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AUTHOR

MEMORANDUM FOR MR. NORMAN TERRELL, NASA, LI-15

SUBJECT: Shuttle-Salyut Experiment Concepts (U)

(U) We have completed an extensive review within DoD of the proposed category 1 through 4 experiment concepts for a Shuttle-Salyut mission. Our review was primarily to determine what, if any, would be the military implication of each of the concepts and what concerns DoD would have if they were to be conducted. The criteria for the DoD review were set forth in the form of four questions:

- . Is there technology, or a potential for technology, of military significance involved in the concept?
- . Is there a potential for transfer of this military technology to the Soviets?
- . Is there a potential value to the DoD in conducting experiments under these concepts? Can we learn anything of military significance or of benefit to our programs?
- . What could be done (besides elimination) to the concept to minimize our concerns?

(S) A summary of the significant comments is attached. You will note that, as previously mentioned in my memorandum of 18 May reviewing your 10 May draft, our greatest concerns are in the area of Earth Observation and Astronomy. We recommend that three experiments not be conducted jointly with the Soviets: Determination of Earth Surface Roughness and Dielectric Constant with the Bistatic Radar, the Millimeter and Submillimeter Space Telescope, and Radioastronomy Aperture Synthesis by VLBI. We do not believe that the potential for benefits of these outweigh the potential for transfer of significant technology to the Soviets and/or the potential for them to collect data which could have immediate military application to our detriment.

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~~Exempt from General Declassification~~
~~Schedule of Executive Order 11652.~~
~~Exemption Category 3.~~
~~Declassify on 31 December 2008.~~

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(S) The remaining experiments pose no serious problems which could not be overcome by careful experiment design. DoD concerns are identified and it is clear what needs to be done to alleviate them. In general, we feel that the experiments must be designed and executed in such ways that we preclude the opportunity for transfer of technology in the following areas:

- . Large antennas (greater than 10 to 20 meters) as well as assembly and alignment in space.
- . Optical and UV diffraction limited mirrors greater than 1 meter.
- . Precision pointing to non-inertial objects requiring motion feedback for accuracies better than 2 arcseconds.
- . Utilization of bistatic radars.
- . Software for real time data processing from mosaic sensors with more than 10^4 elements.
- . Cryogenic cooling techniques.

(S) As I have pointed out in my earlier memo, we find it difficult to believe that the Soviets would accept a system of non-USSR origin for installation on Salyut without preliminary ground inspection and testing or, at the minimum, without engineering details. They would require this if for no other reason than safety, as we would for a Soviet system on the Shuttle. Such a requirement could provide the opportunity for technology transfer. Moreover, if such a system were left aboard Salyut following completion of the experiment, the potential for technology transfer through Soviet inspection, disassembly, or photography would be too high to ignore.

(U) Because of their large number, I have not included the comments of the individual reviewers, which are summarized in the attachment. If further information is required, please feel free to call me.

(SIGNED)

Robert A. Greenberg
Director
Space and Advanced Systems

Attachment

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COMMENTS

~~(S)~~ Solar Physics

1. Solar Gamma (1) Scientific knowledge to be gained from experiment is of no uniquely military significance, although any increased understanding of the sun has the potential for improving prediction of ionosphere disturbances and magnetic storms which affect military systems. There is a potential for transfer of technology of space cryogenic coolers, hence these devices should not be used.

2. Hard X-Ray Imaging Studies (1) Military significance the same as for the Gamma-Ray studies. Area of concern for technology transfer is in the software for processing of data for 10^6 element mosaic detection.

3. Stereoscopic Observations of Solar Corona (1) There is no information of particular significance to the military to be gained from the experiment except with respect to the Lyman Alpha Coronagraph. The reference to the desirability of manned operation in order to observe transient phenomena could lead to the possibility of observing missile burns. Of greater concern is the potential for transfer of high pointing accuracy technology which could then be applied to specific military systems.

4. Studies of the Long Term Evaluation of the Active Regions (1) This experiment is of little uniquely military significance and we believe there are no aspects to it which yield a risk of significant technology transfer.

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~~(S)~~ High Energy Astrophysics

1. Cosmic Ray Investigations (1) and X-Ray Astronomy

Investigations (1) Neither experiment is of any particularly unique benefit to DoD nor poses any problems with respect to technology transfer.

