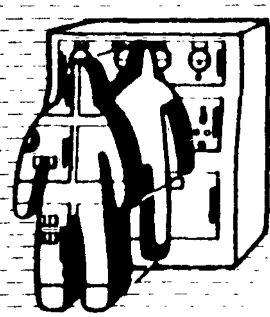
DETAILED EVALUATION REPORT

MISSILE N-23

TITAN II



TITAN II IGS CATEGORY II MAINTENANCE, LOGISTICS, RELIABILITY AND READINESS

TEST AND EVALUATION

DEC 5 1963

AC SPARK PLUG

THE ELECTRONICS DIVISION OF GENERAL MOTORS CORPORATION

MILWAUKEE, WISCONSIN 53201

Technical Operating Report
BOB Approval Number 21R-138.1

IV-AG-235

INERTIAL GUIDANCE SYSTEM
WEAPON SYSTEM 107A-2.

Prepared by
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MAINTENANCE, LOGISTICS
RELIABILITY AND READINESS
TEST AND [redacted]
DETAILED EVALUATION REPORT
MISSILE N-23.

Contract AF 04(694)-177

1 November 1963

Prepared for

BALLISTIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
NORTON AIR FORCE BASE
SAN BERNARDINO, CALIFORNIA

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1. INTRODUCTION

This Detailed Evaluation Report is submitted in compliance with section 14.2 of CR 62-2 (Volume III) Revision 1 "Maintenance, Logistics, Reliability and Readiness Test and Evaluation Plan for TF-2", which requires that a report covering the complete receipt to launch cycle for each applicable Category II missile be submitted within 30 working days following the launch of applicable Category II missiles. This report covers the results of maintenance, logistics, reliability, and readiness test and evaluation conducted by AC Spark Plug Division on the Titan II Inertial Guidance System (IGS) for missile N-23 at Vandenberg Air Force Base, California.

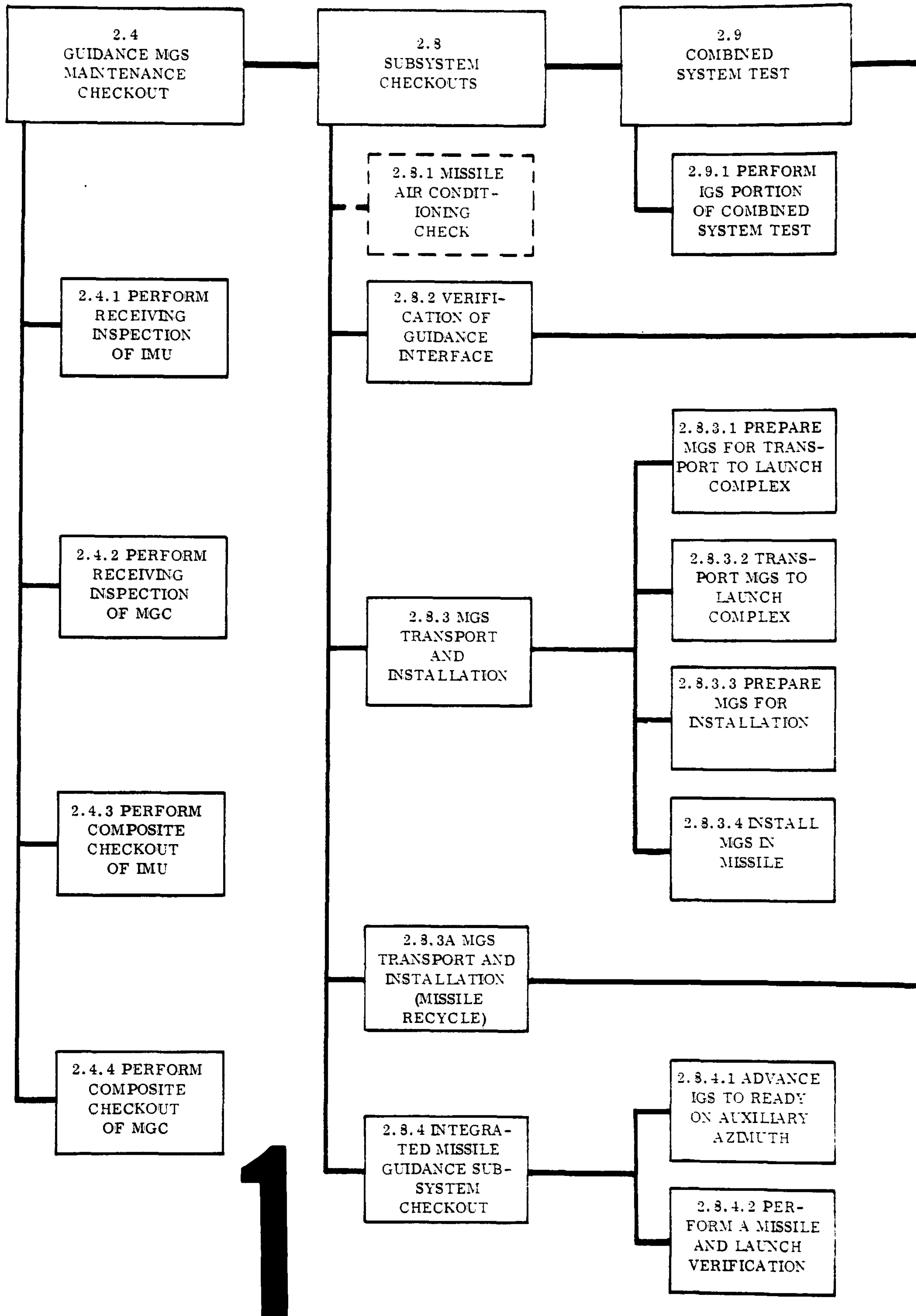
The requirements for and the objectives of the Maintenance, Logistics, Reliability and Readiness Test and Evaluation program are contained in CR 62-2 (Volume III) Revision 1. The general means proposed by AC Spark Plug to meet the requirements and accomplish the objectives are contained in the "Titan II IGS Category II Personnel Subsystem and Maintenance, Logistics, Reliability and Readiness Test and Evaluation Functional Description" 1 July 1963.

This report is organized to present a general summary of guidance activities related to the receipt-to-launch of missile N-23 following this section. The general summary is followed by the specific maintenance, logistics, reliability and readiness test results for N-23 guidance activities related to the CR 62-2 (Volume III) objectives. This latter section will present the specific guidance system maintenance, logistics, reliability and readiness problems uncovered during the receipt-to-launch sequence and discuss the impact of these problems on the sequence and on the accomplishment of program objectives. Guidance and guidance related activities involved in the Titan II receipt to launch sequence are presented diagrammatically in Figure 1 at the end of this section. These activities are titled and numbered as they appear in CR 62-2 (Volume I) Revision 1 "Category II Operational Readiness Verification Test Program".

