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AIR FORCE GLOBAL WEATHER CENTRAL SYSTEM ARCHITECTURE STUDY

FINAL SYSTEM/SUBSYSTEM SUMMARY REPORT

VOLUME 6

AEROSPACE GROUND EQUIPMENT PLAN

SYSTEM DEVELOPMENT CORPORATION
2500 Colorado Avenue
Santa Monica, California 90406

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Prepared for:

DEPUTY FOR DEFENSE METEOROLOGICAL SATELLITE PROGRAM OFFICE
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This document has been prepared in partial fulfillment of CDRL line item A004 of System Development Corporation's Air Force Global Weather Central System Architecture Study contract. Efforts for this report were expended under Task 6, "Conceptual Design and Development Plan", performed under contract F04701-75-C-0114 for SAMSO, under the direction of Col. R. J. Fox, YDA.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) ing system from the vantage point of current and future support requirements, addressing the AFGWC data processing system over the 1977 through 1982 time frame. This study was performed under a unique plan which allows complete traceability between user requirements, Air Force Global Weather Central operational functions, requirements levied upon the data system, a proposed component configuration which meets the data system requirements, and a system specification designed to acquire a system which meets these requirements.

The resultant system described has a number of unique features, including total hardware authentication separation of security levels, load leveling accomplished by assigning main processors in accordance with a dynamic priority queue of tasks, and a system-wide network control capability. Other key features include a central data base processor to fill requests for data from other processors, computer operations centers, the use of array processors for accomplishing difficult numerical problems, and sophisticated forecaster console support. These elements have been designed to provide 99.5% reliability in meeting user requirements.

The proposed system architecture consists of five dual processors each of which is about 3.5 times as powerful as an existing AFGWC processor (a Univac 1108). Each dual processor has an array processor which will be capable of very high performance on vector arithmetic. The array processors are used to assist on the difficult numerical problems, including the Advanced Prediction Model for the global atmosphere, as well as very fine grid cloud models and cloud probability models. Some of the new requirements that will be supported with this system are a one minute response to query interface, reentry support for Minuteman, and limited processing of high resolution (0.3 nautical mile) meteorological satellite data. In addition, cloud cover prediction for tactical weapon systems, ionospheric prediction for radio frequency management, and defense radar interference prediction will be supported by this system.

Volumes of this final System/Subsystem Summary Report are as follows:

- Volume 1 - Executive Summary
- Volume 2 - Requirements Compilation and Analysis (Parts 1, 2, and 3)
- Volume 3 - Classified Requirements Topics (Secret)
- Volume 4 - Systems Analysis and Trade Studies
- Volume 5 - System Description
- Volume 6 - Aerospace Ground Equipment Plan
- Volume 7 - Implementation and Development Plans
- Volume 8 - System Specification

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The Introduction of this document addresses the topics suggested by YDD letter of 1 December 1975, covering the subject: Comments on Aerospace Ground Equipment (AGE) Plan, CDRL Item A006, Contract F04701-75-C-0114. The remainder of this plan is then divided into two sections:

1. An Operating Ground Equipment Section that deals with hardware and software needed for normal operations and scheduled (preventive) maintenance, and
2. A Maintenance Ground Equipment Section where equipment and software to be used for unscheduled maintenance are discussed.

The plan will aid both contractor and Air Force personnel as a communication and planning document through which required support and maintenance components can be procured for AFGWC. This document is thus intended to serve as a framework for more detailed information that will evolve as the AFGWC data system architecture is more explicitly defined.

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RELATIONSHIP OF VOLUME STRUCTURE TO DOMAINS

The two basic sections of this document are each designed to conform to domain structures. A functional approach has been used in the Operating Ground Equipment Section (OGES) to appropriately depict the information and control flow, including preventive maintenance that is part of day-to-day operation. The relationships between the functional domain and the OGES structure become particularly apparent in section 3.2.

In contrast, a structure which is analogous to the architectural (or component) domain has been chosen for section 3.2 of the Maintenance Ground Equipment Section (MGES) where the emphasis is more on the unscheduled servicing of specific hardware and software components. By retaining these established domain structures, traceability of user requirements and system component requirements will be further enhanced, permitting ease of tracking of changes to requirements levied on AFGWC.

APPLICABLE DOMAIN VS. PARAGRAPH NUMBERS VS. PAGE NUMBERS

<u>APPLICABLE DOMAIN VS. PARAGRAPH NUMBERS VS. PAGE NUMBERS</u> (Cont'd)

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INTRODUCTION

This Introduction will address the topics requested in YDD letter of 1 December 1975, covering the subject: Comments on Aerospace Ground Equipment (AGE) Plan, CDRL Item A006, Contract FO 4701-75-C-0114. The first subject concerns the advantages/disadvantages of various alternative maintenance approaches for the recommended architecture. (The possibilities include maintenance by a single commercial vendor, multiple commercial vendors, and full maintenance by military personnel.) The second area involves the adequacy of existing AFGWC environmental support resources (e.g., floor space, air conditioning, and "no break" electrical power) to support the architecture. This last topic will be covered in later versions of the AFGWC System Specification (see reference 2.5.3 in the Operating Ground Equipment Section). The consequences of alternative maintenance approaches will be discussed in the remainder of the Introduction.

In order to describe approaches to life-cycle costs, facility requirements, etc., it is necessary to define a scenario for the mixture of vendors at AFGWC. We have chosen an example which we consider the worst case scenario. Its description follows.

The system is procured in such a manner that main processors, support processors, data base elements, and major consoles are procured at different points in time. Main processor systems come from three distinct vendors. Support processors fall into two different classes and come from two different vendors. Data base elements are grouped according to major subsystems of which there are four, and hence a possible four different vendors. Consoles fall into three different categories: programmer consoles, forecaster consoles, and data system operations consoles (such as network control, operations, special operations consoles). Hence, there is a possibility of three different vendors there. Each main processor system, in addition, may consist of a host processor and an array processor which come from different vendors, and the assumption will be made that the array processor does not come from a vendor capable of providing on-site maintenance for the array processors.

Given this scenario, the following ground rules apply in order to calculate life-cycle cost, facility requirements, military manpower requirements, management impact, logistics requirements, operational considerations and security considerations:

Life Cycle Cost

First of all, consoles are not a sufficiently costly item (and they are not sufficient in quantity) that we will find vendors willing to supply on-site maintenance. Furthermore, it is unlikely that a vendor of consoles would be located in Omaha. Hence, it will be necessary to train military personnel to isolate faults to the plug-replaceable unit level and to replace items within the consoles. Accordingly, a spare parts inventory for consoles must be kept.

In this case, each of the three different kinds, programmer, operations and forecaster consoles would have different spare parts inventories. These spare parts must be kept in an environmentally controlled area to maintain their longevity. If array processors are not procured from the same manufacturers as the hosts, it may be necessary that military personnel also be able to replace pluggable units on the array processors after having isolated faults via vendor supplied diagnostics. In this case, again, there will have to be a spare parts inventory kept. The cost of spare parts should be estimated at about 10% of the cost of the unit itself in terms of a spare parts inventory and this should be proportional to the number of units. The amount of time it will take to exhaust the spare parts purchased by this 10% factor will vary with the components. In Table 1 maintenance costs are estimated for various system components over an expected 10 year life cycle. These costs are "average" since they are based on the expected system configuration in 1982, the mid-point of the 10 year period.

TABLE 1

LIFE-CYCLE MAINTENANCE COSTS

I. MAINTENANCE BASED ON PARTS COST

SYSTEM COMPONENT	SPARE PARTS COST (10% OF PURCHASE COST)	YEARS TO EXHAUST SPARE PARTS	TOTAL 10-YEAR LIFE CYCLE COST
Mass Storage Facility Media	$.175K	1	$ 2K
Switches	$24K	10	$24K
Authentication Chips	$38K	5	$76K
Array Processors	$250K	5	$500K
Forecaster Consoles	$300K	2	$1500K
Operations Consoles	$4K	2	$20K

II. VENDOR SUPPLIED MAINTENANCE (PARTS INCLUDED)

SYSTEM COMPONENT	ANNUAL COST	TOTAL 10-YEAR LIFE CYCLE COST
Main Processors	$1.75M	$17500K
Support Processors	$250K	$2500K
Disks	$350K	$3500K
Programmer Consoles	$10K	$100K

III. ANNUAL AFGWC TRAINING - $50K	$500K
TOTAL	≈ $26000K

Facility Requirements

Facility requirements are based upon the need to have spare parts kept in a environmentally controlled area and upon the need to supply on-site maintenance areas for customer engineers. Each separate vendor should be allowed an on-site maintenance area, except in the case of the array processor or the forecaster console. Customer engineers and spare parts for each major subsystem could be contained within a room 20' by 20' on the average. Each major subsystem as follows would require that area. In the worst case, the two different kinds of support processors would require separate rooms and each of the vendors for the host would require a separate room. Each of the distinct data base elements would not have on-site maintenance. There would be a combined single room for spare parts for on-call maintenance at the disk subsystem. This worst case would then require 6 areas of 20' by 20' for a total of 2400 square feet. This would represent about a 30% increase compared to the total area required by Univac now. (The 1800 square feet mentioned in section 3.5 of MGES represents a more realistic expected number.)

Military Manpower Requirements

Military manpower requirements would not change from what we had estimated because operations personnel would be trained in the use of diagnostics and in the replacement of components. There would be short training courses, no longer than one week in any case, for military personnel in order to enable them to replace components that failed. Failed components would be mailed back to the manufacturer for repair, replacement and restocking.

Logistics Requirements

Logistics requirements have already been covered as part of the life cycle cost, facility requirements and manpower requirements.

Operational Considerations

Operational considerations such as scheduling of preventive maintenance are quite straight-forward. In no case can anyone have a component for preventive maintenance unless he has cleared it with the network controller. There will be a schedule of preventive maintenance which is coordinated with the network control console, subject to modification due to unpredictable failure or unpredictable work loads.

Management Impact

Different management schemes are perhaps the most difficult and complex area with regard to the maintenance of such a large data system. There seem to be three basic possibilities: (1) Have the Air Force manage and take responsibility for the overall data system maintenance, from the standpoint that it subcontracts to each individual vendor their responsibility for maintenance of these components. (2) Give a single vendor contractual superiority such that all other hardware vendors are subcontractors to it for maintenance. (3) Have an independent third party which could take over the bulk of the maintenance of the entire data system, in which case there would be no hardware-vendor-supplied maintenance (to speak of) and a third party would come in and handle all maintenance. Each option has its benefits and its drawbacks.

Third party maintenance has the advantage that a single vendor does the actual physical maintenance of all components, and so there are no arguments with regard to interfaces and no problems about assessing blame. On the other hand, it is difficult for a third party maintenance company, in the long run, to maintain equipment as well as individual vendors, even though third party maintenance companies make a practice of hiring employees away from the vendors. The education and background of such employees has limited periods for which it is useful. As the vendors announce new products, and continue to upgrade old products, each of the customer engineers of the third party becomes more and more obsolete. There really is no good way for these third party people to continue to update the education of their people for two reasons. One is that they do not have access to as much information as the vendor has, as soon as the vendor has it, and they do not have access to the design personnel of the vendor. The other is that these third party companies can afford less time for their employees to go to school because they are selling their services at a lower cost, implying lower overhead.

