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

→ FMSA & Info.

REPLY TO
ATTN OF: WX

DEC 10 1971

MEMORANDUM FOR: Dr. Donald Steininger
Assistant Deputy Director of Science & Technology
Central Intelligence Agency

SUBJECT: Summary of Results of the Joint US/USSR Working Group Meetings

Attached is a copy of the Summary of Results of the Joint US/USSR Working Group meetings of November 29 - December 6, 1971, on rendezvous and docking in implementation of the NASA/Soviet Academy agreement of October 1970. We would appreciate any comments you may have prior to January 24 when NASA plans to dispatch a letter approving these recommendations.

Please note the restriction on release of these results.

Jacob E. Smart
Assistant Administrator
for DOD and Interagency Affairs

Attachment
as stated

SUMMARY OF RESULTS

Of the third meeting of specialists of the USSR Academy of Sciences and the U.S. National Aeronautics and Space Administration, November 29 - December 6, 1971, on compatible systems for the rendezvous and docking of manned spacecraft and stations.

I. INTRODUCTION

1. In accordance with the Summaries of Results of technical talks between representatives of the USSR Academy of Sciences and the U.S. National Aeronautics and Space Administration, held October 26-28, 1970, and on June 21-25, 1971, on questions of providing for compatibility of manned spacecraft and space station rendezvous and docking systems, a meeting of three Joint Working Groups was held in Moscow (USSR), November 29 - December 6, 1971, for the purpose of:

(a) further discussing, coordinating and approving technical requirements for compatibility of such systems in the future; and

(b) further considering possible flight missions to test compatible systems in the mid-1970's period.

In the period between the meetings, technical documents were exchanged and agreed technical tasks performed for subsequent approval.

II. RESULTS OF WORKING GROUP ACTIVITIES

2. The Joint Working Groups considered both the long-term technical requirements for compatible systems and possible flight missions to test such systems, giving consideration at this time to the joint test mission of an Apollo-type spacecraft and a Salyut-type space station noted in the Summary [illegible] in Houston in June 1971.

3. The second stage of possible tests of technical requirements and solutions for compatible rendezvous and docking systems will be considered later, as provided in the Summary of Results of June 1971, namely the docking of a Soviet Soyuz-type spacecraft with a U.S. orbital station of a Skylab or another type to be put in orbit after 1975. The technical desirability of both stages of tests is recognized by both parties, considering also that the sizes and other characteristics of the compatible systems used in the first stage may be altered for the second stage by mutual agreement.

4. The results of the Joint Working Group meetings are noted in their minutes which are attached as an integral part of this Summary of Results (Attachments A, B and C) and which list documents developed and exchanged by the Working Groups. The main aspects of their minutes are briefly listed as follows:

5. Joint Working Group No. 1 completed general documentation on life support systems, coordinate systems, constraints upon spacecraft configuration, and communications between control centers. With respect to the proposed joint Apollo/Salyut test mission, agreements were reached on the objectives of the objectives of the mission and on a list of proposed project documents for the mission. The group agreed to a mutual exchange on launch windows in two months, programs for the test mission by April, and communications channels for the respective control centers within three months. The U.S. side will provide a proposed interface organizational plan for the project for comment by the Soviet side.

6. Working Group No. 2 determined the list of guidance and control systems and onboard equipment of USA/USSR spacecraft which is to be compatible. The documentation on the subjects of lights, docking targets and control and display systems and radio tracking has been

very nearly completed. The Group plans to reorganize its documentation into two volumes covering respectively the future general requirements and the proposed Apollo-Salyut test mission. With respect to the test mission, it is agreed that the two sides develop a communications system and a tracking system to an agreed set of technical requirements and to provide for the installation of the Apollo-type VHF ranging system as a back-up. The Soviet side will consider whether to build its part of this system or utilize equipment provided by the U.S. side. Docking contact criteria have been agreed as a basis for docking system design. Agreement has also been reached on a docking target for installation in the center of the docking hatch. This target will provide a compatible docking alinement system. A docking target, similar to that used in the Apollo program, will also be installed on the Salyut to facilitate alinement. Some parameters may require review as design problems are uncovered. Additional work will be undertaken by one or both sides on control stabilization requirements and their relationship to spacecraft size, and on the design, development schedule, evaluation and installation of the new docking target concept. The Working Group recognizes the usefulness of a meeting in the very near future.

7. Joint Working Group No. 3 discussed and agreed on the document "Technical Requirements for Compatible USA and USSR Docking Systems" and agreed to a series of basic parameter values of Apollo/Salyut docking systems, including the diameter of the transfer tunnel. The working group exchanged and discussed material on a docking system concept. Basic features of a joint concept were developed that will permit further development work. Further study and agreement are required for the development of a single joint concept, listing of parameters and establishing their values so as to ensure compatibility. Also needed is

... and methods of conducting tests at various stages of development. The Working Group agreed also to create a scale model of a docking system that will allow a verification of the parameters that ensure compatibility at an early stage of development. The Working Group recognized the usefulness of a meeting in the very near future and outlined the questions that must be discussed and agreed at that meeting.

III. OBJECTIVES OF AN APOLLO-SALYUT JOINT TEST MISSION

8. The primary objective of a joint flight involving an Apollo-type spacecraft and a manned orbital station of the Salyut-type would be to conduct space experiments to test the technical requirements and solutions for compatibility of systems for docking of future manned spacecraft and stations. Such testing should include the rendezvous and docking of Apollo-Salyut with the active use of all the new equipment required for compatibility which could be available by the time of the mission. The performance of this test mission would include the following:

(a) testing of a compatible rendezvous system in orbit.

(b) testing of androgynous docking assemblies.

(c) verifying the techniques of transfer of cosmonauts and astronauts.

(d) the performance of activities of U.S. and USSR crews in docked flight in accordance with a program that will be determined later.

(e) gaining of experience in conducting joint flights by U.S. and USSR spacecraft, including rendering aid in emergency situations.

IV. OTHER CONSIDERATIONS FOR A FIRST APOLLO-SALYUT JOINT TEST MISSION

9. With particular regard to a possible first joint test mission, involving the rendezvous and docking of an Apollo-type spacecraft and a Salyut-type space station, representatives of the two sides reached the following conclusions:

technical discussions so far, such a

test [illegible] Approved For Release 2005/02/17 : CIA-RDP74B00681R000100150001-5

(b) The baseline for discussion, definition and development of the compatible docking system for the initial test mission will be based on the agreed concept of an androgynous, peripheral system adapted to the particular requirements of the Salyut space station and the Apollo docking module.

(c) A preliminary list of milestones, or major events in the planning, design and implementation of the first proposed test mission, is provided in Attachment D. The parties should exchange proposals before April 1972 for this schedule of activities and its finalization.

(d) The parties consider it essential, in order to begin designing and modeling the components, units, and systems which are required for consideration and possible implementation of the first joint test mission, to provide for continuing direct contact through appropriate organizational and communications arrangements:

(1) Organization. The Project Directors on both sides shall be responsible for direct and continuing contact between them and for taking all technical steps relating to the test mission. They shall utilize Deputy Project Directors as desired, draw on experts from the three Working Groups, and utilize such additional experts from their respective sides as they may require.

