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Where Radiobiology Began in Russia: A Physician's Perspective

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14. ABSTRACT
This report discusses the radiation hazards and injuries encountered by both radiation workers and the general public during the early days of the Mayak Production Association, the first plant built as part of the USSR nuclear weapons program. Construction of the facilities was suboptimal, and prisoners performed much of the work, including highly technical scientific procedures. The development of the radiation biology program in the USSR is described from a historical and medical point of view. Wastes released into the Techa River created serious levels of contamination in the littoral area, requiring the eventual evacuation of around 20 villages and several thousand of their inhabitants. A major explosion in an underground liquid waste storage tank occurred in 1957 (the Kyshtym accident). Although there were no immediate casualties, the explosion released millions of curies into the environment and again forced the authorities to evacuate village residents. Several first-hand comments from radiation injured patients and scientists and other workers involved at Mayak are included.

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CONVERSION TABLE

Conversion Factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY ⟶ BY ⟶ TO GET
TO GET ⟵ BY ⟵ DIVIDE

angstrom	1.000 000 x E -10	meters (m)
atmosphere (normal)	1.013 25 x E +2	kilopascal (kPa)
bar	1.000 000 x E +2	kilopascal (kPa)
barn	1.000 000 x E -28	meter^2 (m^2)
British thermal unit (thermochemical)	1.054 350 x E +3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical/cm^2)	4.184 000 x E -2	mega joule/m^2 (MJ/m^2)
curie	3.700 000 x E +1	*gigabecquerel (GBq)
degree (angle)	1.745 329 x E -2	radian (rad)
degree Fahrenheit	$t_k = (t^o f + 459.67)/1.8$	degree kelvin (K)
electron volt	1.602 19 x E -19	joule (J)
erg	1.000 000 x E -7	joule (J)
erg/second	1.000 000 x E -7	watt (W)
foot	3.048 000 x E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 x E -3	meter^3 (m^3)
inch	2.540 000 x E -2	meter (m)
jerk	1.000 000 x E +9	joule (J)
joule/kilogram (J/kg) radiation absorbed dose	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	4.448 222 x E +3	newton (N)
kip/inch^2 (ksi)	6.894 757 x E +3	kilopascal (kPa)
ktap	1.000 000 x E +2	newton-second/m^2 (N-s/m^2)
micron	1.000 000 x E -6	meter (m)
mil	2.540 000 x E -5	meter (m)
mile (international)	1.609 344 x E +3	meter (m)
ounce	2.834 952 x E -2	kilogram (kg)
pound-force (lbs avoirdupois)	4.448 222	newton (N)
pound-force inch	1.129 848 x E -1	newton-meter (N-m)
pound-force/inch	1.751 268 x E +2	newton/meter (N/m)
pound-force/foot^2	4.788 026 x E -2	kilopascal (kPa)
pound-force/inch^2 (psi)	6.894 757	kilopascal (kPa)
pound-mass (lbm avoirdupois)	4.535 924 x E -1	kilogram (kg)
pound-mass-foot^2 (moment of inertia)	4.214 011 x E -2	kilogram-meter^2 (kg-m^2)
pound-mass/foot^3	1.601 846 x E +1	kilogram-meter^3 (kg/m^3)
rad (radiation dose absorbed)	1.000 000 x E -2	**Gray (Gy)
roentgen	2.579 760 x E -4	coulomb/kilogram (C/kg)
shake	1.000 000 x E -8	second (s)
slug	1.459 390 x E +1	kilogram (kg)
torr (mm Hg, 0^0 C)	1.333 22 x E -1	kilopascal (kPa)

*The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.
**The gray (Gy) is the SI unit of absorbed dose.

