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HANDLE VIA BYEMAN CONTROL SYSTEM

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

9 AUG 1972

Mr. Carl Duckett
Deputy Director, Science & Technology
Central Intelligence Agency
Washington, D. C. 20505

Dear Carl:

Last May, I asked Mr. Frank W. Lehan to undertake a study of future DoD space operations, assuming the use of the NASA space shuttle. This study was to be payload oriented, emphasize new ideas and concepts, and encompass a broad spectrum of possible military space operations. Mr. Lehan has now submitted his report, "Space Shuttle Implications on Future Military Space Activity", two copies of which are attached, and I think you will agree he has done a remarkably fine job of meeting my objectives.

I appreciate the interest and cooperation which you, [redacted] 25X1 and Mr. Brownman showed in this study and particularly the very fine, thoughtful, and comprehensive inputs received from Mr. Dirks.

I hope that you will find this report useful. I would appreciate any comments you may have on the report, or suggestions on actions which should be taken as a result of the points raised by Frank Lehan in this study.

Sincerely,

John S. Foster, Jr.

Attachment (2 cys.)

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CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

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20 July 1972

MEMORANDUM FOR: Mr. Howard P. Barfield
Acting Assistant Director, Space Technology,
O/DDR&E

SUBJECT : Potential Space Shuttle Applications

This paper presents in summary form the conclusions reached as a result of several "brainstorming" sessions on potential applications of the Space Shuttle to strategic intelligence problems. Specifically, the primary focus of attention was Space Shuttle utilization as transportation for reconnaissance systems.

It has been assumed in these considerations that the Space Shuttle will be developed by NASA at no direct DoD program costs. It has been further assumed that a Space Shuttle launch will be achieved for a direct program cost of between [redacted] The Space 25X1 Shuttle model used had a 65,000 pound payload capability into low earth orbit from ETR and a 40,000 pound capability into low earth polar orbit from WTR. The payload bay was taken to be large enough to accommodate a cylindrical payload 60 feet in length and 15 feet in diameter. The zero payload altitude is understood to be 700 nautical miles. Further, the Space Shuttle as such has no synchronous altitude capability; however, there does exist the possibility of developing a "space tug" which would take both men and payload to synchronous altitudes and return. Another possibility under consideration is developing a transfer stage to take a synchronous altitude payload from low earth orbit to synchronous altitudes.

Space Shuttle potential applications were viewed from three different perspectives: (1) the Space Shuttle as a large launch vehicle, (2) the Space Shuttle as a large launch vehicle with a recovery capability, and (3) the Space Shuttle as a transportation system involving men with the ability to perform unique tasks in space. With regard to this last category, very little information appears to be available on the types and complexity of tasks man will be able to perform in a space environment.

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SUBJECT: Potential Space Shuttle Applications

We have assumed that a man in a "shirt-sleeves environment," such as might be provided by a space station or a "sortie module," could perform tasks of comparable complexity to those he can perform on the ground. However, we assume that an extravehicular man in a spacesuit would be much more constrained in the types of tasks that he can successfully undertake. It is clear that if man's unique role in the Space Shuttle is to be fully exploited, NASA must undertake as a priority matter developing a much better understanding of his ability to perform tasks in space. We were able to have a brief look at the SKYLAB program and formed the general view that this program is a major step in the right direction; however, the very limited extravehicular experiments appear to be a major shortcoming of the activity.

I. Space Shuttle as a Large Launch Vehicle.

The Space Shuttle as currently specified will provide some increase in capability over the Titan 3D launch from WTR. The Space Shuttle will give approximately an additional 15,000 pounds of payload while at the same time extending the maximum payload envelope from a 60 foot by 10 foot cylinder to a 60 foot by 15 foot cylinder. Titan 3D can launch up to 15 foot diameter payloads, but then the length limitation is approximately 30 feet. 25X1

[redacted]

Multiple Low Altitude Satellites. There have been frequent studies in the past of employing multiple, low altitude satellites for SIGINT applications as opposed to a few synchronous altitude satellites. The trades have tended to lean in favor of the few high altitude satellites

SUBJECT: Potential Space Shuttle Applications

as opposed to the many low altitude satellites for a combination of cost and technical reasons. The advent of a Space Shuttle, if it were accompanied by an appreciable reduction in launch costs, might well cause these trades to change in favor of multiple low altitude satellites.

