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STRUCTURE AND EQUIPMENT OF THE AUTOMATED SYSTEM FOR STATE STATISTICS

Moscow VESTNIK STATISTIKI in Russian No 3, 1978 pp 52-58

/Article by N. Ivanov and V. Zav'yalov: "Basic Principles for the Creation of the Technical Base for the ASGS:/

/Text/ The technical base for the ASGS /Automated System for State Statistics/, as for any other automated system, is an assemblage of interconnected computers of various types and classes functioning in coordination, together with data collection, transmission and processing equipment, which interacts to perform the technological operation of gathering and processing statistical information and presenting it to users. The technical base of the ASGS is called upon to solve all statistical problems and to perform comprehensive computing work for enterprises and organizations according to their instructions.

The equipment complex of the ASGS includes computers, punch card and perforated tape machines and systems, calculating machines, apparatus for data transmission, teletypes, copying and duplicating equipment and motor tranportation.

From an organizational point of view the technical base for the ASGS is constructed as a network of computer centers and stations of the USSR TsSu /Central Statistical Administration/, functioning with a single methodological, technical, data, technological, and programming base. All activities of the computer centers and stations are centrally planned and controlled. The computer network of the TsSU is a data processing system which provides for the collection, storage and transmission of large volumes of data, as well as the performance of various large-scale and other specialized tasks. The process of technically equipping the computer network includes the capability for technical interaction with industrial branch and government departmental automated data and control systems, and the pace and direction of development of the computer system itself is determined taking into account the prospect for including it as one of the central links in the State Network of Computer Centers.

The equipment complement at a computer center or station depends on its type and its place in the computer system, the volume of data processed and characteristics of the technology for processing statistical data.

The purpose of the technical base for the ASGS is classed as universal. This means that it is intended to perform a wide range of tasks of a varied nature, the list of which is not limited in advance (before the creation of the system). The technical base for the ASGS is used for processing not only statistical data, but also the accounting and economic data of enterprises and organizations of a number of ministries and government departments which do not have their own computing equipment and in which the organization of their own computer centers (data processing stations) is not economically justified. According to number and type of machines, the technical base for the ASGS is a multimachine, nonuniform system. In its operating complement are "Minsk" computers nd computers of the Unified System, M-5000 punch card systems, Tsellatron "S-8205" electronic calculators and other computing equipment.

In creating computer systems with a varied equipment stock the problem of machine compatibility arises. Until the present, in performing each specific task computers of only one type were employed and a multimachine, uniform system was used. This practice was necessitated by features of the creation of the first stage of the ASGS, whose technical base was oriented toward only two types of computer--the "Minsk-22" and "Minsk-32". However, this solution to the problem has the following drawbacks:

a) it does not fully utilize the resources of the system for performing tasks;

b) the flow of data is complicated and group computer centers are introduced into the processing set-up;

c) expenditures in labor and money for the creation of software are increased.

At present, because of the introduction of the Unified Computer System into government statistical bodies, a change of computer generations is under way in the computer system for government statistics. Experience in system data processing gained in the process of creating the first stage of the ASGS makes it possible to solve the problem of compatibility of various types of computers (Unified System computers and the "Minsk-32") by the programming-technological method. This method makes it possible by means of special programming (for example, the conversion method) to perform system processing of one accounting type simultaneously on various types of computers.

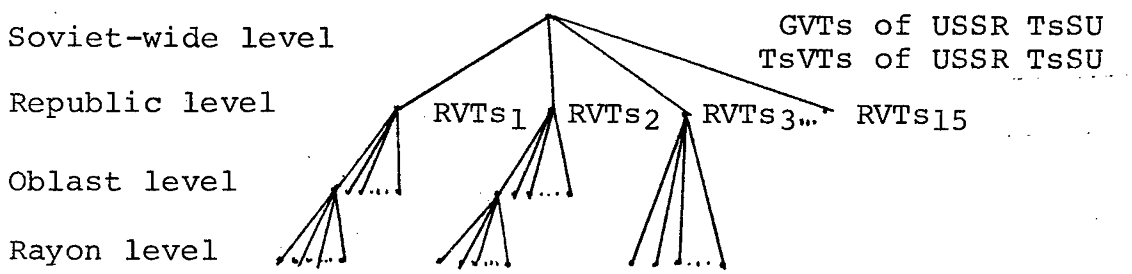
Newly developed Unified System computers, for example the ES-1035, are also important from the point of view of compatibility. In addition to virtual memory and advanced equipment for remote data processing, one of the advantages of this computer is its compatibility with the "Minsk-32" computer based on software emulators.

Solution of the compatibility problem, which is needed not only for the ASGS but for other automated systems as well, will make it possible to increase substantially the productivity and throughput of the system.

According to the degree of territorial dissociation, the technical base for the ASGS is a dissociated system with a fixed structure.

The technical base for the ASGS has a hierarchical structure with four levels (Soviet-wide, republic, oblast and rayon), each of which is an assemblage of computer centers (MSS /Data Processing Stations/, RIVS /Rayon Data Processing Stations/, and RIVTs /Rayon Data Processing Centers/) with a common functional purpose.

The structure of the technical base for the ASGS may be represented in the following general form: (see figure).



Structure of technical base for ASGS

Such a structure presupposes basically sequential data processing. As a result, each level is technologically specialized to perform specific functions in a single computing process.

Improvement of the structural design of the technical base for the ASGS is leading in the direction of simplifying the links between computing elements eliminating the duplication of computing functions and data flows and removing unused data.

The Soviet-wide level of the technical base for the ASGS is represented by the GVTs /Main Computer Center/ of the USSR TsSU and the TsVTs /Central Computer Center/ of the USSR TsSU. The GVTs processes mainly data for current statistical accounts (including yearly accounts); the TsVTs processes materials for mass censuses and surveys (including the All-union Population Census), and also performs computing work according to the orders of ministries and departments, enterprises and organizations. The existence of two computer centers at the Soviet-wide level may be explained by the substantial difference in technology for processing current statistical accounts as opposed to materials for censuses and surveys. The processing of large data blocks for censuses and surveys requires the creation of considerable reserves of computing capacity. In "between-peak" periods these reserves are used for data processing for enterprises and organizations of the national economy. Further, in periods of peak load for equipment of the GVTs, TsVTs reserves are used to process current statistical accounts. The GVTs, and in some work the TsVTs of the USSR TsSU, function in close interaction with RVTs (Republic Computer Centers) of the TsSU of the union republics, from which they receive data through telegraph and telephone channels and on physical recording media and data sheets. Computer centers at the Soviet-wide level of the ASGS are being equipped in the first stage with computers and peripheral equipment which make it possible for them to interact automatically with other computer centers of the USSR TsSU system, and in the future with computer centers of Gosplan, the Ministry of Instrument Building, and other ministries and government departments.

The republic level of the technical base for the ASGS is represented by the fifteen republic computer centers of the union republic TsSU. The RVTs /Republic Computer Centers/ of the union republic TsSU having oblast subdivisons are supplied with advanced equipment complexes enabling them to gather and process data from the computer centers of oblast statistical administrations, and for certain types of statistical accounts--directly from enterprises and organizations, and to transmit the results of their processing to GVTs, as well as to local party, soviet, and economic bodies of the republic.

The RVTs of the union republic TsSU having no oblast subdivisions gather, process, and present statistical accounting data coming directly from enterprises and organizations, and also from rayon computer centers and stations. The computer centers at this level interact with oblast and rayon computer centers and stations of the USSR TsSU, and also with computer centers of the Gosplans of the union republics and computer centers of the Industrial Branch Automatic Control Systems of the ministries and government departments of the republics.

The oblast level of the technical base for the ASGS is represented by computer centers of the oblast, kray, and ASSR statistical administrations. These computer centers gather and process statistical accounts directly from enterprises and organizations at the oblast level. Further, at computer centers of the oblast level there is preliminary processing of a large part of the statistical data: documents are transcribed in machine-readable form and are checked, necessary fixed constant data are input, and so on.

The communications of computer centers of the statistical administrations of oblasts, krays, and ASSR's with RVTs or GVTs are maintained using medium speed data transmission apparatus over telephone and teletype channels; computer centers at the oblast level interact with the computer centers of enterprises and organizations of other ministries and government departments. The rayon level of the technical base for the ASGS is represented by data processing centers and stations. In the course of the next five-year plan, RIVS and RIVTs will be supplied with computers, calculating machines, punch card and perforated tape machines, and equipment for data preparation and transmission. The requirements for equipping this level are determined taking into account government resolutions, which call for mechanization of the primary accounting of kolkhozes, sovkhozes, centralized accounting departments, and other enterprises and organizations. In the largest rayons work will proceed on the creation of computer centers.

Thus the technical base for the ASGS may be placed in the category of complex systems, as seen from the following: the existence of a single functional purpose for the entire technical base; the large number of interconnected and interacting computer elements making up the technical base; the hierarchical communications structure of the computer elements, etc.

We will examine briefly the principles embodied in the creation and applied in the development of the technical base for the ASGS.

The principle of new tasks is embodied in the fact that the creation of the ASGS calls not for the traditional conversion of accounting and statistical work to a new type of computing equipment, but for the introduction of a new processing system technology.

Data processing technology, including the rational organization of data blocks and the construction of a system for storing and retrieving information in a data archive, must integrate data processing with comprehensive data utilization. In accord with this, the system for gathering and processing statistical data must be constructed so that of the established volume of data output, a maximum of the information necessary for analysis, planning, and administration is extracted.

Comprehensive data processing is requisite for the effective use of computers. Its highest form is the use of comprehensive programs for the analysis of statistical indicators using mathematical methods and models. Important for technological implementation is the centralization of statistical data processing--shortening intermediate links in account processing and the performance of this processing at group computer centers.

The basic constituents of the first stage of the ASGS are the KEOI /Electronic Statistical Data Processing Complexes/, each of which, as a rule, is intended to perform processing for several types of statistical work having a common economic and statistical content. Each KEOI has its own (local) specific tasks stemming from the purpose of the statistical data and the nature of the statistical survey, the content and character of the indicators, their methods of calculation and the algorithms used for this, and the level for which that complex was developed. In turn, the basic principle for the development of the complexes is the integration of data at all levels of the system, with the aim of minimizing the volume of data input and eliminating duplication and relative indicators in primary documents. The systematic character of the technology for the complexes is predetermined by the functioning of the computer centers according to a single data, mathematical, and technical implementation with the transmission of results from the lowest level of the ASGS to the highest by physical recording media or on communications channels.

In the current five-year plan there will be work on the further development of operating KEOI toward converting them to a new technical base (the Unified Computer System) and increasing their degree of integration, and there will also be development of new KEOI. This work is viewed as the further development and improvement of the first stage of the ASGS.

The problem of increasing the integration and analytic capability of statistical data processing requires that there be a transition from the documentational method of input, storage, and processing of accounting and statistical data to more effective methods of organizing the storage, retrieval, and processing of data, making it possible to use the capabilities of modern computers more efficiently. At present there is wider and wider use of the register form of data storage, providing for the handling and processing of data independently of forms of statistical accounting. The register is a system of accumulating, storing, updating, retrieving and processing data, formed separately according to statistical observation unit. The common means for describing data, provided in the register, make it possible to process comprehensively any group of indicators from the register's stored data. This is the achievement of a qualitatively new level in data integration and processing. Depending on the degree of integration and the content of the data stored, registers may be formed in the framework of the most important statistical work of individual or of several funcitonal subsystems of the ASGS. Further, with the creation of the register form, consolidated statistical data which was issued until now based on the use of KEOI, may be obtained as a result of the regular functioning of the register.

Thus, registers may be viewed as the initial preparatory form of experimental automated data banks at the territorial level.

At present work is proceeding on the formation of registers based on the Unified Computer System for industrial and agricultural enterprises in the TsSU of the Estonian and Belorussian SSR's, as well as on a register of construction projects in the TsSU of the Usbek SSR.

The technology for handling large blocks of statistical data accumulated and used repeatedly in the ASGS will be developed further in ABD /Automated Data Banks/.

The creation of ABD in the ASGS is a necessary prerequisite for the advancement of comprehensive economic and statistical analysis and the wide use of economic-mathematical methods.

The appearance of ABD makes it possible to decrease substantially the flow of account data, reduce the amount of work required for storing, retrieving, processing, and transmitting data, and sharply improve the quality of data request service to users of economic data by furnishing data within a short period both for regular programs and for separate queries. The storage of data in ABD will satisfy a prerequisite for fuller automation of data quality control and will make it possible to achieve dynamic continuity of stored data.

The ABD will have a decentralized structure corresponding to the territorial construction of the ASGS. It is intended further that the data bases, which will be distributed through the levels of the ASGS, will be logically centralized; that is, the territorial (group) ABD will in its functional aspect be organically united into the common distributed ABD of the ASGS. This will be achieved by the use of common data, programming, and technical implementation, centralized catalogs, dictionaries, and classifiers and common norms and standards. The technology based on the use of ABD levies increased requirements on the type and capabilities of the computer equipment used (volume of internal and external memory, machine productivity, system software, etc.).

The introduction of new technology implements the principle of system unification of computer elements. This principle presupposes the joining of all elements of the technical base (computer centers, MSS, RIVS) into a single computer system. Further, each of the elements fulfills a specific functional purpose assigned under the data processing plan. In other words, each level of the technical base completes a specific data processing stage. For example, at the oblast level primary data is assembled, checked, and processed, and oblast-wide totals are produced; at the Soviet-wide level the republic totals are consolidated, grouped, and analyzed, and Soviet-wide totals are produced. At the same time, processing results are exchanged from level to level on physical recording media (perforated tape, magnetic tapes, etc.) or by communications channels.

Thus the principle of system unification requires, in turn, adherence to the principle of specialization of computer elements for separate levels of the technical base.

Implementation of the principles of system unification and specialization is based on the hierarchical structure of the technical base for the ASGS and the principle of standardizing planning decisions by type. This principal is embodied in common software for the ASGS through all computer elements of the rayon, oblast, republic, and Soviet-wide levels, taking into account the nature of the tasks performed at each of these.

It was further intended in the creation of the ASGS that there be a common, interlinked data organization for all types of recording media. This data organization is provided through the use of common classifiers and designation systems, standardization of the content of indicators by type, and the standardization of a number of auxiliary documents, etc., while adapting them to the automated processing of primary and consolidated statistical forms. Common formats are used for the disposition of data in physical recording media, and standard structures are employed in transmitting data by communications channels.

In the creation of the technical base for the ASGS still another principle is observed--the principle of continuous system development. Its essence is that creating computer centers (data processing stations and centers) and completely equipping them with modern computers, means of communication, and other equipment is a continuous process. This determination comes largely, on one hand, from the overall prospects for the development of statistical science and the work practices of government statistical bodies as the USSR's largest specialized, interdepartmental information system, and on the other hand, from scientific and technical progress in the production and use of computer equipment. In the 10th Five-Year Plan the development of the computer system is proceeding under conditions produced by the transition to the Unified Computer System, on the basis of which it is possible to organize a system for comprehensive data processing at a higher level with broader automation of the entire technological process.

Also very important is the principle of coordinating the throughput capabilities of individual units of the technical base for the ASGS. It would obviously be an error to increase the capacity of any single computer center if the capacities of all other computer centers processing similar data were limited.

Thus in developing the technical base account is taken of the direction of flow of processed data, its volume, timeliness, the complexity of processing, etc. This approach provides for the mutual linking of features of data processing at each computer center with the requirements for continuous and uniform development of the network of computer centers.

Of particular importance for the functioning of the technical base for the ASGS is the principle of resistance to disruption, that is, the ability of the system to make definite compensation for failures and functional deviations of individual elements of the technical base. At present the resistance of the system to disruption is provided to a certain extent by equipping a number of computer centers with several computers of the same type. When one computer fails, the work is continued on another computer. In a prospective development the resistance of the technical base to disruption will be provided by the transfer of the functions of a computer that has gone out of order to another computer of the same or higher class. However, this solution to the problem makes certain demands for communications channels and data interchange equipment and requires the presence in each computer center of satellite machines for organizing the functional transfer process.

To a certain extent the principle of resistance to disruption is satisfied within a single computer center by the solution to the problem of campatibility of various types of computers. For this, current programming and technological methods are being adapted or new ones are being developed for using large data blocks on magnetic tapes received by "Minsk-32" computers for Unified System computers and vice versa.

9187
CSO: 1870

IMPROVING TECHNICAL INFORMATION SERVICES

Moscow TEKHNIKA I NAUKA in Russian No 4, 1978 p 31

[Article including letters by candidate of economic sciences of the Voronezh Patent Department V. Belousov and Moscow engineer designer I. Zhelezhyakov in the column "Control Problems": "Who Needs BTI [Office of Technical Information]?"]

[Text] "Is information always right at hand?" This is the title of an article by the chairman of the VSNTO [All-Union Council of Scientific and Technical Societies] committee on scientific and technical information, corresponding member of the USSR Academy of Sciences G. Pospelov ("TiN", 1976, No 12). An article by director of technical sciences professor G. Artamonov ("TiN", 1978, No 1) was devoted to a discussion of the problems raised in it. Today we will present a word from the readers. The thoughts and suggestions expressed in their letters sound very timely. In fact, in connection with the development of new machines and manufacturing processes in the scope of the complex scientific and technical programs of the Tenth Five-Year Plan, it is necessary to improve information service to designers and production engineers.

ORGANIZERS' FUNCTIONS IN INFORMATION SERVICE

At the present time, enterprises in the business of providing information are still unable to rely completely on sectional and territorial information departments.

As an example, the response time to requests of the Informelektro automatic system is three or more months. And this is one of the better automatic systems in the country! Territorial departments sometimes collect data for the requests from enterprises for a year.

The Voronezh TsNTI [Central Scientific and Technical Institute] has the largest collection of data on foreign inventions in the Central Chernozem region. It was developed on the initiative of the same TsNTI using the resources of Voronezh enterprises. A large amount was spent on the facilities but up to this point the collection is operating ineffectively, actually not even justifying the storage expense. In its present form it is inadequate for data acquisition in the pre-planning stage and for checking engineering solutions for patentability and patent clarity. Specialists of Voronezh enterprises long ago came to the conclusion that, for this, it is quicker and less expensive to use the collection at the All-Union Patent and Technical Library, sending the developers to Moscow.

Large enterprises, as a rule, order the majority of information materials--nearly complete sets of invention descriptions, various information sheets, reference card catalogs and so on. These documents are frequently not processed in the form needed and cannot be used effectively for this reason. It is said that there is only a small staff for information service. In the Voronezh enterprises there are only 0.057% of such workers on the average out of the entire production staff, while the norm is 1-3%. No less critical is the shortage of equipment for processing and duplicating the incoming documents.

Right now, intensive development is underway in the country on a unified information provision system. In this connection it is necessary to consider the degree of technical and organizational readiness of the corresponding services of enterprises and territorial departments to operate in this system.

In our view, it is adviseable to strengthen only the organizers' activity of the enterprise information services, transferring technical functions to specialized departments. Specifically, they must set up automatic retrieval and output for information and its storage. For small and medium-sized enterprises, there is a sense of being denied altogether the procurement of their own reference collections set up through the loan systems of the appropriate territorial and sectional information departments. Large enterprises and industrial associations are able to reduce the volume of collections like this, retaining only those references devoted to highly specialized subjects.

The significance of strengthening the organizer function of enterprise information services lies in the fact that they will improve their operation as a team guiding the creative activity of the workers. This must be carried out in the framework of the production system. At present, in the development of automatic control systems in enterprises, information and patent services are not included in even one of the enterprise control subsystems. This is one of the typical oversights of automatic control system planners.

SEND A DESIGN, NOT A FORM LETTER

It would seem that numerous information services are toiling in the sweat of their brows so that engineers will not invent the already invented, so that a designer will be able to reach a hand out and take the design for a unit he needs from a shelf and simply paste it into the circuit being developed. For this ultimate purpose, more than 60 centers, not counting the republic institutes, are gathering technical information and exchanging it. They send out and receive information sheets and letters, lists of locally available know-how, lists of drafting and design documents, audio journals and information on movie film. And, in spite of this, developers are frequently left out of reach of the data they need.

