# Heavy water.
# History of one priority. Part 2.

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**Version 3 (based on ac\sf[a] documents)**

Heaving got acquainted with the history of the Soviet atomic bomb project, it is not difficult to see that the works on heavy water were rather ill-administered and ill-coordinated. On 20 August 1945, Stalin formed a nine-member Special Committee (*Spetskomitet*) headed by L.P. Beria as part of the State Committee for Defense (after 4 Septemer 1945 at the USSR Council of Ministers) to oversee the whole Soviet bomb effort. The Special Committee had a Technical Council (*Techsovet*). Decisions of the Special Committee were prepared at the Technical Council chaired by former Minister of Armaments B.L. Vannikov, who was, in turn, overseen by Beria (a new interdepartmental "semi-ministry", known as the First Main Directorate (*PGU*, *Pervoe Glavnoe Upravlenie*) of the USSR Council of Ministers also was placed under Vannikov's supervision. PGU was established on 25 August 1945 to implement the measures related to the uses of atomic energy. The Technical Council comprised one section and four commissions including the Commission on Heavy Water Production headed by P.L. Kapitsa who, together with I.V. Kurchatov, "represented" science on the Special Committee. On 5, 6, 10, 16 and 24 September 1945, the Technical Council of the Special Committee discussed the research and development activities of the project team. The Institute of Physical Problems headed by Kapitsa was engaged in the works on heavy water production by hydrogen distillation. At the September sessions, Kapitsa did not reported to the Technical Council on water separation but, jointly with I.K. Kikoin, made a report "Production of Uranium-235 by Gas Diffusion Method", obviously regarding this problem more important. A problem of heavy water was presented by Kornfel'd. After that, the second commission on heavy water was established; the People's Commissar for the Chemical Industry, M.G. Pervukhin[b] was appointed its chairman. Somewhat earlier 4 September it was formulated the decree of the State Defense Committee 9967ss, which ordered to him[1]:

> *"в) That the research and test works on making product 180 by electrolytic separation, isotopic exchange, and distillation methods be organized in GSNII-42[c], at the Moscow Electrolysis Factory, and in the Karpov Physical-Chemical Institute. That for this purpose be used the installations found at the German chemical plants in Leuna Werke and Bitterfeld. <…>*
> *4. It shall be the responsibility of the Narcomkhimprom [eng: People's Commissar for the Chemical Industry] (Cde. Pervukhin) and USSR NKO [eng: People's Commissariat of Defense] (Cde. Khrulev) to provide evacuation from Germany <…> and transportation to Narcomkhimprom facilities <…> of the following equipment:*
> *а) distillation tower and the pilot-scale electrolyzer from the Bitterfeld plant within the period from 10 September till 20 September1945;*
> *б) small pilot plant from Leuna Werke factory within the period from 10 September till 20 September1945;*

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[a] Signature stamp «top secret\special dossier».
[b] During war he was simultaneously Vice-president Council of People's Commissars of USSR and with 1943 supervised a nuclear problematic.
[c] GSNII-42, GOSNII-42 or NII-42 now is the State Scientific Research Institute of Organic Chemistry and Technology (GosNIIOChT).

*в) big pilot plant from Leuna Werke factory within the period from 10 September till 20 September1945;*

*Cde. Pervukhin is to send to the place one of his deputies to exercise control over dismantling of the specified equipment, its repair if necessary, ensure its complete package and oversee its entrainment at factories as well as at the Lvov storage terminal."*

Let's explain: NII-42 (under People's Commissariate for the Chemical Industry) was already engaged in the nuclear project – it was responsible for uranium hexafluoride production. The Moscow Electrolysis Factory was chosen as a testing base. Also still in 1944, Kurchatov and N.M. Zhavoronkov (then the deputy director of the Karpov Institute) had agreed to organize at the Karpov Institute research works on stable isotopes[2].

