



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

November 1, 1973

MEMORANDUM FOR THE RECORD

SUBJECT: Visit to Moscow, October 14-19, 1973

BACKGROUND

On August 14, I had written to Academician M. V. Keldysh, President of the USSR Academy of Sciences, suggesting a mid-term review of the Apollo-Soyuz Test Project. A copy of my letter to Keldysh is attached. In the letter I also stated that in addition to reviewing the current status of the project, I would like to discuss in detail four specific subjects: system failures; participation in and observation of the test activity and flight preparation; project milestones; and the preparation of documentation. I further asked if it would be possible to visit some Soviet space facilities during the course of my visit. Keldysh responded favorably on August 30. (A copy of his letter is also attached.) Then, about a week before my visit, I received a telephone call from Chet Lee, who was already in Moscow, indicating that Keldysh was ill and would be unable to see me. He added, however, that the Soviet side clearly wanted me to come ahead and urged him to convey to me that this is not a "diplomatic illness" and that my visit would be most worthwhile. In order to further make it desirable for me to come, they promised that they would take me to the Soviet Mission Control Center near Moscow. The telephone call was followed by an official telegram from Keldysh and after discussions with Arnold Frutkin we decided that I should go ahead with the visit as planned. (Both Arnold and I asked about Keldysh's health on many occasions after we arrived in Moscow. The response we both received was that Keldysh is not really ill in the true sense of the word but is extremely tired and run-down. He had not taken a vacation after his major operation earlier this year and had worked extremely hard ever since then. He was therefore "ordered" by his physicians to take a rest and not to participate in any of the meetings with me. During the course of my visit, his office was always dark, his secretary was nowhere in sight, and it was quite clear that he was completely away from the office during this week.)

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SUMMARY OF VISITSunday, October 14

Arrived in Moscow with Frutkin early in the evening. Met at airport by Boris Petrov, Vereshchetin, Jack Tech from the U.S. Embassy, and one or two others. Rode to Hotel Rossia in Petrov's car and, as we had requested, did not participate in any official functions that evening.

Monday, October 15, 7:00 a.m.

Executive Session at Hotel Rossia with Lunney and his Working Group chairmen. According to Lunney, the two weeks of preparatory meetings had gone extremely well and much had been accomplished. The "Summary of Results" of their meetings had been prepared and a copy of this is attached. In addition, Donnelly had negotiated a first-phase (pre-flight) Public Affairs Plan which was to be ratified by Petrov and me. We discussed some of the technical results of the meeting but I will cover these later as I discuss each specific item.

Monday, October 15, 9:00 a.m.

We met at the Presidium of the Soviet Academy of Sciences for the Apollo-Soyuz "Mid-term Review." Participating on our side were Low, Frutkin, Lee, Lunney, Cernan, Stafford, Smylie, Dietz, and Frank. Soviet attendees included Petrov, Bushuyev, Vereshchetin, Rumyantsev, Abduevski (the Deputy Director of the Control Center), Cosmonaut Yeliseyev (the Flight Director), Cosmonaut Leonov (the Soyuz Commander); Tulin, Tsorev, and Kozorev of Intercosmos; Working Group Chairmen Timchenko, Legostaev, Syromyatnikov, Nikitin, Galin, and Lavrov; and their intrepeter Zonov. During the course of the meetings, Bushuyev, Lunney and alternate Working Group Chairmen gave a technical review using a notebook of "Vu-graphs." Notebooks had been prepared in both languages so that all of us could follow the review.

Monday, October 15, lunch time

Frutkin, Lee, Lunney, and I joined Petrov, Bushuyev, and Vereshchetin for a small luncheon at the "Club of Scientists."

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Even though this was very informal and there were not too many toasts, it was nevertheless a Soviet-size dinner, with five or six courses, which consumed the better part of two hours.

Monday, October 15, 3:00 p.m.

We returned to the Presidium for another session involving all participants. This was a relatively brief session with only a few questions asked by our side and responses given by their side. At the conclusion of the session, both Petrov and I agreed that good progress had been made in ASTP, that there were no open questions other than those raised by the technical Project Directors in their Summary, and that we had high confidence in meeting our launch date of July 15, 1975.

Monday, October 15, 4:00 p.m.

I had asked for an Executive Session to discuss some of the points raised in my letter to Keldysh which were not brought out during the technical meeting. Participating on our side were Low, Frutkin, Lee, and Lunney, and on their side Petrov, Bushuyev, Vereshchetin, Rumyantsev, Tulin, Tsorev, and Kozorev. During the course of this meeting, I brought up the subjects of systems failures, participation in factory installation of U.S. equipment, documentation, Stafford's desire to see actual spacecraft hardware and not only mock-ups, and the desirability of a press conference before our departure from Moscow. This was a very frank and forceful discussion with our side politely but firmly insisting on responsiveness by the Soviet side.

Monday, October 15, 7:00 p.m.