Option number two, which is to have a single major vendor take over contractual obligation of maintaining the data system, has the same advantage as that of the third party maintenance: a single vendor can be held responsible for the maintenance. On the other hand, here this is a much weaker argument because the contractor does not actually perform the maintenance. He simply holds other people under contract to him. It does, however, to a large extent eliminate interfacing finger pointing problems. There are two drawbacks to this approach. First, the vendor that has been given overall data system responsibility charges for that service and so it will cost more (at least in cash flow) to have an individual vendor take charge of the data system. Second, the system is not viable unless you have one vendor whose equipment dominates the system to an extremely large extent and only a few additional extraneous vendors. Thirdly, these extraneous vendors must have product lines that do not conflict with the major dominant vendor. A good example of this would be if you had a main frame manufacturer and had the telephone company supplying modems and gave the main frame manufacturer responsibility over the telephone company modem maintenance. If you have many vendors who are competing in the situation, it is too difficult for them to really maintain good working relationships despite contractual obligations.

Option number one (of having the Air Force take direct responsibility for the overall data system maintenance with contracts to each individual hardware vendor) implies either contractual or informal penalties for non-performance on the part of each individual hardware vendor. Informal penalties can arise from the competitive situations multiple vendors get into in the upgrading of data systems, and so there is an incentive for each member to perform very well in maintenance situations. It is therefore obligatory that the Air Force maintain a fair and impartial attitude at all times towards all vendors under option number one. It is also essential that the Air Force makes certain that everyone feel the blame for a nonfunctioning data system rather than allowing vendors to finger-point and blame each other. A multiple vendor shop in general requires much more rigid practices with regard to vendor/Air Force relationships than the single vendor architecture of AFGWC currently permits.

A fourth option which exists in the commercial world does not appear to exist for AFGWC, and that is to award a facilities management contract to a systems house. Facilities management of the AFGWC system does not seem practical due to the military mission of the system, and due to the security clearance requirement.

Security Considerations

The most important impact of security considerations lies in the remote debugging of main processor systems. Hardware vendors in general appear to be trending towards the use of centralized debugging facilities, linked over high speed telemetry lines to individual processor systems. Large processors come with maintenance support processors capable of exercising the large processor and passing the results to the remote centralized maintenance facility. This approach has several advantages. First, it allows for ready access to expertise that might otherwise be only called in after many hours of delay. Second, the centralized expertise becomes even more efficient due to the wide variety of problems that they encounter. And, third, centralized expertise allows the dissemination of individual solutions among the widest possible customer base in the shortest possible time, i.e., a problem which is solved in one location is put into a central data bank so that any other similar problem that occurs can be checked to see if the solution will work on it. Vendors are trending in this direction because their manpower costs for maintenance have risen to a much larger proportion of their overall costs due to the inflation of salaries and lowering costs of hardware. Currently it is impossible to allow remote debugging of CPU's within the AFGWC system. This would be possible if the data lines themselves were secure at the highest level of classification, and the personnel at the other end in the central facility were also cleared at that level. Both of these seems to be unlikely and enormously expensive. This is a very serious future problem in the AFGWC data system in that the alternatives are expensive and less efficient.

Another security consideration arises in the access of the data base from various processors. The data base is protected against inadvertent access by improper security level main processor systems via the use of authentication chips. Primarily these authentication chips use cryptographic techniques to avoid inadvertent access. Since they are in the data and control path between processors and the disk controllers, it may be necessary to remove them or set them to "clear" before diagnostics can truly prove the existence of a problem in the controller rather than in the channel or the chip. Therefore, it will be necessary to physically isolate data base elements and data base controllers from the rest of the data system. Alternatively, vendors could propose diagnostics such that they could provide the isolation of failures without clearing the chips.

In summary, we have presented a worst case scenario for maintenance of the proposed AFGWC architecture. It has been our intent to establish an upper bound on the resources involved and not to suggest that this will be the most probable solution to the maintenance problem.

SECTION 1.

OPERATING GROUND EQUIPMENT SECTION

1.0 SCOPE

This document serves as a source of support and maintenance information for the AFGWC Data System. The architecture for this data system was selected to satisfy AFGWC processing requirements for the 1977-1982 period. This Operational Ground Equipment Section lists AFGWC Data System functions that will require satisfaction through the use of Operating Ground Equipment.

The functions identified (and the corresponding OGE references) are products of System Development Corporation's AFGWC System Architecture study, and are intended to provide a framework for the evolution to a complete OGE during subsequent development phases. This OGE section applies to the data system as defined in the system specification (reference 2.5.3), and to squadron and depot maintenance. Boundaries which delimit the scope of this document include organizational boundaries between AFGWC and AFGWC user organizations, jurisdictional boundaries between AFGWC and the Air Force Communications Service, functional boundaries which separate internal AFGWC utility support from external AFGWC support utilities, and architectural boundaries which separate Data System components (which are used for system operation and ongoing system maintenance) from support and maintenance equipment. Another important limit on the scope of this document involves the depth of detail which is currently possible with regard to specific information on reliability, maintainability, and associated procedures for individual components. The following subsections are intended to clarify these OGE delimiters.

1.1 Organizational Boundaries

As of August 1975, the organization which operates the end-item AFGWC system is the newly formed Production Division of Global Weather Central. The end-item system herein discussed does not include the present ETAC, Carswell and 2 Weather Squadron, which are part of the new AFGWC structure. AFGWC reports organizationally to Air Weather Service which is a part of the Military Airlift Command. The data system operated by the Production Division of AFWGC will provide environmental support to organizations such as: SAC, MAC, NORAD/ADC, USAFE,

USEUCOM, USREDCOM, FORSCOM, USAREUR, ALCOM, USSOUTHCOM, PACAF AND AFTAC. The boundary organizationally delimiting the AFGW data system is dependent on the services and products provided. For example, AFGWC provides Computer Flight Plans (CFPs) on request to MAC. AFGWC is organizationally responsible for responding to such requests in the prescribed manner once the request has been received. However, the final use and disposition of the data generated by AFGWC user agencies is the responsibility of each such agency, and is outside the scope of AFGWC's area of responsibility.

1.2 Jurisdictional Boundaries

The Air Force Communications Service will be responsible for the communications system external to AFGWC, which is defined to be each line coming into the system. AFGWC will be responsible for the disk interface, the disk, the main processor, the communication console, and their connecting lines, as well as associated line handler/decoder routers.

1.3 Functional Boundaries

This boundary delimits utility support functions which are necessary for the continued operation of AFGWC, but which are functionally outside the province of AFGWC. Commercial power sources (as opposed to the AFGWC power repository) and water supplies are illustrative of utilities which, although necessary for operation, are neither end-item functions nor AGE items required to support and/or maintain the data system.

1.4 Architectural Boundaries

These boundaries separate components of the AFGWC data system which may be used for operational support or for scheduled preventive maintenance from AGE operational and maintenance equipment which is not part of the system architecture.

End-item software includes: compilers, assemblers, translators and debugging tools used in program development and maintenance; software which supports console interaction; operating system software which analyzes hardware and/or software reliability and, in case of errors, provides notification of the problem and reconfigures the system in order to continue operation at a reduced level; and performance measurement software. AGE software modules which are not end-item components include those provided by computer manufacturers which are used by the maintenance engineers for operability and diagnostic maintenance.

Programmer Consoles are specified as components of the AFGWC data system and, even though used to support software maintenance activities, are not AGE. Hardware which is not a part of the end-item inventory which is representive of AGE hardware includes voltmeters and oscilloscopes used to support the preventive maintenance and unscheduled maintenance of Programmer Consoles.

The computer programmer using the Programmer Console to interactively correct program errors is performing an AFGWC data system activity. The computer hardware maintenance engineer performing both scheduled and unscheduled maintenance on the programmer console is performing an operational support or maintenance activity.

End-item equipment which is used to support data system management and operation includes the network control processor subsystem which constantly monitors the health of the on-line network control processor subsystem. Representative AGE used to support data system management and operation includes the operational support dolly used for transporting paper to the printers and a viewgraph machine used as a management communication aid.

1.5 Component Identification Limitations

Since the specific components eventually procured to meet the requirements developed by the architecture study cannot be identified until the hardware vendor(s) selection, this document can at best only describe analogous off-the-shelf components. This has precluded, in many sections of this document, specifications of pertinent mean-time-between failure, mean-time-to-repair, and reliability figures, as well as procedures and personnel resources required. However, as part of this study, an overall reliability budget will be developed, and tentative allocations of reliability requirements will be assigned to classes of components. As specific components are procured, these budgeted allocations may be modified somewhat in accordance with vendor specifications. However, in no case can the reliability of an individual component adversely affect the total system reliability requirement of 0.995.

This plan, then, shall serve as a framework for the reliability specification and maintenance of data system architecture equipment, including preventive and emergency maintenance. This plan is intended to serve as a document to accompany RFPs for the procurement of this system, such that bidders may submit appropriate specifications to meet system requirements.

2.0 SYSTEM CRITERIA

A number of pertinent documents have been employed in developing this AGE plan. In addition, several key assumptions and guidelines have been postulated in generating this plan. These documents and assumptions are listed in the following paragraphs.

2.1 Appropriate Specifications

2.1.1 MIL-STD-499A (USAF), "Engineering Management," 1 May 1974.

2.1.2 MIL-STD-864, "Ground Support Equipment Functional Classification Categories," 3 July 1969.

2.1.3 AFPI 71-685, "AGE Identification/Selection/Acquisition/Provisioning Document for USAF Contracts," through amendment 1 of June 1967.

2.1.4 Data Item Description DI-A-3014/M-110-1, "Aerospace Ground Equipment Plan," 21 May 1971.

2.1.5 MIL-HDBK-DHI-6, "System Safety."

2.1.6 MIL-STD-1472A, "Human Engineering Design Criteria for Military Systems Equipment and Facilities."

2.1.7 MIL-STD-454, "Standard General Requirements for Electronic Equipment."

2.1.8 MIL-R-9673, "Radiation Limits - Microwave and X-Ray Radiation Generated by Ground Electronic Equipment as Related to Personnel Safety."

2.2 Government Furnished Operating Equipment Data

All maintenance equipment is to be furnished and maintained by vendors requiring it.

2.3 Assumptions

A number of key groundrules concerning the scope of this document appear in paragraph 1.0. Additional assumptions and guidelines are shown below.

2.3.1 Operational and maintenance procedures depicted in this plan are based on the configuration resulting from SDC's AFGWC Data System Architecture Study. The selected configuration is shown in references 2.5.1 and 2.5.2. The System Specification for this configuration appears in reference 2.5.3.

2.3.2 Overall AFGWC system reliability shall exceed 0.995.

2.3.3 Satisfaction of meeting WWMCCS time and delivery requirements shall be accomplished with a reliability of 0.950.

2.3.4 Scheduled and unscheduled maintenance shall be accomplished with minimal disruption to operational activities.

2.3.5 The configuration shown in references 2.5.1 - 2.5.3 will be acquired over the 1977-82 time period, with the major acquisition efforts occurring in 1977-79.

2.3.6 While provisions must be made at AFGWC for security checks of personnel and minor personal equipment (e.g., tape recorders and radios), the equipment, personnel, and procedures required to perform such control are not a part of the data system architecture, and associated equipments are thus not considered to be AGE components.