Not infrequently, technical information institutes, when requested to send a design by one or another plant, answer with duplicate letters sent to two addresses, to the one who asked for the design and to the one who has it: "Please send the technical documents to the interested comrade." The question arises, what help is this to production? Why, the plant itself could appeal to the author of the development.

Another common response to a request is the negative or evasive one. Here are examples of the negative response: "The equipment was produced in drafts which were not retained." "The developer has the designs and he has been fired." "The equipment has been dismantled because it was becoming superfluous." And here are the evasive ones: "Our institute will be able to develop designs of this type of equipment for your enterprise after making inquiries about financing." "In answer to your request, we ask you to send detailed reference data on your manufacturing process." Thus, the expectation of receiving a design promptly is not realized. But is it even possible to conclude an agreement with the enterprises or organizations where the new equipment was developed? Oh, but the whole point is that not every management wants to involve itself with a new agreement with, let us say, a NII [Scientific Research Institute] from an unrelated branch of industry. Instead of this yet another form letter is sent.

At present, a large part of the technical information services of enterprises to their own requests is treated like exorcism: "We agree to purchase the designs sent by C.O.D." And nevertheless the establishment is in no hurry to send them. Why? The explanation is quite simple. The developers are not particularly interested. This situation needs to be changed so that the author of an innovation himself handles the necessary selection of designs and writes recommendations, not in a broad sense but on what is needed specifically by that particular enterprise for that particular part of the production process. Preparing such an answer is not beyond the strength of BTI staff members; they just do not have the appropriate knowledge for this task.

That leaves the desire for better performance in issuing information sheets. The basic defect in them is that they are sent out without a serious attempt at checking. Frequently, the innovations described are none other than inventions which had already been granted authors certificates at that time. During editing of the entries the BTI staff often fails to verify the newness of the published material.

As inconsiderable as the circulation of the sheets is (around 100 copies), the plants do not even have a section for the storage of technical information.

On the whole, it is unnecessary to mention the fact that these sheets might lie unused on the tables of the engineering offices and the plant and shop committees of NTO's [scientific and technical departments]. Is it worthwhile to use up paper if it is known in advance that the information does not get to the developers? This is the result: materials like this are usually only useful so that staff members of the information services might show them to gain indulgence at the next inspection.

8945
CSO: 1870

INSTITUTE DIRECTOR COMPLAINS OF COMPUTER IDLENESS

Moscow STROITEL'NAYA GAZETA in Russian 26 Feb 78 p 3

[Article by Giproelektro Director A. Kalinichenko and Senior Planning Engineer V. Levi: "Idle Computers are Expensive"]

[Text] The (Giproelektro) institute was established just 10 years ago. It was at that time that we decided to acquire computer technology for our purposes. Ten years is not a short time. What has been done in this time?

What we should also talk about in this regard is what has not been done and why.

We began with work on local problems. For example the program "Computation of Drill-Driven Piles" permitted us to determine the cross section of an optimum foundation variant, in which case a computer does the work in not more than 2 minutes. Or take a program such as "Computation of Atmospheric Contamination by Wastes From Industrial Enterprises." Now that the program has been introduced, the computer prints concentration charts of various toxic substances for the industrial and residential zones. Computer working time is only 40-50 minutes. In the past, meanwhile, it took 3-5 man-months to compute the figures and draw highly approximate charts!

We can go on and on with such examples. By making the computer do certain computations we have freed specialists in various production sections from mechanical work and persuaded them of the effectiveness of the new equipment and the new computation methods. In a word, we made the computer a true assistant to the planner.

It was not until the skills of solving engineering problems by computer were accumulated that we were able to begin developing an automated production process planning system (ASTP). We know that the production process part of a plan is the main one. It is precisely what determines the level of completion of all other parts of the plan.

Capitalizing upon the experience of Orgstankinprom [State Planning, Technological, and Experimental Institute (for Organization of Machine-Tool and

Tool Industry)], the Ukrainian SSR Academy of Sciences Institute of Cybernetics, and some other collectives, we developed a procedure for analyzing the existing production process planning system and for selecting the primary subsystems of the ASTP. Here are the first results: Graphical information models of the planning of the basic types of production operations and a model of the ASTP have been created, and technical assignments for development of a number of subsystems informationally associated with one another have been made.

The following fact could not but be instructive: Owing to computer information processing during the planning of the Khmel'nitskiy Transformer Substation Plant, the time of production process planning was almost halved.

In general the future ASTP will in a sense be an automated line with a strictly regulated production process. It is based on the use of a general-purpose computer, the input of which receives the necessary data and the output of which issues the optimum variant of the production process plan.

This is where the question as to disposition of the computer's output capacity arises in all of its acuteness. We must not let matters proceed until every planning institute has its "own" computers. After all, in such a case the coefficient of computer time use would be very low. Consequently we need time-sharing computer centers (VTsKP).

But who in our sector would volunteer to organize such a center? We would.

It has been several years now that we have been trying to create a time-sharing computer center out of our resources for the sector's planning institutes. By concentrating the computers and specialists we could decrease capital investments by 30-40 percent. The staff of developers and operators would decrease by about a third. The economic impact from creating a time-sharing computer center would be, according to our estimates, more than a million rubles per year, and it would not take more than 2.5 years to compensate for the investment.

Such are the estimates and plans. But for the moment unsolved financing problems are a serious obstacle to developing and introducing automated systems. The number of developers and operators of such systems is growing, and the allocated assets are no longer enough. Thus, for example, more than 15 percent of all of the institute's employees are working on automation, and by 1980 this figure should double as a minimum.

It is becoming simply difficult to maintain such a quantity of highly skilled specialists, upon whom the future of planning essentially depends. It would appear that such operations could be financed through the technical administration of our Ministry of Electrical Engineering Industry. This is exactly what is done in many institutes belonging to other ministries (for example the State Institute for the Planning of Mines, the Ukrainian SSR State Institute for the Planning of Municipal Construction, and the State Scientific Research and Planning Institute of Metallurgical Industry). In our case, meanwhile, the question has been "stalled" at the level of the deputy chief of the planning and capital construction administration, Yu. Nikitin, who has not been able to resolve it in the last 3 years.

But is the problem of financing the only one? We, for example, have not and do not believe it dishonorable to acquire engineering tasks developed by other enterprises: This is the direct way to introduce something new. It would appear to be a simple matter: Approach the (TsNIPIASS), which has a library of algorithms and programs, and select the needed tasks from the tremendous storehouse. But how do matters stand in reality? The most effective tasks are not sent to the TsNIPIASS, or they are received there after a great delay. Meanwhile, it is extremely difficult to acquire these tasks through direct channels from the developers: A legal order for their transfer has not been established, and not even the approximate cost standards have been determined.

Here is another problem. As a rule in the situation that has developed today an organization which receives a computer in the first quarter must wait until the second quarter until the computer plant can train a team of operators. Need we offer proof that the situation should be the other way around? Meanwhile, dozens upon dozens of computers stand idle.

From our point of view it would be much easier to solve the specialist training problem by organizing permanent computer program courses at the Zaporozh'ye branch of the advanced training institute of our Ministry of Electrical Engineering Industry.

Electronics is a powerful weapon in the hands of a planner. And the problems raised by its introduction into the institutes must be solved more quickly.

11004
CSO: 1870

HOW TO IMPROVE THE RELIABILITY OF ANTENNA STRUCTURES

Moscow VESTNIK SVYAZI in Russian No 2, Feb 78 pp 29-30

[Article by G. A. Savitskiy, doctor of technical sciences, State Union Design Institute of the USSR Ministry of Communications]

[Text] The reliability of antenna structures depends on the completeness and quality of the engineering investigation of the construction site, including meteorological data, the quality of the design and other factors. Damage to parts or structural elements, inadmissible deformation or serious damage to the structure can occur for many reasons: violations of the rules to be followed in performing the operations, for manufacture and quality control of the structural elements, materials that do not correspond to the design standards, calculation errors (including underestimation of loads) and improper operation and maintenance. In this article an analysis is presented of the most important factors influencing the reliability of antenna structures. Knowledge of these factors and the prevention of deficiencies in the design, construction, operation and maintenance of the structures will make it possible to improve their reliability.

The most frequent cause of low reliability and emergencies resulting from it is the failure to meet the requirements of the overall plan for the performance of the operations (PPR) or the unavailability of clear installation instructions during the construction or rebuilding of the antenna structures. For example, in the mast antenna PPR very often little attention is given to the installation of insulators, the yardarm rings, screens, capacitive caps, wire suspensions (Figure 1) and also the dismantling of the auxiliary mechanisms and attachments. In order to install a base insulator under one of the masts 210 meters high the guys were slacked temporarily. As a result, the mast was destroyed from a hurricane wind (35 meters/second).

Under the auxiliary conditions on the manufacture of the structural elements of tubular lattice-type masts, it is necessary to x-ray the tubes at the points of attachment of the lattice elements (braces and struts) if spill, slag inclusions or crimping is suspected. If this condition is unobserved, it is necessary completely to replace the sections or partially correct the defects during installation. In order to ensure higher quality of metal, the modern requirements on its delivery have been stiffened by the addition of limiting sizes of spill, inclusions or internal defects in tubing and sheet steel.

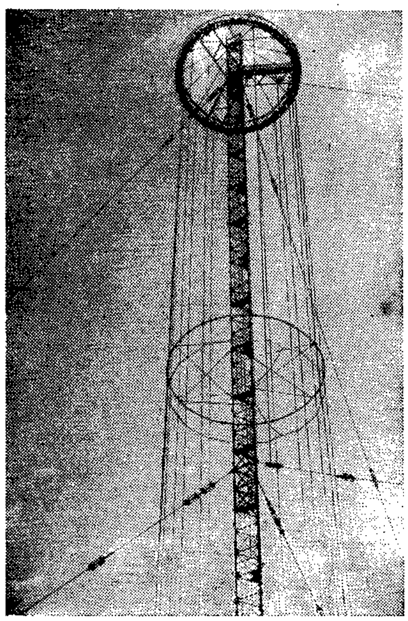


Figure 1. Mast antenna with screen.

Poor welding of the blind flanges sealing the tubes can lead to water in the sections making up the mast which ruptures the tubes when it freezes. Timely detection of damage and repair make it possible to prevent mast emergencies.

An improper process in the manufacture of welded and threaded joints will lead to inadmissibly high stress concentration in the mechanical parts of the mast guys and the insulator fittings, which means insufficient strength of these elements. This is also one of the most frequent causes of mast emergencies. The occurrence of such defects is promoted by low quality of technical control, the absence of physical methods of control and also inadequate technical specifications for the delivery of the fittings in which there are no requirements on testing the endurance of the pilot models.

The damage to parts from exceeding the fatigue strength is most frequently observed during the first 3 to 5 years of operation. The analysis of the damage, improvement of the fittings for the guys and insulators of the antenna networks has made it possible to double their fatigue strength, and to increase their load cycles by four times. The studies were performed at temperatures up to -60° C.

The reliability and service life of the structural elements are built into the design of the structure. What determines them? First of all, they are determined by the strength of the most vulnerable elements subjected to the effects of atmospheric and groundwater (on the foundation) or vibrations if they are not damped.

The service life of the steel structural elements is determined by the degree of corrosion of the lattice elements, for their thickness is several times less than the tube walls. The tube diameter or width of the angle iron webs are selected as small as possible with respect to the flexibility of the element permitted by the standards. This reduces the wind load on the mast or the tower and, consequently, the mass and cost of the structure. Thin-walled pipe is used in the struts and braces, but it must be carefully sealed. The seal is tested under an excess pressure of 0.05 MPa. It has been established experimentally that the service life of the tubular masts with a tube wall thickness of 4 mm is increased if they are sealed.

The ratio of the thicknesses of the elements of the lattice structure must be selected beginning with the significance of the object, the amounts of the initial expenditures on the construction and the degree of aggressiveness of the air environment. It is important to consider that the reinforcing of the lattice rods of the mast or tower already under operation is complicated and sometimes impossible.

The relatively low service life of the twisted cables of the radio masts (spiral, six-strand with a temporary resistance of galvanized wire to 1,800 MPa) is explained by the small wire diameter (2 mm or less), the high values of the temporary and calculated resistances. The cost of replacing the failed guys of the radio mast is high even on repeated use of the previous guy insulators and mechanical parts.

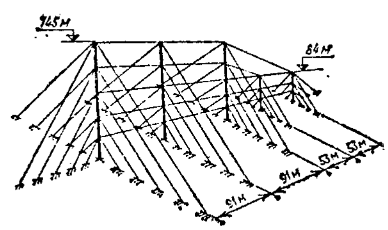


Figure 2. Chain of masts for suspending a set of SGD-RA antennas.

The cable guys made of bright (ungalvanized) wire 3.5-4 mm in diameter and with lower temporary resistance, 1,200-1,400 MPa, protected from corrosion by coatings based on bitumen or polymers have longer life. The reliability level of the mast with such guys is higher. However, these cables which are formed from parallel wires must be manufactured during installation, which increases the construction costs. The cables made of shaped wires are long-lived and comparatively cheap.

The strength and stability of the mast are greatly influenced by the prestressing of the guys. It can be sufficient if they are installed by the measured length method where the cable is drawn on a bench under a force of 0.6-0.7 of its rupture strength. After discontinuation of drawing (after 30-60 minutes) the force is reduced to 1.1-1.2 of the designed prestressing at the drawing temperature. Then the initial length of the cable for installation is established. The reliability of the mast is increased, for the interruptions of the operation of the antenna for repeated adjustment of the guys are reduced.

The clarity of the physical model, which is the base for the methodical analysis has great significance for the reliability of antenna structures. The approximate methods of calculation are very important, for they avoid gross errors and provide clarity of the physical picture especially when calculating and analyzing complex sets of antennas (see Figures 2 and 3). The complex calculations (the studies of the versions of loading and the reaction of the structural elements to it, and so on) are best performed using a computer, for this lowers the danger of overlooking important aspects of the operation of the structural element. The accuracy of the input parameters (wind load, thickness of icing of the wires) must not be forgotten.

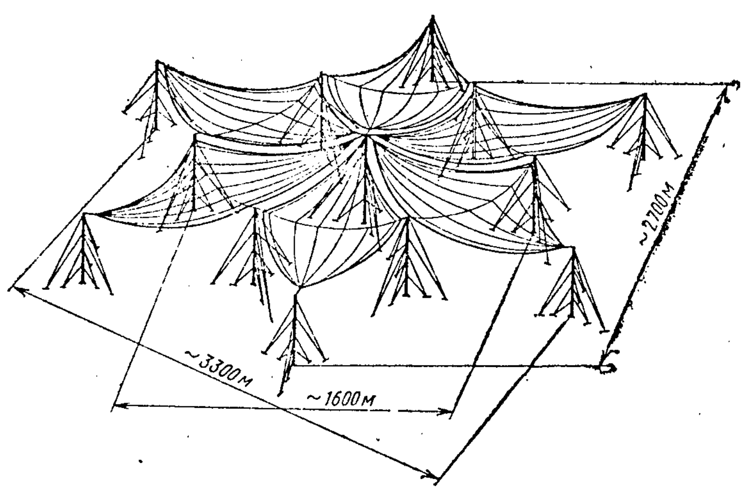


Figure 3. Long-wave antenna.

The reliability and service life of the antenna depend to a great extent on faithful adherence to the rules for technical maintenance of the structural elements and regular preventive measures. It is especially important to maintain the values of the prestressing of the steel cables and extinguishing of the vibrations provided for by the design and it is important to renew the protective and anticorrosion coatings regularly.

There are many unsolved problems in the design of antenna structures. On the modern level of antenna design it is impossible to obtain absolute numerical values of the level of their reliability, for there are no statistical data on long-term operation. However, in predicting reliability it is possible to use the version type design on a computer, that is, to discover which of the versions of the structure is best. In estimating the reliability of the structure it must have a service life for which the strength, stability and, in antenna structures in the required cases, deformativeness of the structural elements are within the given limits.

The investigation of the wind load on the antenna structures, the application of the well-investigated materials and the approved methods of manufacture and installation already now permit probability estimates of the basic calculation parameters of the structural elements, which means, estimation of the reliability level of the various versions. The classification of the different purposes of the antennas with respect to level of reliability must promote bordering of the approach to the determination of the margins of strength. It is necessary to take into account the accessibility of people to the possible antenna failure zone, the enclosed radio station grounds or a mast located in a city.

The reliability of the antenna can be determined by the aerodynamic instability, vibration during wind, the structural design as a whole or its elements, leading to damage and even emergencies. Unfortunately, the problems of aeroelasticity of the structural elements have also been studied little. The theoretical methods of discovering the aerodynamic stability are still unavailable as a result of mathematical difficulties and the necessity for obtaining experimental data. The published recommendations with respect to inadmissibility or extinguishing of the vibrations of the structural elements are valid only for identical structural elements to the finest details. The reliability of new types of antenna structures and even the structural solutions are confirmed by investigating the aerodynamic stability of the models. These relatively inexpensive operations help to discover the behavior of the structural elements and to develop measures with respect to preventing or extinguishing vibrations. Even knowledge of the aerodynamic characteristics of the structural element or the pressure distribution picture over the surface of the solid-walled reflector of the antenna permit estimation of the degree of aerodynamic instability of the structural element. The range of wind velocities possible at the site is considered to be the region of dangerous wind velocities.

The absence of systematic observations of the operation and maintenance of the antenna structures does not permit correction of the norms for the calculation parameters; therefore only small corrections are made to them. As a result, the standards are changed no more frequently than every 10 years. At the same time the available experience in the operation and maintenance of high lattice-type steel structures indicates the possibility of lowering the standards for the wind load so that it will not be the cause of an emergency.

Thus, for structural elements, the wind load on which plays the decisive role, having the statistical observation data and using the operating experience it is possible more precisely to define the physical model and the normative materials. The data on the glazed frost at various heights is also important for the networks. This work will permit excessive margins of strength for the structures to be avoided which means they will be more economical.

10845
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HOW TO REDUCE RADIO INTERFERENCE FROM HIGH-VOLTAGE ELECTRIC POWER TRANSMISSION LINES

Moscow VESTNIK SVYAZI in Russian No 2, Feb 78 pp 33-34

[Article by V. V. Kapitonov and Yu. M. Abramson, engineers]

[Text] The improvement of the quality of radiobroadcast and television reception, expansion of the reliable reception zones--these are the basic goals stated by the 25th Congress of the CPSU for the 10th Five-Year Plan in the area of the development of communications media. Industrial interference and, in particular, interference from the overhead electric power transmission lines, are an important factor influencing the reception quality and the sizes of the reliable reception zones. Knowing the radio interference field intensities and their attenuation on going away from the power line, the radio designers and maintenance personnel of the radio enterprises can estimate the electromagnetic environment along the power line and take the necessary measures to control interference and improve the quality of the reception. In this article data are presented from measurements of the radio interference from the overhead electric power transmission lines and information is given on the methods of determining them.

Until recently the problem of the investigation and normalization of radio interference from electric power transmission lines of more than 30 MHz and especially above 300 MHz has not been given sufficient attention. It was thought that above 30 MHz the interference is of a random nature. However, in connection with the intense use of the frequency band of 30-1,000 MHz for television broadcasting, service radio communications and the creation of overhead electric power transmission lines of higher voltages, the problem of electromagnetic compatibility of the radio equipment with the high-voltage and the superhigh-voltage power lines in the indicated frequency band is becoming an urgent problem. This problem can be solved first of all by knowing the statistical characteristics of the radio interference field intensity and the attenuation of the field on going away from the power line.

The basic sources of radio interference from the electric power transmission lines over 30 MHz are well known. These include defective, contaminated and broken insulators in the chains, poor contacts in the fittings and in the installation equipment of the electric power transmission lines. The local electric discharges occurring on these elements are the cause of interference in the frequency band to 1 gigahertz and higher. However, the studies performed in recent years have demonstrated that there are other sources of noise. Thus, the clean insulators in good working order of the high-voltage electric power transmission lines also create radio interference at a frequency of 30-1,000 MHz and higher which can interfere with the operation of radio systems with high real sensitivity (satellite communications ground stations, radioastronomy targets, and so on). The formation of corona between the wires of the high-voltage and especially the super-high-voltage power lines causes interference under defined conditions on frequencies reaching several hundreds of megahertz.

