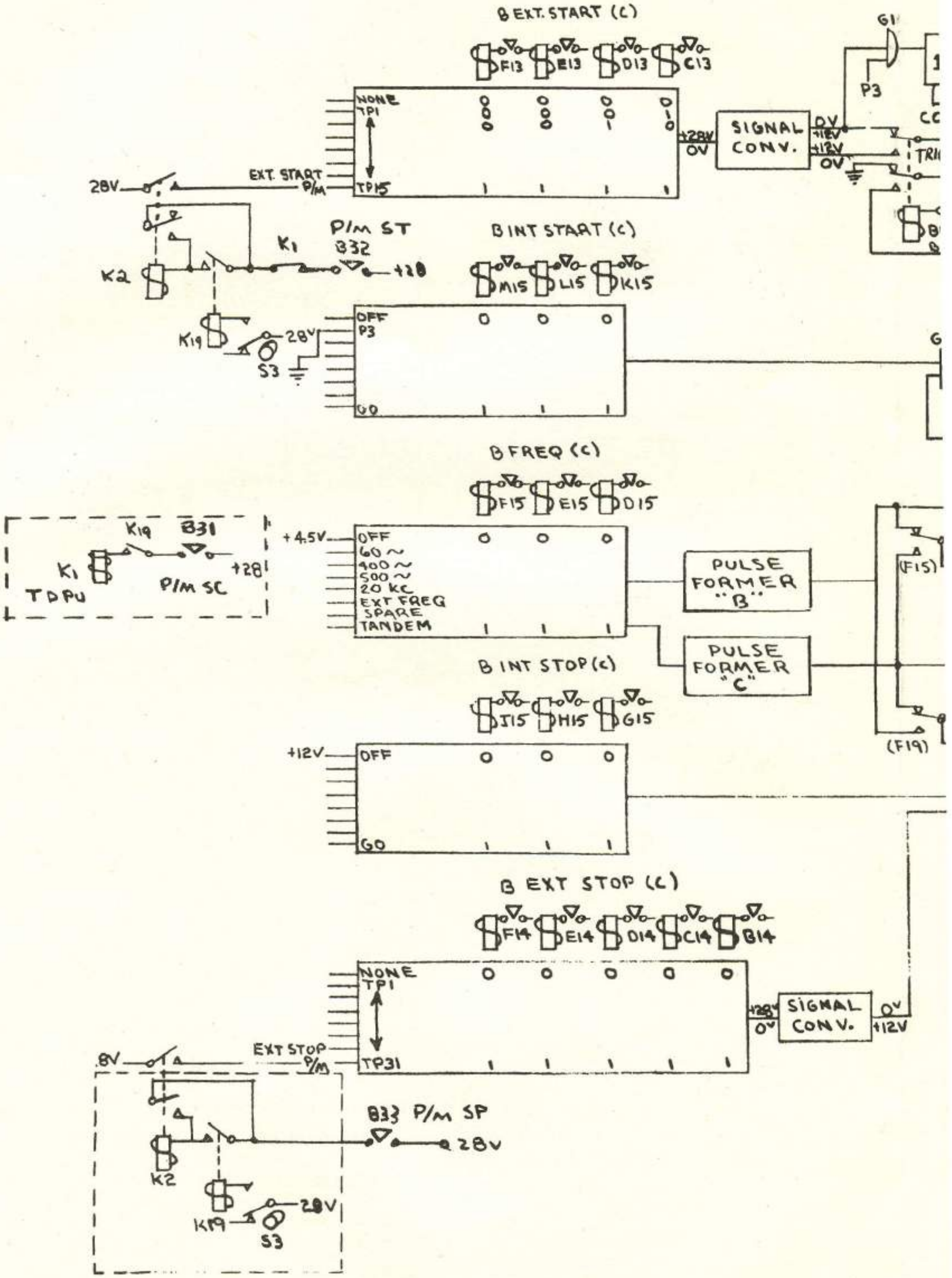


Figure 21

SHEET 2 of 2
DIGITAL COUNTERS


B EXT. START (C)
F13
E13
D13
C13
NONE
TP1
TP15
EXT. START
P/M
28V
+28V
0V
SIGNAL CONV.
0V
+12V
+12V
0V
G1
P3
CC
TRI
K2
K1
P/M ST
B32
+28
K19
28V
S3
B INT START (C)
M15
L15
K15
OFF
P3
GO
G
B FREQ (C)
F15
E15
D15
K19
B31
K1
+28
TDPU
P/M SC
+4.5V
OFF
60 ~
400 ~
500 ~
20 KC
EXT FREQ
SPARE
TANDEM
PULSE FORMER "B"
PULSE FORMER "C"
(F15)
(F19)
B INT STOP (C)
J15
H15
G15
+12V
OFF
GO
B EXT STOP (C)
F14
E14
D14
C14
B14
NONE
TP1
TP31
EXT STOP
P/M
8V
+28V
0V
SIGNAL CONV.
0V
+12V
B33 P/M SP
28V
K2
K19
28V
S3

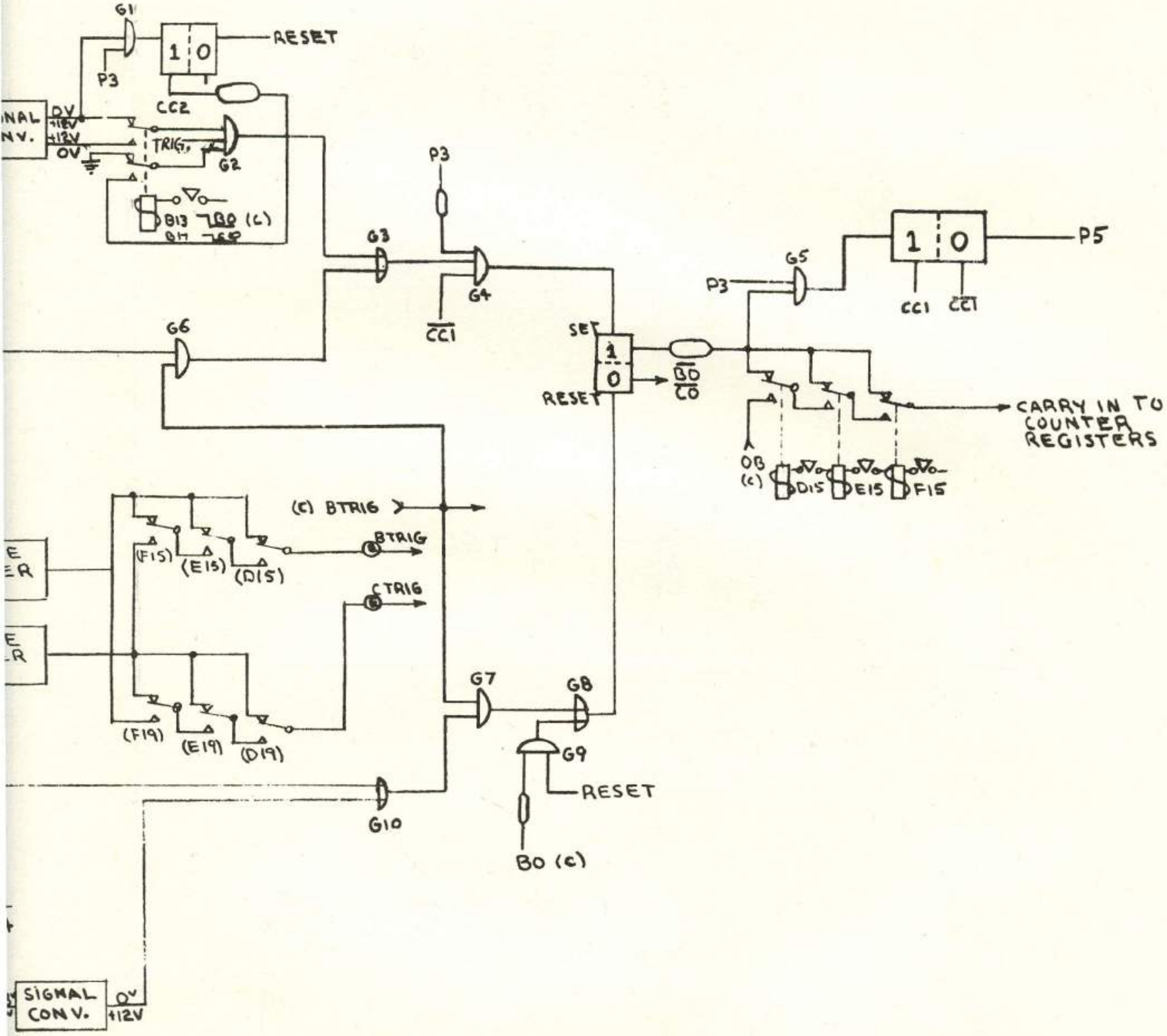


Figure 22

SHEET 1 OF 2

DIGITAL COUNTERS

disconnected from the associated counter and may be used as a control for the ring counter.

Any start condition for the most significant tandem counter may be employed independently of the counter as a requirement for advance to P_4. Also any STOP condition for the counter may be employed as a requirement for advance to P_5, provided that a START is furnished. Use of the counter start/stop module during tandem operation does not require selection of a frequency for the most significant counter.

7. Parallel Connection

This connection allows the counters to be running at the same time. Generally the B and C counters will be connected in parallel but when required A counter may also be used. This connection is used for measuring frequencies. To do this one counter will count at the unknown frequency while the second counter will establish the time period. The binary count in the first counter at the end of the time period indicates the measured frequency.

8. External Start (Figure 22)

Counter registers B and C can be conditioned to start on external signals by programming C13 - F13 for counter B and C17 - F17 for counter C. External start of the counter occurs normally upon the application of a nominal 28V DC signal. However, external start may be conditioned to occur on loss of the 28V DC signal by enabling card hole B13 for counter B and B17 for counter C. Counter A does not have provisions for external start conditions. Delayed internal start commands may be used when an external control is programmed into a counter. This is to insure that the test runs to completion and that a GO/NO-GO comparison is made. The overflow conditions of a second counter or the GO/NO-GO output of the digital comparator can be used to provide a start condition in the event that the external signal fails to occur.

The internal start control selections are similar for counters A, B and C. All internal and external start control signals are enabled by a P_3 output of the ring counter.

The HI, LO, and GO inputs to the internal start control are outputs from the digital comparator. The A13, B13 and C13 inputs to the START control occur upon overflow of the A, B and C counters, respectively (or on the 4096th count from a RESET condition).

9. Internal Stop

The selection of an internal stop is conditioned in accordance with truth tables (Figure 15). Terms not previously defined are 0A, 0B, and 0C, which represent the output carry of counters A, B, and C respectively. They are used to stop a counter on its own overflow. The counter will stop on the next trigger pulse after 0B or with 000 000 000 000 registered in the counter. This condition occurs on the 4096th pulse after a reset condition of all ZERO'S.

10. External Stop

Counter registers B and C may be programmed to stop on a nominal 28V DC signal. This signal is connected to the external stop control selection tree. Counter A has no external stop facility.

When an external stop is used, the internal stop control should be programmed to stop by its own carryout (OB) subsequent to the time of the expected external signal. If the expected external relay closure fails to occur, the programming of OB enables the test to proceed to comparison. A NO-GO is generated, and the counter and test are prevented from continuing indefinitely. By presetting the counter, the waiting time for the backup STOP ON OVERFLOW condition is a NO-GO. Since the counter reads all ZERO'S after stopping on OVERFLOW, the digital comparator lower limit must be set greater than ZERO.

11. Add/Subtact Mode

Counters A, B, and C are reversible; that is, the counter may add or subtract the input trigger pulses. The A, B, and C counter subtract modes are enabled by card holes C11, C15 and C19, respectively.

12. Transfer to Digital Comparator

Selection of card holes L23 and M23 enables a 12-bit number to be connected from 1 of 3 counters to the digital comparator for GO or NO-GO comparison with upper and lower limits. This connection occurs during P_3 for counters B and C and lasts until P_0 of the next card cycle. The A counter or ADCON is connected after the card holes are read during P0.

Printer and Printer-Decoder

1. Printer

The MAPCHE printer employs a continuously rotating drum with 12 rows of characters. Each column of characters is the same width, although "alpha" column spacing is less than the spacing between "numerical" columns. The drum contains all characters required for MAPCHE printouts (Figure 23).

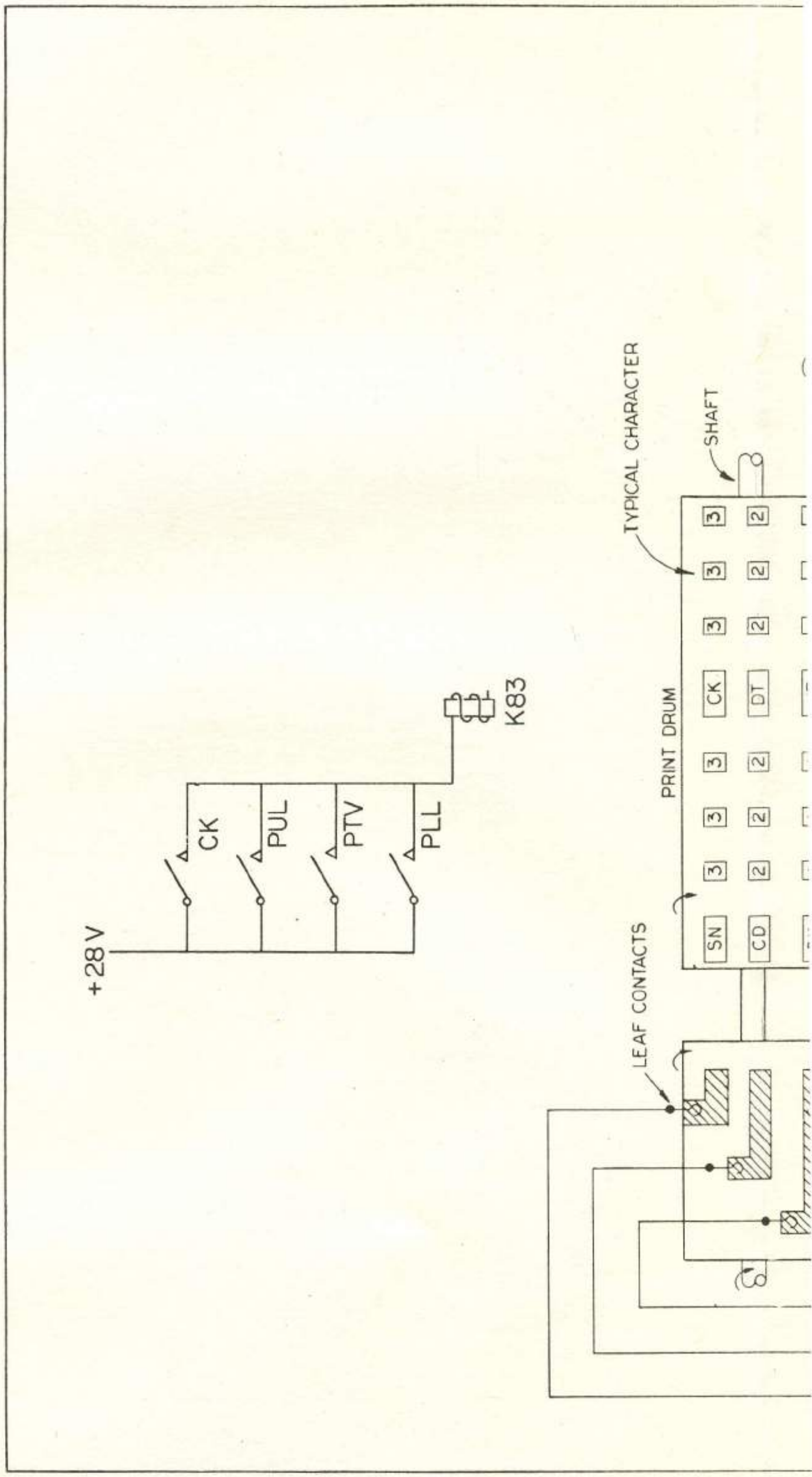
Attached on the shaft with the drum is a commutator whose function is to complete a logic path between a -10.5V source and hammer solenoids when the hammer is synchronized with a character to be printed. Double alpha characters require a pair of solenoids. These solenoids are wired in parallel and energized at the same time; therefore they may be considered to be one solenoid.