(2) Communication. The two sides agree that the development and accomplishment of the test mission require the establishment of rapid and effective communications between the Project Directors and others designated by them.

The U.S. side considers that informal direct communication should begin immediately by voice and telex channels and that it should then be established on a regular basis as follows, as soon as this [illegible]

-- The telex channel will be used as required to establish and record understandings as well as to transmit desired information. It will also be used to organize and arrange in advance the agenda for scheduled weekly voice communications so that such weekly voice conferences will be disciplined and efficient.

-- Voice communications shall be for discussion purposes only. Action should be taken only on the basis of confirming telex messages.

-- Each side will meet the cost of its telex messages. The two sides will share equally the cost of a dedicated voice channel.

The U.S. side considers that such a coordinated system of telex and voice communications is essential for proceeding with the proposed joint mission. The Soviet side will study this question and transmit its proposals simultaneously with the confirmation of this Summary of Results. The two sides agree that documentation should be exchanged by the most rapid means, utilizing the assistance of Embassies. In addition, small groups of experts shall exchange brief visits as required on particular problems.

(e) Since an early final decision would be essential to permit a flight schedule for the mid-1970's, it is necessary that each party send the other, by April 1, 1972, a statement of its position on the prospects for the actual conduct of the test mission in 1975. (The U.S. side proposed Spring or Summer.) The parties will also exchange mission concepts by April 1, 1972.

V. CONCLUSION

10. This Summary of Results is subject to confirmation by the USSR Academy of Sciences and NASA; parties shall inform each other accordingly in writing within two months.

11. The next meeting of the Joint Working Groups is planned for late May or June 1972 in the United States.

Done in Moscow, December 6, 1971, in Russian and in English.

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Robert P. Gilruth

I. P. Rumyantsev

Arnold W. Frutkin

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ATTACHMENT A

WORKING GROUP NO. 1

NOV. 30 - DEC. 6, 1971

MINUTES OF MEETINGS ON COMPATIBILITY OF GENERAL METHODS AND MEANS FOR RENDEZVOUS AND DOCKING

PART I. COMPATIBILITY OF FUTURE SYSTEMS

In the discussion of the agenda items, the following results and conclusions were reached:

a. Coordinate Systems and Units

Group I agreed to accept the document prepared by the US entitled, "Coordinate Systems Standards for International Rendezvous and Docking of Spacecraft," and it was signed by both parties. This document is included as Enclosure 1.

b. Atmosphere, Pressure and Methods of Transfer

The document prepared by the USSR entitled "Specifications for Crew Compartment Atmosphere, Transfer Methods, and Units and Systems Needed to Provide for the Transfer of Crews after USSR and USA Spacecraft and Space Stations Have Docked" was accepted after modification and then was signed by both parties. This document is included as Enclosure 2. We reached an understanding that within two months of this meeting both parties shall exchange information on questions relating to the connection of liquid-cooled garments of the space suits to on-board thermal regulation systems. Data also to be exchanged includes quantitative characteristics (possible times, release of oxygen into the cabin atmospheres) and possible operational solutions (pre-breathing in airlock chambers under lowered pressure in a two-component atmosphere) with a view of finalizing these questions at the next meeting.

c. General Constraints on the Location of Structural Elements and Equipment

Space Vehicles and that a separate agreement should be initialed then was signed by both parties. This document is included as Enclosure 3.

d. Communications Between Control Centers

The US side presented a paper entitled, "Proposal Requirements for Communications between Control Centers," and the USSR side agreed to review the paper and transmit comments to the US within 3 months. Group I is confident that agreement will be reached on this subject.

e. Hatch Sizes

The subject of a clear hatch opening size for future space systems should be discussed further. The present US requirement for future systems is 1.5 meters in diameter. The USSR agrees that it is desirable that hatch sizes for future space systems be larger than those on present spacecraft.

f. Techniques for Assuring Compatibility of Overall Methods and Means

Group I agreed that the Apollo/Salyut test mission being considered is a good opportunity to test our joint solutions for assuring overall technical compatibility.

PART II - APOLLO/SALYUT-TYPE MISSION

In addition to discussing future system requirements, Group I also discussed the proposed test mission involving an Apollo-type spacecraft and a Salyut-type manned orbital station. The results, conclusions, and work to be continued are summarized as follows:

a. Information Exchange

Both sides presented papers covering several subjects at the beginning of the meetings which were very helpful in the discussions and will be valuable as reference material in the work to continue.

b. Project Documentation

Group I agreed that a number of documents are necessary for planning an Apollo/Salyut mission and established a list of documents which need to be

prepared and signed. This list is included as Enclosure 4. As work progresses, other necessary documents may be identified and included on the list by mutual agreement. The group agreed on the general technical content of these documents, although further definition is necessary. We agreed that both sides will exchange outlines of these documents within three months along with a proposed schedule for the preparation of these documents.

c. Organizational Plan

The U.S. side presented an outline of a typical organizational plan for consideration. Group I gave general agreement to the content of such a document. The US will transmit a proposed organizational plan to the USSR within three months.

d. Project Technical Proposal Document

Group I agreed upon the need for a project concept proposal document which would give an overall conceptional description of all the elements involved in the test mission. This document should include a brief description of major items of equipment and mission model. An example of this type of data is shown in the U.S. document entitled, "Design and Operational Description of the US Equipment for Use in the Apollo/Salyut Test Mission." We agreed to exchange proposals on this document by Mid April 1972 which will serve as a basis for a common acceptable document to be developed and signed at our next meeting.

e. Apollo/Salyut Test Mission Objectives

Our group decided that the primary objective of a joint flight involving an Apollo-type spacecraft and a manned orbital station of the Salyut-type would be to conduct space experiments to test the technical requirements for compatibility of systems for rendezvous and docking with the active use of all the new equipment required for compatibility which could be available by the time of the mission. The performance of this test mission would include the following: (1) testing of a compatible rendezvous system; (2) testing of androgynous docking assemblies; (3) verifying the techniques of transfer (the transfer of up to two US crewmen to the Salyut

and the transfer of crewmen to the Apollo Command Module);

(4) the performance of activities of US and USSR crews in docked flight in accordance with a program that will be determined later, and (5) gain of experience in conducting joint flights by US and USSR spacecraft, including rendering aid in emergency situations.

f. Atmospheres Compatibility and Crew Transfer

The group accepted in principle the concept of the use of a special US docking module for use as an airlock between the different atmospheric pressures of Apollo and Salyut. We agreed on a set of preliminary ground rules and have included them as Enclosure 5.

g. Mission Plan

In the course of discussion agreed decisions were reached on some questions; on a number of questions the direction of further studies was defined. The results reached are contained in Enclosure 6.

The parties have agreed to conduct further studies on the possible ranges of launch times for their spacecraft with a view of finding a mutually acceptable solution so as to ensure a daylight Apollo launch. It was decided to exchange the results of these studies within two months.

h. Communications Channels between Control Centers

Group I agreed that the previously exchanged papers on this subject contained the basis for agreement. We agreed that the USSR will review the US proposal and transmit comments to the US within three months. We also agreed that, after the requirements were established and signed, communications specialists from each country should meet to determine how these communications channels would be implemented.

