History of Rocketry and Astronautics

Proceedings of the Twelfth, Thirteenth and Fourteenth History Symposia of the International Academy of Astronautics

Dubrovnik, Yugoslavia, 1978

München, Federal Republic of Germany, 1979

Tokyo, Japan, 1980

Å. Ingemar Skoog, Volume Editor

R. Cargill Hall, Series Editor

AAS History Series, Volume 10

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 5

AAS Publications Office
P.O. Box 28130
San Diego, California 92198

Affiliated with the American Association for the Advancement of Science
Member of the International Astronautical Federation

First Printing 1990

ISSN 0730-3564

ISBN 0-87703-329-3 (Hard Cover)
ISBN 0-87703-330-7 (Soft Cover)

Published for the American Astronautical Society
by Univelt, Inc., P.O. Box 28130, San Diego, California 92198

Printed and Bound in the U.S.A.

Chapter 7

THE CONTRIBUTION OF SOVIET SCIENTISTS AND ENGINEERS TO THE TECHNOLOGY OF ROCKET LAUNCHING*

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In the development of rocket launching as an objective process of improving technology, it is possible to isolate three principal stages:

- o A developmental period involving installations for launching unguided rockets (1405-1945).
- o A period of theoretical and experimental development of launching guided liquid-propellant missiles (1903-1940).
- o A period that created launching systems for carrier rockets and spacecraft (1955 to the present).

In each of these stages Soviet scientists and engineers introduced significant, and in a number of cases, basic contributions to the development of the technology of rocket launching.

FIRST PERIOD

Information about rocket launchers and launch procedures are contained in a Gettengen(?) manuscript dated not later than 1405. This manuscript contains the first known reliable information about launch devices and equipment. One can assume that the first developmental state of rocket launching technique began at that time [4, pp. 6-7 and 13].

The first reliable information about rocket launchers in Russia relate to a later time, in 1732, and is associated with an order to the Petersburg Arsenal to manufacture rocket launchers for the British [4, p. 16]. In Russia, however, rocket launchers

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* Presented at the 12th History Symposium of the International Academy of Astronautics, Dubrovnik, Yugoslavia, October 1978.

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began to be used at the beginning of 16th Century [5]. Consequently, specialists in 1732 already possessed some knowledge of rocket launching. After the beginning of the 18th Century, launchers are mentioned in Russian literature; however, they were not of domestic manufacture, but largely trophies captured by the Russian Army [4, p. 16].

The equipment and methods used in 18th Century Russia for launching combat rockets and flares differed little in practice from those used in other countries. At that time, knowledge about basic rocket launching technique was virtually identical in many countries, and the wide disparity in the development of rocket engineering was not as noticeable as it became during this century.

The rapid development of technology for launching combat rockets in Russia began at the start of the 19th Century, as indeed it occurred throughout Europe. In 1810, a scientific committee on artillery studied the use of combat missiles, and prepared and issued a short manual concerning the manufacture and use of combat missiles and launchers for the Russian Army in 1813. There is evidence that Russian rockets were used for the first time during the siege of Danzig [6]. From the beginning of the 19th Century, close attention was paid in Russia to the problems of rocket launching, since Russian engineers correctly perceived that, to a considerable degree, proper launching determined the effectiveness of rocket weaponry.

The first to pay considerable direct attention to the technology of rocket launching in 19th Century Russia was I. Kartmarov who in 1814 produced rockets of two types, and A. D. Zasyadko who manufactured rockets of various calibers in 1815-1817. But the most significant contribution to the technology of rocket launching during the first half of the 19th Century was introduced by the Russian engineer K. A. Shil'der who, for the first time in the world, proposed launching rockets from a submarine in a submerged position. He carried out experimental rocket launching under water in 1834.

In the second half of the 19th Century, K. I. Konstantinov, F. V. Pestig, N. N. Bogoslavkiy, and A. Lanerev, et. al., successfully dealt with the construction of rocket launchers. They created launchers that corresponded to the requirements of rocket engineering at that time, and designed field, mining, and marine installations for launching combat missiles of different bores, and also launch platforms for signal rockets and flares.

In 1909-1910, Russian engineer N. A. Sytenko developed a rocket system for attacking aerial targets, which consisted of rockets in a fixed, although pointable, launcher. In 1912, engineer I. V. Volovskiy designed a multicharge mobile launcher; the installation, mounted on the chassis of a truck, was intended for combating aircraft [2, p. 174]. In the U.S.S.R. at the beginning of the 1930s, many kinds of rocket launchers were designed and built for launching anti-tank, surface-to-air, surface-to-surface, and air-to-surface rockets. These installations were mounted on the chassis of tanks, trucks, and aircraft. As a result of these efforts, in 1937 *multicharge* launchers were created that could be mounted on the chassis of trucks and on board airplanes.