2. Printer-Decoder

A printer-decoder sets up the logic for proper sequence of the printout. Each solenoid, or solenoid pair, is energized in order to drive the hammers. The hammers strike a paper tape contained between the hammers and the printing drum at the time required to printout the proper alpha or numeric character. An example will demonstrate the operation. (Refer to Figure 23)

Assume that it is desired to print out DK 124 HR. The printer-decoder sets up the proper relay trees and the DK and Cd relays for the above line. A "printer start" command starts the print cycle and is present for the entire cycle. When the first numerical character appears (in this case 1) a path is completed through the commutator, the DK and CD relays, and the numeric relay trees. When the number 1 on the drum lines up with the hammers, the DK, CD and 1 columns are printed. (All this happens while the drum is still rotating.) When the drum rotates to the next row of characters, a 2 in the next column prints since a path is completed between the next commutator strip and the necessary relays and circuits. The next print occurs when 4 lines up with the hammers, and so forth.

Four MAPCHE print modes are possible (Table 6). Print mode 1 is the identification mode, intended to preceed and follow each complete test as the first and last printing of any deck or to be inserted in longer decks for identification purposes. Deck NO. 1 to 999 identify individual decks of cards; cards 1 to 999 identify


+28 V
CK
PUL
PTV
PLL
K83
TYPICAL CHARACTER
SHAFT
PRINT DRUM
LEAF CONTACTS
SN
CD
CK
DT
3
2

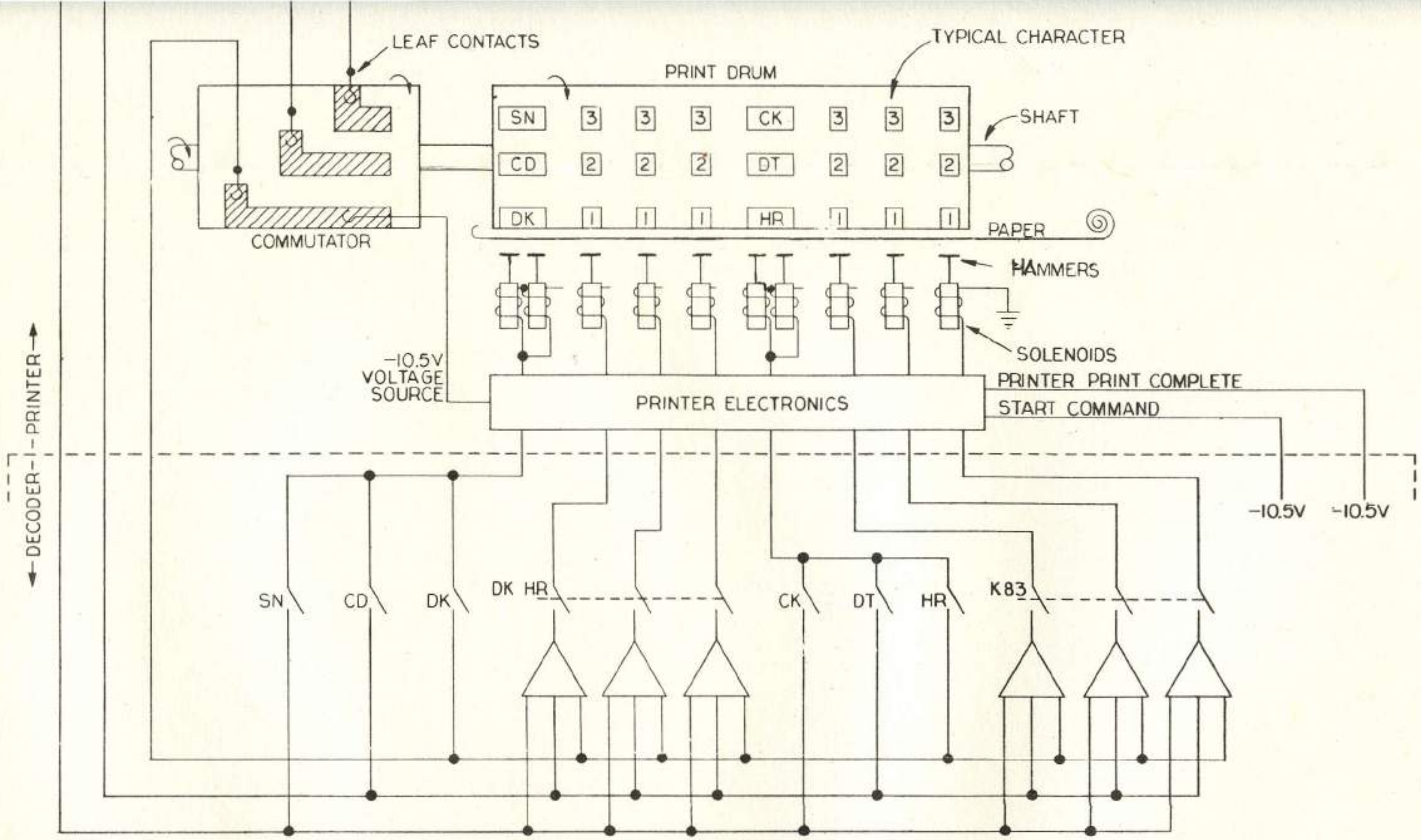


Figure 23 PRINTER & PRINTER DECODER

specific cards within a deck.

Print mode 2 is used during an analog test. It identifies the test by giving card number, the upper and lower test limits, and the test value. On a satisfactory test, CD preceeds the card number. On an unsatisfactory test HI or LO NG will be printed out after the test value.

Print mode 3 performs essentially the same function as mode 2, but test limits are not printed out (although they are used in the comparator to test for a GO/NO-GO condition).

Print mode 4 is used for discrete sampler tests. If there is no malfunction in a sampled circuit of 100 discrete units, only the card number is printed out. The card is then ejected, and a new card is read. If a malfunction exists the discrete sampler locates the fault and prints out the circuit and (system under test) SUT number.

All test value and limit numbers on an analog test are printed out in a four character octal number. All NO-GO circuit numbers in a discrete test are printed out in a three character octal number.

The printer-decoder works in conjunction with the printer and performs the necessary controlling and decoding functions. It decodes binary input and test result data and encodes an octal printout. A decimal printout of deck and card numbers is also accomplished, and signals are sent to the indicator-control panel.

Commands received by the printer-decoder are 28V DC signals.

The commands are:

Mode signal (4 commands)

Start print

NO-GO

Alpha-numerical setup commands

Test complete

Input data:

Deck number

Card number

Upper limit

Lower limit

Test value

Discrete circuit number

Table 5 Printer Definition

NG	NO-GO, out of tolerance	UL	Upper limit
DK	Deck, card deck	TV	Test value
CD	Card, single card in deck	LL	Lower limit
HR	Hour, (no printout)	S	Discrete signal
DT	Date, (no printout)	*	Indicates HI or LO is printed
CK	Circuit		

Table 6 Printout Examples
(All Black Printout)

Mode 1				
		DK245	HR----------	
		CD700	DT----------	
		Sn----------		
Mode 2				
	(GO)	CD031	UL1763 TV1762 LL1761	
	(NG)	CD031	UL1763 TV1764 LL1761	Hi NG
Mode 3				
	(GO)	CD031	TV1762	
	(NG)	CD031	TV1760	Lo NG

Mode 4

(GO)	CD031	
(NG)	CD031	
		CK7101 SNG CK7106 SNG

Discrete Loop

The discrete test assemblies of the mobile automatic programmed checkout equipment (MAPCHE), make possible the transmission of + or - 28V DC test signals to any one of six systems under test (SUT's). SUT NO. 7 is provided for APCHE self-test. The discrete test assemblies are also capable of monitoring for the presence or absence of +28V DC response signals from the SUT's. If the actual conditions at the SUT differ from the desired conditions as programmed on the APCHE card, a NO-GO signal is sent to illuminate the NO-GO lamps on the APCHE indicator-control display panel. The printer is also enabled, and the number of the malfunctioning circuit is printed out on tape.

Discrete Assembly Description

The discrete test assemblies that provide APCHE with these capabilities are listed below. The assembly number preceding the unit name identifies the position of the unit within the electrical checkout vehicle (Figure 24).

A1, A2, A3 - System Selection Selector Units

A4 - System Selection Self-Test Selector Units

A15, A19 - Discrete Sampler Selector Unit

A16 - Discrete Sampler Controller

Figure 17 shows the input and output connections of the discrete test assemblies. The tie-in of the card programmer is also shown to facilitate data flow analysis.

Three of the chassis, the two selector units (A15, A19) and the discrete sampler controller (A16), are collectively referred to as the discrete sampler.

The discrete sampler (Figure 24) is a device designed to service 100 program/monitor (P/M) lines. These lines are connected from the

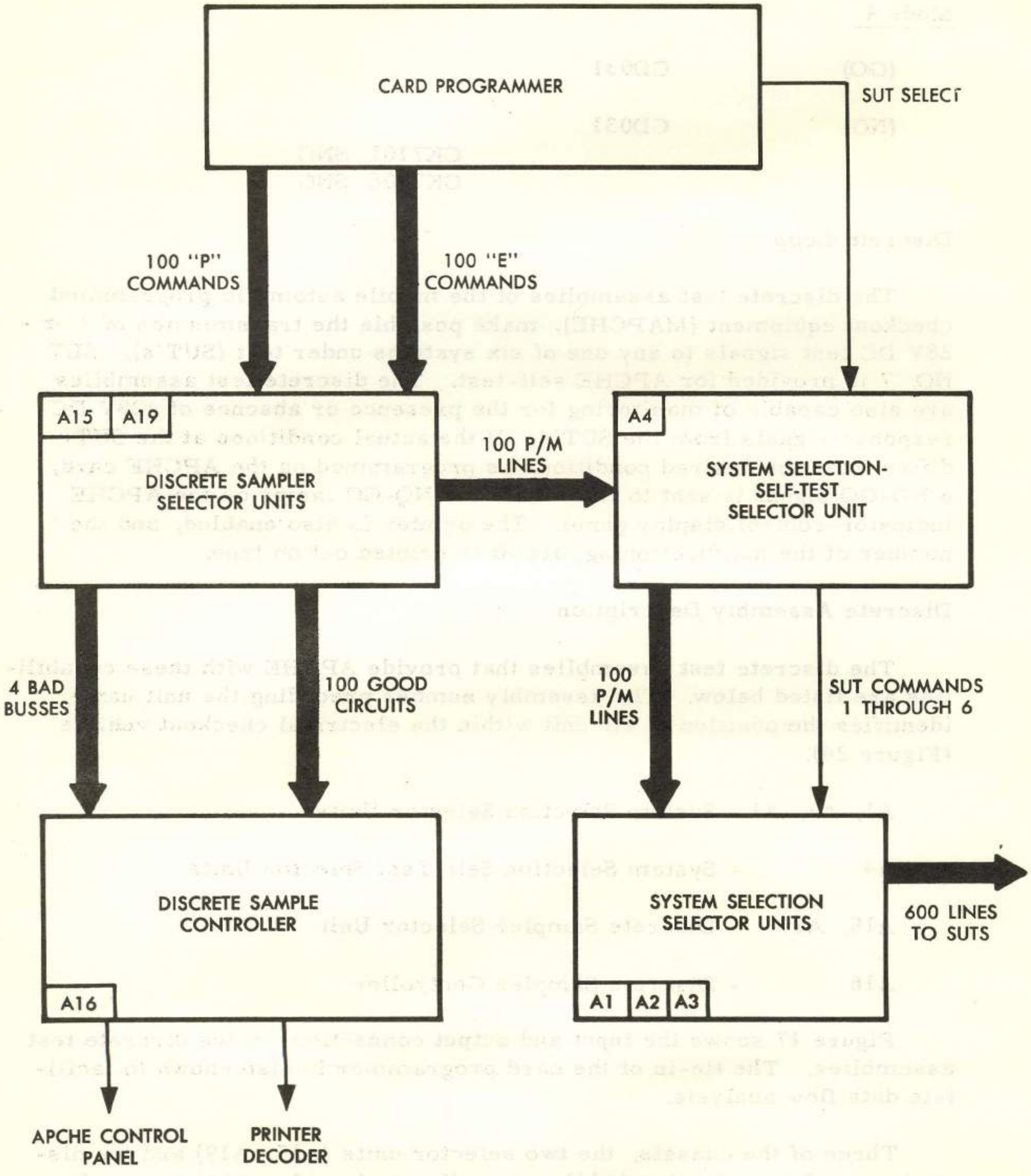


Figure 24 **DISCRETE TEST ASSEMBLIES**

discrete sampler selector units (A15, A19) to specific test points of the SUT by means of the system selection unit (A1, A2, A3).

It should be noted, however, that the 100 P/M lines from the discrete sampler selector units are not connected directly to the system selection selector units. Instead, they are coupled through A4. This setup is incorporated to provide a means of self-checking the discrete sampler itself. A detailed discussion of the self-test unit will be covered in a later section of this study guide. For now it is sufficient to say that basically selector units A1, A2, A3, and A4 provide a means of connecting the 100 P/M lines to any one of six systems. Consequently, 600 lines are shown leaving the system selection selector units. It also should be mentioned at this time, that unit A4 contains a SUT select relay tree which, upon command from card programmed information, sends SUT commands to the system selector unit telling it to switch the 100 P/M lines to the desired system. Keep in mind that the whole purpose of the 100 P/M lines is to either carry +28V commands to the SUT or carry +28V or 0V, responses back to the discrete sampler from the SUT.

The question that now arises is, what determines whether a line is being used to program (send out +28V) or monitor (receive +28V or 0V)? Referring to the sample MAPCHE test program card shown in Figure 11 will help answer this question. Here we find four groups of circuit numbers, encompassed by card locations C - M, 26 - 45. Furthermore each group contains 25 separate circuits, making up the total of 100 available lines. Card locations B27, B28, B29, and B30 are used for group scanning selection. If, for example, card hole B27 is punched, the discrete sampler will service each of the group I circuits, NO. 100 - 130. Card holes B28, B29, and B30 enable scanning of circuits in groups II, III, and IV, respectively.

Further inspection of the MAPCHE card shows that each circuit number is associated with a P and an E card location. The program (P) card location is punched when it is desired to send 28V DC over a P/M line to a SUT test point. The energize (E) card location is punched when the corresponding circuit number is employed for monitoring the presence or absence of a 28V DC signal from a SUT test point, when one or more of the group selection card locations is punched for scanning and print mode 4 is selected, the discrete sampler will program and/or monitor the lines in the selected group. If a programmed line does not become energized or a nonprogrammed line becomes energized, the discrete sampler will generate a NO-GO signal to the printer and the indicator panel. The circuit number of the faulty line will be printed by the printer. Figure 24 shows both the 100 P and 100 E control lines connected between the card reader and the discrete sampler selector units. In this way, programmed card information can exercise the necessary control over the 100 P/M lines.

1. System Selection Selector Unit

The system selector unit assemblies contain relay switching logic for the 100 discrete sampler P/M lines. Selection of the SUT through enabling card holes A18, A19, and A20 (SUT numbers), is accomplished by a series of ganged relays in the system selector. The system selector is separated into three assemblies; two are capable of selecting 33 lines, and one is capable of selecting 34 lines in each of six SUT's. Selecting or discarding a SUT must follow a set sequence. The selection of a SUT must be made on one program card; the application of SUT tree power (card hole A17) must be made on the second card. The discard of a SUT must follow the sequence in reverse; first, SUT tree power is removed, and then the SUT selection is changed or removed. Therefore, the transition from one SUT to another requires two cards that cannot furnish program information.

2. Discrete Sampler Selector Units

Figure 25 shows a typical MAPCHE program/monitor and fault sensing circuit. There are 100 identical circuits of this type, one for each P/M line, contained within selector units A15, and A19. Within each group 25 bad points are all tied together to make one group bad bus. For this reason, four bad buses are shown in Figure 24. On the other hand, the 25 good points in each group terminate at separate outputs and are sampled successively.

Each of the two selector units contain 50 circuits of the type shown in Figure 25. Entering each chassis are circuits for 50 P holes, 50 E holes and a 28V signal delayed by cam S3. Leaving the chassis are 50 good lines and 2 bad buses.

By tracing out the circuit on Figure 25, it can be seen that if a P card location is punched and K1 energizes, "28V will appear on the selected P/M line. If, for example, we desire to send +28V over P/M line 127, card location D29 is punched. This +28V signal can then be switched by the selector units to a specific SUT test point.

The time at which K1 becomes energized is controlled by cam S3 in the card reader. The contacts of S3 are set to close after the MAPCHE counter registers are enabled to start, time P3 on the ring counter. This feature is incorporated so the counters can be used to time a particular test.