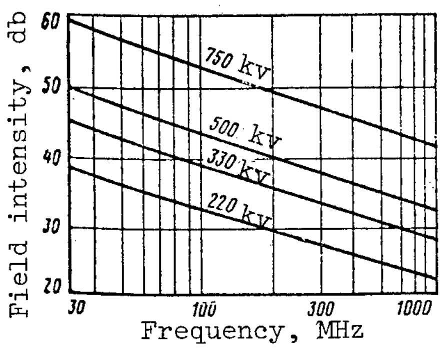

Figure 1. Mean radio interference field intensity as a function of the frequency for various overhead electric power transmission lines.

All of this indicates the expediency of determining the levels of radio interference in the frequency band of 30-1,000 MHz. The electrical component of the field intensity of the investigated radio interference was measured in the following way. Since the interference sources in this frequency band are basically on the power line supports and near them, the antennas of the measuring device are placed opposite the supports. In the majority of measurements the distance between the antenna of the measuring device and the projection of the edge phase on the ground was 15 meters, but the measurements were taken at distances up to 500 meters. The antennas were installed at a height of 3 meters above the earth's surface. In the frequency band of 30-300 MHz, a DR1 type dipole antenna was used, and in the frequency band of 300-1,000 MHz, the DR3 type biconical antenna was used. The FSM-8 type device (the German Democratic Republic) with a set of antennas was used for the measurements.

In accordance with the recommendations of the International Special Committee on Radio Interference, the quasipeak values of the radio interference field intensity with different passband width were measured. However, in the case of insufficient sensitivity of the equipment (when measuring the radio interference from the low-voltage power transmission lines and in the upper part of the 300-1,000-MHz band for the higher-voltage transmission lines) peak values of the field intensity were determined.

The radio interference from the local discharges in the fittings and on the insulators was measured in the summer during good weather, for they were somewhat higher in dry weather. The operating power lines of different voltage classes located in the central part of the USSR and several power lines with identical rated operating voltage were selected. Various sections of them were investigated. There were a total number of 20-60 power line supports with identical operating voltage on which the radio interference was measured.

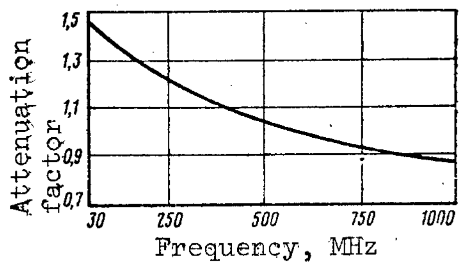

Figure 2. Attenuation factor for the interference of overhead electric power transmission lines as a function of frequency.

The investigation of the radio interference in the mentioned frequency band demonstrated that the radio interference field along the power lines was localized near the supports; the latter can be considered as concentrated statistically equivalent sources of interference independent of each other. The radio interference field intensities created by the set of supports of the power line with identical rated operating voltage fit the logarithmically normal distribution law well. The rate of decrease in the mean value of the radio interference field intensity with an increase in frequency is approximately identical for the power lines with different operating voltages, and it is about 10 decibels per decade or 3 decibels per octave of frequency. It was also established that the mean value of the radio interference field intensity increases with an increase in the operating voltage of the power lines. The mean square deviation of the radio interference field intensities does not depend on the frequency or on the operating voltage of the power line, and it is about 10 decibels. The mean value of the ratio of the peak and quasipeak radio interference field intensities is about 10 decibels with a mean square deviation of about 3 decibels. The magnitude of the radio interference field intensity is proportional to the passband width of the receiver.

The dependence of the mean value of the radio interference field intensity on the frequency for lines of different intensities is presented in Figure 1. The intensity in the band 1 MHz wide at a distance of 15 meters from the power line is presented.

In addition to the measurements of the interference along the power line, a study was made of the attenuation of the interference field on propagation of it from the radiation source to the receiving antenna. The attenuation rate of the radio interference field on going away from the power line is determined by the damping coefficient which, in turn, depends on the frequency and the conditions of propagation: the conductivity and dielectric constant of the soil, the electrical parameters of the air, the presence of obstacles on the propagation path, and so on. The values of these characteristics are inconstant and random.

It is possible to determine the magnitude of the damping coefficient with sufficient accuracy, using the research data obtained under comparable conditions of propagation of the interference. The high-voltage power lines, the routes of which are laid out in rural areas are almost under such conditions. The attenuation factor n can be determined from the expression $E_1/E_2 = (r_1/r_2)^n$, where E_1 and E_2 are the radio interference field intensities at a distance of r_1 and r_2 from the power line, respectively.

The magnitude of the damping coefficient was determined experimentally on several power lines with different operating voltage at distances from the power lines varying from 15 to 500 meters and in the absence of any significant obstacles between the line and the measuring antenna interfering with the radio interference propagation. The attenuation factor is presented in Figure 2 as a function of frequency.

In order to reduce the radio interference from the power lines and improve the electromagnetic situation along the routes, in 1976 the state standard establishing the norms for the admissible radio interference field intensities created by electric power transmission lines in the frequency band of 0.15-1,000 MHz (All-Union State Standard 22012-76) was approved. The presence of standards for radio interference from power lines requires that the designers, builders and organizations involved in the operation and maintenance of the lines take measures to see that the interference level does not exceed the values permitted by the norms.

In addition, by using the given method of investigating the radio interference from the power lines and comparing the indices obtained with the all-union state standard, the radio enterprise maintenance personnel can predict the probable electromagnetic environment along the power lines and solve the problems of electromagnetic compatibility of the power lines and the radio projects accordingly. Under conditions where the effective interference level exceeds the norm, it is possible to demand that the operator of the power line determine and eliminate the causes of the high interference level.

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INFLUENCE OF INERTIAL FORCES OF LUBRICANT FLOW ON THE STABILITY OF A SHAFT ROTATING ON RESILIENT GAS DYNAMICAL PLAIN BEARINGS

Moscow MASHINOVEDENIYE in Russian No 6, Nov-Dec 77 pp 19-23 manuscript received Apr 76

[Article by A.S. Kel'zon and V.I. Yakovlev, Leningrad]

[Text] Bearings utilizing a gas lubricant are fast, have a low friction loss factor, and can function under conditions of cryogenic and radiative environments. But employment of these bearings is hampered in a number of instances by the danger of occurrence of auto-oscillations brought about by the nature of the forces of the lubricant layer. In [3-5] a theoretical and experimental demonstration are given of the feasibility of suppressing auto-oscillations by setting the bearing's bushings in resilient seats. In this article a study is made of the influence of inertial forces of the lubricant, as well as of the escape of gas at the ends on the stability of a shaft whose bearings are set in resilient seats.

Let us consider a rigid vertical shaft of mass m, whose bearings are set in resilient massless seats with rigidity c and a damping factor of κ. Let z and z_1 equal the total amplitudes of the displacement of the center of the pivot and of the center of the resilient seats relative to radial gap δ, and e equal the static unbalance of the rotor. Differential equations for the motion of the rotor without taking into account the mass of the seats, in dimensionless time of $\tau = \omega_0 t$, take the form [3]:

$$\ddot{z}+D\dot{z}_1+z_1=\frac{e}{\delta}\beta^2e^{i\beta\tau},\quad \ddot{z}-\frac{2Q_z}{m\omega_0^2\delta}=\frac{e}{\delta}\beta^2e^{i\beta\tau}, \tag{1}$$

where $D = \kappa/\sqrt{cm}$, $\omega = \sqrt{c/m}$, and Q_z is the total reaction of the bearing's lubricant layer, and $\beta = \omega/\omega_0$ is the dimensionless rotational velocity of the shaft.

Let us apply to equations (1) a Laplace transform with zero initial conditions:

$$s^2z+Dsz_1+z_1=a\frac{\beta^2}{s-i\beta},\quad s^2z-\frac{2Q_z^*}{m\omega_0^2\delta}=a\frac{\beta^2}{s-i\beta},\tag{2}$$

where $a = e/\delta$, s is the variable of the Laplace transform, and Q_z* is the image of function Q_z . Using the method described in [2,4] and taking into account the escape of lubricant at the ends, as was suggested in [1,6], we get:

$$Q_z^*=-\frac{m\omega_0^2\delta}{2}\frac{M[\beta(z-z_1)+2is(z-z_1)]+N[s\beta(z-z_1)+is^2(z-z_1)]}{[ME\beta+i(1+2MEs)]+N\left[E\beta s-i\frac{E}{3}\beta^2+is^2E\right]},\quad (3)$$

(3)

where $N = (2\pi\rho r^2L/\psi m)[1 - (\text{th}\varepsilon/\varepsilon)]$ is a parameter taking into account the inertial forces of the lubricant, r and L are the radius and length of the bearing, $\varepsilon = L/2r$, ψ is the relative radial gap, $E = (1/2)c\psi/\pi pL[1 - (\text{th}\varepsilon/\varepsilon)]$ is a parameter taking into account the compressibility of the lubricant, p is the pressure of the gas at the ends of the bearing, $M = 3\pi K$, and $K = (4\mu L/m\omega_0\ \psi^3)[1 - (\text{th}\varepsilon/\varepsilon)]$ is Tondl's constant, adjusted by a factor taking into account the escape of gas at the ends.

Substituting (3) in (2), we get:

$$s^2z+(sD+1)z_1=\frac{a\beta^2}{s-i\beta},$$

$$(Rs^2+M\beta+2isM+Ns\beta+iNs^2)z-(M\beta+2isM+Ns\beta+iNs^2)z_1=\frac{a\beta^2R}{s-i\beta},$$

where $R=ME\beta+i(1+2MEs)+N(E\beta s-{}^1/_3iE\beta^2+is^2E)$.

(4)

Solving (4), we get:

$$z=\frac{\Delta_1}{\Delta}=\frac{Q_1}{(s-i\beta)\Delta},\quad z_1=\frac{\Delta_2}{\Delta}=\frac{Q_2}{(s-i\beta)\Delta},\tag{5}$$

where Δ is the determinant of system (4), Δ_1 and Δ_2 are determinants obtained from Δ by replacing the individual columns with free terms, and Δ , Q_1 , and Q_2 are polynomials of the fifth, third, and fourth degree, respectively.

Let $\lambda_1,\ldots,\lambda_5$ be the eigenvalues of the matrix of coefficients of system (4). Then solutions (5) can be represented in the following form:

$$z_1=\frac{a_1}{s-i\beta}+\sum_{i=1}^{5}\frac{a_{i+1}}{s-\lambda_i},\quad z=\frac{b_1}{s-i\beta}+\sum_{i=1}^{5}\frac{b_{i+1}}{s-\lambda_i}.$$

The first terms of the row define an image of induced oscillations, and the remaining sum an image of disturbed motion in terms of steady motion. The inverse transform of the image of disturbed motion will represent damping motions if all eigenvalues λ_i have a negative real side. Thus, the problem of the stability of induced oscillations reduces to studying the roots of the characteristic equation of system (4). Images of the forces of the layer and the nature of the disturbed motion are obtained on the assumption that the oscillations of the system are slight.

To study stability let us formulate a characteristic equation for system (4):

$$\begin{vmatrix} \lambda^2 & \lambda D+1 \\ \lambda^2\Big\{[ME\beta+i(1+2ME\lambda)]+ & -M\beta-2i\lambda M-N(\lambda\beta+i\lambda^2) \\ +NE\Big[\beta\lambda-i\frac{\beta^2}{3}+i\lambda^2\Big]\Big\}+ & \\ +N(\lambda\beta+i\lambda^2)+M(\beta+2i\lambda) & \end{vmatrix}=0. \tag{6}$$

We will study stability by the method of D-division. Assuming in (6) that $\lambda = i\alpha$, where α is the dimensionless frequency of auto-oscillations at the stability boundary, and separating the real and imaginary parts, we get:

$$\begin{gathered}-M(1-\alpha^2)(\beta-2\alpha)+ME\alpha^2(\beta-2\alpha)-\alpha^3D[1+NE(\beta\alpha-{}^1/_3\beta^2-\alpha^2)]+\\+ND\alpha^2(\beta-\alpha)=0,\\ -MD\alpha(\beta-2\alpha)-N\alpha(1-\alpha^2)(\beta-\alpha)+\alpha^2[1+NE(\beta\alpha-\\-{}^1/_3\beta^2-\alpha^2)]+DME\alpha^3(\beta-2\alpha)=0.\end{gathered} \tag{7}$$

Solving system (7) in terms of β, we get:

$$\beta=2\alpha+\frac{N\alpha^5D}{M[1-\alpha^2(1-D^2)-E\alpha^2(1+\alpha^2D)]-N\alpha^4D}. \tag{8}$$

To find the dimensionless frequency of auto-oscillations at the stability boundary, we substitute (8) in the second equation of system (7). After transforms we get:

$$M^2ND^2[1-\alpha^2(1-D^2)-E\alpha^2(1+\alpha^2D^2)-N\alpha^4D/M](\alpha^2E-1)\alpha^4-$$
$$-MN^2D\alpha^4(1-\alpha^2+{}^1/{}_3E\alpha^2)[1-\alpha^2(1-D^2)-E\alpha^2(1+\alpha^2D^2)]-$$
$$-{}^1/{}_3N^3ED^2\alpha^{10}+M^2[1-N(1-\alpha^2+{}^1/{}_3E\alpha^2)][1-\alpha^2(1-D^2)-$$
$$-E\alpha^2(1+\alpha^2D^2)-N\alpha^4D/M]^2=0. \tag{9}$$

The procedure for plotting regions of stability reduces to finding the roots of equation (9), the positive values of which are then substituted in (8). It is difficult to solve this problem without using a digital computer.

To estimate the influence of inertial forces of the lubricant, let us turn to consideration of the extreme case, when parameter $M = 3\pi K$ increases indefinitely. This case is of value in determining the width of the auto-oscillation band and makes it possible to make a qualitative determination of the nature of the influence of key parameters of the system on the change in stability boundaries. Practically, this case corresponds to a model of a shaft on bearings with a low rigidity factor. When $M \to \infty$ from equation (9) we get:

$$ {}^1/{}_3NE^2D^2\alpha^6-\alpha^4[ND^2+(1-N)ED^2+N(1-{}^1/{}_3E)(1-D^2+E)+$$
$$+\alpha^2[N(1-{}^1/{}_3E)-(1-N)(1-D^2+E)]+(1-N)=0. \tag{10}$$

Let us consider some specific cases.

1. A shaft with a fluid lubricant, without taking inertial forces into account ($N = 0$, $E = 0$). From (10) and (8), when $M \to \infty$, we have $\alpha = (1-D^2)^{-1/2}$, $\beta_{**} = 2(1-D^2)^{-1}$.

In this case the system has one stability boundary, separating the region of instability ($\beta < \beta_{**}$) and stability ($\beta > \beta_{**}$).

Here the region of stability is indefinite with respect to the rotational velocity.

2. A shaft with a fluid lubricant, taking inertial forces into account ($E = 0$). In this case

$$\alpha_{1,2}^2=\frac{2N-1+D^2-ND^2\pm\sqrt{(2N-1+D^2-ND^2)^2-4N(N-1)}}{2N},\quad \beta_*=2\alpha_1,\ \beta_{**}=2\alpha_2,$$

and the band of auto-oscillations β_* and β_{**} is bound by zones of stability on the left and right. Increasing N results in constriction of the auto-oscillation band, and there exists a finite value of N with which the auto-oscillation band disappears. Assuming in (11) that $\beta_* = \beta_{**}$, we get:

$$N_{кр} = \frac{(6D^2-D^4)+\sqrt{(6D^2-D^4)^2+(1-D^2)16(1-D^2)D^2}}{8D^2}.$$

When $N = N_{kr}$ there ensues total suppression of auto-oscillations throughout the entire range of rotational velocity of the shaft. Thus, inertial forces of fluid lubricant flow exert a stabilizing influence on the stability of the shaft [1].

3. A shaft with a gas lubricant without taking inertial forces into account ($N = 0$). In this case:

$$\alpha^2 = \frac{-(1-D^2+E)+\sqrt{(1-D^2+E)^2+4ED^2}}{2ED^2}, \quad \beta_{**}=2\alpha,$$

and the region of instability is located in the range $\beta < \beta_{**}$.

4. A shaft with a gas lubricant, taking inertial forces into account ($N \neq 0$, $E \neq 0$). Let us begin our analysis with the simplest case, when $N = 1$. Then from equation (10) we have $\alpha_1 = 0$ and

$$\alpha^2_{2,3} = 3\frac{D^2+(1-{}^1/_3E)(1-D^2+E)\mp\sqrt{[D^2(1-{}^1/_3E)(1-D^2+E)]^2-{}^4/_3E^2D^2(1-{}^1/_3E)}}{2E^2D^2}$$

To the three roots of equation (10) correspond three values of angular rotational velocity at the stability boundary: $\beta_* = 0$, $\beta_{**} = 2\alpha_2$, and $\beta_{***} = 2\alpha_3$.

The equality to zero of the first root ($\alpha_1 = 0$) shows that in this case the auto-oscillation band begins at zero rotational velocity. With an increase in velocity there occurs a shift from the unstable zone, $\beta < \beta_{**}$, to a region of stability, $\beta_{**} < \beta < \beta_{***}$. A further increase in rotational velocity is accompanied by a shift from the stability zone to a new zone of instability, $\beta > \beta_{***}$, whose upper limit is indefinite.

In fig 1 are shown estimates of stability boundaries made for this case. Regions of instability are hatched. It follows from fig 1 that increasing E narrows the first zone of instability and widens the second. When $E = 3$ the first zone disappears, and the second approaches the first and the width of the stability region becomes slight. Thus, increasing parameter E results in a shift of the second region of instability toward the zone of effective shaft revolution numbers.

A change in damping, D, slightly transforms the first stability boundary, shifting it into the region of low revolution numbers. The influence of D on the second boundary is more substantial. An increase in D results in a shift of the second boundary into the region of low shaft revolution numbers, narrowing the stability region.

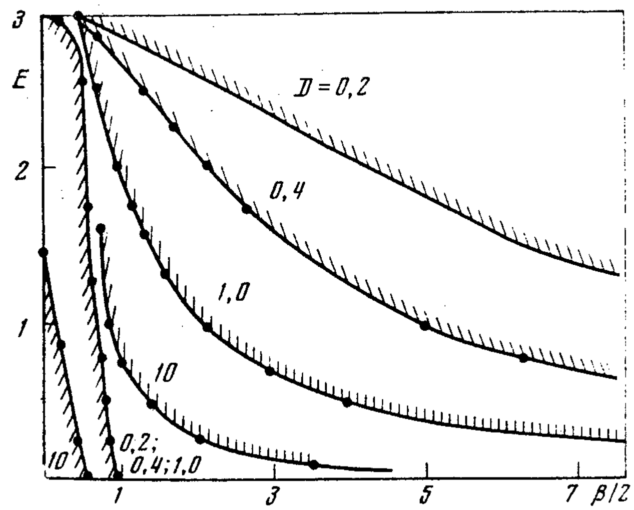

Figure 1. Region of Stability of the System When N = 1 .

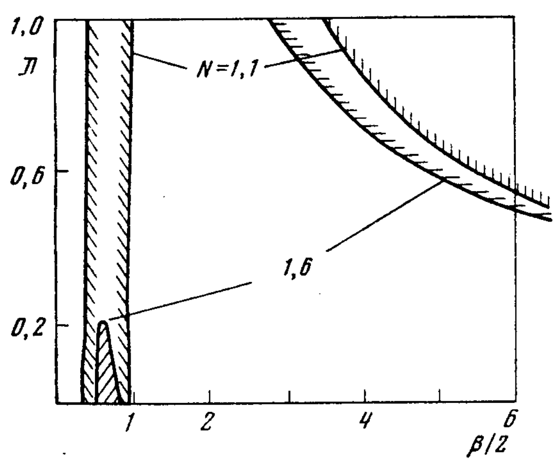

Figure 2. Region of Stability of the System When E = 0.6 .

Thus, inertial forces of the gas lubricant result in occurrence of a new region of instability, which is absent when N = 0 .

These forces exert a destabilizing effect at high shaft r.p.m. This property which has been discovered is characteristic only of a gas lubricant.