The Charge d'Affaires at the U.S. Embassy in Moscow had invited the two delegations for a small reception at the Embassy. This was quite informal and friendly with no detailed discussions about the business at hand. There was great interest in Skylab and the well-being of the Skylab's three astronauts on the part of a number of the Soviet delegation and they appeared to be amazed how well Bean and his crew had done after 59½ days in space. I also picked up the following incidental piece of information from Petrov: It is the Soviet's view that TU-144

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accident was caused by a small French aircraft which flew into the TU-144's flight path. The TU-144 had to veer off and thus flew into the ground.

Monday, October 15, 8:00 p.m.

I met in my hotel room with Donnelly, Shafer, Frutkin, and Lee to discuss the Public Affairs Plan. Donnelly and Shafer appeared to be quite disturbed by some of the things that had happened while they were in Moscow but we agreed not to discuss this any further until we returned to Washington. We then discussed the substance of the Public Affairs Plan and agreed that it was not yet ready for ratification without further clarification.

Tuesday, October 16, 9:00 a.m.

I paid a brief call on Academician Kotelnikof, the Acting President of the Academy of Sciences. This was only a courtesy visit, with some small talk but no substance.

Tuesday, October 16, 10:00 a.m.

Visited the Institute of Geochemistry and Analytical Chemistry of the Academy of Sciences. Vinogradov was to have been our host, but we were told that he suffered a bad cold and we therefore met with his Deputy, whose name I believe is Sorkhov.

Tuesday, October 16, 11:00 a.m.

Next we visited the Institute of Space Research of the Academy of Sciences and met its new head, Prof. R. S. Sagdeyev. Sagdeyev speaks good English, is friendly and open, and looks like the sort of person with whom we ought to be able to develop good relationships.

Tuesday, October 16, 3:00 p.m.

Visited Academician V. A. Kirillin, the Deputy Chairman of the Council of Ministers and Chairman of the State Committee for

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Science and Technology. I had asked for this courtesy visit prior to my arrival in Moscow and as soon as I arrived there were many questions as to why I wanted to see Kirillin. I assured everybody that this was really only a courtesy visit.

Tuesday, October 16, 7:00 p.m.

Went to the ballet in the Kremlin and saw "Don Quixote" for the second time during one of my Moscow visits. For one who doesn't like ballet, this should be considered to be above and beyond the call of duty.

Wednesday, October 17, 8:45 a.m.

Left the hotel to visit the cosmonauts' training center at Star City. At Star City we were met by General Beregovoy since General Shatalov, who is now in charge, was visiting in Japan. We also met the Soyuz 12 cosmonauts, Lazarev and Makarov, as well as ASTP cosmonauts Leonov, Kubasev, and Filipchenko. Petrov and Bushuyev were with us, and we were also joined by Feoktistov, whom I had not seen since my January 1971 visit. The reason for this became apparent later. Feoktistov was there to show us through the Salyut mock-up. He knew Salyut as well as I had at one time known Apollo, and obviously is either the Chief Engineer or Program Manager on Salyut.

At Star City we had a sit-down briefing, a visit to the Soyuz simulators and docking trainers, a discussion of the ASTP version of Soyuz, and then a very detailed description of Salyut, with a tour of its high fidelity mock-up. We were also shown the Soyuz 12 space suit. We then had a quick tour of the museum and the usual seven- or eight-course dinner with the usual number (15 or 20) of toasts. I was a lot smarter this time, though, than I had been on the last visit to Star City. I did not participate in any of the "bottoms up" toasts and merely sipped my vodka politely each time.

Wednesday, October 17, 4:00 p.m.

I had asked for discussion on the ASTP Public Affairs Plan and Petrov and I decided to have this meeting while we were at

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Star City. Participating in this meeting were the same ones who participated in the Executive Session on Monday afternoon. At the completion of this meeting we left for Moscow.

Wednesday, October 17, evening

The evening was free but Arnold Frutkin and I met in our hotel room for further discussions on the Public Affairs Plan. Here we wrote some words which we hoped would clarify the Plan, for additional discussions the next morning.

Thursday, October 18, 9:00 a.m.

Frutkin and I met with Petrov, Vereshchetin, and Rummyantsev on the ASTP Public Affairs Plan. During the course of this discussion, we reached a complete understanding of all points but did not reach agreement on them. Unfortunately, Donnelly had already left Moscow so he was unable to participate with us.

Thursday, October 18, 10:15 a.m.

We left the hotel for the visit to the Soviet Mission Control Center. This was a first for any Western visitors and, of course, of great interest to us. We arrived there approximately 45 minutes later and had a very detailed tour of the Center. Following the tour, at 2:00 p.m., we had lunch at the Control Center, complete with eight different wine, vodka, and brandy glasses in front of us, and served by waiters in dinner jackets. It was again a dinner with many, many courses and many, many toasts. Chris Kraft's cafeteria in the Houston Mission Control Center was really put to shame.

Thursday, October 18, 3:30 p.m.

We visited the Cosmos Pavilion of the USSR Exhibition of Achievements in National Economy. This is the USSR Space Museum, which I had seen once before. I, therefore, looked at only the new exhibits, which included Mars 3, Lunokhod, and several other lesser exhibits. We also were shown a countdown and launch

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demonstration using a complete working model of the Baikonur launch complex.

Thursday, October 18, 5:15 p.m.