FIGURE 1

TITAN II INERTIAL GUIDANCE SYSTEM
RECEIPT TO LAUNCH CYCLE

CR 62-2 (VOLUME I) REVISION 1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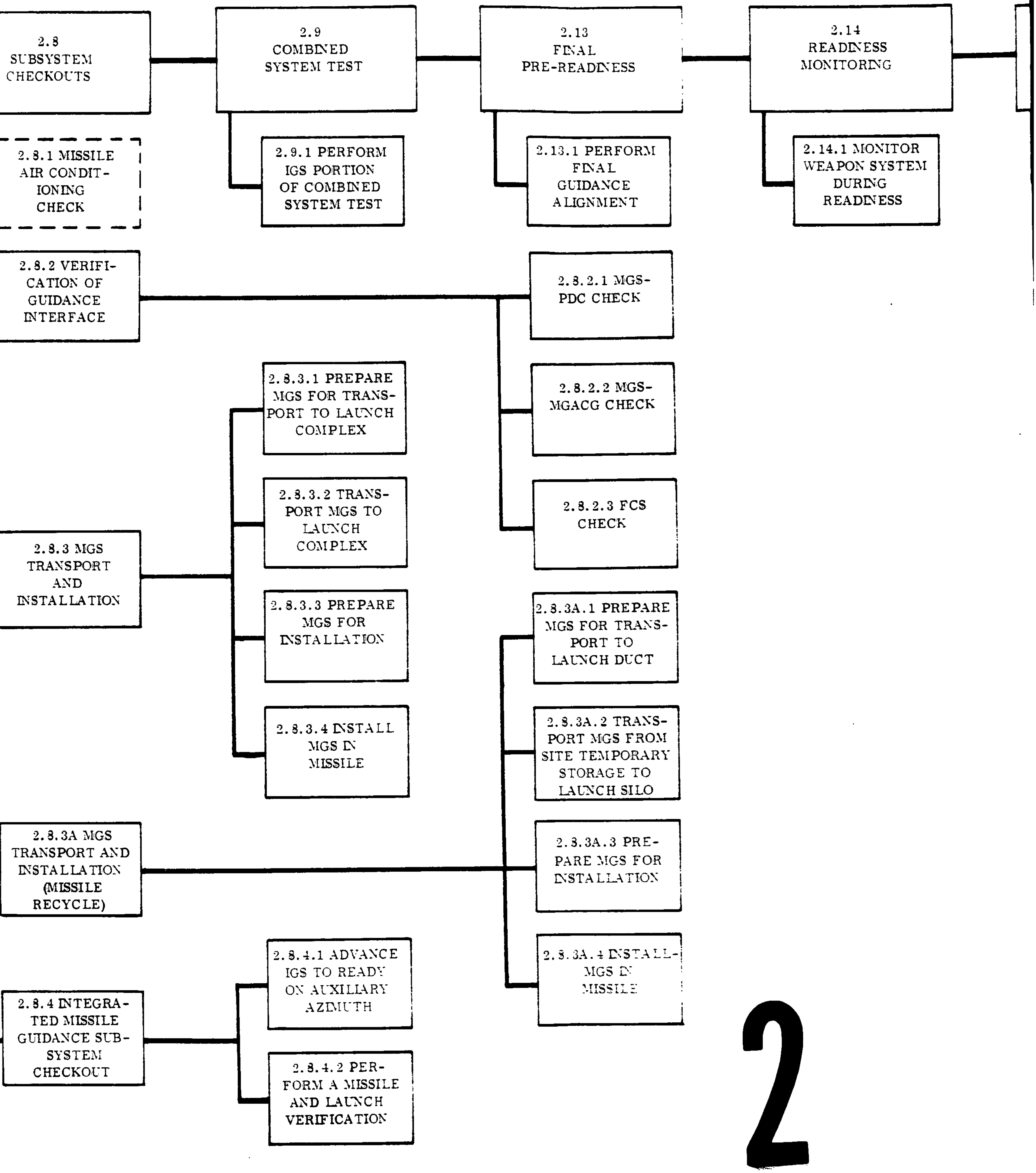
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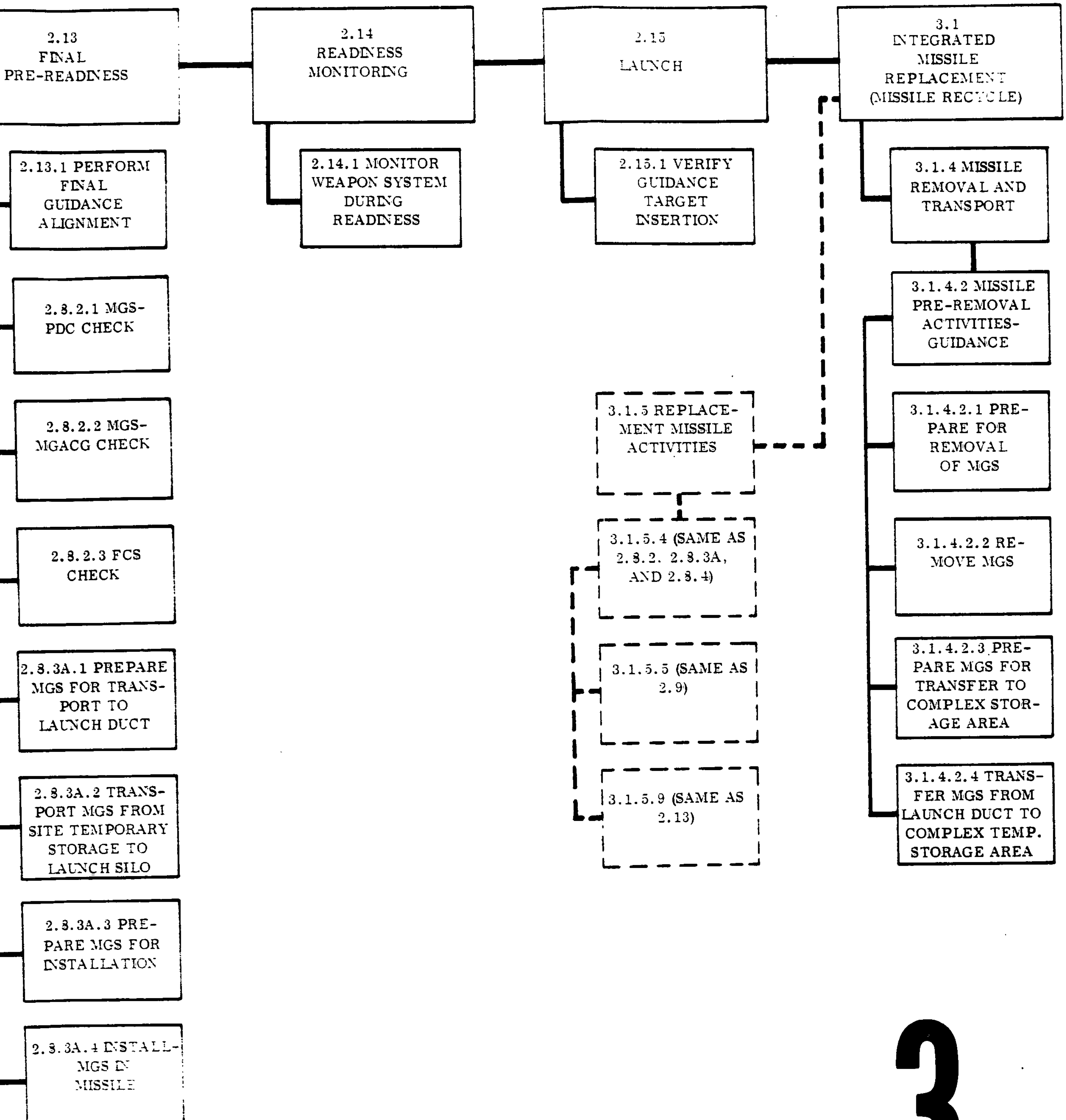
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2. GENERAL SUMMARY

Airborne guidance units designated for Missile N-23 were Inertial Measurement Unit (IMU) 2025 and Missile Guidance Computer (MGC) 2316. When the receipt to launch sequence was initiated, MGC 2316 was in System Test Complex (STC) 1 in the Contractor Maintenance Area (CMA) and IMU 2025 was in storage. Receiving inspection and composite checkout of the MGC and IMU were performed on 5 June 1963 and 6 June 1963 respectively. The checkout was performed in STC 2 and the units were installed in STC 2 until 10 June 1963, at which time they were placed in storage. The units were transported to Site 395 D on 13 June 1963. The installation was started on 13 June and completed on 14 June. Due to other problems, the return to readiness activities for the units were not performed immediately. On 17 June MGC 2316 was interchanged with MGC 2319 which was located at Site 395 C when the sequence was initiated. This interchange was necessitated by the lack of approval of the MGC program for MGC 2319 which was due for a flight from Site 395C on 20 June 1963.

Before installing MGC 2319 in Missile N-23 at Site 395 D, it was checked at STC 2 in the CMA on 18 June. MGC 2319 passed composite checkout satisfactorily and was transported and installed at Site 395 D on the same day. The formal return to readiness procedures were initiated on the following day. The system was used in support of both formal and informal tests on subsequent days. In the succeeding weeks relatively few problems were noted with the guidance system. Problems which did occur, however, concerned inadequate gain on the Azimuth Alignment Set (AAS), regression to standby and the possibility of the MGC heads being dropped, and the loss of the 2.4 volt bias voltage in the 1000 cycle voltage. A major problem was encountered on 5 August when the IMU heater power was lost for approximately 7 hours when integrating contractor personnel attempted to connect the IMU heater power using informal procedures. The next major problem occurred on 8 August and necessitated replacement of MGC 2319 with 2317, Computer Control Power Supply 209 with Computer Control Power Supply 213, and Missile Guidance System Fault Locator 210 with Missile Guidance System

Fault Locator 219. The problem was later isolated to a logic module in the Fault Locator and the drum heads in the MGC being stuck in the up position. At the same time AC Voltage Comparator 210 was removed for modification purposes and AC Voltage Comparator 209 was installed in its place.

Except for problems caused by interfacing subsystems, significant Guidance System problems were not subsequently encountered until the week of 26 August 1963, wherein AAS problems were encountered. The problems were corrected but on 30 August a decision was made to replace MGC 2317 due to considerable electrical interference encountered during testing. At the same time, a decision was made to remove IMU 2025 which had lost its heater power for approximately 7 hours on 5 August 1963. The MGC was replaced with MGC 2307 on the same day and the IMU was replaced with IMU 2019 on 4 September 1963. This is the IMU which was eventually launched in Missile N-23. Also, on 4 September, Circuit Breaker Filter Assembly 210 was replaced with Circuit Breaker Filter Assembly 220 on the basis of an engineering judgment that an earlier Missile Guidance Alignment Checkout Group (MGACG)/Launch Control Console interface problem was caused by this drawer. This was not confirmed at the Bench when Circuit Breaker Filter Assembly 210 was checked.

