COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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APRIL 16, 1979

The Honorable Jamie L. Whitten
Chairman, Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

Your February 26, 1979, letter requested that we review the Department of Defense's plan to purchase two satellites for the Defense Satellite Communications System, Phase II (DSCS II). Our findings, conclusions, and recommendations are summarized below. A more detailed discussion of the results of our review is provided in the enclosure to this letter.

We have concluded that Defense's requirement for the Phase II satellites has not been justified. This requirement is based on a theoretical gap in communications (caused by not having enough satellites in the phase's final years) before the operational Phase III (DSCS III) satellites become available. The problem with this theory, however, is that the two Phase II satellites could not be launched in time to fill any gap between the two phases. The earliest possible launch of the two Phase II satellites could not occur before the Phase III satellites are scheduled to be in orbit and operational. Any difficulties with the remaining Phase II program, such as launch failures or catastrophic failures of on-orbit satellites, could not be alleviated by this additional procurement.

The justification for this procurement was enhanced because Defense Communications Agency program officials used a different criterion than that used by Air Force officials responsible for the satellite procurements to determine the numbers of satellites needed to maintain system availability. This rule change resulted in an apparent need for the two satellites, but, in our opinion, the need is neither appropriate nor practical in terms of actual satellite deliveries and launch schedules. On the basis of Air Force records showing realistic Phase II and III launch dates, we conclude that the gap predicted by the Defense Communications Agency will not occur unless the Phase II satellites either fail prematurely in orbit or they fail to attain orbit. However, the launch of the two new Phase II satellites would not occur before the Phase III satellites become operational.

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The proposed costs for the two satellites and launch associated costs are about $103.8 million in constant dollars for the years programed. This amount would be funded with $16.4 million in fiscal year 1979 funds ($8.3 million to be reprogramed), $55.4 million in fiscal year 1980, and $32 million using fiscal year 1981 and 1982 funds.

The two Phase II satellites could conceivably serve a backup role in the event the Phase III experience turns out to be less reliable than current predictions. However, Air Force officials maintain that the Phase III satellites' estimated production schedule is attainable and the launch vehicle reliabilities will be very high because they will be manned shuttle flights. Since satellites 17 and 18 were not justified on the basis of Phase III experiences, it appears that their procurement is unneeded.

Because of the Committee's urgent reporting requirements, there was insufficient time available for us to obtain formal comments from the Department of Defense on this report. Defense officials with whom we discussed the report declined to provide oral comments.

On the basis of our findings and conclusions, we are therefore recommending that the Secretary of Defense direct the Secretary of the Air Force to terminate all efforts to procure additional Phase II satellites, unless their procurement is justified on some other basis.

As requested by your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of the report. At that time we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

Comptroller General
of the United States

Enclosure

ENCLOSURE I

OUR EVALUATION OF THE DEFENSE DEPARTMENT'S PLAN TO PROCURE TWO DSCS II SATELLITES

HISTORY OF THE DEFENSE SATELLITE COMMUNICATIONS SYSTEM

Defense's first venture into the realm of satellite communications was Project Advent, an experimental program that was terminated in 1962. Defense then established the Initial Defense Communications Satellite Program (IDCSP) during the same year. IDCSP was a system of about 26 satellites in orbit that became operational by 1968 and provided an experimental, but usable, worldwide military communications network.

In 1969 Defense initiated development of the Defense Satellite Communications System, Phase II (DSCS-II) program to replace IDCSP. The DSCS IIs were to have greater communications capacity and flexibility than the IDCSPs and also a limited anti-jamming capability. Since 1969 Defense has bought 16 DSCS II satellites. In early 1979, or about 10 years after its inception, the DSCS II system became fully operational. For full system operation, each one of four DSCS IIs is positioned over one of four ocean areas: the Atlantic, East and West Pacific, and the Indian Oceans. At this time, one spare DSCS II is also in orbit. Defense plans to provide global communications coverage with four satellites and two on-orbit spares.

Defense initiated the Phase III or DSCS III program in 1974. DSCS III satellites have been under full-scale development since February 1977 and they are being considered to provide global communications support to Defense users through the 1980s. A system of four DSCS III satellites in orbit (with two on-orbit spares) is expected to offer improved communications over the DSCS IIs, such as greater communications flexibility, additional communications channels, and specialized antenna designs for selective Earth coverage.

