MISSION ANALYSIS AND
SYSTEMS ACQUISITION DIVISION

B-205335

AUGUST 12, 1982

The Honorable Harrison H. Schmitt
United States Senate

Dear Senator Schmitt:

    Subject: Evaluation of NASA Comments On GAO Report
                MASAD-82-14 "Consolidated Space Operations
                Center Lacks Adequate DOD Planning"
                (GAO/MASAD-82-43)

    As requested in your letter of July 28, 1982, we have evaluated the unsolicited comments of the National Aeronautics and Space Administration (NASA) on our report entitled, "Consolidated Space Operations Center Lacks Adequate DOD Planning" (MASAD-82-14, Jan. 29, 1982). Our review dealt specifically with the Department of Defense activities, and its interrelationship with the NASA-managed Space Transportation System was a secondary issue. In this regard, NASA's comments relative to Johnson Space Center are welcomed, and we believe appropriate, concerning its plans and capabilities.

    While we find NASA's comments informative as to its own plans, no new information was provided that change our findings regarding the Air Force's planned development of a Consolidated Space Operations Center. We find NASA's views support our contention that the Air Force planning is not adequate to begin construction of a Shuttle Operation and Planning Complex (SOPC) at this time. We still recommend that only the Satellite Operations Complex (SOC) be replicated on an interim basis to provide appropriate backup for the Satellite Control Facility in Sunnyvale, California. SOPC, in our opinion, is not time critical.

    NASA's letter also raises questions as to the planning interface it has with the Air Force; namely, NASA appears to support the contention that the Air Force is not bound to any particular computer for SOPC. However, the Air Force will essentially be locked-in sole-source procurement if only NASA software is used. Further, NASA projects cost savings by the sole-source procurement of equipment similar to theirs. We have found that, historically, preselection of computers (before requirements are known) has invariably led to less than satisfactory system developments.

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We are sending copies of this letter to the President of the Senate and the Speaker of the House of Representatives. Copies are also being sent to the Chairmen of the Senate and House Committees on Appropriations and the Subcommittees on Defense and Military Construction; Chairmen, Senate Committee on Governmental Affairs and Committee on House Government Operations; Director, Office of Management and Budget; Administrator, National Aeronautics and Space Administration; Secretary of Defense; and other interested officials. Copies will be available to the public on request.

Sincerely yours,

W. H. Sheley Jr.
Director

Enclosure

EVALUATION OF UNSOLICITED NATIONAL AERONAUTICS AND

SPACE ADMINISTRATION COMMENTS CONCERNING

CONSOLIDATED SPACE OPERATIONS CENTER LACKING

ADEQUATE DEFENSE PLANNING

NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION COMMENT

The GAO report, "Consolidated Space Operations Center Lacks Adequate DOD Planning," MASAD 82-14 dated January 29, 1982, includes several statements which inaccurately represent NASA plans and capabilities relative to the use of data processing systems for Space Shuttle operations support. Of even greater importance is the overall GAO position that the NASA Mission Control Center computer hardware and software are outmoded and that the Air Force is planning to use the same equipment and software in their own facility. These conclusions represent a substantial misunderstanding of what is being planned. The information used by GAO in arriving at their position is both incomplete and inaccurate, and as a result, both the Congress and the scientific community have been seriously misled.

OUR EVALUATION

The National Aeronautics and Space Administration (NASA) has apparently misinterpreted our report as representing an evaluation of their plans and capabilities. The subject of our review was the Air Force's planned construction of the Consolidated Space Operations Center (CSOC) at Colorado Springs, Colorado. We concentrated on Air Force plans to develop and build this facility and the equipment it would need to meet perceived mission requirements. With respect to NASA equipment being obsolete, the Air Force, in its October 20, 1981, Definition and Requirements Study and again in its July 1982 Program Management Plan, discussed the obsolescence of certain NASA Mission Control Center hardware and the fact that these items are no longer commercially available. Air Force documents also reference IBM 3033N models as those to be used by NASA. Further, in April 1982 the EDP Industry Report stated that the IBM 3033N series had been obsolete since October 1981.