More Guidance System problems were encountered in the succeeding weeks than had been noted for any same period of time since the start of the receipt to launch Sequence of Missile N-23. Many of the problems were caused by problems in interfacing subsystems. On 8 September 1963 a decision was made to replace MGC 2307 due to a suspected drum out of synchronization. MGC 2307 was replaced with MGC 2314. On 10 September it was necessary to replace MGC 2314 with MGC 2287 due to the drop of the Airborne 28 volt DC to 23 volt DC during combined system test, introducing the possibility of degradation of information on the computer drum. Not long after MGC 2287 was installed, 28 volt DC Airborne power was lost. Since the power loss could have caused damage to the drum, MGC 2287 was replaced with MGC 2354 on the same day as the previous replacement. MGC 2354 is the MGC which was launched with Missile N-23.

MGC 2354 successfully completed the return to readiness checks on 11 September 1963. One problem noted during subsequent checks was the calibrate and drift hold light extinguishing. The heat demand light also came on for approximately 16 minutes and remained on for approximately 19 minutes after entering the heat mode. The air conditioning temperature was found to be 55 degrees and 54 degrees. In addition, fluctuations of the Airborne 28 volts was noticed which was eventually isolated to a noisy amplifier. The problem remained for approximately one week. The only other Guidance System problems noted prior to launch on 23 September 1963 were downmoding during dynamic response test, and abortion of the Gyro Drift test when Air Force personnel inserted a burst control key in Control Monitor Group 2 during the test. On the day before the flight the system downmoded to align 8 once and required 5 minutes to realign to ready. From the day before the flight until the day of the flight the system remained constantly in the ready green mode, with the exception of a missile verification which was performed an hour before the flight.

A brief description of the flow of the two "flyer" units is as follows. MGC 2354 was received from Milwaukee on 12 July 1963. It was installed and checked out in STC 1 at the CMA on 16 July. It was removed from STC 1 on 17 July and installed in STC 2 in the CMA and checked out on the same day. MGC 2354 was removed from STC 2 and placed in storage on the subsequent day. The unit remained in storage until approximately 23 August at which time it was sent to the Missile Assembly and Maintenance Shop (MAMS) for successful Category II testing activities. MGC 2354 was returned from the MAMS and installed in Missile N-23 as a replacement for MGC 2287 on 10 September 1963.

IMU 2019 was received from Milwaukee on 1 August 1963 and was installed and checked in STC 1 at the CMA on 7 August. Due to suspected problems in the frequency of the airborne wheel power, the unit was returned to Milwaukee on 9 August. It was returned from Milwaukee on 23 August, at which time it was installed in STC 1 at the CMA. The tapes were loaded on that day but no further checks were made. No activity was performed on the STC until 26 August but from that day until the 30th the STC was in use every day. IMU 2019 was removed and placed in storage on 30 August and remained there until 3 September. On 3 September, IMU 2019 was reinstalled in STC 1 and satisfactorily passed composite checkout. The unit was removed from STC 1 on the following day and installed in missile N-23 to replace IMU 2025 which had been removed on 30 August. As in the case of MGC 2354, the handling of IMU 2019 did not appear to be excessive in comparison with other units.

A significant point to consider is that the operating life of a system at Vandenberg Air Force Base is more "strenuous" for the equipment than in the operational situation wherein it will remain in ready for a sustained period of time. However, the two flyer units were not in the missile for an extended period of time. IMU 2019 was in the missile for approximately 20 days, during which time the system was "active" approximately 12 days. MGC 2354 was in the system for approximately 13-1/2 days during which time the system was "active" for approximately 7-1/2 days. The sequencing at the CMA for both units did not appear to be excessive in comparison with the anticipated situation at operational bases.

3. TEST RESULTS

3.1 Maintenance

3.1.1 Objective:

"6.1.1—Determine whether the support activities for the maintenance of the missile and ground equipment are adequate, considering in particular:

a. Malfunctions resulting from prior maintenance and the support activities which may have resulted in these malfunctions.

b. Adequacy of support equipment in the accomplishment of all maintenance activities.

c. Adequacy of maintenance routines in support of non-checklist maintenance activities."

Most of the MLRR deficiencies reported during this phase of the program fall into the "inadequacy of support activities" category. The report for this portion of the objective is not oriented specifically toward the receipt-to-launch sequence for N-23. In order to cover all support equipment problems, the report covers all support equipment problems regardless of where the problem occurred.

"a. Malfunctions resulting from prior maintenance and the support activities which may have resulted in these malfunctions."

Various incidences of malfunctions occurring from previous maintenance activities have been noted. The most significant one for the receipt-to-launch sequence for N-23 is the loss of IMU heater power due to integrating contractor personnel using informal procedures in connecting the IMU heater power cable (Individual Summary Form—ISF 581-2). It is not known whether Air Force technicians would have attempted to use informal procedures in the same manner. Another incident at Site D was a failure of the AAS test on 28 June which apparently resulted from the reference prism being adjusted on 17 June. The one significant maintenance mishap which has not necessarily been traced to a malfunction is the omission of the fourth hold-down bolt for MGC 2354 (the flyer) when it was installed in missile N-23. There is also the possibility that many of the interfacing problems which affected the guidance system could have resulted from maintenance activities. However, it has not been possible to trace the problems to a maintenance activity due to lack of information on the activities of other associates at the Launch Site. An incident noted at the beginning of the receipt-to-launch sequence was a bent pin on the MGACG which was missed in the checkout and detected by an MGC and Computer Control Power Supply (CCPS) NO GO during Return to Readiness monitoring for the initial IMU and MGC (2025 and 2316; respectively). Problems with connector pins have occurred fairly frequently and may become a problem in the operational situation. Special attention will be given to this problem during the remainder of the Category II program.

One series of incidences arose from the lack of proper maintenance of MGE used in the installation and removal of airborne guidance units. Although these problems do not necessarily cause malfunctions, they tend to increase the time for installation and removal which has a direct effect upon downtime per failure. One problem concerned difficulty in locating a holding pin for the portable floor crane adapter. The metal chain which attaches the pin to the boom on the crane reportedly had been broken for some time and the pin was misplaced during a previous function. A second problem (ISF 501-6) concerned a missing part for the right angle torque wrench extension which caused unnecessary difficulties and eventually caused the technician to drop the wrench to a lower level.

Problems associated with inadequate maintenance of MGE were also reported in ISF 575-2. The IMU adapter was missing the drift punch, requiring the use of a screwdriver to align the IMU mounting holes. The hold down pin which holds the crane to the work platform was missing a handle, which allowed the wing nut to fall off and get lost. Since the hold down pins were not attached to the crane, they were left behind when the operators removed the crane.

The above problems were noted at Site D. Similar problems were noted at Site B and are reported in ISF's 501A-1, 557-4, and 557-5. Since the integrating contractor provides the MGE for the launch site removal and replacement activities, the problems have been routed to Martin, via the PSTT, for resolution. It is not known whether these problems of inadequate maintenance are peculiar to Vandenberg.

One incident is not specifically associated with "causing malfunctions" at Site D but is included in the same category since it constitutes a safety hazard. The incident concerns the problem of puddles of oil and/or hydraulic fluid accumulating on the floor of the collimator room at Site B. The fluid makes the floor slippery and constitutes a hazard to personnel and has been reported as ISF 570-2. A safety problem was also reported for Site D and concerned a rubber sheet, which covers the open space between the work platform and the missile, missing from Segment G of the work platform. The lack of the sheet exposed a quarter moon shaped hole approximately 24" by 10", causing a possible hazardous condition. The problems have been reported to the PSTT for resolution.

Another maintenance problem reported which caused later malfunctions (or declaration thereof) concerned the failure of bench check due to improperly maintained multimeters. The problem has been reported as ISF 480-1 and is currently under investigation. Another incident (ISF 505-1) concerned difficulty in installing the teflon supply reel hub on the tape reel shaft. Close examination of the reel hub showed the teflon hub threads partially stripped and damaged, apparently due to cross threading and/or applying too much pressure when tightening the hub. The problem is currently under investigation. One of the incidences was accepted as a "normally expected" incident.

The incident was reported as ISF 583-1 and concerned a malfunction indication being caused by a temporary ground in Martin instrumentation. Since no weapon system deficiency occurred, the problem has been dropped from further investigation.

With the exception of the last incident, all incidences reported as deficiencies or problems either (1) are undergoing detailed investigation, (2) have been resolved, or (3) are awaiting final resolution of recommended changes.

"b. Adequacy of support equipment in the accomplishment of all maintenance activities."

Problems concerning inadequacies of support equipment occurred primarily at the Launch Sites. Problems of facility items are also included since the end result on guidance system maintenance performance is the same.

A series of problems concerning the use of blast lock ramps at Site D were summarized in ISF 501-12. The Personnel Subsystem Test Team (PSTT) declared the deficiency as being "minor" and that the ramps provided are adequate to accomplish the intended function. It was noted that ACSP should include the ramps in preliminary instructions for removal and installation of guidance equipment, since only six pairs of the ramps are provisioned for the operational bases.

