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BY THE COMPTROLLER GENERAL

Report To The Chairman, Committee On Government Operations House Of Representatives

OF THE UNITED STATES

Better Software Planning Needed At The Air Force's Global Weather Central

To support its mission responsibilities into the 1990s the Air Force's Global Weather Central needs to substantially increase capacity for its general purpose computers. However, in attempting to justify keeping the same brand computer it has, the Air Force failed to assess the adequacy of the software inventory.

GAO recommends that hardware procurement be suspended until adequate software plans are complete.

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The Honorable Jack Brooks
Chairman, Committee on
  Government Operations
House of Representatives

Dear Mr. Chairman:

This report is our response to your June 8, 1979, request for information on the Air Force's management and acquisition of computers at its Global Weather Central, Offutt Air Force Base, Nebraska.

As you requested we did not obtain agency comments on the matters discussed in this report.

As arranged with your office, unless you announce the contents of this report earlier, we will not distribute it until 15 days from its date. At that time, we will send copies to interested parties and give copies to others upon request.

Sincerely yours,

Comptroller General
of the United States
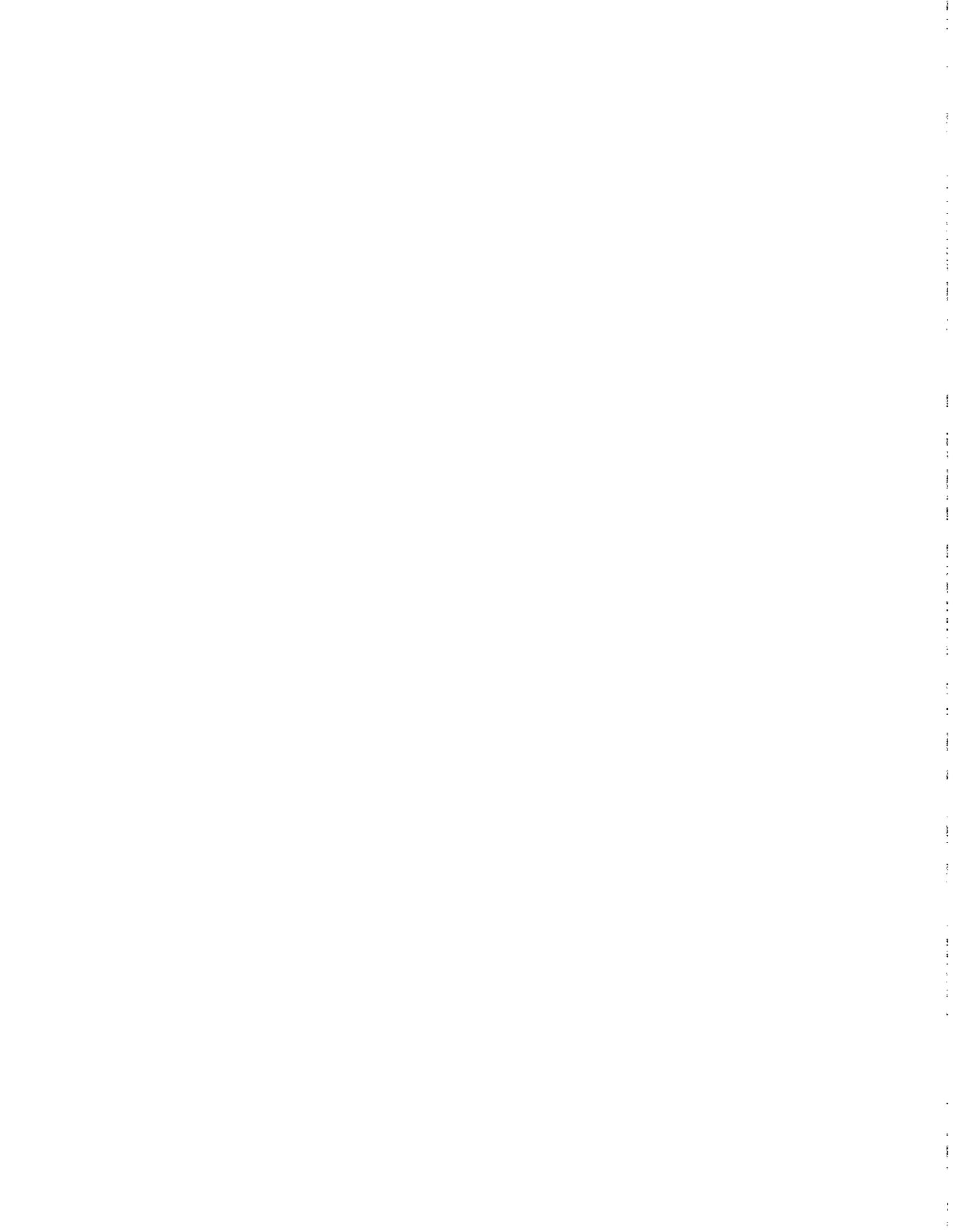
COMPTROLLER GENERAL'S
REPORT TO THE COMMITTEE ON
GOVERNMENT OPERATIONS
HOUSE OF REPRESENTATIVES

BETTER SOFTWARE PLANNING
NEEDED AT THE AIR FORCE'S
GLOBAL WEATHER CENTRAL

D I G E S T

As part of a long range program to improve
its computerbased weather forecasting capa-
bilities, the Air Force insists a series of
sole-source procurements of general purpose
computers from the manufacturer of its pre-
sent computers are in the Government's best
interest. Air Force officials believe that
by avoiding the competitive process, they
can save about $30 million and minimize the
technical risks associated with changing the
brand of computers. (See p. 4.)

The Air Force has used sole-source procure-
ments to acquire general purpose computers
at its Global Weather Central facility since
1972. It wants to continue to do so until
1985 and probably later despite repeated
General Services Administration efforts to
persuade the Air Force to use competitive
procurement. (See pp. 2-3.)

GAO found that the plan to procure the Air
Force Global Weather Central general purpose
computers on a sole-source basis was not
justified. (See pp. 4, 5, and 7.)

The Air Force basis for the estimated $30 mil-
lion savings is a plan to retain about
70 percent of the existing software and, by
remaining with the present manufacturer's
product line, avoid costly conversion of
that software. The Air Force states that
this approach is the lowest overall cost to
the Government. (See pp. 3, 4, and 7.)

GAO disagrees that this approach is in the
best interest of the Government, but agrees
that the conversion may cost $30 million or
more. However, much of the software to be
retained may be obsolescent. (See pp. 11-20.)
And the decisions to retain about 1.7 million

AFMD-81-24

lines of existing software code into the
1990s without major improvements have not
been supported. (See pp. 11-20.)

The Air Force's position, particularly that
concerned with the decisions to retain and
convert so much of the existing software
without increasing the capabilities of that
software for the life of the new hardware,
is not supported adequately. In the absence
of such justification, GAO does not believe
that repeated sole-source procurement of im-
proved computers from the present manufac-
turer's line would be in the best interest
of the Government.

GAO found

--no major problems with the way the Air
  Force defined its mission needs at Global
  Weather Central,

--compliance with GSA's November 1977 dele-
  gation of procurement authority was proper,

--compliance with Federal automatic data
  processing policies and regulations is
  weak (see pp. 21-22), and

--some indications that sole-source procure-
  ment of automatic data processing equipment
  might be an Air-Force-wide problem. (See
  p. 25.)

This review indicates that with any procure-
ment, competitive or noncompetitive, much
of the software may need redesign, enhance-
ment, or replacement despite a certain amount
of concomitant technical and operational
risks. The question seems to be one of tim-
ing. Does the Air Force make these changes
now or later?

Before a decision is made to procure any more
new general purpose computers, GAO believes
that the Air Force needs to analyze, assess,
and better document the current status and
future plans for the massive software inven-
tory.

