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Chapter 4

Rocketry Personnel Training in the U.S.S.R., 1924-1936[1]

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In the late 1920s and early 1930s great attention was given in the Soviet Union to the study of interplanetary communication problems. Various working groups and teams were set up by enthusiasts of jet propulsion to discuss the possibilities of interplanetary flight and to develop the schematic diagrams of rockets and their engines. In addition, some scientists devoted much attention to determining optimal parameters of rocket engine combustion processes and to the estimation of the best ballistic paths.

To facilitate the further development of rocketry, senior leaders believed it necessary to centralize the study of jet propulsion on problems under government control. Therefore, it was expedient to train specialists capable of embracing a wide range of rocket flight problems: designers, engineers, and technicians to conduct theoretical and experimental investigations. The result was the creation of an aggressive rocketry training program for technical personnel beginning in the mid-1920s and its expansion during the rest of that decade in concert with the rapid scientific and engineering development in the Soviet Union.

Several significant Soviet scientists were involved in this process. Perhaps the most important among them was K. E. Tsiolkovsky, whose works originated the idea and skillfully and quickly converted most readers into ardent enthusiasts. Additionally, F.A. Tsander, whose theory and application showed the realization of jet propulsion problems, and who was instrumental in developing a viable personnel qualification pro-

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gram. Moreover, B. S. Stechkin, who outlined the principles of jet designing and development, was also involved. B. S. Zemsky, N. I. Dobrotvorsky, N. A. Zhuravchenko, V. P. Vetchinkin, and V. P. Glushko also made important contributions to the progress of rocketry. Among those who joined with this group were experienced organizers and outstanding scientists including V. P Kapersky, M. G. Serebryakov, M. J. Lapirov-Scoblo, M. A. Rezoumov, D. A. Grave, J. I. Perelman, E. O. Paton, N. A. Rynin, B. I. Sreznevsky, K. K. Seminsky, V. I. Shaposknikov, M. S. Belayev, G. A. Polevoy, Z. G. Pyatetsky, O. V. Kholtshev, and others. Without question, the first echelon of enthusiastic organizers of the personnel qualification system was highly impressive and worked hard to assure the success of the training program.

The complex system of training rocketry specialists underwent a number of changes with time. At first there appeared different groups, teams, and societies; papers and talks were given and exhibitions and conferences were held. These efforts made an invaluable contribution to the development and progress of the theory and application of rocketry. In the 1930s, rocketry personnel training was conducted under the auspices of the Central Council of the Osoaviakhim Society, training that became systematic and planned: Group for the Study of Jet Propulsion (GIRD) was established, which, in fact, became the first Soviet Higher School of Rocketry.

We should like to dwell first on the activities of the scientific communities which were engaged in jet propulsion prior to the establishment of the institute. The first conspicuous steps were made in 1924, when, at the January session of the theoretical section of the Moscow Society of Amateur Astronomers, F. A. Tsander gave a paper "On Spacecraft Design and Flights to Other Planets." In this lecture he suggested the establishment of a "Society for the investigation of interplanetary communication."

A few months later, in April 1924, in response to Tsander's recommendation, a "Section of Interplanetary Communication" was set up by cadets of the Zhukovsky Air Force Academy. A month later, M. J. Lapirov-Scoblo gave a lecture on interplanetary flight in the Big Hall of the Polytechnic Museum, and new members enrolled in the Society for the Investigation of Interplanetary Communication. In October 1924, the Society held a conference on "Flights to Other Worlds," and, in November, V. P. Vetchinkin presented a lecture on the possibility of interplanetary flight. Various lectures were delivered by enthusiasts and experts at aircraft plants and factories, at the N. E. Bauman Moscow Technical School of Higher Learning as well as in institutions at Leningrad, Kharkov, Saratov, Ryazan, and Toula. In June 1925, D.A. Grave presented his "Appeal to the Societies for Space Exploration and Conquest." Also in June of the same year, the Society set up by D. A. Grave organized an exhibition devoted to the problems of space exploration. In 1927, the Moscow Inventors Association held its "First Exhibition of Models and Designs of Interplanetary Apparatuses and Mechanisms." In February 1929, at the Interplanetary Travel Amateur Society set up at the Leningrad Institute of Railway Engineers, J.I. Perelman presented a comprehensive plan devoted to the development of practical work in jet propulsion.

As a result of these initial activities, by 1930 substantial premises had been laid for subsequent fundamental and experimental investigations and also for training highly qualified specialists, and a groundswell of support for the effort had been organized. In response, the Central Council of the Osoaviakhim Society issued a directive on 14 June

1932, that recognized the vast amount of propaganda and popularization of rocket ships and of the active training of highly qualified personnel.

In September 1932, on the initiative of S. P. Korolev, two "Special Courses" were started at the Central Jet Propulsion Investigation Group: a senior group for training spacecraft designers and a junior group for training technicians. The Special Courses were attended mainly by the engineering staff, junior researchers, and senior students. The scientific background of the audience allowed an up-to-date treatment of the theory and calculation methods related to interplanetary flight. S. P. Korolev himself participated in writing the syllabus for the senior group. The term of study lasted one year and amounted to 475 teaching hours. The object of the course was to qualify both senior and junior designers, and senior and junior engineers. Within a short time, the course of instruction was extended to 1000 hours, which equated to a 2.5 year program. In 1934, the first group of specialists graduated from these courses, and they were employed by various rocket enterprises.