2.4 <u>Associate, Integrating, and Subcontractor Data</u>

2.4.1 "FY76 Authorized ADP Schedule Price List - Contract number GS-006-00605," effective 1 July 1975 through 30 September 1976, Sperry Univac Federal Systems.

2.4.2 "DATAPRO: The EDP Buyer's Guide," DATAPRO Research Corporation; May 1975: "Univac 1100 Series."

2.5 Personnel, Logistics, and Facility Planning Data

2.5.1 AFGWC System Architecture Study - Final Configuration Briefing, System Development Corporation, 13 November 1975.

2.5.2 AFGWC System Architecture Study - System Analysis and Trade Studies, TM-(L)-5613/004/01, System Development Corporation, 1 March 1976.

2.5.3 AFGWC System Architecture Study - System Specification, TM-(L)-5613/008/01, System Development Corporation, 1 March 1976.

2.5.4 AFGWC System Architecture Study - Final System/Subsystem Summary Report, TM-(L)-5613/00(1-8)/01, System Development Corporation, 1 March 1976.

2.5.5 AFGWC System Architecture Study - Executive Summary, TM-(L)-5613/001/01, System Development Corporation, 1 March 1976.

3.0 REQUIREMENTS

3.1 General

3.1.1 End Item Description and Types of Functions (Operational Aspects)

The configuration of the AFGWC hardware is centered around 5 conventional dual processor mainframes having as a multiprocessor a relative performance (RP) rating of 3.5 (A one RP machine is roughly equivalent to the computer power of a Univac 1108*). Connected to each dual processor subsystem is a 50 RP special purpose array processor.

Each processor subsystem is allocated its own mass storage in the form of fixed head-per-track disks. A data base consisting of a variety of other types of mass storage devices will be available to processors, in accordance with security constraints.

Tape handling devices and printers, plus consoles for security control, communications, and operations, will reside within the configuration. There is also a network control capability which monitors the status and controls the operation of all processor subsystems.

Normal or preventive maintenance will be routinely scheduled on individual or multiple components within this configuration so that the system can be kept in peak working order with minimal impact on the AFGWC mission. In other words, hardware will undergo the maintenance when adequate backup is available to meet requirements.

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*Each unit processor of a 3.5 RP dual processor mainframe has a "2 RP" performance rating.

A pictorial description of the overall configuration appears in the foldout diagram accompanying Reference 2.5.5.

3.1.2 Factors Affecting Operating AGE

The AFGWC computer system and its routine maintenance are effected by a number of technical, personnel, operational, and financial criteria. The particular points to be covered here include: a) security impacts on computer configuration and maintenance personnel, b) collection and use of system performance statistics, and c) hardware and software maintenance cost considerations.

The factor having the most profound effect on the AFGWC computer configuration is security. To handle security, the system has been physically separated into three areas or perimeters: normal access, variable access, and special access.

The special access area will contain one 3.5 RP processor subsystem, including an array processor, and will primarily handle computer functions associated with the Special Projects Branch. The normal access area will contain three processor subsystems, and will handle the range of security classifications associated with the remainder of AFGWC. The variable access perimeter will contain the remaining 3.5 RP processor subsystem, and will be able to augment either of the other two perimeters to supply necessary backup. The placement of the 5 processor subsystems within specific perimeters reflects the influence of another factor on the configuration: the relative computer power needed in each area to accomplish the required functions.

The satellite and meteorological data bases will be unclassified and located in the normal access perimeter. Consoles for security, communications and operations will be colocated in the normal and special access areas. Network control will be placed in the special access perimeter for direct access to functional performance and status data of the entire system.

The performance statistics are a necessary part of the normal operating routine for the AFGWC system. The characteristics which should be monitored in performance measurement include:

a. Frequency of retrieval and update from identifiable segments of data bases,

b. Maximum and average backlog of requests for access to data bases and/or data base storage units,

c. Main memory sectional usage statistics, and

d. Idle time of central processors.

Once performance statistics in these areas have been collected, they should be organized to determine:

a. Whether update or retrieval should be the principal factor in determining the organization of data bases;

b. Which data bases should be associated or dissociated with which disk storage units to minimize contention for resources among tasks;

c. Which blocks of data or programs are referenced infrequently while in main memory, and hence are likely candidates for roll-in/roll-out;

d. Where additional redundant paths for data transfer may be beneficial to overall performance; and

e. Which combinations of concurrent tasks can most fully utilize the processor subsystems.

As the AFGWC computer configuration becomes more complex, another problem exists which is associated with security access. Specifically, it involves the many different security level requirements and multiplicity of maintenance contractors required in such a large system. This could result in security and personnel mayhem. The alternative is a single point maintenance contractor which would be far easier to monitor and control.

Also related to the level of hardware mixing and complexity are the potential maintenance problems involved with different executives, especially where one executive has to talk to another. As the system is reconfigured, this problem can be compounded, and the already high cost of software maintenance is increased.

Finally, the cost of maintaining the hardware and software of the AFGWC system cannot be overlooked. The cost of 24 hour contractor maintenance of AFGWC system hardware is expected to average around 17.5% of the monthly hardware rental costs. This would suggest a monthly hardware maintenance fee of over $200,000 (over $2,600,000 per year) in 1975 dollars, for the full data system configuration. In addition, software maintenance of applications programs and special purpose executives that are not vendor supplied can be formidable. While cost figures for maintenance of software are less tangible and more difficult to predict than those for hardware, it is clear that the proposed investment of almost $25 million in software development and conversion will involve considerable maintenance costs for these routines, whether these costs are borne by Air Force or vendor personnel. The configuration management and control activity (for hardware as well as for software) can be a considerable (although necessary) expense.

3.2 Operational Complex Operating Functions

This section describes the information flow and preventive maintenance requirements for operating ground equipment in the proposed AFGWC data system. Included are procedures, personnel requirements, maintenance down times, and required equipments. A summary of pertinent OGE support equipments required for the architectural components appears in Table 2. In Table 3, relationships between data system functions and major architectural domain components are presented, including reference to appropriate OGE sections where aspects of preventive maintenance are discussed.

TABLE 2.

OPERATING AGE/ARCHITECTURAL DOMAIN COMPONENTS

OPERATING GROUND EQUIPMENT	storage dev (DATA STORAGE (A10))	memory (DATA STORAGE (A10))	d b design (DATA STORAGE (A10))	DATA TRANSFER & ROUTING (A20)	processors (COMPUTATION AND SOFTWARE (A30))	software (COMPUTATION AND SOFTWARE (A30))	purchased s w (COMPUTATION AND SOFTWARE (A30))	developed s w (COMPUTATION AND SOFTWARE (A30))	TERMINAL INTERFACE (A40)	CONSOLES (A50)	rap response vis (DATA INPUT/DISPLAY (A60))	documentary vis (DATA INPUT/DISPLAY (A60))	misc stat (DATA INPUT/DISPLAY (A60))	selection (DATA INPUT/DISPLAY (A60))	misc comm (DATA INPUT/DISPLAY (A60))	man inputs (DATA INPUT/DISPLAY (A60))	PERSONNEL (A70)	MANAGEMENT (A80)	FACILITIES (A90)
OSCILLOSCOPE (AA-3.2)	X	X		X	X				X	X	X	X	X	X	X	X			
TEST MODULES (AA-9.5)	X	X		X	X					X									
MAINTENANCE CONT (AA-9.1)		X			X														
DISK EXER MODULE (AA-9.3)	X																		
ION FIRE DETECTOR (KK-1.1)																	X		X
CARBON DIOXIDE EXT (KK-1.1)																	X		X
WATER HOSE CABINETS (KK-1.1)																	X		X

TABLE 3.

DATA SYSTEM FUNCTION/ARCHITECTURE DOMAIN REQUIREMENTS

FUNCTIONAL DOMAIN / ARCHITECTURAL DOMAIN	DATA STORAGE (A10)			DATA TRANSFER & ROUTING (A20)	COMPUTATION AND SOFTWARE (A30)				TERMINAL INTERFACE (A40)	CONSOLES (A50)	DATA INPUT/DISPLAY (A60)						PERSONNEL (A70)	MANAGEMENT (A80)	FACILITIES (A90)
	storage dev	memory	d b design		processors	software	purchased s w	developed s w			rap response vis	documentary vis	misc stat	selection	misc com	man inputs			
3.2.1 INPUT (F1000)																			
3.2.1.1 SESS	*	X		*	X	X			*								X	X	X
3.2.1.2 CONV DATA	X	X		X	X	X			X								X	X	X
3.2.1.3 METSAT	*	X		X	X	X			*	X	X					X	X	X	X
3.2.1.4 PROD REQ	X	X		X	X	X			X								X	X	X
3.2.1.5 DIG RADAR	X	X		X	X	X			X								X	X	X
3.2.1.6 SP PROJ	X	X		X	X	X			X								X	X	X
3.2.2 COMPUTATION (F2000)																			
3.2.2.1 SESS	*	*		X	X	*		X	X								X	X	X
3.2.2.2 REQ PROC	X	X		X	X	X		X									X	X	X
3.2.2.3 ANALYSIS	X	*		X	*	X		X									X	X	X
3.2.2.4 FCST/PROG	X	X		X	X	X		X									X	X	X
3.2.2.5 SP PROJ	X	X		X	X	X		X									X	X	X
3.2.3 OUTPUT (F3000)																			
3.2.3.1 SESS	X	X		X	X	X			X								X	X	X
3.2.3.2 FAX	X	X		X	X	X			*								X	X	X
3.2.3.3 SAT/IMAJERY	X	X		X	X	X			X								X	X	X
3.2.3.4 AWN	X	X		X	X	X			X								X	X	X
3.2.3.5 AUTODIN	X	X		X	X	X			X								X	X	X
3.2.3.6 DED CKTS	X	X		X	X	X			X								X	X	X
3.2.3.7 WWMCCS	X	X		X	X	X			X								X	X	X
3.2.3.8 SP PROJ	X	X		X	X	X			X								X	X	X
3.2.4 SUPPORT (F4000)																			
3.2.4.1 S/W O&M	X	X	X	X	X	*	*	*		*	*					*	X	X	X
3.2.4.2 SP STUDIES	X	X		X	X	X				X	X	*				X	X	X	X
3.2.4.3 D S MGT	X	X	*	*	X	X	X	X		X	X	X	*	*	*	X	X	X	X
3.2.4.4 R T OPS	X	X	X	X	X	X				X	X	X				X	X	X	X
3.2.4.5 CONT OF OPS	X	X		X	X	X											X	X	X
3.2.4.6 D B C&M	X	X	X	X	X	X	X	X		X	X						X	X	X

"X" DENOTES THAT THE INDICATED FUNCTION USES THE ASSOCIATED ARCHITECTURE COMPONENTS

"*" DENOTES THE FUNCTION/PARAGRAPH OF THE OGES WHERE THE USE AND PREVENTIVE MAINTENANCE OF THIS COMPONENT IS PRESENTED

3.2.1 Input Processing (F1000)

3.2.1.1 SESS (F1100)

Space environmental support system data enters AFGWC from three primary sources:

a. Astrogeophysical Teletype Network (ATN) messages which are routed from ATN stations to Carswell for input to AFGWC on the AWN line,

b. NOAA messages over a dedicated circuit, and

c. DSP messages over a dedicated circuit.