Let us consider one more hypothetical case: $N \neq 0$, $E \neq 0$, and $D = 0$. From (10) we get:

$$\alpha_{1,2}^2=\frac{(2N+{}^2/_3NE-1-E)\mp\sqrt{(2N+{}^2/_3NE-1-E)^2-4(N-1)(1-{}^1/_3E)(1+E)}}{2N(1-{}^1/_3E)(1+E)} \qquad (12)$$

and two boundaries of regions of stability corresponding to these values: $\beta_* = 2\alpha_1$ and $\beta_{**} = 2\alpha_2$. The third boundary in this case is shifted into a region which is unbounded with respect to the shaft's rotational velocity, and the zone of instability begins at a value of β_* different from zero. Equations (12) can be used to estimate the width of the first auto-oscillation band.

Let us consider, finally, the common case ($N > 1$, $E \neq 0$, and $D \neq 0$). The boundaries of the regions of stability for two values of N are shown in fig 2. The nature of stability regions confirms the qualitative conclusions obtained above: Inertial forces of the lubricant result in narrowing of the first zone of instability, which, when $N > 1$, begins at values of $\beta > 0$, and they cause the occurrence of a second zone of instability at high rotational velocity of the shaft, which converges with the first with high E and D .

Let us note in conclusion that escape of gas at the ends has a substantial influence on the stability zone. With a reduction in the relative length of the bearing, ε, parameters N and M are reduced and E grows. Therefore end seepage results in broadening of both zones of instability.

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GEOPHYSICS, ASTRONOMY, AND SPACE

SPACE SUIT USED ABOARD SALYUT-6 DESCRIBED

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5, 1978 p 38

[Article by Prof G. Il'in and Cand Tech Sci I. Pavlov: "For EVA"]

[Text] The experience of operating orbiting space stations indicates that pressure suits are needed as part of the organic equipment so that the crews can perform scientific research outside the station and do preventive, repair, and assembly jobs on its surface. In a number of cases this significantly reduces the volume of measures required to keep the station in operable state, and it is economically more advantageous as compared to the use of automatic devices or manipulators.

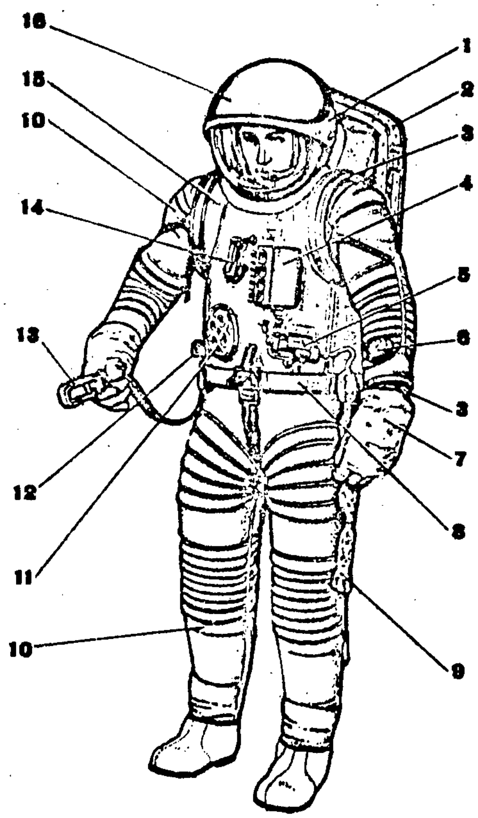
Pressure suits of fundamentally new design in the semirigid category were used for extravehicular activity for the first time in space flight practice aboard Salyut-6.

This pressure suit has a rigid metal body--a cuirass--existing as a single piece together with the helmet and a backpack life support system. Its sleeves and trousers are soft.

The figure below shows the organic semirigid pressure suit aboard the Salyut-6 with the outer heat-insulating cover removed. The glazing on the helmet, which is of rather large area, provides a good view. A hinged light filter protects the cosmonaut's eyes and face from solar radiation. A panel bearing the controls for the life support system's machine units and for monitoring and warning instruments, a suit working pressure selector, a combined pneumatic and hydraulic line with which the pressure suit is connected to onboard systems during preparations for EVA, and a cock used to turn on the oxygen reserve and permit emergency oxygen feed are located on the front part of the cuirass.

The independent life support system is on the back of the pressure suit, and it concurrently serves as the sealed lid of the entrance hatch. The lid is closed by a handle which is secured with a lock. The necessary mobility in the shoulder, elbow, and other joints of the limbs of a cosmonaut present in the pressure suit at excess pressure is provided by sealed bearings and soft hinges.

This design has advantages over soft pressure suits with removable backpacks used earlier. The semirigid pressure suit is easier to use. A cosmonaut can enter it without outside help in 2-3 minutes. It is more reliable, since it does not have external pneumatic and hydraulic lines connecting the backpack to the pressure suit, and the controls are located on the rigid cuirass. The basic systems have back-up. A dependable mechanical joint insures good sealing of the entrance hatch.



Pressure suit of a cosmonaut aboard the Salyut-6 orbiting station (without the heat insulating cover): *1*--Pressure helmet; *2*--independent life support system; *3*—sealed bearing; *4*--control and monitoring panel; *5*--suit pressure regulator; *6*--suit pressure indicator; *7*--removable glove; *8*--power ring; *9*--electric cable socket; *10*--soft part of pressure suit; *11*--combined pneumatic and hydraulic line socket; *12*--pressure suit entrance hatch closing handle; *13*--safety line snap hook; *14*--oxygen reserve switch-on valve; *15*--rigid body of pressure suit; *16*--light filter.

The pressure suit is sufficiently universal: It can be worn by cosmonauts of different sizes. Slight change in the gaps between the body and the outer shell are not important in relation to a rigid pressure suit, and the cosmonauts themselves can adjust the length of elastic limb covers to their height. Only the removable gloves are fit to each cosmonaut individually.

And, finally, there is one more important advantage of the new pressure suit. In its working state (under pressure) its overall dimensions are less than that of an inflated soft pressure suit with the backpack on.

The cosmonaut and the pressure suit's components and equipment are protected from overheating in open space by an external protective cover containing several layers of vacuum-shielded heat insulation. This cover can be compared with a multilayered thermos. The heat insulation also protects the cosmonaut from overcooling when located in shade (when there is no external inflow of heat).

The microclimate within the pressure suit is maintained by the independent life support system, which is a closed regenerating system. In particular it provides oxygen, regulates and maintains a set pressure, suit ventilation, and the required gas composition by removing carbon dioxide and harmful impurities from the gas mixture, and it supports thermoregulation--that is, it removes and disperses, to the outside, heat liberated by the individual and the machine units and heat penetrating through the cover of the pressure suit. The system includes electrical equipment, radio communication resources, and machine unit control and monitoring systems.

The pressure suit's thermoregulation system consists of a water-cooled suit--quilted overalls with a cap made from highly elastic synthetic rubber into which flexible plastic tubes are woven. They form a unique elastic radiator in which water circulates. This suit is put on directly over the cosmonaut's underwear and rests firmly against his body. Water circulating in the suit is cooled in a heat exchanger, and it collects heat liberated by the body. This method of heat exchange is much more effective than removal of heat with a ventilating gas, the method used earlier.

The cosmonauts can change the degree of heat removal by adjusting the amount of water passing through the heat exchanger. This affords him a possibility for maintaining normal thermal conditions in the presence of any physical load while working in open space.

The pressure suit can be reused for EVA. All that need be done is to refill the oxygen reserve, fill the cooling system tank with water, and replace the carbon dioxide absorption block.

Electric power is supplied to the machine units, radio communication with Earth is maintained, and telemetric parameters are transmitted to Earth through an electric line connecting the pressure suit to the station.

An atmosphere with a higher oxygen content is maintained within the pressure suit. This is why fire safety requirements were accounted for during development of the systems and selection of the materials.

The designers of the pressure suit did a great deal of research. Special testing stands, laboratories, and devices were created to reproduce the real conditions under which a cosmonaut would have to work in a pressure suit. The articles were tested in heat and pressure chambers, in airborne laborabories, and in a swimming pool, where conditions close to weightlessness were simulated, as well as in models of the orbiting station and in trainers. The pressure suit was subjected to effects significantly exceeding those encountered in its operation.

The work of cosmonauts in orbital flight confirmed the high characteristics and dependability of the new pressure suit, and of its independent life support system.

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PROSPECTS FOR POWER GENERATION FROM SPACE

Moscow NEDELYA in Russian No 20, 1978, p 11

[Article by I. Zorich: "Energy From Space"]

[Text] While no one has yet been able to technically achieve a thermonuclear reactor, at the same time nature has already created one. It is the stars, including our own good star -- the sun. Within the depths of its nucleus, light-weight elements are fused into heavier ones and huge amounts of energy are liberated. The sun's power is 5,000 times greater than the total power of all remaining energy supplies on earth, and at the same time this source is inexhaustible. A poet has said, that the sun's motto is "to shine always and to shine everywhere." It is honestly fulfilling the first half of this promise -- at any rate, there is no basis to fear that in the next several million years the sun's brightness will decline. But as for "to shine everywhere", unfortunately is not so. In some regions the sun's rays constantly burn bright, and in others they don't peek through for months at a time. Even in the Sahara and Kara-Kum the sun disappears for half a day. It is no wonder that scientists treat solar energy technology as an industrial electrical energy resource without particular interest.

But there is such an area where the sun does shine constantly. This is in open space. In space there are no sunrises and sunsets, no clouds, and no atmosphere to weaken the solar rays. And now scientists are increasingly coming to the conclusion that it is precisely there in space that one needs to scoop up solar energy and send it down to earth. But can this be done? Yes it can, and if not right now, then in the not so distant future.

Already today photoelectric batteries are mounted on satellites and spacecraft. They convert solar energy to electrical and power their equipment and auxiliary engines. Let's imagine a space station located in so-called geostationary orbit at a distance of 35,800 kilometers from earth. The orbital period of such a station is 24 hours (remember that a "normal" satellite located in near earth orbit, circles our planet about every hour and a half), that is they will rotate synchronously and the station will hang as if "suspended" over a single point of the earth's surface. Geostationary, or synchronous, orbits are already familiar. Communications satellites with which telephone-telegraph communications and television transmissions are relayed over great distances are so positioned. In this manner, for more than 99 percent of the time the space station will be illuminated by the sun's rays. Only infrequently, during the days close to vernal and autumnal equinoxes, and then not for very long, will the earth's shadow fall upon it. Each square meter of the solar battery will be able to receive from the sun nearly one and a half kilowatts, of which approximately one tenth can be converted to electricity. One hundred and fifty watts per square meter is, of course, not a lot, but in fact you can have as much free space as you like. There is nothing to prevent us from extending "plantations" of batteries over tens of kilometers and gathering a "harvest" of millions of kilowatts. It is estimated that if a solar electric space station (SKES) were to be equipped with two panels measuring 6 by 5 kilometers each, then the electrical power output would total 5 million kilowatts. Greater than the power output of the Bratskaya GES [Hydroelectric Power Station]! And what if 300 such stations were simultaneously postioned in geostationary orbits!

There is yet another way to transform solar energy to electrical. Solar rays can be collected by gigantic mirrors, concentrated into powerful streams and used to heat a liquid converting it to steam. The steam would function then in the normal way -- turning a turbine to which a generator producing electrical current is connected. The spent steam cools off, condenses and the cycle is repeated. While the turbothermal technique is well in hand under earth conditions (it has advantages there), it has not yet been accepted in space. However, rough calculations show that by using this method one could obtain 10 million kilowatts on a single electrical space station. The Bratskaya and Krasnoyarskaya GES joined together! And one can dispense with the rotating turbine if we use a magnetohydrodynamic generator, which permits the direct conversion of heat energy to electrical.

But there arises the problem of transporting the acquired electrical energy to earth. Certainly not via power lines! Two methods have been proposed for wireless transmission of large amounts of power over great distances. The first is with the aid of a laser beam, and the second via microwave radiation (SVCh). The second is very likely the more practicable.

SVCh technology has received extensive development in the post-war years. It is precisely in this centimeter band that radio astronomers are conducting observations and high frequency radio communications are carried out. Also being studied is the possibility of commercially relaying large amounts of electrical energy via SVCh channels (the first ideas in this area belong to the prominent Soviet physicist Academician P. L. Kapista). This technique promises tremendous advantages -- it will be possible to transfer electricity over wave guides -- pipes laid beneath the ground similar to oil and gas pipelines. But that is under earth conditions, and for the transmission of electricity from space the pipes won't even be necessary. SVCh, a bridge extending tens of thousands of kilometers, will join the SKES with our planet. It won't be hindered by the cosmic cold, the atmosphere's density, fog or thunder storm clouds. It will operate continuously in winter and summer, day and night. On the ground, the bowl of the receiving antenna with a diameter of a kilometer or slightly larger will be able to receive the SVCh radiation, convert it to normal direct or alternating current and transmit it to satisfy the requirements of the national economy.

Fantasy? Not in the least. It's a grandiose project based on the firm ground of calculations and experiments, and on the achievements of space technology. The scale of the project characterizes, for example such figures. The weight (it's more correct to say mass, because what weight is there under weightless conditions) of the equipment for an SKES with a power capacity of 10 million kilowatts, using photoelectric solar batteries, is nearly 35,000 tons, and the SKES, using turbogenerators, is over 100,000 tons. We have to deliver all these materials, assemblies and units into space, collect them, erect, test and put them into operation, and then service it. Special robot-manipulators will be able to set up similar type assemblies, such as supports for the photoelectric batteries or for solar ray concentrators, but the space engineers and mechanics must put together and test the more complex systems. And then the assembled device will have to be transferred to stationary orbit. Hundreds of engines dispersed throughout the surface of the station will be ignited, and it will begin a slow (so that the G-forces won't cause damage or any significant deformation) space voyage lasting tens of thousands of kilometers. This will probably take six months, or even an entire year. The auxiliary engines will also be of use in stationary orbit. They will orientate the batteries towards the sun, compensate for misalignments caused by the action of the "solar wind" and will provide the exacting orientation of the station with respect to the ground receiving antenna.

Certainly we have yet to solve a great number of problems and overcome many difficulties before it will be possible to begin creating electric power space stations. But they are all more of a technical rather than a conceptual nature. However, in addition to the technical, one must also examine the economic, social-legal, ecological and other aspects in creating SKES. How, for example, will the transmission of a powerful SVCh beam affect radio communications? How does one divide the sections of the equatorial plane amongst the nations (although these sections are huge, they are not boundless), and guarantee equal rights and equal capabilities to all nations? And there are many other questions.

On the other hand, what rich prospects are opened up by SKES. It is estimated that six such stations could satisfy the demands in electrical energy of a country such as Japan, and 30 - 40 stations for the needs of the U.S.

But now let's pose a question which at first glance is a paradox and crosses out all that has been said above. Is it really necessary to send energy from the SKES down to earth?

Here on earth, in order to limit the construction of high-voltage electric power lines and reduce the construction costs associated with them, the energy losses, and the unproductive use of the land, we attempt to bring the power-consuming industries closer to the electric power stations. It is easier and cheaper to tranport raw materials than it is energy. Won't it be possible to follow the same course in space? Might it be more advisable to build the enterprises of several industries directly in orbit in a unified complex along with the SKES? "Shuttle" transport craft and space ferries will deliver raw materials there and return prepared materials or even finished products; even passenger runs will transport service personnel working the "watch" system. This will offer a tremendous number of advantages. First of all, it will permit a significant reduction in the amount of wastes being exhausted into the earth's atmosphere by the more "dirty" industries. Secondly, in space, under conditions of weightlessness and an almost complete vacuum, it is easier than on earth to obtain extra pure substances or materials with a uniform distribution of contaminants, and to grow large crystals with the desired properties. Soviet cosmonauts have set the stage for space technology, which undoubtedly will be developed and perfected, moving out of the sphere of experimentation into the area of industrial acceptance. Our "Soyuz" and "Salyut" spacecraft are not only serving today's scientific and national economic needs, but in no small degree are working for the future of mankind. And one of the urgent tasks in the future will be the mastery of the virgin territory of energy production in space.

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COSMONAUTS UNDERGO MEDICAL GROUND TRAINING

Moscow ZEMLYA I VSELENNAYA in Russian No 2, 1978 pp 11-15

[Article by Dr Med Sci N. N. Gurovskiy and Dr Med Sci A. D. Yegorov: "It is Not Easy to Become a Cosmonaut"]

[Text] The cosmonaut selection and medical training system must guarantee maintenance of health and working ability in the conditions of a planned flight.

The Cosmonaut Selection Stages

Steel smelter, miner, seaman, cosmonaut: All occupations impose specific requirements on people attempting to master them. As we know, cosmonaut candidates were first selected exclusively from among pilots. It was clear to everyone that in addition to good health, a person that is to fly in space must have strong will, swift reactions, and the capability for making a correct decision in complex situations. And, of course, he must be acquainted with the wide blue yonder and with the action of factors similar to those expected to be encountered in space flight. Fighter pilots were better versed in all of this than others. And the first cosmonaut selection programs were based on a well-developed procedure of pilot medical selection and examination. Continuity is the fundamental principle at the basis of cosmonaut medical selection. Selection begins at the clinic, continues in the hospital and at the Cosmonaut Training Center, and it ends at the spaceport.

The clinic stage must reveal obvious diseases and health impairments which might hinder participation in space flight, for example reduced vestibular stability.

The hospital stage of selection has the purpose of revealing latent diseases which do not reveal clearly pronounced symptoms in their early stages and which are not accompanied by any sort of complaints but which could manifest themselves in flight. However, it is not at all enough to ascertain that the cosmonaut candidate is healthy; we must still determine the unique features of reactions of his body to various loads, and we must reveal his functional reserves. Load tests, with which the work of the cardiovascular system, the vestibular apparatus, and other physiological systems can be assessed, have been developed for this purpose. They include analysis in a centrifuge and in a pressure chamber, and special vestibular tests.

Research on the psychoneural sphere occupies a special place. It permits us to determine beforehand the way a cosmonaut would behave himself in response to unusual influences and the sort of emotions that would accompany his behavior--positive or negative. A decision is made as to whether he would remain composed and self-confident or begin to panic.

We recall the night before the first human flight into space, when physicians placed special sensors under the mattresses of Yu. A. Gagarin and G. S. Titov. These sensors were to "tell them" about the sleep of the cosmonauts. If the stylus of the recorder produced an even curve, they were sleeping calmly, while if they tossed about and experienced restlessness, the curve would break and vary.

S. P. Korolev, who lived next door, looked at the apparatus four times during the night (it was not in the house itself but outside of it) and asked how things were going. He was astounded by the peacefulness of the cosmonauts' sleep.

"I would not have slept so soundly in their place," he said.

"Does this mean that we trained them well, Sergey Pavlovich?" the duty physician asked. In response he heard:

"Yes, without a doubt."

Because flight duration is increasing, it is especially important to evaluate how people behave themselves in the process of joint activity. Sensible crew composition with a consideration for psychological compatibility depends on the effectiveness of these methods.

Cosmonaut candidates who successfully penetrate the "barriers" of the hospital are sent to the Cosmonaut Training Center imeni Yu. A. Gagarin to participate in the stage of concrete flight training. The main goal of the medical subdivision of this training is to heighten the body's resistance to space flight factors.

Medical data acquired in all training stations and the results of the medical examination immediately before the flight are what a conclusion as to the cosmonaut's readiness for the given space flight is based on.

It should not be believed that the medical selection system is static. It is constantly developing, accumulating today's achievements of clinical and space medicine and the experience of space flights. Cosmonaut selection proceeds in a differentiated manner, with a consideration for the program being planned and the length of the flight, as well as the various responsibilities of the crewmembers--the commander and the engineer.

Development of cosmonautics, growth in the complexity of space technology and the need for testing it in flight, and the diversity of scientific research have made it necessary to include engineers and other highly qualified specialists in the spacecraft crew. These people have come to be called cosmonaut-scientists. The need has arisen for a more-flexible approach to the problems of selecting and training new categories of cosmonaut candidates. From the standpoint of space medicine we are dealing with "older" people with a lower level of physical fitness. This is why such candidates were "treated" and their health was improved before a final decision was made. The first and longest training stage proceeds while the candidate is still engaged in his principal work, and he is sent to the Cosmonaut Training Center only for immediate training as a crewmember. After the flight, such people return to their main place of employment.