FOREWORD

After World War II the Soviet Union rapidly accelerated its nuclear weapons program. Under the leadership of Igor Kurchatov and others at the Ministry of Medium Machine Building, facilities for processing fuel for weapons were quickly set up, first near the city of Chelyabinsk in Russia and later near Tomsk and Krasnoyarsk. The first facility, called the Mayak Production Association (MPA), had three main work areas: the reactor, where plutonium was produced (and the inevitable fission products); radiochemical production, where plutonium was chemically extracted after a cooling period; and the plutonium production plant, where it was made suitable for use in weapons. Access into and out of these special areas was restricted, and workers at the plants received medical care from a system separate from that for other citizens in the region.

As this report clearly illustrates, there were several issues, some unavoidable, some not, that combined to increase the injury rate at the MPA. Workers were given tasks without being informed about the hazards involved or how to prevent or mitigate risks. There was not a “safety culture” that governed the approach to dangerous work. Sometimes this was because the risks were unknown, but sometimes supervisors simply didn’t, for whatever reason, notify the workers. The buildings and laboratories were hastily constructed, and often not suitable to the safety of the work being carried out within them. As in any new industry unanticipated problems with procedures and equipment arose, and accidents occurred. There was considerable pressure from higher up to accelerate the work in order to catch up with the US. For example, the initial cooling period, intended to allow the highly radioactive isotopes in a slug from the reactor to decay long enough to permit radiochemical extraction, was shortened. This increased the radiation exposure rate to those in this particular plant.

The general public, which was intentionally not informed of the type of work performed at the MPA or even of its existence, also suffered from high radiation exposures. Treatment was complicated by the fact that the doctors couldn’t even tell the patients what was the cause of their illnesses. Initially, after the startup of the MPA, radioactive wastes less than a millicurie/liter were discharged directly into the Techa River. Villagers downstream used the Techa’s waters for fishing, watering gardens and crops, bathing, cooking, and drinking, preferring river water to well water. After a few years, medical and dosimetric investigations were carried out, and serious health effects were noted. The practice of dumping radioactive wastes directly into the river was halted, and several thousand people from approximately 20 villages were evacuated.

Higher level wastes were kept in storage ponds or underground tanks. In 1957 a catastrophic explosion occurred in one of the tanks, spewing 20 million curies of radioactive material into an area north and east of the tank site near the village of Kyshtym. This area became known as the Eastern Urals Radioactive Trace (EURT). In 1967 Lake Karachay, where intermediate-level wastes were stored, dried up considerably due to a drought, allowing winds to disseminate these isotopes along the EURT.

Branch No. 4 of the Institute of Biophysics of the USSR Ministry of Health (later the Urals Center for Radiation Medicine and Ecology) was set up to provide health services for the population exposed due to radiation incidents at the MPA and conduct studies of long-term health effects of radiation exposure on that population and also the general public along the Techa River. The Center has accumulated considerable amounts of data from the radiation injuries experienced by both workers and the public, and how they were managed.

In 1992 the Department of State authorized the Department of Defense to initiate cooperative work with scientists and physicians in Russia and other former Soviet republics. One such project, entitled *"Long-Term Evaluation of Irradiated Personnel"*, included work on the subject of biological effects of radiation from the former Soviet Union's nuclear weapons program. The first contract the Defense Nuclear Agency made under this project was with the Center, because of its unique position to evaluate large numbers of people who had been exposed to high levels of radiation. In 1994 the Armed Forces Radiobiology Research Institute (AFRRI) published as a contract report "Analysis of Chronic Radiation Sickness Cases in the Population of the Southern Urals", by Kosenko M.M., Akleyev A.A., Degteva M.O., Kozheurov V.P., and Degtaryova R.G. The Center subsequently provided two more papers on chronic radiation sickness and the effects of radiation contamination on the reproductive function of residents along the Techa. Dr. Mira M. Kosenko was the primary author on all three documents.

Dr. Kosenko has been in a unique position to observe the development of radiobiology in the former Soviet Union. This is not only because of her extensive clinical experience with those injured by radiation exposure at the MPA and along the Techa River, but also from her conversations with those involved in radiobiology from the beginning of the weapons program there. She has compiled a detailed account of her reading, records, and personal experience that gives valuable insight into how this field developed. The hard lessons in radiation hazards and injuries experienced during the startup days of the nuclear weapons program in the USSR should never be forgotten.