<u>Injection Into Transfer Orbit for Synchronous Missions or Twelve-Hour Period Polar Elliptical Missions.</u> If a high performance transfer stage were available, the Space Shuttle could be used to place a synchronous altitude payload together with the transfer stage into a low earth orbit with a total capability leading to an equatorial synchronous payload in the 8,000 to 10,000 pound range. This compares to a 3,000 to 3,500 pounds for the Titan 3C launched from ETR. This increase in payload capability along with the potentially reduced costs is very attractive both from the standpoint of launching larger spacecraft and from the standpoint of launching more than one smaller spacecraft. However, we encountered a problem in considering the Space Shuttle for these applications. The payload bay volume limitation would preclude several potentially interesting applications. For example, the payload bay would not be large enough to launch two synchronous payloads [redacted] on a Titan 3C. Further, it is possible to conceive of large deployable structures which also would suffer from volume limitations, particularly if allowance is made for the volume occupied by the transfer stage. 25X1

<u>Potential Spacecraft Cost Savings as a Result of Excess Payload Availability.</u> For smaller spacecraft where the Space Shuttle payload capability and volume would provide considerable margin over those normally needed based on current design practice, there is a potential of some development and recurring cost savings. These savings are difficult to quantify, but it is apparent that in many instances less exotic materials could be employed if weight and volume were not a serious design constraint. Also, thermal control problems might be considerably alleviated in the same manner. On the other hand, electronic payloads are tending towards low power, microminiaturization for the very reason that large scale integration offers sizable cost and reliability advantages; therefore, in the electronics area added weight and volume might not trade off nearly as favorably. In any case, it seems clear that NASA must carefully consider the structural interface

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SUBJECT: Potential Space Shuttle Applications

between the Space Shuttle and payload vehicles if maximum advantage is to be accrued by the space vehicle designer. Our limited insight led us to conclude that insufficient attention has been paid to this issue.

III. Space Shuttle as a Recovery Capability.

Spacecraft Recovery for Repair and Reuse. The capability of the Space Shuttle to rendezvous, capture, and return to the earth's surface with large spacecraft already in orbit offers the potential of recovering, repairing, and reusing certain classes of spacecraft. This recovery capability could either be exercised in a planned way where recovery was conducted on a schedule basis or in the event of unexpected failure of a spacecraft on orbit. Our examination of this capability concluded that recovery and refurbishment was most likely to be advantageous in the case of very large, expensive spacecraft systems -- particularly those with significant electromechanical gadgetry which is difficult to make fully redundant.

Nuclear Power Supply Recovery. The various classes of nuclear power supplies currently available and projected for future years offer numerous advantages in the design of spacecraft systems. Unfortunately, such power supplies are frequently prohibitively expensive because of the cost of the nuclear material or lead to huge weight penalties because of requirements for radiation shielding. Since nuclear material and power supplies have both a very high dollar value and also a long useful life, recovery of such power supplies with or without the using spacecraft might be a useful mission.

Checkout of Spacecraft Prior to Deployment on Orbit. The Space Shuttle offers what might be a substantial advantage in that a payload spacecraft can be inspected and verified from a performance standpoint prior to ejection from the shuttle payload bay. In the event that the spacecraft did not survive the launch environment, the Space Shuttle could simply return the spacecraft to earth for repair and later reuse.

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SUBJECT: Potential Space Shuttle Applications

Summary. All of the above potential Space Shuttle applications would be advantageous only if they lead to significant dollar savings. No unique reconnaissance or intelligence related function has been identified which moves from the realm of the infeasible to the role of practical simply because the Space Shuttle has the capability to recover objects from space. In fact, recovering large quantities of material from space has been a property of the satellite reconnaissance program for many years, and the lack of a more flexible recovery capability such as that offered by the Space Shuttle has not caused any serious feasibility difficulties.

We noted that recovery of failed vehicles, particularly large vehicles with attitude control system failures may pose unique problems and difficulties. NASA should be encouraged to pay explicit attention to this issue with the end of developing specific recovery techniques. It seems clear in general that the recovery of spacecraft and returning them through the re-entry environment will in practice require that the spacecraft be specifically designed for such operations. The recovery and securing in the payload bay of any arbitrary spacecraft not designed for this purpose would seem to pose serious limitations and difficulties.

III. Unique Role of Man in Space Shuttle Program.

In all the above discussion of the potential impact of the Space Shuttle on satellite reconnaissance, the man has been considered as an element in the system only insofar as he contributes to recovery operations. In addition, we did consider what unique role man might play in expanding the reconnaissance activities that could be performed from space platforms. The following is the summary of these considerations.