In summary, Working Group I exchanged views on the Apollo/Salyut test mission and reached an understanding of the main elements required for such a mission. We have reached agreement on mission objectives, document requirements, preliminary planning data for the mission model, and some other technical parameters.

Done in duplicate in the English and Russian languages.

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[ATTACHMENT B]

Minutes of the Working Group No. 2

November 29 - December 7, 1971, Moscow

1.0 The sides continued discussion of the following questions concerning USA/USSR spacecraft rendezvous and docking.

-- external lights (flashing light beacons, onboard orientation lights, floodlight),
-- docking target and sighting devices,
-- voice communication radio systems,
-- rendezvous radio systems,
-- initial contact conditions for designing the docking unit,
-- requirements for spacecraft control systems operation in rendezvous and docking modes and docked mode,
-- documentation format.

2.0 External lights

2.1 Both sides confirm the agreements on the flashing light beacon, the onboard orientation lights and the floodlight which were agreed upon at the second meeting in Houston in June 1971 with the following changes and definitions.

a) Acknowledging the desirability for providing the detection of flashing light beacons in any direction up to the range of 50 kilometers, the sides may assume a reduction of these requirements for a particular spacecraft. In these cases the specific characteristics of beacons will be included in the general technical requirements defined for the appropriate spacecraft, and these will be agreed to by both sides.

b) Both sides permit the presence of regions of no coverage for the onboard orientation lights. The preferred values for these regions and their locations for each spacecraft will be agreed to by both sides.

c) The sides agree to change the agreement with respect to the number of onboard orientation lights and their locations according to the document "General Technical Requirements for Onboard Orientation Lights for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking."

2.2 Both sides agreed to the format of the following documents: (See Appendix 3 for correct titles for this and all following sections.)

a) General Technical Requirements for Onboard Orientation Lights for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

b) General Technical Requirements for Flashing Light Beacons for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

c) General Technical Requirements for Floodlights for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

Both sides have agreed to certain technical specifications in these documents, but both sides consider that it would be expedient on the following technical questions:

a) flashing light beacon turn-off range;

b) beacon shading in emergency conditions;

c) onboard orientation light locations, and;

d) color coordinates for white lights, to carry out further analyses, to define technical specifications, and to exchange these in the form of technical documents in preparation for their discussions at the next meeting.

2.3 The parties consider that the general technical requirements for spacecraft external lights may be extended to the Apollo/Salyut international mission with the appropriate modifications and agreement

will be made upon the technical requirements for such devices.

For this purpose both sides have agreed upon the following documents:

a) General Technical Requirements for Onboard Orientation Lights of the USSR Orbital SpaceStation Salyut-type During Rendezvous and Docking with the USA Spacecraft Apollo-type.

b) General Technical Requirements for Flashing Light Beacons of the USSR Orbital Space Station Salyut-type During Rendezvous and Docking with the USA Spacecraft Apollo-type.

c) General Technical Requirements for Onboard Orientation Lights of the USA Spacecraft Apollo-type During Rendezvous and Docking with the USSR Orbital Space Station Salyut-type.

d) General Technical Requirements for Flashing Light Beacons of the USA Spacecraft Apollo-type During Rendezvous and Docking with the USSR Orbital Space Station Salyut-type.

e) General Technical Requirements for Floodlight of the USA Spacecraft Apollo-type During Rendezvous and Docking with the USSR Orbital Space Station Salyut-type.

Some characteristics of the external lights of the Salyut space station and the Apollo Command/Service Module, in particular the Apollo floodlight location, the orientation light shading and location and the Salyut flashing light beacon intensity require further analyses and definitions. The results of these analyses will be exchanged between the sides for information and further discussion.

2.4 Both sides consider that the passive spacecraft must have devices for shading of optical sighting and measuring instruments from damage by the flood[illegible] during docking.

3.0 Targets

3.1 It is agreed that a standardized docking target will be designed for future USSR and USA spacecraft and space stations. The target will be mounted on the docking mechanism hatches of each country's spacecraft and space stations. The target design and location requirements will be specified in the "General Technical Requirements for Docking Alinement Targets for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking." (to be completed and approved at a later date).

The standardized target design has been tentatively described. A final design will be discussed and adopted at the next meeting. In the event that significantly new docking devices are developed, then modifications to the standardized target design may be necessary and changes will be made by mutual agreement.

3.2 For the performing of the Apollo/Salyut mission it is agreed to mount on the Soviet Salyut station 2 docking targets, one of them being made in accordance with " General Technical Requirements for Docking Alinement Targets for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking."

The second docking target for the Apollo/Salyut mission will be mounted on the Salyut and located coincident with the Apollo line of sight. The target will generally be of the type shown in Figures 1 and 2. (General dimensions are shown on Figure 1.) The back of the target will be located on the Salyut within 1 meter of the docking interface and shall not be more than 0.6 meters in diameter. The USA will select the final design of the target and inform the USSR about this choice. The location accuracy and manufacturing tolerances for the target will be defined when the target selection is made.

4.0 Communication System

4.1 The sides confirm the agreements achieved on radio communication at the second meeting in Houston (June 1971) and consider that these agreements should be extended to the particular Apollo/Salyut mission.

4.2 Standard radio communication equipment, the composition of which was determined at the second meeting, should not be used for other tasks (range measurements) as such a multi-purpose use of the equipment limits the possibilities of spacecraft-ground stations-astronaut communication in international missions.

4.3 The Soviet operating frequency is 121.75 MHz. The American operating frequency is chosen from frequency band of 100-300 MHz. The USA will inform the USSR about the exact frequency during March 1972. After this, the sides agree to proceed with preliminary designs.

4.4 The parties agreed on the preliminary common technical requirements for the compatible station for radio communication (see Appendix 1).

4.5 The sides agreed that the Apollo VHF Communications and Tracking System will be placed as a back-up system on both spacecraft during the Apollo-Salyut mission at the same time with the standard communication station corresponding to Appendix 1. The USA will send the documentation of the Apollo VHF Communication and Tracking System during January 1972 so that the USSR can determine the possibility of manufacturing this system.

4.6 It is agreed that the primary communication mode will be simplex, simultaneously on both operating frequencies.

4.7 The following questions will be discussed in the future:

a) The final agreement of the requirements on the compatible radio communication equipment and their refinement;

b) Characteristics of antennas and their locations;

c) Energy potential calculations for ranging and tracking data modes calculations;

d) Techniques and the order of checking the equipment for compatibility;

e) The Soviet possibilities of manufacturing the Apollo VHF Communications and Tracking System.

5.0 Tracking Systems

Both sides continued discussion of requirements for radio guidance systems during rendezvous operations and came to the agreement that:

5.1 The final goal for both sides is the development of a compatible, common system which provides for radio guidance during rendezvous operations. The transponder for the passive spacecraft will be developed to meet the common technical requirements mutually agreed to by both sides. Both sides will design, independently, the equipment for the active spacecraft.