In October 1945 the Pervukhin's commission has prepared the following program[3]:

"*1. For the purpose of choosing an optimal industrial method for heavy water production, to develop preliminary designs of industrial plants based on the following methods:*

- *distillation;*
- *hydrogen sulfide isotopic exchange combined with distillation;*
- *two-temperature water–water vapor–hydrogen isotopic exchange;*
- *hydrogen sulfide isotopic exchange.*

*2. Design for each of the specified methods should be made for a commercial plant with a capacity of 5 kg/day 1-2 % heavy wate***r <…>**

*3. The development of preliminary designs for all methods specified except for the method of hydrogen sulfide isotopic exchange combined with distillation is to be conducted by the special group of specialists created for this purpose under Laboratory No 2 of the Academy of Sciences of the USSR, on a lump sum basis. Professor M.O. Kornfel'd is to be placed in charge of organization and administration of the design team* <…>

*6. The designs are to be completed and presented to the Cde. Pervukhin's commission till 15 October this year. The commission is to report to the Technical Council its proposals on selecting the method for one-percent heavy water production on 19 October this year.*

*7. The Institute of Physical Problems of the Academy of Sciences of the USSR (academician P. Kapitsa) is to be placed in charge of development of the design of a distillation tower similar to that used by academician Kapitsa in his separation plant.* <…>

*Cdes Kapitsa and Kornfel'd are to carry out comparative analysis of the two design techniques for the first three methods of heavy water production."*

It was then that the Geib's destiny was predetermined – it was decided that he would not be recruited for the contract job in the USSR. In the Technical Council's report No 6 from 29 October 1945 it is written[3]:

*"It is approved to invite from Germany professor Bangoffer for work in laboratory "G" and professor Hund for work in laboratory "A". Doctor Geib is to be used at Leuna-Werke factory for mounting and launching the pilot plant for heavy water production."*

On 8 May 1945, when the operation "Russian Alsos" already started to act, Kurchatov had presented Beria the list of German scientists from whom the information on uranium project in Germany could be collected. The list included 35 person sorted into three groups: "world renowned scientist", "greatest scientist" and "skilled physicist". The tenth with a mark "specialist on heavy water" went Geib, opening in this list the third group[4]. As can be seen, doctor Geib's qualification was estimated rather high.

Thus, in October 1945, the trophy technical documentation gained from Leuna (where from another source could possibly come?) had been analyzed to reveal the processes which could be potentially developed or adopted based on this information. What else people who have heard of the secrets of heavy water for the first time could do in one month? Obviously, they

have carried out recalculation of the processes developed in Leuna, reducing them to the common denominator, i.e. the given capacity, and that's all. It was accepted to continue the works on both methods, i.e. isotopic exchange in water–hydrogen sulfide (hydrosulfide process) and water–hydrogen systems (see reactions (1) and (2), Part 1). Works on the second method were assigned to Leuna-Werke; the previous decision on evacuation of relevant plants from Germany was cancelled. This arrangement facilitated better use of German specialists, who were also put in charge of executing the detailed design of the hydrosulfide commercial plant. The same capacities (5 *t* $D_2O$/year) appearing in the CIA report and – earlier – in IG Farben blueprints, is apparently not a coincidence (see Part 1). The construction of the pilot plant for testing the design process was started in NII-42.

About a year later Kurchatov, Vannikov, and Pervukhin had prepared the detailed note addressed to Stalin on a progress of works on atomic energy use in 1945-46 ("the Kurchatov's Report to Stalin"[3, 5]). Interestingly, this document carries a hand-written comment: "*in accordance with the directive of Cde. Beria, the report was not sent anywhere*"). The report mentions the pilot plants No 471 in NII-42 and the intermediate-capacity industrial-scale test plant No 472 at the Combine100 in Aleksin. Later on the latter was abandoned in favor of building the full-capacity industrial plant (4 *t* $D_2O$/year that is close to the value set in the detailed design). This plant went into operation in 1949.