RECOMMENDATIONS TO THE ADMINISTRATOR
OF GENERAL SERVICES

GAO recommends that current action to procure
the general purpose computers at the Air Force
Global Weather Central be suspended until the
Administrator of General Services determines
whether competitive or sole-source procure-
ment is in the best interest of the Government.

As part of that determination the Adminis-
trator of General Services should require
the Air Force to provide:

--The following documentation for each signif-
   icant software component in the current
   software inventory:

   ● Estimated aggregate costs for such items
     as maintenance, modifications, enhance-
     ments, and redesigns over the remainder
     of the software's full life cycle.

   ● Projected assessments of its technical
     status relative to the state-of-the-art
     for each remaining year of its full
     life cycle.

--Plans for new software for the period 1982-
   1992.

--Estimated costs and technical criteria that
   will be used to reduce dependence on the
   present manufacturer.

--A long range plan of the software sharing
   arrangements that it will propose and/or
   implement with other Federal weather agen-
   cies.

--A comparative analysis that shows estimates
   of the technical, financial, and operational
   advantages and disadvantages of sole-source
   and competitive acquisition over the life
   cycles of both the hardware and software.

During that period of modernizing the overall
automated capabilities of the facility, GAO
believes it is reasonable for the Air Force
Global Weather Central to use hardware and

software from the Univac product line to
support critical user needs and maintain an
orderly phaseover period.

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In accord with the wishes of the requestor,
GAO's normal policy of obtaining agency com-
ments on its reports was not followed.

Contents

ABBREVIATIONS

ADP	automatic data processing
AFGWC	Air Force Global Weather Central
DBMS	data base management system
DOD	Department of Defense
FIPS	Federal Information Processing Standards
FPMR	Federal Property Management Regulation
FPR	Federal Procurement Regulation
GAO	General Accounting Office
GSA	General Services Administration
OMB	Office of Management and Budget
SDC	System Development Corporation

CHAPTER 1

INTRODUCTION

On June 8, 1979, the Chairman, House Government Operations Committee, expressed concern 1/ about an apparent Air Force philosophy that competitive acquisitions are not in the Government's best interests. He requested that we investigate the Air Force weather program to determine whether the Air Force has (1) justified its need for a proposed sole-source upgrade of two Univac 1100/81 computers, (2) properly defined its mission needs, (3) complied with Federal automatic data processing (ADP) policies and regulations including the November 10, 1977, General Services Administration (GSA) delegation of procurement authority, and (4) properly justified its plan to perpetually upgrade general purpose computers on a sole-source basis. Also, the committee chairman asked that we consider the potential impact on the Air Force's Global Weather System of a previous report we issued. 2/ And, in the event the Air Force's current sole-source plans for Air Force Global Weather Central (AFGWC) are symptomatic of broader Department-wide problems, we should expand the investigation to identify problem areas and recommend corrective actions.

AIR FORCE GLOBAL WEATHER CENTRAL,
THE LARGEST MILITARY METEOROLOGICAL
FACILITY IN THE WORLD, IS HEAVILY
DEPENDENT ON COMPUTERS

Air Force Global Weather Central provides aerospace environmental services globally to conventional and space operations of the Air Force, the Army, and other Department of Defense (DOD) and governmental agencies. AFGWC has over 700 scientists and technicians and 5 large UNIVAC computer systems.

The AFGWC concept of operation is to construct the world's most comprehensive environmental data base and apply the data to the specific operational requirements of its customers.

To help provide that data base, approximately 118,000 weather reports per day are gathered from conventional meteorological sources throughout the world. These data are blended with information available from other military programs to

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1/See app. I.

2/"Federal Weather Activities: Stronger Central Direction is Needed," LCD-80-10, Oct. 16, 1979.

construct an integrated environmental data base. Current
weather information is extracted from this data base, evalu-
ated, and relayed to AFGWC customers. These data also initi-
ate computer prediction models periodically (every 3 to 12
hours) for the preparation of global weather forecasts. A
series of scientific computer programs are employed to con-
struct a model of the existing atmosphere and to project the
changes that will occur in the future. These basic meteoro-
logical tools are made available to the scientists and tech-
nicians for application to the specific problems of each
customer. A similar process is followed in addressing many
problems encountered by operations in the space environment.

AFGWC relies heavily upon the interaction between the
person and the machine to produce accurate and complete serv-
ices individually designed for each operational problem. The
products and services of AFGWC are available to the President,
special strategic programs, many unified and specified com-
mands, major commands, various operational elements of the
Army, the National Security Agency, and a variety of DOD and
other governmental agencies. Environmental information is
disseminated over many communications and facsimile circuits
to customers throughout the world, and data and meteorological
products are exchanged with the National Weather Service and
naval facilities.

Continued efforts to meet expansion
needs by sole-source procurement of
general purpose computers have
caused problems

Increasing weather data processing requirements have
dictated that AFGWC continually expand its ADP capabilities.
However, Air Force use of sole-source procurements since 1972,
as part of this expansion effort, resulted in serious dis-
agreements with the General Services Administration which has
responsibility for approving acquisitions of large computer
systems for the Federal Government.

GSA tried to get the Air Force to commit itself to ac-
quire the AFGWC system by a competitive procurement; however,
the Air Force would not make that commitment. The following
excerpts from briefings and a very extensive correspondence
summarize the GSA efforts and the Air Force responses.

1. November 10, 1977 - GSA delegated authority to the
    Air Force to purchase a Univac 1110 computer sole
    source,

    "* * * conditioned on your agreement to, and
    acceptance of, an obligation to plan and"

"conduct a fully competitive replacement pro-
curement in such a timely manner as to ensure
that the UNIVAC 1110 system and the UNIVAC 1108
systems, including any interim upgrades which
may be subsequently authorized, are replaced by
the future successor systems by the end of
their eight year systems life."

2. <u>December 1978</u> - In a study report on the competitive
   replacement of Air Force Global Weather Central's
   Univac computers, the Air Force acknowledged a com-
   mitment to GSA to "competitively replace AFGWC's six
   UNIVAC computers, plus interim upgrades, by 30 Septem-
   ber 1985."

3. <u>February 9, 1979</u> - In a memorandum to the Director
   of Computer Resources Headquarters, U.S. Air Force,
   the Assistant Secretary (Financial Management) wrote,

   "* * * I am very concerned by the number of
   cases which request my approval for noncompeti-
   tive acquisition of ADP equipment. While there
   are occasional ADP projects for which noncom-
   petitive procurement is warranted, the current
   trend is unacceptable and indicative of inade-
   quate long range planning."

4. <u>March 28, 1979</u> - Despite the Federal policies as well
   as the Air Force's commitment to GSA, the Air Force
   in a letter to GSA insisted on acquiring Univac com-
   puters for AFGWC by sole-source methods as explained
   below.

   "We plan to acquire all components of the new
   architecture except the general purpose com-
   puters through fully competitive acquisitions.
   These new components, based on projected pur-
   chase costs, will account for 70% of the new
   architecture.

   "The ADP system now at AFGWC was initially com-
   petitively acquired in 1968-69. That system
   has been incrementally upgraded since the
   original acquisition. In order to preserve
   our investment in that system, we now plan to
   continue to acquire general purpose computers
   through incremental upgrades in the incumbent
   vendor's line. The savings which may accrue
   to the Air Force from a fully competitive ac-
   quisition for the general purpose computers"

3

"to be used in the new architecture will not offset the costs of preparing for the competitive acquisition, acquiring ADPE before it is needed, site preparation, software conversion, and other trade-off costs. Neither can we accept the known technical, security, and operational risk of a recompetition for the general purpose computers to replace the present ADP system."

* * * * *

"If on the other hand, you judge the merits of competition to outweigh the expected additional costs of about $30M plus the risks we have identified, we need your direction, through an appropriate DPA [Delegation of Procurement Authority], to that effect."