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BYE-109602-72
Page Five

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SUBJECT: Potential Space Shuttle Applications

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<u>Repair of U.S. Spacecraft on Orbit.</u> The presence of man capable of conducting extravehicular activities opens the possibility of rendezvous with failed or partially failed U.S. spacecraft and conducting repair operations. There do appear to be a class of relatively simple failures such as solar panels which did not deploy or antennas that did not deploy or doors that did not come open which a man in all probability could remedy. The next class of repairs which appears to be in principle feasible are failed electrical boxes; however, for these operations to be feasible, it is clear that the spacecraft would have to be specifically designed for ease of access and dismounting. Repair of complex electromechanical equipment, much of which might well be buried in the workings of a spacecraft, would in all probability be very difficult for a man to access and repair effectively on orbit. The value of attempting to conduct on orbit repairs can only be assessed after detailed study. Presuming that electronic technology continues to evolve in the direction it has been over the past several years, reliability will be improving and the cost of redundancy will be decreasing. This will be particularly so in the case if the Space Shuttle were used as the launch vehicle in that for many missions spacecraft weight would not be as constraining as it is currently. It is also unclear what design compromises would be required to facilitate on orbit repairs by man. Nonetheless, it is possible to envision a set of circumstances where a rendezvous and repair would be valuable.

<u>Assembly of Large Structures in Orbit.</u> There are a number of reconnaissance missions from space where large extended structures such as antennas are critical. We are currently limited by our ability to design mechanical gadgetry and packaging concepts to transport these structures onto orbit and deploy them remotely. The Space Shuttle and

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SUBJECT: Potential Space Shuttle Applications

the presence of man could make key contributions in these areas in two ways. First, it is possible to envision more complex deployment operations with a man on hand to perform key steps or, at a minimum, to supervise the activity. Second, it would be reasonable to consider several Space Shuttle trips bringing up pieces of a large structure for on orbit assembly. The major problem we see with the Space Shuttle in its current configuration is that the greatest need for extended structures such as large antennas is at synchronous altitude and not at lower orbit. We have considered the possibility of assembling these structures in low earth orbit with a man present and then using low thrust levels over a long period of time to slowly transfer the assembled structure to a higher altitude. While this concept has not been examined in any detail, we can find no reason why it should not be practical.

<u>A Manned Space Station</u> [redacted] One 25X1
concept which has some instinctive appeal is a manned space station
to use as a platform for a variety [redacted] This 25X1
notion holds some particular appeal because once the space station
itself has been paid for there might well be a considerable motivation
for employing [redacted] any one of which could 25X1
be justified if a separate spacecraft development program were required.
Such an approach might also provide a more flexible [redacted] 25X1
activity which could be more rapidly configured to meet changing needs
and evolving technology. On the other hand, such a space station by
definition would be in a specific orbit which would not be optimum for
[redacted] Whether the compromises 25X1
would overwhelm the basic utility of a generic platform of this sort is
not clear. There would certainly be a continued need for some separate
[redacted] vehicles, but it might be that a majority of the 25X1
[redacted] activities could be made compatible with a single 25X1
platform.

IV. <u>Summary.</u>

In general, considerable more thought is required to get a good handle on what a manned Space Shuttle might do for satellite reconnaissance or intelligence in general. However, several things are clear at this time.

Approved For Release 2008/03/20 : CIA-RDP75B00514R000200260001-6

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SUBJECT: Potential Space Shuttle Applications

First, if the Shuttle is to be of maximum utility, effort must be expended from the outset to ensure that it is designed taking into account the real applications envisioned. This consideration goes all the way from mundane issues of mechanical interface and deployment to the ability of man to perform various levels of tasks in a space environment. Second, there is a major problem associated with program planning for Shuttle utilization. If payloads are to be available for use with the Shuttle when development is completed, then these payload development activities must be initiated two to four years prior to the availability of the Shuttle for operational use. To aggravate the problem still further, the budgets that will pay for these payload developments must, in general, be laid down several years before the payload development programs themselves are initiated. This means that planners will be making decisions which depend upon success of the Shuttle development program long before a demonstrated capability comes into existence. This whole process will clearly require careful, high level planning and coordination.

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LESLIE C. DIRKS
Acting Director of Special Projects

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BYE-109602-72
Page Eight

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