Cosmonauts G. M. Grechko, V. N. Kubasov, N. N. Rukavishnikov, V. I. Sevast'yanov, and others underwent selection and training in accordance with this system. Special emphasis should be laid on the fact that in the Soviet cosmonaut selection and training system, much attention is devoted to the individual features of the body.

Physicians Prepare Cosmonauts for Flight

Cosmonaut training is a continuous process in which the cosmonauts learn their occupational activities and develop high resistance to unfavorable space flight factors--accelerations, weightlessness, and psychoneural stresses associated with the unique features of flight.

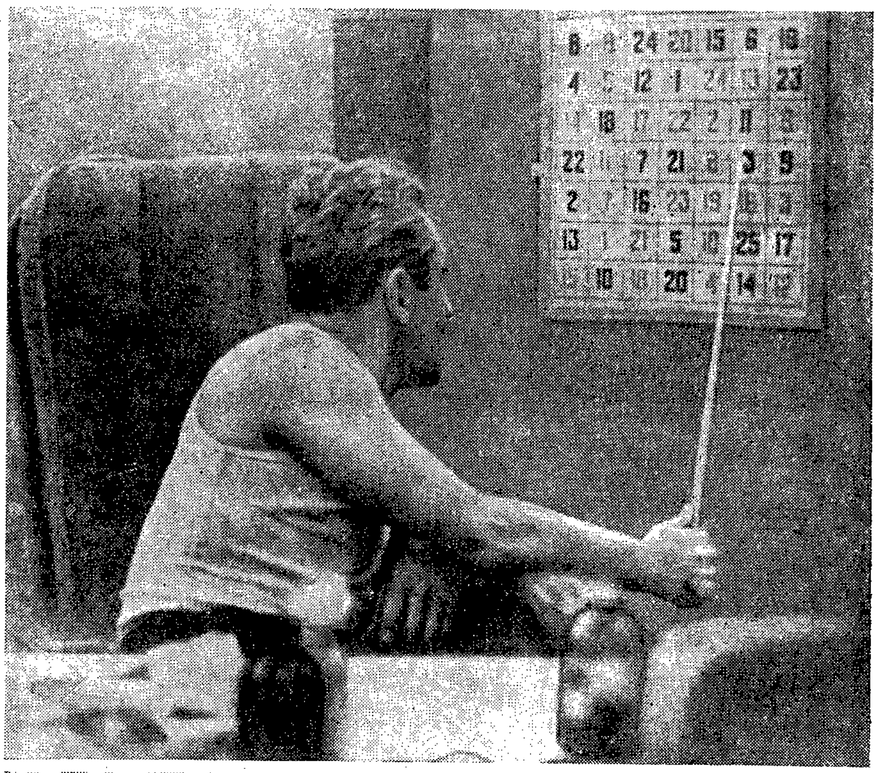
How is the body's resistance increased? Two ways are known in medicine. The first is to subject the individual many times to the factor in relation to which he must heighten his resistance. The second is to heighten the body's overall fitness. As an example when the body is trained for oxygen starvation its resistance to ionizing radiation increases as well.

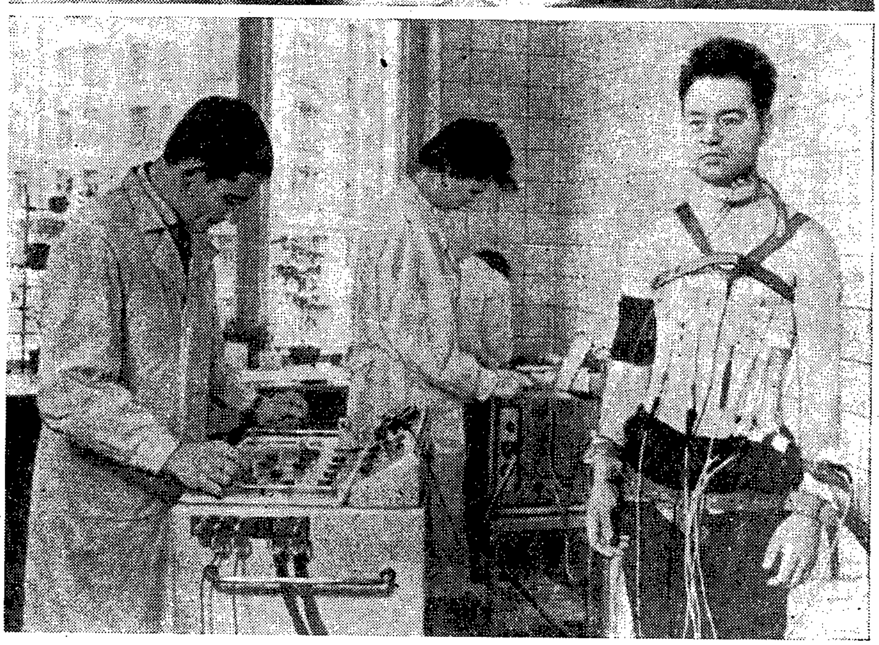
It must not be thought that cosmonauts are trained only by some sort of special methods. Physical exercises, therapeutic baths, and acclimation to higher altitudes heighten the body's resistance to unfavorable effects, though of course special training that heightens working ability and endurance in complex space conditions plays an important role in cosmonaut training as well. Such conditions are created through parabolic flight aboard airplanes creating short-term weightlessness, tests and exercises in a mock-up of the spacecraft, rotation in a centrifuge, and others.

The principles behind the structure of cosmonaut training reflect the general laws of training: Repeated influence, gradual growth in intensity and duration, and an individual approach to selection of the intensity and duration of factors in accordance with the state of the body and the forthcoming assignment. Those forms of training which improve health are included in the program with an average load. The planning of all types of training accounts for the time between exposures to particular factors and the sequence of different exercises. The Soviet cosmonaut training program includes not only systematic but also some types of one-time loads having the main purpose of providing information on individual features and the reserve capabilities of the body.

The cosmonaut undergoes various tests in his medical training. Here are just a few of them.

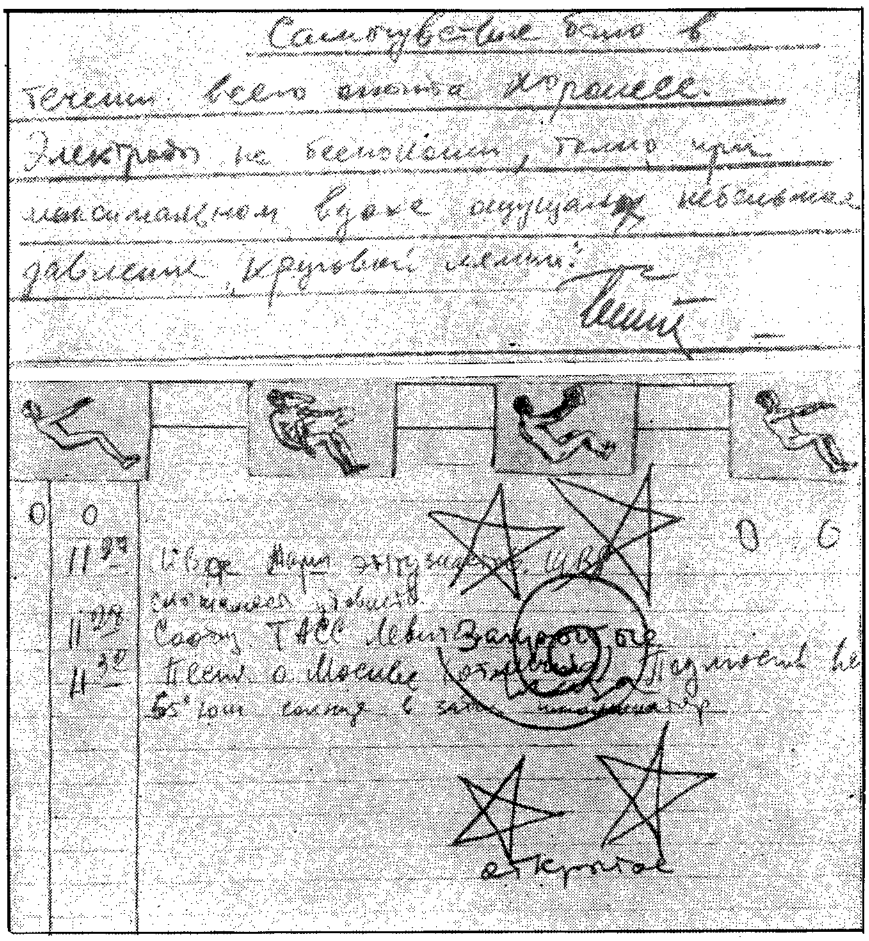
The black-and-white numerical table is used to study the stability of preprogrammed activity. The numbers are in a random combination precluding the possibility of memorization. The subject points out black numbers in growing order and red numbers in decreasing order, alternating these actions and pointing first to a black and then to a red number in the table.





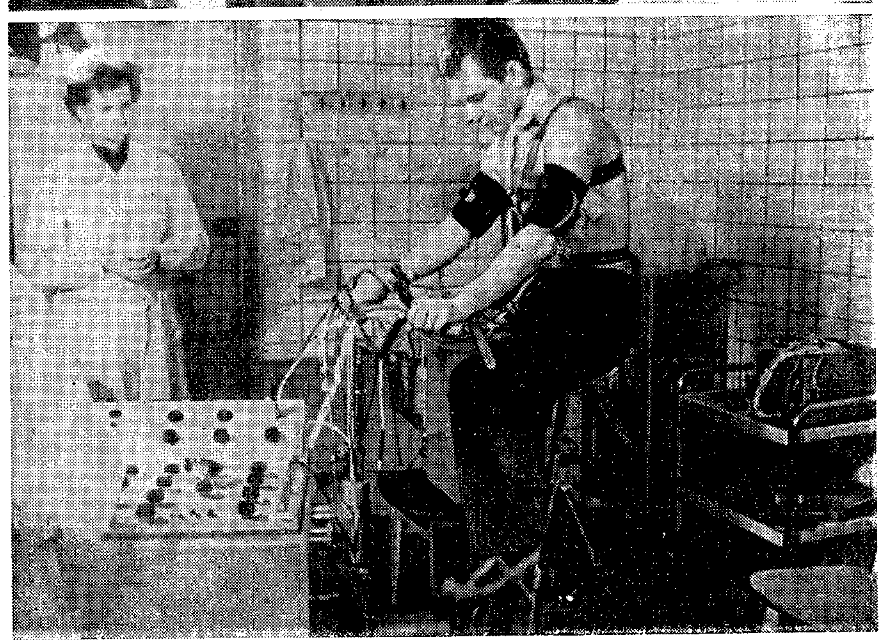
G. M. Grechko undergoes a medical examination

G. S. Titov's handwriting while in a mock-up of the Vostok craft.



The first vestibular tests of G. S. Titov in space flight. The two upper stars were drawn with the eyes closed.

Flights are an inherent part of cosmonaut training. A. S. Yeliseyev sits in the airplane cockpit.



Training on a bicycle ergometer. V. N. Kubasov prepares for flight.

Tests in a soundproof chamber are used to assess the cosmonaut's psychoneural stability and determine his capability for performing assignments precisely in the conditions of prolonged isolation and quiet.

Cosmonauts lived and worked in the soundproof chamber in accordance with the schedule of the future flight. Special complexes of physical exercises and methods for recording biomedical information were checked out during preparations for the first flight. The cosmonauts remained in the soundproof chamber for from 7 to 10 days.

To gain an impression of the nervous load experienced by a person in a soundproof chamber, recall that one reporter perceived a slight squeaking in the television screen, which no one had ever noticed in ordinary conditions. He experienced visual and auditory sensations leading him to imagine that he was in a logging area (where he had worked once) and could hear the whine of saws and the noise of falling trees. Some cosmonauts also experienced such sensations to one degree or another. The soundproof chamber was a mandatory test prior to flight. Today cosmonauts are subjected to it only when first accepted for their team. The test must be conducted to check the psychoneural area, though not always.

The psychoneural stability of the cosmonauts is checked throughout the entire period of training. Emotional reactions and behavior during forms of training distinguished by significant influences upon the human mind (parachute jumps, rotation in a centrifuge, airplane flights, capability for performing assignments precisely, capability for relaxing and then quickly returning to active activity) are studied.

Special training in thermochambers experienced by the first groups of cosmonauts heightened their resistance to high temperature and helped determine the body's reactions to heat (60°C). This could have been important in emergency situations. Subjection to thermal influences is still in the program, but today it is aimed at assessing reactions of the cardiovascular system and revealing latent pathology.

Airplane flights are performed with the purpose of creating short-term weightlessness--for just a few dozen seconds. They help reveal persons with insufficient resistance to such an effect, they permit the study of the body's individual features, and they train and strengthen will.

Despite significant differences between reactions to short-term and long-term weightlessness, parabolic flights afford a possibility for assessing the predisposition of the functions of the vestibular apparatus for disruption and acquaint the cosmonaut with this unusual state.

Rotation in a centrifuge provides an idea of the action of accelerations of different durations and intensities upon the human body; it permits us to determine how well cosmonauts endure accelerations in the different phases of placing the craft in orbit and its return to Earth. It heightens the body's resistance to inevitable accelerations.

Training of the vestibular apparatus has the goal of heightening its resistance to stimuli in the most diverse conditions.

Active and passive methods are employed. Active methods include various physical exercises. Passive methods involve training on a swing and in rotating stands.

Physical training is one of the ways to heighten the body's resistance to the action of both space flight factors. It consists of intense morning physical drill and special group assignments. During group assignments the cosmonauts play football, volleyball, and basketball, and they perform acrobatics. Physicians try to individualize the exercises as much as possible and strictly comply with the principle of gradual, strictly controlled growth of loads.

V. V. Kovalenok worked with a bicycle ergometer during the time the crew was preparing for its flight aboard Soyuz-25. One day he noticed that the work was harder for him than usual, and the physicians revealed a slight increase in pulse. Being a disciplined person, however, he completed his assignment. It was found later that rather than the 750 kg load on the foot pedals, the maximum load--1,200 kg--had been set. This example attests not only to the high moral qualities of the cosmonaut but also his outstanding physical fitness. The same can be recalled in relation to the other crewmember, V. V. Ryumin. During high-altitude training he kept pace with his local guide while climbing with a 20-kg backpack filled with lunch for the entire group.

We have only briefly described the medical aspect of the tiring and often difficult training of cosmonauts. Many believe them to be fortunate and are "green" with envy, thinking: "Perhaps even I could someday travel in space as they do." But cosmonauts are not simply lucky fellows who won a lottery; they are also people who had labored greatly to make their dreams come true.

11004
CSO: 1870

FEOKTISTOV INTERVIEWED ON FUTURE OF SOVIET COSMONAUTICS

Moscow OGONYEK in Russian No 15, Apr 78 pp 14-16

[Interview with Hero of the Soviet Union, USSR Pilot-Cosmonaut, Doctor of Technical Sciences, Professor K. P. Feoktistov by Correspondent S. Vlasov: "Will There Be Cities in Space?"]

[Text] Question: Konstantin Petrovich, what had you imagined today's cosmonautics to be 20 years ago, after the flight of the first satellite?

Answer: Speaking frankly, I believed that mankind would have attained more. As an example we envisioned flights to Mars. The real results are much more modest. The reason for this lies in the difficulties which no one had known or presupposed would be so great.

Question: What is the main problem facing cosmonautics today?

Answer: To learn how to live and work in outer space. This is precisely what we are trying to do in our long flights. We do not know as yet how long man can remain in weightless conditions. For 3 months he can. But what about longer? This is precisely why we are gradually increasing the time man remains in space. We do not as yet know exactly which groups of muscles do not operate in weightless conditions. After all, it could be that some muscles may undergo atrophy, and they may rupture at the most unexpected moment in response to even a small load. Or calcium may begin to be leached out of bones. Unfortunately neither dogs nor monkeys can come to the aid of man in this regard. They would simply go out of their minds if they were to remain in space for so long. They do not have the ability to adapt themselves to the situation.

Question: Are there grounds for believing that 3 months are not the limit of man's capabilities?

Answer: Yes, I think we can go even farther. Not right away, of course, but gradually, because we do not know what sort of surprises long flights are preparing for us. Today, not a single specialist in space medicine can tell us what would happen to an individual if he were to spend a year in weightless conditions, not to mention longer. This is why the main question we want to answer today is: "How long can man fly in space and then return to Earth without detriment to his health?"

The answer to this question will go a long way in defining the future of cosmonautics, because if artificial gravity devices will become necessary, this will make man's conquest of the distant planets much more difficult and a longer wait. Earlier, we could not imagine that a flight to Mars, which would last 2-3 years, could be completed without creating artificial gravity in the craft. We believed that man would not be able to live so long in weightless conditions. The hope that he might be able to do so has already arisen today, though it is slight.

Question: But is man's presence in space so necessary? Automatic devices do not manage poorly without his interference.

Answer: Yes, automatic machines can work fabulously: They can explore natural resources, perform scientific experiments, and so on. But man must start the ball rolling. All begins with man--both on Earth and in space. He comes forth, poses the tasks, teaches the automatic machine to do what is most laborious and boring to him, and then he goes on to discover new, unknown things. So it will be in space as well. After the message is clear and the apparatus is set up, all of the most complex work must be entrusted to the automatic machine. But for the time being, all automatic systems in the world, no matter how long they have operated, have been under human control. In this case something can always be corrected or repaired, but how would they be able to work for a long time during a space flight? We do not have an answer to this question as yet: We do not yet know how to create self-repairing automatic complexes.

Of course we do not count on the hope that we might be able to build perpetual automatic machines. This is why we have tested the Progress-1 cargo craft which can deliver apparatus to a station to replace apparatus that had broken down. Nevertheless this is not the main method. The main method is to gradually develop equipment capable of serving us dependably for a long time.

Question: I had read about plans for future space habitats, for example for 100,000 persons with movie theaters, bicycle tracks, gardens, the sort of climate we find on the Hawaiian Islands, and vegetables and fruit year round.

Answer: From an engineering point of view such a habitat is fully realistic. But it is believed that it would take 10 years to build one. I think that even if we were to begin such construction in 30 years, mankind would have to devote a significant amount of its efforts to building it. Mainly, though, I do not see reasons why people must move into space.

Question: What about overpopulation of the planet?

Answer: This problem must be solved here on Earth. I think that man would live in space as he lives on our planet only in the event of a worldwide catastrophe. He who has been abroad for even a short time knows the longing one feels for home. This longing persists even though the birches, lakes, and the Sun are the same out there as here. They are the same, but not exactly the same. Everything would be artificial in space--the ground, the sky, the rivers, and the forests. But what is most important is that space will be very limited. Will man be able to live in such an artificial situation?

Question: When a peasant who had lived all of his life in a village moved to an urban apartment with a bath and central heating, perhaps he longed for a long time for the open countryside, for the *zavalinki* and the stoves with the cast iron pots. But his grandchildren, who were born in the city, are oblivious to such nostalgia. Is it not possible that people who are born and grow up in space would also fail to understand the longing of their "grandfathers" for Earth in the same way?

Answer: Perhaps that is so. But this would be far from the most pleasant part of life for the first immigrants. Nevertheless we might always find seekers of adventure who would want to live at exotic points of the Solar System such as, for example, Venus or Jupiter. But I think that they would want to return rather quickly. First of all man will be developing outer space as a way to apply his efforts, in order to engage in industrial activity. In the same way that there are stations on both poles of our planet today, permanent scientific stations will appear in outer space. This is natural. But no one is ready to move permanently to the North Pole. Or to Antarctica, though it is much more convenient to live there than in outer space. Dozens of times more convenient, relaxing, and comfortable.

Question: Despite this, however, is it possible to build space habitats? What would they be built of? It would be very expensive to deliver materials from Earth.

Answer: It is difficult to respond definitely at the moment. Estimates exist indicating that lunar material could be used advantageously. Metals could be produced on the Moon, hurled to the construction site by electromagnetic catapults, and structures could be manufactured and assembled right at the construction site. I cannot agree with these ideas because I cannot comprehend how the thrown material is to be collected together. From my point of view it would be more profitable to transport construction materials by means of ion-plasma jets from asteroid belts.