We were back at the Presidium for the "signing ceremony." Here we signed the Summary of Results of our meeting which, in this case, was very brief since the detailed Summary had been signed by Lunney and Bushuyev. The Summary, as well as the press release, had been worked out by Frutkin and Vereshchetin and had been previously approved by Petrov and me during our meeting at Star City. (Copies attached.)

Thursday, October 18, 5:30 p.m.

Petrov and I, in the company of Lunney and Bushuyev, held a press conference at the Presidium. Petrov preferred to call this a "meeting" with the press because he did not invite the foreign press corps (other than U.S.) nor many of the Soviet press corps. We had, however, insisted that the entire American press corps would be invited. After a brief introduction by Petrov, I gave an opening statement summarizing our entire visit. We then opened it up to questions. Unfortunately, the American press wasn't smart enough to ask some of the more difficult questions like "Where is the Mission Control Center?" or "What did you learn about the Soyuz 11 failure?" We were prepared on both of these questions. However, Lunney did talk to some of the American press after the press conference and did at that time get into the record that we had indeed been given a detailed report on the Soyuz 11 failure.

Thursday, October 18, 7:00 p.m.

The Soviet delegation had a dinner and reception in our honor at the "Hall of Mirrors" of the Hotel Prague. This was another formal sit-down dinner with many more toasts and, I might add, the second big dinner of the day. Somehow we all survived.

Friday, October 19, 8:00 a.m.

We left Moscow Airport on an Aeroflot flight for London and from there back to the U.S.

GENERAL OBSERVATIONS

MOSCOW

Moscow seemed to be a friendlier place this time than I remembered it from my previous visits. There were more cars, more lights, people appeared to be livelier, and even the hotel staff appeared to be less dour. Either there has been a change or perhaps we have become accustomed to their way of life. The fact that I could understand their language this time, at least at times, and the fact that I could speak it well enough to order breakfast, get my room key, and leave a wake-up call, may also have had something to do with the apparent change in attitude.

Relations with Academy of Sciences and ASTP Personnel

In general, both sides seemed to get to the point quicker and easier and appeared to reach a fuller understanding of each issue. Discussions were more direct and more open and frank. Each side made a special effort to make sure that there would be no misunderstandings in the agreements which were reached. (The single exception appeared to be in the negotiation of the Public Affairs Plan where our people have less experience in working with the Soviets.)

NASA Contingent

The NASA contingent under Glynn Lunney is doing an outstanding job. They are diplomatic but firm in all their dealings with their Soviet counterparts. They excel not only during the course of technical discussions but also at social functions.

USSR Reaction

The general reaction to us and to our work still appears to be one of inferiority, but at the same time one that seeks parity. After each visit we were asked, "How did you like it?" "What did you think?" "How does it compare with yours?"

International Situation

We were in Moscow at the height of the Middle East conflict and at a time when Handler and Keldysh were exchanging rather firm

letters on the Sakharov affair. Yet neither one of these subjects came up at any time during our visit and the situation appeared to be perfectly normal. (From our side, of course, we missed getting any news about the Middle East situation.) As a matter of fact, the New York Times concluded "The warm treatment of Mr. Low and a team of American specialists, working with their Soviet counterparts to prepare for the Apollo-Soyuz mission, was read as a deliberate gesture by Moscow to emphasize its interest in Soviet-American cooperation and the detente despite the frictions of the Middle East conflict."

Personal Reaction

I had learned a great deal about how to "survive" for a week in Moscow since my first visit and, therefore, this visit was very much easier than previous ones had been. Generally, I had only one meal per day, that is lunch, which, as I have mentioned previously, was always a full dinner. (On Thursday, however, we had two of these dinners.) I always had only a very minimal breakfast of tea, bread, and butter at the hotel "cafeteria" and more often than not no evening meal at all. I also learned that I could coax a single vodka through many toasts.

TECHNICAL STATUS OF ASTP

During the course of the status review, Bushuyev gave a basic introduction which was followed by status reports on internal preparations in the U.S. and USSR given by Lunney and Bushuyev, respectively. Next, each of the Working Group chairmen (either a Russian or an American) gave a progress report for their respective groups: mission model, operations plans, experiments, and spacecraft integration; guidance and control, and docking aids; mechanical design; communications and tracking; and life support and crew transfer. Each group gave a detailed schedule and report of progress against that schedule. By and large, all milestones were met and when they were not being met workarounds were available.

Agreements have been reached on five joint experiments; on reciprocal participation of specialists as observers during life support system tests of Apollo and Soyuz; participation in joint seal tests; on a number of safety assessment reports and others

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that yet had to be written; on studies for the need of electromagnetic compatibility tests of the cable communications system; and on the participation by U.S. specialists at the Soviet launch site during the pre-flight checkout of the VHF AM equipment. In addition, drawings had been exchanged on the Soyuz orbital module and the Apollo docking module. The problem of mixed crew descent had been discussed and it was decided that this would be considered an "unexamined contingency situation." Another area open for further discussion is additional dockings subsequent to the first undocking.