> *"Heavy water production by the method of hydrogen sulfide isotopic exchange combined with distillation (installation No 471)*
>
> *The Council of Ministers of USSR decreed (No 2-2ss from 2 Jan 1946) that the Ministry of Chemical Industry be obligated to build in NII-42 the pilot plant for implementing the title method, with a capacity of 0.1 kg/day based on 100% product. The dead end for plant mounting had been set as 1 June 1946. However, construction and mounting of the plant had been finished only in December 1946. At the trial start of the plant, malfunction of the blower and of the partial condenser were detected. Presently the correction of these defects is almost finished, and the plant will soon be started for test-mode operation so as to determine and optimize its operational and economical parameters.*
>
> *Heavy water production by the method of water–hydrogen sulfide isotopic exchange (installation No 472)*
>
> *The Council of Ministers of the USSR decreed (No 2-2ss from 2 Jan 1946) that the First Main Directorate of the Council of Ministers of the USSR and the Ministry of Agricultural Machine-Building be obligated to build at the facility No 100 the pilot plant for heavy water production by the method of isotopic exchange with a capacity of 5 kg/day based on 100% product with a concentration of 1%. The method of isotopic exchange (in the system water–hydrogen sulphide) is poorly studied and has serious drawbacks, i.e. strongly corrosive medium and difficulty of process control. This method can be recommended for the high-volume industrial use only after preliminary testing on the plant No 472."*

The first and the second in the world industrial plants for heavy water production based on GS process were being developed in Aleksin and Dana autonomously and contemporaneously. Their capacities differed by several orders of magnitude, proportionally to the practical experience of the USSR and USA in heavy water expressed in its stocks: about 3 *kg* in the USSR and $3 \times 10^4$ *kg* in the USA. However the development of both technologies took almost equal time. In the USSR, the works on the process development were started three years earlier than in the USA, and this gap was retained all the way through. Additional data on isotopic exchange equilibrium and the calculation procedures used for equipment design were in due time gained by Kornfel'd, Rozen, and Kalinin. The main difficulties were encountered at the start-up stage, mostly associated with corrosion and stress-corrosion cracking. They were the same in Aleksin and Dana with the only exception that instead of precipitation of $H_2S$ hydrates, in Aleksin they had encountered with precipitation of free sulfur resulting from hydrogen sulfide

oxidation by air oxygen sucked in by blower and dissolved in water fed without appropriate deaeration[6]. Thus, preliminary pilot testing of the hydrosulfide processes turned out to be very important.

Now with certainly no doubt about the USSR being the first to start producing heavy water on an industrial scale, there is no such clarity regarding the authorship to the process employed in the Soviet production plant.

In K. Sakodynsky and N. Zhavoronkov's review published 50 years ago it is put as follows[7]:

> *"The dual-temperature exchange between water and hydrogen sulphide was first studied by Geib in Leuna during World War II. Contemporaneously the research on isotopic exchange in this system was started in the United States, however, then the method was not implemented at industrial scale because of the expected problems to result from strongly corrosive construction materials. The industrial heavy water production based on the dual-temperature isotopic exchange between water and hydrogen sulphide was first accomplished by the USSR. The large-scale industrial plant built in the USSR within the period from 1946 to 1949 is still successfully operated".*

Rozen in his articles mentioned the German specialists engaged in the Soviet heavy water project (Vollmer and Bayerl), so it would be quite natural if at least he add to[6] that the heavy water production process developed in the USSR was based on the Geib's method. Rozen, however, apart from his reticence about this "intellectual reparation", had completely ignored the existence of the pilot plant No 471 in NII-42.

Nonetheless, Geib's name was not forgotten. The hydrogen sulfide process is now commonly referred to as "Girdler sulfide (GS) process, also known as the Geib-Spevack (GS) process"; it was newly interpreted[8] to take its name from Karl-Hermann Geib and Jerome S. Spevack, who independently invented it, although originally GS definitely designated Girdler sulfide. The starting point for the development of heavy water production in the USSR was the German detailed design based on Geib's results. The USA also had got the trophy documentation as well as the "alive" information in the person of Harteck. It is still unknown how far had Germans advanced in their work on heavy water and whether Spevack either Girdler specialists could adopt anything from their data. Officially the process carrying the name "Girdler sulfide" corresponds to Spevack's patent. The new interpretation of its name is fairly rightful as equalizing both authors of the hydrosulfide method.