One problem (ISF 557-1) concerns the unavailability of protective clothing (as specified in CL-16-1) for use during removal of the IMU and MGC from a fueled missile. So far there have been no reports of the use of this clothing in the evaluation of any activity where its use is identified as a requirement. The problem may be specific to VAFB but whatever the reason, it constitutes a hazardous situation and deprives the contractors of the opportunity to evaluate performance with protective garments. Inadequacies of MGE for the removal and installation of Missile Guidance Set (MGS) units have also been noted (ISF 501A-1). The problems include the pin holding the MGC adapter sling to the boom being too large for its slot and inadequacies of the holding pins which hold the computer during installation. These problems have been routed to the integrating contractor via the PSTT. Latest reports indicate that a design change is being considered.

An MGE problem specific to ACSP is summarized in ISF 557-3. The problem concerns the "butterfly" clamp on the MGC and drawer containers and is one which has been frequently observed and reported. This clamp requires an unusual amount of torque to clamp the container together, and this condition eventually causes the handle to break off. The deficiency is under investigation but has not as yet been resolved.

Problems concerning incompatibility between assigned transport vehicles and the elevator hoist at Site B were reported on ISF 501A-6. The Air Force resolved the problem by reallocating transport vehicles (pick up trucks and two trucks with hydraulic tail gates) to operational bases which are compatible with the elevator hoist.

Problems with support equipment were noted for those activities concerned with transferring MGS units to the silo and removing and installing the MGC units. One problem concerned the use of the handles on the cover of the IMU Carrier/Container to pull the unit when transferring it through the blast locks. These handles were not designed for this purpose. Redesign possibilities are currently being investigated. A second problem concerns the lack of provisions for containing or attaching the three special hold down bolts which secure the portable floor crane and holding bar to the silo platform. These bolts are not wired, chained, or otherwise attached to the crane; nor is there any apparent space to store them on the unit itself. The problem has been routed to the integrating contractor (via the PSTT) for resolution.

A reported facility problem (ISF 566-1) concerns work space limitations constraining the removal and installation of the bolts in the IMU rear mounting lugs with the floor crane and adapter attached to the IMU. AC Spark Plug is considering the possibility of resolving the problem by revising the procedures to remove this equipment prior to performing the bolt installation or removal.

Problems of inadequacies of MGE for supporting other activities have also been reported. While performing the IGS interface checks (part of Missile Post-Installation) at Site B, a substitute impedance bridge had to be used rather than the specified AN/URM-90 since this bridge was not operating correctly (ISF 500A-2). The bridge used was a Hallcross Model 638 Wheatstone bridge, but there was no information regarding functional equivalence relevant to tolerance of measurement. In addition, several problems were encountered in the use of test lead probes (ISF 500A-3). The pins on the probes are pointed and constitute not only a hazard to personnel, but to the equipment. On a number of occasions the plastic insulating material around the adapter pins was torn or stuck by the probe pins. In one case when one probe was inserted in a connector, another probe could not be inserted in the same row adjacent to the first probe. In addition, the probes were not properly labeled, which resulted in some confusion on the part of the test subject. In some cases, the probe required two hands due to the lack of proper handles on the probe. The former problem is currently under investigation. The latter problem is being resolved by inserting instructions on the T.O. on a method of fabricating adequate probes.

A problem noted during Bi-Weekly Time Critical Maintenance activities at Site B concerned an inadequate supply of desiccators. Due to the lack of spare desiccators, the desiccators were removed from the AAS, the desiccant was emptied into a cell assembly cover, and a heat-shrink gun was used to dry the desiccant. After drying the desiccant was replaced. The advisability of this procedure was questioned since excessive heat may damage either the desiccant or the optical cell cover.

Evaluation of activities in the Collimator Room also uncovered a facility problem which affects the adequate performance of maintenance activities. The problem has been noted at both Site B (ISF 568A-3) and Site D (ISF 569-1). The problem concerns an aluminum drip shield which protects the Autocollimator from condensation and/or leaks from an overhead air conditioning system. The height of the drip shield does not allow sufficient head room clearance in front of the Autocollimator. The present clearance at Site D is approximately 70" from the Collimator room floor, and at Site B, is reportedly 2" lower. In addition to the personnel hazard there is the possibility of an annoyance factor which may have an adverse affect upon the operator while performing critical adjustments of the C-3546 Control unit. A recommendation was submitted (to the PSTT) to paint the edge of the drip shield a bright color to make it prominent and/or to pad the edge with soft material.

The evaluation of activities in the Collimator room at Site B also uncovered problems with an ACSP-supplied MGE item. The problems were reported in ISF 569A-3 and 569A-4. One problem concerns the electrical equipment support assembly which supports the C-3546 control chassis when it is removed from the case for adjustment. The access notch in the electrical equipment support assembly to enable adjustment of resistor R4458 on the C-3546 control unit is located on the wrong side of the support. Viewing from the bottom, the notch is on the left side of the assembly, whereas it should be on the right. The second problem is primarily a safety problem. When the chassis of the C-3546 control is pulled out of the case onto the support assembly with the door open and the electrical cables attached, there is a definite tendency for the chassis to tip forward on the support assembly. An accidental bump or any downward force on the control door would probably cause it to topple forward and suffer damage. An "L" type holding bar which utilizes the existing screws and screw holes on the C-3546 control case was recommended to prevent the unit from tipping forward. The recommendation is currently under consideration.

Several problems were observed in the performance of the Azimuth Transfer Survey. Problems have been noted at Site B concerning aluminum filings being deposited in the threads of the AAS sight tube blast cover studs when the soft aluminum blast cover is removed and replaced (ISF 568A-1). In addition to causing damage to the studs and nuts, the filings also prevent hand tightening of the studs and nuts. Consequently, a wrench must be used to turn down the 16 nuts at least 2-3/4"; as a result, the airmen are not replacing all of the nuts because they are difficult to install. This affects site "hardness." ISF 578A-2 reports the problem of an inadequate seal for the AAS sight tube pit cover. The rubber gasket that is currently being used is not permanently attached to either the cover or the pit, and water seeping into the pit has reached the depth of 6".

A problem of lack of tools has also been reported (ISF 568A-6). The tool kit for 312X2F does not contain a wrench that will fit the nuts on the Azimuth Alignment Set (AAS) sight tube blast cover studs. A socket will not work because the studs extend between 3" and 6" beyond the blast cover. A recommendation has been made to add an open end wrench to the tool kit or to cut off the studs so that a socket can be used.

Another problem concerns the chains holding the cap assembly to the hose of the vacuum pump (ISF 568B-1). The chains do not appear to be of sufficient strength to withstand normal usage of the equipment.

Considerable difficulties have been noted in the numerous attempts to use the electronic equipment shelter (ISF 568-2). The problem was noted at Site D but is applicable to all locations. Most frequently the operators do not use the shelter even though some shelter from the open air is obviously desirable. The operators maintain that the tent is hazardous in a stiff wind, since its light aluminum frame tends to buckle and the canvas sides bow in to the extent that the operator is knocked against the transfer theodolite tripod. The shelter does not provide much protection against cold temperature nor can it be illuminated to allow the operator to check the bubble level of the instrument on a night transfer.

The tripod for the T-3 theodolite has been reported to be too high for use by a normal sized airman. Since the tripod and upper optical cell assembly can be adjusted as low as necessary, the problem is one of assisting the operator to make the correct adjustment. Supplementary instructions are planned for inclusion in the T.O. Additional equipment to secure the tripod in the correct position is also being considered for ECP submittal.

Inadequacies have also been noted with the battery power for illuminating the survey targets (ISF 568-4). A 6-volt DC dry cell battery Ever-Ready type Number 1461, MBAE 6135-643-1037, was used in place of the target battery power pack for illumination of the survey targets. Previous surveys have proved the target battery power pack insufficient to provide proper illumination of the survey targets for a complete survey. In addition to the problem of inadequate power supply, problems regarding the lack of mounting hooks on the side of the target monoliths to support the battery power packs have also been reported (568-5). Batteries have been reported to fall off of the monolith in a high wind, and become damaged. The operators have improvised staging to support the batteries against the side of the target monoliths.

ISF 568-6 reported that the same type battery box which provided illumination of the survey targets was also used as a source of power for the T-3A Transfer Theodolite. After approximately 2 hours of use, the operator found the battery power pack could not supply sufficient power to obtain a sharp image of the reflected light beam. This problem has since been resolved by the use of a transformer power pack which plugs in to the 115 VAC outlet in the vicinity of the survey transfer station.

In summary, a considerable number of problems have been noted for the MGE provided to support Azimuth Transfer Survey. Although some of the problems have been resolved, most are still outstanding. It is anticipated that lack of proper resolution will have a significant effect on both the time required to perform the survey and the variability of the measurements. In addition, negative attitudes toward IGS MGE are also anticipated and are currently being demonstrated.