5.2 During the Apollo/Salyut rendezvous experiment, the existing US ranging system will be considered as a backup system. The transponder for this system will be installed on the Salyut space station together with the compatible common transponder. For determining the possibilities of the US system manufacture by the USSR, the American side will submit detailed technical requirements for this system during January 1972.

5.3 Taking into account that the standardized waveband 3-10 CM suggested by the Soviet side includes part of the waveband 8-15 CM suggested by the American side, both sides came to a preliminary agreement to develop a compatible common radio guidance system for rendezvous operations in the 10 CM waveband. The accurate values for interrogator and transponder carrier frequencies will be coordinated during the next working group meeting. The suggestions of each side on nominal carrier frequencies of the interrogator and transponder shall be communicated by mail for review by each side before the meeting. Each side will send to the other the draft of technical requirements for the transponder for review by each side before the meeting.

6.0 Initial Contact Conditions for the Designing of Docking Mechanisms

6.1 The sides agreed to define the form of technical specifications of contact conditions for the designing of docking mechanism.

6.2 The sides agreed to be governed in further investigations by the following values of parameters for future space vehicles and for Apollo/Salyut missions:

-- closing velocity	0.05 - 0.3 m/sec
-- for Apollo/Salyut mission a question should be discussed concerning increase of the lower limit up to	0.1 m/sec
-- lateral velocity	0.1 m/sec
-- lateral misalinement	0.4 meters
-- angular misalinement	7.0 degrees
-- roll misalinement	7.0 degrees
-- angular velocity (active vehicle)	1.0 degree/second (around any axis)
-- angular velocity (passive vehicle)	0.1 degree/second (around any axis)

These parameters are defined in a document titled "Docking Initial-contact Condition Criteria for Application to the USA Spacecraft Apollo-type and the USSR Orbital Space Station Salyut-type."

6.3 The sides agreed to exchange the results of their investigations and to conform finally the values of the parameters for the Apollo/Salyut mission at the next mission.

7.0 Control Systems

7.1 Discussions have been conducted concerning the requirements for the attitude control system of the Salyut spacecraft during the docking maneuver and the docked flight of the Apollo/Salyut mission. It is agreed that the document submitted (see Appendix 2) by the USA will serve as a basis for exchange of data. The USSR agrees to prepare a corresponding document and the format will be agreed to at the next meeting.

7.2 Both countries have agreed to study the question of allowable angular rates for unstabilized vehicles. The studies will evaluate angular rate values between 0.05 - 0.1 degrees/second.

7.3 It is agreed to exchange necessary data on the moments of inertia, bending, fuel slosh, mass distribution, thruster location, block diagram and phase plane of the attitude control system, etc., to evaluate the control system requirements of the docked Apollo/Salyut.

8.0 Documentation

It is agreed that both sides shall prepare and exchange required documents for application to USA/USSR compatible rendezvous and docking. These documents will further define the system parameters set out in these minutes. The documents will be individually approved by each side after they are exchanged and studied. The sides have preliminary versions of these documents and a list is given in Appendix 3. The documents are a part of the minutes. This list may be added to through mutual agreement.

USSR		USA
V. P. Ierostayev (Chairman)	V. A. Podelyakin	D. C. Cheatham (Chairman)
O. I. Pakkov	V. A. Pospletin	R. H. Dietz

APPENDIX I

THE PRELIMINARY COMMON TECHNICAL REQUIREMENTS FOR THE COMPATIBLE RADIO COMMUNICATION STATIONS

1.1 General Parameters

This document formulates the requirements for radio stations intended to ensure:

--simplex voice and AT (audio tone) telegraph communications on FM at a frequency fFM equal 121.75 MHZ.

--simplex voice and AT telegraph communications on AM at a frequency of 100 - 300 MHZ

--duplex telephone and AT telegraph communication at frequencies fFM and fFM.

The primary communication mode is simplex, simultaneously on the frequencies fAM and fFM. In the duplex mode, the active spacecraft transmits fFM and receives fAM; the passive spacecraft transmits fAM and receives fFM. AT telegraph is used according to the discretion of each side.

It is proposed that each side develop its radio stations separately. The basic parameters and structural elements of the stations required to ensure compatibility will be standardized in these technical specifications.

Each space vehicle will be equipped with a radio station in cases where possibility of rescuing the crew must be provided, as will every rescue vehicle.

The operating frequencies of the radio station are selected on the basis that it may be possible for stations or ship stations of both countries to monitor conversations and contact them from the ground.

1.2 General Technical Specifications

1.2.1 The radio station must include:

-- a transmitter for fFM;

-- a transmitter for fAM;

-- a receiver for fFM;

-- a receiver for fAM;

-- antenna switches;

-- control panel

-- tape recorder and telegraph key (according to discretion of each side)

1.2.2 The radio station assembly on each spacecraft includes the following:

-- the radio station itself;

-- instructions for operation in flight;

-- dictionary of accepted words and expressions;

-- and set of magnetic tape cassettes (if necessary);

1.2.3 The radio station must ensure radio communication between vehicles at distances of 0 to at least 150 km at any flight altitude (after antennas are deployed) and in any mutual position.

1.2.4 It is assumed, if one of the parties considers it desirable, that the individual devices in the radio station or the radio station itself will be able to be used for other forms of communication. This will require elaboration of all requirements discussed in these technical specifications and will not limit voice radio communication.

1.2.5 The radio stations must accept leads from low frequency modulated inputs and have outputs from the receivers to other onboard communication systems.

1.2.6 The receivers must have squelches. The threshold of squelch operating must be e.g._____

1.2.7 The compatible parameters of the radio station will be as follows:

-- operating frequency fFM of the first receiver-transmitter. (121,75 MHZ)

-- operating frequency fAM of the second receiver-transmitter (. . . MHZ)

-- permissible frequency variation of transmitters and receiver heterodynes not to exceed 50x10-6

-- output power of transmitters in series with 50 ohms not less than 5-10W

-- coefficient of nonlinear distortion for transmitters 10% for fFM and 15% for fAM.

-- frequency variation of transmitter at fFM with modulating frequency of 1,000 Hz. 10 peak KHZ.

-- percentage modulation of fAM with nominal modulating voltage and modulating frequency of 1000 Hz. 0.9

-- attenuation of parasitic radiations in transmitters with reflectivity of 5 MHz, at least 80 db

-- receiver sensitivity when S/N ratio on audio output is equal 10db

must be less or equal to 1.5 μV at fFM
2.0 μV at fAM

-- pass band of receivers at 0.7 level 80 KHz (Amplitude of frequency curve)

-- attenuation of spurious channels at least 80 db

-- receiver selectivity with 100 KHz misalignment 60 db

1.2.8 The antenna-feed must allow transmission or reception for any direction of a communicating station relative to the vehicle on both frequencies fFM or fAM. The antenna radiational pattern of each antenna system must not contain dead areas below 10 db for any size vehicle, even during simultaneous operation at both frequencies. The antenna radiational patterns for each frequency must have a fill factor of at least 0.9 at 10 db.