## Nonviable sector

We cannot tell for sure whether the detailed design for a plant for the hydrosulfide process at Leuna-Werke was ready by 21 October 1946, but the researches on isotopic exchange in water–hydrogen system had not been completed. The equipment had to be evacuated urgently during Operation Osoaviakhim: on the night of 21 October 1946, NKVD and Soviet Army units, commanded by Beria's chief deputy Colonel General I. A. Serov, began rounding up in short order thousands of German scientists and technicians of all types across the Eastern zone, along with their families, and transporting them to the Soviet Union in 92 different trains for work in the Soviet armaments industry. That had also entailed deportation of the Herold's group to the USSR. However, in the Kurchatov's Report to Stalin[3, 5] no mention of the brought specialists had been made:

> *"1. Under the decree of the Council of People's Commissars of USSR, the Ministry of Chemical Industry with engaging German specialists at Amoniak-Werke factory in Merseburg had rebuilt the destroyed by Englishmen pilot plant for making heavy water by the method of the multistage dual-temperature isotopic exchange.*
>
> *With this plant it was possible to achieve stable operation mode yielding 30–35 grams per day of 1–1,2% heavy water (based on 100 % product).*

*The detailed design prepared by German specialists had shown this method to be exceptionally complex and bulky and demanding for realization rather a plenty of equipment, which makes its implementation inexpedient.*

*The main shortcoming of this process is destruction and ablation of catalyst by water vapors.*

*Now the plant is dismantled and all valuable equipment is evacuated to the USSR (Karpov Physical-chemical Institute).*

*2. At the same site the high-pressure pilot plant for isotopic exchange in the system hydrogen–liquid water was rebuilt and tested. The fulfilled experiments gave satisfactory results. Substantial increase in the exchange rate compared with the hydrogen–water vapor system is achieved. Isotopic exchange at ambient temperature is proved. This plant also is dismantled and evacuated to the USSR for revamp in the KarpovPhysical-chemical Institute."*

Most probably, these two are the same above-mentioned "small" and "big" pilot plants at Leuna-Werke, which had been planned to be taken out still in 1945. The "big" one is the "Stalin's Organ". Yet the Karpov Institute was not ready to accept the Germans with their equipment.

Now let's return to the beginning of our story. Obviously, the Kapitsa's Commission on heavy water production was established to deal with the underlying science and related problems. However, it held its only meeting as late as two months after establishment. The Commission recommended that Kapitsa, Vollmer, and Bayerl report to the Technical Council on heavy water production process based on the distillation of ammonia and liquid hydrogen. As a result, on 17 December 1945, the Technical Council had made the following decision: *"without delay to start works on implementation of the developed by P. Kapitsa process for making product 180 by low-temperature separation"*. After Kapitsa's withdrawal from Technical Council (because of his disagreement with the program and with the path chosen by Beria as well as his sharp personal differences with Beria) the Commission disbanded and the process was implemented later by the Institute of Physical Problems headed by the new director, A.P. Aleksandrov.

Fundamental research concerning heavy water production was assigned to Laboratory No 2. In the report of the meeting of the Technical Council from 18 October1945 it is written[3]:

*"8. Laboratory No 2 of the Academy of Sciences of the USSR is to execute the following research works:*

*a) study of the separation mechanism behind water electrolysis;*
*b) study of isotopic exchange between ordinary water and hydrogen of heavy water without catalysts under high-temperature and high-pressure conditions;*
*c) development of analytical methods for heavy water for industrial applications;*
*d) development of the method for final enrichment of the product;*
*e) determination of equilibrium constants of isotopic exchange;*
*f) development of technical specifications for the final product;*
*g) development and experimental study of heavy water enrichment process based on distillation.*