5.   March 29, 1979 - In a briefing presented to the Comissioner, Automated Data and Telecommunication Service (ADTS), GSA, the Air Force stated, among other things, that it had an exceptionally strong requirement for an upgrade in the AFGWC ADP operation to replace three Univac 1108s with two Univac 1100/81s. The Air Force stated also that issues of sole-source acquisition have stopped all progress on the upgrade and as a result AFGWC was not meeting new customer commitments and wartime support requirements.

6.   May 10, 1979 - The Air Force informed the Assistant Commissioner, ADTS

"* * * that under the provisions of FPR [Federal Procurement Regulation] 1-4.1105(b) we already have full authority to procure the ADPE * * * will proceed with procurement of the UNIVAC 1100/81s to contract award on 31 May 1979 unless action is taken by GSA to preclude the authority * * *."

    The preceding excerpts indicate the Air Force's position on updating AFGWC's capabilities.

    We issued our report on Phase 1 of the review on January 24, 1980. 1/ We reported among other things that sole-source

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1/"Air Force Sole Source Computer Acquisitions Not Warranted," FGMSD-80-30.

4

acquisition of the two 1100/81 computers was not justified because

   --with some change in operations there was sufficient
     capacity at AFGWC to satisfy validated operational
     requirements without the new 1100/81 computers and

   --a number of specific criteria required by Federal
     Property Management Regulations to support sole-
     source acquisitions were not met including

      o a requirement that the need for additional capacity
        be unforeseen and urgent and

      o sharing with other Government agencies and consid-
        eration of commercial sources.

Also, we pointed out that Federal Property Management Regulations (FPMRs) caution that the mere availability of better cost performance equipment within a vendor's product line is not sufficient justification for a sole-source procurement.

The Air Force disagreed strongly with our Phase 1 report. The central issue in this report is not simply the sole-source procurement of two 1100/81 computers, but whether the Air Force has supported its decision to continue through 1985, and possibly indefinitely, the sole-source procurement of Univac computers at AFGWC.

OBJECTIVES, SCOPE, AND METHODOLOGY

We performed our review in two phases. In the first phase our objective was to determine whether the Air Force had justified its need for a proposed sole-source upgrade of two 1100/81 computers. We received an introductory briefing by Air Force staff personnel in Washington, D.C., and extensive briefings by AFGWC personnel at Offutt Air Force Base, Nebraska. We evaluated the computer workload statistics on site at AFGWC. We evaluated the urgency of the requirements through studies of Air Force documents and interviews with personnel at AFGWC and users at Scott Air Force Base, Illinois, and McGuire Air Force Base, New Jersey.

During the second phase we reviewed the remaining issues raised in Chairman Brooks' letter of June 8, 1979. We relied heavily on extensive studies performed for the Air Force by System Development Corporation (SDC), Aerospace Corporation, and an Air Force Scientific Advisory Board as well as on numerous Air Force documents.

Our work for this phase of the review was primarily at AFGWC, Offutt Air Force Base, Nebraska. We also worked at the following: Air Force Headquarters, Washington, D.C.; Military Airlift Command Headquarters, Scott Air Force Base, Illinois; the Navy's Fleet Numeric Oceanographic Command, Monterey, California; an Air Force contractor plant--SDC in Santa Monica, California; and the Office of the Federal Coordinator for Meteorological Services, Washington, D.C.

CHAPTER 2

SOLE-SOURCE UPGRADE OF COMPUTER CAPACITY

AT AFGWC NOT JUSTIFIED

The Air Force has determined that a 12-fold increase in computer capacity is needed at AFGWC in order to meet mission requirements in the 1980s. 1/ The Air Force has proposed a sole-source acquisition of the general purpose computers and plans to upgrade the system within the incumbent vendor's product line. The decision to go sole source in the upgrade is based primarily on two assumptions.

--There would be an added cost of about $30 million resulting primarily from conversion of about 1.2 million of the 1.7 million lines of software code if a vendor other than Univac wins a competitive acquisition. 2/

--Conversion to another brand would impose technical risks that might disturb the operational effectiveness of AFGWC.

We do not believe the sole-source decision was adequately justified. An appropriate analysis of the remaining life of the software would have shown it, when compared with the current state-of-the-art, to be approaching obsolescence and a decreasing potential for supporting changing Air Force needs in the late 1980s and 1990s.

It is obvious that it is going to be costly to convert the software but no one knows the cost. The Air Force has estimates that range from $8 million to $62 million. (See app. II.)

With any procurement, competitive or noncompetitive, much of the software must be redesigned or replaced despite a certain amount of associated technical and operational risks. The question seems to be one of timing--does the Air Force bite the bullet now or bite it later.

The reason the Air Force is unable to adequately justify its decision to acquire the general purpose computers on a sole-source basis stems from the fact that the Air Force

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1/The 12-fold increase includes both specialized array processors and general purpose computers.

2/These figures are based on an Air Force July 1979 acquisition plan which indicates that about 70 percent of the software code would be retained.

--failed to aggregate and project over the remaining
    life cycle of each significant software component the
    estimated costs for redesign, maintenance, and/or en-
    hancements;

--failed to identify or evaluate the remaining opera-
    tional life of the individual components of the soft-
    ware inventory; and

--failed to compare the financial, technical, and opera-
    tional advantages and disadvantages of the software
    planned for retention with new or redesigned competi-
    tively acquired software.

Each of these issues is discussed in the following sections
of this report.

ESTIMATED COSTS FOR REDESIGN, MAINTENANCE,
AND/OR ENHANCEMENT OF EACH SOFTWARE COMPONENT
WERE NOT AGGREGATED AND PROJECTED OVER THE
REMAINING LIFE CYCLE

The decision to retain about 1.7 million lines of the
existing software and save an estimated $30 million through
sole-source procurement was based on an assumption that the
retained software would be cost effective well into the 1990s.
However, no documentation was available to show that the re-
maining life cycle costs of the individual software compo-
nents had been considered in making that decision. Federal
Property Management Regulation 101-35.206(c)(3) 1/ states
that

"* * * Any asserted cost burden associated with
conversion of existing systems to other vendor
product lines is not normally considered the con-
clusive factor in justifying such sole-source or
single product-line procurements. However, where
potential conversion costs and/or operational impact"

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1/This regulation was one of many revised just before comple-
    tion of our report. However, the former was applicable
    during the period covered by this review. Also, the require-
    ment to document software conversion plans is retained and
    expanded in the revisions. See for example revised FPMR
    101-35.206-2 effective January 15, 1981, which states that
    specific agency actions taken to reduce the risk and cost
    of conversions "* * * shall be described in software con-
    version studies submitted with agency procurement requests."

"are substantial and the requesting agency regards
them as essential in a determination of 'best in-
terests of the Government,' such conversion factors
should be clearly and fully justified and docu-
mented."

Without adequate documentation we were unable to substan-
tiate the validity of the assumption.

Sound management practices as well as DOD and Office of
Management and Budget (OMB) policies require that Federal
agencies account for the full cost of operating data process-
ing facilities including

"* * * depreciation for capitalized costs of developing,
converting, or acquiring software * * *." 1/ Both DOD and
OMB policies also require agencies to establish cost account-
ing procedures which are consistent with Federal Government
Accounting Pamphlet Number 4, published in 1978 by us. We
believe that compliance with these policies, particularly
those for depreciation of software investments, requires
projections of the life cycles for significant, individual
software components.

Despite statements by the Air Force that the AFGWC ac-
quisition planning is based on life cycle analysis, we were
unable to obtain life cycle projections of the costs or use-
ful life of individual software components. For example, we
know from Air Force documents that to respond to operational
requirements, over 700 changes per month are now made to the
AFGWC current operational software programs. The projected
cumulative costs of these changes over the life cycle of the
software components being changed has to be considerable in
both lines of computer program code and dollars. In briefings
and extensive interviews with about 25 people responsible for
different portions of the software inventory, we obtained in-
formation about the size, operation, technical complexity, and
opinions on expected life of the software. However, AFGWC
planning documents show no life cycle projections of expected
changes or estimated costs for individual components of the
software inventory. We found no planning documents that indi-
cated management had obtained or even considered such infor-
mation in making the decisions to retain and convert the soft-
ware.