Glen I. Reeves, MD

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1.0 Introduction

I am a medical doctor. My patients were people who had been irradiated from radiation accidents. These accidents happened a long time before Chernobyl. They happened in the USSR, in the Urals, in a factory where plutonium for an atomic bomb was produced. During 50 years all information about these accidents and about the irradiated people was regarded as state secrets. As soon as the period of "perestroika" began in the USSR it became possible to publish medical information on the consequences of radiation. Some of the first publications were Technical Reports published by the Armed Forces Radiobiology Research Institute (AFRRI), then a part of the U.S. Defense Nuclear Agency: "Analysis of Chronic Radiation Sickness Cases in the Population of the Southern Urals" (Kosenko, 1994); "Chronic Radiation Sickness Among Techa Riverside Residents" (Kosenko, 1998); "Effects of Techa River Radiation Contamination on the Reproductive Function of Residents" (Kosenko, 2006), which showed the results of essential joint scientific projects of Russian and American specialists. This research wouldn't have seen the light of day without the very active participation of the AFRRI Scientific Director, E. John Ainsworth, and the New Independent States Initiatives Coordinator, Glen I. Reeves. These reports contained tables, graphs, and scientific conclusions. But they did not tell the living stories of eyewitnesses who saw the outcomes of the radiation accidents and what those exposed to the effects of radiation underwent. No one had asked them whether it was possible to prevent people from being irradiated. The Urals Mountains contained (and, yes, I am sure they still contain) many unpublished "atomic secrets." The first biophysical laboratory (Laboratory B) in which, besides young Russian scientists, political prisoners and Germans interned after World War II worked was created in the Southern Urals.

The attempt to tell this story, in ordinary informal words, was the impulse behind writing these pages. Separate parts of this publication are devoted to the description of what medical problems accompanied the activity of the nuclear monster "Mayak" in the Southern Urals region of the USSR. Others describe the irradiation of the population that lived around "Mayak". I tried to describe the radiation accidents in the Urals in the words of the eyewitnesses. The resulting conclusion is that this nuclear weapon still "shoots", even when it is not used.

2.0 "It's Where Radiobiology Began in Russia"

That is how V.I. Ivanov, academy member and director of the Medical Genetic Research Center, described Laboratory B. (cited in Yemelyanov, 2000). The first time I ever heard of this secret laboratory was from Nadezhda Alexeyevna Poryadkova, whom I met at a meeting of the radiobiology school in Perm. Nadezhda Alexeyevna, who graduated from Timiryazev Agricultural Academy and had the option of remaining in Moscow for graduate work, preferred to begin her career at the "Object." There she worked with N.V. Timofeev-Resovsky and met her husband, scholar and prisoner Nikolay Viktorovich Luchnik. In March 1981 she told me in a whisper—since information on the laboratory was classified—about her path in the field of biology, which began in the Urals. After certain information regarding nuclear issues was declassified, B.M. Yemelyanov and V.S. Gavrilchenko wrote "Laboratory B, Sungul Phenomenon," a fine book illustrated with many documents. (Yemelyanov, 2000). It was published in 2000 in Snezhinsk. Unfortunately, the total print run was only 2000 copies. Conversations with N.A. Poryadkova, the memoirs of N. Timofeev-Resovsky and materials from the book by Yemelyanov and Gavrilchenko are the foundation for this story.

