THE RUSSIAN PROGRAM FOR THE INTERNATIONAL SPACE STATION AND RUSSIAN UTILIZATION PLAN

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Abstract

In this report, the summary data on the International Space Station Russian Segment (ISS RS) deployment plans and status of work on the development of research and experiment program at ISS deployment phase are presented.

Russia utilization plan

The Russian researchers are hopeful on that the maximum ISS payoff will be achieved due to joint efforts of scientists from all International Space Station partner states.

From the result of design and development studies of various options for ISS Russian Segment structuring, it has been shown a significant advantages has an option which calls for launch of Functional Cargo Module (FGB-EM, 1A/R) in 1998; Service Module (SM, 1R) in 1999; Docking Compartment-1 (4R) in 2000; Science/Power Platform (SPM, 9A.1); Universal Docking Module (UDM, 3R) and Docking Compartment-2 (5R) in 2001; Docking and Logistics Module (9R) in 2002; Laboratory Module No.1 (LM1, 8R); and Laboratory Module No.2 (LM2) in 2003.

On the estimates available, carrying out studies on FGB-EM is only possible as a support of its normal operation over the specified time period.

Hence, a major amount of research on the ISS RS can be performed on Science/Power Platform, Universal Docking Modules and laboratory Modules.

In order to enhance the effectiveness of researh to be conducted on the ISS RS, the replaceable payload concept is presently being developed which provides the ability for promt replacement of experiments and science instruments both in pressurized compartments and on external surfaces of Russian Segment modules. Meanwhile, it is being considered for providing as maximum interchangeability as possible with iternational partners' replaceable payloads to provide high effectiveness of joint science research and experiments in future.

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Traditionally, Russian science research onboard manned space facilities has been carried out in the following main science areas:

- space material science and space processing technology;
- life sciences;
- study of Earth natural resources and environmental monitoring;
- study of planets, their moons and small selestial bodies;
- space biotechnology;
- technology studies and ex-periments;
- extraatmospheric astrono-my;
- integrated studies;
- space power and propul-sion system problems.

Significant scientific and practical results in all above science areas have been obtained over about 40-year history of manned cosmonautics in Russia.These data and huge practical experience of research and experiments on manned facilities are fundamental for developing and conducting research and experiment program on existing and prospective space facilities.

Main findings from review of research results obtained during Mir space station operation period are as follows:

- valuable scientific and practical results have been obtained in various science and application research areas;

- scientific teams have been formed and the science and technology potential for further studies has been created;

- research directions in particular disciplines have been refined (example: enhancing the fundamental focus on space processing technology);

- practical experience in interaction with foreign partners has been obtained including one built under commercial contracts;

- in the conduct of work on Mir station, regulatory and technical issues of international cooperation have been worked up in the interests of International Space Station to include those using Russia's unique experience in building and operation of permanent manned space facilities and in performing long-duration human space flights.

Work on definition and implementation of Russian research and experiment programs on manned space facilities is underway and is performed in two directions: on one side, due to extention of Mir operations to 1999, research program has been established and is to be performed through 1999; and on other side, the research program on ISS Russian Segment is being developed based on

research performed on Mir station.

Research in these areas is performed under RSA/RAS Science and Technology Advisory Committee (STAC) leadership and is part of science and application research programs on manned space facilities.

For the purpose of creating effective science research program, results of which would help successful solving the scientific and economic problems on Earth, the following principles are put in the base of its formation:

- wide as possible engagement of science and technology community in Russia;
- proposal selection on competitive basis;
- coordination of efforts of scientists from Russia and other countries;
- bringing in additional funds including out-of-budget funding.

Work on building of ISS Russian Segment is conducted under strict funding constraints which prompt to seek the opportunities for cutting ISS Russian Segment building and operation costs.

In developing studies and experiments program at ISS RS deployment phase, significant emphasis is being placed to following efforts:

- rationalization of priorities of proposed studies and experiments;
- development of criteria for selection and ranking of studies and experiments;
- assessment of expected characteristics of science instruments and equipment;
- building effective science and industry cooperation in support of experiment implementation;
- preliminary assessment of studies coat and possible ways their reduction.

Design and system trade-off analyses are being set up which are directed toward effective utilization of ISS Russian Segment to include:

- definition of science requirements to ISS RS mission payloads;
- rationalization of the optimal combination of science, application, commercial and international studies on ISS Russian Segment;
- marketing assessment of joint studies.

Of more than 400 submitted proposals, over 240 proposals have been recommended.

By now, design assessment of technical feasibility of all selected experiments based on availability of on-board resources and experiment requirements has virtually been completed. The possibility for conducting science

research at ISS Russian Segment deployment phase has been relatively thoroughly reviewed and assessed.

During that, the feasibility of following experiments on Service Module has been shown:

- geophysical studies;
- life science studies;
- space biotechnology;
- technology studies and experiments;
- extraatmospheric astronomy;
- space power and propulsion problem.