1/DOD Instruction 7920.1, Oct. 17, 1978, and OMB Circular
   A-121, Sept. 16, 1980.

9

We asked Air Force officials for the projected mainte-
nance costs over the remainder of the life cycle for the
individual software components of the total inventory. They
told us that for the entire AFGWC complex it was 100 staff-
years a year. This included training, software development,
maintenance, redesign, testing, and documentation. 1/ The
officials were not able to provide the estimates on an indi-
vidual basis for the significant software components.

Because the Air Force software retention decision and
conversion estimates did not include an analysis of the re-
maining life cycle for each software component, the cost ef-
fectiveness of the software inventory cannot be projected into
the 1990s. We were told that current Air Force estimates were
based on experience with old programs that had been dropped
and new programs that were added. However, no analysis had
been made of the individual software components to determine
whether each should be

--Converted. This is the work done to make a program
  run on a computer other than the one for which it was
  originally written. All the existing functional capa-
  bilities (for example, operational input and output)
  are retained on the new system.

--Modified. The work done to make an existing applica-
  tion accomplish user requirements beyond those origi-
  nally intended. Also known as enhancement.

--Redesigned. A change to an application that involves
  a change to the functional specifications for that
  software. When completed the application software will
  provide new functions and/or capabilities. It is akin
  to new development.

We have previously reported on the importance of good
software planning and effective management preparatory ac-
tions as a means of facilitating competitive acquisitions. 2/
Also, GSA recently issued a large number of revised regulations

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1/SDC estimated that the maintenance of the present software
  inventory requires 108 staff-years per year.

2/"Millions In Savings Possible In Converting Programs From
  One Computer to Another," FGMSD-77-34, Sept. 15, 1977; also
  "Conversion: A Costly Disruptive Process That Must Be Con-
  sidered When Buying Computers," FGMSD-80-35, June 3, 1980.

for Federal management and procurement of ADP resources. 1/
Some of the key software management actions described in the
revised regulations have been summarized in appendix II.
Implementation of these actions will go a long way toward
eliminating most of the deficiencies we observed at AFGWC.

THE AIR FORCE FAILED TO IDENTIFY OR
EVALUATE THE REMAINING OPERATIONAL
LIFE OF THE INDIVIDUAL COMPONENTS
OF THE SOFTWARE INVENTORY

AFGWC does not have documentation that identifies the
individual components of the software inventory, assesses
their current capabilities against the state-of-the-art, or
estimates the remaining effective operational life of those
components. In addition to being a major capital investment,
the software inventory is the heart of the AFGWC operational
capabilities. Our analysis of various studies and interviews
with AFGWC personnel indicate that although the software is
currently meeting operational requirements, it is technically
outmoded, will become operationally obsolete during the 1980s
and, if not upgraded, will have an adverse impact on AFGWC's
mission performance.

For example, an Air Force Scientific Advisory Board re-
ported in April 1979 that, although AFGWC now leads the field
in the use of cloud and moisture information and in cloud
forecast techniques, it is not operating at the state-of-the-
art in numerical dynamic modeling. The Board also reported
that the current dynamic models are inadequate for supporting
many low level weapon delivery systems. It added that service
relative to the state-of-the-art will deteriorate if improve-
ments are not made. As a consequence of current practices the
Board stated that the Air Force is receiving forecasts that
are not as good as the state-of-the-art permits. The Board
cautioned that

> "* * * the meteorological models now used by the
> Air Force are well behind where they could be now.
> Hardware procurement, software development, and
> system implementation take considerable time.
> Because of the importance to the Air Force of
> cloud forecasting, it should look ahead to what
> the state of the art will be when a new system is
> in operation."

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1/See Federal Procurement Regulations Amendment 211 and Fed-
  eral Property Management Regulations Amendment F-44 both
  dated Dec. 29, 1980, and effective on Jan. 15, 1981.

11

Because the Air Force could not provide us with adequate documentation that showed its assessment for the remaining life of individual software components, we were forced to compile our own. 1/ In developing our assessment we used the information in the SDC studies, the Aerospace study, an Air Force Scientific Advisory Board report, Air Force studies, other documents, and interviews with about 25 employees at AFGWC.

Our assessment indicated that AFGWC needs to carefully review and evaluate the remaining life of hundreds of existing, individual software components containing about 1.6 million lines of code. (See app. IV.) From such a review, AFGWC should determine if each of these components should be retained into the late 1980s and perhaps beyond. If yes, then the component considered is a valid candidate for conversion. If no, then the component should be considered for redesign or replacement and not included in a conversion estimate that might bias a decision toward sole-source procurement. FPMR Subpart 101-35.206(c)(2)(ii) is specific regarding these matters. 2/ It states

"* * * conversion costs may be considered only to the extent that such costs can be shown to be clearly essential to continuing agency needs taking into account the probable economic life of the resources to be converted; that due consideration be given to the possibility of redesigning current systems and software to take advantage of enhanced system capabilities or eliminating obsolete or nonstandard software in conflict with applicable Federal Information Processing Standards * * *."

1/Paragraph 3a of DOD Instruction 7910.1 of Oct. 17, 1978, "Life Cycle Management of Automated Information Systems," requires, among other things, that the head of each DOD component shall ensure "that * * * ADP * * * plans are developed and maintained to reflect * * * obsolescence conditions."

2/This FPMR also was revised effective Jan. 15, 1981. However, it was applicable during the period covered by this review. Also, the requirement to document software planning is made even stronger. For example, revised FPMR 101-35.204 now requires that GSA be provided with a copy of the agency annual ADP plan with supplemental information on new technology, software improvements, and planned redesigns to improve the efficiency and effectiveness of software applications, consistency of documentation with guidelines issued by the National Bureau of Standards, and similar items.

Air Force officials stated that such an assessment has not been made. Instead, based on past experiences, the Air Force estimated that an aggregate of 485,000 lines of code will be replaced and about 1.7 million lines will be retained.

Air Force representatives questioned the validity of our assessment that the software is approaching obsolescence. We are aware that a definition of obsolescence can range from one that concentrates on technical structure and capabilities to one that is concerned only with whether the software output contributes to mission performance--regardless of its technical structure. We know also that the large software inventory is, for the most part, meeting operational requirements. However, based on our studies and interviews as discussed on pages 13-18, we believe that much of the software has fallen behind the state-of-the-art, and unless a program is instituted to change that trend, the future operational effectiveness of AFGWC will be adversely affected.

Included in the software that we believe is falling behind the state-of-the-art are the weather models, the data manipulation software, operating system, communication code, and application software. Each of these categories is discussed in one of the next three sections.

Weather models should be considered for redesign or replacement

The weather models have not kept pace with the state-of-the-art. They are as much as two generations behind models currently being implemented. Because of past limitations in computer capacity, Air Force consultants said that AFGWC models are currently limited in three critical areas: (1) the number of data points (the grid size, both horizontal and vertical, into which the atmosphere is segmented), (2) the scope of the model (hemispheric versus global), and (3) model physics (physics relating to such things as moisture and cloud friction).

A substantial increase in hardware capacity and increasing the number of data points can improve the accuracy of weather forecasts. However, refining the model physics, which represent an estimated 35 percent of the prediction error in current weather models, will require extensive software revisions.

The principal conventional forecast model at AFGWC is the hemispheric primitive equation model. 1/ It is an old

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1/This is a numerical model, based on a 200-mile grid size, that produces forecasts for the northern hemisphere.