Before the end of the war, in early May 1945, a team of Soviet specialists led by A.P. Zavenyagin flew to Germany "to identify scientific, technical and technological advances of the Germans in atomic projects." Avramy Pavlovich Zavenyagin was a leader in the Soviet atomic project. Soviet specialists had visited a number of industrial enterprises and research laboratories, including the Institute of Biophysics and Genetics in Buch near Berlin, where N.V. Timofeev-Resovsky worked from 1925-1945. By 10 May 1945, the State Defense Committee had decided to export the property of the Kaiser Wilhelm Institute of Physics and the research laboratory of M. Ardenne and G. Hertz to the USSR. Not only the equipment was taken; German specialists were also "recruited" to work in the USSR. They were exported to secret laboratories and institutes being created in the USSR. Also in 1945, laboratories A and D were established near Sukhumi and Laboratory C in Kaluga.

Figure 2.1 Map of Russia

The Mayak nuclear complex was between Yekaterinburg and Chelyabinsk. http://geography.about.com/library/cia/ncrussia.htm, accessed 13 Sep 2010.

2.1 Laboratory B

There are rumors that when work was underway to create an atomic weapon, Joseph Stalin summoned Lavrenti Beria and said, "We are building a bomb, we don't know how to escape it…" (Medvedev, 2001) The order to create Laboratory B in the Urals had already been given at the beginning of 1946. The primary requirements for the location were an isolated area that ensured secrecy could be maintained and that was close to a large-scale reactor. They found such a place on the small peninsula of Mendarkin that was lapped by two lakes, Sungul and Silach, and which was 20 km from the ancient city of Kasli and 40 km from the first large-scale reactor for the production of a plutonium bomb.

The name Mendarkin comes from someone who lived here at one time and was a wealthy Bashkir, hunter and rancher. Old Believers settled there later, establishing a monastery on its hilly cape. During the Soviet era, an agricultural commune appeared on the peninsula. These places are extraordinarily beautiful. In the beginning of the 1930s, the Commissariat of Interior Affairs (NKVD, later called the KGB) decided to build a special therapeutic resort there. The name of the peninsula was changed to Sungul, the name of its lake. The resort was given part of the forest belonging to the Kasli dacha. Three spacious buildings with wonderful detail and workmanship were erected.

It was apparently the idea of A.P. Zavenyagin to place Laboratory B here. The Sungul resort was transferred to L.P. Beria's agency, the USSR Ministry of Internal Affairs (MVD). The MVD had a special 9th Directorate that ran "Special Institutes." The name of Laboratory B was changed many times: "USSR MVD Site 0215"; "Kasli, P.O. Box 0215"; "Site Sungul"; and even "Urals MVM Technical College". The site was divided into different areas; persons entering into each area had to pass through an access control point. In the first restricted area stood the laboratory, which was enclosed by stone pillars and tall metal rods. The second area was residential; in addition to the dormitory block, there were several cottages for senior specialists. The third area was for support service workers. Not only was the entrance to the premises guarded, but also the waters of the peninsula. Lab employees were prohibited from walking outside in the area without an escort.

The laboratory was located in a three-story building with high ceilings and a large number of rooms. This was the redesigned Building № 1 of the resort, which became known as Building A. Additional stories were later added to the right wing of the building. To support the laboratory, two buildings were constructed for a vivarium and a greenhouse (blocks D and E), block G, with two concrete shafts for powerful radiators, and block H for working with radioactive isotopes. The basement was outfitted for storing containers of solutions obtained from the Chelyabink-40 production reactor. An underground storage facility was constructed for radioactive waste.

2.2 "Sharashka" and its Inhabitants

This was the "Sungul Sharashka," one of three described by A.I. Solzhenitsyn (Solzhenitsyn, 1973):

> "It was a remote apocryphal legend, confirmed by no one, of which you would hear about every now and then in the camps: that somewhere in this archipelago there are heavenly islands. No one had seen them, no one had been there; whoever had was silent and would not speak of them. It was said that they were islands of milk and honey, and that no one was feed anything less than sour cream

> and eggs; it was clean as a whistle there, they said, always warm, where the work was intellectual and 100 percent classified. And here at these heavenly islands ("sharashkas" in the words of the prisoners) I wound up for a half term. I was indebted to them because I remained alive. It would have been impossible for me to survive my entire sentence in the camps. I am indebted to them that I am writing this work, although I can't envision a place for them in this book…"

How did prisoners find themselves in the sharashkas? N.A. Poryadkova told me a fuller version of the story, one about her husband, N.V. Luchnik.