The Kurchatov's Laboratory No 2 had got overloaded with applied research, so the fundamental research tasks and their coordination had been transferred to the Karpov Institute, which in 1930 had got the "head institute" status that actually puts the institution in the position of the institute of the Academy of Sciences. This resolution was mentioned in the "Kurchatov's Report to Stalin"[5]:

*"Till 1945 the USSR had not conducted regular and targeted works in the field of heavy water production. They were initiated in 1946.*

*The Karpov Physical-chemical Institute*

*By the decree of the Council of Ministers of the USSR No 2492-1044ss from 14 November 1946, the leading scientific center is created to study heavy water production – the Karpov Institute."*

Further were listed the works to be done including those earlier planned to be conducted by the Laboratory No 2. As it was prescribed by the decree, in the Karpov Institute was organized Sector No 8 with a special Scientific Council under it. By this time the Karpov Institute was already involved with the nuclear program. The Aerosol Laboratory headed by young professor, the Stalin's premium winner I.V. Petryanov-Sokolov was reoriented to work on heavy water. Before the war the laboratory had developed industrial production of a material for gas-mask filters under the trademark MF (Military Filter). In the late 1940s, the filter materials from ultrafine fibers got an official name "FP-filters" (filters of Petryanov) and became widely known under that brand[9].

On 28 September 1945 by the decree of the Technical Council *"On additional engaging of scientific institutes, individual scientists, and other specialists in works on the use of interatomic energy"* Petryanov was appointed as a head to[1]:

- *"study and select new isotopic chemical exchange systems;*
- *study the isotopic exchange between water, water vapor, and hydrogen in the presence of catalysts (together with Tunitskii, Karpov Institute).*
- *test the performance of the process for making product 180 by isotopic exchange with simultaneous water distillation on the scaled-up pilot plant as well as on semi-industrial plant (together with engineer Bogatkov, NII-42)."*

In 1945, Petryanov had missions in Germany. In Aerosol Laboratory, FP material was tested as a separation membrane in electrolyzers for heavy water production, also the floatation method to determine $D_2O$ concentration was developed. Contemporaneously FP had been tested as a potential membrane for the separation of uranium isotopes by gaseous diffusion[10, 11].

Later in 1952–53 Petryanov had been sent to Noril'sk to attend to the heavy-water plant (the so-called "*makaronka*") that had used the method of isotopic exchange in water–ammonia system in combination with distillation of ammonia. Its start-up was unsuccessful; finally this factory turned out to be impotent because of the absence of ammonia of needed quality, besides, there was expensive energy. Initially it was planned to be built at the nitrogenous-fertilizer facility in Stalinogorsk (now it is Novomoskovsk). The site had been changed because of the conflict between Pervukhin and Zavenyagin caused by the transfer of the works on the correspondent process development from GIAP (where they were already begun) to German specialists in NII-9. Further came the point of intellectual property redistribution and the conflict had evolved to the opposition of the whole departments, i.e. the Ministry of Internal Affairs and the Ministry of Chemical Industry. Offended Pervukhin prohibited housing the plant based on the "gone" process at his ministry's sites[6, 12]. The contract German specialists were also used to exercise the supervisory control over plant start-up in High Arctic. By this time Petryanov and his laboratory had already resumed their work on FP filters[13].

Other studies on heavy water conducted at the Karpov Institute were not directly concerned with our story, thus we shall not discuss them but turn to the technical part of the program. The transfer of the institute under the "head" status in 1930 was followed by the closure of the newly set pilot station in the building No 2 which was purpose-built to house it[14]. The decree of the Council of Ministers addressed the issue of the test facility in the last paragraph:

*"10. The Ministry of Internal Affairs of the USSR (Cde. Kruglov) is to fulfill <…> in the Karpov Physical-chemical Institute of the Ministry of Chemical Industry overhaul and restoration of engineering buildings, construction of the transformer substation, expansion of the machine shop, conversion of the building housing the pilot plant, and is*

*also to build a ten-apartment bulkhead to the residential building in 1946–1947 with the total amount of work costing 2 million rubles with the execution term dated 1. VI. 1947*

