UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

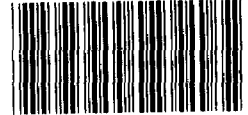MISSION ANALYSIS AND
SYSTEMS ACQUISITION DIVISION

B-205335

AUGUST 12, 1982

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The Honorable Harrison H. Schmitt
United States Senate

Dear Senator Schmitt:

Subject: GAO Position on Several Issues Pertaining to
Air Force Consolidated Space Operations Center
Development (GAO/MASAD-82-45)

This is in response to a July 30, 1982, request from represen-
tatives of your office that we provide additional information to
address your concerns regarding Air Force computer acquisition
plans for the Consolidated Space Operations Center (CSOC). Spe-
cifically, we were asked to comment on the following points:

--Sole-source implications of the Air Force duplicating
  NASA software.

--Implications of Air Force computer system acquisition
  based on our prior audit experience.

--Potential benefits from using the Department of
  Defense's Ada software language.

--A summarization of the factors supporting our position
  that construction of the Shuttle Operations and
  Planning Complex (SOPC) portion of CSOC should be
  deferred until such time as SOPC planning is completed.

Our evaluation of the above points is attached as an enclosure
and is based, in part, on our extended experience in auditing
Department of Defense computer systems development and acquisi-
tion.

As requested, we are restricting this letter for 30 days.
However, upon expiration of the restriction or prior release by
your office, copies will be sent to the President of the Senate,
Speaker of the House of Representatives, Chairmen of interested
committees and subcommittees, Director of the Office of Management

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and Budget, and the Secretaries of Defense and Air Force. We will
also make this letter available to the public on request.

Sincerely yours,

W. H. Sheley, Jr.
Director

Enclosure

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RESPONSE TO
SENATOR HARRISON H. SCHMITT
ON AIR FORCE COMPUTER SELECTION PLANS FOR
THE CONSOLIDATED SPACE OPERATIONS CENTER

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The following sections of this enclosure provide our discussion of concerns expressed by representatives of Senator Schmitt regarding Air Force development of the Consolidated Space Operations Center (CSOC). Specifically, we discuss (1) sole-source implications of the Air Force duplicating National Aeronautics and Space Administration (NASA) software, (2) implications of Air Force computer system acquisition based on our prior audit experience, (3) potential benefits from using the Department of Defense's (DOD's) Ada software language, and (4) a summarization of the factors supporting our position that construction of the Shuttle Operations and Planning Complex (SOPC) portion of CSOC should be deferred until such time as SOPC planning is completed.

SOLE-SOURCE IMPLICATIONS OF THE
AIR FORCE DUPLICATING NASA SOFTWARE

The Air Force and NASA are currently involved in a $10 to $11 million system configuration study for SOPC predicated on duplicating, "as much as possible," many Johnson Space Center (JSC) functions. If the Air Force insists on duplicating NASA software at JSC as the primary basis for development of its SOPC, the result will most likely be a sole source or brand equivalent hardware procurement. This is due to the limiting nature of software languages and/or commands written expressly for one type of processor.

Other alternatives to meeting the SOPC functional requirements do not appear to be considered at this time. In other words, after SOPC is constructed, additional funds will most likely be necessary to modify SOPC to meet military space requirements such as interoperability with the Satellite Operations Complex (SOC). The cost of not considering alternatives now could be considerable because retrofit costs are generally much higher than original design expenditures.

Consequently, the Air Force rush to replicate selected JSC functions could force higher life-cycle costs because future modification is more expensive than design. In essence, this approach permits the Air Force to avoid exploration of feasible alternatives and cost-benefit analyses needed to develop an integrated CSOC capability.

IMPLICATIONS OF AIR FORCE
COMPUTER SYSTEM ACQUISITION

We have reviewed a number of DOD and Air Force computer system development projects over the past decade. Several of the Air Force projects could be considered restrictive because they involved situations, such as standard hardware that was mandated but not adequate to meet functional requirements or preselection of hardware to accomodate previously developed software. Our audit experience with these and related approaches has generally indicated weaknesses, such as

--lack of adequate consideration of user functional requirements,

--emphasis on justifying old software rather than determining what hardware and software are necessary to meet system objectives,

--state-of-the-art technology not reflected in resulting systems.