BASIS FOR DECISION TO PROCURE TWO DSCS IIs

On March 25, 1978, DSCS II satellites 9 and 10 were lost due to a launch-related failure to attain orbit. The Air Force immediately requested the Space and Missiles System Organization (SAMSO), which is responsible for

managing all DSCS satellites' development and production contracts, to report on the impact of this failure to the DSCS program. In response, SAMSO had its technical consultants, the Aerospace Corporation, perform a DSCS II availability analysis, using the corporation's computer model called the "General Availability Program" or "GAP" analysis. Aerospace has historically analyzed DSCS satellite availabilities for SAMSO's use in estimating the number of satellites needed and the satellites' predicted need dates to sustain operational criteria. SAMSO bases the contracted number of satellites and their delivery schedules from the contractor on the GAP results.

In April 1978 Aerospace reported on the results of its GAP analysis. The Aerospace results were then reflected in SAMSO's April 11, 1978, letter from the DSCS Deputy Program Director to Air Force Headquarters and also to the Defense Communications Agency (DCA), which is responsible for the overall DSCS program management. SAMSO recommended that DSCS II satellites 17 and 18 be dropped. According to the letter, Aerospace's GAP analysis shows that a "buy of additional DSCS II satellites 17 and 18 does not appear warranted based on our analysis of availability requirements." The letter also stated:

> "In our assessment, the most significantly reduced system availability predictions pertain to the present period; procurement of additional satellites is too lengthy a process to alleviate the current shortage."

Therefore, in April 1978 SAMSO recommended against buying two additional DSCS II satellites.

In mid-1978, DCA recommended to the Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence (OASD/C3I) in favor of buying the two additional satellites. However (according to SAMSO), OASD/C3I deferred that decision to await the outcome of a planned launch of DSCS II satellites 11 and 12.

Satellites 11 and 12 were launched successfully in December 1978. In January 1979, four operational (and one spare) DSCS II satellites were, for the first time, providing full global coverage. Concerning these satellites' latest status, a March 3, 1979, SAMSO document stated, "Flights 9434, 9437, 9438, 9441, and 9442 continue to operate normally,

providing uninterrupted communications service." At that time, therefore, the five DSCS IIs were functioning normally. Also, no other satellite launches had either been scheduled or had occurred since the last successful launch.

It is pertinent at this point to describe the parameters SAMSO and Aerospace used in April 1978 as inputs for their GAP analysis:

--The mission success criteria for each satellite on orbit was to have four channels operational on the DSCS IIs and at least three channels operational on the DSCS III satellites.

--The DSCS II and III satellite reliability functions 1/ with respect to time were about 4 and 14 years, respectively.

--The satellites' reliability functions were also truncated at their respective design lives of 5 and 10 years. 2/

--At least four satellites are required in orbit.

--Each launch vehicle had a reliability of 0.85 (derived from dividing the number of Titan IIIC launch successes by the total number attempted).

--All satellites already in orbit and the proposed launch dates for known successor satellites were used as inputs to the GAP.

The input parameters that have the greatest impact on availability are (1) satellite reliability, (2) launch vehicle reliability, and (3) launch schedules. The satellite availability function, which results from all of the above parameters, is plotted as a function of time. Each point where

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1/Probabilistic mathematical functions representing each satellite's reliability over a period of time.

2/The integration of each satellite's reliability function to its truncation point in time results in its mean mission duration or average life. In this case, the mean mission durations are about 4 and 8 years, respectively.

the satellite availability curve degrades to 90 percent 1/ is used as the need date for a successor launch of satellites. If a significant period of time passes before a successor launch can be scheduled, the mission success criteria predicts that a gap in communications will occur. SAMSO would normally schedule launches to ensure that no gaps occur.

DCA JUSTIFICATION CHANGES THE PROCUREMENT GROUND RULES

DSCS program officials at DCA gave us the chart shown on page 8 as the justification for the planned buying of two DSCS II satellites. In the interest of maintaining the unclassified nature of this report, the actual calendar years have been replaced by relative years in order to conceal planned launch dates. The family of availability curves in DCA's chart, which are called "sail curves," represents four-satellite availability based on their reliability functions. Each discontinuity, or leading edge of the curve, represents either the launch of a pair of satellites, or in the cases of the DSCS III developmental flight satellites (DFS 1 and 2), the points where they become operational. 2/ The decaying edge of the curves represents satellite system availability which degrades exponentially as a function of satellite reliability.