Nikolay Viktorovich Luchnik was the son of an entomology professor. He moved from Stavropol to Moscow in 1939 and entered the mechanics and mathematics department of Moscow State University, but soon transferred to the biology department. Luchnik finished his sophomore year when World War II began, and was conscripted by the army. His unit was located in Iran. A hepatitis epidemic began spreading among the soldiers, as a result of which there was a partial demobilization, so Luchnik was sent in July 1942 from the unit to the Stavropol military commissariat. He arrived at Stavropol on the last train before the city was occupied by Hitler's troops. The military commissariat had already been evacuated. Luchnik was stuck in occupied Stavropol. He was 20 years old. For five months he studied at the Stavropol agricultural institute. Then, as B.M. Yemelyanov and V.S. Gavrilchenko wrote, N.V. Luchnik, "under threat of being sent to the camp for military prisoners, worked as a draftsman and translator for the Germans for two months in a construction office."

After Stavropol was liberated by Soviet troops, N.V. Luchnik was arrested on 3 April 1943 and sentenced to ten years in prison and five years exile. He served his time in Rustavi.

N.V. Luchnik's book, "The Second Game," (Luchnik, 2002) contains excerpts of letters to his mother. While in prison, he learned in 1945 that atomic bombs had been dropped on Japanese cities. Luchnik asked his mother to send him Bronstein's book "Atoms, Electrons, Nuclei"…, "any university chemistry textbook (the thicker, the better)." In February 1946, he wrote that he had "begun developing a very important theory concerning one of the murkiest subjects in chemistry (the structure of the atomic nucleus)." Strictly speaking, he had two ideas: a theory of the structure of the atomic nucleus and a design of a hydrogen bomb. With these ideas in his pocket, N.V. Luchnik began putting them on paper in letters to the head of the camp, to the GULAG, the Academy of Sciences, an Academy member, the Ministry of Defense and to "Comrade Stalin." The purpose of the letters was to escape the prison camp and get into the sharashka.

His work piqued their interest. In 1947, N.V. Luchnik was sent to work with a "special team formed in connection with his discovery." The prisoner N.V. Luchnik was delivered to the Sungul Sharashka, or in his own works, "from Hell to a P.O. box."

The story of how Nikolay Vladimirovich Timofeev-Resovsky turned up in the Sungul Sharashka has been described in a number of books. He was arrested in Germany in September 1945 for refusing in 1937 to return to the USSR from a foreign assignment. A military division of the Supreme Court of the USSR sentenced him to 10 years in a labor camp, the loss of political rights for 5 years, and the forfeiture of his property. N.V. Timofeev-Resovsky was taken to the Karagandinsky camp, where he became ill with pellagra and would have died had not A.P Zavenyagin found him. After a stay in the MVD hospital in Moscow, N.V. Timofeev-Resovsky was sent in May 1947 to Laboratory B although still a prisoner. In September of that same year, his family—wife Yelena Alexandrovna and twenty-year old son Andrey—arrived at Sungul from Berlin-Buch. Pieces of equipment, furniture, large aquariums and the scientific books in Nikolay Vladimirovich's library were brought to the USSR from the institute in Buch.

At the Institute of Genetics and Biophysics in Germany, N.V. Timofeev-Resovsky worked with zoologist and geneticist Sergey Romanovich Tsarapkin, who was also convicted as a defector and sent to Sungul in October 1947.