2. Gamma Ray Astronomy Investigations (4) There may be some benefit to DoD in the development of techniques for monitoring the upper atmosphere for nuclear material and possibly for inspection of nuclear activity aboard a spacecraft. The instrumentation involved is unlikely to permit significant technology transfer.

~~(S)~~ Earth Observations

1. Bistatic Microwave Radar Investigations (4) This experiment concept with its obvious surveillance potential involves technology which is very significant to the Department of Defense. The conduct of the experiment, if not carefully controlled, could offer the Soviets an opportunity to gather detailed information of very high resolution on sensitive U.S. military installations, over the U.S. and elsewhere. Because the Salyut orbit permits coverage of only about one third of the USSR, we would not have the same opportunities. Even if carefully controlled so that no surveillance information of a military and/or intelligence significance is obtained during the experiment, the bistatic radar and large antenna technology the Soviets may develop could be applied to the military

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mission of detection and tracking of objects (aircraft, missiles, satellites) from space, as well as gathering of terrain data over the U.S. for missile guidance and targeting. The U.S. could benefit in the same way, but we do not believe sharing these benefits with the Soviets is appropriate. It should not be conducted as a joint US/USSR experiment.

(U) Life Sciences

Comments in this section presuppose that there is, or will be, a requirement for military operations in space (other than research) which will require the physical presence of man. Such a requirement would mean that man must have the ability to effectively function at all times during a space mission from immediately after entering orbit through extended periods of weightlessness until reentering the atmosphere.

1. Human Cardiovascular System Studies During Adaptation to Prolonged Zero-G Exposure (1)

2. Crew Member Bone Calcium Loss During Prolonged Weightlessness Flight (1)

3. Blood Changes and Immune Response During Flight (1)

In that any technology that will permit man to increase his tolerance to long orbital missions is significant to manned space operations, these concepts have military significance and are of potential value to DoD. While the Soviets would benefit as well, we could not develop this technology alone with current U.S. space hardware and thus stand to gain from the long mission duration capability of Salyut.

4. Heart and Lung Activity in Monkeys or Baboons During Weightlessness (4)

This concept also is of military significance since knowledge obtained may

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potentially enhance man's performance during space maneuvers and military crews may be less vulnerable to G forces encountered in space or during reentry. Although the USSR has no experience with non-human primates, we feel the potential for transfer of this technology is not of significance in this or other experiments with these subjects.

5. Endocrine and Metabolic Changes of Non-Human Primates Due to Space Zero-G Environment (4) This concept would be of value to DoD. Through these experiments we may be able to elucidate the marked increase in hormone excretion rates and insulin levels during space flight and bed rest. We may also be able to define the mechanisms responsible for the decrease in skeletal muscle mass. Soviet technology in this area is equal to or exceeds our own.

6. Sensory Changes in the Monkey During Adaptation to Flight (4) There is a potential value to the DoD in conducting these experiments, because it may provide methods of selecting military space crews which are less likely to get space motion sickness. This has potential military significance, particularly on short duration missions, since it will increase man's utility in space. The Soviets are probably ahead of the U.S. in this area.

7. Study of Body Rhythms of Heart Rate and Deep Body Temperatures in Non-Human Primates (4) There is potential value to the DoD in conducting experiments in this area. Heart rate and deep body temperature are useful in predicting degradation in human performance in sleep/wake cycles. Peak human performance may be very essential in a military space environment. There has been no evidence to date of deterioration in performance during human space flight, but this has been due to careful scheduling of sleep/wake cycles based on studies in non-human primates. The experiments may

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be relevant to very demanding military space missions where information is needed regarding crew ratio/crew utilization.

- 8. Plant Growth and Development of Algae in Low Gravity Environment (1)
- 9. Higher Seed Plant Growth Configuration and Development During Space Flight (1)
- 10. Small Mammal Reproduction and Development on Long Exposure to Zero-G (1)

While of general scientific interest, none of the above three concepts are of particular significance or value to DoD.

11. Studies of the Time-Course of Zero-G Muscle and Bone Alterations in Non-Human Primates (4) There is potential value to DoD in conducting experiments in this area. Previous space missions have resulted in degradation of the musculoskeletal system, including cessation of bone growth, calcium loss, decreased breaking strength of bones, and a significant decrease in muscle fiber diameter. These may be critical factors in military space missions where peak performance is required. There is little potential for transfer of significant technology to the USSR., since they are ahead of us in this area.