*Chairman of the Council of Ministers of the USSR I. Stalin*

*Executive secretary of the Council of Ministers of the USSR J. Chadaev."*

When the decree had had being prepared nobody thought that evacuation of the pilot plants from Leuna would be so hasty. There still was not any place ready to rebuild the "small" high-pressure pilot plant for isotopic exchange in the system hydrogen–liquid water. This method had been obviously considered feasible since the research on the corresponding process was before appointed to Laboratory No 2 (see above). Firstly the measures were taken to get ready the test facility, i.e. to build the transformer house, machine shop, and the new purpose-designed building No 3. The design provided for the roof turret placed at top of the latter. It was required to house a reflux condenser of the distillation column rather than being an architectural excessiveness. The column was situated in the central part of the building, passing from a basement floor up to the roof. The building No 3 was erected by captive Germans[13]. On the date specified "June 1, 1947" it was not ready and, moreover, was obviously rather far from completion. The Pervukhin's order on the close down of the Sector No 8 had followed; its contents is actually duplicated in the Pervuhin's letter to Beria[15].

About the conflict between the Ministries little was known. Historical articles and reports about the Institute were typically written for anniversaries or other dates and thus never spoke of unsuccessful projects or any unpleasant things.

Any failure was a serious trouble for the facility newly established at the highest level, particularly in the case when the task was not too difficult. But here the situation had got still worsened by Pervukhin's personal differences with Zavinyagin resulting in the "nonsocialist" competition between their departments. In this competition, the Ministry of Chemical Industry appeared to be a bit behind. After the transfer from GIAP to NII-9, the development of the new method for heavy water production had accelerated appreciably[3, 5]:

*"In 1946, professor Vollmer with the cooperation of Bayerl and Richter had fulfilled a considerable amount of theoretical and experimental work on determining the separation factor of the exchange between light and heavy hydrogen at ammonia distillation and the distribution coefficient for heavy hydrogen under water–ammonia isotopic exchange.*

*These data obtained by Vollmer had formed the base to design a heavy water production plant with the capacity of 8 tons per year* **<…>**

*The plant's cost totals about 50 mln rubles that is several times lower than the cost of an electrolysis plant of the same capacity. For testing the lab data, in NII-9 the 8 m high pilot column is built to verify the performance of Bayerl's plates and other parameters."*

As to the method of isotopic exchange under high pressure, no substantial results had been achieved in a year at the Karpov Institute. Besides, there was the trouble with Geib who made the mistake of applying for asylum in Canada… However, an equally unpleasant incident in the same 1948 had happened and in the system supervised by Zavenyagin. The conflict between the contract German scientists and administration of the Obninsk Institute "B" headed by the German physicist Heinz Pose was caused by an error in contracts with German specialists, where 2-year instead of 10-year terms of contracts were specified. The Germans wanted to take advantage of this inaccuracy; the incident ended tragically[16].

May be the role of the "political" factor is somewhat exaggerated. Anyhow, in 1948 nobody had returned to the idea of creating of *"the scientific center for studying the problem of heavy water production"* at the Karpov Institute. Specialists from Herold's group had moved from the institute and changed the object of research, sector No 8 was closed, the "small" plant for isotopic exchange shared the destiny of the "big" one, and namely, it was dismantled to be used for spare parts and scrap. The construction of the heavy water plant at the Ammunition Facility No 100 in Aleksin had come to the finishing stage.

*№ 219*

***To the deputy chairman of the USSR Council of Ministers***
***Cde. Beria L.P.***

*14 December1948*
*top secret*
*(special dossier)*

*By the decree of the Council of Ministers of the USSR No2492-1044ss from 14 November 1946, Sector No 8 with a special Scientific Council under it was organized in the Karpov Institute of Physical Chemistry in order to oversee the research works on hydroxiline production. The Scientific Council is to exercise the supervision over research and applied works on hydroxiline.*

*Professor N. M. Zhavoronkov was appointed the head of the Sector No 8 and the chairman of the Scientific Council H.M., and the deputy director of the Karpov Institute, A. A. Zhukhovitsky was appointed the deputy chairman of the Scientific Council.*