To understand more fully the quality and depth of the program, it would be useful to review one of the senior group syllabuses. In the early 1930s it included these general items:

1. A course on jet propulsion (25 hours) embraced theory and problems of rocket structure and engine design. M. K. Tikhonravov gave lectures on the aims and purposes of reactive propulsion; J. A. Pobedonostsev delivered a course of lectures on the fundamentals of the pressure fed liquid propellant jet engine.
2. Lectures on aerodynamics and aviation theory (40 hours), covered the basic laws and provisions of practical aerodynamics and the problems of aerodynamic flight.
3. Physiology of rocket flight (10 hours).

A specialized part of the overall curriculum for the senior group comprised the following sections:

1. V. P. Glushko lectured on propellants and combustion (30 hours), which embraced propellants for jet engines and basic theories of combustion.
2. M. K. Tikhonravov delivered the majority of lectures on material properties and the impact of technological designing and external factors on structural strength and construction reliability (30 hours). Here, as well as in other courses, for the first time in the history of science, the lecturers treated the fundamentals and principles of classical disciplines in terms of their application in jet propelled aircraft and engines.
3. V. P. Vetchinkin and B. S. Stechkin delivered lectures on the propulsion theory (60 hours), which included the derivation and analysis of the basic equations for variable mass body motions, thermodynamics, heat transfer, and heat calculation methods. Additionally, V. V. Uvarov gave lectures on gas dynamics.
4. A. N. Zhuravchenko gave lectures on experimental aerodynamics and the dynamics of rocket flight (40 hours) involving the derivation of a set of equations for rocket ballistics, the theory of aerodynamic rocket flight, the laws of gravity and air drag, and rocket control principles. A. N. Zhuravchenko treated these problems in terms of reactive propulsion.

5. Lectures on instrumentation (15 hours) with special emphasis on instruments for practical use in engine and rocket testing.
6. Lectures on rocket operation (25 hours) formulated the main tactical-technical requirements for rockets and engines and tactical-operational conditions for spacecraft.

Many celebrated professors, such as S. P. Korolev, M. K. Tikhonravov and others attended the lectures with a view to broadening their outlook.

These lectures were followed by practical training (190 hours) in independent aerodynamic, heat and strength calculations, and also in the actual designing of rockets, engines, and engineering units. M. K. Tikhonravov supervised this course. The students attended classes once or twice in a 6-day week from 6 to 10 p.m., after work. An optional course was also included in the syllabus.

In late 1933, GIRD became a part of the newly originated Rocket Research Institute (RNII) and, in accordance with a decision adopted by the Council of Labor and Defense, all the work connected with scientific and technical propaganda, publishing of scientific literature and personnel training, was reorganized and placed under the Reactive Propulsion Group of the Military-Scientific Committee, established in January 1934 in the Central Council of the Osoaviakhim Society of the U.S.S.R.

The rocket group directed by I. A. Merkulov gave a final course and prepared the first graduation group of rocket designers. In 1936, the Special Course was arranged for new groups of students. V. P. Glushko was responsible for the scientific and methodological guidelines for training engineers in rocketry at the Military-Scientific Committee. Unfortunately, few people have preserved synopses of lectures presented by Glushko and others, including M. K. Tikhonravov, N. M. Dobrotvorsky, A. I. Zhouravchenko, B. M. Zemsky, V. P. Vetchinkin, B. S. Stechkin. We have only a small number of historical documents, a few pictures of student groups, some diploma papers, and diploma design themes.

From what remains available, however, we have reconstructed an assignment example. The student in the 1930s was supposed to:

1. Design a meteorological rocket with a rated flight altitude of 10 km, using methane and liquid oxygen as propellants
2. Study the structural materials available;
3. Estimate heat design for jet exhaust;
4. Make complete calculations of the combustion system, its construction, strength, and weight;
5. Determine the rocket center of gravity; and
6. Develop the general design view and prepare the necessary auxiliary drawings.

Designs proposed in the above assignment required substantial knowledge of the subject. Indeed, the knowledge of graduates in the course on rocketry was quite comprehensive, at least profound enough to ensure further success in the activities of GIRD and of RNII.

A review of the diploma designs, and a reading of the lecture synopses, convinces us that many special problems concerning the theory of rockets and engines were, for

the first time, developed comprehensively. Some engineering solutions advanced by the students were much ahead of their time. To name but a few, the students designed and developed reusable rocket vehicles, rocket engines with high economic parameters, original stage combinations of ballistic and aerodynamic vehicles, etc. The knowledge acquired during the course enabled many specialists in later years to develop and present their subjects to scholars engaged in rocketry, and to contribute to the training of new generations of engineers for design departments and research institutions engaged in rocketry and astronautics.

From 1935 to 1938, the Reaction Group Section issued three series of publications on "Jet Propulsion" compiled by budding and leading scientists. In later years there appeared textbooks, handbooks, and monographs devoted to problems of jet propulsion. The literature published in this area made a significant contribution to further improvement of personnel training in rocketry in the Soviet Union.