The fates of prisoner-scientists Professor S.A. Voznesensky, N.G. Polyansky, D.I. Semenov and others who worked in laboratory B, were approximately the same: study, scientific work, often war and capture, sentencing under Article 58 "for participation in an anti-Soviet organization," labor camp, and then the sharashka. Academician L.A. Buldakov, who was a civilian employee in Sungul, says that A.P. Zavenyagin prepared and turned over a list of the specialists he needed to Colonel A.K. Uralets, the head of the laboratory, who traveled to the camps and searched for them among the prisoners. At the requests of N.V. Timofeev-Resovsky, Dr. Dmitry Ivanovich Semenov was sent from the labor camp to the laboratory. He had treated Nikolay Vladimirovich at the labor camp, who had promised to hire him in the future "when he had established his own institute."

In addition to the prisoners, many Germans were interned at Laboratory B. In 1945, nearly 300 Germans, up to 50 of which were PhDs, ended up in the USSR along with their families. Several of these German specialists had signed contracts; ten were military prisoners; there were also immigrant experts, ethnic Germans from the Volga region, who worked in support positions. B.M. Yemelyanov and V.S. Gavrilchenko found documents in an archive describing the fate of Mark Yulianovich Tissen, a research associate at the laboratory. In 1944, he was given special settler status because of his German family. In a routine check in 1949, it was discovered that he was Russian and that he had been improperly registered as a special settler.

The famous biophysicist Karl Gunter Zimmer, radiochemist Hans Joachim Born and Alexander Siegfried Koch, a doctor by education, were brought to the site in December 1947. A.P. Zavenyagin had had his eyes on these specialists since 1945. Later, in September 1950, Nicholaus Riehl and his family and Dr. Henri Ernst Ortmann were sent to Sungul.

Civilian employees with a biological and medical education—Yu.I. Moskalev, V.N. Streltsova, L.A. Buldakov, N.A. Poryadkova, S.A. Rogachev and others—were assigned to Sungul after finishing the institute or completing graduate studies.

Civilians were prohibited from socializing in their off-hours with the German specialists and prisoners, but the rules were not strictly observed. Civilian N.A. Poryadkova married prisoner N.V. Luchnik in 1951. They had two sons in Sungul, Andrey in 1953 and Igor in 1954, though Nadyrov Most was listed as their place of birth. N.V. Timofeev-Resovsky's son, Andrey was married in 1953 to civilian Nina Alexandrovna Remezova, who came to Sungul from

Vishnevogorsk to be a geography teacher. Andrey and Nina had no children, which saddened Nikolay Vladimirovich Timofeev. There was no one to take the name Resovsky in the family, which was the name of his ancestors from the Resa River, given only to the firstborn son in the family.

2.3 Radiation Biology Begins

Laboratory B was created to be a radiobiological laboratory. Its mission was to assess the effects of ionizing radiation on living organisms and the behavior of radionuclides in nature. A biological department, headed by N.V. Timofeev-Resovsky, and a radiochemical section, led by S.A. Voznesensky, were created. The laboratory also examined unsettled biological problems that arose during the atomic project in the USSR. Thus, they conducted broad research on methods for radioactive waste removal following the contamination of the Techa river basis with radioactive waste from a commercial nuclear enterprise (Complex № 817, which was the Mayak nuclear complex). However, lab employees were not permitted to see for themselves the actual situation at the sites of the industrial complex and could not even obtain detailed information. This is likely the reason that the result of their research was “not what we had expected.”

A large production laboratory was used to isolate pure isotopes from unseparated mixtures of uranium fission fragments. The mixture, officially named “Product 904,” was nicknamed “yushka” by N.V. Timofeev-Resovsky. It was produced from the reprocessing of standard uranium bars at Industrial Complex № 817 (Chelyabinsk-40). They wrote and spoke in Aesopian language: irradiation was referred to as “fumigation”, radioactivity as “aggressiveness”, atomic reactor as “mechanism”, plutonium as “Sirius”, and uranium as “Mars”.