13

model that was used at the National Weather Service in 1966.
This model, which became operational at AFGWC in 1975, does
not consider a moisture variable, an important factor used in
more advanced models. Another important AFGWC model, cloud
forecasting, is close to the state-of-the-art but significant
increases in data points plotted and the physics employed are
needed for future requirements such as support for future
weapon systems. An Air Force Scientific Advisory Board rec-
ommended that AFGWC address the growing deficiencies in the
area of cloud forecasting by (1) increasing the computer ca-
pacity and (2) improving the forecasting techniques.

Existing weather models constitute about 500,000 lines
of FORTRAN V code. 1/ According to Air Force data, this code
would cost $3.5 million to convert to another vendor's equip-
ment. Using Aerospace data, the conversion is estimated at
$8.2 million. Both the Air Force and Aerospace state that
future models need additional physical factors such as moisture
content, radiation parameters, and friction of cloud or air
mass movements. Also, global rather than hemispheric models
are needed. Models that employ more advanced physics and plot
more data points are available in other weather services today.
In the absence of a critical analysis and assessment of ex-
pected future effectiveness, we question the wisdom of deci-
sions to retain and convert such a large inventory of software.

Data base, operating system, and
communication code must be updated

The data base manipulation software, at least 215,000
lines of code, should be analyzed to determine if a techno-
logical updating is warranted. The current data base written
in the FORTRAN V language has evolved piecemeal to accommodate
new and changing requirements; however, SDC questions the
system's ability to meet future requirements. Although the
data base is stable and currently functional, it does not
adhere to modern data base design techniques. For example,
AFGWC data base access routines are interwoven into the appli-
cation software and are heavily dependent on Univac-unique
data manipulation routines. Further, specific routines have
been designed, developed, and tailored by AFGWC personnel
which pack information into the Univac 36-bit word length to

1/A programming language used for computer programs which
   automate scientific or mathematical calculations.

14

overcome limited data storage space. 1/ Although the packed data base enabled AFGWC to better support its mission requirements, it required the use of specialized Univac programming techniques when developing, enhancing, or maintaining applications software. This specialized requirement has continued so that even if new applications are written in the newer, more standard ANSI FORTRAN language today they must be modified to interface with the packed data base thus continuing AFGWC's dependence on Univac. 2/ Advances in technology during the 1970s would have enabled AFGWC to unpack the data base; however, Air Force officials said that was never a priority project.

These factors have severely increased the dependence of AFGWC on the Univac product line and make converting this system to other than Univac computers extremely difficult and costly. Unpacking to a lower density and redesigning the data base would simplify future conversions; however, about 70 percent of the applications that use the data also would have to be modified to interface with the unpacked data base.

Aerospace saw no immediate advantages to converting the data base. Nevertheless, it recommended that the data base system be redesigned as part of an architecture upgrade. 3/

SDC recommended a different approach. It questioned whether the current data base could accommodate future needs. It stated that

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1/This procedure is known as packing. Several units of data are stored within the 36-bit word length in such a way that the individual units can be retrieved. For example, the AFGWC stores or packs 6 digits in the 36 bits.

2/ANSI FORTRAN is a standard for the FORTRAN language developed under the auspices of the American National Standards Institute (ANSI). On September 4, 1980, this standard was approved by the Secretary of Commerce as a Federal Information Processing Standard (FIPS) effective on the date of publication. FIPS publication 69 will publish the standard. The National Bureau of Standards states that when not in conflict with Federal requirements, it encourages participation in and support of these standards.

3/Architecture refers to the general structure used to integrate the different components of the system.

"* * * simply modifying the current data base
structure is an undesirable approach in formulating
the new meteorological data base. We think that a
hierarchical gridding system * * * should be investigated
and recommended. The data base structure should
then be optimized to fit the application."

Also, regarding the current data base design, SDC stated that
the intermingling of applications code and data base handling
code should be abandoned. It further recommended that AFGWC
consider a different data-oriented language rather than con-
tinue its heavy dependence on FORTRAN for data handling.

Aerospace recommended a gradual evolution to a less
tightly packed data base. A gradual evolution may be much
more acceptable in an operating environment. However, the
main issue here is not how the change should be made or what
it is to be. The key issue is the failure of the Air Force
to provide a firm plan on which to determine if a change is
to be made.

The real-time operating and communication systems soft-
ware must also be considered for technological and operational
updating. These are inhouse-developed systems that use about
130,000 lines of code written primarily in assembly language.
An assembly language is generally designed to the architecture
of a specific computer. It is machine dependent and very dif-
ficult and costly to convert for operation on another vendor's
equipment. AFGWC required a real-time operating and communi-
cation system before one was available commercially. It de-
veloped its own using the Univac specialized assembly language.
Although still operational, the system is now technologically
outmoded and AFGWC must continue to maintain and, when needed,
enhance this system itself. The cost of converting this code
was included in the estimates provided by the Air Force and
its contractors. Again, we question the wisdom of converting
these nonstandard systems. SDC, in describing the real-time
operating system's ability to meet future requirements, stated
that even if the Univac system is retained, the real-time op-
erating system "will most likely not be able to react to neces-
sary changes smoothly and efficiently." 1/

1/A real-time system is one that can provide information about
the process it is describing fast enough for the process to
be continuously controlled by an operator using this infor-
mation.

Regarding the communications system, SDC stated the current single processor communications system violates security separation requirements. The use of small communication processors for each level of security was recommended. SDC also pointed out that AFGWC needs a standardized message protocol, especially considering that standards are necessary to benefit from new communication systems such as Autodin II. 1/ Finally, SDC pointed out that making the recommended changes to the communications system would require that the real-time operating system be discarded or rewritten.

Application software must be rewritten

The application software written primarily in the Fortran V language is an older one and nonstandard, and we believe the Air Force should have a plan which indicates the expected remaining operating life of each significant component of that software. It has evolved over the past 10 years from the base software that was converted from IBM to Univac computers in 1968. The base software has been modified, enhanced, and expanded. However, modern programming techniques were not employed in developing the software and many older architecture and system-specific features were used to exploit the performance of the Univac system. The application software is heavily tied to the current data base manipulation software. Furthermore, a FORTRAN V compiler is no longer supported by Univac. 2/

In most instances, when a vendor no longer supports a compiler, it is an indication of that vendor's position that the state-of-the-art has moved on to a new and more effective compiler. The cost of maintaining such software is much greater than that of maintaining well-structured, standardized software. Maintenance costs and the advantages of standardization should be evaluated when determining the remaining useful life of software. We found no such evaluations at AFGWC.

1/Autodin II is an advanced communications system used in the Department of Defense.

2/A compiler is a programming system that produces a program from a series of statements prepared by a person known as a programmer. The statements are in a symbology, such as numbers, letters, or words. They are input to the computer through a device such as a punch card reader. The compiler translates the symbology into a binary number system which is then used to control or use the computer.

The failure of the Air Force to analyze its software inventory and document the estimated remaining useful life of the significant components in the above categories of software raises questions about the basis for deciding to retain and convert that software.

We believe that if the Air Force is willing to acquire the hardware needed for its weather service, it should be equally willing to assess its existing software and if necessary invest in the new software required to provide more up-to-date and accurate weather forecasting.

THE AIR FORCE FAILED TO COMPARE THE FINANCIAL, TECHNICAL, AND OPERATIONAL ADVANTAGES AND DISADVANTAGES OF SOFTWARE PLANNED FOR RETENTION WITH NEW OR REDESIGNED COMPETITIVELY ACQUIRED SOFTWARE

The Air Force procurement study failed to compare the software planned for retention with alternative financial, technical, and operational advantages and disadvantages of enhanced, new, or redesigned competitively acquired software.

