History of Rocketry and Astronautics

Proceedings of the Twenty-Fourth Symposium of the International Academy of Astronautics

Dresden, Germany, 1990

J. D. Hunley, Volume Editor

Donald C. Elder, Series Editor

AAS History Series, Volume 19

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 11

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 1997

ISSN 0730-3564

ISBN 0-87703-422-2 (Hard Cover)
ISBN 0-87703-423-0 (Soft Cover)

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

Printed and Bound in the U.S.A.

Chapter 6

On the History of Rocketry Developed in the U.S.S.R. in the First Years After the Second World War*

(The Participation of German Specialists in the Development of Soviet Missile Technology in the Early Post-War Period)

P. Bork† and G. A. Sadovoj‡

When the Second World War was over, the Soviet Union faced the problem of determining the main direction for the further development of rocketry. Soviet scientists and engineers, based on national and foreign experience accumulated during the years from 1930 to 1940, had resumed research and development on liquid-propellant rockets, which had been interrupted by the war, and in short order had achieved considerable progress.

It is of interest, in this respect, to study the part that the German rocketry engineers, who worked in the U.S.S.R. after the war, played. This subject seems not to have found, until now, sufficiently objective treatment.

At the beginning of 1945, when the allied armies entered German territory (particularly after the German capitulation), the specially selected specialists of

---

* Presented at the Twenty-Fourth History Symposium of the International Academy of Astronautics, Dresden, Germany, 1990.

† Germany.

‡ U.S.S.R.

these armies started an intensive search for Germans in those fields of science and technology where they had achieved especially great programs, and where they were superior to the allies. Considerable efforts were aimed at finding the specialists in rocketry, and also the prototypes of the rockets, launching equipment, and production technology.

The leading German scientists, headed by Wernher von Braun and Walter Dornberger, had turned out to be in the arms of the Americans. The finished prototypes of German rocketry and the technological documentation of Peenemünde were also important American trophies. Soon after, the scientists, engineers, and many samples of rockets and equipment had been moved to the U.S., where the tests of launching those rockets were made. Similar actions were carried out by England and France.

In this situation, when the relations between the Soviet Union and its former war allies were strained, the U.S.S.R. took measures to further the development of its rocketry. Some of these measures consisted of the study and mastering of German experience in rocketry production during the war. The leading Soviet rocketry specialists were sent to Germany to work together with German specialists in the institutes established there, such as "Rabe," "Berlin," "Nordhausen," and also at the plants "Mitterwerke," N 3, and others.

By the decision of the Council of Ministers of the U.S.S.R., adopted on 13 May 1946, German rocketry specialists were to be transferred from the Soviet occupation zone in Germany to the Soviet Union. The decision touched upon other important issues relating to missile technology development. Then, a group of Germans working at the Zentralwerke in the town of Bleicherode, comprising specialists of different trades and qualification levels, were transported to the Soviet Union in late October/early November 1946.

Specialist Group Composition, Evaluation of Their Work and Organization

The Scientific and Research Institute-88, charged as a leader in developing liquid-fuel rockets, got 152 experts with their families (all in all 495 persons, 18 of them unmarried). Of the family members, 7 turned out to have worked earlier in the fields our country was interested in. This export group included 13 professors, 32 Doctors of the Sciences, 85 professionally qualified engineers and engineers of high education, 21 technicians and engineers of practical experience, and 8 masters and mechanics. The bulk of the newcomers and their families were accommodated in rest houses closed at the beginning of the war, and located in Kaliningrad, Moscow region, and in the outskirts (111 families).

The rest resided on the island of Gorodomlia (Seliger Lake), in a specially built settlement of branch I of the Institute. P. G. Sukhomlinov was assigned as the Branch Director; his co-directors on the German side were Voldemar Wolf, a former head of the ballistics section of the Krupp firm, and I. Blass, a design engineer. The group was comprised of experts on ballistic and anti-aircraft missiles, engines, gyros, ballistics, and measuring techniques. It included theoreticians, designers, technologists, as well as highly qualified workers on aluminum and its alloy welding, and other processes modern for the time.

Some professors and Doctors of the Sciences were known as prominent scientists outside Germany: H. Zeise—an expert in thermodynamics; Franz Lange—an expert in radar location; Werner Albring—an expert on aerodynamics; Kurt Magnus—a pupil of Ludwig Prandtl, and a theoretician on gyroscopes; Hans Hoch—a theoretician on missile flight stability; and Helmut Gröttrup—a qualified engineer and a notable expert, who closely cooperated with Wernher von Braun in developing automatic control systems for rockets.

As was revealed later, many foreign specialists did not have certificates of education, and they did not prove their scientific degrees or education either by documents or through the results of practical work.