At the end of the 1930s Soviet engineers made a significant contribution to rocket launching technology. After much study and experimentation, they designed a new type of rail guide in the form of a beam with a slot for the pins of the rocket in the form of a "reverse T," which made it possible to launch rockets of various sizes with finned tail assemblies, and that sharply increased the accuracy of the combat rockets. From that time forward, multicharge rocket launchers that featured this type of beam and slot found wide acceptance in rocket engineering. The development of this multicharge experimental rocket launcher was carried out by I. I. Gvay, V. N. Galkovskiy, A. P. Pavlenko, and A. S. Popov, et. al.

Soviet engineers also introduced considerable improvements in launching techniques for unguided solid-propellant rockets after the start of the Great Patriotic War: for the first time in the practice of missile construction they solved entire complexes of problems for multicharge marine and field installations, and for the first time created launchers of this type which met all the requirements for combat. This achievement predetermined wide acceptance and increased attention to this type of launcher in other nations. Those who introduced major contributions in the creation of launchers between 1941 and 1945 were Soviet engineers V. P. Barmin, Yu. E. Epdeka, V. A. Timofeyev, A. N. Vasil'yev, V. N. Rudnitskiy, A. An. Glyuske, et al.

Thus it is evident that Soviet scientists and designers made significant contributions to the development of the technology of launching unguided solid-propellant rockets.

SECOND PERIOD

However much attention was paid to the launching techniques of unguided solid-propellant rockets and the significant results achieved in this field, Soviet scientists and engineers also addressed the problems of launching liquid-propellant rockets from the moment the theory of space rocket flight was conceived. The theory was first advanced in 1903 in the work of the Russian scientist K. E. Tsiolkovskiy: "Study of Outer Space by Jet Propulsion." In our view, questions of the equipment needed for rocket launching are partially touched upon in this work.

Although Tsiolkovskiy did not isolate clearly the questions of rocket launching, by substantiating the possibility of space flight with the aid of liquid-propellant rockets, he touched on questions partially solved through launching technique: the maintenance of accelerating spacecraft within assigned limits, the inadmissibility of a considerable increase in the velocity of flight in the lower layers of the atmosphere, and acceptable flight trajectories, etc. [8, pp. 51-52, 61, 71], which makes it possible to assume that Tsiolkovskiy at that time outlined the problems connected with rocket launching. In another work [9], published in 1911-1912, Tsiolkovskiy not only developed the previously expressed ideas, but also spoke about the advantages of launching rockets at the equator of the Earth, from high mountains, taking into account the Earth's peripheral velocity of rotation. [9, No 2, p. 2-3], which directly relates to questions of equipment required for launching rockets. His recommenda-

tions, which arose as a result of his scientific approach to the resolution of problems, were expressed for the first time and, subsequently, some of them found practical application. This makes it possible to consider that the work of Tsiolkovskiy marked for the first time scientific substantiation of questions concerning equipment for launching spacecraft.

Beginning in the 1920s, Tsiolkovskiy addressed the problem of launching space vehicles, and considered it more advantageous to impart to the rocket considerable speed using boosters in ground-based launchers. Thus, we see that Tsiolkovskiy's theoretical work on rocket flight during the first quarter of the 20th Century considered in some detail the questions of rocket launching.

Among the significant contributions introduced by Soviet engineers to the technology of launching space vehicles in the first quarter of the 20th Century was the world's first design of a launcher, carried out by N. G. Polev in 1913. The space vehicle, placed inside a launch container for protection, was accelerated in its launcher to take-off velocity with the aid of electric power. After attaining the planned velocity, the rocket shed the launch container to complete its solo flight. Tsiolkovskiy consulted with Polev on this project.

Besides Tsiolkovskiy and Polev, A. F. Tsander and Yu. B. Kondratyuk made contributions to the technology of rocket launching during the first third of the 20th Century. In 1924 Tsander proposed using aircraft as a launch platform, permitting rocket launching at altitude, in the upper air. This idea in the 1950s drew the attention of many foreign engineers. Kondratyuk in 1919 considered the possibility of using an electromagnetic gun for launching rockets into space. He proposed the schematic of such a gun and the equipment needed for some of its components.