The following five examples of reports issued demonstrate the types of problems generally encountered.

Problems in Developing the
Air Force's Advanced Logistics
System (LCD-75-101, June 17, 1976)

We found that the Air Force's Advanced Logistics System was facing considerable developmental problems. Significant causes of those problems included:

--The Air Force was developing computer systems without adequate planning, concept evaluation, and testing.

--The design of the system, while considering overall mission requirements, was essentially being modified by fixes to problems noted in testing the system.

Audit results: Several get-well schemes were attempted, but in December 1975 the Congress instructed the Air Force to terminate the program. At that point, the Air Force had spent about $250 million.

NORAD's Information Processing
Improvement Program--Will It
Enhance Mission Capability?
(LCD-78-117, Sept. 21, 1978)

The Air Force attempted to develop a computer system at the
North American Aerospace Defense Command (NORAD) to support mis-
sile warning, space surveillance, and an integrated communication
system segment. We found that after schedule delays of 3 years
and cost overruns approximating $100 million, the Air Force still
had the following problems:

--They had built the system to meet the capabilities of
  the preselected Honeywell H6080 computers. These com-
  puters were unable to meet Air Force performance
  capabilities. Therefore, the system specifications
  were reduced to accommodate the Honeywell computers.
  The result was an inadequate system.

--The hardware that NORAD was directed to use (by the
  Air Force) was old and inadequate to meet certain
  NORAD real time processing needs.

--The software available with the Honeywell computers
  was inadequate for NORAD mission requirements and
  required extensive modification to meet minimum per-
  formance capabilities.

--Management of the development program was fragmented
  and there was little consideration given by the
  development managers to functional NORAD requirements.

--System configuration was based on a design to dollars
  and time situation. The concept of Equivalent Opera-
  tional Capability was introduced when it was realized
  that the system would not reach Initial Operating
  Capability in time.

--There were certain weaknesses in the system that made
  it susceptible to catastrophic failure.

Audit results: Little was done to correct specific problems noted
in our report until congressional hearings were held in May 1981
on failures of the missile warning system. At that time, the Air
Force began to explore replacements for the system and develop a
new system architecture based on requirements and taking advantage
of advances in the state of the art in computer equipment. The
new system is intended to be operational by the late 1980s.

The Air Force Should Cancel
Plans to Acquire Two Computer
Systems at Most Bases
(FGMSD-80-15, Oct. 26, 1979)

     The Air Force was planning to install two computer systems at
each of 105 Air Force bases for life-cycle costs of approximately
$4 billion. However, we found that:

     --The requirement for the computers had never been jus-
       tified as mission essential or operationally required.

     --The configuration of computers was selected without
       adequately developed or defined base-line functional
       requirements.

     --Approximately $600 million to $1 billion in life-cycle
       costs had been overlooked in the Air Force planning.

     --There was a premature commitment to the two computers
       at each base without support from validated require-
       ments.

     --Adequate consideration was not given to cost-effective
       alternatives to the selected approach.

Audit results: We recommended cancellation of the program (also
known as the PHASE IV program). The program was redirected in
1980, and the Air Force reevaluated its requirements for replace-
ment computers and supporting data communications at each of its
105 bases.

Better Software Planning
Needed At The Air Force's
Global Weather Central
(AFMD-81-24, Feb. 24, 1981)

     In an effort to upgrade its computer-based weather forecast-
ing system, the Air Force Weather Service attempted to justify
sole-source upgrade of their system on expected savings of
$30 million. In our review, we found that:

     --Estimated costs for redesign, maintenance, and/or
       enhancement of each software component were not aggre-
       gated and projected over the remaining life cycle.

     --The Air Force failed to identify or evaluate the
       remaining operational life of the individual compo-
       nents of the software inventory.

     --The weather models being used should have been con-
       sidered for redesign or replacement.

--The data base, operating system, and communication
   code should have been updated.

--The application software had to be rewritten.

--The Air Force had failed to compare the financial,
   technical, and operational advantages and disadvan-
   tages of software planned for retention with new or
   redesigned competitively acquired software.

Audit results: We recommended that the General Services Admini-
stration suspend the hardware procurement until it determined
whether, in this case, competitive or sole-source procurement was
in the best interests of the Government. The Air Force did agree
to develop a software improvement plan, and the General Services
Administration allowed the procurement to proceed. We intend to
monitor this program's progress.