The Air Force will essentially be locked-in to sole-source procurement if only NASA software is used because NASA software only works on one brand of computers or compatible computers. For example, software using special commands developed for a compiler available on an IBM 3033 will not readily run on a Honeywell computer unless software conversion is accomplished. The reason is that the special commands on the IBM system may not be available on the Honeywell computer and these commands would have to be converted to those available on the Honeywell system.

The fact that the Air Force was planning to install IBM 3033 equipment in the Shuttle Operations and Planning Complex (SOPC) of CSOC was determined from statements made by officials of the Air Force's Space Division, System Program Office for CSOC. Also, the NASA Master Measurements Data Base System Configuration Definition Plan indicates the use of IBM 3033 equipment in the system to be replicated in SOPC. From Department of Defense (DOD) information gathered in our review, it is the expressed intent of the Air Force to use IBM 3033 or compatible upgrade computers in CSOC for both the SOPC and Satellite Operations Complex (SOC) functions.

NASA COMMENT

At the Air Force's request, NASA is conducting a 15-month, $10 million System Definition Study to identify the most cost-effective methods for the Air Force to acquire a Shuttle operations capability as quickly and as economically as possible, while assuring that when this capability is in operation both the NASA JSC Mission Control Center and the USAF SOPC can serve as fully-functional backup for each other.

OUR EVALUATION

In February 1982, subsequent to issuance of our report, NASA and the Air Force initiated a SOPC System Configuration Study. It will cost $10 to $11 million, take 15 months to complete, and is funded by the Air Force. In our opinion, this type of study should have been completed before Air Force requests for CSOC funding and equipment acquisition. This study supports our previous reported position that DOD planning is not adequate to serve as a basis for the proper selection of equipment.

NASA COMMENT

Of paramount importance is the fact that the Air Force will not be restrained in their selection of hardware. The System Definition Study will establish a baseline which will describe the minimum host hardware capability needed. The Air Force will have the option of choosing any technology level they feel is necessary to meet their needs. Since the Air Force has not yet made their choice, it is difficult to see how GAO can say that they are acquiring outmoded capability.

However, as part of this process we do intend to make maximum use of the existing software which we have developed at a cost of almost $420 million. We believe that this is the most sensible and prudent course to follow in view of the fact that in recent years the development of new software has become the most costly element in the procurement of any new data processing capability.

OUR EVALUATION

Our review of official documents and discussions with Air
Force officials indicate that the Air Force plans to replicate
selected parts of the NASA system at Johnson Space Center (JSC) in
SOPC. To provide "like system" capability, using the same NASA
developed Shuttle software "as much as possible," constrains the
Air Force to using only a limited selection of IBM or IBM compati-
ble computers. The NASA assertion that the Air Force baseline for
"host hardware" has not been established, while stating the system
should be replicated, can be interpreted in several ways. For
example, is the real purpose of the $10 million plus study to pro-
vide selective replication of JSC Shuttle planning and operation
capabilities on a sole-source basis or would development of func-
tional specifications allow for a more competitive procurement and
the acquisition of state-of-the-art technology?

NASA states that original development of its Shuttle soft-
ware, onboard and ground, cost about $420 million. Recent dis-
cussions with officials at JSC indicate this cost includes about
7.5 million lines of code or a cost approximating $56 per line.
However, unsolicitated DOD comments to the Comptroller General,
dated June 21, 1982, state that conversion of about 5 million
lines of JSC Shuttle software into an integrated system (SOC and
SOPC) would cost from $100 to $150 per line, or about $500 to
$750 million. Further, in its response to the Senate MILCON Sub-
committee on June 24, 1982, the Air Force stated that $150 per
line of code was the industry standard for software conversion and
estimated a cost of $1.3 billion for conversion of 6 million lines
of JSC code and 3 million lines of Satellite Control Facility
code. Consequently, the Air Force maintains the most attractive
approach is a colocated, noninteroperable SOPC.