There is also an alternate route from Carswell directly to a SESS teletype at AFGWC, bypassing all computational components for immediate dissemination of significant solar phenomena. This line, however, is the responsibility of the Air Force Communications Service and is not within the scope of this AGE plan.

All SESS input data are unclassified, and are routed through the unclassified line handler/decoder router (LHDR), which decodes these messages and routes them to a data base disk for temporary storage of the raw data. These data are subsequently accessed by appropriate routines in a 3.5 RP processor, which accesses the raw data from disk, performs initial analysis and validation operations on this information, and stores the validated data back into the data base on other disks. These validated data remain in the data base for eventual access by SESS computation functions.

In addition to automatically routing decoded messages to the 3.5 RP machine, the LHDR routes garbled messages to a minicomputer working in conjunction with the communications console. Garbled messages are manually analyzed, temporarily stored in a disk buffer area as necessary, and valid manually decoded messages are routed to a 3.5 RP machine as soon as possible.

Preventive maintenance on the disk unit controllers consists of exercising software diagnostics and inspection of disk heads. This will be performed over a period of _____ hours every 30 days. Personnel specialties required are _____. Necessary maintenance equipment includes:

a. Oscilloscope (AA-3.2)*
b. Test modules (printed circuit cards) that are installed on a controller for test purposes (AA-9.5)
c. Disk exercising module (AA-9.1)

The major component for communications interface is the line handler/decoder router. Preventive maintenance on this hardware consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

In addition, preventive maintenance for other data routing hardware components will be performed in conjunction with processor maintenance, as discussed in section 3.2.2.1.

3.2.1.2 CONVENTIONAL DATA (F1200)

Conventional data inputs consist of surface data, upper air data, and severe weather advisories/warnings. All such data are currently

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* Functional classification category, as listed in reference 2.1.2.

received on the AWN line from Carswell. In 1977 and 1978, new inputs will include surface data from unattended Automated Weather Stations, upper air data from the Advanced Weather Reconnaisance System, and severe weather advisories from Air Route Traffic Control Centers. However, it is expected that these additional inputs will have a small effect on AFGWC, and will also be input via AWN.

Conventional data will all be unclassified, and will be handled via the unclassified LHDR. These data will therefore use the same components and associated preventive maintenance procedures as SESS data described in section 3.2.1.1.

3.2.1.3 METSAT/IMAGERY DATA (F1300)

These inputs currently enter AFGWC at the Site 3 ground station, and now consist of primary and special sensor data from the DMSP satellites. Primary and secondary data from the GOES satellite is expected in 1976 (through its own AFGWC ground station), and similar data is expected from TIROS-N in 1978 (also through a dedicated ground station).

All primary sensor inputs will be stored on tapes concurrent with entry to the satellite data support processor. This data formatter computer will then route the raw data to dedicated batteries of random access disks for storage of DMSP smoothed data, DMSP fine data, TIROS-N smoothed data, and GOES data. Gridding and mapping of these data will subsequently be effected by this same processor, by extracting the raw data and distributing 1/4 orbit tasks to four available 3.5 RP processing units. (These large core machines will enable more I/O overlap associated with each 1/4 orbit task.) Gridded and mapped data will then be routed from these processing units to the data base manager (a 3.5 RP machine), which will store the processed data onto dedicated random access disks.

Special sensor data are separated from primary data in the satellite input support computer, and stored in raw data files on disk. However, unlike primary sensor data, special data are not rerouted to the satellite data support computer, but are retained in the satellite raw data base for eventual processing by special data processing routines (no "validation" of these data is done by 3.5 RP processors, as it is for conventional data. All preprocessing is done in the satellite data support processor).

The 3.5 RP processors are discussed in section 3.2.2.1, while disk components were covered in section 3.2.1.1. Preventive maintenance for the tape units and controllers consists of running of software diagnostics and inspection of the tape heads on a monthly basis and cleaning at every personnel shift change. Personnel specialties required are _____. Necessary maintenance equipment includes:

a. Oscilloscope (AA-3.2)
b. Test modules (printed circuit cards) that are installed on a controller for test purposes (AA-9.5)

Preventive maintenance on the satellite data support processor consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

3.2.1.4 PRODUCT REQUESTS (F1400)

Product request inputs involve a wide variety of classified and unclassified inputs, encompassing CFP requests, command and control system requests, and numerous types of miscellaneous inputs. Unclassified requests over AWN and dedicated circuits will be decoded, routed, validated, and temporarily stored the same as SESS and conventional data described earlier, and will use the same kinds of equipment. The current AUTODIN line (which can carry messages up to the Top Secret level) will eventually be phased out in favor of AUTODIN II, which will have a Top Secret capability, and which will enter AFGWC through a special LHDR: the Datanet 355. Other Secret and Confidential inputs will be routed through LHDRs of the appropriate classification level, and subsequent validation and storage will be processed in a manner similar to unclassified data, except that all classified inputs will be written into the data base in a classified overlay.

All classified LHDRs will also have the responsibility of analyzing security classifications of incoming messages and, whenever a message of a lower classification level than that of the line or LHDR is encountered, it is sent to the LHDR of the appropriate classification.

Preventive maintenance procedures, personnel requirements, and equipment requirements for components associated with product requests are discussed elsewhere in this plan.

3.2.1.5 DIGITAL RADAR (F1500)

Digital radar inputs (planned for 1980 implementation) will enter AFGWC on an unclassified high speed dedicated line. It is assumed that 105 current TAF locations will be the sites for AWS digital radars. For effective collection and preprocessing, it is assumed that about 4 "preprocessing" sites will accept data from about 25 radars each (plus several radars from NWS), performing extensive compression of site inputs to eliminate the transmission of useless data to AFGWC. These preprocessing sites could communicate with the AFGWC by uplinking to a communications satellite, with a single downlink from this vehicle to AFGWC.

Data rates are expected to be about 2 X 10^5 bits/second to AFGWC for 4 seconds (one second from each of the four regional sites), with this rate occurring as often as every 15 minutes under severe weather conditions. These data should be sent in virtual real time for maximum utility; therefore, no more than one second should be allowed for the data from each processor site. This infers a 200 kilobit uplink capability to the communications satellite from each preprocessing station and a 200 kilobit downlink to AFGWC.

These unclassified data will be accommodated by the unclassified LHDR and by other components handling unclassified inputs. Discussions for these components appear in other sections of this plan.

3.2.1.6 SPECIAL PROJECTS (F1600)

Input communications processing in the special access perimeter will follow the same basic type of data handling scheme indicated in sections 3.2.1.1 (SESS), 3.2.1.2 (Conventional Data), and 3.2.1.4 (Product Requests), and will employ line handler/decoder router equipment and other components in the special access perimeter. The use and preventive maintenance of associated components will be analogous to those depicted in section 3.2.1.1.

3.2.2 Data Base and Related Computations (F2000)

3.2.2.1 SESS (F2100)

SESS functions run the gamut of security classifications, but will usually be handled within the normal access perimeter. Input processing will trigger computational models for both analysis and forecasting algorithms. These will execute on the 3.5 RP processors and will retrieve from and store into the data base and classified overlay areas. Most jobs will be run at scheduled times and activated by Network Control, but some are event dependent and impossible to schedule in advance, and therefore will be initiated as batch runs.

Some of the routine maintenance aspects of the hardware components used to support SESS activities have been covered by other discussions. The disk storage which makes up much of the central data base has been discussed in 3.2.1.1.

Preventive maintenance on the 3.5 RP processors consists of executing confidence tests (using software diagnostics) and checking lamps and filters. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes:

a. Oscilloscope (AA-3.2)
b. Maintenance controller (AA-9.1)
c. Test modules (AA-9.5)

The 3.5 RP processors will be configured with maximum primary and extended memory. This memory can be maintained with the 3.5 RP processors and will require no special procedures or additional equipment.

Part of the data base storage will consist of an automated mass storage facility. Preventive maintenance on this hardware consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

3.2.2.2 REQUEST PROCESSING (F2200)

Typically, the request processing function will involve computer flight plans or related trajectories. The classification of such requests could run anywhere from Unclassified to Top Secret and might be handled in either the normal or special access perimeters. After having passed through the LHDR processor, the request will be routed to a 3.5 RP processor where necessary computations will be performed. The central data base will be accessed for new and climatological data as well as archived records and libraries, and the result will be routed back to the LHDR processor. Although most requests are more apt to be made at certain hours of the day, they are essentially random and require short reaction times.

The routine maintenance aspects of the hardware components used to support Request Processing have been covered by other discussions. The 3.5 RP processor and the central data base have been described in section 3.2.2.1.

3.2.2.3 ANALYSIS (F2300)

The bulk of the computer power at AFGWC can be considered to be dedicated to functions classified as general analysis and forecasting. Almost all these routines can be scheduled far in advance and therefore will be scheduled and handled by Network Control. The large and more complicated of these functions are candidates for use on the 50 RP array processors which will be associated with the 3.5 RP processors. The models involved in analysis (as well as forecasting) will retrieve from and store into the data base and, when security dictates, make use of the classified overlays to the data base.

The routine maintenance aspects of the hardware components used to support the analysis (and forecasting) functions have been partially covered in other discussions. The 3.5 RP processor and the data base and classified overlays have been described in section 3.2.2.1.

Preventive maintenance on the 50 RP array processor consists of confidence tests (using software diagnostics). This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes:

a. Oscilloscope (AA-3.2)
b. Maintenance Controller (AA-9.1)
c. Test modules (AA-9.5)

The 3.5 RP processors will be configured with maximum primary and extended memory. Part of this memory will be needed to operate the 50 RP array processors. There will be no special or routine maintenance procedures or OGE designed for this memory (see 3.2.2.1).

3.2.2.4 FORECAST/PROGNOSIS (F2400)

See section 3.2.2.3

3.2.2.5 SPECIAL PROJECTS (F2500)

Jobs associated with the Special Projects Branch run at a special access security level. These functions will be handled by the 3.5 RP processor located in the special access perimeter. Jobs will be equally divided between those that are scheduled and those that are more or less random. Most have a high priority and require a fast reaction or minimal deviation from scheduled completion time.

The routine maintenance aspects of the hardware components used to support Special Projects functions have been covered by other discussions. The 3.5 RP processor and the data base and classified overlays have been described in section 3.2.2.1.

3.2.3 Output Processing (F3000)

3.2.3.1 SESS (F3100)

Space environmental support output products consist of a wide variety of unclassified event warning messages and analysis summaries which are transmitted over dedicated lines to NORAD, MAC, SAC, and other customers. Messages are also transmitted to ATN operating locations through the Carswell link. Data messages can be automatically generated, or they can be assembled by a combination of computer-driven techniques and manual procedures.

SESS output processing will consist of the accessing of SESS messages which have previously been assembled by appropriate conventional routines and stored in the data base. Extraction will be via a 3.5 RP processor, which will pull formatted information from the data base in accordance with runstream, operator, or forecaster commands and pass this information to the unclassified LHDR for transmission over appropriate circuits.