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(U) Materials Processing in Space (all category 4) -

The first four of the experiment concepts discussed in this section are based on processing materials under the micro-gravity conditions of an orbiting laboratory with the objective of producing materials of improved purity, homogeneity or crystallographic perfection. All of this work can be considered basic research and as such we see no technology involved which is of particular significance to DoD. The improved materials could, of course, later find their way to military applications but this is not of great concern in terms of the experiments themselves and the benefits to the US could be equal to those to the USSR. We see no potential for transfer of technology which would be of detriment to the US

The remaining concept, the relativity experiments could be of some benefit. We should avoid providing instruments for the facility aboard Salyut which may have been specifically developed for military space systems.

~~(S)~~ Astronomy

1. Use of Starlab on the Salyut Space Station (2). This concept does not appear to be of any particular military significance. While required pointing accuracies are high, the techniques for tracking and pointing of inertial objects like fixed stars to even greater accuracies are already well known to the Soviets. There is some concern expressed over a possibility of transfer of the CCD array technology but such transfer does not appear likely without the Soviets removing and disassembling these detectors in violation of agreements. Such action could be detected.

2. Small General Purpose Photometric/Polarimetric Telescope (4). Again, as designed for ultraviolet measurements, there is no particular significance

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In this concept for DoD. There is some concern for the potential of turning the instruments toward the earth or earth's limb where background or signature measurements useful in detection and tracking of missiles or spacecraft launches could be made. It seems unlikely the Soviets could accomplish this without our knowledge, and risk of international embarrassment. There is no technology of significance to be transferred. Potential scientific return is high.

3. Millimeter and Submillimeter Space Telescope (4). Data from this experiment could be useful to DoD in surveillance, guidance, and missile and spacecraft applications. There is also a potential for using this instrument in a downward looking mode for ocean surveillance applications in the 1.5 to 4 mm band. However, the potential for transfer of significant technology, much of which has been developed for military applications, is large. In particular, concern exists for a technology loss in the capability for precision assembly and alignment of large antennas and optical components in space, large system thermal control techniques, sub-arcsecond pointing and long wavelength application to ground target acquisition. Although this type of investigation would be of value to DoD there is considerable doubt as to any advantage that would accrue by virtue of conducting it in collaboration with Soviets. It would be better done by the US independently. We recommend it not be included in the package presented to the Soviets.

4. Ultraviolet Sky Surveys from Shuttle/Salyut (2). The data here could be militarily useful as helping to establish a background against which a UV surveillance system might have to operate. However, DoD has ongoing programs of its own to accomplish this. Other comments are the same as those for the Starlab experiment concept.

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5. Radioastronomical Space System of Aperture Synthesis by Very Long Baseline Interferometer (1). DoD concerns for this experiment are similar to those for the earth observation experiment previously discussed. The large antenna provides an inherent capability for ELINT. Of greater concern is the technology transfer which we do not believe can be completely prevented. At present the Soviets have demonstrated no capability for spaceborne antennas anywhere near the size of this one. A joint effort in this area could only assist them in gaining this capability. We recommend it not be presented to the Soviets for consideration.

(U) Atmospheric Research

1. Thermospheric/Exospheric Composition and Temperature Measurement (3). While the data from this experiment has no special significance or military implications, they could prove useful in later applications to UV surveillance, and the development of UV lasers, and in spacecraft trajectory prediction. The basic instrumentation has been flown in Apollo-Soyuz so there are no concerns over technology transfer.