Question: But what if Mars or Venus were to be used as the construction site?

Answer: I am sure someone has already made the necessary computations. I have not done so, and therefore I cannot say anything categorical about this. But I think it is too cold on Mars. Mars receives almost a third less solar energy than does Earth. And once again it would be very expensive because it is so far away.

Question: But are modern rocket engines all we are going to have forever? Some day, would they not appear as primitive to us today as the kerosene lantern? Certainly the cost of construction in outer space would decrease significantly when new propulsion units are created.

Answer: We would hardly be able to master any sort of jet transportation of greater effectiveness in the near future. Of course the idea of thermonuclear engines exist. But no one knows how in fact to design them. Of course were we to do so, then space journeys would become as commonplace as airplane flights are today. But this is still far in the future.

Question: Much has been recently said about development of the Moon. There are even plans for building an entire city there. It has been suggested, for example, that we can use lunar craters for this purpose. Just build a roof over them and connect them together by sublunar passageways. What do you think about development of the Moon?

Answer: I think that this would be unfeasible today. It costs 15 times more today to deliver men and cargo to the Moon than it does to deliver them to near-Earth orbit. The flight of Apollo-11 cost almost $400 billion.

Question: What about 50 years from now?

Answer: Then, I think, we will be engaged in research which could be advantageously conducted on the Moon. The conditions for astrophysicists are very favorable there. On the other hand, however, it appears even more advantageous to me to conduct such research aboard an orbiting station: In weightless conditions we can build antennas and telescope reflectors of such proportions that could not be created in the presence of gravity, even lunar gravity which, as we know, is six times less than that of Earth. But special problems which will require construction of lunar observatories may arise.

Development of the Moon will begin only after we create an economical shuttle system. For example the Americans suggest a system consisting of three types of reusable spacecraft, each of which travels only in its own portion of the route. One craft, a transporter, would deliver people and cargo into Earth orbit, from where an interorbital ferry would convey them to lunar orbit, and another spacecraft would then drop them down to the Moon. According to American computations such a system would make it possible to decrease transportation costs by several dozen times.

Question: But while development of the Moon and the planets is a matter for the relatively distant future, would industrial activity in Earth orbit not begin much sooner?

Answer: Yes, doubtlessly. People have already come to recognize that the reserves of coal, petroleum, and gas are not infinite. Even countries possessing much of these resources are already thinking about the future: "What will we do tomorrow? Where will energy come from?"

In principle, the computations show that we can solve the planet's energy problem with orbiting electric power plants. Imagine that a plant which has double the capacity of the Bratskaya GES is hanging over the same point on the equator. There could be many such plants, hundreds and even thousands.

How would such a power plant work? It will receive energy from the Sun, transform it into electric power, and then it will transmit it to Earth by means of electromagnetic waves. We could solve this problem today from a technical standpoint. The working element of such a power plant would be a special film stretched over an openwork frame (this is what a solar cell is) which is not damaged by the effects of ultraviolet rays. And, of course, it would be very light. The total area of such power plants would be tremendous, several dozen square kilometers.

Question: But we cannot build them on Earth. Would this not mean that we would have to create entire plants and assembling and welding shops in outer space?

Answer: Of course. Estimates have shown that this is practically possible. A plant could be launched into space in parts, as modules, and assembled in outer space. In principle, in the same way that orbiting space complexes are docked today. Of course it would be difficult to predict today the production processes that would be used in weightless conditions. After all, even something like a transporter, to which we are accustomed, would be useless out there.

Such plants will not be built in outer space tomorrow. It will be some time in two or three decades. I think that by that time orbiting electric power plants will be able to compete fully with terrestrial power plants. Of course, the experiments will begin earlier. In essence, they have already begun.

Question: But entire space trains and not just single rockets would be needed to deliver material for an electric power plant into orbit.

Answer: Yes, we would launch the most powerful rockets daily to deliver several hundred tons of cargo to the construction site. This would be profitable industrial activity. Computations show that such an orbiting power plant would pay for itself in 5-7 years after its creation.

Question: What sort of plants could be created in outer space?

Answer: As an example suprapure antibiotics and other medicinal agents that are much simpler to obtain in weightless conditions could be produced out there. Or we could produce semiconductors. The acquisition of some crystals needed in electronics is quite expensive on Earth because we are unable to obtain a uniform structure: Gravity is an obstacle. This problem does not exist in weightless conditions. Perhaps we could also manufacture reflectors for the needs of astronomy out there.

Question: But could we not also place all harmful production operations that are poisoning our planet in outer space?

Answer: At first, yes. Until we attain wasteless production processes. But we must remember that contaminating outer space is no less dangerous than it is to contaminate the Earth.

Were we to have orbiting objects producing on the order of billions of kilowatts, by directing the energy fluxes toward the necessary points in the atmosphere we would be able to affect the planet's weather by creating manmade cyclones.

As an example there is an enviably great amount of moisture in the polar regions. Why not move it to arid regions? Some concrete ideas about how this could be done already exist. But it is important for us to learn how to produce energy at various distances from the Earth's surface. To do so, we would have to create energy in various frequency ranges. Of course, we must be very careful with climate control; otherwise we might overdo it. After all, in principle the Earth is not so poorly balanced.

Question: And, of course, would our exploration of the planets not continue as before?

Answer: Yes, most likely, basically with the help of automatons. It is extremely enticing to receive information about signs of life on one of the planets of the Solar System. And to establish the genetic code of this life. Here is what is especially interesting: If our genetic codes differ from theirs, then there are grounds for assuming that spontaneously evolved life must exist throughout the entire Universe, and then we would most probably not be alone. But if the code is the same as ours, this would really perplex people.

But all of these are hypotheses, guesses, and suppositions. The only thing that we can say something about with full confidence is that development of outer space will become a common matter of many of the world's countries. It is only through close cooperation among nations that mankind will be able to realize the bold dream of subjugating the Solar System.

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GEOPHYSICS, ASTRONOMY AND SPACE

SPACECRAFT CREW GROUND TRAINING DESCRIBED

Moscow ZEMLYA I VSELENNAYA in Russian No 2, 1978 pp 5-10

[Article by Twice-Awarded Hero of the Soviet Union, USSR Pilot-Cosmonaut, Candidate of Technical Sciences, A. G. Nikolayev: "Cosmonauts are Trained on Earth"]

[Text] All work requires training. But we distinguish the concept "cosmonaut training" from all similar concepts pertaining to other spheres of human activity.

Before solo flight, a pilot undergoes a check flight with an instructor aboard a trainer aircraft. The instructor could indicate the errors made, and the entire procedure could be repeated if necessary. Cosmonauts do not undergo training flights in space. A cosmonaut is sent on his flight into space (even the first time) straight from a ground trainer, without an instructor. He must perform the tasks foreseen by the flight program.

This is why special requirements are placed on cosmonaut training, on its forms, resources, and methods. All cosmonauts beginning with Yuriy Gagarin have invariably emphasized that flight success depends on the quality of flight training.

What sort of knowledge is needed by cosmonauts?

They must know how to control the spacecraft and make proper use of the craft's onboard service systems; they must be ready to test space equipment and conduct scientific research in outer space. Moreover, physicians must prepare the cosmonaut's body for the effects of the environment and the space flight factors.

Two basic stages are commonly distinguished in cosmonaut training--the stage of general space training, and the stage of space flight (immediate) training for flights.

In the first stage all cosmonauts of a given group are trained in accordance with a general program. They receive the necessary minimum of knowledge on the theoretical fundamentals of cosmonautics, and they study the structure of manned spacecraft and their onboard systems. During this time the cosmonauts undergo training flights aboard airplanes, make parachute jumps, and engage in general physical and special biomedical training.

The stage of general space training lasts about 2 years. In the second stage the cosmonauts undergo training as crewmembers in accordance with the concrete program for a forthcoming flight. This program is the same for two or three crews (the main crew and standby crews). Space flight training can proceed in parallel in accordance with several programs of forthcoming flights; as an example this is the way training was performed in the Salyut and the Soyuz-Apollo programs in 1975.

During immediate flight training cosmonauts study the spacecraft they are to fly, its onboard systems, scientific equipment, and the flight program. They must learn to control the spacecraft and all of its systems, achieve efficient interaction among the crewmembers in flight, and achieve interaction of the crew with flight control and support groups.

Even a brief description of the basic subdivisions of training can provide an impression of the complexity of the cosmonaut training program.

Flight and parachute training is one of the basic subdivisions of cosmonaut training in both stages. It develops qualities in the cosmonauts necessary for space flights--efficient thinking and emotional stability, and psychological preparedness for the complex conditions of the flight.

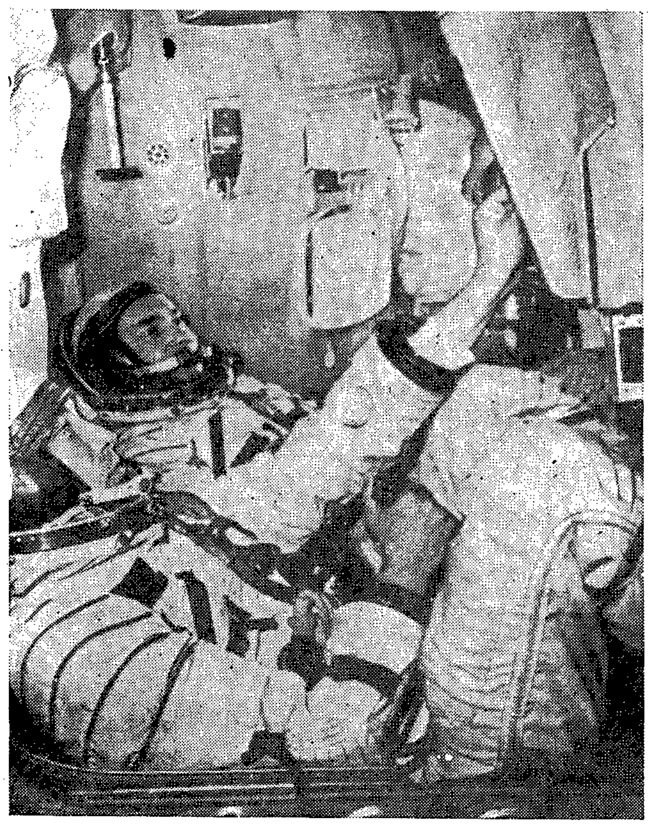
During flight training the future cosmonauts assimilate and improve airplane piloting techniques, learn to orient themselves in space, engage in radio transmissions, and receive a possibility for estimating the situation and making a decision in the presence of a lack of time. Flight training heightens the resistance of the body to accelerations, weightlessness, noise, vibration, and so on.

Occupational knowledge, skills, and habits applicable to the concrete spaceflight program are very important. Technical training plays the main role here.

The cosmonauts study the structure of the spacecraft and the station and their systems, and the technical characteristics, principle of operation, and capabilities of the onboard service systems of the craft and station, and their scientific equipment. During technical training they must acquire firm knowledge and habits in the operation of the craft (station) in flight, they must learn how to assess the work of individual systems and the craft (station) as a whole from the standpoint of a test pilot, and they must master the methods of scientific research and experiments.

The forms of technical training are very diverse--lectures and seminars, independent study, and cosmonaut participation in tests on individual systems and in integrated tests of the craft (station) at the manufacturing enterprises and at the spaceport.

Twice-Awarded Hero of the Soviet Union, USSR Pilot-Cosmonaut V. A. Shatalov masters weightlessness.



Hero of the Soviet Union, USSR Pilot-Cosmonaut V. V. Aksenov and Twice-Awarded Hero of the Soviet Union, USSR Pilot-Cosmonaut V. F. Bykovskiy undergoing training in an integrated trainer.

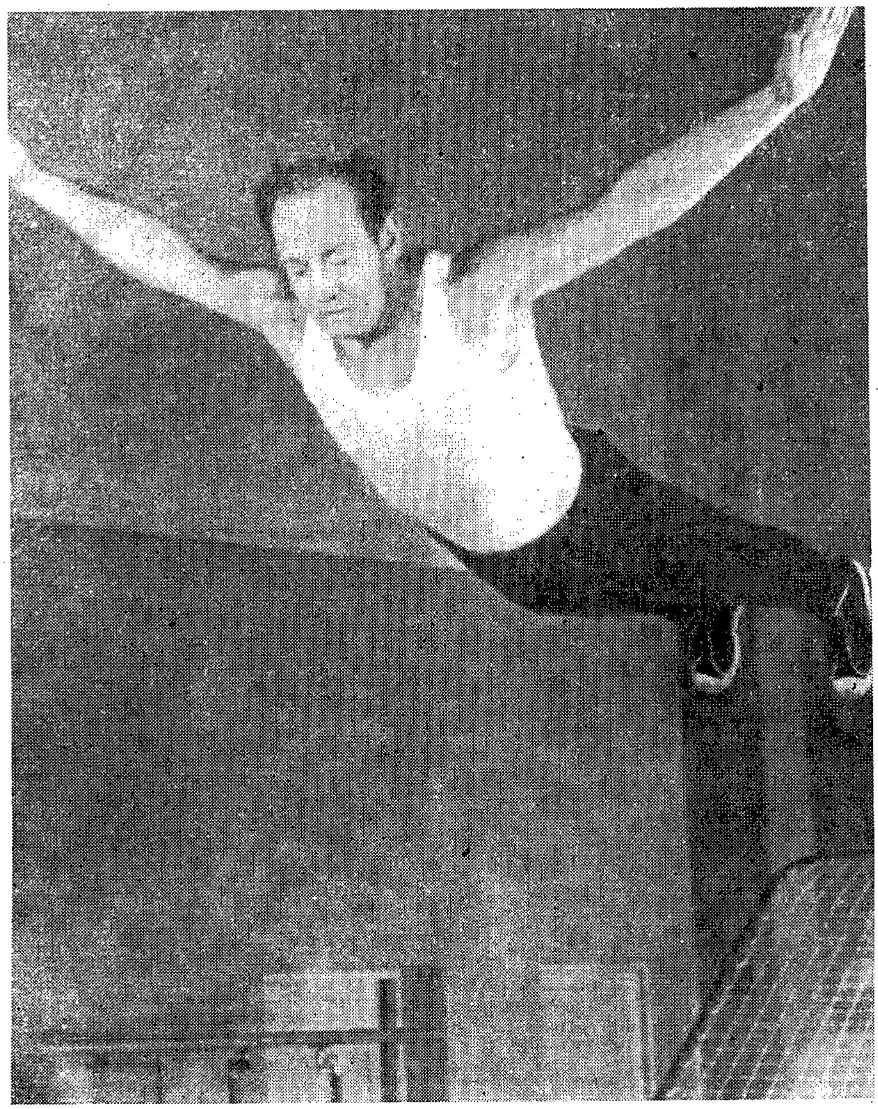
Twice-Awarded Hero of the Soviet Union, USSR Pilot-Cosmonaut G. T. Beregovoy and Hero of the Soviet Union, USSR Pilot-Cosmonaut V. D. Zudov study the flight program.

During the tests the cosmonauts not only study the structure and principles of operation of the craft's systems more deeply and thoroughly, but they also frequently make significant proposals concerning improvement of the craft, especially in terms of the layout of equipment in manned compartments.

Training in specialized and integrated trainers is the most important way to prepare cosmonauts for the flight program. Specialized trainers are used for the most complex and critical operations--docking, orientation, and navigation. The appropriate system and its operation are fully simulated in these trainers. An integrated spacecraft trainer is the principal ground crew training resource. It permits the crew to work out the operations in all of the principal flight phases--prelaunch preparations, assumption of orbit, orbital flight, orbit correction (maneuver), approach, mooring and docking, and re-entry from orbit.

Cosmonauts V. V. Aksenov and V. F. Bykovskiy work with the MKF-6 still camera in the laboratory.

All independent operations are performed in their real sequence in an integrated trainer. Interaction of the crewmembers among each other and with the Flight Control Center has an important place. During training with the integrated trainer, the crew learns to inspect and check the craft's equipment, monitor the initial state and correctness of the work of systems, and control the craft during orientation upon the Earth and the Sun, maneuvers in orbit, and orbit corrections. The cosmonauts must learn to install and remove interchangeable equipment, they must know how to reveal and correct faults in the craft's systems, and the crew's actions in response to emergency situations must be practiced.

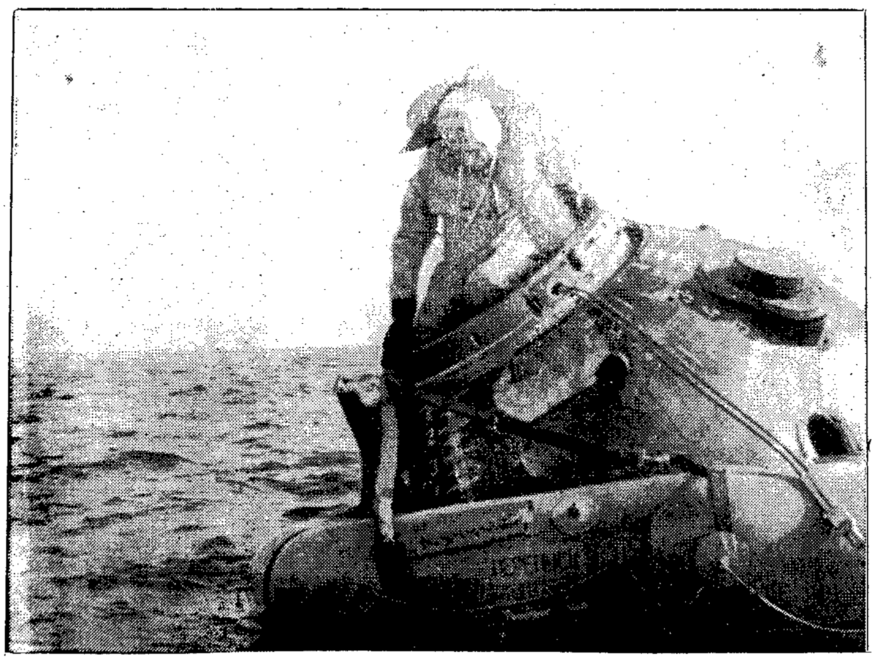


Twice-Awarded Hero of the Soviet Union, USSR Pilot-Cosmonaut A. A. Leonov exercises on a trampoline.

Training cannot be limited to a trainer or a test stand in relation to some subdivisions of the training program. These subdivisions require theoretical lessons and practical work with operating apparatus and instruments (duplicates of onboard equipment) both in training laboratories, at industrial enterprises, and in institutions of the USSR Academy of Sciences and other departments on one hand, and during flights aboard airplanes on the other.

These subdivisions include preparation for the conduct of scientific, technical, and biomedical experiments and studies.

Cosmonauts must know how to abandon their craft quickly after landing on water.

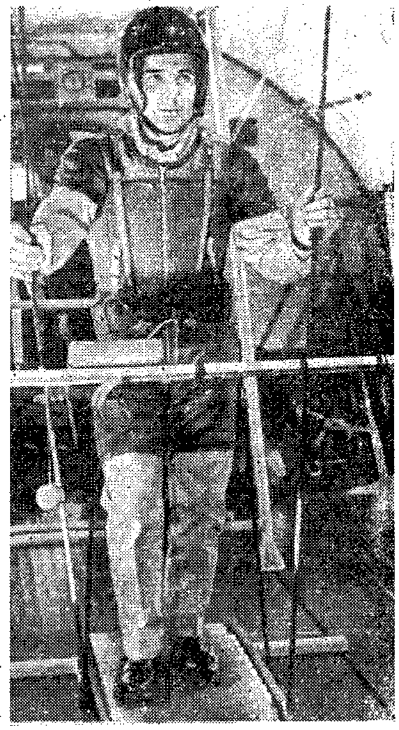


Motion picture and still photography training provides the cosmonauts with knowledge on the fundamentals of photography and photographic apparatus. Without it, the cosmonauts could hardly complete the program of onboard motion picture and still photography.