Transmissions will generally be initiated by an operator at a SESS forecasting console (Automated Work Center). His equipment will include alphanumeric, color, and high resolution CRTs, alphanumeric and functional keyboards, and other console devices tailored to this application. Preventive maintenance on this hardware consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes:

Oscilloscope (AA-3.2)

These forecaster consoles communicate with the 3.5 RP processors and other key elements of the data system through special forecaster support processors. Preventive maintenance on this hardware consists of _____ . This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

Maintenance of other key components are detailed elsewhere in this plan.

3.2.3.2 FACSIMILE PRODUCTS (F3200)

AFGWC will transmit a wide variety of digital and analog facsimile products over STRATFAX, PACFAX, and RAFAX circuits, and will also send digital charts over the Weather Graphics System to European subscribers. In addition, AFGWC will continue to provide backup support to the NWS on NAFAX and NAMFAX networks with analog facsimile products until AFOS becomes operational, when the National Distribution Circuit will be used to support NWS.

To accommodate total automation from a centralized CONUS weather facsimile facility, AFGWC will use minicomputers (similar to the Interdata Model 50) of the same type that NWS is employing at the National Meteorological Center (NMC). The ID Model 50 will be hereafter referred to as the WFSC. The WFSC will replace the manual facility at Offutt AFB, Nebraska, and Suitland, Maryland. The WFSC will receive digitized weather facsimile maps from both the Suitland NMC and AFGWC. The maps/charts will be relayed to users on a predetermined schedule. The WFSC will be a store and forward system whose products will be received in digital form via the 3.5 RP processors from the data base and converted to an analog signal compatible with customer facsimile recorders. A Keyboard Video Display Terminal (KVDT) will be used for monitoring system performance. It will allow operators to control and alter facsimile schedules. A teletype device will be used to provide a permanent record of data transmitted and received by the WFSC. An intermediate storage device (disk) can be used for map storage. The WFSC will also receive manually drawn charts. These charts will be digitized and stored on the intermediate storage device. A schedule of transmission requirements can also be kept on the disk, and schedules can be executed automatically under program control.

Preventive maintenance on the WFSC components consists of ____. This will be performed over a period of ____ hours every ____ days. Personnel specialties required are ____. Necessary maintenance equipment includes ____.

3.2.3.3 SATELLITE/IMAGERY-RELATED PRODUCTS (F3300)

The Satellite Imagery Dissemination (SID) system will provide satellite imagery data dissemination from various weather satellites. This system will provide imagery from the Defense Meteorological Satellite Program (DMSP), from the NASA-NOAA/NESS GOES satellites, from other NOAA/NESS satellites, and from foreign satellite systems as they become available. These data will be sent to AWS CONUS and overseas units in near real time.

Gridded and mapped data will be extracted from disks in accordance with inputs from an operator console associated with the SID support processor. These inputs will trigger the 3.5 RP data base processor into accessing the requested data from disk, performing initial formatting, and routing the data to the SID processor. This processor will perform final formatting and message assembly, and forward the data to users, either through vehicle-dedicated ground stations or on separate dedicated lines directly from the processor.

Raw satellite data can also be sent directly, employing SID console commands. In this case, data are retrieved in real time from data formatter outputs at the vehicle ground station and routed through the

SID processor for dissemination to users. In this manner, time is saved and the use of the 3.5 RP data base processor is eliminated, but the data are not corrected, mapped or gridded, and appear in relatively crude form.

Preventive maintenance aspects of most of the equipment associated with the dissemination of satellite data are discussed elsewhere. Preventive maintenance on the SID support processor consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

3.2.3.4 AWN PRODUCTS (F3400)

A wide range of manually prepared and automated teletype messages will be sent to AWN subscribers over the Carswell line. All data are unclassified, and are routed in real time to the unclassified LHDR or are stored in the data base for later extraction and routing.

Preventive maintenance procedures for associated equipments have been discussed elsewhere. In particular, the LHDR maintenance is covered in section 3.2.1.1.

3.2.3.5 AUTODIN PRODUCTS (F3500)

Several types of manual, automatic, and computer assisted message products will be generated for transmission to AUTODIN subscribers. (A key message type that will be sent much more frequently in the future is that of Computer Flight Plans.) AUTODIN can now carry messages up to a classification level of Top Secret, and messages will be extracted from the data base by the data base processor and routed to the AUTODIN LHDR for final formatting and transmission on AUTODIN. These procedures will be followed until the Top Secret

AUTODIN II system is available (about 1978), when Autodin output traffic will be sent to the AUTODIN II LHDR (a Datanet 355) for final formatting and dissemination on this new high speed line.

Preventive maintenance on the Datanet 355 LHDR consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

3.2.3.6 DEDICATED CIRCUITS (F3600)

AFGWC will continue to serve numerous user agencies on several dedicated KSR, ASR, and high speed lines. In addition, the operational branches of AFGWC itself will receive data from the data system via a number of internal dedicated circuits. These outputs will be initiated directly by data system computers or by a combination of automatic and manual means.

Classification levels of these circuits range from Unclassified to Secret. The techniques of accessing, routing, and transmitting messages over dedicated circuits are basically the same as those discussed for SESS in section 3.2.3.1, except that the 3.5 RP processor will, for dedicated circuit outputs, determine the appropriate LHDR to accept these messages, based on the security classification of these data, and route these messages accordingly.

Preventive maintenance for all associated components have been described elsewhere, with LHDR maintenance covered in section 3.2.1.1.

3.2.3.7 WWMCCS (F3700)

In 1978 the WWMCCS Intercomputer Network (WIN) will be operational. The current 2-channel AUTODIN will be replaced by a 4-channel circuit supporting both WWMCCS and the current AUTODIN. AUTODIN will then gradually be phased out, and WWMCCS will be served by what will then be AUTODIN II.

The WIN will be capable of carrying messages through a classification of Top Secret. Output messages for the WIN will thus be sent to the LHDR that will accommodate AUTODIN II (the Datanet 355) for outside dissemination. Preventive maintenance discussions for associated components have been provided in other sections.

3.2.3.8 SPECIAL PROJECTS (F3800)

Output communications processing in the special access perimeter will follow the same basic type of data handling scheme indicated in section 3.2.3.1 for SESS, and will employ line handler/decoder router equipment and other components in the special access perimeter. The use and preventive maintenance of associated components will be analogous to those depicted in section 3.2.3.1.

3.2.4 Support Processing (F4000)

3.2.4.1 SOFTWARE DEVELOPMENT AND MAINTENANCE (F4100)

Software development and maintenance includes those activities necessary to design, write, test, document, and upkeep all input, computational, output, and support processing functions at AFGWC. Most of the tasks involved will be unclassified, low priority, and run in batch mode. They may be associated with either the normal or special access perimeters and might require processing on either the 3.5 RP or 50 RP processors. Frequently, programmer interface consoles will be used to assist in the area of software development and maintenance.

Some of the routine maintenance aspects of the hardware components used for software development and maintenance have been covered in other discussions. The 3.5 and 50 RP processors were described in sections 3.2.2.1 and 3.2.2.3 respectively.

Preventive maintenance of the programmer console and associated support computers, automated work center equipment, printers, and card handling equipment consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes:

Oscilloscope (AA-3.2)

3.2.4.2 SPECIAL STUDIES AND ANALYSIS (F4200)

Special studies and analysis functions are confined to the development of new meteorological analysis and forecasting methods and (to a lesser extent) the investigation of new software techniques which will enhance AFGWC computer operations. In this development stage, all such operations are unclassified and will run in the normal access perimeter. These functions are low priority and will run on either the 3.5 or 50 RP processor, accessing the central data base. Most will run in a batch mode but some will be scheduled to run routinely as tests and will be time critical. Programmer consoles will be used to assist in special studies and analysis.

The routine maintenance aspects of most hardware components used for special studies and analysis have been covered in other discussions. The 3.5 and 50 RP processors were described in sections 3.2.2.1 and 3.2.2.3 respectively.

Preventive maintenance of the programmer consoles and their associated minicomputers and automated work center equipment consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

3.2.4.3 DATA SYSTEM MANAGEMENT (F4300)

Data system management includes the two major functions of network control and quality control. Quality control consists of the policing of AFGWC products to maintain a high level of excellence. It should be present in all functions, primarily in the support area, and in that respect is really tied to all access perimeters, security classifications, and hardware components. As explained in sections 3.1.1 and 3.1.2, the network control capability physically exists within the special access perimeter but monitors the status and controls the operation of all processors in all perimeters. The primary tool used for network control is one 3.5 RP processor.

Routine maintenance aspects of the 3.5 RP processor have been discussed in section 3.2.2.1.

Preventive maintenance on network switches consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

Preventive maintenance of the network control console and its associated automated work center hardware consists of _____. This will be performed over a period of _____ hours every _____ days. Personnel specialties required are _____. Necessary maintenance equipment includes _____.

3.2.4.4 REAL TIME COMPUTER OPERATIONS (F4400)

The computer operations included under this heading include unscheduled production, tape handling, console operations, error processing, output data processing, preventive maintenance, processing of interrupts, and error reporting. None of these tasks represent complete functions by themselves. They are steps in more complicated procedures and as such have been covered either implicitly or explicitly by other discussions.

3.2.4.5 CONTINUITY OF OPERATIONS (F4500)

Certain functions which normally are handled by organizations outside of AFGWC must nevertheless be backed up by AFGWC in case of system failure. The operations involved include those normally performed by Carswell, ETAC, and NWS/NMC. This category also includes the transmission of satellite data to FNWC. To a large extent, these entail a minimum amount of computational processing (on the 3.5 RP machines) and a maximum of input and output processing, particularly as it involves communication. ETAC backup is furthermore involved in the archiving of meteorological data, placing a burden on AFGWC's tape drives and library. (It is assumed that the Mass Storage Facility, MGES 3.2.1.1.7, would be of no use for ETAC backup because of the resulting incompatibility between the highly unique nature of AFGWC's recorded data and ETAC's reading devices.)

No special hardware components will be required for continuity of operation. The routine maintenance aspects of other hardware components used to support continuity of operations and other functions have been covered by other discussions. Specifically, the 3.5 RP processor and the data base have been described in section 3.2.2.1.

3.2.4.6 DATA BASE CONSTRUCTION AND MAINTENANCE (F4600)

The manager of the data base will be a central automated monitor who will oversee the attempts to access the data base. This task will be the responsibility of one 3.5 RP processor, but because of the importance of data management to the health of the entire system, an alternate processor will be available at all times to take over the job. Data base management will be an unclassified operation and will occur in the normal access perimeter, although some minor data management (especially as applies to the classified overlays) will be left to all individual processors where the data are used.

The routine maintenance aspects of hardware components used to support data base construction and maintenance have been covered by other discussions. The 3.5 RP processor and the data base have been discussed in section 3.2.2.1.

3.3 Squadron Area Operating Functions

Squadron area operating functions include repair and maintenance of equipment which cannot be handled in machine room areas, due to lack of space or proper equipment. More specifically, the procedures might include temporary replacement of a defective component and its removal to the squadron area where it can be properly calibrated or adjusted.

An area adjoining or reasonably close to the operating equipment is used so that removal of components from the site is not necessary. Conditions in this area must be controlled so that they can support the equipment being tested and repaired in the same manner as its normal environment (e.g., temperature and humidity control to verify behavior of electronic components over extended periods). The area should be unclassified if possible to allow easy access by specialized contractor personnel who do not possess proper security clearances.