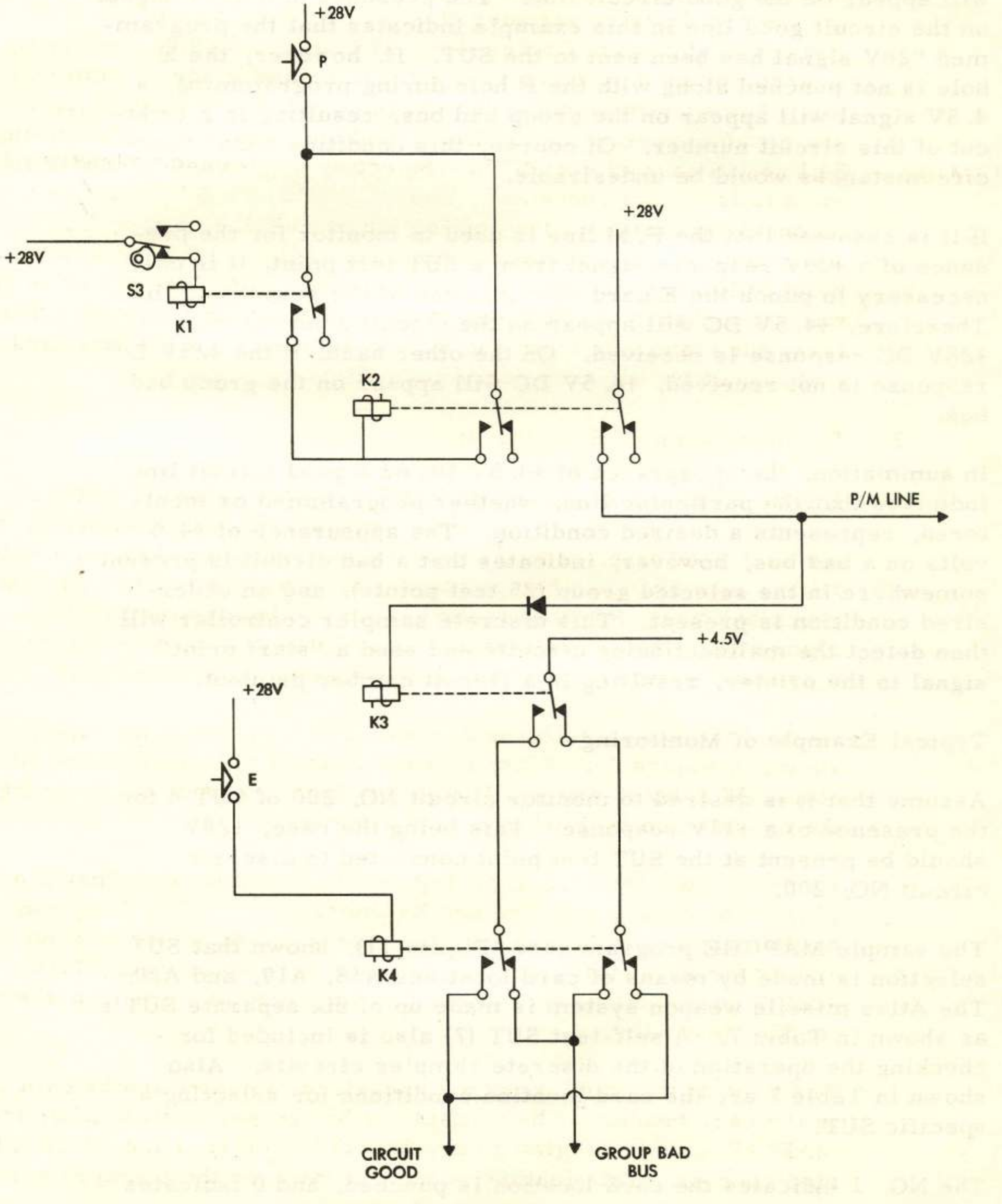


Figure 25 **PROGRAM-MONITER AND FAULT SENSING CIRCUIT**

It should be noted that once K2 is energized, it is latched through its own contacts unless otherwise programmed on a succeeding card. It can also be seen that if the P hole is punched, the E hole of the same circuit number must also be punched so a 4. 5V signal will appear on the good circuit line. The presence of a 4. 5V signal on the circuit good line in this example indicates that the programmed "28V signal has been sent to the SUT. If, however, the E hole is not punched along with the P hole during programming, a 4. 5V signal will appear on the group bad bus, resulting in a printout of this circuit number. Of course, this condition under these circumstances would be undesirable.

If it is assumed that the P/M line is used to monitor for the presence of a +28V response signal from a SUT test point, it is only necessary to punch the E card hole location of the respective line. Therefore, +4. 5V DC will appear on the circuit good but if a +28V DC response is received. On the other hand, if the +28V DC response is not received, +4. 5V DC will appear on the group bad bus.

In summation, the appearance of +4. 5V DC on a good circuit line indicates that the particular line, whether programmed or monitored, represents a desired condition. The appearance of +4. 5 volts on a bad bus, however, indicates that a bad circuit is present somewhere in the selected group (25 test points), and an undersired condition is present. This discrete sampler controller will then detect the malfunctioning circuits and send a "start print" signal to the printer, resulting in a circuit number printout.

3. Typical Example of Monitoring

Assume that it is desired to monitor circuit NO. 200 of SUT 4 for the presence of a +28V response. This being the case, +28V should be present at the SUT test point connected to discrete circuit NO. 200.

The sample MAPCHE program card (Figure 11), shown that SUT selection is made by means of card locations A18, A19, and A20. The Atlas missile weapon system is made up of six separate SUT's as shown in Table 7. A self-test SUT (7) also is included for checking the operation of the discrete sampler circuits. Also shown in Table 7 are the card location conditions for selecting a specific SUT.

The NO. 1 indicates the card location is punched, and 0 indicates it is not punched. As mentioned previously, after the "SUT select" control signals are initiated at the card reader, they are sent to a SUT select relay tree in the system selection self-test unit. At this point, the selected SUT command is sent to the system selection selector unit telling it to switch the 100 P/M lines to the desired system.

Table 7 shows that SUT 4 is selected by punching card location A18. Since a +28V response signal is being monitored at circuit 200, it remains to punch the energize (E) card location at circuit 200. Figure 11 (MAPCHE card) shows that card location L31 should be punched for this selection. If the proper condition is present, "28V DC will be present on the P/M line leading to the fault sensing circuit (Figure 25). Relay K3 will then energize. Since the E hole is punched, K4 will also energize, resulting in a +4. 5V signal at the circuit good output point. If, however, the 28V response signal were absent, K3 would remain deenergized and K4 would energize, resulting in a 4. 5V potential on the group bad bus.

Table 7 SUT Selection

SUT	CARD LOCATION			SYSTEM
	A18	A19	A20	
None	0	0	0	
1	0	0	1	Propellant Utilization
2	0	1	0	Pneumatics
3	0	1	1	Missile Electrical and Pneumatics
4	1	0	0	Propulsion
5	1	0	1	Flight Control and Hydraulics
6	14	1	0	Unassigned
Self-check	1	1	1	MAPCHE Discrete Sampler

4. Discrete Sampler Decoding System

The next discrete assembly to be described is the discrete sampler controller (A16), which consists of the decoder system and the cycling control system. Each of these systems will first be described separately and then as an integral unit.

Figure 26 contains a block diagram of the decoding system. The output of the system is called the circuit sensor. The cycling control system is a 7 bit binary counter. This counter generates the command signals used to control the transistorized switching in the decoding system.

By use of the decoding system the circuit sensor is connected successively to each of the 100 good lines shown entering the top of the decoding box. Keep in mind that the potential at the circuit sensor is a direct indication of the condition of the P/M line being sampled. A good circuit will apply +4. 5V at the input to the decoder.

The whole purpose of the decoding system is to successively connect each of the 100 good circuits to the circuit sensor. The circuit sensor then relays this information to the cycle control system where the evaluation is performed.

5. Cycling Control System

This system initiates a discrete sampler test on command from the P_5 relay (end of test). It also determines whether there is an error in a selected group. If there is an error in a selected group, it scans the group until it finds the bad circuit or circuits. It then initiates signals to the printer-decoder, causing the printer to printout the number of the faulty circuit. On notice from the printer-decoder that the print cycle is complete, cycling control system cycles again to the next faulty circuit until all bad circuits in the selected group are printed out. At the end of the cycle a "test complete" signal is generated.

Basically, the cycling control system consists of 12 flip-flops. Seven of these are used in a binary counter, S_1 through S_7. The other five are used to indicate control signals for the discrete sampler, the printer and the card reader. The use of this seven stage counter is rather unique in that this counter controls the switching accomplished in the decoding system and also identifies the faulty circuit number by its binary count.

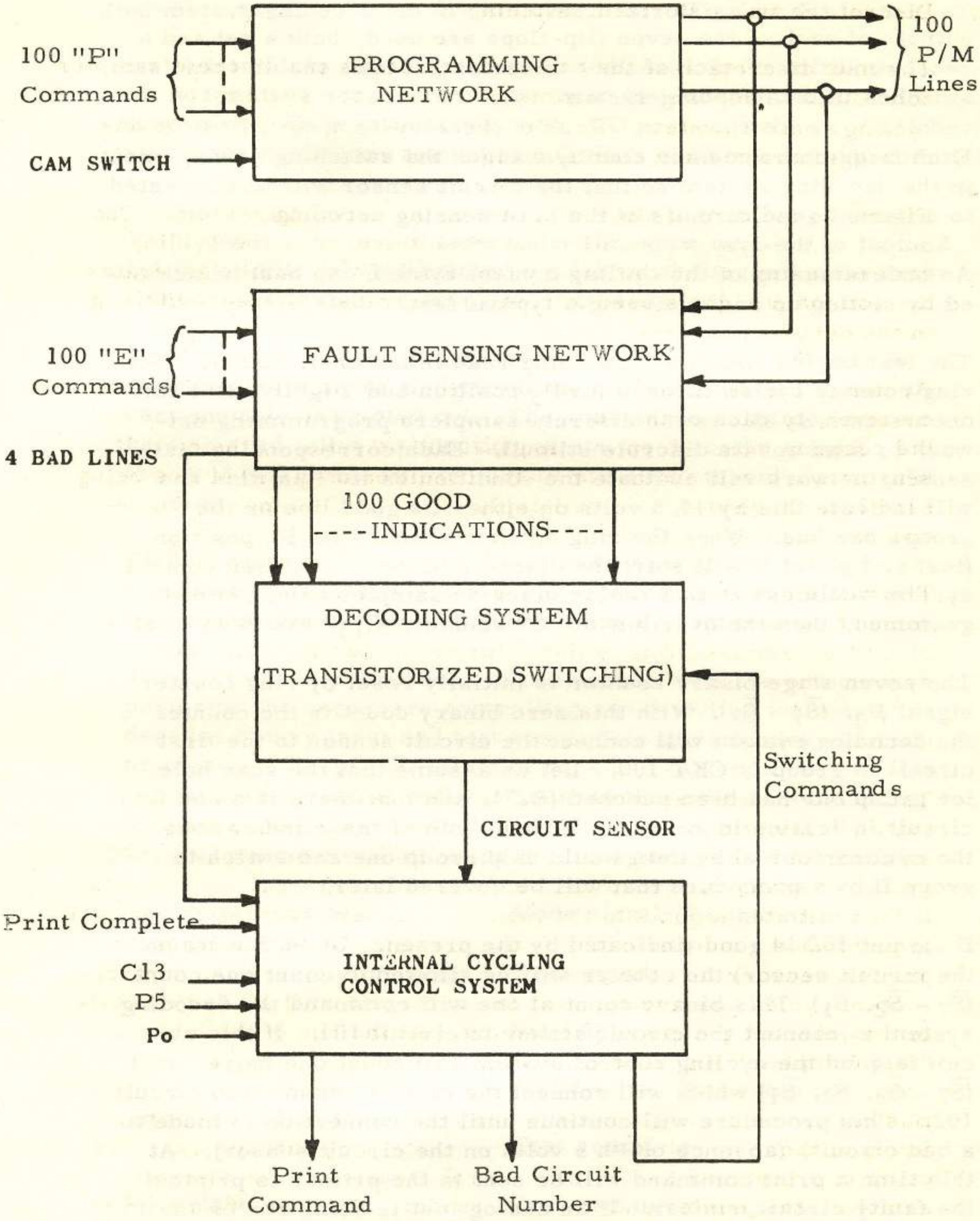


Figure 26 Decoding System Discrete Sampler

To control the transistorized switching in the decoding system both outputs of each of the seven flip-flops are used, both a set and a reset condition of each of the counter stages will enable transistor switches in the decoding system.

Each trigger the counter counts, changes the switching arrangement in the decoding system so that the circuit sensor will be connected to different good circuits of the fault sensing networks.

An understanding of the cycling control system can best be achieved by setting up and analyzing a typical test.

The test begins with the card being read in the card reader. The ring counter cycles through its P_3 position and slightly after this occurs cam S_3 allows the discrete samplers programming network to send out its discrete stimuli. Each corresponding fault sensing network will evaluate the condition on its P/M line and will indicate this by +4. 5 volts on either its good line or the groups bad bus. When the ring counter reaches its P_5 position (test complete) it will start the discrete samplers cycling control system. (Unless D. D. S. delay discrete sampler has been programmed, then the overflow of "C" counter, C_{13}, would do this.)

The seven stage binary counter is initially reset by ring counter signal P_0, ($\overline{S}_1$ - $\overline{S}_7$). With this zero binary count in the counter the decoding system will connect the circuit sensor to the first circuit in group I, CKT 100. Let us assume that the scan hole for group one has been punched (B27), and that there is a bad circuit indication in group I. Without both of these indications the cycling control system would skip group one and switch to group II by a procedure that will be covered later.

If circuit 100 is good (indicated by the presence of +4. 5 volts on the circuit sensor) the counter will be allowed to count one count. ($\overline{S}_7$ - $\overline{S}_2$, S_1) This binary count of one will command the decoding system to connect the circuit sensor to circuit 101. If this circuit is good the cycling control system will count one more count ($\overline{S}_7$ - $\overline{S}_3$, S_2, $\overline{S}_1$) which will connect the circuit sensor into circuit 102. This procedure will continue until the connection is made to a bad circuit, (absence of +4. 5 volts on the circuit sensor). At this time a print command will be sent to the printer to printout the faulty circuit number. If an analog test is being run on the same card this signal will be delayed until the completion of the analog printout. When the discrete circuit number has been printed out the printer will send back to the cycling control system a print complete signal which will allow the counter to continue counting. The cycling control system will continue counting through all the circuits in group I stopping on each faulty circuit until it has been printed out.

When the counter reaches a count of 32 ($\overline{S}_7$, S_6, $\overline{S}_5$ - $\overline{S}_1$) it will have completed counting through group I and will be into group II with the circuit sensor connected to the first circuit in group II, circuit 200.

The seven counter stages S_7 and S_6 control the group selections, S_5 through S_1 control the individual circuit selection. At this time the cycling control system will proceed through group II the same way it went through group I unless either the group II scan hole B28 was not punched because the test did not concern circuits in group II or there were no faulty circuits in group II (zero volts on group II bad bus.)

Either of these last two conditions would cause the following to occur. The first five stages of the seven stage counter would be preset to all ones (S_5 - S_1) before the counter makes its first count in group II. The next trigger which comes through will reset the first six counter stages ($\overline{S}_6$ - $\overline{S}_1$) and set the seventh (S_7). This binary count will command the circuit sensor to be connected to the first circuit in group III, circuit 300. What physically happened was that the cycling control system bypassed a group of 25 circuits because there was no need to check each one individually.

This same method of counting will continue until the counter has counted through the four groups. When all 7 stages of the counter are filled (S_7 - S_1) the counter will overflow on the following count giving the card reader a discrete sampler test complete signal which will cause the next card to be cycled if the card reader is in the automatic mode.

6. Circuit Number Printout

Up to this point one of the functions of the counter S1 - 7 has been described: namely, to control the operation of the decoding system for checking each circuit "good line".

The other purpose of the 7 bit counter is to supply the control signals for the circuit number printouts. For example, consider that circuit NO. 125 is being monitored for an energized condition; that is, +28V are expected at this circuit. Assume, however, that an incorrect response (0V) is received. The printer would be enabled and circuit NO. 125 printed out. Here is where the 7 bit counter performs its other essential function. The value of the unit digit, 5 in this case, is determined by the state of counter stages S1, S2, and S3; the tens digit, 2 in this case, by stages S4 and S5; and the hundreds digit, 1 in this case, by stages S6 and S7. As will be seen shortly, circuit number decoding is based on the octal system.