We know of no industry standard of $150 per line of code. A
recent estimate provided by the Congressional Research Service
indicating a cost as low as $10 and the above illustrated NASA
development cost of $56 per line tend to repudiate such a stand-
ard. Unfortunately, this leads us to conclude that insufficient
analyses have been performed by the Air Force to support the argu-
ment of exhorbitant software conversion cost. We continue to
maintain that an integrated and interoperable CSOC is cost effec-
tive.

NASA COMMENT

GAO STATEMENT: "JSC upgrade anticipates at least 10 IBM 3033s."
"The IBM 3033s were developed about 1977, and if CSOC reaches its scheduled
Initial Operating Capability by 1987, they will be 10 years old. They have
already been pronounced obsolete, being replaced by the IBM 3081 computers.
This raises serious questions about maintenance repair parts and maintenance
personnel availability in 1987."

NASA COMMENT: This segment of the report is inaccurate in two ways. In the
first place the report implies that the 3033 systems are in the Mission
Control Center when, in fact, they are not. They have never been a part of
the Mission Control Center and we do not plan to install any of them there.
In addition, the statement that we are buying 10 IBM 3033 systems is not
correct. Our existing contract with IBM calls for the phased acquisition of
three IBM 3033s rather than the 10 cited in the report. These systems are to
be placed in our Software Production Facility, which is used to generate the
Orbiter onboard software loads. One 3033 system has been delivered, one is
scheduled later this year, and another two years later. At the present time
we are negotiating with IBM to explore the feasibility of substituting a newer
3083 system for the third 3033.

We agree with GAO that the IBM 3081 systems are more powerful than the
3033-type systems, but at the time we began this procurement we did not
choose the 3081s because IBM did not offer them. This occurred because our
specifications called for a multiple-system capability using several smaller
systems which could be used as backup for each other, as well as accommodate
simultaneous secure and non-secure processing. This technology is fully capable
of meeting current mission requirements, and as these requirements change, the
use of smaller, multiple systems will allow us to take advantage of new
technology without undue cost or loss of the software capability already
developed.

We have not experienced any difficulty in maintaining our own systems in the
past, and we have not encountered anything in our planning which would
indicate that there will be a problem in the future.

OUR EVALUATION

The 10 IBM 3033 computers referred to in our report were
those that the System Program Office officials felt would be
necessary for CSOC to replicate selected JSC capabilities. As we
have stated before, it was the Air Force's intent to use 3033 com-
puters because of software compatibility with the NASA IBM 360,
370, and 3033 computers. This statement was not meant to infer
that NASA was installing 10 IBM 3033 computers at JSC.

NASA COMMENT

GAO STATEMENT: "In addition to being old, these business type processors (scalar) are not the scientific type of computers (vector) that are more efficient for complex satellite orbit computations. If a normal automatic data processing development cycle had been followed, the advantages of more capable scientific computers probably could have been considered."

NASA COMMENT: Complex space vehicle orbit computations make up a relatively small percentage of the total processing performed by JSC mission support computers. If complex vector processing were a significant requirement in this environment, the existing system 370 computers in the Mission Control Center could have been readily augmented with the attachment of standard IBM vector processing subsystems.

OUR EVALUATION

According to evidence gathered during our review, the Air Force could have data processing requirements that are different from NASA space requirements. These situations should be reviewed by the Air Force to determine if scientific (vector) processors are more appropriate than scalar (business type) processors. The NASA statement that scalar computers are sufficient for their purposes may be true, but we believe that the Air Force should consider alternatives in faster vector processors commercially available for their mission requirements. For example, if the vector machines were operated in the scalar mode, they would be from 2 to 5 times faster than the current NASA scalar machines.

This capability of vector processors enhances the potential for integration. For example, in our report (MASAD-82-14), we mentioned that the Space Defense Operations Center (SPADOC) could be a candidate for integration into CSOC. The Air Force acknowledged the economies of this type integration in December 1979 when it reported:

> "Many of the requirements which drive the design of the CSOC are inherently the same as those for the SPADOC. The computer system and software (orbital mechanics algorithms) requirements are similar, and in many cases, computational routines will be identical. Communications links, terminal requirements . . ., automated switching and message handling are also expected to be similar, if not identical. The capability to calculate orbits for predictive avoidance in CSOC and SPADOC would allow the flexibility to run the program in SPADOC while CSOC is saturated with another high priority job, or during a subsystem failure."