Various problems of support equipment inadequacies were also reported for activities at the MAMS. Problems of inadequate illumination were noted in checking the adapters which have extremely small pin designations (ISF 475-4). A recommendation has been made (to the PSTT) for the Aerospace Medical Group (AMG) to determine the illumination levels of the MAMS such that valid recommendations can be made. The now-familiar "inadequate probe" problem was also experienced in checking the adapters (ISF 476-2). Instructions for fabricating adequate probes will be provided in the T.O.'s.

Inadequacies of MGE were also noted during the evaluation of Bench Checkout and Test of MGACG Drawers (ISF 479-1). The operator used the tip of a jewelers screwdriver and a long nose pliers to adjust resistor R2 located at the top of the Lamp and Relay Module inside the 28 vdc power supply. There is approximately 2" of clearance between the R2 adjustment screw and the front panel of the drawer. This problem is currently under investigation.

MGE problems during bench checkout can be especially perplexing due to the underlying assumption of the T.O. procedures that the test equipment is in satisfactory condition. The validity of this assumption is currently questionable in view of the problems encountered with test equipment and connecting cables (ISF 454A-1). While checking the AC Voltage Comparator drawer, the technician was instructed (by the T.O.) to return the drawer to the depot. An investigation of failure resulted in the discovery of an intermittent short circuit of the coaxial cable that connects the unit to the frequency counter. The problem was corrected by repairing the cable.

The final problem in the "inadequate support equipment" category concerns problems of battery failure in the IMU Battery Power Supply Assembly (ISF 472). The problem is due principally to an excessive trickle charge rate which is identified in the T.O. procedures and designed into the battery charge equipment. Detailed investigation of the problem is currently in progress.

"c. Adequacy of maintenance routines in support of non-checklist maintenance activities."

Various "inadequacy" problems were noted for the maintenance at the MAMS. However, the approval of the MAMS checklist essentially places the MAMS activities in the "covered by checklist" category. Therefore, MAMS problems will not be included in this report.

The only major function not covered by checklists is the Azimuth Transfer Survey and unscheduled maintenance. Recent data indicate that the technicians rarely, if ever, use the T.O. in performing the Azimuth Transfer Survey. This is apparently due to the extensive cross-referencing and detailed guidelines in the T.O. Suggestions by the technicians and the noted performance discrepancies indicate that a checklist should be provided for this function.

Additional "non-checklisted" problems include certain inadequacies of unscheduled maintenance procedures and problems with the computations involved in determining the required angles from data contained on the missile launch site data sheet and the trajectory data sheet. Both are discussed in detail in the monthly PSTE/MLRR reports and will not be repeated here.

3.1.2 Objective:

"6.1.2—Determine that operational maintenance requirements, as performed, validate the condition of the weapon system and represent the minimum requirements at a maximum time interval."

The discussion for this objective will have to be provided in two parts due to our interpretation that the objective refers to two different aspects of the guidance system. One aspect refers to validating the flight capability of the guidance system (that is, effect required CEP), and the second aspect concerns validating the capability of the guidance system to maintain the flight capability for a maximum period of time. The operations at VAFB do not facilitate evaluation of the latter aspect of this objective. However some judgments can be made on the basis of the tests conducted at VAFB.

The basic question with respect to validating the condition of the guidance system is whether the checks do in fact indicate the qualification of the airborne units for flight. Some caution must be employed in interpreting the data since the checks cannot be made perfect. In other words, a singular incident of a flight failure when the checkout declared GO does not necessarily mean that the checkout is insufficient with respect to the over-all system requirements. By the same token one successful flight does not necessarily mean that the checkout is adequate since the checkout is presumably designed to detect problems which affect flight and checkout performed with a system lacking those problems does not necessarily qualify the checkouts. In any case, a sample of one provides no degree of freedom for inferences, that is, we cannot infer to other launches.

The N-23 flight will be considered to be a failure for the guidance system for purposes of this discussion. The question of course is why this failure, or the potentiality thereof, was not detected during the checkout phase. As mentioned earlier MGC 2354 (the flyer) was installed on 10 September and the Return to Readiness monitoring activities were performed immediately thereafter. The MGC passed the tests and was used subsequently for many repetitions of missile and launch verification activities. In addition, the unit was used for other special tests. Data indicate that only three hold down bolts were used to install MGC 2354 and no other comments regarding the fourth hold down bolt were ever mentioned. The Mlog indicates that installation was performed by integrating contractor personnel. It is not known whether this had any effect upon the MGC failure in flight. IMU 2019, the flyer, was installed on 4 September 1963 and successfully completed what is equivalent to a Return to Readiness Monitoring on 6 September. During the Return to Readiness sequence problems of the computer were detected which, among other things, resulted in frequent indication of "calibrate required." Between the time of installation and launch, IMU 2017 was involved in not only the Return to Readiness Monitoring for its installation but also the Return to Readiness Monitoring for three computers and numerous missile and launch verifications. In addition, various special tests were performed. Between the time of installation of the MGC 2354 (the flyer) and the time of launch no significant guidance system problems were noted although it was exposed to fluctuations of the airborne 28 vdc. Since the Return to Readiness Monitoring activities for the MGC are somewhat similar to the Return to Readiness Monitoring activities for the IMU, the former checks can be regarded as repetitions of the checkout activities for the IMU. Since no incompatible results were noted between the various checks and since an IMU problem was not noted in flight, it can be concluded tentatively that the checks qualify a good IMU. Whether the checks will detect all non-flyable IMU's remains to be seen. On the other hand, the fact that the MGC passed the test and yet resulted in flight problems tend to indicate further investigations are required for this problem. The problem is being investigated by systems engineering. Specifically systems engineering is determining whether this problem should be detected by the Return to Readiness Monitoring checks and if not whether it is feasible to provide an evaluation of this type of condition during Return to Readiness Monitoring or an earlier Composite Checkout.

The reader should be cautioned that these checks were made under Vandenberg conditions and do not necessarily reflect the manner of conducting the checks at the operational situations. Even if the specified checks are adequate, this still does not mean that personnel will in fact perform the checks in an adequate fashion. Data collected during the earlier period of this receipt to launch sequence tend to indicate some problems in this nature.

Some problems have been encountered in the acceptance of checks specified at the MAMS, that is, specifically the System Test Complex (STC) qualification checks. The problem is documented as deficiency 402-2. The STC qualification checks are specified to assure that the STC is in a position to provide the proper condition for an adequate check of the unit under investigation. No quantitative value can be established at this time regarding the additional confidence the qualification check provides with respect to the adequacy of Composite Checkout.

ISF 570-1 also raises some questions regarding the validity of the sequence of checks to validate the condition of the system. This deficiency questioned the location of the gyro drift test with respect to the calibrate test during scheduled maintenance. However, the problem no longer exists since the gyro drift test is performed only on demand, never on schedule.

Four deficiencies were reported on the method of conduct of the checks to validate the condition of the guidance system (ISF's 470-1, 575-1, 575-4, and 579-2). ISF 470-1 questioned the adequacy of coverage of a Trouble Analysis Diagram (TAD) when a dynamic response test is failed. The problem has been resolved by a change of the TAD.

ISF 575-1 concerns a redundant step in the T.O. which is currently under investigation. ISF 575-4 concerns the method of attaching the sling to the IMU in preparation for the end-to-end check and is currently under investigation. ISF 579-2 concerns an inadequacy in the T.O. regarding the period of time in Ready mode prior to gyro drift test. The problem has been corrected by a Technical Order Change Notice (TOCN).

Whether the operational maintenance requirements represent the minimum requirements at a maximum time interval is difficult to determine under the Vandenberg testing conditions. The system is not left in a sustained Ready condition for any extended period of time. In addition, special tests are performed almost constantly which places a strain on the equipment. However, these tests do provide additional information about the system which can be used to make a qualitative validation of the "normal" maintenance checks. During the receipt-to-launch sequence of concern, only two IMU's were installed, the second one being the flyer. The first one was replaced because the heater power had been lost for approximately 7 hours. The first IMU (2025) remained in the system for 79 days and the second one remained in the system for 20 days. If it can be assumed that the absence of a malfunction indicates that the system would have remained in READY-GREEN, it can be stated that the Return to Readiness Monitoring checks after the initial installation of IMU 2025 were adequate to qualify it for approximately 79 days, probably more if the IMU heater power had not been lost in the intervening period. However this must be regarded as strictly a qualitative judgment based upon a shaky assumption since the system was not left in Ready for any period of time.

The story for the MGC is somewhat different. Seven MGC's were installed during the receipt-to-launch sequence. The first replacement however was not due to any problem but rather due to the MGC at Site D (2316) being required at Site C. No replacement was made for approximately 51 days at which time the MGC and 3 drawers were replaced. Whether the system could have remained in Ready during this intervening period is somewhat doubtful in view of the problems noted with the AAS.

On the other hand, it is very likely that the AAS problem would have been detected and corrected during either the Return to Readiness Monitoring activities or scheduled checks. Because the tests were not run in the sequence or in the period specified for the operational situations, no conclusions can be drawn except to state that it looks as if a proper implementation of the scheduled maintenance activities would have qualified the system for at least a 45 day period, and perhaps longer.