Table 8 shows the equivalent circuit number digit values that result from control signals S1 - S7.

Table 8 Equivalent Circuit Number Digit Values

Hundreds	Tens	Units
Signal Digit	Signal Digit	Signal Digit
$\overline{S7}\ \overline{S6} = 1$	$\overline{S5}\ \overline{S4} = 0$	$\overline{S1}\ \overline{S2}\ \overline{S3} = 0$
$\overline{S7}\ S6 = 2$	$\overline{S5}\ S4 = 1$	$S1\ \overline{S2}\ \overline{S3} = 1$
$S7\ S6 = 3$	$S5\ S4 = 2$	$\overline{S1}\ S2\ S3 = 2$
$S7\ S6 = 4$	$S5\ S4 = 3$	$S1\ S2\ \overline{S3} = 3$
		$\overline{S1}\ \overline{S2}\ S3 = 4$
		$S1\ \overline{S2}\ S3 = 5$
		$\overline{S1}\ S2\ S3 = 6$
		$S1\ S2\ S3 = 7$

As shown in Table 8, the unit and tens circuit number digits are decoded in straight binary-to-octal form, while the hundreds digit is derived by adding 1 to the binary-to-octal equivalent of S6 and S7. Thus, setting S6 and S7 is equivalent to binary 3, added to 1 makes 4 as the hundreds digit.

This number represents the group number of the circuit printout. If the tens digit of the circuit number is considered, it can be seen from Table 8 that when stages S4 and S5 are set (that is, in the ONE state) octal 3 results from straight binary-to-octal conversion. The number 3, of course, is the highest tens digit needed to permit printout of the highest circuit number (430).

Furthermore, the highest unit digit is 7 (made possible when stages S1, S2, and S3 are set). Setting of S1, S2 and S3 results in binary 111 or octal 7. Consider the case where a circuit number printout of 327 is desired. For this example stages S1, S2, S3, S5 and S7 would be set and S4 and S6 reset.

7. System Selection Selector Unit - Self-Test

The circuits contained within this unit actually perform two separate functions; namely, initiate the SUT commands and provide the logic for the self-test capability of the discrete sampler.

The logic diagram in Figure 27 will help explain how SUT commands are initiated. It should be remembered that selection of a SUT is made possible through enabling card holes A18, A19 and A20. Also, card location A17 is used for SUT tree power, and card location A21 is used for parity.

In actual practice, the selection of a SUT must be made on one program card, and the application of SUT tree power must be made on the second card. This procedure is used to insure that the SUT select tree relay contacts are closed before the 28V SUT command is applied. Arcing at the relay contacts is prevented this way.

In reference to parity, a few examples will show that this card location, A17, need only be punched when an even number of SUT selection locations are required.

Once the SUT command is generated, it is sent to the system selection selector unit where the closure of relay contacts enables the connection of 100 P/M lines to the desired SUT.

Let us now refer to Figure 27 and trace the logic of a typical SUT command. First assume that SUT 1 is desired. Since this case necessitates the punching of only one location, A20, parity need not be punched. Punching location A20 causes relay K3 to become energized; thus +28V DC can be traced through A2-A3 of K4, B2-B3 of K1, B2-B3 of K2 and B1-B2 of K3. This 28V signal is now present on the good parity line and also at point A2 of relay K5. If, however, K3 fails to energize upon command, the same +28V signal is applied to the bad parity line, at which time the

SYSTEM SELECT PARITY light on the MAPCHE status indicator panel will illuminate red. Illumination of this light indicates to the operator loss of system select parity and/or failure of associated circuitry.

Now that the +28V signal is present at contact A2 of relay K5, the next card is programmed with card location A17 punched. This action causes K5 to energize. From A2, the +28V signal is coupled to A1, through C2-C3 of K1, D2-D3 of K2, and F1-F2 of K3, thus enabling the +28V SUT 1 command to be sent to the appropriate relays in the system selection selector unit.

SUT 3 is selected if in the next example, 2 SUT select card locations must be punched, namely A19 and A20. Furthermore, since an even number of selections were made, parity, A17, must also be punched. If parity is not punched, +28V is applied to the bad parity line. This can be seen by tracing out the circuit in Figure 27. Parity is employed as a means of detecting a malfunctioning relay in a select tree.

The next function of this unit to be discussed is self-test. Figure 27 shows that self-test is initiated in SUT 7 by punching A18, A19 and A20 on the first card and A17 on the second card. Note that the SUT parity need not be punched since an odd number of selections have been made.

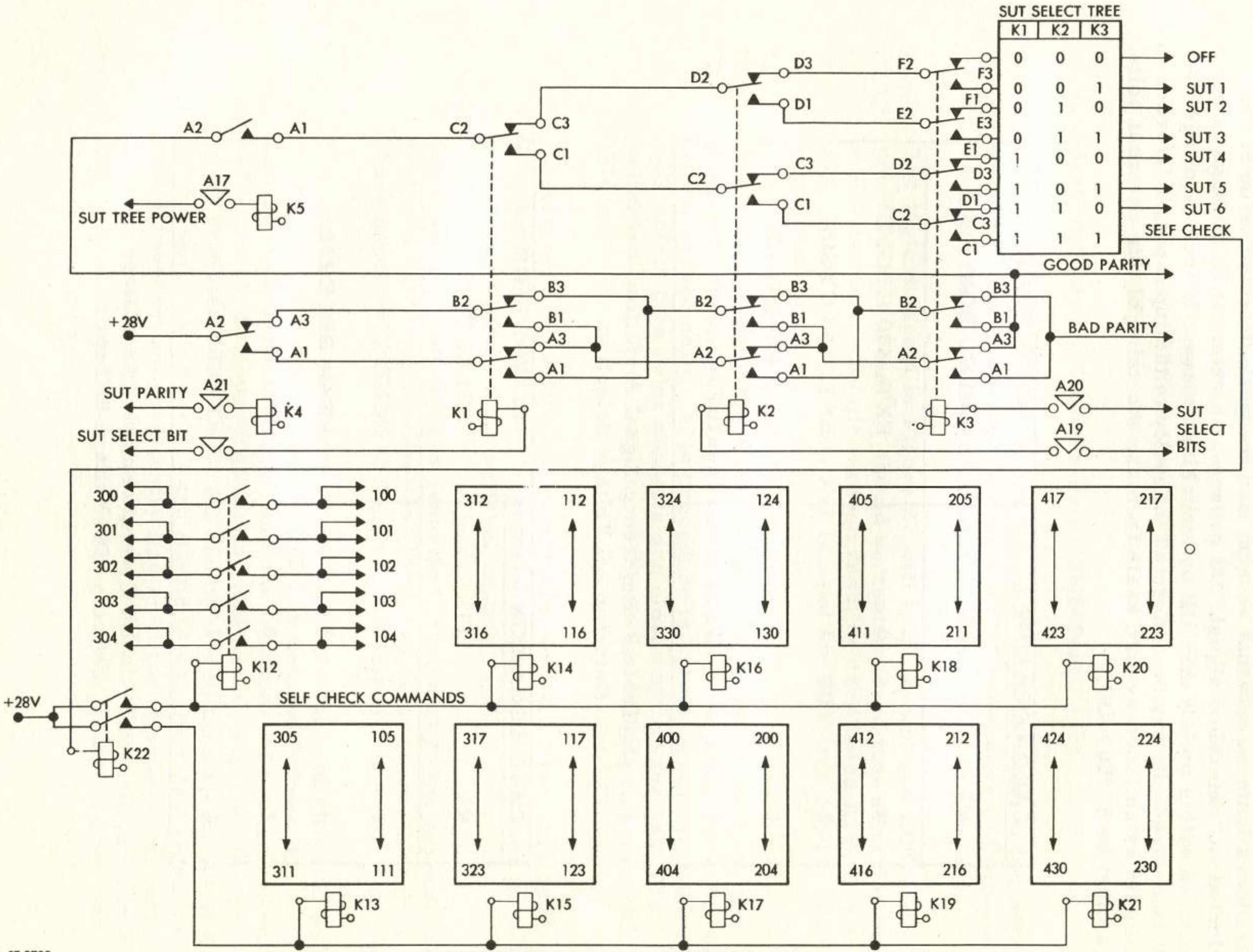
Programming the self-test SUT causes K1, K2 and K3 to energize and enable +28V to appear across relay K22. Upon energizing K22, +28V applied across relays K12 - K21. The effect of energizing these relays is to provide shorting connections between discrete sampler groups I and III, and II and IV.

Analog Loop

Reference Signal Amplifier-Detector

The reference signal amplifier-detector is located in chassis A21 of the electrical checkout vehicle. A selection of reference voltages for the ADCON and the 2 DACON's scaling ladders are made by programming both AC and DC reference voltages, card holes M5 and L5 for AC selection (Table 9) and card holes K5 and J5 for DC selection (Table 10).

Selection of AC and DC reference voltages allows the programming of an AC or DC voltage as the output of either or both DACON 1 and DACON 2. Permissible selections of AC voltages are 60- to 400-cycle line voltage generated externally, a 400-cycle regulated voltage generated internally,



K1	K2	K3	
0	0	0	OFF
0	0	1	SUT 1
0	1	0	SUT 2
0	1	1	SUT 3
1	0	0	SUT 4
1	0	1	SUT 5
1	1	0	SUT 6
1	1	1	SELF CHECK

57-9733
MAP-TY-E19/S

Figure 27 SYSTEM SELECTION, SELF-TEST SELECTOR UNIT

FOR TRAINING PURPOSES ONLY

and a 400-cycle line voltage modulated by either 0. 5, 2, or 10 CPS generated by the transfer function analyzer (TFA). Permissible selections of DC voltages are a regulated DC voltage generated internally, a DC voltage introduced from an external source, and the peak-detected value of the selected AC reference signal. At present, an external DC voltage is not provided within mobile APCHE by switching relays. If such a voltage input is desired, it may be connected manually to the input plug. In order to maintain established system scale factors, the value of this external voltage must be 9. 000V DC.

CARD LOCATION		AC VOLTAGE SELECTION
M5	L5	
0	0	EXT. 400 CYCLE
0	1	EXT. 60 CYCLE
1	0	INT. 400 CYCLE
1	1	T. F. A.

Table 9 Reference Signal Amplifier-Detector AC Voltage Selection

CARD LOCATION		DC VOLTAGE SELECTION
K5	J5	
0	0	NONE
0	1	PEAK DETECTOR
1	0	INTERNAL DC
1	1	EXTERNAL DC

Table 10 Reference Signal Amplifier-Detector DC Voltage Selection

The use of the peak detector as the source of DC voltage permits the measurement of an AC signal independent of a fluctuating AC line voltage. The AC reference voltage is programmed to provide the DACON units with the desired voltage for the input of the unit being tested. If the input voltage to the unit being tested is derived from a source outside of mobile APCHE, the AC reference voltage is programmed to the external source (i. e., external 400-cycle or external 60-cycle). By selecting the peak detector as the DC reference voltage source, a DC voltage (which is a function of the input voltage to the unit being tested) is applied to the comparison scaling ladder network of the ADCON. A fluctuation in the line voltage and the input voltage to the unit being tested is reflected also in the ADCON scaling network voltage, which compensates for the line voltage variation during measurement by the ADCON.

An AC or DC voltage output to each DACON is selected by enabling card hole H5 for DACON 1, and G5 for DACON 2. The DC polarity and/or AC output voltage relationship to phase A for the DACON's is selected by enabling card hole L1 for DACON 1 and card hole L2 for DACON 2. (See Tables 11 and 12) The DC polarity for each DACON may be selected independently of the other DACON. However, the output voltage relationship to phase A (0^{o} or 180^{o}) is identical for both DACON's. If both DACON's are selected for an AC output, and neither card hole L1 or L2 are enabled, the outputs of both DACON's are 180^{o} out of phase with the A phase voltage. If both DACON's are selected for an AC output, and card hole L1 or L2 is programmed (punched), the outputs of both DACON's are in a phase with the A phase voltage. If one DACON is selected for a DC output, AC voltage conditions may be selected for the second DACON independently of the polarity selection of the first DACON.