The parameters used by DCA in their analysis are (1) launch vehicle reliability for a Titan IIIC = 0.80 (13 and 14), Titan 34D/IUS 3/ = 0.80 (15 and DFS-1), Titan 34D/IUS = 0.90 (16 and DFS-2), STS/IUS 4/ = 0.97 (17 and 18 and all DSCS III production flights) and (2) all the other parameters are consistent with those used by SAMSO.

The most significant point to make about the difference between DCA's and SAMSO's GAP analysis is that SAMSO allows the availability to degrade to 90 percent before scheduling

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1/Contractually imposed on the DSCS III contractor.

2/The developmental satellites become operational after 6 months testing.

3/Interim upper stage.

4/Space Transportation System or Space Shuttle.

new launches. This approach is consistent with the 90 percent mission success, performance requirement, which is contractually imposed on the DSCS contractor. Conversely, DCA's analysis allows launches to occur at an accelerated rate regardless of the 90 percent point and before it occurs. This has the overall effect of compressing the DSCS II mission life, and an apparent gap in availability is the result. In summary, DCA's analysis forces accelerated launches, which creates an impression of an availability gap during calendar year 4. The gap appears to exist in DCA's chart until the DSCS III launch in early calendar year 5. According to DCA officials, this gap could be filled if the two new DSCS II satellites were to be launched in the second quarter of calendar year 4. This part of DCA's rationale is inconsistent with launch schedule realities, however, as explained below.

ACTUAL SATELLITE DELIVERY DATES AND LAUNCH SCHEDULES NEGATE THE DCA GAP

We reviewed the DSCS II and DSCS III contracts and other pertinent SAMSO documentation to determine the reasonableness of DCA's assumptions, which are used as justification for buying the two DSCS II satellites. SAMSO and Aerospace officials were interviewed to determine the appropriateness of launching the satellites prior to reaching 90 percent availability on DCA's chart. We also asked these officials to run another GAP analysis and to use our provided inputs to the model. The Aerospace official declined to do this because of time constraints, and he stated that another computer run would not change Aerospace's earlier conclusion. Since no other launches have been attempted since the successful launch of 11 and 12, no significant parameters could have changed. Therefore, an availability gap still should not exist.

Since there was an apparent discrepancy between Aerospace (SAMSO) and DCA launch strategies, we discussed the appropriateness of allowing the DCA availability curves to degrade to 90 percent before launching the next pair of satellites. The Aerospace official said that by using DCA's curves and (by curve fitting) allowing them to degrade to 90 percent availability, a good first-order approximation to new launch dates could be accomplished. We performed this approximation and plotted the results on a chart that is similar in scale to DCA's. (See chart on p. 9.)

The conclusions to be derived from the second chart are:

--By allowing the system availability to degrade to 90 percent before requiring a launch, the potential gap that is of concern to DCA, no longer exists. This launch approach is consistent with SAMSO's, Aerospace's and the contracted mission success criteria for the DSCS satellites.

--DCA used a different criterion than that used by SAMSO, which resulted in an apparent need for the two satellites.

In addition to the rule change, we found that DCA's analysis dismissed prevailing satellite and launch vehicle delivery schedules that should have been known to both the SAMSO and DCA officials, since they both manage the DSCS program elements. At each point in time where the sail curves (see chart on p. 9) reach 90 percent availability, the resulting date is consistent with either contract satellite delivery dates or launch schedules. Since these scheduled dates would not occur earlier (see p. 8), then DCA's compressed launch schedule is unrealistic and any predicted gap in availability should not occur as a result.

Most significantly, however, the launch of DSCS II satellites 17 and 18 cannot occur any earlier than very late in calendar year 5. This schedule reality negates DCA's use of the two satellites as gap fillers if the DSCS III production satellites meet the mission success criteria which should be well before the first possible 17 and 18 launch.