One cannot help mentioning the evaluation of the work of these specialists made by Wernher von Braun and the German experts on rocketry who had gone with him to the U.S. They reiterated their statements that all the most talented experts from Peenemünde had gone to the U.S., and the U.S.S.R. had gotten only technical specialists.

According to their estimate, ". . .The U.S.S.R. did manage to get Helmut Gröttrup, a chief expert on electronics. . . . But he turned out to be the only outstanding specialist from Peenemünde they had got." And though this evaluation was made by persons who obviously do not sympathize with our country, it almost exactly characterizes the true value of the German personnel whom we got at that time.

Upon arrival, the Germans, who were referred to as "foreign specialists" in documents, were organized into a production team, called "Collective-88," and they were subdivided into the following groups:

1. Control systems group with an attached control mechanism laboratory (27 persons), headed by H. Hoch and K. Blasig.
2. Design group with a guided anti-aircraft missile design bureau (20 persons), headed by W. Quessel, including a leading engineer on the Wasserfall missile project, Emil Mende.
3. Production group (21 persons), headed by Alois Jasper, a technical leader.
4. Thermodynamics and motor group, headed by Karl Umpfenback.

5. Aerodynamics and ballistics group, headed by W. Albring.
6. Construction group (7 persons), headed by Geinz Jaffke, and other groups.

A plan of themes for the team was worked out for 1946. It included:

- Consulting on making a Russian version of the A-4 drawings;
- Working out organizational schemes of scientific and research laboratories (concerning the A-4 and guided anti-aircraft missiles);
- Analyzing problems pertaining to the A-4 engine boosting;
- Developing a 100-ton-thrust engine;
- Laying out plant production rooms and their preparation for equipment accommodation;
- Preparing missile assembly using German-made elements.

One of the most important aspects of the German specialists' work at the end of 1946 and in the first half of 1947, was the preparation of proposals for the A-4 firing program, the aim of which was to obtain a maximum amount of measurements having considerable value for future missile technology development.

On 4 June 1947, the institute director held a meeting which helped greatly in organizing the German specialists' activities. The meeting gave a just estimate of their capabilities, based on almost a half year of experience working in the institute. The conclusion was that the German specialists were not to be considered a staffed group, capable of solving, in the aggregate, problems of designing and fabricating new missiles of some significance. Nonetheless, all of them were allowed to test their creative forces and to try to develop a unique, long-range ballistic missile design, later called G-1 by the proposal of H. Grottrup.

To realize the proposals adopted at the meeting in August 1947, the German specialists were included in department "G," headed by H. Gröttrup, who simultaneously was assigned as chief designer of the missile. The department had all the rights the other institute research departments had. It was subordinated directly to the chief engineer and consisted of sectors for ballistics, aerodynamics, engines, flight control systems, missile tests, as well as project/construction and design bureaus.

To get better results, all the foreign specialists were placed in Branch I of the institute. Soviet experts worked in Branch I along with the foreign specialists. Their number is shown in the following table.

Themes of the reports and papers produced by the German specialists in 1947, dealt with a narrow circle of scientific and production issues: missile sta-

bilization; gyroscopes; control-surface actuators; fuels; an engine-test firing bench; production room lay out; and light alloy welding techniques and others.

Table 1

	1.1.47	1.1.48	1.1.49	1.1.50	1.1.51
German specialists	73	96	170	172	166
Soviet specialists with high education	3	4	19	31	32

Judging by the reports and paper titles and their volume (the reports and papers have been lost), one may come to the conclusion that in these papers there were no serious developments of units and instruments, new themes and maneuvers for new missile types; rather, they explained the physical sense and design principles of some assemblies and units of the A-4 missile, and they did not embrace specific solutions of missile technology problems.

It is worth dwelling on the legal and material state of the German specialists in this country. They were transferred from Germany to the U.S.S.R. by the decision of the Council of Ministers of the U.S.S.R., and all those chosen by the Soviet military administration had to move, regardless of their consent. Family heads were allowed to take family members with them: parents, wives, and children. All of them were provided with food, according to the norms established in this country by the rationing system, which was in force until 1947 and on a par with the Soviet citizenry. They were housed in buildings quite suitable for living. They were provided with buses to get to work and back home. A specially organized commandant's office was vested with the administrative management of the business of the foreign citizens. Their pay was set depending on the specialists' qualifications, scientific degrees, and titles. Doctors of the Sciences and engineers of high qualification got a rather high salary. So, Doctors of the Sciences, K. Magnus, K. Umpfenbach, and T. Schmidt, got 6,000 rubles a month, H. Zeise 5,500, H. Gröttrup and R. Schwarz 4,500, and W. Quessel 4,000. Qualified workers were highly paid, too. For the sake of comparison, let us list the pay of leading Soviet specialists in 1947: S. P. Korolev, 6,000 rubles a month; Y. Pobedonostsev, a chief engineer, 5,000; deputy-chief engineer B. E. Tchertok, 3,000; and deputy-chief designer V. P. Mishin, 2,500.