For AFGWC, _____ square feet should be provided for these purposes, and should include easy access to power and other required utilities.

3.4 Depot Area Operating Function

Depot area operating functions include equipment repairs which cannot be handled within AFGWC facilities, wherein defective equipment is removed from the site and taken to an area supported by the contractor and/or the Government, but apart from a contractor's factory. Corrective measures taken at the depot area might involve complicated techniques or equipment which are unavailable at the site, either in the machine rooms or squadron area. Such depot facilities must be accessible enough, however, such that the overall reliability requirement can be met with the number of spares and replaceable units acquired.

3.5 Facility Requirements

Facility considerations for OGES will include upkeep on the non-interruptable power reservoir, maintenance of the proper environmental conditions, and identification of the physical areas needed to contain equipment and material involved in routine and preventive maintenance.

The AFGWC computer complex receives its power directly from a configuration of batteries connected to commercial and backup power sources. This setup is designed to handle fluctuations in power which might incapacitate the computers. It requires routine checking (once every _____ days) to ensure it is in proper working order.

The two main factors establishing the environment for machines and material are temperature and humidity. The material mentioned primarily includes computer punched cards, paper for alpha-numeric terminals and high speed printers, magnetic tape, and photographic film. Both hardware and this supporting material can be housed effectively in an environment maintained between temperature and humidity ranges of 67°F and 73°F, and 30% and 60% respectively.

The facility area established to contain equipment and material is affected by security as well as the physical size of the objects to be stored. For example, magnetic tapes associated with the special access perimeter cannot be co-located with those from the normal access perimeter. Separate rooms of sizes 180 square feet and 750 square feet are needed respectively. The impact of security on facility space needed for storage of maintenance hardware, paper, film, and cards is assumed to be negligible as long as the items are stored in areas unclassified or associated with the normal access perimeter. Storing the hardware, paper, film, and cards will require _____, _____, _____, and _____ square feet respectively.

Finally, floor space will be required for hardware used in routine or preventive maintenance. Past experience at the AFGWC site indicates that approximately 1,800 square feet will provide adequate working area and equipment storage space for this new data system.

3.6 Personnel and Life Support Requirements

AFGWC Data System functions and components defined in references 2.5.1 - 2.5.5 will impact the requirements for personnel and life support OGE at AFGWC. Although current responsibility for the installation and maintenance of AFGWC personnel and life support safety equipment resides with the AFGWC safety officer, needs for state-of-the-art personnel and life support equipment will be identified in the following sections. Early identification of these personnel and life support requirements should help assure that proper lead times are provided for in the procurement (or development) of such equipment.

3.6.1 Safety

Systems safety engineering principles shall be in accordance with the general requirements of MIL-HDBK-DHI-6, MIL-STD-1472A, and MIL-STD-454. These principles and standards are to be applied throughout the design/development, manufacture, test, installation, checkout, and operation of the AFGWC equipment.

Safety equipment required for support of AFGWC Data System operation includes _____.

3.6.2 Fire Fighting

Fire fighting equipment required for support of AFGWC Data System operation includes automatic equipment, such as an overhead sprinkler system (triggered by _____°C heat extremes) and manually operated equipment, such as wall mounted Carbon Dioxide fire extinguishers.

Specific fire fighting equipment includes:

a. Ionization type fire detectors (KK-1.1)
b. Portable carbon dioxide extinguishers (KK-1.1)
c. Water hose cabinets (or equivalent) (KK-1.1)

3.6.3 Radiation Hazards, Nuclear, Electromagnetic

Radiation hazard limits are in accordance with the requirement of MIL-R-9673. OGE required for AFGWC Data System life support protection against radiation hazards and nuclear or electromagnetic effects include _____.

3.6.4 Acoustic Levels

All technical equipment supplied to AFGWC shall be designed so that facility and equipment noise is controlled per MIL-STD-1472A. The noise level in console and work areas should not be more than 15 db above audible threshold. OGE required for noise control includes:_____.

3.6.5 Escape and Recovery

OGE required at AFGWC for the purpose of escape and recovery includes: _____. Such provisions should be available on a 24 hour/day - 7 day week basis, and are particularly appropriate for fire, radiation, and toxicological hazards, as discussed in sections 3.6.2, 3.6.3, and 3.6.8 respectively.

3.6.6 Decontamination

OGE required at AFGWC for the purpose of decontamination includes:_____.

3.6.7 Sustenance and Waste Removal

OGE required at AFGWC for the purposes of sustenance and waste removal includes: _____.

3.6.8 Toxicological Hazards

Toxicological hazards that may be present at AFGWC includes the airborne residue which can result from burning computer tapes in the event of a fire in the machine room or tape storage area.

OGE required at AFGWC for protection against tape toxicological hazards includes an appropriate automatic sensing and warning system that can detect toxicological particles in the density of _____ ppm in the ambient air, and that can sound a distinctive audible alarm that will be _____ db above average ambient noise level. Automatic safeguards must also be present to remove such hazards from the air, such that the toxicological level is reduced to _____ ppm within _____ seconds/minutes after initial sensing.

3.6.9 Temperature and Humidity Control

The relative humidity should be not less than 30 percent nor more than 60 percent. The effective temperature should range between 67°F and 69°F when heating or humidification is required, and between 69°F and 73°F when cooling or dehumidification is required. At least 15 cubic feet of fresh air per minute per person should be provided from an outside source.

SECTION 2.

MAINTENANCE GROUND EQUIPMENT SECTION

1.0 SCOPE

This document serves as a source of support and maintenance information for the AFGWC Data System. The architecture for this data system was selected to satisfy AFGWC processing requirements for the 1977-1982 period. This Maintenance Ground Equipment Section lists AFGWC Data System functions that will require satisfaction through the use of Maintenance Ground Equipment.

The Data System functions identified (and the corresponding MGE references) are a product of System Development Corporation's AFGWC System Architecture Study, and are intended to provide a framework for the evolution to a complete MGE during subsequent development phases. The MGE section places major emphasis on maintenance as it applies to the AFGWC operational complex, and also discusses squadron area maintenance (maintenance on the AFGWC premises but separate from the computer room) and depot maintenance (maintenance performed at a location other than the AFGWC-squadron site or the factory site). This section applies to the data system as defined in the system specification (ref. 2.5.3) and the OGE used to support the data system. Boundaries which delimit the scope of this document include: organizational boundaries between AFGWC and AFGWC user organizations, jurisdictional boundaries between AFGWC and the Air Force Communications Service, functional boundaries which separate AFGWC from AFGWC support utilities, and architectural boundaries which separate Data System components (which are used for system operation and ongoing system maintenance) from support and maintenance equipment. Discussions of these constraints appear in paragraph 1.0 of the OGES.

2.0 SYSTEM CRITERIA

The specifications, assumptions, and related documents listed in section 2.0 of the OGES also apply to aspects of the data system involving unscheduled maintenance. Additional publications and assumptions dealing specifically with the maintenance and repair of equipment and software after malfunctions are presented in the following paragraphs.

2.1 Appropriate Specifications

See 2.1, OGES.

2.2 Government Furnished Maintenance Equipment

See 2.2, OGES.

2.3 Assumptions

2.3.1 Appropriate Air Force and contractor personnel and required equipment will be available on a 24 hour/day - 7 day week basis to perform corrective maintenance, such that the overall data system reliability requirement of 0.995 will be maintained.

2.3.2 On site spares levels will be sufficient to support the data system reliability requirement, and to permit _____ hours/days of "button up" operation (i.e., continuous autonomous site operation without leaving the premises for resupply of spares or consumables).

2.3.3 Online and offline computer programs exist or will be developed to perform fault detection and isolation of failed components. These programs will have sufficient speed and accuracy to support the data system reliability requirement.

2.3.4 A Line Replaceable Item (LRI) is the lowest level of equipment interchangeable item which is removed and replaced at the operational complex maintenance level to maintain the data system operational availability.

2.3.5 A Lowest Repairable Unit (LRU) is the lowest unit, assembly, or subassembly which can be restored to a serviceable condition by removal and replacement of parts, alignment/adjustment, or other authorized repair action.

2.4 Associate, Integrating, and Subcontractor Data

See 2.4, OGES.

2.5 Personnel, Logistics, and Facility Planning Data

See 2.5, OGES.

3.0 REQUIREMENTS

3.1 General

3.1.1 Overall Description of System (Maintenance Aspects)

The basic determinant of a system's ability to be maintained in non-routine circumstances (i.e., other than preventive maintenance) is its reliability. This quantity is in turn a function of the Mean Time Between Failure (MTBF) of the individual components which make up the entire system. Specifically, the operational reliability of a hardware component is defined as the probability of no failures adversely affecting operations over a specified period of operation. Operational reliability (R_O) may be defined by the following equation:

$$R_O = e^{-\lambda T}$$

where λ is the average failure rate or 1/(MTBF),
and T is the operating time at which the reliability is desired, referenced to a "base time" T_O.

Therefore, in order to ascertain the reliability of a network like the automated work centers, it is necessary to define every link in the connection between the man at the AWC and the host computer and determine the individual MTBF's. Finding the resulting reliability becomes an involved mathematical exercise.

In the case of the AFGWC system the reliability is not an unknown; a minimum goal of 0.995 has been established. The problem now is to reverse the process and define acceptable MTBF levels of system components which will meet the stated reliability.

The limited reliability of certain state-of-the-art components within the AFGWC system further complicates the picture. The 50 RP array processors and, to a lesser extent, the 3.5 RP computers, are examples. If these individual machines have reliabilities below the stated goal of 0.995, then redundant units must be purchased to bring the reliability up to an acceptable level. If these reliabilities are still low but above 0.995, then they become a weak link in the network chain and the other components are forced to have a reliability near unity, since the total reliability is a multiplicative combination of the components.

Related factors or requirements reflecting on the system's general performance and therefore its reliability include integrity, testability, adaptability, and availability.

As used here, integrity pertains not just to the meteorological information content but to the correctness of any data propagated, manipulated or hosted by the AFGWC system. It is proposed that no specific integrity requirement be levied with the exception of a detailed presentation of an approach taking into account the reliability of the components as were described earlier in this section.

Testability is another implicit requirement. It must be assessed by the impact on reliability. Testability pertains primarily to new components (hardware and software), and the ability to meet the implicit factor of the reliability computation.

Adaptability is required to the extent that growth potential is envisioned. Beyond that must be identified the set of standards and specifications which effect a modularity of functions and specify a generality of form and purpose which far exceed the requirement of growth.

Availability is a direct functional relationship of reliability and maintainability. It reflects the span over which potential tasks must be accomplished and the abilities for recovery. It involves the MTBF discussed earlier in this section. Specifically, availability is defined as the probability that the hardware will perform as specified at any given time. In the following relationship, "A" excludes ready time, supply downtime, and waiting or administrative downtime, and may be expressed as:

$$A = \frac{T_s}{T_s + T}$$

where T_s = total failure free operating time

T = total active maintenance downtime, including PM downtime

Another consideration is system effectiveness. System effectiveness is defined as that portion of time that the hardware is up and operational with respect to total time in use, where

$$P_{up} = \frac{\text{Total Time Up}}{\text{Total Time in Use}}$$

This is a general term and will be used interchangeably in this study with reliability.

A final parameter to be used in following discussions, defined as the average down-time of a hardware component, is the Mean Time To Repair (MTTR).