The head of the site and official research director was an employee of the MVD, Colonel Alexandr Konstantinovich Uralets. His actual surname was Ketov. During the Civil War he used “Uralets”, which was a Communist Party nickname that eventually became his surname in all documents. Everyone who worked for Uralets regarded him as an exceptional individual. It is for certain that he knew absolutely nothing about biology. N.V. Timofeev-Resovsky agreed to teach Uralets the basics, and the “pupil” diligently kept records in a notebook. Uralets was a good judge of character and was bright and sincere. Nicholaus Riehl wrote of him: “He was free of any ideological limitations and acted pragmatically and flexibly… The majority of the involuntary residents at the site never knew the risks he took to make their lives easier.” It was due to A.K. Uralets’ being “free of any ideological limitations” that Laboratory B was the only lab in the USSR that continued breeding fruit flies and studied mutation after genetics had been quashed. N.V. Timofeev-Resovsky, writes N.V. Luchnik, was a “fruit flyer, Mendelist and a Morganist.” You could not find any words more pejorative at the time. A.K. Uralets tried as best he could not to interfere with the genetic fruit fly research. He was eventually forced to destroy all the fruit flies and the scientist moved on to studying genetic effects in plant cells.

A.K. Uralets did a lot to ensure that the employees had good living conditions. Timofeev-Resovsky’s family lived in a separate five-room cottage, as did Voznesensky’s family. Both the Soviet specialists and the Germans received handsome salaries.

In the article “Secret People,” journalist M. Fonotov tried to look at the scientists in Laboratory B through the eyes of the people who lived outside Sungul (Fonotov, 2002):

> Someone told me how once (not long after the war) he had a vision, similar to a hallucination: in the forest, on the shore of one of Kasli’s lakes, strange people suddenly appeared in strange garments speaking in German. One in a hat, one without, one in a raincoat, another in a checkered suit, they stood with their hands behind their backs and raised their heads, exchanging short retorts, clearly enjoying the quiet, the smells, the forest, lake, sky… The strange newcomers disappeared as suddenly as they appeared. Only a gray “Pobeda” car flashed behind the trunks of the pines. The landing of the German scientists into Sungul then, in 1947, very likely appeared like an alien landing. Such people in Kasli were an oddity. They were clearly from another world, another life beyond the dreams of local residents.
>
> The aliens not only appeared to be German, but also Russian scientists. From the perspective of the locals, the scientists at Sungul lived behind barbed wire and spiked fences in heaven. And the prisoners were for some unknown reason lavishly rewarded. Is it by accident that a prisoner has a five-room villa? The department heads were paid up to 4,500 rubles a month and the German scientists up to 6,500. The average salary in the industry was 700 rubles. A village in those years rarely ever saw money.

Despite the good living and working conditions, no one felt free. It is not without reason that Nicholaus Riehl, who became a Socialist Labor Hero of the USSR, entitled his memoirs “Ten Years in a Gilded Cage.” (Riehl, 1988, quoted in Yemelyanov, 2000). The book was not printed in Russia. N.V. Luchnik documented his feelings about everyday life in the Sungul Sharashka in the poem “Sunguliad” (quoted in Luchnik, 2002):

> Here the months are all the same,
> We meet for lunch and in the evening;
> Walking in the forest adjacent,
> There is nothing here to see.
> Here we forgot the peace pipe
> And found nothing else better,
> Than each in his shell,
> A woodchuck tucked into his burrow.

Later, N.V. Luchnik (Luchnik, 2002) broaches the topic of the German and Russian scientists in Sungul:

> Once in the evening, at tea,
> Not especially long ago
> Unintentionally and inadvertently
> I overheard a conversation.

On my left two were speaking
About the preceding year.
One of them calmly said:
“It won’t happen without the Germans.
One can already tell:
They have too much breadth,
If the West cannot,
Then we will not solve the problems.
All the talented people–
With names ending in –OV and –SKI,
They were beyond the border,
They do not have Russian brains.
And if not, then probably their grandfather’s [ended]
In –STEIN or –MANN,
They know German too,
Their background is a fraud.”