3.1.3 Objective:

"6.1.3—Compare the levels of maintenance as performed and on which data is gathered with like entries in T.O. 21-SM68B-18 and make recommendations on inconsistencies and voids (to the extent possible after publication of T.O. 21-XM68B-18)."

Inputs have been provided to the -18 manual based on AFBM 60-26A and AFBM 60-50A data. The source data have been and are continuously being analyzed, that is, most of the scheduled maintenance activities and a portion of the unscheduled maintenance activities. The only possible problem noted with respect to levels of maintenance was a computer drum problem which possibly could have been repaired at the MAMS but was returned to the factory instead. However, this is not considered to be a deficiency since the existing data do not show any significant advantages one way or the other with respect to where the drum is replaced.

3.1.4 Objective:

"6.1.4—Determine whether time required to perform scheduled tasks is within prescribed T.O. limits. Time required for tasks not directly related shall not be included."

Analysis of this requirement indicates that the only areas of concern are the functions identified in T.O. 21-SM68B-6 as Guidance Tracking and Instrumentation, and Guidance Tracking and Installation.

The reports for Function 3.3.3 " Perform Biweekly Time Critical" include the timed performances for those scheduled maintenance tasks for Guidance Tracking and Instrumentation, and include the following tests: Dynamic Response Test, Target Select and Verify, Calibrate Test, Gyro Drift Test and Memory Hold Test, and AAS and IMU Alignment and Acquisition Check. Since these performances were not performed at Site D, the data gathered at site B will be evaluated. See Table 1.

Table 1. Comparison of Specified and Actual Periodic Maintenance Time

Test	T.O. Time	Observed Sessions 570 & 571	Observed Sessions 578	Observed (misc.)
Dynamic Response Test	2	10	2	—
Target Select and Verify	1	10	1**	—
Calibrate Test	110	90*	—	94*
Gyro Drift Test	73	31*	30*	31*
Memory Hold Test	23	—	24*	25*
Flight Simulation	6	5	5	5
AAS and IMU Align and Acq.	22	95	—	—

* Time does not include 25 minute Ready Monitor Punchout
**Only 1 target loaded

The observed times do not represent minimum or maximum times, but rather actual times recorded during the numbered sessions indicated. Generally, any difference between estimated time and actual time based on small samples must be regarded with extreme caution. However, when the difference is quite large and two or more actual times tend to agree, one would do well to trust the actual time.

Table 1 indicates that the time specified for the performance of Gyro Drift Test has been overestimated. Three observer performances indicate that this specified time should be reduced to 31 minutes. This time includes the realignment, but not the 25 minute Ready Monitor punchout since in the latter case the system is in READY-GREEN.

The disparity between the observed and specified times for Dynamic Response Test and Target Select and Verify should be noted. The 10 minutes indicated as observed was the time indicated for the starting of sequential tests by operators who had never performed these functions before. There is no reason to believe that the specified times are not realistic for the operational situation. The performance times observed for test session 578 tend to support this contention. The disparity of time for AAS and IMU Alignment and Acquisition Check is not as significant as it appears. The specified time is for check only and does not include the time for adjustment. Contrarily, the observed time includes check and adjustment. The data do not provide any justification for concluding that time is not sufficient for this check.

This test activity was not performed at Site D. In addition, this has been changed to a 45 day check. The Calibrate and Drift Tests are not performed periodically any-more, only on demand, with one exception. If the Calibrate is not required during the 45 day interval, it is scheduled to be performed during the 45 day check.

The reports for Function 3.3.6A "Perform Azimuth Transfer Survey" also include timed performances for scheduled maintenance tasks. All performances of this activity have experienced difficulties with support equipment as reported in: ISF 568-2 for Electronic Equipment Shelter being inadequate; ISF 568-3 for inadequate support for leveling targets; ISF 568-4 for inadequate power source of the target battery box; ISF 568-5 for lack of battery box mounting hooks on target monolith; ISF 568-6 for inadequate power source for T3A transfer theodolite; ISF 568A-1 for aluminum filings in the threads of the upper site tube blast cover studs; ISF 568A-2 for water in the sight tube pit; ISF 568A-3 for lack of an adequate tool in the tool kit for tightening the nuts on the sight tube blast cover studs; and the general problems of the erratic appearance of fog, and the lack of continuous operation of the vacuum pump in cool weather, apparently due to the viscosity of the crankcase oil. Table 2 presents a comparison of observed performance and specified times.

Table 2. Comparison of Specified and Actual Azimuth Transfer Time

Activity	T.O. Time	Observed Session 568	Observed Session 568C	Observed Session 568D	Observed Session 568F
Azimuth Ref. Check	380	410	656	710	397
(Set-up)	—	216	186	238	205
(Survey)	—	194	470	472	192

The performance time for survey is variable due to the varying density of fog and personnel training. There have been two reports of stopping the survey; once to replace a target marker that blew off of the target monolith, and once to replace exhausted batteries in a target battery box, but these times have not been included in the observed times.

Secondly, the time for set-up can be significantly reduced by correction of the ISF's referenced. In addition, it was observed that the set-up steps were performed out of sequence, which further increases time. Taking the observed minimum times for set-up and survey, the Activity could have been completed in 378 man minutes. This problem is currently undergoing detailed investigation.

It should be noted that these times are check times only and do not include adjustments.

3.1.5 Objective:

"6.1.5—Evaluate the operation of the AFTO form system during Category II and compare this operation with the overall intent of applicable portions of T.O. 00-20E-1."

The discussion for this objective will be presented in two parts. The first part will cover the data presented on the AFTO's and the second part will cover briefly the analysis of the data provided on the AFTO forms.

All available and applicable AFTO data received by AC Spark Plug to date have been reviewed to meet this objective. Although there are deficiencies in the coverage of maintenance data specified in the AFTO's, the major problem appears to be in the usage of the AFTO's and inefficiency of the form. Nine basic deficiencies have been noted and are described below:

1. The description of the discrepancies in Block K of AFTO 211 is, in most cases, inadequate. More often than not, the entry in Block K is a description of the corrective action taken rather than a description of the discrepancy. Examples of entries are provided below.

> "Remove signal conditioner and replace with like item" (Report No. 5075)
> "Remove pulse code modulator and replace with like item" (Report No. 1577)
> "Remove MGC" (Report No. 30)
> "Remove ACSP encoder S/N 4502, weight 20 pounds 8 ounces, P/N 7870903-011" (Report No. 4414)

Most of the applicable AFTO 211's reviewed contained discrepancy descriptions somewhat similar to the examples cited above. These descriptions are redundant to the description in the corrective action block and do not provide any useful information to the analyst. A clear, concise description in Block K is probably the most singularly important entry in the AFTO 211. The lack of compliance with the intent of this block indicates improper training.

2. The labor hours specified in Block 12 of AFTO 211 is oriented toward man hours. Since many activities can be performed concurrently, the specification of activities in man hours will not provide any useful information with regard to determining downtime for the system. In addition, no clear definition is provided as to when to start determining the labor hours or when the system downtime is initiated.

3. The "how malfunctioned" codes are quite ambiguous. A malfunction may be placed in a number of different categories which apparently tends to confuse the technicians. In addition, it is very likely that the codes will require a considerable amount of search of the T.O. 21-SM68B-06-1/2 to find the appropriate category or categories. In some cases filling out this block in the AFTO 211 will necessitate a certain amount of failure analysis which the technician is very likely not equipped to do. On the other hand, this code can be useful if it is oriented towards what the technician will encounter. This should be system or equipment reactions, or lack thereof. In some cases it will be external defects, but in most cases it will be operational reactions such as no voltage, too high gain, too low gain, fluctuating voltages, malfunction indications, etc. Codes oriented toward system or equipment reaction combined with proper description of the discrepancies in Block K should provide some useful information for determining the basic cause of the malfunction. It appears that this basic cause is the information required in data analysis in order to determine trends. It appears unreasonable to expect technicians in the field to do more or less an on-the-spot failure analysis. It appears more reasonable to require the technician to provide a concise but accurate description of the condition before, during, and after maintenance and have failure analysis experts removed from the work situation do the actual coding.

4. There is no code for readiness monitoring in the "when discovered" codes. The lack of readiness monitoring in the "when discovered" codes appears unreasonable in view of the fact that the system is designed to remain in the READY mode for most of its operational period. This information is critical in calculating downtime per failure if either location logs are maintained and/or provisions are made to document the specific downtime data.

5. There are no entries made in the operating time blocks (16 and 19). Operating time is necessary to determine the failure rate. The provision of blocks to provide the information signifies the adequacy of the form for this particular information but there seems to be a problem in implementation.

6. There is no provision for data required to isolate activity problem areas. Activity problem areas may be defined as those problem areas which cause either a delay in performance or an error in performance. Examples of activity problem areas are delayed time due to the lack of MGE or personnel, personnel performance errors (either one of omission or commission), lack of spares, etc. This is a set of information extremely critical in evaluating the maintenance of the system at an integrated level but for which no provisions are being made except for the Category II program.