Kondratyuk also divided rocket payloads for space flight between cosmonauts, launched on highly reliable rockets, and automatic instrumented spacecraft, launched on simpler, less expensive and less reliable rockets [1]. This idea drew the attention of many engineers beginning in the 1950s [11]. Currently, the launching of manned and unmanned spacecraft in this manner has been partially adopted in the U.S.S.R. (Cargo ships of the "Progress" type are launched on different rockets from the "Soyuz" type.) Although the same first-stage carrier rocket is used for both, undoubtedly further development of cosmonautics will lead to different types of carrier rockets for these purposes, and, consequently, more completely embody the idea of Kondratyuk.

Besides the theoretical developments in the 1930s, Soviet engineers successfully constructed ground launch equipment for liquid-propellant experimental rockets, developed the technology for their launching, and conducted successful launchings that contributed to scientific experience in this area of launching technique.

THIRD PERIOD

The third period in the evolution of technology for rocket launching commenced in 1955 when Soviet scientists and engineers began developing ground equipment for the carrier rocket Vostok, which, during October 1957, injected into earth orbit the first artificial satellite (ISZ). In this period they created ground equipment, launched a new class of carrier rocket, and solved numerous, complex, interconnected scientific and engineering problems.

As is known, the carrier rocket Vostok represented a considerable achievement in the practice of missile construction. From the standpoint of rocket launching technique, however, designers in the 1950s had to solve numerous questions never before addressed, especially those associated with the launching of such large starting masses like the Vostok class rocket--about one thousand tons [3].

Existing liquid-propellant guided missiles of that time had installed at the top of their first stage load-bearing supporting elements permitting installation of the rocket on the launch platform. Although the carrier rocket Vostok featured an "even" diameter, it did not have supporting elements at the top of the first stage suitable for installation on a similar launching platform. Therefore, it did not reflect the accumulated experience in launching methods, or permit a launching system in the form of a table.

In the mid-1950s, Soviet engineers faced the task of launching carrier rockets of similar diameter and of large overall sizes without impairing their flight characteristics. At that time, to be sure, both Soviet and foreign scientists had developed recommendations regarding appropriate methods for launching large rockets. But these were of a general nature and did not specifically contribute to the development of launching techniques for the carrier rocket Vostok.

An analysis of possible methods of launching the Vostok booster rocket revealed that the most optimum method must include launching in a vertical plane using a field launching system. Then it was necessary to create a launching structure and launch procedure that ensured reliability while at the same time held the Vostok upright during launch preparations and did not block its motion upward during the launching.

After further analysis of possible solutions for this launching system, engineers settled on a version of support that mounted the carrier rocket and its power packs on a central block (instead of attaching it to lateral blocks) with the aid of four load-bearing, but retractable, supporting trusses. This technical solution proved in over 20 years of operation to be the preferred launching system. The creation of this launching system for the carrier rocket Vostok was a significant contribution to the development of rocket launching technique as a separate branch of knowledge.

In another significant contribution to the development of this technology of rocket launching, Soviet engineers for the first time devised methods for testing the separate Vostok stages and assembling them at the launch site in an "assembly test frame" (MIK), the subsequent transportation of the stages in the horizontal position

in the MIK to the launch pad, for vertical erection and installation of the booster rocket in the launching system, and for the final testing and servicing prior to launch. The use in the U.S.S.R. of this method of launch preparation of the carrier rocket Vostok for many years showed that it completely answered the launch requirements imposed on it.

It is interesting to note that American engineers arrived at equivalent solutions only in 1962. In the USA, a similar launch method was termed "mobile" and used for the launch preparation of the carrier rocket Saturn V.*

During the creation of ground equipment for the carrier rocket Vostok, Soviet scientists and engineers for the first time solved other unique engineering problems in the technology of rocket launching. First, the rocket and space vehicle had to be serviced with large quantities of propellant and compressed gases; it had then to be transported to and installed vertically on the launching platform. Provision had to be made for deflecting the high-temperature gas jet of the engines to a safe distance, and for the rescue of operators at the maintenance tower in case of an emergency situation, etc.

Thus it is evident that Soviet scientists and engineers in the mid-1950s successfully solved for the first time complex technical problems in carrier rocket launching. It proved to be a significant contribution in missile construction and helped open the space age for humanity.

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* **Editor's Note:** This reference to "copying" is unclear, for the Saturn V was erected and tested vertically on its launch platform inside a building, then moved in a vertical position to Launch Complex 39 atop an immense, tracked crawler.