At the conclusion of the meeting, four potential problem areas were described. These were: documentation; the desirability of U.S. access to the factory in the event of problems during the installation of the VHF equipment; the launch window; and the need for continuing timely exchange of ground and flight test data on ASTP-type Soyuz and Apollo vehicles and systems.

The subject of documentation was discussed during the main meeting as well as during the executive session. I also brought it up privately with Petrov. It seems that a great deal of progress has been made by the Soviets in recent weeks in catching up in all areas where they were behind on documentation. Nevertheless, Lunney is concerned that as time grows shorter they will once again fall behind and we may stub our toe on the entire project. The Soviet solution to the problem is a better forecast of documentation requirements. We agree with this point of view but we say that this is not the complete solution because we can't possibly foresee all problem areas. I believe that Petrov finally understood what we were getting at and promised to personally keep an eye on the situation.

On the subject of access of U.S. specialists during the installation of the U.S. provided VHF equipment, it is quite clear that they do not want our people in their factory but have no objection to their presence at the launch site. We told them that we accepted their view on this but that they should consider now what they would do in the event they were to run into trouble and then really required our presence at the factory. I later told Petrov during the executive session that we understood that this might present difficulties and that he would be wise to work these out now for the contingency situation which might require our presence.

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Insofar as the launch window is concerned, it now closes on September 22 as a result of lighting constraints in the recovery area. Both sides agreed to work on this to see whether it cannot be extended into December.

The last point concerning the timely exchange of ground and flight test data is closely related to the documentation question which I have already discussed.

VISITS TO USSR FACILITIES

The present Soviet decision is that Star City, the Control Center, and the launch site will be open to our technical people. The Soyuz factory will not. Although we reached agreement only on pre-flight activities insofar as the launch site is concerned, Petrov let it be known during the press conference that there would be no problem with our specialists staying there during the time of the launch. Insofar as access for the news media is concerned, the present decision seems to be that Star City, or at least parts thereof, will be open to the news media but the Control Center and the launch site will not.

Tom Stafford had also voiced a concern to me about the fact that he would only see Soyuz simulators and never actual Soyuz flight hardware. I discussed this concern during the executive session. We were told that simulators really were exactly like the flight hardware but nevertheless I said that Stafford was looking for subtle differences and that it was quite important to him to see the actual flight hardware. I suggested perhaps that this too would be possible at the launch site since their spacecraft arrived there some four to six months before the launch. During the course of the executive session, Petrov agreed to look into this and later told Stafford that he thought this would be possible.

SOVIET FAILURES

During the course of the technical visits preceding my review, the Soviets had made a detailed presentation of the Soyuz 11 failure and had given us a copy of their failure report. They had not discussed any other failures. In the failure report, they also stated that Cosmos 496 and Cosmos 573 were both

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unmanned test flights of the changes made after the Soyuz 11 failure and prior to the Soyuz 12 flight. During the course of the technical review they also stated that there will be two or three more manned Soyuz flights in 1974 and prior to the ASTP flight. Soyuz 12, by the way, did not incorporate a docking system while the 1974 flights will incorporate the ASTP-type docking system.

During the course of the executive session, I told Petrov that we greatly appreciated their report on the Soyuz 11 failure but that we were also concerned about additional failures reported in the American press during the summer of 1973. I specifically mentioned Salyut 2, which the press had reported as a failure, and Cosmos 557, which some American press reports had also called a Salyut-type vehicle.

Petrov was obviously prepared for the Salyut 2 question, but not for the Cosmos 557 question. On Salyut 2, he said that this bore no relation to the Soyuz which we will use in our joint mission. He stated that Salyut 2 was an improved modernized version of the Salyut. Because of the significant changes, the Salyut 2 flight had been planned from the beginning as an automated flight and was never intended to be manned. We were told that many of the changes were in the automatic control system and these changes clearly required an unmanned flight. To add emphasis, this point was repeated many times. Petrov went on to say that Salyut 2 should be considered a flight for the development of future space stations, that the Salyut is completely independent of the Soyuz, and, finally, that it was not important where it returned to the earth, merely that it returned some place in the open sea.

In summary, it was never clearly said whether Salyut 2 was a failure or a success, but only that whatever it was did not concern us because it did not relate to Soyuz.

I again brought up the subject of Cosmos 557 since there was no response on this question. Petrov did not respond, but another in the group--I believe it was Tsorev--did. He said that Cosmos 557 bore no relation to a manned flight and was neither related to Salyut nor to Soyuz. He said the reports in our press obviously were mistaken.

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STAR CITY

I saw more of Star City this time than I had during my previous visit. Of major significance is the amount of new construction underway at the present time. A new training building is being put up especially for ASTP training. It is a 4-story building which will include classrooms, lecture halls, display rooms for our spacecraft subsystems, etc. In addition, they are building a new hotel and dispensary for the United States team. I think both of these projects are underway so that astronaut treatment at Star City won't appear to be shabby in comparison to cosmonaut treatment in Houston. In addition, two or three other large buildings for training or to house simulators are under construction, as well as a large centrifuge with a capability of up to 20 g's at an onset rate of 2 g's per second for personnel or 4 g's per second for equipment. Both the ASTP classroom and the ASTP hotel buildings were started after the ASTP agreement had been reached, and neither will be quite ready at the time of the November visit but should be ready for the second visit of our astronauts.