Space navigation training foresees, in addition to acquiring firm theoretical knowledge, development of the skills and habits of solving navigational problems with the assistance of onboard navigational measuring instruments and onboard computers. The flights aboard airborne laboratories are broadly employed in navigational training to solve practical problems of navigation making use of real onboard apparatus and real stars.

Participation of the cosmonauts in tests and research heightens their professional level as broadly specialized space equipment testers and scientists. Participation in research and in ground, marine, and flight (aboard airplanes and helicopters) tests of space equipment broadens and deepens the knowledge of the cosmonauts in different areas of space science and technology, produces a creative understanding of the physics of the processes and phenomena occurring, and promotes deep analysis of the methodological principles of the tests.

Twice-Awarded Hero of the Soviet Union, USSR Pilot-Cosmonaut P. I. Klimuk runs on a treadmill in an airborne laboratory.



Twice-Awarded Hero of the Soviet Union, USSR Pilot-Cosmonaut A. A. Leonov in the rotating chair.

Study of onboard and flight documents is an inseparable part of cosmonaut training, organically associated with their participation in tests of space equipment. During this training the crew acquaints itself with the content and structure of the documents and the format in which information is presented within them. Work with documents permits the cosmonauts to also improve the way the material is presented and its content.

Training in a water environment helps the cosmonauts to study the unique features of performing simple and complex operations in weightless conditions. Zero bouyancy is imparted to the cosmonaut and to objects with which he works during training under water. Assembly-disassembly operations and the operations of transporting loads within the spacecraft and outside it are what are basically practiced here.

High-altitude training is conducted so that the cosmonauts could acquire the habits of working in pressure suits (rescue suits and those intended for extravehicular activity). The training is conducted in special pressure chambers which simulate high altitude--that is, create lower air pressure. Airlock operation, transfer, extravehicular activity, and transportation of loads are practiced. The way the cosmonauts react to presence in a pressure suit is assessed at this time as well.

Training aboard airplanes--airborne laboratories--develops the cosmonaut's habits of sensibly organizing his activity in weightless conditions. The methods for using various scientific equipment and the procedures of self-orientation while performing operations away from the cosmonaut's work chair are practiced in such training.

Training in a centrifuge helps the cosmonauts to reinforce the habits of doing the work of an operator in flight phases such as assumption of orbit and re-entry, when high accelerations are present. In addition to developing operator qualities, this training has the purpose of determining how well the cosmonauts can endure accelerations.

Training in various climatic and geographic conditions makes the cosmonauts ready for action in any complex conditions when their craft lands in an unplanned area.

Crew biomedical training is conducted in this stage of immediate flight training with the same goal as in the stage of general space training; in this case however it corresponds in volume and content completely with the program for the forthcoming flight.

In the concluding stage of crew training related to a concrete flight program, integrated training is provided to all crews (main and standby). Use is made of an integrated trainer in which the crew performs the basic operations of the flight program, and of a training command post simulating the work of all ground flight control and support resources. In this training, the crew practices the flight program and interaction with the Flight Control Center and other ground services in a real time scale. Various cases and contingency (unplanned) situations are "played out" here, making it possible for the cosmonauts to practice making decisions in a complicated or emergency situation.

Cosmonaut training is a complex multilevel process directed at making the crew of a spacecraft or station capable of effectively solving problems in space flight.

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GEOPHYSICS, ASTRONOMY AND SPACE

'INMARSAT' ROLE IN MARITIME COMMUNICATIONS AND NAVIGATION DISCUSSED

Moscow RADIO in Russian No 4 Apr 78 pp 15-16a

[Interview with Yuriy Sergeyevich Atserov, president of the All-Union Association "Morsvyazsputnik" of the USSR Merchant Marine Ministry, on 12 April 1978, place not given, by correspondent L. Vilenchik: "Sailors Cooperate in Space"]

> [Text] Our nation is playing an active role in the work of various international organizations, the activity of which is connected with resolving the global problem of developing space and the world's oceans. A new international system of maritime communications and radio navigation -- "Inmarsat" -- is currently being created. RADIO magazine reporter, L. Vilenchik asked the president of the All-Union Association "Morsvyazsputnik" of the USSR Merchant Marine Ministry, Yuriy Sergeyevich Atserov, to discuss this system.

[Question] Comparatively recently, alongside the widely known international organizations "Intersputnik" and "Interkosmos" yet another "space" title, "Inmarsat", appeared. What does it stand for?

[Answer] "Inmarsat" - the International Maritime Satellite - is the designator for an international organization whose objective is the creation of an international satellite system for maritime communications and radio navigation. Existing communications systems at the present time do not allow for the handling of round the clock communications with ships at any point on the world's oceans. It is especially difficult, for example, for several European countries' ships while they are sailing in the Atlantic Ocean off the coasts of Central and South America, and in the southern part of the Indian Ocean. Communications outages with such ships on the average run 6 - 8 hours, and sometime last all day.

It is totally obvious that under present day conditions to effectively control the merchant fleet uninterrupted communications with the ships regard-less of where they are located is essential. For their own part, the ships should have the capability at any time to transmit necessary information to their consigners and consignees. Today such communications can be accomplished most expeditiously with the assistance of artificial earth satellites (ISZ). In addition, the utilization of ISZ opens the way for the broad application of printing and high-speed, as well as facsimile equipment while guaranteeing high transmission reliability for the information.

The necessity for creating an international communications satellite system is dictated by the international character of navigation itself and the need to collectively ensure the safety of ships sailing the seas. Continuous and rapid satellite communications will make ship navigation significantly safer.

[Question] What is the role of the USSR in this newly created "Inmarsat" organization?

[Answer] One of the leading roles in this organization belongs to our country. The USSR, for example, submitted the document, "Exemplary Principles For the Creation and Operation of the International Organization on Maritime Satellite Communications and Radio Direction Finding" for consideration by the special-purpose institute OON (Inter-governmental Maritime Advisory Organization). At the present time, a preliminary committee has been formed with the task of researching information for standardizing "Inmarsat" activities, as well as the selection of technical-economic parameters for the communications satellite system which will provide the basis for the future development of the satellite. "Inmarsat" will commence operations in 1980-1981.

[Question] What are the organizational and technical essentials for the construction of an international maritime communications satellite system?

[Answer] As presently defined, the maritime communications satellite system encompasses the Pacific, Atlantic and Indian Oceans along a belt between 70 degrees north to 70 degrees south latitude. During the initial stage, a single satellite will be placed in geosynchronous orbit over each ocean (see section 1 of the figure). The communications of the shore stations located in different countries will be carried out through these ISZ with transport, fishing and scientific research ships equipped with special apparatus, as well as with drilling rigs located at sea.

It is proposed that there be several shore communications satellite stations. Any ship will be able to communicate with one of these stations (figure 2) through a satellite "visible" from on board the ship, and in addition will be able to establish communications through normal international land channels with their own steamship company, base or any other subscriber. In so doing, the ship's radio operator will select that shore station which is closer to the subscriber.

In the "Inmarsat" system, the utilization of telephone communications channels is envisaged. The satellites' retransmitters will each have several trunklines with a capacity of 40 - 50 telephone channels each. The largest number of trunklines (approximately 4 -5) is projected for the ISZ over the Atlantic Ocean. The telephone channels are combined into trunklines on the basis of the principle of frequency multiplexing, and the signals are transmitted in non-overlapping frequency bands using the method of narrow band frequency modulation. The maximum frequency deviation is approximately 12 khz, and the bandwidth occupied by a single channel is 27 khz.

Several telephone channels (22 telegraph channels may be transmitted in a single telephone channel) of a single trunkline may be separated out for telegraph channels. In so doing, the principle of time multiplexing is easily realized where telegraph signals are transmitted sequentially in "batches" of several samples each. In this manner, a cyclic structure, which is called a frame, is formed from the "batches" of impulses from the different telegraph channels. The frame duration in the "Inmarsat" system for ship-to-ISZ transmissions is about 1.8 seconds and for transmissions from ISZ to a shipborne station -- 0.3 seconds. A frame is subdivided into 22 spaces of 40 milliseconds each. The position of each such space is fixed and is separated from the others by a protective space. Within one working space it is possible to transmit approximately 100 telegraph samples with an error rate of 10^{-5}. In the process of communicating with a specific telegraph channel, the specific time interval within the frame is fixed.

[Question] It is known that the world's fleets number some 60,000 ships. Will the system under development be able to provide communications for such a huge number of ships?

[Answer] It will, considering that about 20,000 ships with a displacement of 283 cubic meters or greater are at sea at any one time. The multi-station access (MSD) relay system which is installed on the satellite serves this requirement. In this manner, a grouped signal consisting of the individual signals of designated subscribers is transmitted through the retransmitter.

The process for a ship to establish communications with its own steamship agency begins when on a separate special call-up channel there is placed a call-up signal consisting of a code combination containing the ship's call-sign, the number of the ocean region in which the ship is sailing, the number of the shore station being called, the number of the subscriber being called and the priority of the call. If this is an SOS distress signal, then it proceeds immediately.

After the ship's station, whose structural diagram is depicted in figure 3 of the enclosure, has sent the call-up signal, it receives a notification from the shore station that its call has been placed in queue. Furthermore, in telephone communications they are transmitted the carrier frequency, and for telegraph the time position of the transmission interval spacing within the frame. The average waiting time for communications on the system is one minute.

[Question] One of the primary tasks of the "Inmarsat" system is to increase navigation safety. How are distress signals transmitted in the system?

[Answer] As I already stated, SOS signals are transmitted at immediate precedence from the shipborne stations, and if there are no free channels the communications of any subscriber are broken into.

In addition, a ship in distress will cast emergency buoys overboard. Automatic stations installed on them will transmit coded signals containing information concerning the ship's location, its callsign and nature of the emergency to the ISZ. These signals will proceed through a specially selected channel of the retransmitter. There is no doubt but what thanks to the "Inmarsat" system SOS signals will be received in tiem.

[Question] In which frequency band is the "Inmarsat" supposed to operate?

[Answer] Frequency bands in the 1.5 and 1.6 ghz range have been selected for operational radio traffic via maritime communications satellites. Communications between ships and ISZ will be accomplished on these frequencies, and for shore station communications with ISZ the frequency band in the 4 and 6, as well as 11 and 14 ghz range, has been selected.

[Question] Describe, please, the main technical characteristics for the antennae of the "Inmarsat" communications system.

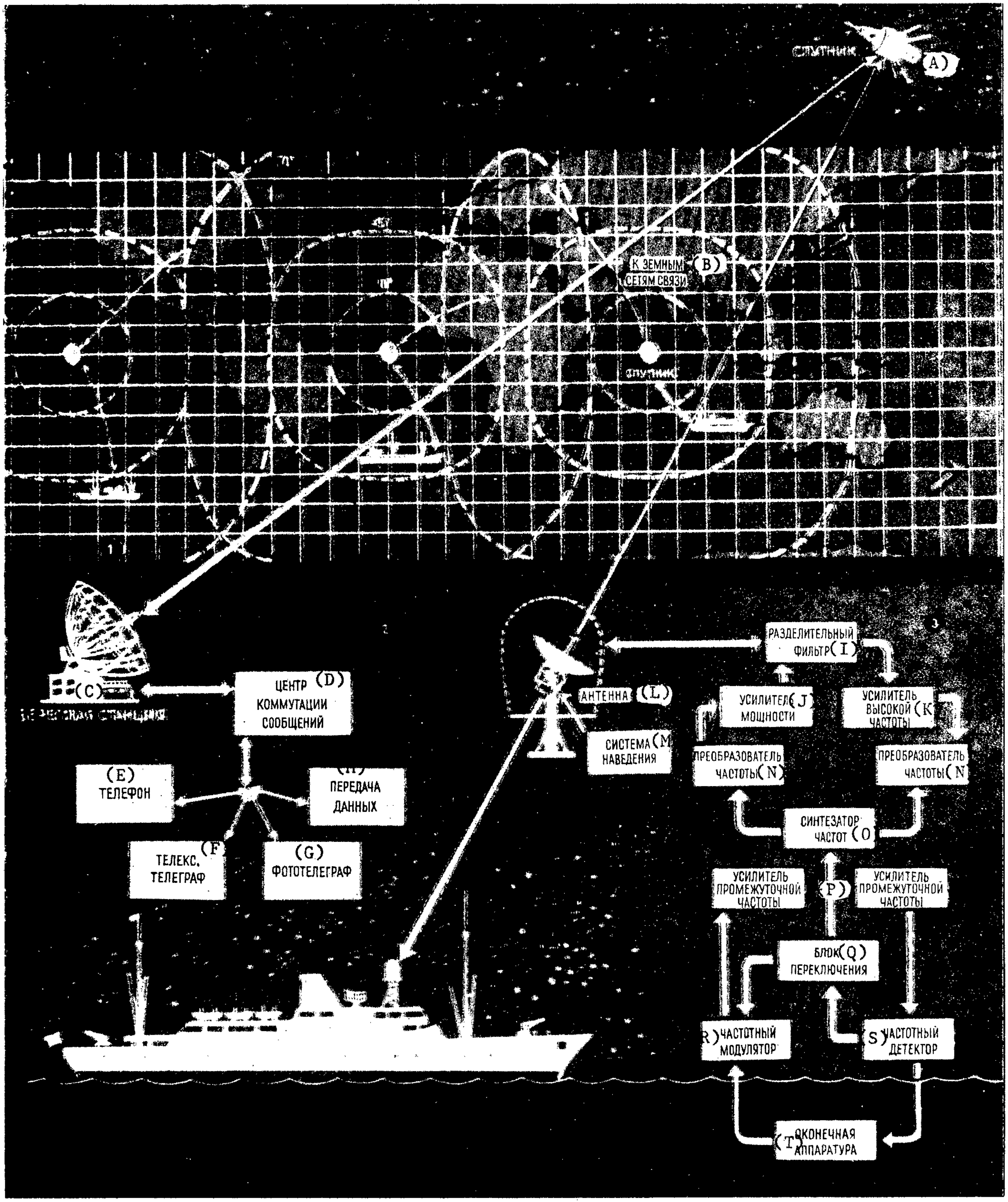
[Answer] Parabolic antennae, traditional for these bands, are being employed for both the shore and shipborne stations. The antenna diameter of a shore station is 12 meters, its gain is on the order of 50 db, beam width pattern is 1 degree and radiated power is 1 kw. The shipborne antenna is one tenth the size. Its diameter is 1.2 meters, gain in 23 db, beam width pattern is 10 - 11 degrees and the radiated power is approximately 40 watts.

The satellite retransmitter antenna is a complex device. It provides practically omni-directional transmission and reception of the signals of ships located within the bounds of their zone as shown in figure one, and at the same time forms narrow beams directed to the shore stations.

[Question] Up til now our conversation has concerned the application of satellites for communications. How will they be utilized for navigation?

[Answer] As experience operating the satellite system has shown, their application is extremely promising for navigation. In similar systems the parameters of the mutual position of the satellite and ship are measured.

In view of the fact that the "Inmarsat" ISZ system is destined to be placed in geosynchronous orbit, the so-called differential distance measuring method


СПУТНИК
A)
К ЗЕМНЫМ СЕТЯМ СВЯЗИ
(B)
(C)
ЦЕНТР (D) КОММУТАЦИИ СООБЩЕНИЙ
(E) ТЕЛЕФОН
(H) ПЕРЕДАЧА ДАННЫХ
ТЕЛЕКС, ТЕЛЕГРАФ (F)
(G) ФОТОТЕЛЕГРАФ
АНТЕННА (L)
СИСТЕМА НАВЕДЕНИЯ (M)
РАЗДЕЛИТЕЛЬНЫЙ ФИЛЬТР (I)
УСИЛИТЕЛЬ МОЩНОСТИ (J)
УСИЛИТЕЛЬ ВЫСОКОЙ ЧАСТОТЫ (K)
ПРЕОБРАЗОВАТЕЛЬ ЧАСТОТЫ (N)
ПРЕОБРАЗОВАТЕЛЬ ЧАСТОТЫ (N)
СИНТЕЗАТОР ЧАСТОТ (O)
УСИЛИТЕЛЬ ПРОМЕЖУТОЧНОЙ ЧАСТОТЫ
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УСИЛИТЕЛЬ ПРОМЕЖУТОЧНОЙ ЧАСТОТЫ
БЛОК (Q) ПЕРЕКЛЮЧЕНИЯ
R) ЧАСТОТНЫЙ МОДУЛЯТОР
S) ЧАСТОТНЫЙ ДЕТЕКТОР
(T) ОКОНЕЧНАЯ АППАРАТУРА

will be used for navigational purposes. However, the practical solution of the problems associated with navigation is envisioned for phase two following completion of the work involved in creating the communications system.

Figure 1. Geosynchronous "Inmarsat" Satellite Placement

Key:
- A. Satellite
- B. To Ground Communications Net

Figure 2. Shore Station Functions

Key:
- C. Shore station
- D. Traffic switching center
- E. Telephone
- F. Telex-telegraph
- G. Facsimile
- H. Data transmission

Figure 3. Shipborne Station Diagram

Key:
- I. Distribution filter
- J. Power amplifier
- K. High frequency amplifier
- L. Antenna
- M. Guidance system
- N. Frequency inverter
- O. Frequency synthesizer
- P. Intermediate frequency amplifier
- Q. Switching assembly
- R. Frequency modulator
- S. Frequency detector
- T. Terminal equipment

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PHYSICS AND MATHEMATICS

LASER APPLICATIONS DISCUSSED

Moscow SOVETSKAYA ROSSIYA in Russian 4 May 1978 p 4

[Article by V. Torgaev: "The Mission of the Laser Beam"]

[Text] Science and technology have long valued the merits of lasers. Nowadays, in many industries, lasers are replacing highly-qualified welders and inspectors. The light pulse drills the most precise holes in superhard materials and cuts fabric.

The laser beam has become not only a scalpel in the hands of a surgeon or stomatologist but even a therapeutist's tool. The ability of a coherent (narrowly directed) laser beam to create a three-dimensional image on a multi-layered X-ray film allows it a diagnostic capability.

In the development of microscopy, which began with the simple lenticular microscopy, the laser has also done its bit. Laser projection microscope systems created in latter years, which allow the possibility of looking at a specimen directly upon a large screen, are finding wider and wider application.

One of these systems created by the scientists of the USSR Academy of Sciences Physics Institute imeni P.N. Lebedev (FIAN), allows the possibility, with the aid of laser amplification, of increasing image clarity many times without raising the target illumination. This is very important in many investigations, especially in medicine and biology.

Among the numerous scientific fields opened up by the laser, great attention is being directed to its use in communications technology and television. These expectations, above all, are coupled with the appearance in latter years of low-loss glass filament light guides. Along such a thin glass conductor, it is possible to simultaneously transmit tens of television programs and hundreds of telephone conversations.

Scientists of the Physics Institute created a televised image transmission system with the help of a laser beam, where image signals are transmitted along a glass filament of but 0.15 mm thickness.

Besides that, they proposed to replace the usual picture tube with a picture tube with a laser screen without changing the television layout. This screen is a raised, machined, for the most part thin, monocrystalline semiconductor plate. The directed electron beam running across its surface, one line after another as in the picture tube of the ordinary television, creates a luminous image. At the same time, the radiation intensity of the semiconductor screen, measuring one square centimeter, is so great that the image can be projected on a movie screen with an area of several square meters! Applying plates of various materials, one can get radiation of any color and the combination on the screen of the "pictures" of the primary colors gives an excellent color image.

It is known that nuclear fusion may become one of the most promising sources of energy. Scientists of many countries of the world are trying to "tame" this reaction.

One trend in this direction is work toward utilization of laser energy for these purposes. This research is also being carried out at FIAN. There was created here a unique laser device "Delfin" in which 54 laser beams, with a total energy of about 5000 joules, are focused, in a vacuum chamber, upon a special deuterium-tritium target. These laser beams must simultaneously create a very short and powerful light pulse with a duration of about a millionth of a second. It is reputed that the power of this flash exceeds the power of all the electric power generating stations in the world...