The antenna feed loss (including diplexer loss) must not be greater than 3.0db.

1.2.9 The control panel must have the following controls:

-- fFM simplex, off and on;

-- fAM simplex, off and on;

-- duplex off and on;

-- mode switch for voice/telegraph

-- switch squelch, off and on

-- tape recorder, off and on (according to discretion of each side)

-- volume control knob.

1.2.10 The AT telegraph must use modulating voltage at a frequency of 800 ±100 Hz, with deviation of the operating frequency fFM by 10 KHz and percentage of modulation to be at least 80% of the operating frequency fAM.

1.2.11 The radio station must function normally under cabin conditions in space vehicles and stations.

1.3 As the program develops, it is allowed that changes may be made to this document after mutual agreement by both sides.

Appendix II

GENERAL TECHNICAL REQUIREMENTS FOR STABILIZATION AND CONTROL SYSTEM REQUIREMENTS FOR APPLICATION TO USA/USSR COMPATIBLE RENDEZVOUS AND DOCKING STUDY APOLLO/SALYUT

1.0 INTRODUCTION

1.1 Scope

This document defines the stabilization and control system requirements on the active (Apollo) and passive (Salyut) vehicles for the docking/undocking operations and the docked flight regime.

1.2 General Requirements

The control systems of the active and passive docking vehicles, Apollo and Salyut, respectively, will be capable of performing certain control functions for the above stated flight operations and flight regime. Each control system will be capable of attitude maneuvering or holding the combined configuration after docking, and also of limited translation of the combined configuration along its longitudinal axis for orbit maintenance or other TED purpose.

Requirements on the individual vehicle control systems are given below, section 3.0.

2.0 REQUIREMENTS

2.1 Stabilization and Control of the Passive Vehicle

The passive vehicle (Salyut) will provide an inertially stable docking target for the active vehicle (Apollo) during docking. This stability will be achieved by means of the attitude hold control capability of the passive vehicle. Maximum attitude angles and maximum attitude rates will be ±1 degree and ±0.1 degrees/second, respectively, about any Salyut axis during attitude hold.

The Salyut control system will also be capable of

initiation of the mode more than TBD degrees per second about any single fixed axis nor more than TBD degrees per second about each of its three principal axes simultaneously.

2.2 Stabilization and Control of the Docked Configuration

The Salyut and the Apollo control systems will each be capable of holding the docked Apollo/Salyut configuration to a solar inertial reference, a local vertical reference, or a TBD reference within a tolerance of ±TBD degrees attitude and ±TBD degrees per second residual attitude rate. Each control system will be capable of a FREE mode in both the soft latch and hard latch docked configurations.

Both the Salyut and the CSM control systems will be capable of maneuvering the docked configuration to any TBD desired attitude at an angular rate not to exceed TBD degrees per second.

3.0 VEHICLE MASS PROPERTIES

(See Table I.)

4.0 CONTROL SYSTEM CHARACTERISTICS

4.1 The Apollo

4.1.1 Thruster Locations

4.1.2 Thruster Characteristics

4.1.2.2 Minimum Impulse

4.1.2.3 Quad Configuration

4.1.3 Attitude Control System

4.2 The Salyut

4.2.1 Thruster Locations

4.2.2 Thruster Characteristics

APPENDIX 3

LIST OF THE DOCUMENTS OF WORKING GROUP 2

1. General Technical Requirements for Flashing Light Beacons for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

2. General Technical Requirements for Onboard Orientation Lights for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

3. General Technical Requirements for Floodlights for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

4. General Technical Requirements for Flashing Light Beacons of the USSR Orbital Space Station Salyut-type During Rendezvous and Docking with the USA Spacecraft Apollo-type.

5. General Technical Requirements for Onboard Orientation Lights of the USSR Orbital Space Station Salyut-type During Rendezvous and Docking with the USA Spacecraft Apollo-type.

6. General Technical Requirements for Onboard Orientation Lights of the USA Spacecraft Apollo-type During Rendezvous and Docking with the USSR Orbital Space Station Salyut-type.

7. General Technical Requirements for Flashing Light Beacons of the USA Spacecraft Apollo-type During Rendezvous and Docking with the USSR Orbital Space Station Salyut-type.

8. General Technical Requirements for Floodlight of the USA Spacecraft Apollo-type During Rendezvous and Docking with the USSR Orbital Space Station Salyut-type.

9. General Technical Requirements for Docking Alinement Targets for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

10. Docking Initial-contact Condition Criteria for Application to the USA Spacecraft Apollo-type and the USSR Orbital Space Station Salyut-type.

11. Docking Initial-contact Condition Criteria for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

12. General Technical Requirements for Guidance and Control Systems and Onboard Equipment to be Standardized for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

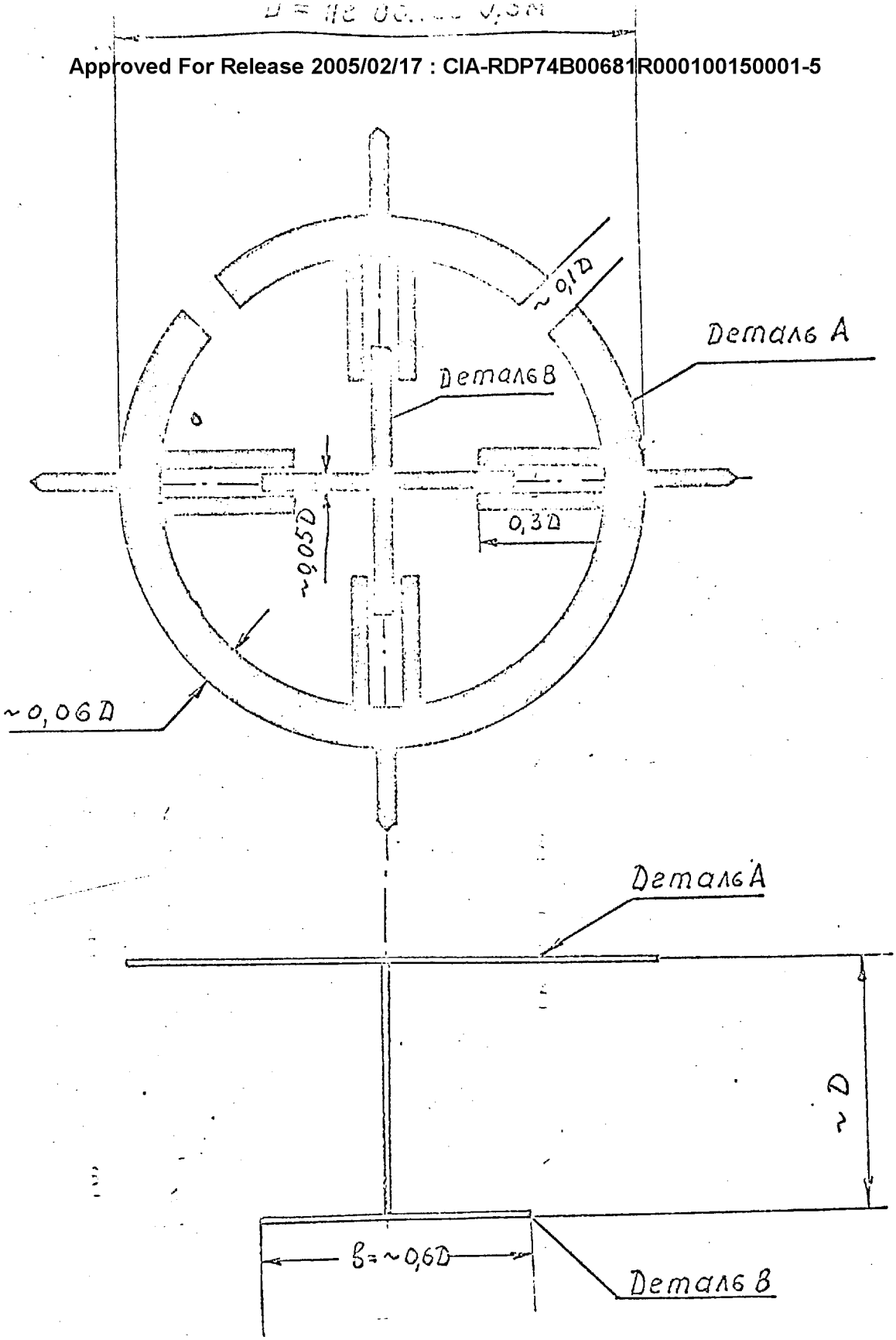
13. General Technical Requirements for Docking Alinement Target of the USA Spacecraft Apollo-type During Rendezvous and Docking with the USSR Orbital Space Station Salyut-type.