The July 1979 procurement study considered four alternative approaches; two within the Univac product line and two outside that product line. The four alternatives were all based on retaining most of the existing software. Under such circumstances the upward compatibility of the software, within the Univac product line, obviously biases the procurement toward a sole-source approach. That bias toward a sole-source procurement is clearly evident in items 5 to 10 of table 1 which show two of the four alternatives presented in the Air Force acquisition plan.

Air Force Regulation 300-2 states that when selecting ADP resources, consideration should be given to the possibility of redesigning current systems and software to take advantage of enhanced system capabilities. It also states that where potential conversion cost or operational impact is substantial and regarded as essential in a determination of "best interests of the government," such conversion factors should be clearly and fully justified and considered. Despite plans for a major upgrade at AFGWC, the procurement alternatives in the acquisition plan did not consider the possibility of redesigning the individual components of the current software inventory.

We do note that the Air Force's outline of its future system (app. V) does include improving numerical forecasting by the acquisition of more computational capacity (two array processors). However, there is no documentation describing

Table 1

Two of the Four Alternatives Considered in

the Air Force July 1979 Acquisition Plan

		Alternative 2A (sole-source)	Alternative 2B (competitive)
		----------(millions)----------	
1.	Purchase equipment	$39,894	a/ $44,038
2.	Maintenance of equipment	29,765	29,765
3.	Personnel	53,060	54,740
4.	Integration with other systems	600	1,150
5.	Parallel operations	120	5,230
6.	Site preparation	220	1,510
7.	Training	-	830
8.	Temporary duty and travel	-	300
9.	Software conversion	-	15,540
10.	Contractor assistance to develop procurement specification	-	-
11.	Miscellaneous costs	-	2,700
		$123,659	$155,803

a/This cost is greater than the sole-source purchase (alternative 2A) because of a difference in both the schedules and equipment acquired. For example, alternative 2A calls for new model improvements to two existing computers in fiscal 1982 and fiscal 1983 and purchase of three new computers in fiscal 1985. Alternative 2B calls for purchase of five new computers in fiscal 1985. Because the software conversion cost is the dominant issue, we did not evaluate the validity of the schedules or costs for these two hardware procurements.

the software component of the planning to improve numerical forecasting nor is there any documentation clearly showing if any of the existing numerical forecasting models were excluded from the conversion cost estimates.

The Air Force's failure to include a software inventory assessment and proposed software redesign plans in the procurement alternatives it considered may stem from a recommendation by an Air Force study group to a 1976 conference that the question of software system redesign be separated from that of software conversion. We agree that separation of the actual conversion and redesign processes is probably warranted to reduce the complexity. However, we cannot agree that consideration of software redesign needs, plans, and costs should be excluded from consideration of procurement alternatives as was done in this case.

Because the redesign needs and upgrading of its software inventory have not been considered adequately, we believe the Air Force has not clearly and fully justified that sole-source procurement of the general purpose computers is in the best interest of the Government.

CHAPTER 3

OTHER FACTORS AFFECTING THE

SOLE-SOURCE DECISION

The four remaining issues raised by Chairman Brooks' letter of June 8, 1979, can be summarized as follows:

1. Did the Air Force properly define the mission needs for AFGWC?

2. Did the Air Force comply with ADP policies and regulations including the November 10, 1977, delegation of procurement authority from GSA?

3. Does our report "Federal Weather Activities: Stronger Central Direction Is Needed" have any impact on AFGWC?

4. Are the Air Force's sole-source plans for AFGWC symptomatic of broader Department-wide management problems?

We found no major problems with the first issue. In fact, we were impressed with the documentation on the mission requirements and with the effort to correlate the requirements with the software.

Our views on the remaining three issues follow.

AIR FORCE COMPLIANCE WITH
FEDERAL ADP POLICIES IS WEAK

While the Air Force did comply with the November 10, 1977, delegation of procurement authority issued by GSA, it did not comply adequately at AFGWC with Federal policies that require (1) the avoidance of vendor specialized software 1/ and

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1/FPMR 101-35.206(c)(2)(ii) in effect when this review was made states that "In considering conversion costs care must be taken to avoid undue biases or predispositions which are prejudicial to free and open competition." The revised FPMRs effective January 15, 1981, also emphasize the requirement for competition. For example, revised FPMR 101-35.206-1(b)(5) cautions agencies to avoid the use of vendor-supplied nonstandard software features.

(2) documentation of its software inventory. 1/ A primary purpose of these policies is to make the software more transportable among the computers of different vendors and thereby facilitate competitive acquisitions as well as intraagency sharing of the software packages. However, we found a general lack of compliance with these policies at AFGWC as illustrated by the following three examples.

The FORTRAN V computer language used extensively at AFGWC cannot be transported and made to work on the equipment of another vendor without costly conversion. The basic FORTRAN language itself does have some degree of transportability. However, by locking itself into specialized Univac features of that language, AFGWC gave up the transportability for this software. By contrast the ANSI FORTRAN version which AFGWC has used on some applications in recent years is transportable. Its degree of transportability is illustrated by the fact that the Air Force did not include any cost for 240,000 lines of ANSI FORTRAN when developing its conversion cost estimates.

The almost complete lack of documentation for its existing software is another example of a lack of compliance with Federal ADP policy. Without documentation that permits the software to be understood and worked on by personnel other than the few now responsible for it, a competitive acquisition is made much more difficult. The seriousness of the software documentation problem at AFGWC is illustrated by Aerospace's statement in its study report that

> "* * * Whether the existing software will be modified, partially moved to super computers, or converted to new mainframes * * * it is mandatory for the current system * * * to be documented to military standards."

Aerospace believes that this task is too large to be handled by AFGWC and recommends that a contractor do it. We confirmed Aerospace's observations regarding the level of documentation and found that as of early 1980, AFGWC did not have an ongoing effort to bring its documentation up to standard.

The packing feature mentioned earlier is a third example of the use of specialized software features. In order to

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1/Documentation policies are in the Manual for DOD Automated Data Systems Documentation Standards (DOD Manual 4120.17M, Dec. 29, 1972). Using this manual is mandatory for all Defense activities in accord with DOD Instruction 4120.17.

pack data and retrieve it, specialized programs must be developed and then used as part of the system's everyday operation. We recognize that there were good reasons for using this packing feature. Storage is more efficiently used and, as one consultant pointed out, the time required to move data to and from storage is reduced.

Nevertheless, the price paid by AFGWC for failing to comply with ADP policies is substantial. There is an increasing technical and operational dependence on the specialized features of the incumbent manufacturer's system as well as on the AFGWC developed operating system software such as the real-time operating system. (See p. 16.) The longer this dependence continues the more costly, technically difficult, and operationally risky it will become when a change in computer brands is finally made. And, unless some action is in effect to reduce this dependence, major pressures to avoid a competitive acquisition will continue to be generated.

We believe that AFGWC has already painted itself into a corner where sole-source procurement of general purpose computers appears to the Air Force to be the only viable course. Getting out of this situation involves potentially serious technical problems with resulting operational risks if not managed effectively. By using the ANSI FORTRAN language, the Air Force has taken a step in the right direction. However, it still has a long way to go.

Does our report "The Federal
Weather Program Must Have Stronger
Central Direction" (Oct. 16, 1979)
have any impact on AFGWC?

Because our October 16, 1979, report considered AFGWC as one of the three major centers in the Federal weather program that report does have an impact on AFGWC. 1/ However, while the current review focuses primarily on AFGWC, the purpose of our earlier review was to assess the adequacy of Federal coordination mechanisms for ensuring the effective use of civilian and military operational weather capabilities and fully integrated national weather programs. In that report we cited several important problems and deficiencies. For example, we pointed out the need for more comprehensive planning of major

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1/The three centers are the Air Force Global Weather Central, the Fleet Numerical Oceanography/Naval Environment Prediction Research Facility, and the National Meteorological Center/National Environmental Satellite Services.

weather service programs or functions and provided examples of how each of the three weather organizations generally develops programs to satisfy its own needs without considering the others' capabilities and requirements.