Soyuz Simulator and Docking Simulator

I had seen both of these on my previous visit to Star City in January 1971. Leonov conducted the briefings on both. The basic change in the Soyuz reentry module is that it is equipped for only two cosmonauts now while it had room for three during my previous visit. There are also provisions to connect pressure suits and the new pressure relief and shut-off valves which were installed subsequent to the Soyuz 11 failure are very evident. We were told that the simulator was currently in the Soyuz 12 configuration. This configuration did not include a docking hatch. In the orbital module, we were shown the potassium superoxide air regeneration system and during the course of the discussion there was much talk about condensation removal. This must at one time have been a problem. On the way to the orbital module simulators, one passes through the room in which the optical systems for the displays are mounted. These included both Soyuz and Salyut models.

The docking trainer also showed no difference from 1971 except that the visual targets for docking now included both the Soyuz and the Salyut, whereas only the Soyuz was included in 1971.

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Mock-up Area

We next went to the mock-up area where Bushuyev went over the Paris Air Show display of the Soyuz with the new docking system, as well as an "external mock-up" of each of the two Soyuz modules. I put the words "external mock-up" in quotes because for all I know this might have been flight hardware. Of interest on this external mock-up was the external insulation, which is a fabric blanket, and the fact that the orbital module had an old style docking system, and it too was said to be in the Soyuz 12 configuration. Again we were told that the ASTP docking system will not be flown until 1974. Bushuyev also indicated that in the Soyuz 12 configuration, Soyuz is a 4-day vehicle if flown alone and a 60-day vehicle if flown with Salyut.

Space Suit

This was modeled by a technician and described by Cosmonaut Kubasev. It is a fairly lightweight garment which, according to Leonov, takes five minutes to don. It will be the type of garment used in ASTP. It is expected to be worn only for about two hours at any one time and, therefore, has no provisions for sanitation. The outer garment provides the strength. The inner garment is a thin rubber bladder, which is sealed by gathering up a bunch of rubber, twisting it, and then tying it with a large rubber band. This sealed garment is then tucked underneath the folds of the external garment which is laced shut. The suit is worn for launch, docking, undocking, and reentry.

Salyut

In the same mock-up building with the Soyuz Paris Air Show exhibit is also the Salyut mock-up. Incidentally, this is a fairly new building in which the ASTP training will also be conducted. It has a glass partition and we were told that the news media will be able to watch from behind that partition when our crews are there. (Even though the building is fairly new, somehow they managed to make the bathrooms look as though they were twenty years old.) Feoktistov was our guide around and through Salyut. (He had already met with Lunney earlier during the visit because Lunney had asked why we never see him anymore. At that time,

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Lunney asked him when he would again visit the U.S. Feoktistov responded that he had many very serious problems and thought that he would not be able to visit for a long time to come.) Externally, the Salyut we saw differed from the pictures I had previously seen in that it had three solar panels mounted on the main part of the body. Two were mounted horizontally like wings on an airplane and the third vertically but in the same section as the horizontal ones. The horizontal ones could be pivoted to get a better exposure to the sun even while the Salyut was flying at an angle. (I don't recall whether the vertical one could also be pivoted.) Feoktistov told us that Salyut could fly in any attitude for an indefinite period of time without thermal problems.

We entered Salyut through a hatch on the side of what in Skylab would be the multiple docking adapter. I forgot to ask, however, whether it was possible to dock with more than one spacecraft at a time. I don't believe it is. We then went into the main section and first looked at the instrument panel which is very similar to that of the Soyuz. In fact, many of the instruments are identical, as are many of the subsystems. The propulsion system, for example, we were told is exactly like the Soyuz system, and the ECS is a version of the Soyuz system. In response to my question, Feoktistov said that Salyut nominally had a 60-day lifetime but that this could easily be extended to four months by trading on-board consumables for propellants. He also mentioned that food, water, and the air generation system could be resupplied but the propellant could not be resupplied. However, if the Salyut is in a sufficiently high orbit the amount of propellant used for attitude stabilization is minimal. There are no control moment gyros. We saw two rather primitive fire extinguishers, a bungee cord exerciser, including a treadmill, and a wall chart indicating the exercises to be taken. Sleep stations are tucked away around a 10-meter focal length solar telescope. There were a number of other scientific instruments--spectrometers, cameras, star sensors, sun sensors, etc.--all of which were explained in detail by Feoktistov. There is also a refrigerator and a food warmer. Finally, the bathroom is at the very tail end of the station and does not appear to be as complete as the Skylab bathroom. Also at the tail end of the station are two trash airlocks, both used for dumping garbage in bags to the outside. They are at approximately $\pm 45^\circ$ from the vertical and appear to be of inordinately heavy construction.

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Incidentally, Lunney told me that he inferred from some discussions that there might be some heavy flight activity in the March-April time period next year since many of the specialists with whom he normally deals will then not be available.