CARD LOCATION		DACON 1
H5	L1	VOLTAGE SELECTION
0	0	-DC
0	1	+DC
1	0	-AC
1	1	+AC

Table 11 Voltage Selection for DACON 1

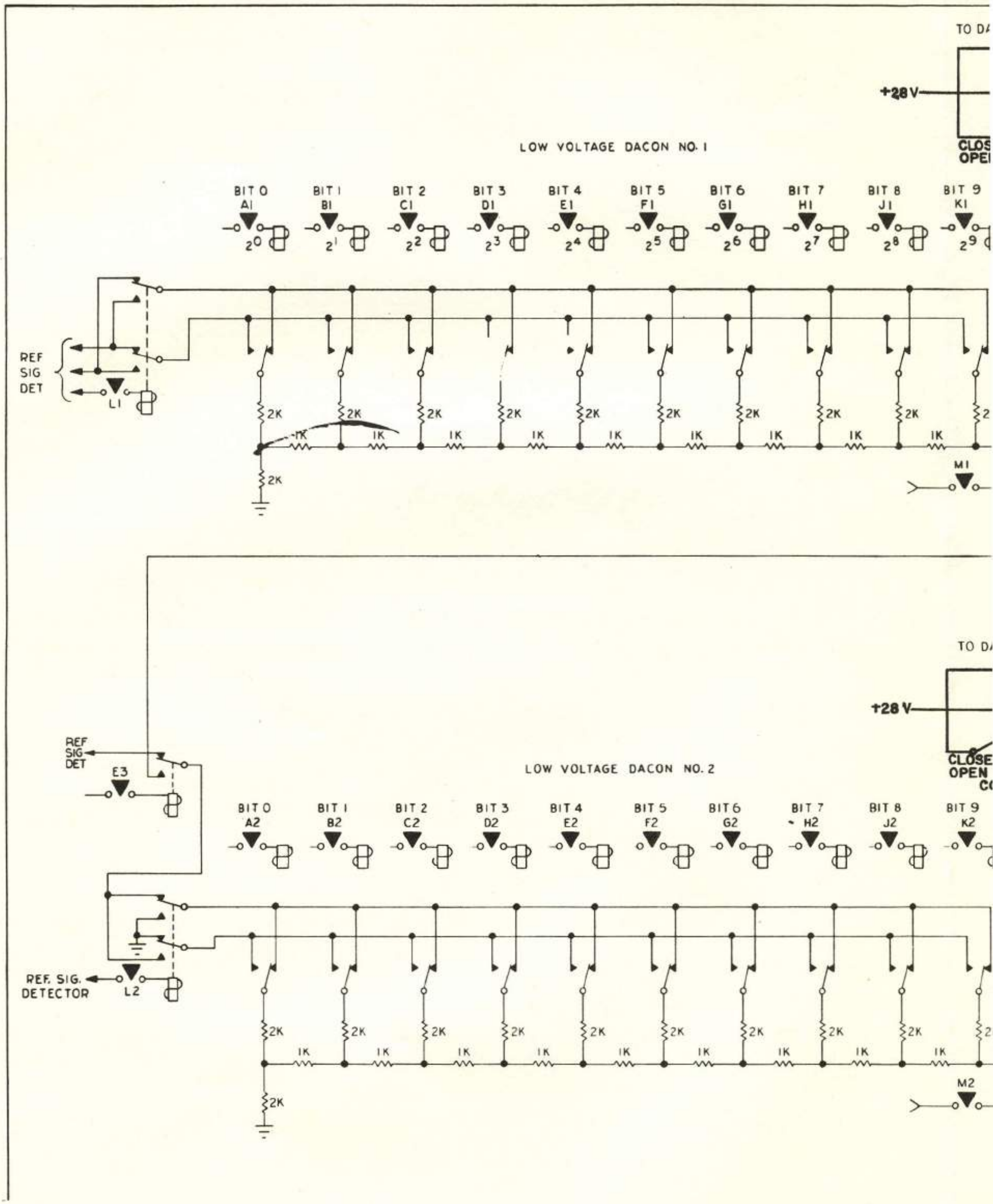
CARD LOCATION		DACON 2
G5	L2	VOLTAGE SELECTION
0	0	-DC
0	1	+DC
1	0	-AC
1	1	+AC

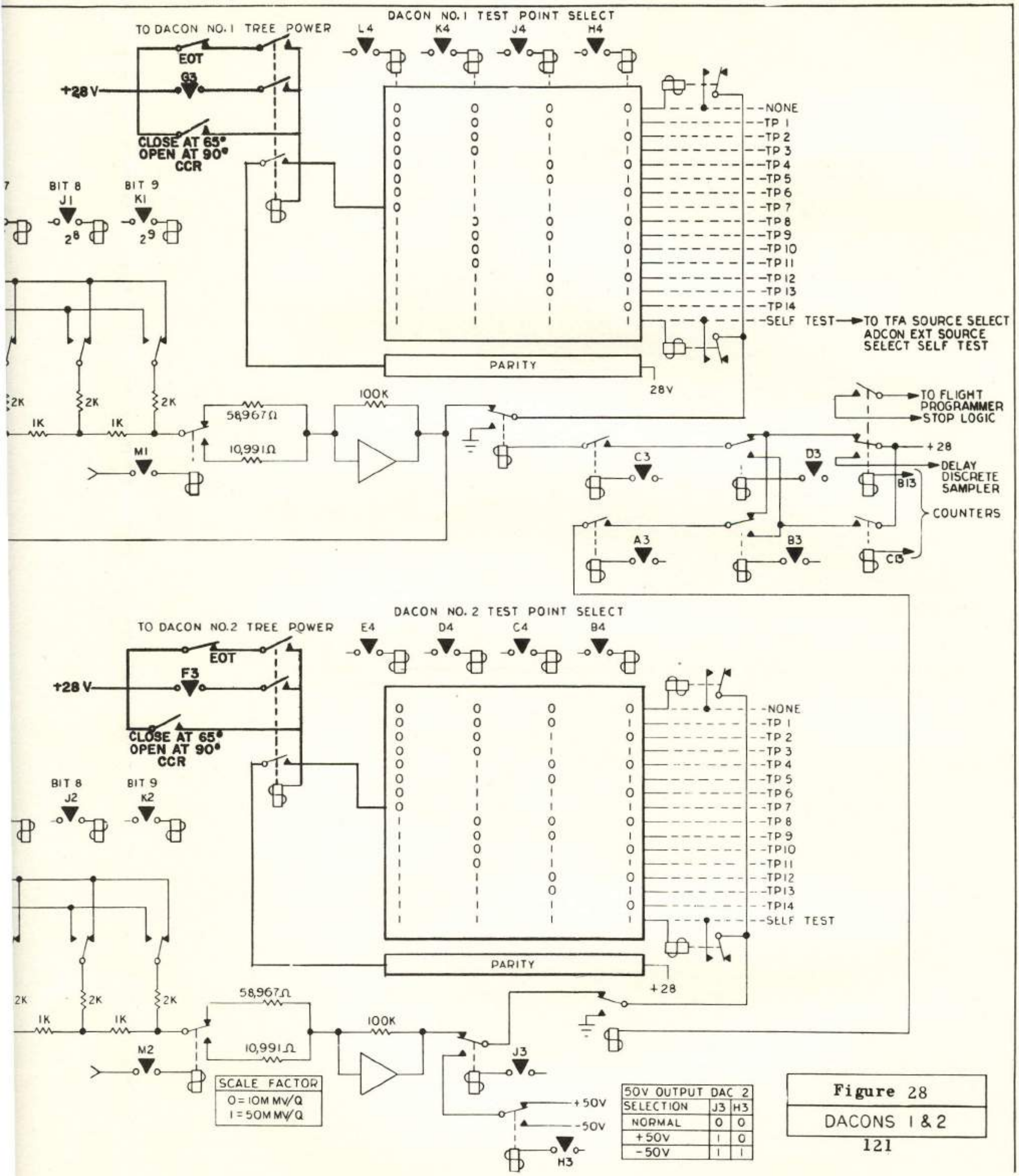
Table 12 Voltage Selection for DACON 2

When mobile APCHE is performing a check using the transfer function analyzer (TFA), the reference signal amplifier detector supplied the DACON with the 400-CPS modulated waveform from the TFA. Two signals must be switched. The 400-CPS modulated signal is sent to the DACON. At the same time, the external 400-CPS reference is sent to the peak detector. Here it is detected and rectified, and the positive and negative DC signals are supplied to the ADCON as reference signals. This keeps a close relationship between the TFA stimulus and response.

Digital-to-analog Converter (DACON)

A test analog voltage to a unit being tested is provided by the DACON unit. Amplitude of the test voltage is determined by the programming of the DACON scaling ladder. The DACON scaling ladder is a network of resistances adjustable in 1023 binary-bit steps. The amplitude of the reference voltage applied to the network determines the ladder output voltage step increment. In all instances except one the voltage applied to the scaling ladder is 6. 141V DC or peak AC. The values of network resistance steps, the input voltage amplitude, and the gain of the amplifier in the output of the DACON unit determine the final incremental voltage steps for the DACON binary scaling ladder. DACON voltages are programmed (Figure 28) by enabling applicable card holes A1 - K1 for DACON 1 and A2 - K2 for DACON 2. Normally, the DACON output voltages can be varied in scales of 10- or 50-MV increments. Scale variations are achieved through establishing different gains in the DACON output amplifiers by enabling card holes M1 for DACON 1 and M2 for DACON 2. The maximum outputs of the DACONS's using 10 MV per step (quantum) is 10. 23V DC or peak AC. The maximum output that can be computed for the DACON's using 50 MV per quantum is 51. 15V DC or peak AC. However, limiting DACON


TO D
+28V
CLOS
OPE
LOW VOLTAGE DACON NO. 1
BIT 0 A1 2⁰
BIT 1 B1 2¹
BIT 2 C1 2²
BIT 3 D1 2³
BIT 4 E1 2⁴
BIT 5 F1 2⁵
BIT 6 G1 2⁶
BIT 7 H1 2⁷
BIT 8 J1 2⁸
BIT 9 K1 2⁹
REF SIG DET
L1
2K
1K
M1
TO D
+28 V
CLOSE
OPEN
C
LOW VOLTAGE DACON NO. 2
REF SIG DET
E3
BIT 0 A2
BIT 1 B2
BIT 2 C2
BIT 3 D2
BIT 4 E2
BIT 5 F2
BIT 6 G2
BIT 7 H2
BIT 8 J2
BIT 9 K2
REF. SIG. DETECTOR
L2
2K
1K
M2



50V OUTPUT DAC 2		
SELECTION	J3	H3
NORMAL	0	0
+50V	1	0
-50V	1	1

Figure 28

DACONS 1 & 2

output amplifiers prohibits programming of voltages greater than 40V DC or peak AC. If it is desired to have a DACON output greater than 40V DC, a fixed +50V DC output may be obtained at the output of DACON 2 by enabling card hole J3. A fixed -50V DC output from DACON is obtained by enabling card holes J3 and H3. These voltages replace the scaling ladder and the output DACON amplifier and are independent of reference voltage source selection.

Phase Selection

The one application in which the voltage applied to the scaling ladder is not 6.141V peak is selected by enabling card hole E3. In this instance, the output of DACON 1 is connected to the input of DACON 2. This connection is employed to provide outputs from the 2 DACON's that are 180° out of phase with each other. While it is possible to use this application with a DC output, it will serve no useful purpose.

Test points for the output selection of DACON 1 are programmed using card holes A1 - K1; test points for DACON 2 are programmed using card holes A2 - K2. Specific test point functions and binary codes are outlined in the applicable truth tables furnished in Figure 28. The relays associated with the selection of DACON 1 and 2 test points are contained on the analog-digital selector unit.

Step Function Output

A step function DACON output is selected by enabling card holes C3 and D3 for DACON 1 and enabling A3 and B3 for DACON 2. Upon occurrence of either B13 or C13 as programmed, the output of the selected DACON is disconnected from the programmed DACON output test point, and the test point is connected to ground.

ADCON Testing of DACON Output

The output voltage of the DACON's may be checked by the ADCON in 2 ways. One method is that during application of a voltage to a unit being tested the DACON output may be monitored by the ADCON (by programming "DACON 1" or "2") on the ADCON internal source select tree. The second method is that prior to application of a test voltage to a unit the DACON output voltage may be checked by programming "self-test" (ST) on the applicable DACON test point selection tree and on the ADCON external source selection tree. This test connects the DACON and ADCON and permits checking of the accuracy of the DACON output. Also, since the self-test test points on both ADCON and DACON select trees use all card hole relays, the ability of the card hole relays to activate is thereby tested.

Programming Calculations

Calculations necessary for the programming of data to be entered on mobile APCHE program cards are explained in the following paragraphs.

A selected DACON output voltage must be encoded into binary form before specific assignment to card holes A1 - K1 for DACON 1 and A2 - K2 for DACON 2. Card holes L1 and L2 have been defined previously as the polarity binary bits for DACON 1 and 2 output, respectively. The relative magnitude of the output voltage is selected by programming applicable card holes with the following established quantum values.

Binary Bit Number	10	9	8	7	6	5	4	3	2	1
Quantum Value	512	256	128	64	32	16	8	4	2	1
DACON 1 Card Holes	K1	J1	H1	G1	F1	E1	D1	C1	B1	A1
DACON 2 Card Holes	K2	J2	H2	G2	F2	E2	D2	C2	B2	A2

The relative magnitude of the voltage is determined by considering the magnitude that increases from a positive value to a more positive value or from a negative value to a less negative value. Therefore, a positive DACON voltage output value increases from a zero value to a maximum positive value, and a negative voltage output value increases from a maximum negative value to a zero value. Relative magnitudes of DACON scales are shown below.

Magnitude			Binary Code
Absolute	Relative	Scale Factor	(less sign bit)
+ 0V	0V	10 MV/Q	0 000 000 000
+ 10. 23V	10. 23V	10 MV/Q	1 111 111 111
+ 0V	0V	50 MV/Q	0 000 000 000
+ 51. 15V *	51 15V	50 MV/Q	1 111 111 111
- 0V	10. 23V	10 MV/Q	1 111 111 111
- 10. 23V	0V	10 MV/Q	0 000 000 000

- 0V	51.15V	50 MV/Q	1 111 111 111
- 51.15V *	0V	50 MV/Q	0 000 000 000

* Maximum voltage that may be programmed is ± 40V DC or peak AC. The magnitude of the output voltage is normally specified in absolute quantities.

Input Signal Amplifier-detector (Figure 29)

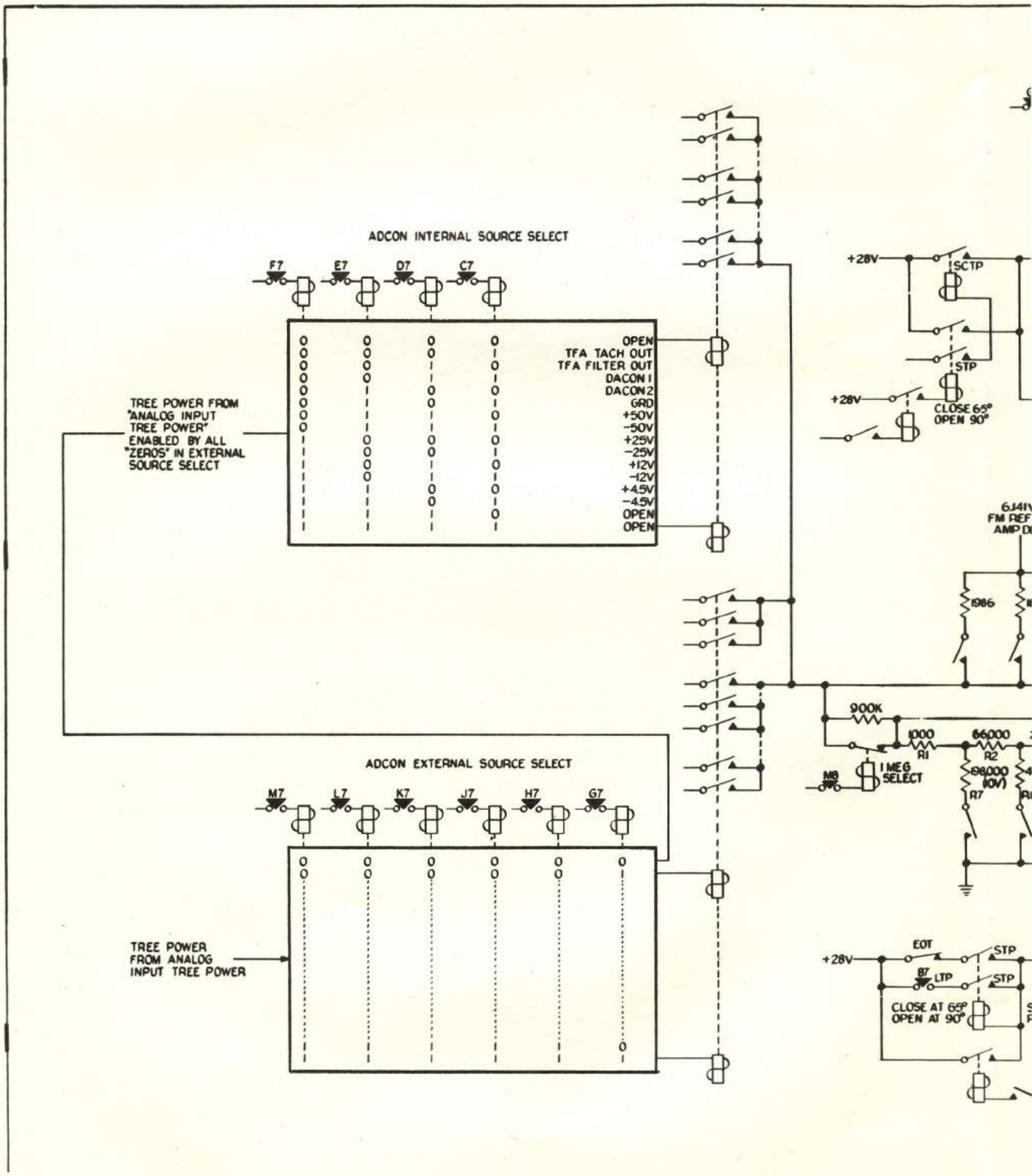
Although the ADCON is capable only of detecting voltages, the input signal amplifier-detector allows it to measure phase shift synchronism and resistances between a test signal and the phase A frequency signal. To do this, the amplifier-detector is provided with detecting and scaling devices. A buffer amplifier is provided for impedance matching purposes.

The ADCON can be used to measure resistances by converting an unknown resistance value to a representative DC voltage in a resistance converter (RESCON) included in the amplifier-detector. A reference voltage is applied across a series circuit consisting of a known resistance and an unknown resistance, and the voltage division is measured by the ADCON. A low-pass filter is included to eliminate stray pickups that may affect the accuracy of high-resistance measurements. The filter is selected by enabling cardhole switch B9. The filter may also be used for any DC voltage measurement.

Four detector selections are possible. They are selected by cardhole switches B8 and C8 (DETECT). If neither hole is selected, a DC test value voltage is passed directly to the ADCON. Various combinations of cardhole punches select an AC peak detector, an AC synchronism detector or a phase comparator. The peak detector is capable of detecting voltage within a frequency range of 60 to 1000 CPS. It is insensitive to the phase of the AC signal. The peak detector gives a positive DC output voltage resulting in a positive ADCON test value.

The synchronous detector provides 400-CPS peak amplitude measurement and phase detection. The results are a positive DC value to ADCON for an in-phase relationship between the test value, plus a 400 CPS phase A voltage, and a negative DC voltage to ADCON for an out-of-phase relationship. Detection occurs at the peak of the phase A reference voltage.

A 400-CPS phase comparison mode is provided to measure the phase of a 400-CPS signal with respect to phase A reference in 2 ranges: 0° ± 30° and 180 ± 30°.