3.1.2 Development of Maintenance Complex

The ground areas at which maintenance functions are to be performed include in-house facility space, squadron area facility space, and depot area space. Squadron and depot areas for MGES maintenance functions are covered in Sections 3.3 and 3.4 respectively. In-house facility space already mentioned as serving OGES needs (see Section 3.5 of OGES) will also meet MGES requirements.

3.2 Operational Complex Maintenance Functions

This section describes the non-scheduled maintenance requirements for operating ground equipment in the proposed AFGWC data system. Included are reliability statistics, required equipment, typical procedures, and personnel specialty requirements. The section is organized to correspond directly to the structure of the architectural domain down to varying levels depending on appropriateness to MGE discussions. A summary of pertinent MGE support equipments required for the architectural domain divisions appear in Table 4.

3.2.1 Data Storage (A10)

3.2.1.1 STORAGE DEVICES (A11)

3.2.1.1.1 Support Disk (A111)

These storage devices will be used for the normal special access forecaster consoles, printer support, and Satellite Imagery Dissemination. Their size and exact specifications will vary depending on their application, but for all these disks the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a

TABLE 4.

MAINTENANCE AGE/ARCHITECTURAL DOMAIN REQUIREMENTS

MAINTENANCE GROUND EQUIPMENT / ARCHITECTURAL DOMAIN	storage dev	memory	d b design	h w linkage	sec separation	controllers	interface	routing	switching	compatibility	merging	conceptual	processors	purchased s w	software	developed s w	normal access(c)	normal access(u)	special access	satellite data	routing	general	other	mission sup	mission ops	rap response vis	documentary vis	misc stat	selection	misc comm	man inputs	PERSONNEL (A70)	MANAGEMENT (A80)	FACILITIES (A90)
	DATA STORAGE (A10)					DATA TRANSFER AND ROUTING (A20)						COMPUTATION AND SOFTWARE (A30)					TERMINAL INTERFACE (A40)							CONSOLES (A50)				DATA INPUT/DISPLAY (A60)						
OSCILLOSCOPE (AA-3.2)	X	X											X										X			X								
MAINTENANCE CONT (AA-9.1)		X											X																					
DISK EXERCISOR (AA-9.1)	X																																	
TEST CARDS (AA-9.5)	X																																	
OSCILLOSCOPE PROBES(AA-12.6)																										X	X			X				
DIG VOLTMETER (AA-1.1)																										X								
ELEC VOLTMETER (AA-1.2)																										X								
VTVM (AA-1.1)																										X								
PHOTOMETER (AA-7.4)																										X								
MICROSCOPE (10X) (AA-7.3)																										X								
TEMPLATE ALIGNMENT (AA-7.1)																										X								
HOT-LINE STICK (AA-1.3)																										X								
SAFTEY GLASS (FF-2.3)																										X								
CKT CARD TESTER (AA-9.5)																											X							
SCOPE WITH PLUGIN (AA-3.2)																											X			X				
DIG MULTIMETER (AA-1.4)																											X							
CARD EXTRACTOR (GG-7.4)																											X							
CARD EXT BOARD (AA-12.6)																											X			X				
MECH FORCE GAUGE (AA-8.8)																											X							
VACUUM GAUGE (AA-8.4)																														X				
SPRING SCALE (AA-8.8)																														X				
MULTIMETER (AA-1.4)																														X				
DIG SOFTWARE (AA-9.1)																							X											
ION FIRE DETECTOR (KK-1.1)																																X		X
CARBON DIO EXT (KK-1.1)																																X		X
WATER HOSE CAB (KK-1.1)																																X		X

reliability of _____. MGE required include:

Special purpose disk exerciser (AA-9.1)

This equipment will be used in the following procedures: using software diagnostic tools and running the exerciser. Personnel specialties include _____.

3.2.1.1.2 Fixed Head Disk (A112)

These storage devices will be used for the operating system, roll-in/roll-out, model scratch area, and some data base. A typical unit is the Univac 8405. MGE requirements are the same as 3.2.1.1.1.

3.2.1.1.3 Combination Disk (A113)

These storage devices will be primarily used for communication libraries. MGE requirements are the same as 3.2.1.1.1.

3.2.1.1.4 Satellite Disk (A114)

These storage devices will be used for the raw and gridded satellite data. MGE requirements are the same as 3.2.1.1.1.

3.2.1.1.5 Bulk Disk (A115)

These storage devices will make up the central data base. MGE requirements are the same as 3.2.1.1.1. A typical unit is the Univac 8433 disk.

3.2.1.1.6 Tape Unit (A116)

Tapes will serve as indefinite storage areas for classified data which cannot use the Mass Storage Facility and provide a means by which data can be physically shipped between AFGWC and its customers. A typical unit is the Univac 0862-04. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include:

a) Oscilloscope (AA-3.2)

b) Test cards (AA-9.5)

This equipment will be used in the following procedures: using software diagnostic tools and downing the individual tape drive. Personnel specialties required are _____.

3.2.1.1.7 Mass Storage Facility (A117)

This storage device will be used as a staging device to faster disks and for long term unclassified data storage. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following precedures: _____. Personnel specialties required are _____.

3.2.1.1.8 Low Capacity Storage Device (A118)

These storage devices will be associated with consoles dedicated to communications and security. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of

_____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.1.2 MEMORY (A12)

3.2.1.2.1 Main Processor Memory (A121)

The 3.5RP processors (see 3.2.3.1.1) will be configured with full memory. For this hardware, the average MTBF and MTTR values are 1000 hours and 0.25 hours respectively producing a reliability of 0.999. MGE required include:

a) Oscilloscope (AA-3.2)
b) Maintenance controller (AA-9.1)

This equipment will be used in the following procedures: running a built in off-line exerciser (which is a software controlled technique used to diagnose memory problems) and activating the maintenance controller. If this is not sufficient to isolate and diagnose a problem, a major subset of the multiprocessor system (e.g., one CAU main memory, and associated components) must be removed from service and inspected. If this does not work, the entire processor and its main memory must be removed from operation for emergency maintenance. Personnel specialties required are _____.

3.2.1.2.2 Support Processor Memory (A122)

Support processors are discussed in section 3.2.3.1.3. MGE requirements are the same as section 3.2.1.2.1.

3.2.1.2.3 Array Processor Memory (A123)

Array processors are discussed in section 3.2.3.1.2. MGE requirements are the same as section 3.2.1.2.1.

3.2.1.2.4 Auxiliary Memory (A124)

Same MGE requirements as 3.2.1.2.1.

3.2.1.3 DATA BASE (A13)

These considerations of data base structure and management are not applicable to the MGE.

3.2.2 Data Transfer and Routing (A20)

3.2.2.1 HARDWARE LINKAGES (A21)

Hardware linkages in the AFGWC system will be secured, unsecured, one-way, control-only, upgrade and downgrade. They have a high level of reliability and require no special maintenance considerations.

3.2.2.2 SECURITY SEPARATION (A22)

Authentication devices are listed in this category. They have a high reliability and require no special maintenance considerations.

3.2.2.3 CONTROLLERS (A23)

3.2.2.3.1 Support Disk Controller (A231)

For the controller associated with the support disk, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include:

Special purpose disk exerciser (AA-9.1)

This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.2.3.2 Fixed Head Disk Controller (A232)

The controller associated with the fixed head disks has the same MGE requirements listed in 3.2.2.3.1. A typical unit is the Univac 5039-99 controller.

3.2.2.3.3 Combination Disk Controller (A233)

The controller associated with the combination disk has the same MGE requirements listed in 3.2.2.3.1.

3.2.2.3.4 Satellite Disk Controller (A234)

The controller associated with the satellite disk has the same MGE requirements listed in 3.2.2.3.1.

3.2.2.3.5 Bulk Disk Controller (A235)

The controller associated with the bulk disks has the same MGE requirements listed in 3.2.2.3.1. A typical unit is the Univac 5039-99 controller.

3.2.2.3.6 Tape Unit Controller (A236)

The controller associated with the tape units has the same MGE requirements listed in 3.2.2.3.1. A typical unit is the Univac 5017-00 controller.

3.2.2.4 INTERFACE (A24)

The device connections and input/output parts listed in this area have a high reliability, and have no special MGE requirements.

3.2.2.5 ROUTING (A25)

No special MGE requirements are applicable to this area.

3.2.2.6 SWITCHING (A26)

The manual, gang, and multiprocessor switches listed in this area are highly reliable and require no special MGE considerations. Furthermore, their ability to enhance the reliability and therefore the maintainability of the whole system when used as a data path hook-up is worth noting.

3.2.2.7 COMPATIBILITY (A27)

This architectural concept requires no MGE considerations.

3.2.2.8 MERGING (A28)

This architectural concept requires no MGE considerations.

3.2.2.9 CONCEPTUAL (A29)

This architectural concept requires no MGE considerations.

3.2.3 Computation and Software (A30)

3.2.3.1 PROCESSORS (A31)

3.2.3.1.1 Main Processor (A311)

The 3.5 RP processors will be the primary mainframe computers of the GWC system configuration. This requirement can be satisfied by a computer similar to Univac's model no. 3023-93 of the 1100/40 series. The 3.5 RP will be configured as a multiprocessor, with a normal mainframe plus an additional CAU (Central Arithmetic Unit) and IOAU (I/O Access Unit). Both maximum primary and extended memory will be provided, with 524,288 and 1,048,576 words respectively. For this hardware, the average MTBF and MTTR values are 1,000 hours and 0.25 hours respectively producing a reliability of 0.999. MGE required includes:

a) Oscilloscope (AA-3.2)
b) Maintenance controller (AA-9.1)

This equipment will be used in the following procedures: running software diagnostics to isolate the problem, running the maintenance controller, downing a subset of the system while the rest is in service, or downing the whole system. Personnel specialties required are _____.

3.2.3.1.2 Array Processor (A312)

The 50 RP processor will be an array type, designed to handle unique analysis and forecasting algorithms. Since this array processor will be attached to a 3.5 RP processor acting as a host, it will necessarily be a compatible type of hardware. The seismic array processor produced by Univac is one such example. For this processor, the average MTBF and MTTR values are 3,000 hours and 0.5 hours respectively producing a reliability of 0.999. MGE required include:

a) Oscilloscope (AA-3.2)

b) Maintenance controller (AA-9.1)

This equipment will be used in the following procedures: running software diagnostics and the maintenance controller. Personnel specialties required are _____.

3.2.3.1.3 Support Processor (A313)

The smaller support processor will be used in configuration with consoles for forecaster and various other operations. For this hardware, the average MTBF and MTTR values are ____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.3.2 SOFTWARE (A32)

AFGWC data system reliability requirements are a function of hardware reliability and software reliability. The 0.999 reliability of the 3.5 RP and 50 RP processors discussed in the previous sections reflects hardware considerations. That is, a 0.999 reliability factor is achievable if the software which operates on these processors will cause no failures. In addition to insuring that no failures are caused, maintenance of the software must be performed to insure AFGWC data system integrity. System software which supports maintenance of the system includes executive control, which performs facility status checks, prints information messages and provides memory "dumps". AFGWC Data System support software necessary for effective maintenance of the 3.5 RP and 50 RP processor software includes compilers, assemblers, translators, interactive debugging programs, data recording and reduction programs, and configuration control support software. The software maintenance aids have a high reliability, provided procedures for their use are adhered to.