SOVIET MISSION CONTROL CENTER

The drive to the Mission Control Center from the hotel took approximately 45 minutes. We headed out of town in a northerly direction, passed the Exhibition of Achievements in the National Economy (Space Museum), then the Moscow city limits, and then drove for another five minutes or so. The Center is located in the village of Kaliningrad. (After leaving the Center and on the way to the press conference, I asked Petrov how I should respond to a question concerning the Control Center's location. At first he stated that I should merely say that it is at the outskirts of Moscow, but apparently he checked this out after we reached the Academy of Sciences again and then told me that I could state, if asked, that it is in Kaliningrad. I was not asked.)

The Center is located within a large complex of buildings surrounded by a security wall. The way we entered and left the area it was difficult to see much of the other buildings. They all are several stories high and could house all sorts of equipment. There were no antennas in evidence. Some new construction is also going on. Within the Control Center building, all of the curtains on the street side were open but all of the curtains facing the rest of the complex were conspicuously drawn. The Control Center building is approximately three or four years old. It had been used in the past for the control of unmanned flights but the first manned flight under control of this Center was Soyuz 12. We were told that it would be used for all future manned flights, Soyuz as well as Salyut, but that not all Salyut flights would be controlled from there. Apparently, there will be some unmanned Salyut flights to be controlled from somewhere else. The building itself is well-constructed and well-appointed. (I will later describe the Institute of Space Research, which is very poorly constructed. By contrast, a lot more money was spent on the physical building of the Control Center than on the Institute of Space Research.) We were first taken into the conference room on the second floor where we were greeted by Abduyevski (the Deputy Director of the Control Center). Abduyevski was with us all of the time but answered few, if any,

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questions. I have the feeling that he is relatively new in the Control Center and does not know a great deal about it yet. In fact, he may be there solely for the purpose of dealing with NASA. Next we were briefed by Yeliseyev, the Flight Director. He used three charts which had been prepared in English as well as in Russian. These charts depicted how the Control Center fits within the overall operations (launch, network, communications, control, etc.); the flow of information within the Control Center; and the organization of flight controllers within the mission operations control room. In the first order, there is no difference in any of these areas from the way we operate in Houston. It is possible, however, that some of the functions that are performed at Goddard for manned flight control in the U.S. are actually performed within this Control Center in the USSR.

Data flow from the tracking stations apparently without any pre-processing at the stations. They are then manipulated and formatted within various parts of the Control Center and finally displayed in digital form on TV displays in the Mission Operations Control Room. Voice transmissions to the spacecraft flow in the opposite direction. There are no electronic commands generated within the Control Center. Command decisions are made at the Control Center, of course, but the electronic command generation takes place at the tracking stations.

We left the conference room through a second door and found ourselves in the viewing room of the Missions Operations Control Room. This is on a balcony overlooking the main floor of the Control Room. I don't know exactly what I expected to see when I entered the Control Room, but somehow I was surprised and had the feeling that I had wound up in the midst of a Hollywood set. The Control Room is extremely well-appointed and well-outfitted. It is not very different in appearance from our Control Room in Houston. On the front wall there are a number of large screens for either optical or television displays. Television displays are handled with an eidophor just as they are in our case.

As we entered the Control Room, a playback of the Soyuz 12 final countdown was in progress. Across the top of the front wall are a number of clocks showing Moscow time, elapsed time, station acquisition time, and station loss-of-signal time. On the left hand screen were displayed a number of trajectory parameters-- apogee, perigee, period, etc. The top of the center screen was

a world map with a lighted dot indicating the spacecraft location. The bottom part of the screen was a piece of flight plan concentrating on the "dynamic mode" which refers to the type of control of the spacecraft, as well as a display concerning the type of data being displayed (real time, playback, etc.). On the right hand screen the top half was a television display of the booster at the launch site (later on it switched to onboard television), while the bottom half of the right hand screen contained additional flight planning parameters. (We saw later that there was access to at least this screen from a typewriter at the back of the Control Room, and they were able to type the message "Welcome American colleagues" on that screen.

On the floor were four rows of consoles. The very back row, which is out of sight from the balcony, is for the people who set up the communications and data flow within the Control Center. Also the Project Director (Bushuyev) will sit in this back row. The Flight Director is in the next row from the back and is the focal point for all activity in the Control Center. To his left and right, and in the two rows of consoles in front of him, are the various support functions, which are pretty much the same as the functions within our own Control Center, except that there is no launch vehicle console. Each console has a number of television screens, and the Flight Controller at that console can call up all sorts of displays, either out of the computers or from any one of a number of hard copy projectors. Real time data apparently are only a few seconds behind the actual event. They are also able to generate within the computer a display which merely indicates whether all parameters on a given subsystem are normal or abnormal. If they are normal, that's the end of it. If they are abnormal, the Flight Controller can then go to another display to find out which function is specifically abnormal. There are no warning tones with any of the displays. The communications system allows the Flight Director to talk to any or all of the other consoles as well as to the back rooms. We learned that the Control Center takes over after the spacecraft has been separated from the launch vehicle in orbit. Until that time, the flight is under full control of the Launch Center. The reason for this was explained to us as follows:

First, there are no booster functions that can be performed by the astronauts themselves. Second, spacecraft functions must also be read out at the Launch Center for checkout purposes, and spacecraft experts are at the Launch Center for checkout purposes.