The Germans were awarded big premiums for accomplishing stage works on a par with Soviet specialists. So the German specialists were not in a position of prisoners of war, as some authors wrote at the time.

G-1 (R-10) Ballistic Missile Design Development

In 1947-1948, the main independent theme for the German specialists was to develop a ballistic missile of about 600 km firing range. Such a missile began to be developed in 1946 at the Centralwerke. It was designated G-1 (R-10), when included into the schedule.

The major requirements for developing the G-1 missile were to ensure the same dimensions as of the A-4 missile, but reducing its dry weight and greatly increasing fuel volume; to transfer flight control functions, significantly, from on-board devices to ground control systems; to simplify, as much as possible, the missile design and ground facilities; to heighten targeting accuracy; to ensure missile warhead cast-off along a downward trajectory; and to reduce the time, by half, for fabricating the missile and preparing it for launch. The G-1 engine, like that of the A-4, was designed to consume ethyl alcohol and liquid oxygen pumped into its combustion chamber. But the turbine rotating the pumps was to be set into motion by gas, obtained from the combustion chamber upper part. In doing so, the need for a steam generator was excluded, thus reducing the engine weight from 930 to 770 kg, greatly minimizing the number of engine devices (from 45 devices of the A-4 missiles to 10 of the G-1). The missile's weight was diminished: the A-4's was 3.17 tons, while that of the G-1 was 1.87 tons. Especially great innovations were to be introduced in the control system. High hitting accuracy required the use of radio control.

The new control system design was based on the following principles:

1. The engine was to be cut off at an estimated trajectory point upon reaching the assigned speed. To achieve this, the missile speed was constantly measured and corrected by the ground control commands, controlling the engine fuel supply through the whole trajectory linear portion (after the insertion curve).
2. The missile speed was measured with an accuracy of up to 0.01 percent, using radiometric techniques, ensuring range deviation of 0.1 percent, i.e. 600 m.
3. The missile coordinates were measured continuously, both in azimuth and elevation. To regain the trajectory when the missile began to stray off course, commands were transmitted to activate the missile control surfaces.
4. The number of on-board devices, in comparison with the A-4, was sharply reduced, thus reducing weight and cost.

On 25 September 1947, the control system design, and the missile design as a whole, were discussed at the section meetings and the plenary meeting of

the Scientific and Technical Council of the Institute. A report on the missile preliminary design was made by H. Gröttrup.

Upon analyzing the design, the leading Soviet specialists, V. P. Mishin, V. P. Glushko, M. K. Tikhonravov, M. S. Riazansky, and others who took part in the meeting, arrived at the conclusion that the design comprised a number of interesting ideas. But judging by the degree of its optimization, it did not meet even the requirements for a preliminary design and was just an initial concept. One could also note that these ideas were not original, but that they developed the proposals contained in the works of K. E. Tsiolkovsky, F. A. Tsander, H. Oberth, and E. Sänger. The radio control system, i.e. the design's chief element, turned out to be the least developed.

The proposals put forward were not distinctly substantiated theoretically; many assertions were disputable. All the control system elements were to be developed anew. The engine design was not optimized either. As V. P. Glushko said, the gas obtained from the combustion chamber head section could not be used effectively for turning a turbine, since the fuel vapors in the head section were of comparatively low temperatures, and hot gases are required to rotate a turbine.

The Scientific and Technical Council recommended continuing development of the design, and to bring it to the state of a technical design. During 1948, the preliminary design took shape, and in December of that year it was again discussed at a plenary meeting of the Institute's Scientific and Technical Council. The council noted that the documents on the R-10 missile, submitted by Branch I, exceeded the requirements for the preliminary design by its volume and optimization depth, but it suggested that further development of the R-10 design be made, accelerating experimental work on clarifying new design problems.

Since the flight control system differed principally from those known at that time, the recommendation was made to equip the A-4 missile with the system and to flight-test it (the R-10 aerodynamics were similar to that of the A-4).

The design was being developed during 1949 as well, but it did not take the shape of a technical design. The main reason was that the specialists did not manage to make either control system devices (except prototypes), or an engine, using the basic ideas of the project.

The management became still more convinced of the unfeasibility of the project. By October 1949, proving-ground tests of the 2RE missile (the experimental version of the R-2), developed by Soviet specialists headed by S. P. Korolev, had been carried out. The tests had shown that the approach to developing the R-2 missile with a range of 600 km, chosen by the Soviet specialists, was correct and realizable within the shortest period of time, while the German

project of the R-10, with similar characteristics, was far from realization. In such conditions, it was inexpedient to spend money on further development of the German project.