14. General Technical Requirements for Docking Alinement Target of the USSR Orbital Space Station Salyut-type During Rendezvous and Docking with the USA Spacecraft Apollo-type.

15. Format for Combined Documentation Related to USA/USSR Compatible Rendezvous and Docking.

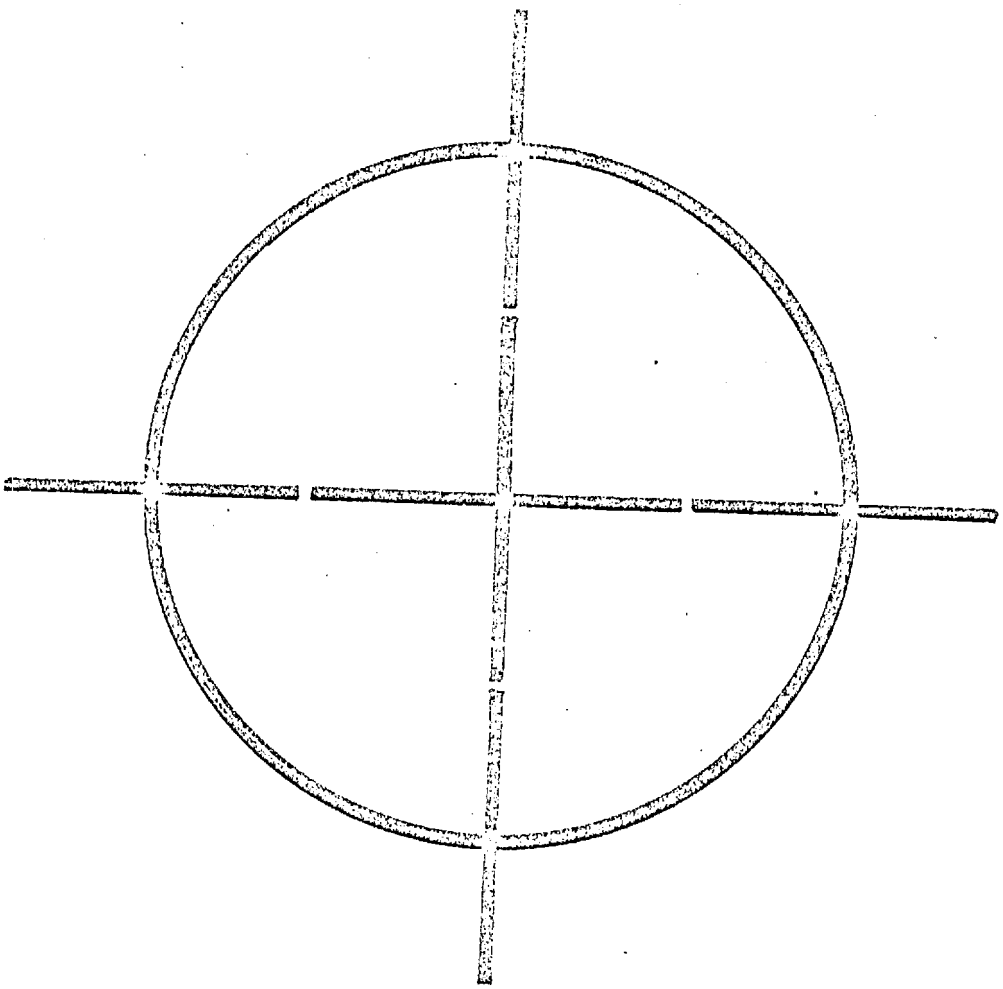
Document I. General Technical Requirements for Guidance and Control Systems and Onboard Equipment to be Standardized for Application to USA/USSR Spacecraft During Compatible Rendezvous and Docking.

Document II. General Technical Requirements for Guidance and Control Systems and Onboard Equipment to be Standardized for Application to the USA Apollo-type Spacecraft and the USSR Salyut-type Spacecraft During Compatible Rendezvous and Docking.



Фиг. 1.

Предлагаемый вариант стыковочной мишени для полета Аполлон - салют



Фиг. 2.

Предлагаемый вариант стыковочной мишени для полета Аполлон-Салют.

-Possible Design of the docking target for the Apollo-salyut mission.

[ATTACHMENT C]

APPENDIX C

WORKING GROUP NO. 3

NOVEMBER 29 - DECEMBER 6, 1971

MINUTES OF MEETINGS ON ASSURING THE COMPATIBILITY OF THE DOCKING SYSTEMS AND TUNNEL.

Working Group No. 3, responsible for assuring the compatibility of the docking system and tunnel, has discussed the items of its agreed agenda and has reached agreement as follows:

I. Technical Requirements for Compatibility of Docking Systems of USA and USSR Spacecraft

The sides reviewed, discussed and agreed on the document, "Technical Requirements for Compatible USA and USSR Docking Systems." It was agreed that the values of the parameters discussed in the technical requirements document will be agreed to in the process of developing the docking systems. A separate document will be prepared on agreed values of parameters and characteristics of docking systems that insure their compatibility. Some of these values have been agreed to at this meeting and are shown in Section III of these brief minutes.

Separate documents will be prepared on agreed parameters designed to insure compatibility of docking systems for Apollo and Salyut spacecraft as well as for future spacecraft.

II. Docking System Concept

Both sides exchanged material relating to the concept of an androgynous type peripheral docking system. They discussed this material and agreed as follows:

1. The baseline for discussion, definition, and development of the compatible docking system for the initial test mission will be based on the agreed concept of an androgynous, peripheral system adapted to the particular requirements of the Salyut space station and the Apollo docking module.