NASA COMMENT

GAO STATEMENT: "Besides modern hardware, new developments in software technology have not been recognized. The replication of SCF hardware and software may be the least expensive short-run option available. In the long run, however, the increasing difficulty with maintaining old software may offset any savings. We have noted that SOC and SOPC are written in older languages, Jovial and Fortran. The Air Force intends to replicate the JSC software and rewrite the upgraded SCF system in Jovial J-73. In this regard, DOD is currently standardizing on a new high level language called Ada. This state-of-the-art language is intended to replace the older Jovial and provide more cost-effective software development and maintenance capability. While we have not fully reviewed the DSM program, we believe that converting the programs to Jovial J-73 then having to convert into the DOD standard Ada language is not a cost-effective approach."

NASA COMMENT: GAO's implication that software maintenance will be more efficient if reprogrammed into the newer language has no basis in fact. As previously stated, the System Definition Study does not mandate that the Air Force duplicate the data processing hardware existing at JSC. Most of the $420 million software investment currently executes on IBM and UNIVAC computers. This software is upward compatible with newer IBM and UNIVAC computers so the Air Force is free to procure newer computer systems.

A certain amount of reprogramming and restructuring of data files is always needed when new host computers are being considered. However, the costs of these activities are not significant when it is considered that the Air Force will not be required to make any investment in the development of the software, and their maintenance costs will be limited to the amount required for software development unique to the SOPC.

In addition, the replication will result in a savings by preserving the commonality of software needed to enhance the mutual backup capability of the two Centers thereby saving most of the $420 million already invested.

OUR EVALUATION

According to industry sources, software maintenance is simpler for software written in the Ada high level language because of capabilities such as the Ada "package" (building block) architecture. To make changes, you only concern yourself with one package, not the whole program. In our opinion, the Air Force has not adequately considered using the Ada language compiler for IBM 370 architectures currently scheduled to be delivered to the Air Force Systems Command in the 1983-84 time frame. This $7 million contract between Systems Command's Rome Air Development Center and Intermetrics Corporation of Cambridge, Massachusetts (F3-0602), is for delivery of a compiler and essential software tools that would facilitate developing software for SOPC in the newer machine transportable Ada. The IBM/Ada compiler could, if necessary, handle routines written in older high-level languages, such as JOVIAL and FORTRAN, and make the CSOC architecture less manufacturer dependent.

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In summary, we believe the information provided by NASA in their comments on our report reinforces our recommendation that the SOPC portion of CSOC is not yet adequately planned. We believe that until the Air Force has a firm definition of what SOPC mission and configuration requirements are, no SOPC specific equipment procurement should be started. We still believe that the Air Force should only build an interim SOC capability in Colorado at this time.

The NASA comments did raise the issue of the means of procurement that may be used to buy the computers for SOPC. Their indications of cost avoidance by using sole-source upgrades to IBM and UNIVAC computers are not, in our opinion, appropriate. As we have stated, and NASA reaffirmed, the requirements for SOPC have yet to be fully determined.

We believe that no procurement of SOPC computers should be made until such time as requirements have been firmly established and consideration given to the advantages of using the new DOD standard high-level language Ada. Such an action, while requiring an initial investment, should pay dividends in the future. The Air Force will be able to upgrade its equipment to more technologically capable machines when it becomes cost effective, without having to limit their selection to certain manufacturers. In effect, the Air Force could be nearly manufacturer independent.

The fact that Air Force and DOD have been computer manufacturer dependent in the past is not necessarily bad because primarily the manufacturer had enough expertise to conceive and develop computer application systems. However, DOD need no longer encourage manufacturers to specify equipment for their systems because of the current diversity of independent computer system design organizations.