F7	E7	D7	C7	
0	0	0	0	OPEN
0	0	0	1	TFA TACH OUT
0	0	1	0	TFA FILTER OUT
0	0	1	1	DACON 1
0	1	0	0	DACON 2
0	1	0	1	GRD
0	1	1	0	+50V
0	1	1	1	−50V
1	0	0	0	+25V
1	0	0	1	−25V
1	0	1	0	+12V
1	0	1	1	−12V
1	1	0	0	+4.5V
1	1	0	1	−4.5V
1	1	1	0	OPEN
1	1	1	1	OPEN

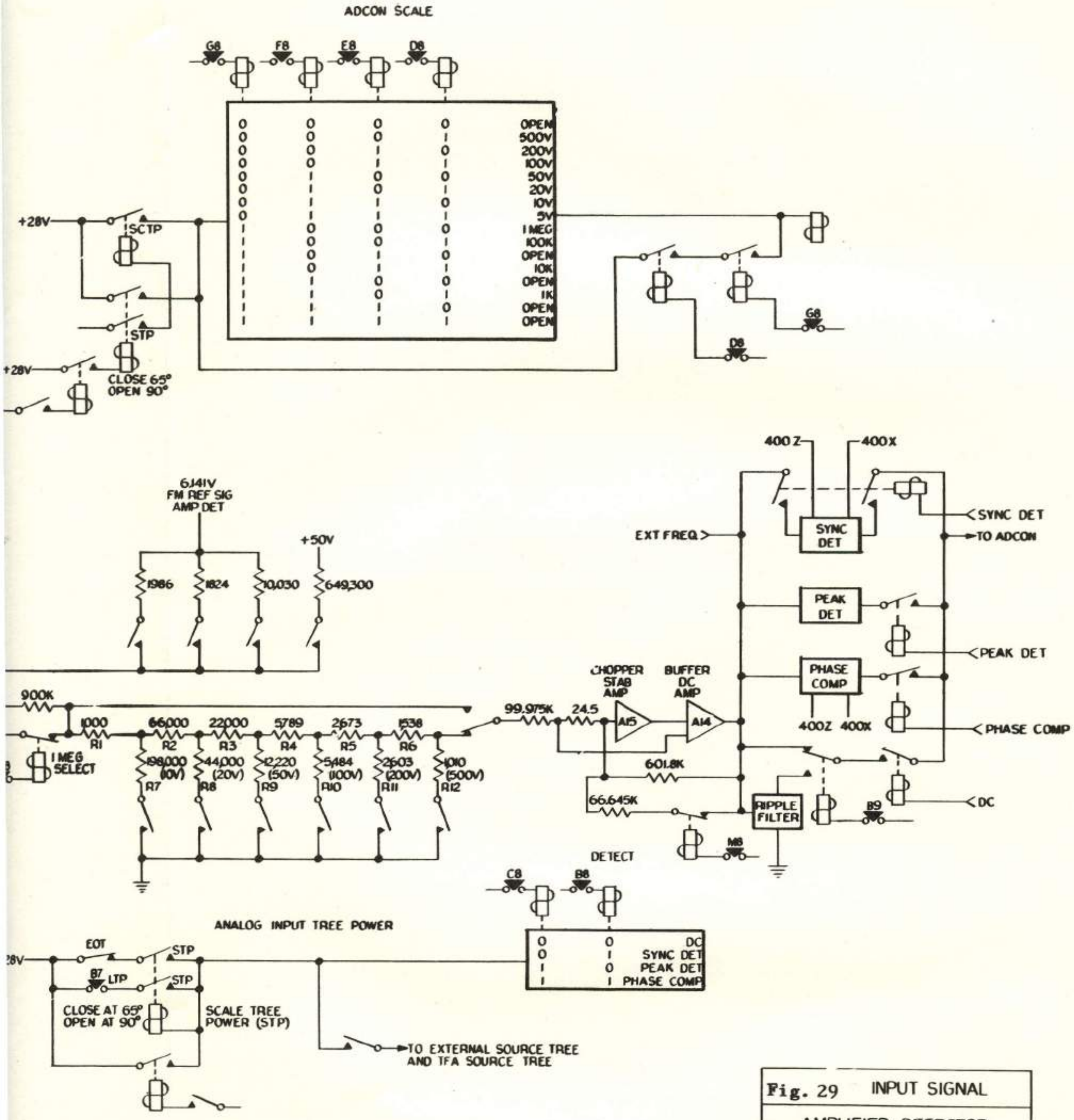


Fig. 29 INPUT SIGNAL AMPLIFIER DETECTOR

DC voltages greater in magnitude than 3. 069V are scaled down to values acceptable to ADCON by means of an attenuator network. The attenuator consists of a ladder network in the test value input line. The voltage is scaled down to 3. 069V or less. The specific scale is selected by the test programmer.

Although the input impedance to the amplifier-detector is normally 100 KILOHMS, a high impedance may be selected where high input impedance is desired. A 1 MEGOHM impedance is selected by cardhole switch M8.

Two methods are provided to self-test the ADCON and DACON units. The self-test-mode selects all ONE's to be programmed in the DACON test point select tree and the ADCON external test point select tree. This mode checks the ADCON capability to measure maximum voltage and checks the ability of all ADCON external and DACON test point select relays.

The second method provides a means of checking DACON by routing the output to both a test point and to the ADCON where it is measured. This is done by selecting either DACON on the ADCON internal select tree.

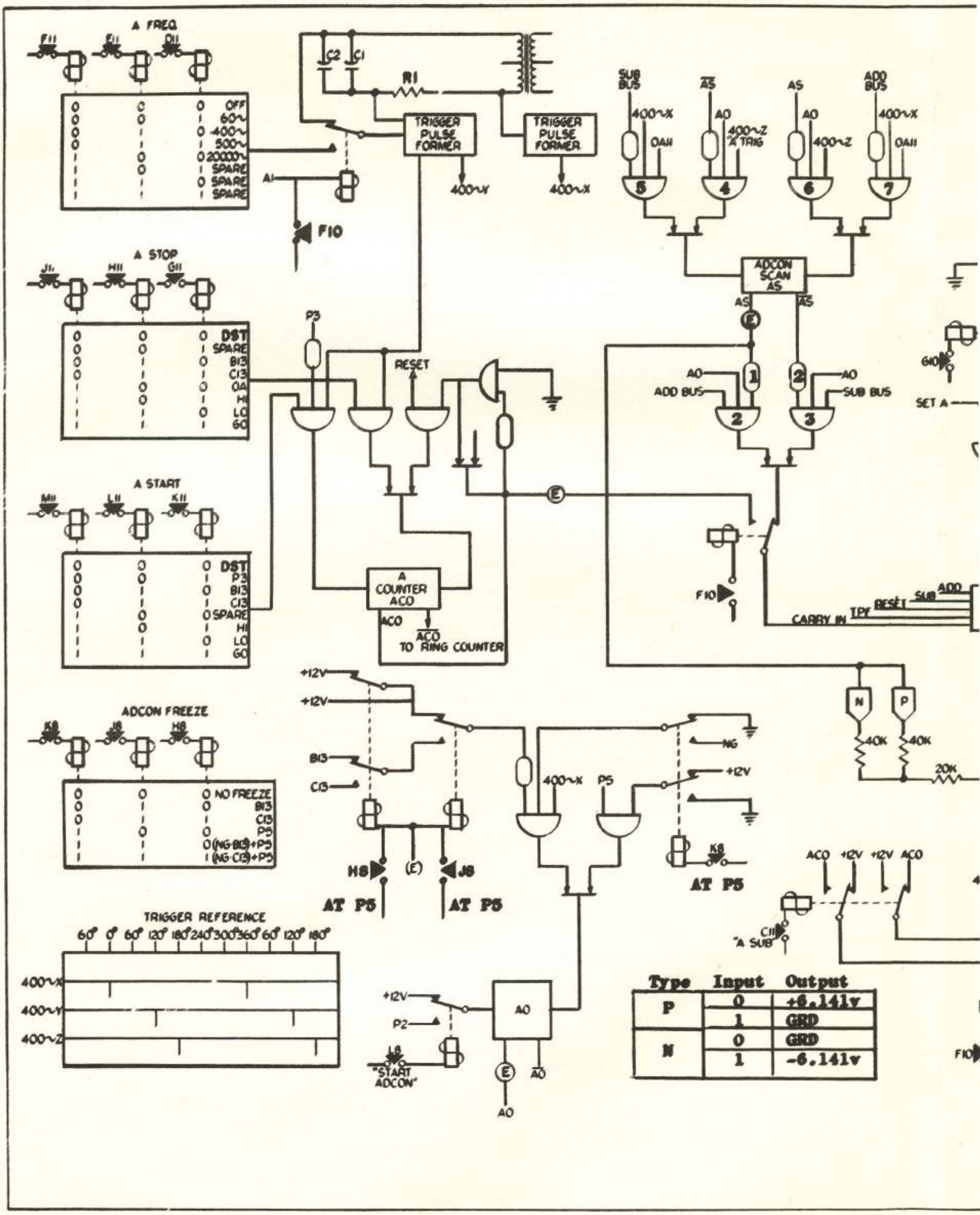
Analog-to-digital Converter (ADCON) (Figure 30)

The ADCON is used to convert analog quantities received from a unit under test to binary-coded equivalents. The analog quantities are in the form of DC voltages, and the voltage range is +3 069 to -3. 069V DC.

A reference voltage is generated through a resistance ladder network with which the test voltage received by the ADCON is compared. The ladder network is controlled by a rapid-slewing counter. The difference between the scaled reference voltage and the test voltage drives a 11-stage, reversible binary counter, which switches the ladder network, driving the reference output voltage toward the test voltage. When the difference is within 3 MV, the binary counter has a setting proportional to the magnitude of the test signal. This digital value may be frozen (retained) and transferred to the digital comparator for evaluation or to the B or C counter for storage.

Polarity

Only 10 bits of the counter are used to represent magnitude. Bit 11 is used to establish polarity of the counter output resulting in 2 distinct representations of 0V: +0V and -0V. All ZERO's in the register provides a reference voltage of +3. 069V, which is reversed by a buffer amplifier in the ADCON detector circuit. Therefore, all ZERO's represent a full-scale negative value (-3. 069V), and all ONE's represents a full-scale positive



Type	Input	Output
P	0	+6.141v
	1	GRD
N	0	GRD
	1	-6.141v

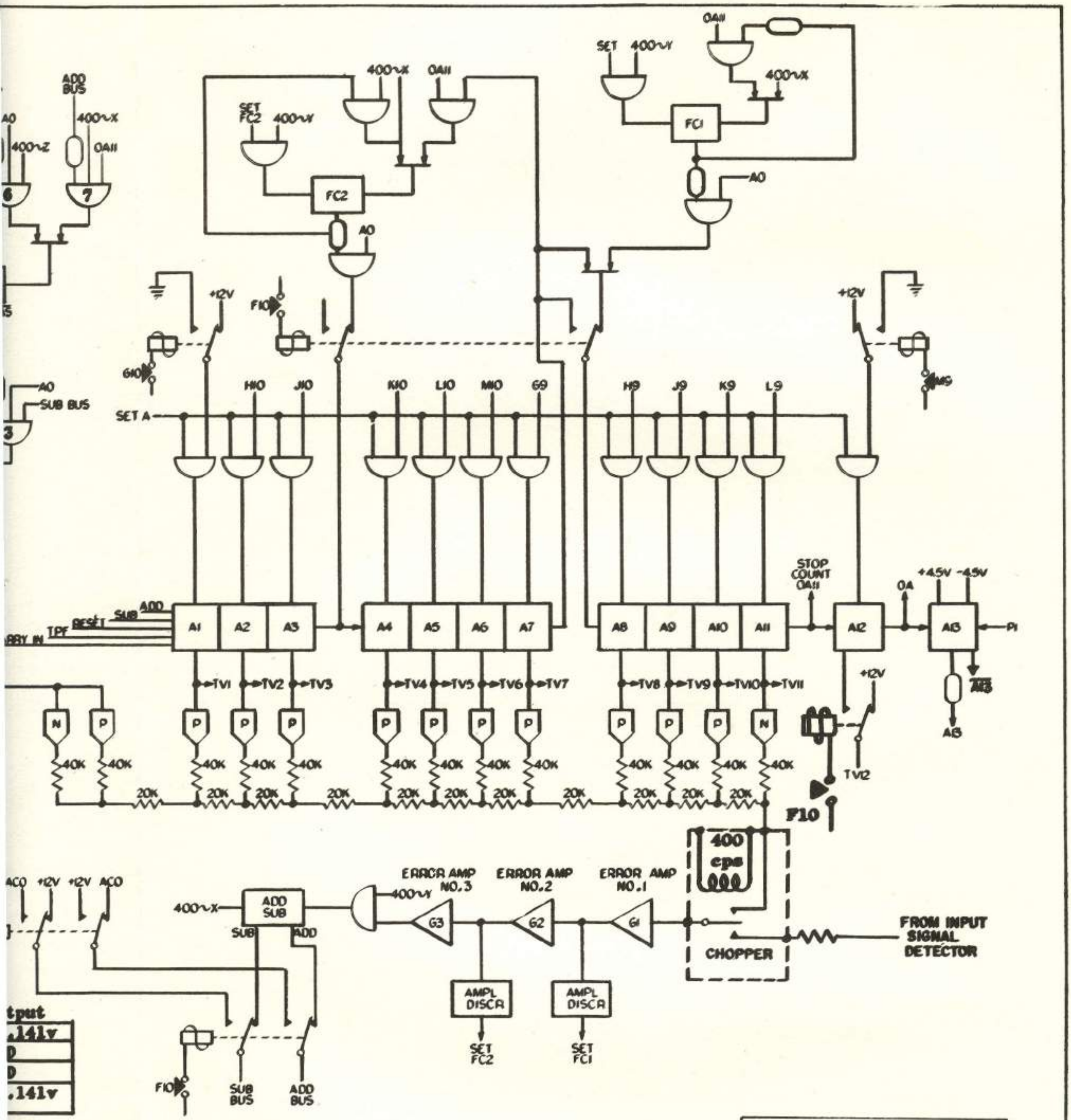


Figure 30 ANALOG TO DIGITAL CONVERTER (ADCON) value (+3.069V).

Slewing for Fast Evaluation

The ADCON slews from +3.069V in 3-MV steps or 2046 counts in 10.235 SEC. However, a medium and a fast carry are provided to reduce this time to 150 MILLISEC. The medium and fast carry are energized by amplitude discriminators in the test value input line. If the test value exceeds 0.09V, the medium carry inserts a signal to bit 4. If the test value exceeds 1.53V, both the medium and fast carry are energized, and signals are inserted in bits 4 and 8.

P_2 Slew

When card hole L8 is enabled, the ADCON begins slewing upon the occurrence of P_2 of the ring counter. The counter initially slews from the value attained on the last previous test toward 0V unless lock tree power holds in the counter value.

ADCON Freeze

The ADCON can be stopped and made to retain its value by use of card hole switches H8 - K8. The first 2 selections (B13 and C13) allow the ADCON to track a test value for a length of time determined by programming the B or C counter. Upon the occurrence of B13 or C13 and the next 400X pulse the ADCON will be frozen. The ADCON counter freeze selections are in the truth table, Table 13.

The last 2 ADCON freeze selections (NG B13 + P_5 or NG C13 + P_5) allow the ADCON to be frozen by a NO-GO condition obtained from the digital comparator. Due to inherent ADCON circuitry, a NO-GO obtained before B13 or C13 will not freeze the ADCON. If the condition is continuous, ADCON freeze will occur at B13 or C13 and the next 400X pulse. If a GO condition is obtained, the ADCON will freeze on the occurrence of P_5. The P_5 command freezes the ADCON upon occurrence of P_5 of the ring counter.

ADCON Internal Source Selection

The selection of an internal signal is programmed into the ADCON by card holes F7 - C7 as shown in Table 14.

ADCON External Source Selection

The selection of an external test point is made using card hole M7, L7, K7, J7, H7, G7. There are 62 different test points that may be programmed. By punching all the above designated card holes a self-test of the ADCON input tree and the ADCON can be made.

ADCON as an A Counter

The start, stop and frequency selections used when the ADCON is used as a normal 12-stage binary counter are shown in Table 15. To start the A counter, card holes M11 - K11 are used. To stop the A counter, card holes J11, H11, G11 are used. For example, if the A counter were to stop on overflow of B counter, H11 would be programmed. The operating frequency for the A counter will be selected using card holes F11 - D11. If it were desirable for the A counter to count at a 20-KC rate, card hole F11 would be programmed.