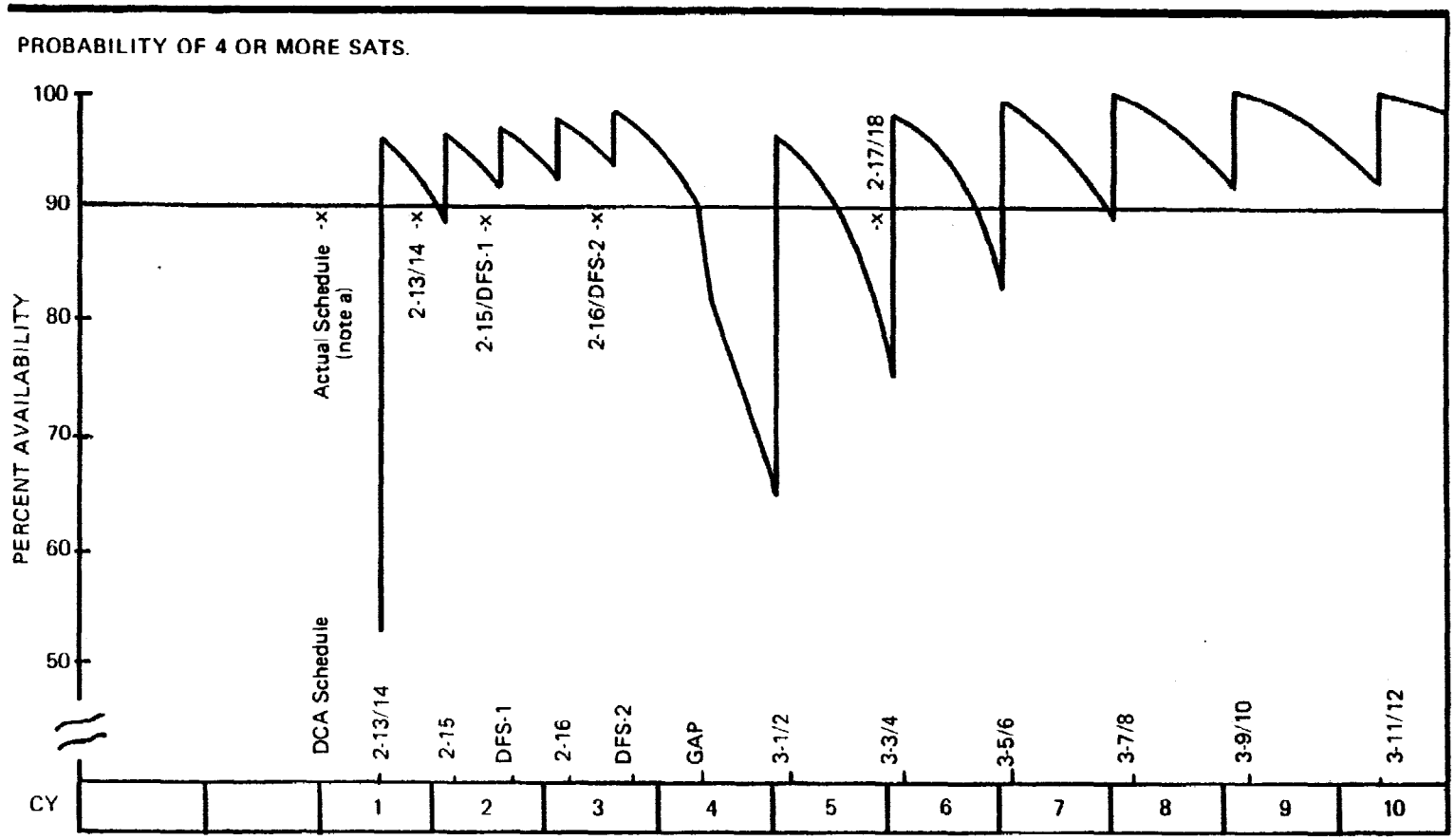
The Air Force would launch the two DSCS II satellites on an STS/IUS as the prime launch vehicle. Funding for the first-time integration of DSCS II satellites to the STS/IUS launch vehicle has not been included in the Air Force's current budget or the January 1979 Five Year Defense Plan. The standard STS/IUS integration period is at least 4 years.

According to the Air Force, compressing the STS/IUS schedule for the two DSCS IIs could be particularly difficult since the 17/18 payload would be pathfinding the integration process as the first dedicated STS payload for Defense. Any DSCS II design modifications required for STS compatibility would complicate the process and ultimately extend the 4-year period. The above information was presented at the DSCS III Air Force Systems Acquisition Review Council meeting which

was held in early March 1979. In addition, since pertinent design studies are not underway and Defense has not initiated negotiations for purposes of contracting, the award of an STS/IUS and DSCS II first-time integration contract could be delayed by many months.

The impact of the DSCS II and STS/IUS integration schedule places the potential launch of 17 and 18 on the STS/IUS in the late calendar year 5 or early calendar year 6 time periods. Any significant delay to the standard integration schedule would push the launch date back to a proportionally later time in calendar year 6 or beyond. Production DSCS IIIs are scheduled to be providing system availability well before the first possible DSCS II launch date. On this basis, the two DSCS II satellites would not be useful as operational gap fillers and their procurement is therefore not justified.