As a result of our October 1979 report and OMB actions, the Federal Coordinator for Meteorology of the Department of Commerce arranged for a series of crosscut reviews of Federal weather programs. Because of these studies, we limited our work in this area to monitoring the study effort. As of this date the following two crosscut studies have been completed by a contractor:

--"Agency Roles, Missions and Program Subtasks, Final Report--September 1980."

--"Numerical Meteorological Processing Centers Subtask, Final Report--September 1980."

If particular study recommendations are implemented, there can be some impact on AFGWC. For example, the study on Numerical Meteorological Processing Centers presented seven alternative organizational structures for the three major Federal weather centers. The alternatives ranged from a single large center to "Centers of Specialization." The concept under this latter alternative, is that

"* * * each processing center would specialize in the production of a particular type of analysis, or forecast that is different from the specialized products of either at the other two centers. Some processing functions would be common to all centers, but the common effort would represent a small fraction of the total effort and would be mainly for convenience or to permit customized products to be matched to user requirements."

*   *   *   *   *

"* * * concept would develop by mutual agreement as each center began to rely more fully on those products to which the other centers gave greatest priority, and which they were able to produce more accurately or on a more timely schedule."

We have not evaluated the report or made an indepth analysis of the comments assembled by the Federal Coordinator. However, there is considerable information presented which we believe merits close followup to insure that parochial interests do not dominate follow-on actions.

Are the Air Force's sole-source plans for AFGWC symptomatic of broader Department-wide management problems?

While we did find some indications that the Air Force may be having some Department-wide problems related to sole-source procurement of computer equipment we cannot, from our review at AFGWC, conclude that the problems we found are symptomatic of Department-wide management problems. The indications that there might be such problems were expressed on February 9, 1979, by the Assistant Secretary of the Air Force (Financial Management). (See p. 3). And, in a letter of the same date, the Director of Computer Resources, Air Force Headquarters, wrote to all the top ADP managers of each Air Force major command:

> "* * * The inability of AF activities to properly plan for and manage their programs for competitively replacing existing ADPE systems or Central Processing Units (CPUs) has reached proportions unacceptable to SAF/FM and myself. * * *

> "* * * when this lack of advance planning for replacement systems continues to result in requests for other than fully competitive acquisitions and forces the Air Force to accept 'interim' upgrades and/or modify written agreements to fully compete, the credibility of the Air Force, its ADP Program and its senior managers here and in the field - suffers."
>
>   *   *   *   *   *
>
> "* * * In this regard, our review of noncompetitive requirements will be extremely comprehensive and approvals, except for the most unusual circumstances, rare."

Based on our October 16, 1979, report, our work in this review, and the information in the above correspondence, we believe the issue might warrant further investigation. However, the Air Force now has underway an ADP acquisition improvement project which we believe will address the problems mentioned in the preceding correspondence. Also, we are now separately reviewing ADP procurement issues Government-wide. This review will include a detailed study of the Air Force acquisition process and procedures. In view of these efforts we did not expand the scope of this review to consider Department-wide management problems.

CHAPTER 4

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

SUMMARY AND CONCLUSION

As part of a long range program to improve the computer based capabilities of the Air Force Global Weather Central, the Air Force insists that a series of sole-source procurements of general purpose computers in the present manufacturer's product line are in the Government's best interest. The Air Force believes that by avoiding the competitive process, it can save $30 million and minimize the technical risks associated with changing vendors. On this basis the Air Force decided to pursue a sole-source acquisition.

We found that the decisions to retain and convert software were not based on life cycle analyses or projected costs of the individual software components such as the weather models, data base manipulation system, and applications programs. We believe that much of the software may be obsolete or approaching obsolescence; and that the remaining life cycles for individual software components should have been projected, costed, and operationally and technically assessed for effectiveness into the late 1980s and documented to provide the basis for management procurement decisions. We found no life cycle documentation for software which indicated that management considered the potential operational, technical, or financial benefits of competitive alternatives that included redesign, enhancement, replacement, or sharing of software. When all these factors are considered, they may well indicate that, in the long run, the Air Force's present sole-source efforts may be more costly than a competitive acquisition.

We believe that management's failure to insist on compliance with Federal policies that would have reduced the AFGWC technical dependence on the current manufacturer's product line has resulted in undue economical, technical, and operational pressures to remain with that manufacturer.

In the absence of definitive documentation covering the projected costs and planned use of the AFGWC software components into the 1990s, we believe that the $30 million is not a valid estimate of the savings that can result from a sole-source procurement. Therefore, we do not believe that the Air Force has properly justified its plans to repeatedly upgrade the AFGWC general purpose computers on a sole-source basis.

RECOMMENDATIONS TO THE ADMINISTRATOR
OF GENERAL SERVICES

We recommend that current action to procure the general purpose computers at the Air Force Global Weather Central be suspended until the Administrator of General Services determines whether competitive or sole-source procurement is in the best interest of the Government. As part of that determination, the Administrator of General Services should require the Air Force to provide:

--The following documentation for each significant software component in the current software inventory:

● The estimated aggregate costs for such items as maintenance, modifications, enhancements, and redesigns over the remainder of the software's full life cycle.

● Projected assessments of its technical status relative to the state-of-the-art for each remaining year of its full life cycle.

--Plans for new software for the period 1982-1992.

--Estimated costs and technical criteria that will be used to reduce dependence on the present manufacturer.

--A long range plan of the software sharing arrangements that it will propose and/or implement with other Federal agencies.

--A comparative analysis that shows estimates of the technical, financial, and operational advantages and disadvantages of sole-source and competitive acquisition over the life cycles of both the hardware and software.

During this period of modernizing the overall automated capabilities of the facility, we believe it is reasonable for the Air Force Global Weather Central to use hardware and software from the Univac product line in order to support critical user needs and maintain an orderly phaseover period.

NINETY-SIXTH CONGRESS

Congress of the United States
House of Representatives

COMMITTEE ON GOVERNMENT OPERATIONS

2157 Rayburn House Office Building

Washington, D.C. 20515

June 8, 1979

Honorable Elmer B. Staats
Comptroller General of the United States
General Accounting Office
Washington, D.C.   20548

Dear General:

For some time now, the Committee, with the assistance of your office, has been pursuing an investigation of the management and use of ADP and telecommunications resources in the Department of the Air Force.   These efforts have proved to be very useful in understanding the management problems of the Government's largest dollar volume user of ADP resources.

In recent weeks, the Department has requested procurement authority to upgrade, on a sole-source noncompetitive basis, two large scale computers to support its Global Weather Central System.   It is my understanding that this acquisition is but a small part of a larger Air Force plan to replace, on a sole-source basis, its entire complement of computer equipment supporting this program.   The total cost of this plan is estimated to be over $100 million.

This proposal is of great concern to me, particularly since the Air Force agreed in 1977 to competitively replace the equipment.   Of even greater concern to me is the apparent philosophy of the Air Force that competitive acquisitions are not in the Government's best interest, and that continued sole-sourcing is the only way in which the Air Force can meet its mission requirements.   While I am aware that this and other recent Air Force procurements have been justified as matters of national security, it has been my experience that the undue reliance on sole-source acquisitions by DOD components has served to undermine rather than enhance our national defense objectives.

I am therefore requesting that you initiate an immediate investigation of the Weather Program to determine whether the Air Force has 1) properly defined its mission needs, 2) justified its need for the proposed sole-source upgrade, 3) complied with Federal ADP policies and regulations including the November 10, 1977, delegation of procurement authority, and 4) has properly justified its plan to perpetually upgrade this equipment on a sole-source basis. This review should take into consideration the potential impact that your recent draft report on "Federal Weather Activities: Stronger Central Direction is Needed" may have on the Air Force's Global Weather System.