7. There is no provision for data indicating the MGE used to perform the maintenance. Actually, the data required is not the MGE used so much as whenever a deviation is made from the MGE specified.

8. There is no provision for providing data which can be used to determine the adequacy of specified maintenance, primarily preventative maintenance. The specific data required for this purpose is provided in the AC Spark Plug In Process Review of the personnel subsystem and maintenance, logistics, reliability, and readiness test and evaluation program dated 15 October 1963.

9. A considerable percentage of the AFTO's reviewed contained missed entries. In some cases, these missed entries would significantly affect the identification of the equipment item malfunctioned, and location.

The analytical aspects of the AFTO form system were not evaluated due to the lack of information regarding how the Air Force is processing the data. However, in view of the data provided with the AFTO forms, it is anticipated that a complete evaluation of the maintenance subsystem cannot be made. For one, the data are inadequate for determining the availability of the system due to the maintenance time being oriented toward man hours. In addition, the lack of operating time entries will necessitate calculating failure rate on the basis of estimated operating time obtained from calendar time. Furthermore, the scheduled maintenance aspects of the maintenance subsystem cannot be evaluated completely due to the lack of data for indicating drift and gain within tolerance, recalculating failure rate, and so on. The analysis is somewhat questionable in view of the ambiguity of the "how mal" codes. The lack of provisions for data regarding problems in the maintenance activities would tend to orient the analysis toward only the determination of the status and not toward possible corrective action. For example, an increase of certain types of failures may be caused by a substitute MGE used which would not be detected by using the AFTO forms.

3.1.6 Objective:

"6.1.6—Evaluate the functional flow sequence as performed and determine the validity of the sequence charts. Make recommendations when necessary to improve the sequence as performed."

The functional flow sequences for almost all equipment units have been evaluated on a GO basis in a segmented fashion. The constraints of other on-going programs at Vandenberg Air Force Base prevented any evaluation on a continual flow basis. Evaluations were made for the functional flow sequence for some equipment units in a NO GO condition and tended to be less segmented. The noted lack of a job guide to the technician for a functional flow sequence at the MAMS has resulted in the approval for a MAMS checklist.

Since many of the activities for this receipt-to-launch sequence were performed at the CMA, the flow was basically not controllable by a pre-established sequence. It is anticipated that the MAMS checklist in combination with the launch site checklist should minimize any problems of functional flow sequences.

Some problems regarding the validity of the sequence charts for launch site activities have been noted and corrections made as deemed necessary. Many of these were direct T.O. changes and were not necessarily reported as deficiencies. Although most of the "formal" evaluations were with respect to the receipt-to-launch sequence, the flow for a NO GO condition was evaluated when malfunctions were encountered at the launch site.

3.2 Logistics

3.2.1 Objective:

"6.2.1—Evaluate spares consumption and spares compatibility data to determine the adequacy of logistics requirements established by AFBM 60-50A and provisioning documents."

If this objective is interpreted to mean "for an operational base" on the basis of the data collected from the N-23 receipt-to-launch sequence, the objective was not met since the basic tool for meeting this objective is not as yet ready for use. This tool is the Maintenance Subsystem (MSS) model which has been developed but is presently undergoing program debugging. It should be noted that failure data obtained only from the N-23 receipt-to-launch sequence in all likelihood would not be representative of the operational situation.

If this objective is considered to be specific to the N-23 receipt-to-launch sequence (that is, no inference to an operational situation), it can be stated that the spares available were compatible with the spares required. In addition, it was not necessary to cannibalize Site B or Site C to obtain a spare for Site D.

3.3 Reliability

3.3.1 Objective:

"6.3.1—Collect failure data with identification of system, subsystem, component or part involved, collect total time or operating cycles and record the time/cycle of operation since last failure."

Applicable failure data have been collected with many different forms. A near complete collection has been made with the discrepancy reports. The failure data have also been collected on AFTO 211. In addition, failure data are indicated on ACSP peculiar forms, and evaluation packets whenever the corrective maintenance activity was observed by the O/E.

The only provisions made for operating times/cycle data were the instructions provided for the Special Unit Records (SUR's). However, stringent adherence to the instruction was not followed and therefore the operating time data are somewhat sketchy. Some indication of the operating times can be obtained from the Location Logs which indicated each time the system was turned on. Approximately 308.5 operating hours were accumulated at Site D during the sequence. However, this excludes operating time accumulated on the bench for the drawers. The exclusion of the operating time data on the maintenance records must be considered to be a major lack in the data obtained. Cooperation will be required to correct this problem (see In-Process Review).

Figure 2 (following) presents all of the forms (with the exception of SUR's and location logs) associated with each evaluation packet, at Site D. The table indicates that AFTO 211 coverage has been quite complete. The coverage of MLOR's has also been quite good. Whether the data serve the required purpose is another matter and was discussed previously.

3.3.2 Objective:

"6.3.2—Provide the necessary AFTO failure data and operating time data to existing contractors reliability and in-commission rate study programs which were established under AFBM 60-11A throughout the Category II test program."

Failure data have been provided to the group responsible for reliability estimates. However, the in-commission rate study program, a part of the AFBM 60-11A effort, is being accomplished as an integral part of the ongoing PSTE/MLRR program. The failure data currently in use for determining reliability estimates are primarily the discrepancy reports although eventually the AFTO forms will be used if valid entries are provided in the AFTO forms.

3.3.3 Objective:

"6.3.3—Evaluate the achieved reliability of countdown and flight of the weapon system, its major subsystem, and its major components with the reliability data collected under AFBM 60-11A and AFTO data collected during Category II testing."

It is not possible to draw any inferences from a sample of one since the degree of freedom with a sample of one is zero. In other words, statistically speaking, we can only conclude regarding the specific launch of N-23 and cannot infer from that specific launch to other possible launches. With respect to the N-23 launch, it can be stated that the countdown was successful but flight was not. It should be noted that the Vandenberg flights are not designed to evaluate the CEP capability of the guidance system since the CEP achievement is not an IGS requirement for VAFB flights.

Some extremely gross inferential judgments can be made regarding the reliability of countdown by utilizing data collected during launch verifications. It should be noted that the launch verifications are not necessarily a good simulation of the countdown but probably provide the best estimate of the actual countdown. A gross estimate of the countdown capability can be obtained by comparing the number of failures during launch verification with the number of times the launch verification was performed.

The approximate total operating hours accumulated at Site D from receipt-to-launch is 308.5 hours. During this time approximately 13 launch verifications were performed

FIGURE 2

MAINTENANCE FORMS FROM
SITE 395D

PKT NO.	DATE	FUNCTION	MLOR NO. (AC)	MALFUNCTION	UNIT S/N	NOMENCLATURE	REPL. UNIT S/N	CORRECTIVE ACTION	AFTO	DISCREPANCY REPORT NO. (MIL 1552)	REMARKS
500	6-10-63	IGS Interface Check	500								
501	6-14-63	IMU and MGC installation	—		2025 2316	IMU MGC				66673	
561	6-14-63	Preliminary IGS Alignment	561	Cables not connected properly	1157	MGACG					
563	6-16-63	MGC Installation	—								
502	6-19-63	Preliminary IGS Alignment and Checkout	—						210 901557		
503	6-26-63	Missile Verification	—								
564	6-26-63	Launch Verification	—								
566	6-27-63	End to End Phasing Check	—								
569	7-15-63	C-3546 Adjustment	569		1293	C-3546 Control		Adjust C-3546 Control	210 903140		
581	8-5-63	Combined System Test	581	Missile plug 590-P4 improperly mated. Keyway of J590-4 broken	2025					66632, 66635, 66636, 66673	
579	8-8-63	Inspection	579A 579B						210 903144 210 903145		
			579C 579D		210 209	Fault Locator Computer Control Power Supply	219 213	Replace Fault Locator Replace Computer Control	211 33299J 211 33301J	66639, 66640	
			579E 579F		2319 210	MGC AC Voltage Comparator	2317 209	Replace MGC Replace AC Voltage Comparator	211 38201J 211 33287J		
			579G 579H		118	Logic Module 120	112	Repair Fault Locator Check MGC	211 33299J 211 38201J	66659 66636	Repaired at MAMS Checked at MAMS and Returned to Depot
			579I			Relay K3		Repair Computer Control Power Supply	211 33301J	66638	Repaired at MAMS
580	8-8-63	IGS Turn-on									
583	8-22-63	MFI for MGC and Computer Control Unit NO GO	583 583A	Logic Module 79	226 214	Computer Control Mode Control	265 209	Replace Computer Control Replace Mode Control	211 33334J 211 33333J	66637, 66677, 66658	Logic Module 7[illegible] — S/N [illegible] Replaced with S/N [illegible]
564A	8-23-63	Launch Verification and 24-hour Readiness Monitoring									
568C	8-29-63	Azimuth Transfer									
581A	8-30-63	Replace IMU	581A	(Same as 581)	2025	IMU	2019	Replace IMU	210 903112* 211 6538xx		Also [illegible]
568D	9-3-63	Azimuth Transfer									
585	9-4-63	Replace MGC	585	Damaged by Electromagnetic Test	2317	MGC	2307	Replace MGC	210 909202	66642	
584	9-9-63	Replace MGC	584		2307	MGC	2314	Replace MGC	210 903144 211 38204J	66645	
587A	9-9-63	Replace MGC	587A	Problem with BPS causing possible MGC damage	2314	MGC	2287	Replace MGC	211 6541		
			587B		2287	MGC	2354	Replace MGC	210 903115 211 38205J		
568E	9-11, 12, 16-63	Azimuth Transfer									
505A	9-17-63	Final IGS Alignment									
588	9-17-63	Missile/Launch Verification									
568F	9-20-63	Azimuth Transfer									