On Science/Power Platform, the possibility of conducting studies in the following areas has been shown:

- Space processing and material science;
- geophysical research;
- study of planets and small bodies in Sun system;
- space biotechnology;
- technology studies and experiments;
- extraatmospheric astronomy;
- space power and propulsion system problems.

It is envisaged that the Universal Docking Module (UDM) will provide studies in the following areas:

- space processing and material science;
- geophysical research;
- life science;
- study of natural resources and environmental monitoring;
- space boitechnology;
- technology studies and experiments;
- space power and propulsion systems problems.

At ISS RS deployment phase, 136 experiments are planned using 169 science instruments and facilities.

Total mass of involved equipment is expected to be approximately 3920 kg with peak power limit for simultaneously operating equipment of approximately 5840 W. Correspondingly, 52 experiments are expected to be carried out on Service Module using 68 science instruments with total mass of about 768 kg and simultaneous-operation peak power limit of about 259 W.

According to current project assessments, 23 experiments are possible on Science and Power Platform at ISS RS deployment phase using science equipment of 35 types totaling about 1992 kg of mass and about 5000 W of simultaneous-operation peak power limit.

It is expected that using Universal Docking Module at the ISS RS deployment phase, 61 experiment is possible with science equipment of 66 types and

total mass of 1160 kg and peak power limit of 590 W.

Tables 1-3 present the structure of studies being considered for early phase of ISS Russian Segment deployment with their differentiation by particular modules.

It can be seen that already in early phase of ISS RS deployment, the possibility exits to carry out studies that are scientifically and practicallymeaningful, and the program virtually in all areas of studies which have traditionally been carried out on manned space facilities.

Some studies are expected to be conducted in wide international cooperation. In particular, work is already underway on preparation of joint experiments for Service Module, namely, experiment Ramon ("Radiatsionny Monitoring" - dynamics of radiation dose accumulation in antropomorphic phantoms) using Matryoshka platform and various dosimeters and high-energy radiation spectrometers; and experiment GTS (development of methods for use of Global Time System).

In this connection, the approval by Russian Science community of ISS RS replaceable payload concept based on International Standard Payload Racks (ISPR) compatible with ISS IP rack, appears to be as timely.

According to current assessments, this will provide:

- reduction of development time for science instruments and decrease of work on interfacing science instruments with onboard service systems;
- increasing amount and cutting cost of studies and experiments to be carried out on ISS RS;
- extending capabilities to commercial use of science and technical potential of ISS RS and more total coordination of internal and foreign scientific and application-oriented research programs.

Russia's science community and potential users of ISS RS seem it necessary to combine efforts of international ISS partners in the cause of enhancing scientific and practical payoff of ISS and its segments as creative development and effective of ISS science and technical potential.

The following designations are adopted in tables 1 through 3

Area 1 - space processing and material science;

Area 2 - geophysical research;

Area 3 - life science;

Area 4 - Studies of natural resource and environmental monitoring;

Area 5 - study s of planet and small bodies of Sun system;

Area 6 - space boitechnology;
Area 7 - technology studies and experiments;
Area 8 - extraatmospheric astronomy;
Area 9 - integrated studies;
Area 10 - space power and propulsion system problems;
Ne - quantity of experiments;
m- overall mass of science equipment;
P - range of peak power required.

Table 1. Proposals for implementing studies on Service Module of ISS RS

Area \ Characteristics	Ne pcs	Na pcs	m kg	P W
1	-	-	-	-
2	6	9	260	2÷200
3	15	31	305	1÷200
4	-	-	-	-
5	-	-	-	-
6	12	8	29	TBD
7	12	8	29	15÷100
8	2	3	10	Not required
9	-	-	-	-
10	2	2	44	to 250

Table 2. Proposals for implementing studies on Science/Power Platform

Area \ Characteristics	Ne pcs	Na pcs	m kg	P W
1	1	3	20	500÷1500
2	4	14	180	10÷500
3	-	-	-	-
4	-	-	-	-
5	3	4	265	10÷5000
6	3	4	17	720
7	3	4	17	10÷5000
8	1	1	500	30÷450
9	-	-	-	-
10	4	4	110	50÷400

Table 3. Proposals for implementing studies on Universal Docking Module

Area \ Characteristics	Ne pcs	Na pcs	m kg	P W
1	3	1	65	≤ 400
2	6	8	180	10÷500
3	24	24	300	10÷200
4	4	8	360	50÷590
5	-	-	-	-
6	19	21	150	10÷200
7	19	21	150	100÷290
8	-	-	-	-
9	-	-	-	-
10	1	1	50	≤ 540

Conclusion

As it is seen from stated above, the research and experiment program for initial ISS RS deployment phase has virtually been scheduled and prepared for agreement and approval.

Program for research and experiments for the first 5 main missions to Russian Segment is being refined. Work on building science and industrial cooperation has been completed; calendar plans for creating of science instruments have been developed and agreed; development of technical specifications for science instruments and auxilliary equipment is being completed.

Russian scientists and engineers are ready, together with international partners, to use effectively the capabilities of International Space Station for humankind.