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For both of these reasons it was more convenient then to handle all abort control at the launch site and not at the Mission Control Center. These facts were further borne out when we saw the onboard TV of the Soyuz 12 launch. The cosmonauts were lying in their couches with their hands folded in their laps. They are obviously just passengers during the launch phase.

In the Mission Operations Control Room Yeliseyev answered all questions concerning flight control. He has obviously been there before and has obviously worked in the Control Center on at least some simulations if not on Soyuz 12. The questions concerning the Control Center itself were answered by the "Deputy Flight Director for Measurements." I believe his name was Miltsin, but I am not sure of this. At any rate, he obviously knew the Control Center well and was able to answer every question which we asked. There was no holding back.

We left the Control Room floor and went behind the large screen where we saw the display projectors. From there we looked into a large number of rooms housing, first, communications equipment, and then computing equipment. We also went to one of the staff support rooms, which was located quite a distance from the Control Room floor, but was equipped with consoles similar or identical to those in the Control Room. Communications gear included a large number of teletype machines as well as all sorts of terminals, recorders, strip charts, and the kind of gear you see in any communications center.

We also saw rooms where all of the onboard tapes were being processed, but none for photographic processing. All of the computing equipment appeared to be made in the Soviet Union. There are three large digital computers, and my guess would be that they are of the generation we used for Mercury and Gemini and not of the Apollo generation. The external memory is a drum memory with 16 drums, each storing 32,000 48-bit words for each of the computers. I don't recall the numbers for the internal memories. In addition to the main computers, there are quite a few peripheral computers used for special tasks. The computers are used for trajectory as well as telemetry work.

As I said earlier, every one of our questions was answered in detail, and if there is anything we don't know it is only because we didn't have enough time or didn't know to ask the

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right questions. Lunney and Frank, both of whom are very familiar with our own Control Center, should, of course, have a much better view of the real significance of what we saw. It was also of interest that the Control Center was obviously not controlling a flight while we were there. There was very little activity, although one or two people were in evidence in each of the rooms where we opened a door.

During one of the toasts at lunch, Abduevski said that frankly they had been quite concerned about our visit because they knew of our wonderful technology and hoped that they compared favorably. Many of the private questions we were asked afterwards also concerned our views of their Center. They are obviously very proud of it.

VISIT TO INSTITUTE OF GEOCHEMISTRY

This is Vinogradov's institute where lunar samples are being analyzed. The area of sample handling and preliminary analysis is extremely primitive. Samples from Luna 16 and 20 and from Apollos 11 through 17 were all in storage. The various tools for sample analysis throughout the institute also appeared to be extremely primitive and mostly foreign made. We were shown equipment for spectrographic analysis, a scanning electron microscope, and equipment to measure magnetic spin resonance. I was impressed by neither the people nor the equipment.

INSTITUTE OF SPACE RESEARCH

This institute is in a brand new building which is not yet fully in operation. Apparently the building was constructed by a military labor battalion. It is the shoddiest construction I have ever seen.

We were taken to various laboratories in the Institute and saw flight instrumentation used in gamma ray astronomy, X-ray astronomy, particles and fields measurements, and ionospheric measurements. We also saw some of the instruments which are now on their way to Mars. Incidentally, I asked Sagdeyev whether the newspaper reports to the effect that no life sensing instruments were on the present Mars spacecraft were indeed true, and he said yes, they were not yet ready to send any instruments

that were capable of searching for life. He implied, however, that they were working on such instruments for the next Mars opportunity. He also asked how long it had taken us to develop the instruments we intend to fly on Viking. There was some additional discussion about the present flights to Mars and apparently one of the four spacecraft is having telemetry difficulties which have not yet been resolved.

The X-ray type instrumentation we saw apparently has already been flown and some results have been published. By their own admission, however, these results are not as good as those obtained with Uhuru. They indicated that since their satellite was not in an equatorial orbit and was only in orbit for a short period of time, they could not match Uhuru's results. The gamma ray instrumentation we saw had not yet flown on a satellite. Insofar as ionospheric measurements are concerned, they apparently have a very active program, both with sounding rockets and with satellites.

In summary, we saw instruments of the type flown in our physics and astronomy and planetary programs. Although earth resources work is also going on in the same Institute, this was not discussed nor were we shown any of the work. Our guess is that they just don't have anything worth seeing.

The remaining time at the Institute of Space Research was spent on a discussion of the results of the Venus 8 spacecraft. (Sagdeyev pointed out that this was done especially at the request of Keldysh since we had discussed our Mars results with Keldysh.) The briefing was given by Abduevski, who, as I mentioned earlier, is now the Deputy Director of the Control Center. Whereas he was a novice at the Control Center business, he knew all about the engineering of the Venus 8 spacecraft as well as the details of the scientific results. My guess is that he was deeply involved in the Venus 8 flight.