FREEZE			
Selection	K8	J8	H8
Don't Freeze	0	0	0
B13	0	1	0
C13	0	1	1
P5	1	0	0
(NG B13) +P5	1	1	0
(NG C13) +P5	1	1	1

Table 13 Counter Freeze Selections

ADCON INTERNAL SOURCE				
Selection	F7	E7	D7	C7
None	0	0	0	0
T. F. A. Tach Out	0	0	0	0
T. F. A. Filter Out	0	0	1	0
DACON 1	0	0	1	1
DACON 2	0	1	0	0
Gnd.	0	1	0	1
+50	0	1	1	0
-50	0	1	1	1
+25	1	0	0	0
-25	1	0	0	1
+12	1	0	1	0
-12	1	0	1	1
+4. 5	1	1	0	0
-4. 5	1	1	0	1
Spare	1	1	1	0
Spare	1	1	1	1

Table 14 ADCON Internal Source Selection

DIGITAL COUNTER REGISTER

A Counter

A START			
Selection	M11	L11	K11
None	0	0	0
P3	0	0	1
R13	0	1	0
C13	0	1	1
Spare	1	0	0
HI	1	0	1
LO	1	1	0
GO	1	1	1

A STOP			
Selection	J11	H11	G11
None	0	0	0
Spare	0	0	1
B13	0	1	0
C13	0	1	1
OA	1	0	0
HI	1	0	1
LO	1	1	0
GO	1	1	1

A FREQUENCY			
Selection	F11	E11	D11
None	0	0	0
60	0	0	1
400	0	1	0
500	0	1	1
20 KC	1	0	0
Spare	1	0	1
Spare	1	1	0
Spare	1	1	1

Table 15 Truth Tables

ADCON Operation

The input signal detector chassis has now been used to condition all input signals to DC voltages ranging from +3. 069 to -3. 069V at the ADCON chopper. A positive DC response from the system under test will be a negative signal at the ADCON chopper, while a negative response from the system under test will appear as a positive signal at the chopper. Each of these conditions is due to polarity inversion in the -0. 6 buffer amplifier.

The ADCON is composed of a 400-CPS chopper, 3 error amplifiers and discriminators, fast carry circuits, an add-subtract control a reversible binary counter, electronic switches, and a resistor ladder.

The ADCON samples the response signal from the input signal chassis and the output of the resistor ladder. Any difference is sent to the error amplifiers as an error signal. This error signal will cause the binary counter to add or subtract. As the counter adds or subtracts, the output of the resistor ladder changes and causes the error signal to decrease. This process continues until the error signal is at a minimum amplitude. At this time, the counter is frozen, and its digital output, in the form of an 11-bit number, is read as the converted test value.

In ADCON operation, a start signal must be used to unlock the counter. Card location L8 is used. It allows P_2 to set the A0, or count control, flip-flop. Stages A1 - A10 apply +6. 141V DC to the ladder when they are set and a ground signal when they are reset. Stage A11 applies -6. 141V DC to the ladder in the set condition and ground in the reset condition. The 11 stages may count up to decimal 2047 counts. Table 16 shows the voltages and outputs in binary, decimal and octal form for the ADCON counter. The ADD-SUBTRACT control is affected by the phase of the error signal. When the counter is counting up, or in the add mode, the resistor ladder is becoming more and more negative.

When the counter is counting down, or subtracting, the resistor ladder becomes more and more positive. The counter adds when the response is more negative than the ladder and subtracts when the response is more positive than the ladder. Each count whether up or down changes the output of the resistor ladder by 3 MV.

The magnitude of the difference between the ladder and the response, or the error signal, controls the speed of scanning.

Error amplifier NO. 1 receives the error signal. Any error signal at the input to amplifier 1 greater than 0. 384V in amplitude will cause amplitude discriminator 1 to generate a fast carry signal to set fast carry flip-flop NO. 1. Fast carry flip-flop NO. 1 will cause stage A8 to set in the add mode or reset in the subtract mode. Stage A8 will then either add or subtract 128 counts from the total count in the ADCON.

RESPONSE FROM SUT	CHOPPER VOLTAGE	BINARY COUNT	DECIMAL	OCTAL
+400V DC	-2. 400	111 001 000 00	1824	3440
+200V DC	-1. 200	101 100 100 00	1424	2620
+ 2V DC	-0. 012	100 000 001 00	1028	2004
- 2V DC	+0. 012	011 111 110 11	1019	1773
-200V DC	+1. 200	010 011 011 11	623	1157
-350V DC	+2. 100	001 010 000 11	323	0503

Table 16 ADCON Analog-Digital Conversions

Error amplifier NO. 2 will generate a fast carry signal to set fast carry flip-flop NO. 2 any time the error signal at the chopper exceeds 0. 024V. Fast carry flip-flop NO. 2 will cause stage A4 to set in the add mode or reset in the subtract mode. Stage A4 will then either add or subtract 8 counts from the total count in the ADCON. As a result, the ADCON can count from 0 to 2047 counts in less than 125 MILLISEC.

Error amplifier NO. 3 will generate an add signal to the add-subtract flip-flop as long as the response at the chopper is more negative than the ladder output. The ADD and SUBTRACT signals are applied to all stages in the ADCON counter. An absence of an add signal will result in resetting the add-subtract flip-flop and causing a subtract signal.

The ADCON counter will continue to add or subtract until there is no difference between the ADCON ladder and the signal from the system under test. At this point the counter will add one count too many, and the direction of count will be changed in order to remove the error. The ADCON scanning bit is used to perform this operation. It changes the output of the ladder by 1. 5 MV. This provides the ADCON with a conversion accuracy of ± 1. 5 MV.

Once the ADCON is tracking the voltage from the system, the flip-flop from stage A1 to A11 will be in some binary state. The counter will still be counting. In order to readout or use the 11-bit test value, the A0 signal must be removed, and the $\overline{\text{A0}}$ signal generated. The process just described is called freezing the ADCON. Table 9 shows the list of the freeze control circuit card locations. The freeze signal causes the A0 flip-flop to reset and generate a $\overline{\text{A0}}$ signal. This signal disables the ready gate, and the ADCON counter stops counting (scanning).

The ADCON may also be used as counter register A. In order to accomplish this, card location F10 is punched. The counter register operates in the same manner as counter registers B and C. Counter A, however, does not have an external stop or start, and it cannot be operated in tandem with either B or C.

Digital Comparator

The digital comparator is used to compare a test response from a unit being tested with upper and lower test limits to produce a GO or NO-GO indication. The upper and lower limits are determined by card hole switches A24 - M24, and A25 - M25, respectively.

The digital comparator is composed of a 12-stage lower limit comparator, a 12-stage upper limit comparator, and a summary output circuit. The summary output circuit receives the outputs of the upper and lower limit comparators and provides outputs of HI, LO, NO-GO and GO to the printer-decoder and control circuits.

The upper and lower limits and the test value are 12-bit binary numbers. The values used may represent time, voltage, phase or resistance, depending on the test being performed at the SUT. The test value may be obtained in a 12-bit binary number from counter registers A, B or C. If the test value is from the ADCON, it will have 11 significant bits. The 12th most significant bit will always be a ZERO. The input to the comparator is selected by card locations M23 and L23. These locations also apply the test value to the printer-decoder circuits. The upper and lower limits are programmed from the card locations.

Accessories

Status Indicator Panel

The Status Indicator (Figure 31) has been designed to display status information for the instrumentation listed below, with indicators organized into five displays. Both pilot lights and illuminated windows are employed. They are color coded red, green, or white. Two of the five displays have

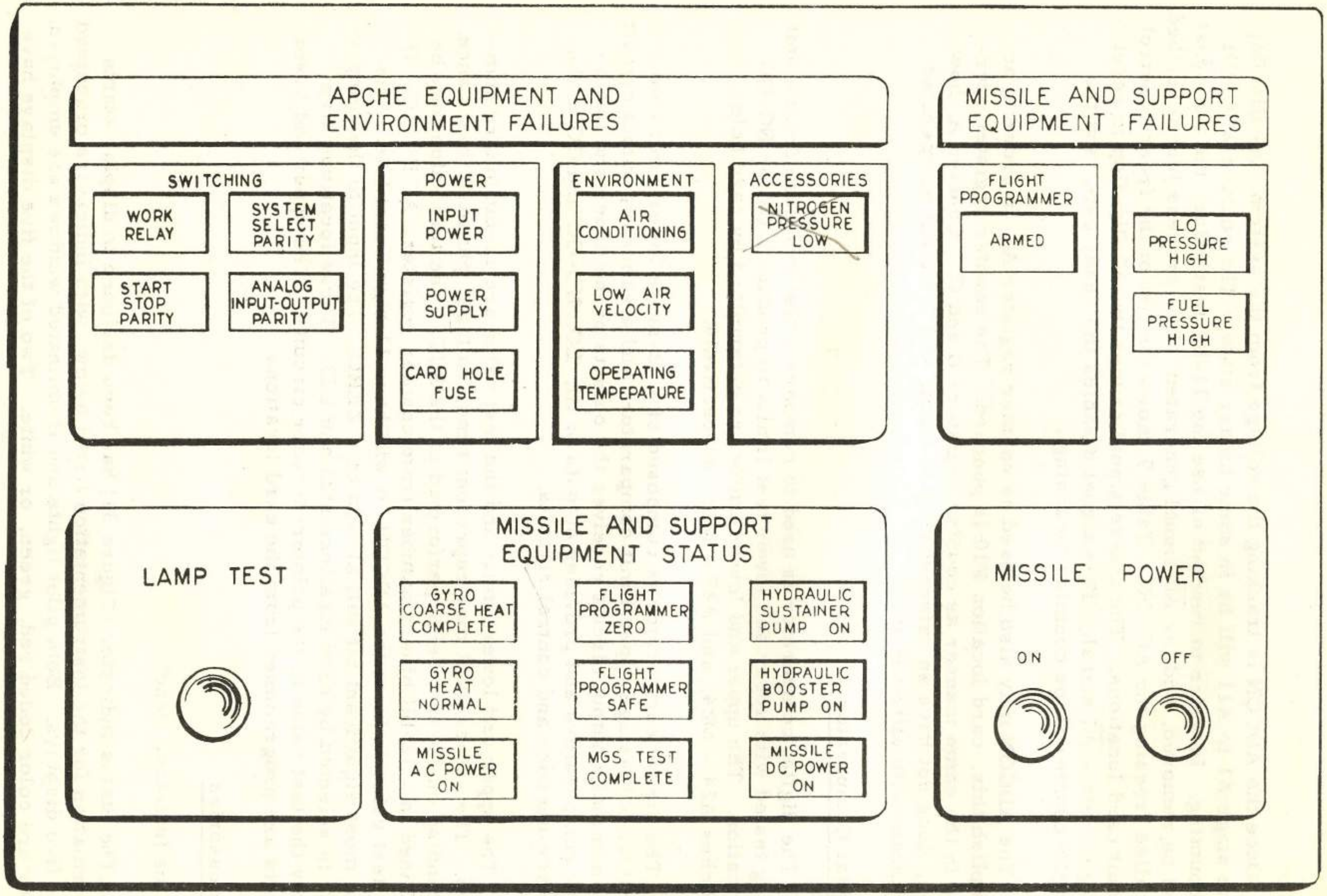


Figure 31 Status Indicator Panel

been given subdisplay divisions as noted.

APCHE Equipment and Environment Failures

Sub-displays

1. Switching

   Monitoring of switching failures is provided by indicators which illuminate red when a failure appears. Labels are indicative of the circuits involved; Work Relay, Stop-Start Parity, System Select Parity, Analog Input-Output Parity.

2. Power

   Red illuminating indicators are provided for monitoring failures in three circuits; Input Power, Power Supply, Card Hole Fuse

3. Environment

   Red illuminating indicators are provided for monitoring failures in equipment indicated by three labels; Air Conditioning, Low Air Velocity, Operating Temperature.

4. Accessories

   The single indicator in this sub-display illuminates red when the condition labeled appears; Nitrogen Pressure Low.

Missile and Support Equipment Failures

Sub-displays

1. When the Flight Programmer is armed, the corresponding Status Indicator is illuminated red, and the window will read ARMED.

2. Accessories

   Two indicator windows provide status information on the Dynamic Checkout Safety Monitor LOX and Fuel ullage tanks, illuminating red if pressure becomes too high.

Lamp Test

A pushbutton control provides lamp testing for all indicators.

Missile and Support Equipment Status

This display has nine windows which illuminate white as the status of the items indicated by the window legends is tested. Failure of any window to illuminate, as listed below, indicates an unready condition exists.

1. Gyro Coarse Heat Complete
2. Gyro Heat Normal
3. Missile AC Power On
4. Flight Programmer Zero
5. Flight Programmer Safe
6. MGS (Missile Guidance Set) Test Complete
7. Hydraulic Sustainer Pump On
8. Hydraulic Booster Pump On
9. Missile DC Power On

Missile Power

Two pushbuttons provide on-off control for missile power. When power is on, the ON pushbutton is illuminated white.

Power Supply Subsystem

The Power Supply Subsystem comprises three chassis: two identical High Voltage Power Supplies (A26, A31), and the Low Voltage Power Supply (A25). These provide the regulated power required by the several systems of the Mobile APCHE.

Voltage on all lines is adjustable. Safety and alarm provisions have been designed for each of the three chassis. If any one of the power supplies is overloaded, or goes out of range, all three chassis are automatically shutoff. This will cause the Alarm Buzzer to be activated and the Status Indicator Power Supply Indicator will illuminate red. Ripple is held to a 5 millivolts peak for any supply.

Low Voltage Power Supply (Chassis A25) - Outputs of this unit are:

1. +4.5V DC - at least 0.2 ampere
2. -4.5V DC - at least 0.2 ampere
3. +12.0V DC - at least 2.5 ampere
4. -12.0V DC - at least 0.5 ampere

High Voltage Power Supplies (Chassis A26, A31) - Outputs for each of these units are:

1. +25V DC - at least 1.0 ampere
2. -25V DC - at least 1.0 ampere
3. +50V DC - at least 1.0 ampere
4. -50V DC - at least 0.5 ampere

Dynamic Checkout Safety Monitor

This unit (Chassis A27) monitors the pressures in the missile fuel and liquid oxygen ullage tanks in the Dynamic Checkout Unit. In the event of an overpressure, the Dynamic Checkout Safety Monitor, within 50 milliseconds, initiates a command that closes the missile booster tank Helium Shutoff Valve and holds it closed, even though the overpressure may be a transient condition. The Dynamic Checkout Safety Monitor command also opens the ullage tank vent valves. In addition, signals are sent to APCHE indicators for indication of which ullage tank became overpressurized. Simultaneously, the Alarm Buzzer is activated. The unit also contains a number of valve drivers to handle heavy current switching.

Flight Control Selector System

The Flight Control Selector System consists of two chassis; the Gyro Nulling Unit (A28) and the Gyro Heat Unit (A30). A description of their functions follows.

The Gyro Nulling Unit (Chassis A28) contains roll, pitch, and yaw gyro-nulling amplifiers which are connected to the gyro-emitter-follower circuits and torquer-amplifier input circuits, thus holding the gyro electrical output at zero. Relay switching controls the nulling amplifiers which enable gyro nulling, and may be removed for checkout purposes.

The missileborne integrators can be nulled by grounding applicable test points on this chassis. Relays are provided to remove the nulling of each integrator upon command from the Discrete Sampler, otherwise all these integrators are nulled at all times. The signal-amplifier-output and rate-gyro-output of each axis is grounded at all times to isolate signal inputs, except during the APCHE test, which requires the output signals. Relays will remove each ground on command from the Discrete Sampler, with the exception of the roll-rate gyro output.

Another section of the unit provides start-and-stop control of the Flight Programmer and enabling of the Flight Programmer times-ten speed. The start of the Flight Programmer is accomplished by momentary ungrounding of two START FLIGHT PROGRAMMER pins. Stop of the Flight Programmer is accomplished by continuously grounding the STOP FLIGHT PROGRAMMER pins.

Interlocks prevent application of gyro-spin motor power whenever any coarse-heater-thermostat contact is closed. The Flight Programmer will not start, or continue to cycle, if the arming switch is in the ARMED position. The ARMED indication is monitored for the latter interlocks, and presence of this indication will stop the Flight Programmer.

Gyro Heat Unit (Chassis A30) provides control circuits for monitoring operation of gyro coarse-heater-thermostats and fine heater control voltage.

Coarse-heater monitoring is accomplished by thermostat-controlled circuits which cutoff coarse-heater-power when gyro temperature reaches a sufficient value. When all pitch, yaw, and roll-displacement-gyro thermostat switches open, a 28V DC COARSE HEAT COMPLETE indication is generated which activates the corresponding indicator lamp on the Indicator-Control Display Panel. An interlock on this panel prevents application of missile AC and DC power, unless the COARSE HEAT COMPLETE indication is present.