I am sure that you are as concerned as I am about the broad, Government-wide implications of the Air Force's contention that sole-sourcing is in the best interest of the Government. I can only hope for an expeditious resolution of this matter. Since the Committee has been working closely with Messrs. George Sotos and John Ortego of your office on ADP requests similar to this case, I would hope that they would be assigned to this effort.

In the event that this investigation reveals that the Air Force's current sole-source plans for the Global Weather Central program are symptomatic of broader department-wide management problems, I request that you expand the investigation to identify the problem areas and recommend corrective actions.

With best wishes, I am

Sincerely,
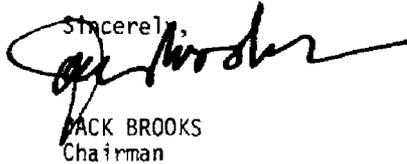
JACK BROOKS
Chairman

ESTIMATED COSTS FOR CONVERTING SOFTWARE IF
A VENDOR OTHER THAN UNIVAC WINS A
COMPETITIVE PROCUREMENT

Transition cost elements	Cost estimated by		
	Air Force	SDC	Aerospace
FORTRAN V code	$ 9,960,000	$2,220,000	$25,880,000
Assembler code	5,580,000	2,400,000	17,220,000
Runstream code	(a)	300,000	3,020,000
Data base	(a)	360,000	10,250,000
Documentation	(a)	600,000	5,600,000
Additional equipment	4,144,000	(b)	(a)
Parallel operations	5,230,000	(b)	(a)
Site preparation	1,510,000	(b)	(a)
Contractor specifications	2,700,000	(b)	(a)
Other	2,280,000	2,320,000	(a)
Total	$31,404,000	$8,200,000	$61,970,000

a/Not estimated.

b/Not applicable for comparison.

The major reason for the wide variance in costs is the
difference in the estimated productivity rates of programmers
who would convert the existing software. SDC assumed the most
competent programmers would be assigned to the task, the soft-
ware functions would not be changed during the conversion
process, and no slippage would occur. Aerospace assumed the
opposite.

<u>EXCERPTS FROM FEDERAL PROPERTY MANAGEMENT REGULATIONS,
AMENDMENT F-44, DECEMBER 29, 1980
(effective Jan. 15, 1981)</u>

1. <u>Paragraph 101-35.206</u> Conversion management and planning.
Conversion from one computer architecture and operating
system software to another is a recurring and costly
activity. * * * However, proper management of an agency's
software inventory and planning for future conversions
will reduce the risk and cost of conversion, enhance com-
petition, and improve the efficiency of ADP operations.

2. <u>Paragraph 101-35.206-1</u> Procurement and management
<u>responsibilities.</u>

   (a) Federal ADP managers and contracting officers share
       the responsibility for assuring that data processing
       requirements are met at the lowest overall cost,
       price, and other factors considered.

   (b) The following are examples of management and planning
       actions that ADP managers should take to facilitate
       future conversions.

                    *   *   *   *   *

       (2) Identify relevant characteristics of all appli-
           cations software; e.g., programming language,
           number of source statements or lines of code,
           type, and size of records and data files, and
           security provisions.

       (3) Use only software design and documentation
           techniques that minimize future software conver-
           sion to develop new application software.

       (4) Use Federal standard or other ANSI standard
           high order languages to the maximum practicable
           extent in developing all new user application
           software. Document agency files with the justi-
           fication for using nonstandard languages at the
           time the waiver is granted.

       (5) Avoid the use, where possible, of implementor-
           defined features and vendor-supplied nonstandard
           extensions in high order languages compilers.

[See GAO note below.] Where it is necessary to use these features and nonstandard extensions, document agency files to support their use and retain the documentation to manage the software during its system life.

(6) Use to the maximum practicable extent data base management systems (DBMS) supported by and that will run on equipment offered by multiple manufacturers of different product lines of ADPE. * * * Where it is not possible to use such a DBMS, document agency files to support this decision and retain the documentation to manage the DBMS during its system life.

(7) Write application software requiring software redesign in Federal standard or other ANSI standard high order languages unless the use of assembly or other languages is clearly justified on the basis of operational requirements or demonstrable economy and efficiency. Document agency files with the justification for using nonstandard languages at the time the waiver is granted and retain the documentation to manage the application software during its system life.

(8) Rewrite application software written in assembly or other nonstandard languages but not requiring redesign in Federal standard or other ANSI standard high order languages to foster competition for subsequent procurements to the maximum practicable extent.

(9) Review, revise, and update as necessary documentation for all existing applications to reduce the risk and cost of future conversions.

(10) Evaluate all feasible alternative courses of action for meeting agency data processing needs before ADPE is acquired on either a sole source, specific make and model, or compatible basis since these types of purchase descriptions limit the competitiveness of the procurement.

GAO Note: Nonstandard extensions are software programs that are developed primarily for one manufacturer's equipment. High order language is a computer programming language that is less dependent on the limitations of a specific machine. For example, FORTRAN is a high order language.

GAO COMPILATION OF STATUS OF SOFTWARE AT AFGWC (note a)

Software Categories	Lines of Code	
	Current totals	Code that needs further analysis to determine if should redesign, enhance, or replace (note a)
	----------(thousands)--------	
FORTRAN V	c/ 1,516	b/ 1,516
Data base manipulation code	-	213
Weather forecast models	-	500
Applications	-	803
ASSEMBLER	235	140
Real-time operating system	91	91
Real-time communication system	39	39
Satellite ingestor	24	-
Intersystem communication	21	-
Mixed mode security (estimate)	10	10
Unknown	50	-
ANSI FORTRAN	241	-
OTHER (job control, etc.)	128	
	b/ 2,120	1,656

a/Because we could not obtain a breakdown of the software
which showed the Air Force's assessment of the components
within each of the above categories, we compiled this
information from our analysis of the various documents we
received and interviews with AFGWC personnel. Our analysis
indicates that, even though the software is functional and
provides effective mission support now, about 1,656,000
lines of code may be approaching a level of obsolescence
that will require it to be enhanced, redesigned, or replaced
before the 1990s.

b/The Air Force, based on past experience, already decided to
replace 485,000 lines of this quantity, but we could not
identify the specific categories.

c/As of August 1980, the Air Force revised the FORTRAN V
estimate upward to 1,666,000 lines.

REQUIREMENTS AND COMPONENTS OF DISTRIBUTED PROCESSING ARCHITECTURE

Year	Requirement	Components of architecture
1980	Meet command control requirements. Meet war readiness required for 3,000 computer flight plans. Eliminate saturation. Expand incoming satellite data handling capability.	General purpose computers, replace 3 Univac 1108s with 2 Univac 1100/81s. Satellite data handling system which includes support processors, cathode ray tubes, and a communication bus.
1981	Automate forecaster work centers. Improve numerical weather forecasting.	Interactive processing and display system which includes support processors, forecaster terminals, & a communication bus. Two array processors. a/
1982	Increase satellite data processing. Consolidate communications functions at AFGWC.	Two array processors plus enhance 2 Univac 1110 general purpose computers. Two frontend minicomputers.
1983	Minimum fuel computer flight plans. Tailored probability forecasts. On-line support to Air Force Technical Application Center. Automated command and control support.	General purpose computers enhance 2 Univac 1100/81s to 2 Univac 1100/82s. (This sole-source acquisition will about double the capacity of the 1100/81s.)
1984	Predict weather and environmental effects affecting laser and infrared weapon systems.	Central data base. This is primarily a software effort which should free considerable computer time.
1985	Replace Univac 1100s due to age. Meet support requirements for high resolution cloud, rain, severe weather, icing, and significant weather forecasts.	General purpose computers. Replace 3 Univac 1110s. Add network control.
1986	Meet space environment support requirements.	One array processor.

a/As a result of the findings in the Aerospace study report, AFGWC is considering large scale scientific processors rather than the array processors.

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