*Currently Cdes Zhavoronkov and Zhukhovitsky are dismissed from their directorship in the Institute. Cde. Ya. M. Kolotyrkin, PhD in chemistry, is now appointed as director of the Karpov Institute, and G. S. Zhdanov, doctor of science in physics and mathematics, is appointed as deputy director.*

*Two years of the research work had proved the Sector No 8 is nonviable; actually the work was only done by Scientific Council.*

*In the light of the above, I ask you:*

*a) to give a permission to close down the Sector No 8 in the Karpov Institute of Physical Chemistry, with keeping the Scientific Council under Institute;*

*b) to approve the director of the Karpov Institute, PhD in chemistry, Cde. Ya. M. Kolotyrkin as the chairman of the Scientific Council, and professor G. S. Zhdanov – as deputy chairman, therewith to dismiss Cdes Zhavoronkov and Zhukhovitsky from these posts.*

*I ask you to sign the enclosed draft decree of the Council of Ministers of the USSR.*

*M. Pervukhin*

## "Osoaviakhim contractors" from Leuna

The Herold's group which had been brought with the equipment from Leuna to the Karpov Institute comprised near ten scientists. Those who worked with Germans were bound by written cognizance not to disclose any information, so only some remarks on this matter could be heard. Now the disclosed official information being available, it can finally be combined with some witness memories.

German specialists were brought from Babushkin (then the Moscow suburb) to the Karpov Institute on the Obukha street (now Vorontsovo pole) and back by bus. Administratively they were overseen by the fellow carrying an illustrious surname, Rabinovich. At lunch time the Germans usually ate in the institute refectory, colleagues began to greet them, the Germans answered pleasantly. But very few of the colleagues knew where they were from and what their work was. Apparently, the group was under the Sector No 8 since it was subordinate to the director and deputy director, Zhavoronkov and A.A. Zhuhovitskii, respectively. Externally the

group was overseen by the Special Technical Bureau represented in the Karpov Institute by S.Z. Kagan and his assistant A.I. Gelbstein[a]. Probably, German specialists were grouped into two teams: Herold supervised the studies of heavy water, and Friedrich Asinger worked on rocket fuel. It is also likely that the former administrative subordination from Leuna could simply be retained – Asinger in the wartime at Leuna-Werke and later in Moscow was Herold's assistant

Naturally, deportation, new working conditions, and especially the uncertainty about the pilot plant start-up made the German specialists feel uncomfortable. The professor who headed the laboratory at Karpov Institute heard one of them saying: *"In Germany we could not understand why Russia had won the war. Now we are here, we can hardly understand anything at all".*

Meanwhile work and discipline degraded badly. Institute administration began to practice penalties like deductions from salary for absence at workplace without medical certificate; furthermore, German specialists were warned that they can be treated in accordance with the Soviet labor law articles. In those years this meant the possibility of applying extremely severe measures, even imprisonment. Strict discipline was finally established. Leaving work was first to be sanctioned by Herold or Asinger and could be only authorized by the signature of Zhuhovitsky or, in case of his absence, Kagan.

Then, however, came the trouble with Geib, who attempted to gain a political asylum in Canada[17]:

> *"Dr.Geib, Professor Harteck's brilliant research pupil who had evolved the revolutionary hydrogen sulphide dual-temperature exchange process for manufacturing heavy water, had also been removed to Russia. He arrived at the Canadian Embassy one day and applied for asylum, giving the name of Professor E. W. R. Steacie as a reference in Canada. The inept Embassy officials told him to come back next day. The young German never returned; his wife was sent his personal effects a few days later and told that he was dead".*

About Geib very little is known. He was born in 1908, worked in the Institute of Physical Chemistry and Electrochemistry of Kaiser Wilhelm, then at Leuna-Werke; since 1937 was the member of NSDAP.