The Venus 8 spacecraft was designed to withstand the Venus surface temperatures for a short period of time (approximately 1 hour). This was achieved with good insulation and through precooling the spacecraft for several days before it arrived at Venus. Abduevski made a major point of the fact that the insulating properties of the insulation change drastically with increasing pressures of the kind encountered at the surface of Venus (90 atmospheres), and that new materials with lower "filtration constants" had to be designed.

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The most interesting result was the measurement of surface lighting in an area near the Venus terminator. The conclusion is that there is adequate lighting on the surface of Venus for television, even near the terminator.

VISIT WITH KIRILLIN

As I mentioned before, this was a courtesy visit made at my request. After a few words of welcome by Kirillin, I opened the discussion by reviewing the status of ASTP and other joint projects.

Kirillin then asked my views concerning the practical results of the exploration of space. I spoke of the usual things--communications, weather, and earth resources--as well as the potential long-range results of some of the scientific efforts in space. Kirillin came back to the point that the future of space must be practical and added one subject which I had left out of my discussions of earth resources, and that is geology. He felt that major contributions to geology can be made from space.

I then asked Kirillin where he thought our future cooperation in space might go. My purpose in asking this question was to find out whether he had given the matter any thought. Apparently he had not and gave only a very vague answer.

Finally, I brought up the subject of aeronautics, reminding Kirillin that NASA, of course, has a major effort in aeronautics research and asking whether he had ever considered any cooperation in this area. His eyes immediately lit up and he started talking about some of the commercial discussions now underway with Boeing, General Dynamics, and McDonnell Douglas, but he wondered what I had in mind and how NASA might fit in. I told him that I had really nothing specific in mind when I brought up the subject but that any cooperative efforts with NASA would have to be in the area of aeronautical research as opposed to in the commercial areas. Both of us agreed to think about future possibilities in possible cooperation in aeronautics and said that we might pursue this at a later time.

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PUBLIC AFFAIRS PLAN

Donnelly had negotiated the first phase of a Public Affairs Plan covering preflight activities. This plan had been signed by Lunney and Bushuyev; it was to be confirmed by Petrov and me. When I met with Donnelly to review the plan he was concerned that the definition of news media in the plan was not clear and that it was quite likely that the Soviet side would not permit television cameramen to accompany television correspondents. Instead, he felt that they would want to impose on us the usual practice of having the Soviets take all television film and of selling that film through Novesty news agency. Donnelly, therefore, suggested that we should not confirm the plan until this issue had been settled. (Since this was an open issue, it is still not clear to me why he asked Lunney to approve the plan in the first place.)

In subsequent discussions with Petrov, it became clear to me that the plan as signed lacked in two other respects: first, it would be quite possible that the Soviet side would admit its own news media to a joint function without at the same time admitting U.S. news media; and secondly, Donnelly indicated that he had verbal agreements that our astronauts could be accompanied by their own documentary photographer. This was not written down in the plan.

In my first meeting with Petrov (the meeting at Star City), he appeared to understand all the points that needed to be covered, and also appeared to be in agreement with them.

We adjourned our meeting at Star City, and Frutkin and I wrote additions to the Public Affairs Plan in the area of the three points mentioned; that is, the definition of news media, the participation of news media from both sides in joint activities, and the possibility of bringing along a documentary photographer. When we met again the next morning, Petrov was not as willing to include these new additions as he had implied the night before. Obviously, he must have checked into this with somebody better versed in the ways of the press in the Soviet Union. He threw up a smoke screen about things like the copyright agreement and the lighting required whenever TV cameramen were present. I told him that I wanted him to understand that there is only one serious issue in the definition of news media and that concerns television

cameramen. Will U.S. cameramen be allowed in the Soviet Union or not? The meeting broke up without reaching any conclusion. Subsequently, Frutkin had additional discussions with Vereshchetin, and I had additional discussions with Petrov. Vereshchetin assured Frutkin before we left Moscow that they agreed in principle with all of our points, but they were not sure whether they could agree exactly with our language. They promised that they would send, at an early date, a new version of the Public Affairs Plan, incorporating the substance of our additions. We could then either confirm the plan or, if we still did not like it, we would have to have further negotiations.

MISCELLANEOUS ITEMS

Comet Kohoutek

I gave Petrov several reprints of the Kohoutek article which appeared in the October issue of Aeronautics and Astronautics, and asked whether the USSR would have any interest in participating in the planned observations. On the following day Petrov informed me that they would ordinarily be quite interested in participating, thanked me for the invitation, but told me that during the time of the Comet the weather would be so bad in the Soviet Union that it was unlikely that any of their ground observatories would be able to see it. I took this as a polite way of saying "no."

Reaffirmation of the Low-Keldysh Agreement

Frutkin informed me that he believed that the Low-Keldysh Agreement needed to be reaffirmed three years after it was approved, or in the spring of 1974. Although I was not quite sure that this was the case, I did bring up the subject with Petrov. He implied that the spring of 1974 would be a bad time because this will be the 250th Anniversary of the Soviet Academy of Sciences, and Keldysh is expected to be very busy. However, he suggested that we might get together in the summer or fall of 1974. Although he assumed that we would get together in the Soviet Union, I issued an invitation to do this in the United States. However, I am not sure how necessary it is to do anything other than to exchange letters on the subject.

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