* "Flyer" unit installed

Figure 2. Maintenance Forms From Site 395D

and two were failed. The probability of detection according to these figures is 0.85. If the actual launch is included the probability increases to 0.86. It is not known whether the same results would have been obtained if the same system had been used to perform the actual launches 14 times. These estimates are based on the entries in the Location Logs and are not from the AFTO forms. The AFTO forms do not provide sufficient information to allow this type of qualitative evaluation. In any case, the results should be looked at with considerable skepticism due to the conditions under which the data were collected.

It was not possible to make any sort of estimate regarding the reliability of the flight of the guidance system due to the sample of one.

3.3.4 Objective:

"6.3.4—Determine whether special precautions and procedures are required to eliminate critical weaknesses and low reliability."

This objective is currently being met by the AC Spark Plug Reliability Department using existing methods of analyzing failures reported from the field. The discrepancy reports provided from the field are being evaluated. The AFTO forms currently are not in use due to the lack of many relevant data.

3.4 Readiness

3.4.1 Objective:

"6.4.1—Estimate the in-commission rate of the weapon system on the basis of the information collected under AFBM 60-11A and AFTO and contractor forms during Category II and evaluate the inter-related effects of operations, maintenance and reliability on in-commission rate."

The basic tool for meeting this objective (that is, the MSS model) was not in operation by the completion of the N-23 launch. Therefore, it was not possible to estimate the in-commission rate of the operational bases in the manner originally planned, nor to evaluate the inter-related effects of operations, maintenance and reliability on in-commission rate. In addition, the test peculiar condition at Vandenberg during the receipt-to-launch sequence more or less invalidates much of the maintenance data collected at Site D during that period. Special tests of various types were performed and regular tests were curtailed or expanded as the need arose.

A gross estimate of the in-commission rate based on the receipt-to-launch sequence for N-23 has been made. The estimate is based on the assumption that the sequence started on 13 June with the installation of IMU 2025 and MGC 2316. The replacement of MGC 2316 with MGC 2319 on 17 and 18 June is excluded from the estimate. This appears reasonable in view of the fact that this replacement was accomplished to provide an operational MGC to Site C where a launch was imminent. The estimate is also based on the assumption that the absence of a problem is representative of the READY-GREEN condition even though the system was either operated or left in the standby mode or lower, that is, not maintained in READY-GREEN. In addition, malfunctions of or caused by interfacing subsystems were excluded. A slight problem was noted on 26 June but did not regress the system and therefore was not counted. On 28 June the AAS was found to be out of alignment and an azimuth transfer check was performed on 3 July. The time to perform was counted as downtime since the silo is "softened" during the activity. The approximate time for performing the azimuth transfer check was 8 hours. On 15 July a minor problem was noted with the AAS which required a realignment of the autocollimator to the reference prism. The total time for the check and realignment with subsequent checks was approximately 2 hours and 15 minutes. Since this would have resulted in the system not being ready for launch, this time was included in the downtime.

On 22 July a "drift required" was indicated and when the inhibit calibration discrete was removed the system regressed to the standby mode (Note: this resulted in the possibility of the MGC heads being dropped). Since the system regressed out of Ready, the time was included as downtime. On 8 August the MGC, AC Voltage Comparator, CC Power Supply, and Fault Locator were replaced with the MGC. The system was off for approximately 1 hour. A drift required was noted on 15 August and subsequent performance of the test consumed approximately 26 minutes (which is approximately 1/2 hour). During the week of 26 August,* it was discovered that the IMU prism was out of alignment and therefore was adjusted which required an Azimuth Transfer Survey. The total time added to downtime was approximately 8 hours. During this week both the IMU and MGC were replaced but the replacement of the IMU was not counted since the replacement was due to the loss of the IMU heater power earlier. An assumption was made that the replacement of the MGC took approximately 8 hours. This was repeated three times. An Azimuth Transfer Survey was performed but was not counted since it appeared to be primarily a precautionary measure, that is, not necessarily required. The day before launch the system regressed to Align 8 but was immediately advanced to Ready (5 minutes).

The availability of the system has been computed using approximate figures for downtime and available time, and is contained in the classified supplement to this report. (See Appendix A.)

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*The calculation excludes replacement of a mode control and a computer control drawer on 22 August. Relevant information is missing from the Location Log.

Some of this downtime was caused by unqualified movement of the prism during the test activities. However, in most cases there was no evidence of maintenance activities having an impact on the system availability as measured in this report. However, it should be noted that problems with interfacing subsystems can cause the guidance system to either downmode or cause guidance system damage (or suspicion thereof).

3.4.2 Objective:

"6.4.2—Investigate and recommend methods of optimizing weapon system in-commission rate with respect to limitations imposed by hardware, personnel, and procedures."

Since the basic tool to meet objective 6.4.1 has not been completely developed yet, AC Spark Plug was not able to meet this objective for the results of the N-23 flight. However, it should be noted that even with the MSS Model it would not have been possible to utilize the data collected from the N-23 flight to estimate the in-commission rate of the guidance system on the basis of information collected under AFBM 60-11A and AFTO and contractor forms. The conditions at Vandenberg, especially under the launch site conditions, havenot and will not provide data which can be used to infer to the operational situation. The large number of special tests and special sequences of tests plus the fact the the system is not maintained in ready tends to invalidate any attempts at measuring in-commission rate on the basis of data collected at Vandenberg.

It will be possible to evaluate or estimate in-commission rate on a periodic basis but it cannot be based on a restricted set of data collected during the receipt-to-launch sequence. The receipt-to-launch sequence is not representative of the maintenance subsystem or the normal flow of equipment during the operational situation. Attempts to optimize with such limited data could be extremely uneconomical. However, AC Spark Plug will attempt to optimize (using the MSS model) with the best set of available data—whatever the source.

3.5 Weapon System Capability

2.5.1 Objective:

"6.5.1—Develop and maintain a mathematical model to measure the weapon system capability. Weapon system capability as defined by the weapon system evaluation group (DOD) is the probability of a weapon system delivering a warhead as planned excluding effects of enemy action. It is the product of alert readiness reliability × launch reliability × in-flight reliability × warhead reliability."

A maintenance subsystem (MSS) model has been developed to measure the alert readiness capability of the Titan II IGS, as well as to measure other subsystem parameters such as spares consumption, personnel and MGE utilization, maintenance turn-around time, queues, and so on. The model will not provide any direct calculation of "over-all" capability, that is, will not provide measures of launch reliability, or flight reliability but will provide alert reliability data which can be used to calculate "over-all" capability.

In addition, AC Spark Plug has reviewed some input data and associated criteria for the weapon system model under development by the Martin Company and which is designed to measure the alert reliability for all subsystems. Neither model, however, will provide measures of "over-all" capability. The MSS model, for the Titan II IGS is designed to show the relationship between MAMS and Launch Site activities and can allow for personnel errors and the probability of incurring damages during certain maintenance activities. It should be noted that the model is designed not only to measure the status of the system, but also to aid in investigating problems and possible solutions, that is, optimize per objective 6.4.2.

All input data for the MSS model have been compiled for the first simulation exercise and are being used to "debug" the computer program. The data in most cases do not include data collected during the receipt-to-launch sequence for N-23. Some special sessions for bench checkout activities were performed during this time, but were not specifically part of the receipt-to-launch sequence. These data will be used for the second simulation exercise but were not designed to be a part of the first simulation exercise. Performance time and error data collected at the launch sites (including Site D) during this time period were too test specific to merit inclusion in a simulation exercise.

3.5.2 Objective:

"6.5.2—Determine the weapon system capability with the data collected and evaluated in paragraph 6.5.1 above."

The only capability estimation made is the one discussed for objective 6.4.1 concerning the estimated availability based on data collected at Site D, assumptions regarding the various conditions at Site D, and generalizations from one site to many sites. It was not possible to make a true determination due to the lack of completion of the development of the MSS model and the lack of launch site data collected under simulated operational conditions. The special conditions at Vandenberg can in no way be construed to be representative of the operational conditions at the bases.