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CONFERENCE OF INTERKOSMOS PROGRAM EXECUTIVES

Moscow ZEMLYA I VSELENNAYA in Russian No 2, 1978 pp 75-77

[Article by Ye. F. Chugunov, Corresponding Secretary, Interkosmos Council, USSR Academy of Sciences]

[Text] A routine conference of the executives of national coordinating agencies of countries participating in the Interkosmos program was held from 9 to 15 August 1977 at the capital of the Mongolian Peoples Republic, Ulan-Bator. Representatives of Bulgaria, Hungary, GDR, Cuba, Mongolia, Poland, Romania, USSR, and Czechoslovakia participated in the conference. The Soviet delegation was headed by Academician B. N. Petrov, chairman of the Interkosmos Council of the USSR Academy of Sciences.

The conference participants noted with satisfaction that the intergovernmental Treaty on Cooperation in Exploration and Use of Outer Space for Peaceful Purposes, signed in Moscow on 13 July 1976 by representatives of nine socialist countries participating in the Interkosmos program and representing a new stage in scientific-technical cooperation, went into effect on 25 March 1977.

The treaty will promote successful conduct of new joint research and experiments as well as more-effective use of the obtained results. This important document makes official, at the governmental level, the agreement of participants of the Interkosmos program to work together in every way to develop cooperation in exploration and use of outer space.

The conference participants heard reports from permanent working groups concerning joint research and experiments conducted in the last 2 years (ZEMLYA I VSESENNAYA, No 3, 1976, pp 28-37; No 6, 1976, pp 86-92; No 6, 1977, pp 23-29--*editor*).

In September 1976 the USSR launched the Soyuz-22 manned spacecraft carrying the MKF-6 multizonal still camera developed by specialists of the GDR and the USSR and manufactured in the GDR (ZEMLYA I VSELENNAYA, No 2, 1977, pp 10-15--*editor*). Satellites in the Interkosmos series continued to be launched successfully.

In June 1976 the Unified Telemetric System was tested aboard the automatic general-purpose orbiting station. Its purpose is to receive scientific information from satellites in the Interkosmos program at ground stations of the socialist countries. The Interkosmos-16 artificial Earth satellite was launched into near Earth orbit in July 1976 to study ultraviolet radiation from the Sun.

In October 1976 the Vertikal'-4 geophysical rocket analyzed the atmosphere and the ionosphere and studied interaction between solar shortwave radiation and the Earth's atmosphere.

Remote probing of the Earth's surface by means of airplane-carried laboratories was performed in Bulgaria, the GDR, and Poland. In May 1976 a spectrometer-interferometer developed by the GDR and intended for remote probing of the atmosphere was tested aboard the Meteor meteorological satellite. These experiments were continued successfully in June 1977 aboard the next Meteor artificial Earth satellite.

Integrated biomedical research on the influence of the factors of prolonged space flight on various organisms was conducted in December 1975 (Kosmos-782) and in August 1977 (Kosmos-936). Biological objects from the USSR, Czechoslovakia, and a number of other countries were aboard the satellites.

Meteorological rockets are regularly launched to study the parameters of the atmosphere's higher layers. Specialists from socialist countries participated in these launchings.

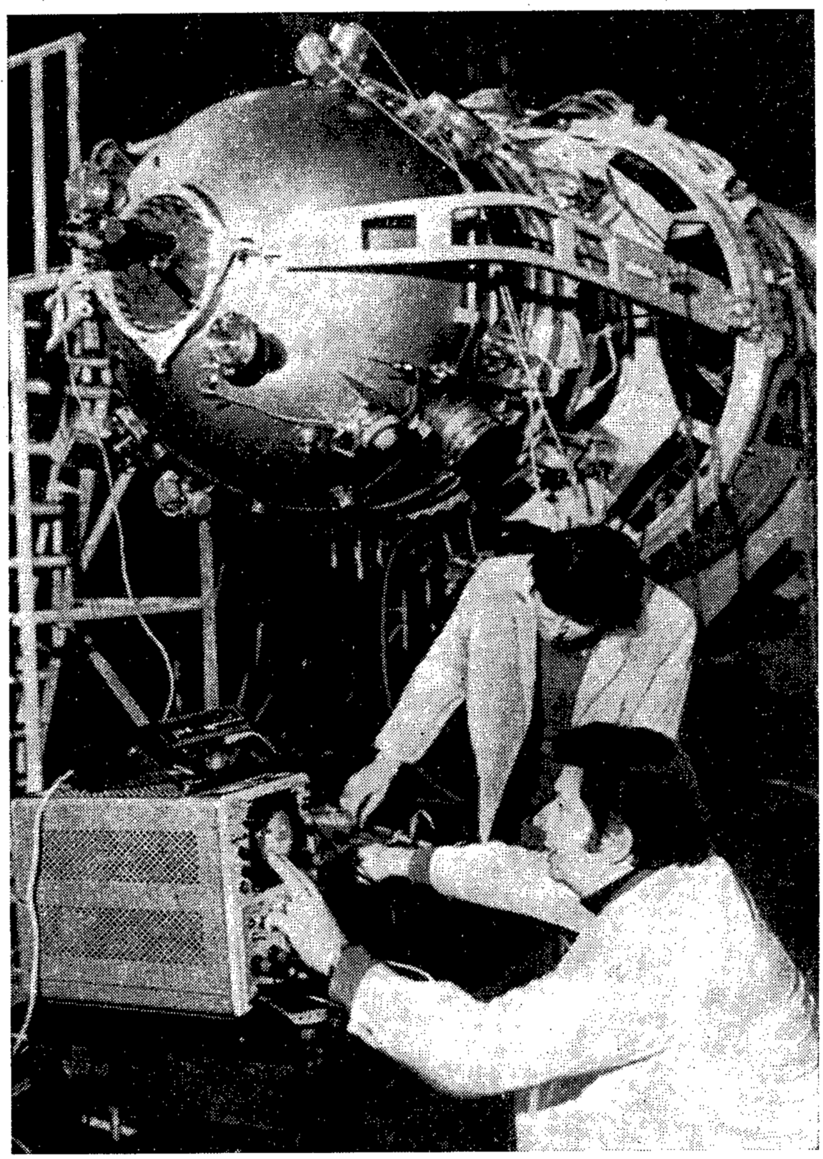
Treatment and analysis of scientific information obtained from spacecraft launched earlier is continuing.

The conference participants approved the reports of all five working groups--on space physics, space meteorology, space biology and medicine, space communication, and remote probing of the Earth using aerospace resources. The important scientific and applied nature of the joint projects completed was noted.

Much attention was devoted during the conference to the new problems of joint research. Catalogs of the basic directions of cooperation within the framework of the Interkosmos program being prepared for 1981-1985 will be used to develop concrete plans and programs of joint research and experiments. The conference approved the order of preparation of the catalogs and instructed the chairmen of the working groups (sections) to complete this work.

Recommendations on the order of national and international registration of objects in space, developed and manufactured in countries participating in the Interkosmos program and launched as part of this program were examined and adopted. Such recommendations are very important. The fact is that the Convention on Registration of Objects Launched Into Outer Space went into effect on 15 September 1976.

This convention foresaw mandatory national registration of space objects launched into Earth orbit or into outer space.



Scientific apparatus installed aboard the Vertikal'-6 geophysical rocket is being tested by Bulgarian specialists S. Chapkynov and Z. Tsvetkov.

The countries must submit information concerning launched space objects to the UN Secretary-General. This information, which includes the name of the country, the name of the object, the launch date and place, the purpose of the object, and the basic parameters of its orbit, is entered into a special register.

If the space object is launched into orbit by two or several countries, the latter jointly determine which of these countries will register the given object.

Prior to the time that the convention went into effect, countries reported information concerning their space objects to the United Nations only periodically on a voluntary basis. Satellites in the Interkosmos series launched from the territory of the USSR had been registered earlier only by the Soviet Union. The conference participants agreed to retain this order only in regard to space objects developed and manufactured in the USSR. Objects created in other countries participating in the Interkosmos program must be registered by the appropriate countries, which will promote an increase in their role and authority in the international "space community."

A collection of scientific articles, "Po programme 'Interkosmos'" (The "Interkosmos" Program) prepared by scientists and specialists in socialist countries was published at the end of 1976. The book contains the basic scientific results of 10 years of cooperation in space exploration. The conference participants felt it suitable to publish scientific data acquired through space research in the future.

Participation of civilians from socialist countries in joint flight aboard Soviet spacecraft and orbiting stations is an important step in development of the Interkosmos program. The first group of future cosmonauts from Czechoslovakia, Poland, and the GDR have been undergoing training for the flight at the Soviet Cosmonaut Training Center imeni Yu. A. Gagarin since December 1976. Delegates attending the conference listened to Academician B. N. Petrov's report on the successful progress of this training with great interest. It was noted at the conference that cosmonaut candidates are being selected and subjected to initial training in other countries participating in the Interkosmos program as well.

Delegates from the participating countries discussed the immediate plans of joint work and the program of experiments in outer space, as well as a number of scientific organizational problems of general interest.

The work of the conference proceeded in an atmosphere of friendship and complete mutual understanding. The next meeting of the executives of coordinating agencies will be held in 1978 in Poland.

At the conclusion of the conference the Soviet delegation held a reception for Zh. Batmunkh, a member of the Politburo of the Mongolian Peoples Republic Party Central Committee and chairman of the Mongolian Peoples Republic Council of Ministers. The problems in further development of scientific cooperation and participation of Mongolia in the Interkosmos program were discussed during the meeting.

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COUNCIL ON COORDINATION OF SOVIET SCIENTIFIC ACTIVITIES MEETS

Kiev PRAVDA UKRAINY in Russian 20 May 78 p 2

/Article: "In the Main Directions of Scientific Exploration"/

/Text/ On 18 May in Kiev there was a meeting of the 35th session of the Council on Coordination of Scientific Activity of the Academies of Sciences of the Union Republics of the presidium of the USSR Academy of Sciences. Participating in its work were members of the presidium of the USSR Academy of Sciences, presidents and vice-presidents of the republic academies of sciences, leaders of scientific centers and branches of the USSR Academy of Sciences, and leading Soviet scientists.

In his introductory address the president of the USSR Academy of Sciences Academician A. P. Aleksandrov, who opened this meeting of the session, characterized the tasks of Soviet scientists for the near and distant future and the key economic problems for which Soviet science is called upon to participate actively in finding solutions. Particular attention was paid to the development of the Soviet fuel and energy complex, a broad field for activity not only of institutions of the USSR Academy of Sciences, but of republic academies of sciences as well.

An expanded program of activities for scientific collectives was noted in the directives and recommendations given by General Secretary of the CPSU Central Committee and Chairman of the Presidium of the USSR Supreme Soviet Comrade L. I. Brezhnev during his trip to the Siberian and Far East regions. The president of the USSR Academy of Sciences emphasized that the most important condition for the successful implementation of this program and the acceleration of the pace of scientific and technical progress is the further strengthening and development of the creative cooperation of scientists in all the union republics and the unification of the efforts of researchers working in the various branches of science.

The report "The Development of Scientific Research in the Academies of Sciences of the Union Republics and the Scientific Centers and Branches of the USSR Academy of Sciences Directed toward Strengthening the Mineral and

Raw Materials Base of the USSR" was presented by vice-president of the USSR Academy of Sciences Academician A. V. Sidorenko. He dwelled on the accomplishments of Soviet geological science, which embodies Lenin's precept concerning the necessity of systematically and consistently studying the natural riches of the USSR. The scientists of the academies of sciences of the union republics, centers, and branches, in close cooperation with the scientific institutions of the USSR Academy of Sciences, are working on a broad range of urgent problems and projects, the results of which are finding ever greater application in the national economy. A multitude of facts was cited revealing the great importance of geologic research in deepening our knowledge of the earth and in strengthening the mineral and raw materials base of the republics, of separate regions, and of the USSR as a whole. The fruitfulness of scientific exploration is witnessed by the creation in formerly undeveloped outlying areas of large-scale ferrous and nonferrous metallurgical enterprises, and by the opening of dozens and hundreds of deposits of various types of useful minerals. Note was made of the contribution of scientists of the Academy of Sciences of the Ukrainian SSR to creating a high-capacity raw materials potential in the European USSR.

The work of Soviet geologists, remarked the speaker, is widely known both in the USSR and abroad. The development of geological research has brought with it the creation of whole fields of investigation and schools which have made a substantial contribution to Soviet science. Cited as an example was the large contingent of petroleum scientists working in Azerbaijan. They have made a considerable contribution to the development of the scientific basis for the exploitation of oil and gas deposits and the development of a number of important principles for rational planning, and have produced original solutions which have been practically applied in the oil and gas extraction industry of that republic and of other areas of the USSR. In the academies of sciences of Armenia, Kazakhstan, and the Ukraine and in institutes of the Far East Scientific Center there have arisen schools of specialists in metallogeny who have developed the theoretical and scientific-methodological basis for compiling metallogenetic forecasting charts.

The report emphasized the great importance of the cooperation of academic institutions with organizations of the ministries of geology of the USSR and of the union republics and with collectives at VUZ's. Such close and businesslike ties were established, in particular, by the Academy of Sciences of the Ukrainian SSR, where there is successful implementation of a new form of multifaceted creative cooperation--comprehensive programs for special purposes. The successful development of geological research for developing the mineral and raw materials base has been conducted jointly by the academies of sciences of the Ukraine, Belorussia, and Moldavia according to a plan of coordination.

Having dwelled on the prospects for the development of geological science in the academies of sciences of the union republics and in branches and scientific centers of the USSR Academy of Sciences, the speaker indicated that these institutions are bound by necessity to solve a whole range of essential problems in geology. Among the most urgent tasks is the study of geologic structures and the laws of formation and distribution of useful minerals in the territory of a republic or of another region. There was also discussion of the specific problems caused by features of one or another region, along with its prospects for exploiting individual types of useful minerals or its economic construction objectives.

The guarantee for the successful implementation of this broad program is the further strengthening of the material base of scientific institutions. All measures must be taken to expand the laboratory bases of institutes and to equip them with modern apparatus, and most importantly--to strengthen scientific personnel. Particular attention must be paid to the training of more highly skilled personnel in the leading geological organizations of the USSR. The chief emphasis of our work as required by the resolutions of the 25th CPSU congress, concluded A. V. Sidorenko, must be placed on raising the effectiveness of scientific research and increasing its contribution to strengthening the mineral and raw materials base for the USSR.

Participants at the meetings heard the report of the president of the Academy of Sciences of the Ukrainian SSR Academician B. Ye. Paton, which was devoted to research in materials science in the Academy. He noted that there has been especially intensive development of theoretical and applied materials science in the last 10 to 15 years as a result of the expansion of existing and the creation of new research institutes specializing in materials science in the Academy of Sciences system, and the improvement of the scientific and organizational structure of the management and, in particular, of the organization of scientific centers in various regions of the republic.

Today in the Academy of Sciences of the Ukrainian SSR, universally recognized scientific schools are in operation for welders and electrometallurgists, and research in successfully being conducted on various problems of solid state chemistry and physics, applied materials science, and new methods for extracting and exploiting metallic minerals. Inspired by the resolutions of the 25th CPSU congress and by the high value placed on the activities of the Academy of Sciences of the Ukrainian SSR by Comrade L. I. Brezhnev in a meeting with the leaders of the academies of sciences of socialist countries, scientists of the republic are striving to multiply their contribution to increasing the effectiveness of scientific exploration and are steadfastly working on the creation of new and advanced materials and the technologies for producing them.

The report covered in detail the work of materials scientists in various fields and the introduction of the results of their research into practice. It emphasized the tremendous significance of the creative cooperation of scientists and production specialists. It was by their joint efforts that a start was made in a new branch of metallurgical production--special electrometallurgy.

Among the developments recounted in the report were the production of a new cheaper construction material, high-strength cast iron, which is not inferior in its properties to carbon steel, the synthesis of extremely hard materials at high pressures, the initiation of the production of refractory metals and alloys, materials for power engineering, and multilayer pipe for main gas and oil pipelines, new methods for producing and applying protective coatings, and many others. Considerable success has been achieved in the development of equipment and materials for welding and in the automation of welding processes. This is of fundamental importance for the transition of this production to a qualitatively new technical level. Not far off is the time when tens of thousands of welders will be freed of monotonous and difficult work and when control systems based on computer equipment will make it possible to automate a multitude of technological operations.

Much highly important research is being conducted by materials scientists of the Ukraine in cooperation with scientific collectives from other union republics. Fruitful ties are maintained with colleagues at many scientific centers and enterprises of the USSR by the Institute of Electric Welding imeni Ye. O. Paton and by institutes of problems in materials science, institutes of extremely hard materials, institutes of problems in casting, and by other institutions of the Academy of Sciences of the Ukrainian SSR.

The 25th CPSU congress, remarked B. Ye. Paton, set a most important task--increasing the efficiency and quality of production. The task applies as well to producers of materials which are the basis for machines, mechanisms, and structures, space and nuclear technology, and domestic appliances and equipment. This is why in the near future there is to be a broadening of programs for materials science in the Ukrainian Academy of Sciences, in addition to a strengthening of the material and technical base for institutes in this specialty and the creation of new laboratories and scientific fields. There will be further development of research in solid state physics and chemistry, the aim of which is to produce new materials with special physical properties. As a necessary condition for successfully carrying out expanded tasks, the desire was expressed in the report that an interdepartmental (inter-republic) center for metallurgical materials be organized under the Academy of Sciences of the Ukrainian SSR. The center would be charged with coordinating the joint activities of the materials science institutions of the USSR Academy of Sciences and the union republics and with insuring the rapid introduction of completed research into practice.

Vice-president of the USSR Academy of Sciences Academician V. A. Kotel'nikov devoted his report to the creation of national centers for the use of unique experimental devices and equipment of the USSR Academy of Sciences and the academies of sciences of the union republics. Having remarked on the great significance of the use of large and complex modern devices and instruments for the development of science, he emphasized the importance of their collective use. In particular, he spoke of the unique telescope in the astrophysical observatory in the northern Caucasus, on which work is performed not only by members of the observatory but also by scientists from other Soviet institutions, as well as by foreign explorers of the universe.

Such examples were also cited from other branches of sciences, including nuclear physics. The speaker pointed out the necessity of utilizing more fully the large nuclear reactors available in the USSR and defended the idea of creating a joint research center of the Academy of Sciences of the Ukrainian SSR based on the U-240 accelerator and a number of others. Among the innovations which would serve a wide circle of scientific institutions and which would aid in solving highly important problems in various fields of modern science were named a unique electron microscope with a power of one million electron-volts, and advanced magnetic devices.

The effectiveness of the concentration of scientific apparatus and instruments is confirmed by results of the work of the spectroscopic center founded five years ago at the Academy of Sciences of the Belorussian SSR. It is now used by dozens of scientific research institutes and VUZ's of Belorussia and institutions of other republics. Speaking of the advisability of creating such research centers, the speaker noted that not only would there be a greater return from the use of the scientific apparatus, but scientists from various institutions would be able to exchange accumulated experience more fully and effectively.

Participants in discussions of the reports included the chairman of the presidium of the Kola branch of the USSR Academy of Sciences G. I. Gorbunov, the president of the Academy of Sciences of the Azerbaijan SSR G. M. Abdullayey, the vice-president of the Academy of Sciences of the Kirgiz SSR M. M. Adyshev, the first deputy chairman of the presidium of the Urals Scientific Center of the Academy of Sciences of the Belorussian SSR N. A. Borisevich, and the president of the Academy of Sciences of the Armenian SSR V. A. Ambartsumyan.

Resolutions were adopted based on the topics examined.

Taking part in this meeting of the session were Politburo member and secretary of the Central Committee of the Communist Party of the Ukraine A. A. Titarenko, chief of the Department of Science and Educational Institutions of the CPSU Central Committee S. P. Trapeznikov, deputy chairman of the Council of Ministers of the Ukrainian SSR I. P. Kochevykh, deputy chairman of the State Committee of the USSR Council of Ministers for science and technology S. M. Tikhomirov, and chief of the department of science and educational institutions of the Central Committee of the Communist Party of the Ukraine F. M. Rudich.

On 18 and 19 May the participants in the session visited a number of institutes of the Academy of Sciences of the Ukrainian SSR, the Central Republic Botanical Garden of the Academy of Sciences of the Ukrainian SSR, and the Central Museum of Natural Science of the Academy of Sciences of the Ukrainian SSR, and attended the Exhibition of Economic Achievements of the Ukrainian SSR.

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