LAUNCH SCHED. WITHOUT 11-17/18
(DSCS III – DFS 1&2 SLIP 7 MO.)

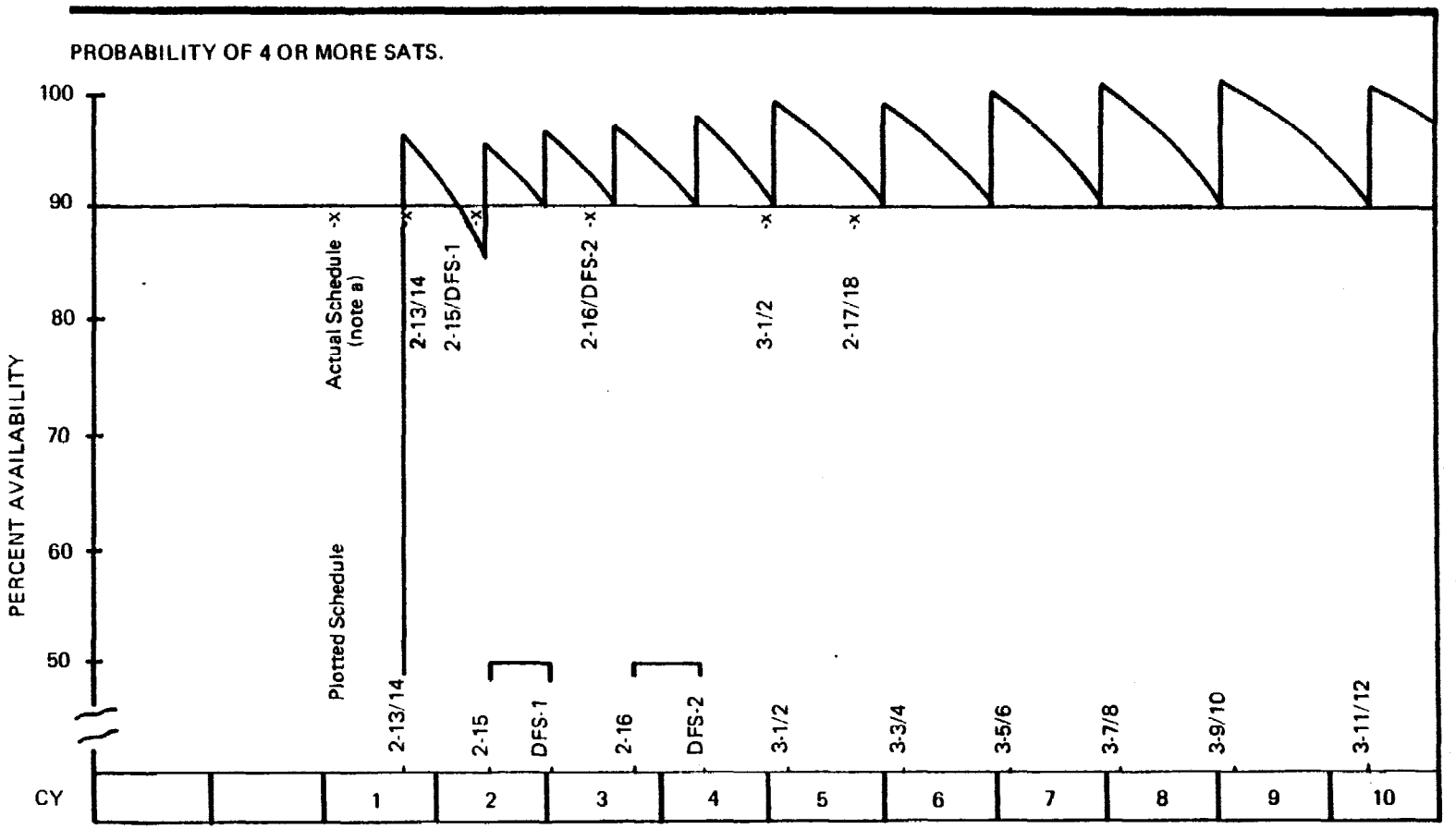


a/ For purposes of comparison, we have inserted scheduled launch dates based upon satellite and launch vehicle availabilities denoted by -x.

CHART1

ENCLOSURE I

CURRENT LAUNCH SCHED. WITHOUT 11-17/18
ALLOWS DEGRADATION TO 90 PERCENT



a/ For purposes of comparison, we have inserted scheduled launch dates based upon satellite and launch vehicle availabilities denoted by -x.

CHART 2

ENCLOSURE I