The design concept includes a ring equipped with guides and capture latches that are located on movable rods which serve as attenuators and retracting actuators, and a docking ring on which are located peripheral seals for capture latches with the docking ring seal.

2. The basic geometry and dimension of the ring guides, of which there will be three, will conform to Figure 1. The dimensions and shape of the guides must insure capture during initial contact conditions as set forth in 3 (a) of Section III.

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5. Capture latches generally will be constructed as provided for in material furnished by the US side; the latches on the passive vehicle will be located on the docking ring as provided for in the material furnished by the Soviet side.

6. The construction of the attenuator rods and retracting actuators on which the ring with guides is located may be different. But each side must insure the synchronization of the movement of all rods in the course of retraction.

7. The docking interface generally will be as provided for in material furnished by the Soviet side. (Figure 2)

8. The number, location, principles of action and parameters of the peripheral docking latches generally will be as provided in material furnished by the Soviet side. If necessary, the force exerted by the latches and the length of their movement will be increased.

9. It is recognized that the basic variant for further analysis and development of the location and configuration of the docking seal is the variant presented in the material furnished by the Soviet side. The variant "Androgynous seal" as furnished by the US side also must be studied. The nature of the seal material, as well as its cross section, are chosen independently by each side. In this connection, it is recognized that the peripheral latches and their connections will be subject to space environment.

10. The guiding pins and their sockets that serve as hydraulic connections, as shown in material furnished by the Soviet side, will be utilized solely to align the docking ring interfaces.

11. The configurations and the dimensions of the docking ring must not preclude the location of electrical connections, as shown in material provided by the Soviet side.

The variant providing for locating the electrical connections on the inner walls of the transfer tunnel to permit manual connection also will be studied.

12. The number and location of the spring thrusters on the interface will be as shown in the material provided by the Soviet side.

The sides also agreed that a scale model of the docking system will be created to permit a verification of the parameters that insure compatibility at an early stage of development. The method of verifying compatibility of the models is subject to agreement. In this connection, each side will decide independently which elements will be active and which will not be present. The principal parameters of this model are subject to agreement at the next meeting. The scale factor is chosen to be equal to 2.5.

III. Values of Parameters for Docking Systems of Apollo/Salyut Spacecraft

To allow for the investigation and design of compatible docking systems, both countries have agreed to the following values of parameters for docking systems to be used in an Apollo/Salyut mission. These parameters are based on agreements defined in the document, "Technical Requirements for Compatible USA and USSR Docking Systems."

1. Environment

a. Pressure: 760 mm Hg to 10^{-9} mm Hg

b. Solar Intensity: 1400 watts/meter^2

c. Earth Planetary Emission: 216 watts/meter^2

d. Average Albedo (Earth) 0.39

2. Mass Properties of the Spacecraft

The mass properties and basic dimensions of the spacecraft are presented in Figure 3.

3. Docking Interface Contact Condition Limits

a. At initial contact:

Closing Velocity 0.05 to 0.30 meters/sec.
(The proposal to increase the lower limit to 0.10 meters/sec should be studied.)

Lateral Velocity 0.1 meters/sec.

Lateral Misalignment 0.40 meters
(The proposal to decrease the upper limit to 0.33 meters should be studied.)
Angular Misalignment 7.0 degrees

Rotational Misalignment 7.0 degrees

Angular Velocity 1.0 degrees/sec. (about any axis)
(Active Spacecraft)

Angular Velocity 0.1 degrees/sec. (about any axis)
(Passive Spacecraft)

b. At structural ring contact:

Lateral Misalignment 2 milimeters

Angular Misalignment 0.1 degrees

Rotational Misalignment 0.2 degrees

Contact Velocity 0.03 meters/sec.

4. Internal Diameter of Structural Ring

The internal diameter of the structural ring will be 800 milimeters.

5. Other Parameters

There are other parameters, the values of which cannot be identified at this time. In accordance with the basic technical requirements document, these parameters and their values will be identified at a later date.

IV. Future Joint Work Milestones

Following are the principal steps in the joint development and testing of the compatible docking systems for the Apollo and Salyut spacecraft. These steps are subject to further study by both sides for the purpose of establishing dates of completion of the steps, including preparation of the joint documents required therefor.

1. Development and agreement of docking system concept.

2. Manufacture and tests of scale model.

3. Agreement on a final interface control document with values of all parameters for compatibility defined.

4. Completion of development and manufacturing of docking system.

5. Joint development tests.

6. Completion of technical specifications for qualification testing of the docking systems.

7. Independent qualification testing.

8. Joint qualification testing.

9. Interface checkout of flight docking systems.

10. Flight

To ensure compatibility in the joint development process, the following additional groups of documents will be created:

a. List of values of the parameters that ensure compatibility of docking systems.

b. Method of conducting and programing of joint tests.

c. Requirements for docking systems in flight and their interaction in case of need.

A joint development plan, including the creation of the additional documents, will be discussed and agreed to at an early future meeting. In establishing the dates for completion of the major milestones, each side will be guided by the fact that the joint Apollo-Salyut flight will take place in mid-1975.

V. Objectives of the Next Meeting

The members of this Working Group agreed that it will be necessary to meet soon to agree on technical questions that must be decided during the initial stages of the development of docking systems, in accordance with the basic features of the docking system concept agreed to at this meeting. Specifically, the following items should be accomplished:

1. Confirm the possibility of creating a docking system in accordance with the concept adopted at this meeting and introduce improvements if necessary.