Development of the Other Missile Designs

During the whole period of the German specialists' work in Branch I, they dealt to a certain extent with design and theoretical works on guided anti-aircraft missiles. Their aim was to update the German Wasserfall and Schmetterling missiles, and to make a preliminary project of a new guided anti-aircraft missile.

As in the case of the other endeavors of the German specialists, their effort in developing anti-aircraft missiles did not help the U.S.S.R. either to reproduce the Wasserfall missile or to update the Schmetterling—or to create a new guided anti-aircraft missile version.

In 1948-1949, the Institute's Branch I was developing the R-12 (G-2) ballistic missile initial concept with a firing range of about 2,500 km, and a payload weight of 1 ton. A propulsion system for the missile was intended to comprise a block of three missile engines. By the designers' concept, the block of three controlled engines excluded the use of jet vanes and prevented the loss of engine power.

The control system was absolutely similar to that of the R-10 missile. The same is true of the missile body, although its technological effectiveness was improved. But the R-12 missile design was not developed even to a preliminary stage.

The volume of the work on the R-10 and R-12 missiles, out of the total volume of the Branch's research and development in 1948-1949, amounted to 62 percent (44 percent on the R-10 and 18 percent on the R-12). Besides these missiles, the documents contain references to the following missiles, developed by German specialists in 1949-1950:

1. G-3 missile of both ballistic and cruise versions, with a range of 8,000-10,000 km and a 3-5 ton payload.
2. R-13 (G-1M) missile, with the body of the R-10 missile and the A-4 boosted engine.
3. G-4 (R-14) ballistic missile, with a 3,000 km range and a 3 ton payload. Necessary aerodynamic and ballistic calculations, as well as model aerodynamic wind-tunnel tests were made.
4. G-5 (R-15) cruise missile of 3,000 km range and a 3 ton payload.

All of these developments were on the level of initial design (diagram drawings and main parameter calculations), with still lesser depth of substantiation than that of the A-9/A-10 intercontinental ballistic missile design, which left its traces on paper only.

Missiles with similar characteristics were developed more successfully at that time, by Soviet specialists, and it is quite natural that the German specialists were not acquainted with the results.

Branch I Changes its Functional Character in 1950

Along with Research and Development Branch I, Research Institute No. 88 developed laboratory, experimental, and production bases, too. Here again, the Germans participated in these efforts.

At the end of 1946, Branch I had just begun to be organized and did not have an experimental or production base, but, by the end of 1947, its production area was 1,528 m^2, 1948—2,461 m^2, 1949—3,555 m^2. In spite of the laboratory and production area growth, it did not ensure the solution of technical problems in the sphere of either complex long-range missile designing or control system development. Gaps between the tasks assigned to the German specialists and real capabilities for their realization widened still further, and this fact could not help affecting negatively the results of their work. They became unpredisposed to work and felt unsure of their capabilities.

In April 1950, the U.S.S.R. Ministry of Armament, considering the situation, made a decision to stop further work on long-range missile design in Branch I. There were several reasons to arrive at such a decision. The first was the revealed inability of the German experts to do the work, due to the low qualifications of the majority of them. The second was the unwillingness of the Soviet administration to acquaint foreign citizens with details of an enterprise producing missile technology, which at the time would have been considered as disclosing the most important state secrets. The third reason was the Branch's weak laboratory and production bases, which did not allow work on developing long-range ballistic missiles. And finally, the disloyalty and open enmity of many of the Germans to the Soviet social system resulted in their unwillingness to work with maximum efficiency. Due to their isolation, the German specialists lagged behind the Soviet specialists in knowledge and experience; the value of their work steadily dropped, and to use them for developing missile technology became inexpedient.

The Branch's mission became the developing and producing test-experiment types of on-board and ground control system devices, refining a three-plane functioning on any section of a trajectory (Bahnmodel), optimizing a

multi-component balance for wind tunnels, and producing some types of fixtures for propulsion systems.

To fulfill these missions, the Branch director was advised to reassign the specialists in accordance with the work volume and its significance. In 1950, development of control system devices, simulator, and wind tunnel balance for C3T-1, C3T-2, T-112, and T-113 wind tunnels were of paramount importance.

In October 1950, all work of a secret nature in Branch 1 were stopped. The Germans worked on themes having nothing to do with missile technology; computers, boat motors, and other things were developed. The further presence of the German specialists in the U.S.S.R. had lost any meaning, and, in September 1951, a decision was adopted to send them to the GDR. They departed in several echelons, the last one leaving in November 1953. Thus ended the work of the German specialists in the Soviet Union after more than 5 years.