MGE required for maintenance of the 3.5 RP processor software includes _____. Personnel specialties required are _____.

3.2.3.3 PURCHASED SOFTWARE (A33)

See Section 3.2.3.2.

3.2.3.4 DEVELOPED SOFTWARE (A34)

See Section 3.2.3.2.

3.2.4 <u>Terminal Interface</u> (A40)

3.2.4.1 NORMAL ACCESS (CLASSIFIED) (A41)

The primary hardware used to interface AFGWC communications with users is the line handler/decoder router (LHDR). In general, one such device is used for each classification level. Each has the responsibility of routing incoming and outgoing messages in accordance with appropriate security levels, and each device also performs message formatting and decoding as necessary. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.4.2 NORMAL ACCESS (UNCLASSIFIED) (A42)

The same comments and MGE requirements apply as stated in Section 3.2.4.1.

3.2.4.3 SPECIAL ACCESS (A43)

The same comments and MGE requirements apply as stated in Section 3.2.4.1.

3.2.4.4 SATELLITE DATA (A44)

The satellite ground station complex consists of several major subsystems which handle the reception and initial processing of all primary and secondary satellite data. This equipment includes the recording or archiving subsystems, the data formatter (DF) which converts the analog signal to digital data, and the switching and patching subsystem (SPS). After the data is sent from the ground station equipment to the SPS, the 3.5 RP processor, and the central data base, photographic displays of the gridded and mapped result can be generated. This involves routing the refined data back to the satellite ground station where special display devices are located. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.4.5 ROUTING (A45)

The same comments and MGE requirements apply as stated in Sections 3.2.4.1 and 3.2.4.4.

3.2.4.6 GENERAL (A46)

These architectural considerations have generated no MGE requirements.

3.2.4.7 OTHER (A47)

Teletype and facsimile communication are the major considerations here with facsimile hardware the primary one. Equipment for the transmission of analog and digital facsimile charts consist mainly of equipment in the Weather Facsimile Switching Center (WFSC). This facility will be under control of the Air Force Communications Service but since their activities are so closely allied with those of AFGWC analysts and forecasters, unscheduled maintenance of this equipment is described in this section.

The key component of this facility is the WFSC minicomputer, similar in size and type to the Interdata 50. The WFSC mini has average MTBF and MTTR values of _____ hours and _____ hours respectively producing a reliability of _____. MGE required include:

a) Oscilloscope (AA-3.2)
b) Diagnostic software (AA-9.1)

This equipment will be used by running the diagnostics to isolate faults, analysis of hardware faults by scope techniques, and remedial repair. Personnel specialties required are _____.

3.2.5 <u>Consoles</u> (A50)

3.2.5.1 MISSION SUPPORT (A51)

The only component involved in the mission support consoles not discussed elsewhere involves the minicomputers located at each console serving to coordinate the functioning of other hardware components. For such a minicomputer, the average

MTBF and MTTF values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.5.2 MISSION OPERATIONS (A52)

The same comments and MGE requirements stated in section 3.2.5.1 also apply here.

3.2.6 Data Input/Display (A60)

3.2.6.1 RAPID RESPONSE VISUAL (A61)

3.2.6.1.1 Aphanumeric CRT/Control (A611)

An alphanumeric CRT will be used at those consoles where it is necessary to display data lists and prepare and edit bulletins and other messages. The CRT should be at least 14" in size and have a full range of meteorological symbols and upper and lower case ASCII characters. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include:

a) Oscilloscope for waveform measurement (AA-3.2)

b) Oscilloscope probes for waveform measurement and for checking HVPS output ripple and approximate levels (AA-12.6)

c) Digital voltmeter for checking voltages below 500V (AA-1.1)

d) Electrostatic voltmeter for checking HV outputs above 5 kV (AA-1.2)

e) VTVM for checking supply voltages between 500 V and 5 kV (AA-1.1)

f) Photometer for setting brightness levels (AA-7.4)

g) Microscope, 10X for close examination of displayed characters and vectors (AA-7.3)

h) Template alignment for setting up adjustments affecting size and location of mode data (AA-7.1)

i) Hot line stick for discharging high voltage points (AA-1.3)

j) Safety glass, anti-parallax, for CRT mode and axial alignment (FF-2.3)

This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.1.2 Color CRT/Control (A612)

A color CRT will be used at consoles where displays being designed have a high level of complexity with conflicting line segments and curves. Color will allow for easy visual differentiation of the information presented. The CRT should have a minimum range of about 8 colors, be 19" in size, and have a pixel density of about 512 x 512. The limited pixel density means that this CRT will not be suitable for displaying alphanumeric characters in a high density format.

MGE requirements are the same as those given in Section 3.2.6.1.1.

3.2.6.1.3 High Resolution CRT/Control (A613)

A high resolution CRT will be used at those consoles where it is necessary to display satellite data or digital radar data. The CRT should be about 19" in size, have a pixel density of approximately 1000 x 1000, and be able to display close to 63 grey shades.

MGE requirements are the same as those given in Section 3.2.6.1.1.

3.2.6.2 DOCUMENTARY VISUAL (A62)

3.2.6.2.1 Special Character Printer (A621)

This printer will have a full range of ASCII and special programmable characters. For this hardware, the average MTBF and MTTF values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include:

a) Circuit card tester (AA-9.5)

b) Oscilloscope with plug-in (AA-3.2)

c) Oscilloscope probe (AA-12.6)

d) Digital multimeter (AA-1.4)

e) Card extractor (GG-7.4)

f) Card extendor board (AA-12.6)

g) Mechanical force gauge (AA-8.8)

This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.2.2 Standard Printer (A622)

This printer shall operate at a speed up to 2,000 lines per minute and have a full range of ASCII characters. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE, procedures, and personnel required are all the same as Section 3.2.6.2.1.

3.2.6.2.3 Plotter (A623)

This X-Y plotter will be located at the programmer consoles located in the studies and analysis section. It will contain a full range of ASCII and programmable characters. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.2.4 Hardcopy Device (A624)

This device will be associated with CRT's where it is necessary to get a hardcopy version of a display. It will have the capability of producing a black and white version of either a black and white or color picture. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.3 MISCELLANEOUS STATUS (A63)

These status displays provide network system and subsystem status information to the control areas of AFGWC. They monitor both system configuration and security level. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required inlcude _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.4 SELECTION (A64)

This area includes the following switch panels:

a. Network switch panel
b. Unit switch panel
c. Data base selector panel
d. Processor selector panel

For the hardware associated with these panels, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.5 MISCELLANEOUS COMMUNICATIONS (A65)

This heading includes computer card and paper tape handling devices. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include:

a. Vacuum gauge (AA-8.4)
b. Extender card (AA-12.6)
c. Oscilloscope with plug-in (AA-3.2)

d. Oscilloscope probes (AA-12.6)

e. Spring scale (AA-8.8)

f. Multimeter (AA-1.4)

This equipment will be used in the following procedures:

a. Operation of confidence test diagnostic software

b. Fault detection

c. Removal and replacement of failed line replaceable items

d. Equipment checks to verify maintenance actions

e. Alignment and adjustment of the equipment/components

Personnel specialties required are _____.

3.2.6.6 MANUAL INPUTS (A66)

3.2.6.6.1 Alphanumeric Keyboard (A661)

The alphanumeric keyboard shall be the primary means of controlling the equipment located at each console. It has the full range of ASCII characters and positive and negative, decimal, numerical designators. For this keyboard, the average MTBF and MTTF values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.6.2 Fixed Function Keyboard (A662)

The fixed function keyboard will activate standard functions provided via software and not found on the alphanumeric keyboard. The MGE requirements are the same as those given in Section 3.2.6.6.1.

3.2.6.6.3 Lightpen (A663)

This device will allow for entry of data to the CRT or for modification of information already displayed there. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.6.4 Magnetic Cursor (A664)

This device will be provided for use of digitizing tables and graphic CRTs. It will allow for data entry or modification. For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.6.6.5 Digitizing Table (A665)

A digitizing table will be the primary means of modifying CRT displays with a high level of precision. It will provide more accuracy than other techniques and will allow the forecaster to transfer data from a weather chart to a CRT by tracing the chart on the table. The digitizing table must be at least 2' by 3' in size (to allow for overlay of weather charts). For this hardware, the average MTBF and MTTR values are _____ hours and _____ hours respectively producing a reliability of _____. MGE required include _____. This equipment will be used in the following procedures: _____. Personnel specialties required are _____.

3.2.7 Personnel (A70)

3.2.7.1 MISSION SUPPORT POSITIONS (A71)

As is explained in the introduction to this document, the exact effect of maintenance on personnel requirements is dependent on a number of maintenance alternatives still open.

3.2.7.2 MISSION OPERATIONS POSITIONS (A72)

See Section 3.2.7.1.

3.2.7.3 TRAINING (A73)

See Section 3.2.7.1.

3.2.8 Management (A80)

3.2.8.1 CONTROL (A81)

Not applicable to MGE considerations.

3.2.8.2 OPERATIONS (A82)

Not applicable to MGE considerations.

3.2.8.3 LOGISTICS (A83)

Not applicable to MGE considerations.

3.2.8.4 PLANNING (A84)

Not applicable to MGE considerations.

3.2.8.5 DEVELOPMENT (A85)

Not applicable to MGE considerations.

3.2.8.6 MAINTENANCE (A86)

Not applicable to MGE considerations.

3.2.9 Facilities (A90)

3.2.9.1 SUPPORT (A91)

See Sections 3.3 through 3.5.

3.2.9.2 PERSONNEL WORK AREA (A92)

See Section 3.6.

3.2.9.3 STORAGE AND SUPPORT (A93)

See Section 3.6.

3.3 Squadron Area Maintenance Functions

Squadron area maintenance functions include those which cannot be handled within machine rooms, but do not require removal to a depot or factory area. This topic has been discussed in OGE Section 3.3.

3.4 Depot Area Maintenance Functions

Depot area maintenance functions include those which cannot be handled at the site (either the machine rooms or squadron area) but do not require removal to a contractor factory facility. This topic has been discussed in OGE Section 3.4.

3.5 Facility Requirements

Facility requirements already established in OGE section 3.5 also apply as a description of facilities needed for MGE. This is based on the fact that essentially the same equipment is used for the two types of maintenance. This same approach is also presented in MGE Section 3.1.2, which describes the development of the maintenance complex.

3.6 Personnel and Life Support Requirements

Some unique hazards may be encountered during the unscheduled maintenance of AFGWC data system components. As with OGE equipment, primary responsibility for the welfare and safety of data system personnel resides with the AFGWC Safety Officer. However, while some special safety considerations may arise in connection with non-scheduled emergency maintenance of components, virtually all of the personnel and life support considerations associated with problems encountered during normal operations also apply to emergency maintenance situations. Reference is therefore made to Section 3.6 of the OGES for a discussion of personnel safety and life support aspects.

3.7 AGE Recommendation Data

AGE Recommendation Data (AGERD) that will be developed in subsequent planning and acquisition phases of the proposed AFGWC data system shall reference appropriate sections and paragraphs of this plan. AGERD documentation will provide, under separate cover, descriptions of additional types of maintenance equipment that will be required.

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