The World Wide Military Command and
Control Information System--Problems
In Information Resource Management
(MASAD-82-2, Oct. 19, 1981)

     The Air Force is now executive agent for DOD in the develop-
ment of the WWMCCS Information System (WIS). DOD had spent
several years attempting to come up with a viable upgrade program
for WWMCCS before designating the Air Force as executive agent.
We found that:

--A concept of operations had only recently been
   approved.

--There was no plan that properly defined the detailed
   requirements necessary for system acquisition.

--DOD had prematurely selected a computer system archi-
   tecture relying on state-of-the-art advances not yet
   achieved.

--There was no centralized manager for the WIS, nor was
   there any recognition of the need for one.

We recommended that immediate action be taken to

--complete detailed requirements definitions,

--employ life-cycle management practices,

--develop an architecture based on functional specifica-
   tions,

--centralize management and control of resources, and

--employ proven state-of-the-art computer technology.

Audit results: DOD has established the WIS-Joint Program Management Office (JPMO) and should give this office the necessary control to manage WIS. The Air Force is responsible for JPMO. It has prepared a WIS plan for DOD review and submission to the Congress. We intend to perform a followup review to determine if DOD is adequately resolving the problems.

POTENTIAL BENEFITS FROM USING
DOD ADA SOFTWARE LANGUAGE

We agree with the DOD rationale for development of the standard high-level Ada language. The capability to be manufacturer independent with a standard software language that effectively supports real-time operations and economical maintenance of large-scale software programs implies significant life-cycle cost savings in DOD computer system developments in the near future. While the Air Force takes the position that Ada capability is not readily available, it has entered into a $7 million contract for the development of an Ada compiler for two computer systems, including the IBM 370 family (same family as 3033s) currently in use at JSC and at the Sunnyvale Satellite Control Facility.

DOD needs a language that can inherently support the modular (building block) and real-time programming techniques necessary for cost-effective performance, high reliability, and extended software life. The modular approach is the same capability that also supports lower maintenance costs. While many existing languages, such as the Air Force JOVIAL, can be adapted, in part, to support these real-time, reliability and maintenance needs, DOD selected a new language with these capabilities more inherent in the structure of the language itself. We believe the DOD approach is economically justified and would not recommend extensive modification or utilization of an older language such as JOVIAL.

Finally, the Ada language has been commercially and internationally accepted. We have met with industry officials whose organizations produce Ada based architecture computers and who provide Ada-based compilers and off-the-shelf Ada applications software using available subsets of Ada. Notwithstanding the Air Force reluctance to accept the rapid technological achievements in support of Ada, the commercial and international sectors are starting to implement Ada. We understand the Air Force need to have a complete language available, however, several successful organizations are building production software in the meantime, using Ada subsets.

By considering the use of Ada in CSOC, we believe the Air Force could realize significant benefits. Such benefits include

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high system reliability, reduced software maintenance costs,
enhanced real-time processing capabilities, and manufacturer
independence. This could substantially reduce life-cycle costs.
Since Ada is the recommended direction for new DOD software
investment, we believe that the Air Force should report to the
Congress and provide justification for continued use of non-Ada
software programming applications such as is proposed for the
CSOC development. Further, we believe that the Air Force should
cost the Ada compared to non-Ada alternatives to better support
their position not to use Ada to the Congress.

SUMMARIZATION OF REASONS FOR
DEFERRING SOPC FACILITY

    To summarize our reasons for recommending against the immedi-
ate development of the SOPC portion of the CSOC, we must reiterate
those points made in our primary report (MASAD-82-14) of Janu-
ary 29, 1982, and our rebuttal to DOD comments dated March 22,
1982. They are:

    --There is no overall DOD plan for the military exploi-
       tation of space that defines the role of military
       Shuttle missions.

    --Planning for the SOPC portion of CSOC is still in the
       formative stages (scheduled completion is June 1983)
       and exact requirements for computers have not been
       adequately articulated.

    --The Air Force position that there is an immediate need
       to substantially duplicate Shuttle control and opera-
       tions functions at JSC is questionable.

    In this regard, we are concerned that if the Air Force pro-
ceeds with immediate implementation of SOPC development, the
probability of success could be reduced.