Herold in the book "Spying on science"[18] is presented as a frequent deserter:

> *"The struggle between East and West over the returnees turned them into Cold War tennis balls, flying between the two sides. An example is Dr Paul Herold, one of directors of the Leuna werke. He twice went West and twice East. In each case, he once went voluntarily and was once taken by force. In June 1945 he was evacuated by the Americans from Leuna, to deny him to the Soviets. On his release from American control in West Germany, he returned to Leuna, presumably because the Americans would not give him a proper job. In October 1946 the Soviets deported him to the USSR, where he spent several unhappy years. On his return to the DDR he was reappointed a director at the Leuna werke so that he would stay in the East. But he fed to West Germany in 1958. As a leading chemist, his defection may have been induced. By that time, of the 55 scientific returnees who had taken up jobs at the chemical plants in Bitterfeld, 26 had defected."*

Asinger (1907-1999) was also the member of NSDAP since 1933. He joined the party in his homeland in Austria but in Leuna showed no political activity. After spending "*8 years and 9 winters*" he too had leaved to the West, taking advantage of the Austrian citizenship. Asinger became the known chemist with the name reaction, the author of several books on the chemistry

[a] Kagan then was the senior research assistant at the Mendeleev Institute of Chemical Engineering (MKhTI); he is known as the author of textbooks on phase equilibrium. Gelbstein had remained in the Karpov Institute; for the long time he headed the Department of Kinetics and Catalysis.

of hydrocarbons. In his memory, his pupils and colleagues from RWTH Aachen University have published a historical essay[19].

While working in the Karpov Institute on the rocket fuel or in Rubizhnoe, he subjected pentan-3-one and cyclohexanone to elemental sulfur and gaseous ammonia. This treatment even at a room temperature afforded some product in quantitative yield. When leaving the USSR, Asinger managed to take out an ampoule with this substance. On return to GDR in 1954, he had soon accepted the posts of professor at the Martin Luther University in Halle and director of the Institute of Organic Chemistry at the Dresden University. In Halle it was possible to quickly identify the substance from an ampoule. It appeared to be a structural analogue of vegetative poison (the class of thiazoline alkaloids) traditionally used by native Americans and Africans to poison arrowheads. Asinger undertook to develop these reactions. The formation of such heterocycles in the presence of sulfur and ammonia had got his name (the Asinger reaction, three-component one-pot reaction). By now, about 20 various types of heterocycles are synthesized by the follow-up reactions described in more than 120 publications and 60 patents.

We can add nothing to the story of Herold's group; no information about its other members could be found.

## Afterword

The reader will remark that the three versions presented above differ a lot. According to the first version, "*the priority of the USSR in the development and commercial implementation of the method"* was achieved entirely independently and relying on own resources, with own experimental research, the independently developed new approaches to calculation of the isotope exchange process and equipment, design solutions, etc. The second version assigns a good deal of results to the Germans. Oleynikov comments on the citation from the report of CIA: *"The facility in Tula, with a high degree of certainty, can be attributed to the Germans' work"***.** Apparently, the truth is somewhere in the middle…

It is necessary to add that the construction of the building No 3 in the Karpov Institute was completed in the beginning of 1950. The first store in its left part was occupied by the Laboratory of Stable Isotopes. The trophy hardware was used to erect the distillation plant, which was situated in the central part of the building. However, if it only was employed to produce heavy water, it was $H_2O^{18}$ rather than $D_2O$. Above this laboratory on the second floor resided the compressor station. There long dwelt two high pressure (300 *bar*) German compressors. Obviously, these were the remains of the "small" pilot plant from Leuna.

The German heavy-water trace in the Karpov Institute will extinguish soon. The building No 3 now is nearly empty and almost ready for demolition.

The author is grateful for the assistance and support of N.V. Kulkova, A.Yu. Strugatskaya and D.Yu. Murzin.

The work on this article was supported by the Russian Foundation for Basic Research (Project No. 06-06-80299-a).

On Zemlyanoj val street near the bridge over Yauza there is a place from which still recently one could see
the building No 3 of the Karpov Institute with its time-skewed spire.

To the right of it – the former GIAP building.
The close up – opposite side view

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