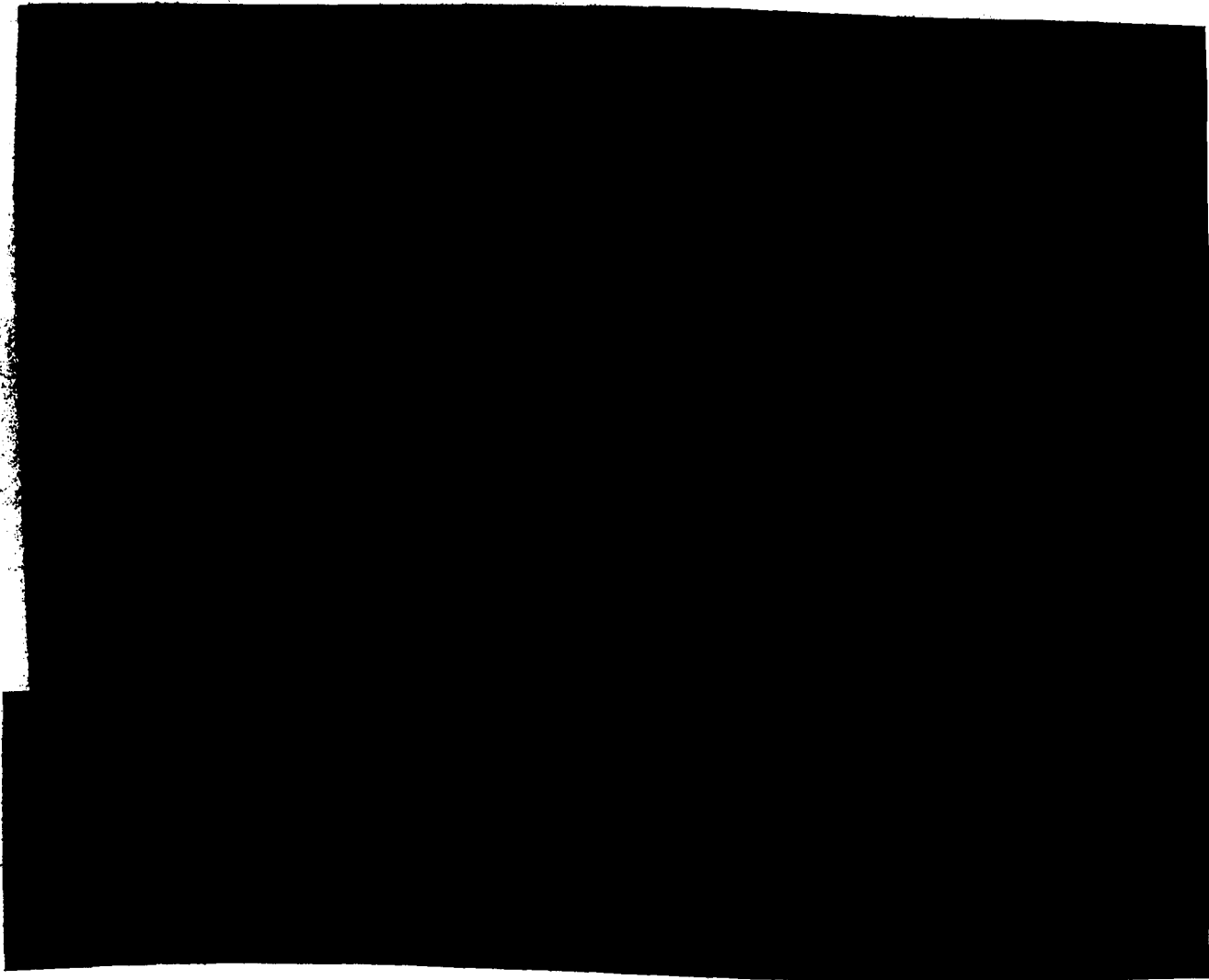
2. In Situ Measurements of Thermospheric Internal Gravity Wave Parameters (3). In the sense that these data would potentially have value for improving atmospheric models, the experiment is of significance to the DoD, where knowledge of the atmosphere is essential in the design of many weapons systems. Provided all data is available to both sides, the experiment should be of equal benefit to the US and USSR. We do not see a potential for significant technology transfer although some insight into the generation of artificially induced gravity waves may be gained.

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3. Laser Measurement of Trace Species. Again, the data could be useful in military applications requiring good knowledge of the upper atmosphere but there is no particular military significance of the data themselves. Pointing accuracy required for the laser is probably high and thus if a laser is also placed on Salyut the Soviets should provide their own pointing system to avoid any transfer of this significant technology.

~~(S)~~ Space Plasma Physics



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3. Vehicle to Vehicle Radio Link (3). There are no uniquely military implications to this experiment. Data obtained would be useful in a variety of studies within DoD as elsewhere in the scientific community. Since there is little if any equipment developed especially for this experiment, we have no new concerns for technology transfer.

4. Ionospheric Modification by High-Power Radio Waves (3). In that ionospheric modification can affect military communications, this experiment has special significance to DoD. There is some concern over technology transfer both in the areas of modification techniques and through actual utilization the unique Thomson bistatic radar scatter concept. This concern is not sufficient to warrant recommending against the experiment in light of the potential benefits to DoD.

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