2. Further convergence toward final docking system geometry and component design concept.

3. Exchange and coordinate preliminary development plans and schedules.

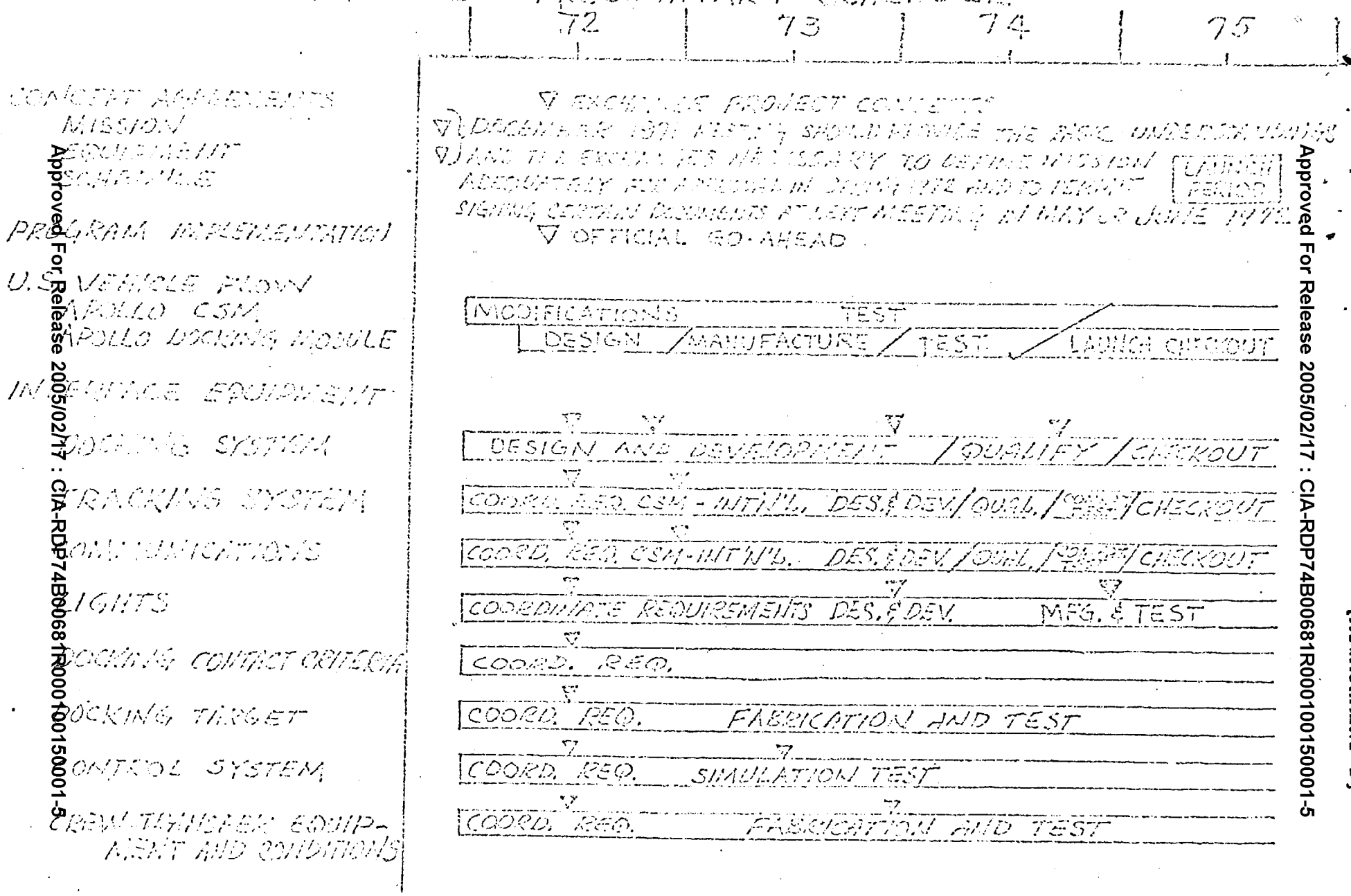
4. Discuss requirements and details of a scale model of the docking system.

5. Further establish values of those parameters necessary for compatibility.

MEMBERSHIP OF JOINT WORKING GROUP 3

USA	USSR
Donald C. Wade D. Wade (Head)	V. Syromyatnikov (Head)
C. C. Johnson C. C. Johnson	V. Zhivoglotov
R. White R. White	A. Nikitorov
J. Jones J. Jones	A. Maksimenko

PROPOSED PRELIMINARY SCHEDULE



LEGEND: ▽ DESIGN REVIEWS AND AGREEMENTS
TO BE SCHEDULED AS REQUIRED

[ATTACHMENT D]

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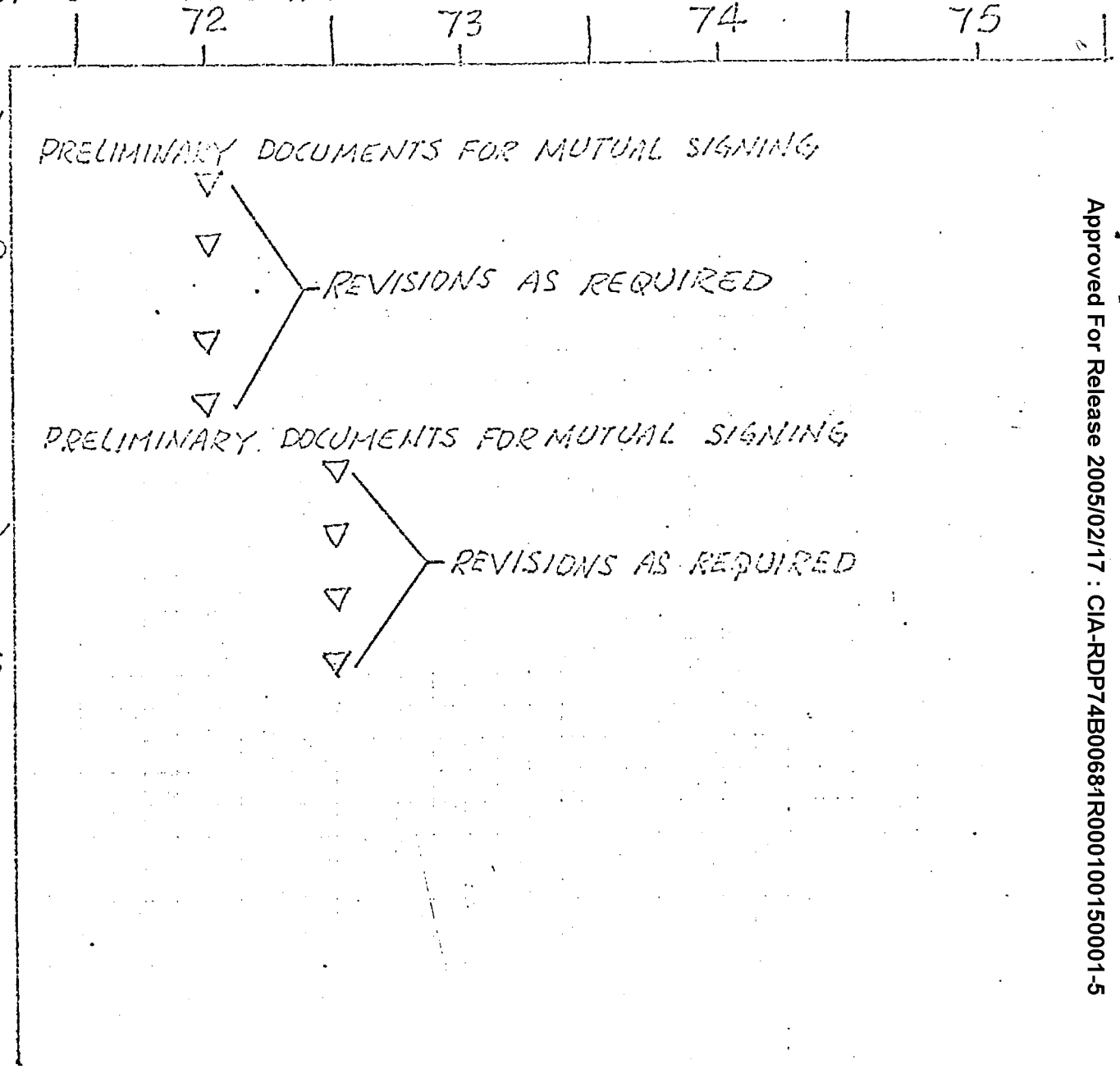
PROPOSED PRELIMINARY SCHEDULE



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