Fine heater monitoring is accomplished by use of control voltage from a magnetic amplifier, having a nonsinusoidal output. Comparators are used to monitor the state of the gyro fine heaters by determining that heater voltage, and heater power level, is within prescribed limits. When all three fine heater control voltages are within these limits and the signal COARSE HEAT COMPLETE is present, the HEATER NORMAL indicator lamp on the Status Indicator Panel is illuminated. The unit also contains a fine heater simulator which generates 400 CPS simulation voltages, corresponding to the upper and lower limits of the comparator thresholds. Low voltages are provided by a DACON. Relays permit selection of a simulator voltage to drive all three channels simultaneously and isolate the simulator signals from the missile signal. These relays are activated by the Discrete Sampler.

Transfer Function Analyzer

The transfer function analyzer (TFA) is a mobile APCHE test system capable of performing low frequency, steady state testing of missile autopilot servomechanisms and measuring the response. A very low modulation frequency is generated for use in exercising the vernier engines servomechanisms also.

1. General Description of Operation

On signal from the card reader, a 400-CPS signal modulated at 3 frequencies is transmitted to servosystems under test. This is done by programming the reference signal source selection, DACON 1 and/or 2 scaling ladders, and DACON 1 and/or 2 test point selection. A 400-CPS response signal is received from transducers in the SUT, which indicate the position of the engine gimbals relative to the TFA stimulus. A response signal, in which the modulation envelope is in phase with the modulation envelope of the applied signal (zero phase shift), indicates that the engine position commands have exactly followed the transmitted command. A time lag between the transmitted command and execution of the command is indicated by a response signal whereby the modulated envelope lags that of the applied signal. This signal is resolved into 2 components: an in-phase component and a quadrature component (90° phase shift). It is then converted to a DC voltage and sent to the ADCON for comparison of the response and then to the comparator and printer.

2. Frequency Selection

A 400-cycle signal is modulated by one of 3 preset low frequencies 0. 5, 2, and 10 cycles, which are selected by card holes E6, F6, and G6 (TFA frequencies). The voltage selected at the modulation frequency control is amplified and through push-pull operation enables the 2-phase AC servomotor to run at the selected speed. Stabilization of motor speed is achieved through feedback provided by a tachometer-generator that feeds back an out-of-phase voltage to cancel part of the input to the amplifier. Should the motor speed increase, the tachometer-generator output would increase, and feedback would decrease the signal to the amplifier and reduce motor speed. The reverse is true if the motor slows down. Tachometer-generator output would decrease in amplitude, the feedback would be reduced canceling less of the input voltage, and the motor would speed up.

3. Signal Generation

Depending on the choice of frequencies commands, the servosystem will set the motor running at a fixed speed to produce the desired modulated signal output. The modulated signal is generated by a transmitting resolver whose rotor is driven through a 3:1 reduction gear by the servomotor. The resolvers stator windings are excited by 400-cycle 11.7V reference voltage, and the rotor windings provide a 400-cycle modulated driving voltage to the SUT. The envelope frequency of the modulated 400-cycle signal is a function of the angular velocity of the generator rotor. As the rotor, driven by the motor, cuts through the field of the stator, transformer action will develop the sinusoidal output voltage envelope. The output of the TFA is then sent to the DACON and from there to the selected SUT test point.

4. Response Signal from the SUT

The servo response is received by the TFA phase detector circuit by enabling card holes H6 - L6 (TFA source). This analysis circuit provides, through card hole D6 (quad), 1 of 2 DC voltages proportional to the magnitude of the quadrature or the in-phase component of the response signal. The amplitude of these signals is resolved in the multiplier resolver analyzer. This mechanism resolves the SUT response into its sine and cosine components. Similar to the modulated frequency generator, it is basically a transformer with a variable position secondary. When 2 secondary windings are at right angles to each other, one secondary will have a voltage induced in it proportional to the sine function of the angle. The other will have a voltage proportional to the cosine of the angle. The multiplier resolver is mechanically coupled to the same drive motor as the signal generator and is positioned in space relative to it. Therefore, the phasing of the 2 will be the same, regardless of the angle of rotation.

5. Detector

This detector is a phase sensitive rectifier whose purpose is to rectify the response signal output of the multipler resolver analyzer. If the input to the detector is the in-phase response signal, and if this signal is exactly in phase with the 400-cycle reference, the amplitude of the output of the detector will be maximum. If engine movement is not sufficient the response signal from the transducer will be smaller in amplitude at the input to the detector, reducing the output amplitude. The amplitude of the response signal, therefore, represents the amount the engine is gimbaled. If the quadrature output of the resolver is selected by enabling card hole D6, the angle of lag in engine response can be measured. If the engine response is sluggish the difference in phase between the response and reference signal will reduce the quadrature detector output signifying engine lag. If comparison between the in-phase and quadrature output voltages shows the phase lag to be small yet the signal amplitude is reduced, it would mean the signal to the engine is in error. If the amplitude of the return signal is smaller than programmed and a large phase lag is detected it would show engine response to be sluggish.

COMPOSITE CHECKOUT AT LAUNCH SITE

The mobile checkout and maintenance (MOCAM) unit employs two basic test procedures in missile checkout: analog and discrete. An example of each test and a brief description of the components tested in each missile system at the launch site will be covered in the following paragraphs. Due to the complexity of the test procedures and the many factors involved, only the quantities within the scope of this course will be covered.

Analog Test Measuring a Function at T_1

In the type of test described here, a stimulus voltage provided by the digital-to-analog converter (DACON) causes a stage of amplification to conduct to output. The counter register is preset to freeze analog-to-digital converter (ADCON) tracking after a determined period of time (T_1). The stage of amplification is expected to be conducting to output no later than T_1. The value in the ADCON is evaluated in the comparator against predetermined limits.

Analog Test Response Measured at Times T_1 and T_2

In this test, an analog stimulus provided by the DACON commands an increase in tank pressure. Two points during the pressure rise are considered critical in amplitude related to time elapse (T_1 and T_2). A pressure transducer had to be built into the tank in order to convert the pressure to a proportional voltage that can be monitored by APCHE.

Since the two points to be monitored are close in time, it is necessary for the APCHE to utilize both counter registers for timing functions and at time 1 (T_1) convert one counter into a storage device. In this manner it can continuously track the increasing pressure (voltage) rise without loss of time or continuity. At the termination of time 1 (T_1), the second counter starts, and the first counter instantaneously samples and stores the contents of the ADCON without affecting its tracking. At time 2 (T_2) the second counter freezes the ADCON. Once APCHE has detected the voltage at T_1 and T_2 and has them stored in the counter register and the ADCON, the only remaining steps are to insert the values into the comparator one at a time and compare them against predetermined limits. (See Figure 32)

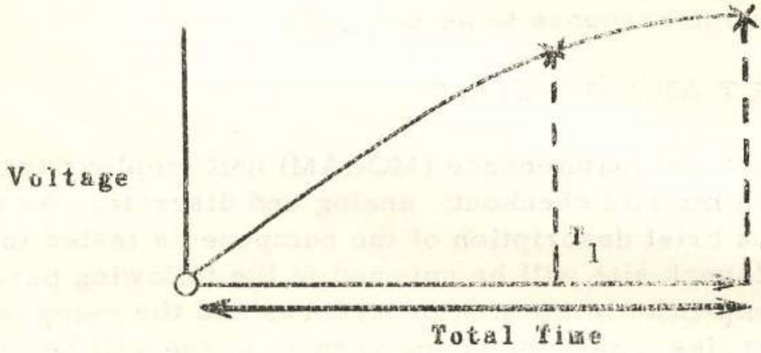


Figure 32 Voltage Compared to Time

Analog Test Measuring the Duration of an Analog Function

This test is utilized when the duration of an event or voltage function (such as a peaking or step function) is critical. The signal itself is not measured for value but only for duration. The increase in amplitude of the voltage function (or, conversely, in some cases the decrease) past a predetermined critical point causes a counter register to operate. When the voltage function is completed and drops below a given point, the counter register is stopped. The value in the counter corresponds to the duration of the analog voltage function. It is then compared in the digital comparator against predetermined limits.

Measure a Frequency

The object of this test is to evaluate the frequency at which the system under test (SUT) is operating and determine if it is within the required limits. To accomplish this, the unknown (test) frequency is fed into 1 counter register while a known (internal) frequency is fed into the other. Both counters are started together. The counter operating at the known frequency is preset to overflow and stop the other counter after a predetermined number of counts. The unknown frequency is then fed to the comparator for evaluation against predetermined upper and lower limits.

Measure the Resistance of a Circuit

In this test, a known voltage is dropped across a known resistor (RESCON) and the unknown resistance. (The unknown resistance is the circuit under test.) A point between the two resistances is tapped, and the voltage dropped across the unknown is impressed at the ADCON chopper. The ADCON converts the value, and it is then compared against predetermined limits in the digital comparator.

"F" Decks and SUTS

MAPCHE decks for "F" have been set at 3 decks at the LCC, and 3 decks at the MAB. The decks have been reduced from the number used in the "E" concept in order to (1) provide a more adequate survey test as well as enabling immediate isolation to the canister level without requiring additional decks to be run, (2) to provide one set of general setup instructions, (3) to eliminate useless repetition of printed data. Decks to be used are as follows:

(LCC) Deck 450 - MAPCHE Checkout, can be broken down into four parts
- Part I Calibration
- Part II Self test
- Part III Interface check at Checkout Distribution Unit
- Part IV Interface check at missile riseoff disconnects

(LCC) Deck 451 - Systems checkout, can be broken down into six parts
- Part I Electrical system
- Part II Propulsion system
- Part III Propellant Utilization system
- Part IV Autopilot without hydraulics
- Part V Integrated guidance
- Part VI Autopilot with hydraulics (frequency response not included)

(LCC) Deck 452 - Hydraulic fill and bleed

(MAB) Deck 400 - MAPCHE Checkout, can be broken down into five parts
- Part I Calibration
- Part II Self test
- Part III Interface check at Checkout Distribution Unit
- Part IV Interface check at missile riseoff disconnects
- Part V Interface check at MDU

(MAB) Deck 401 - Systems checkout, can be broken down into seven parts
Part I Electrical system
Part II Propulsion system
Part III Pneumatics system
Part IV Propellant Utilization system
Part V Autopilot without hydraulics
Part VI Integrated guidance
Part VII Autopilot with hydraulics (frequency response included)

(MAB) Deck 402 - Hydraulic fill and bleed

SUT Assignment	Description
1	Propellant
2	Pneumatics
3	~~APS and Pneumatics~~ MISSILE ELEC.
4	Propulsion
5	Flight Control and Guidance
6	Unassigned
7	Self-test

SUMMARY

The control console provides indication and controlling functions for mobile APCHE equipment. From this panel the testing is started/stopped and monitored by the operator. The indication presented on the display panel shows the operator the status of the test, the card and deck number controlling the action at that time, and test results as a GO/NO-GO condition. When deviation from test routine is required, the APCHE will stop, and indicators will tell the operator what function is required at that time. The course of action is spelled out from the deck manual.

Card Reader

The card reader transcribes punched card hole information into electrical signals that actuate the components necessary to run the test. By punching a specific hole the sensing pins energize relays enabling functions to occur in their proper sequence. The lack of a punched hole in a specific position inhibits that specific circuit. A motor-driven cam controls the sequence of operation of the APCHE test. A sensing circuit detects misaligned cards or decks, stopping the test if this should occur.

Ring Counter

The electronic transistorized ring counter, by its position, controls the steps each card goes through from start to finish. The first 2 positions of the ring counter are controlled by cam operation; the remaining steps are controlled by punch card information. The ring counter controls when events occur (such as, counter starting and stopping, transfer of information) and to print test results.

B and C Counter Registers and Start/Stop Selector Unit

The B and C counter registers are identical 12-stage, reversible, binary counters, capable of digital timing and storage of information. Each counter can be conditioned independently by enabling applicable card holes. These switches connect the trigger frequency and start/stop controls to the counters. The counters may be operated in tandem or series sequence as desired. The ADCON may also be used as a 12-bit counter register but not in tandem or series sequence. The start/stop selector unit contains the necessary start/stop relay trees and frequency selection for counter programming and control.

Reference Switching

The selection of reference voltages for the analog-to-digital converter and the 2 digital-to-analog converter scaling ladders is made by programming AC and DC voltages through this chassis. Also the TFA output of .5-, 2-, or 10-cycle modulated signals may be selected through this chassis when testing the missile gimbaling system.

DACON's

The test analog voltage to a unit being tested is provided through the 2 DACON's. Amplitude of the test voltage is determined by the DACON's scaling ladder.

Power Supplies

APCHE power utilized in test is regulated by the high-and low-voltage power supplies. Precision voltages are adjustable by test points readily accessible on the front of each chassis using a digital voltmeter.

ADCON

The ADCON is used to convert analog quantities received from a unit under test to binary-coded equivalents. A reference voltage is generated through a resistance ladder network with which the test voltage is compared by the ADCON. The difference between the reference and test voltages drives the 12-stage reversible binary counter, which switches the ladder driving the reference output voltage toward the test voltage. When the difference is within 3 MV, the binary counter has a setting proportional to the magnitude of the test voltage. This digital value may be frozen and sent to the comparator or transferred to the B or C counter registers.

Input Signal Chassis

The input signal chassis allows the ADCON to measure phase shift and unknown resistance values. By applying a voltage between a known and unknown resistance in the input signal amplifier-detector and programming the voltage drop of the known resistance to the ADCON, the value of the unknown can be found. Phase comparison and sync detection may be accomplished by programming peak detection. By use of the resistance ladder, voltages as high as 500V may be used in the ADCON; its maximum input voltage being 3. 069V DC.

Digital Comparator

The evaluation of the test problem is done at the digital comparator. By comparing the test values against preprogrammed upper and lower limits, a GO/NO-GO evaluation is accomplished. These results are sent to the printer and indicator on the control panel.

System Selection Selector Units

There are three identical system selection selector units (chassis A1, A2 and A3), which switch the 100 P/M lines in the discrete sampler to any one of the six SUT's. Each chassis has a relay tree that selects the system to which the 100 P/M lines will be connected.

System Selector Unit - Self-Check

The system selector unit self-check (chassis A4) controls operation of the three system selection selector units. It also provides for self-check of the 100 P/M lines from the discrete sampler feeding the three system selection selector units.

Discrete Sampler

Each of the two discrete sampler selector unit chassis (chassis A15 and A19) provides 50 P/M lines to the system selector units. Program lines carry +27. 5V DC command signals to the missile system or ground system under test. These signals initiate an operation or function. Monitor lines detect the presence or absence of 27. 5V DC in the missile system or ground system under test. If there is any discrepancy between predicted response and response from the SUT identification numbers of the faulty circuits are presented to the printer sequentially on discrete sampler select unit output lines.

The discrete sampler controller (chassis A16) receives direction from programmed card holes, and, in turn, directs operation of the discrete sampler selector units. The discrete sampler controller also analyzes the P/M lines in four groups of 25 lines each. The lines of each group are first checked simultaneously for faults. If a fault appears, the lines of the group are checked sequentially, and the number of the faulty circuit is sent to the printer for printout. The unit is completely transistorized.

Printer

The printer produces a paper tape readout with 12 columns of information printed at the rate of 6 lines per second. The MAPCHE version of the printer uses a continuously rotating drum, keyed with the characters by a commutator brush arrangement. This relieves the necessity for all circuit numbers to be greater than zero.

The printer-decoder is the controlling decoding chassis for the printer. It decodes binary digital input data for octal and decimal printout. Cards and deck numbers are decimal printouts; test results are octal printouts. The printer-decoder also decodes card and deck number signals that actuate indicators on the status indicator and indicator-control display panel. The unit employs hermetically sealed relays for maximum reliability, and is mounted in a drawer-type chassis.

REVIEW QUESTIONS

1. What are some of the advantages gained by the use of mobile checkout equipment?
2. Describe the difference between PI inspection and second periodic.
3. Why is automatic checkout equipment employed?
4. What type aircraft will transport the mobile APCHE?
5. What is the purpose of the pneumatic checkout vehicle?
6. What is an analog test?
7. What is a discrete test?
8. Explain how an analog function is timed.
9. How are frequencies measured with APCHE?

10. What card hole controls print mode three?

11. Where does the test value to the printer come from?

12. How many lines can the discrete sampler program and monitor at one time?

13. Where do the commands for the system selection selector unit come from?

14. When will the discrete test take place, before, after, or during an analog test?

15. What system is checked out in SUT 5?

16. What is the purpose of the general survey deck?