I, without the strength to object,
Will in no way contradict them.
Such scientists in Russia
Are indeed hard to find.
And if somewhere they find one,
Be he young or old,
They will turn him into a bookkeeper
Or a country veterinarian.”

The end of the poem strikes a patriotic note:

The first that trod this path
The Russian genius—Lomonosov…
Not for rations, not for pay
Nor vodka gained in dispute,
Science is a private treasure
Seek it in the quiet of the laboratories.
No: for the Fatherland, for honor,
Both day and night, with body and soul.
To assess or consider it,
Is in the end, not our affair...

Laboratory B existed for six years. There they studied patterns in the reactions of animals and plant cells to radiation, the distribution of radioactive isotopes among organs, and the protection provided by different substances against the effects of radiation. The scientific research conducted in 1947-1951 by N.V. Luchnik paved the way for the conclusion that damage to genetic material is not irreversible and that radiological irregularities were reducible. This was a discovery. Dr. Pani and Dr. V. Menge were able to create drugs that helped eliminate radionuclides from the body. In the seventies, I prescribed the drug Pentacin, hoping to reduce the amount of radioactive strontium in my patients. A. Koch, a medical doctor by education, was also working on removing radioactive substances from the body, as well as K.G. Zimmer, a specialist in radiodosimetry in Germany who successfully continued working in this area in the Sungul laboratory. Together, they released a thorough report titled "The Slow Neutron Dosimetry Method and Constructive Proposals."

Vera Nikolayevna Streltsova, a medical doctor who worked in Laboratory B as a civilian employee, spoke about the "accidental" nature of her discovery. She was ordered to study acute radiation sickness during the first thirty days after rats were injected with radioactive isotopes, sacrificing the animals at that time. But she allowed one group of irradiated animals to live until their "natural" death. Several of these developed cancerous growths in their bones, hematopoietic organs, liver, lungs and mammary glands. Thus, she demonstrated the carcinogenic effects of internal irradiation.

The results of the research were classified as "secret" or "top secret" in the reports produced in triplicate by the typist. Obviously, several employees of the secret Institute of Biophysics were familiar with these materials, since one copy of the reports was sent there for review. Other specialists did not see them. The results of the research conducted in the laboratory were never published in full. Dr. V.I. Korogodin, who happened upon the reports after they were declassified, called them a "buried but living product of the intellect." Thirty-four years were to pass before N.V. Luchnik received a diploma confirming his discovery in Laboratory B in 1951. Professor H. Bonka from Aachen, after meeting me at a meeting in Munich in 1993 and learning I was from Chelyabinsk, asked me to send him N.V. Timofeev-Resovsky's work in the Urals on radiological biocenology. I was unable to help him because I could not find the published work.

Laboratory B was also known as the "Sungul Phenomenon." It may appear paradoxical but many scientists regard their time at the site as the most fruitful period of their lives. N.V. Timofeev-Resovsky judged his research in the Urals as his "most productive experimentally."

2.4 Closure of Laboratory B

The order to close Laboratory B was signed 5 April 1955. Evidently, the primary reason for its closure was that its facilities, essentially constituting a secluded town, were needed to create another research institute in the Urals. This institute, NII-1011, was to become a duplicate of Design Bureau № 11 (Arzamas-16)—a Federal nuclear center and institute in the Urals for creating nuclear units and "articles," i.e., bombs. Sungul, the town on the lake, was renamed Chelyabinsk-70 at that time, and is now known as Snezhinsk. Academy member B.V. Litvinov, who works in Snezhinsk, says, "I was always convinced that research is possible only in these small towns like Pushchino, Chernogolovka, Obninsk, Dubna, Protvino… It's like this all over the world because cities like Moscow are too big; conducting research there is too taxing. When a person has to waste an hour and a half getting to work, and then the same time on the way back, how can one conduct research?" (quoted in Gubarev, 2010)

By the time Laboratory B was closed, many specialists had already been discharged after completing their sentence. They were not, however, allowed to return to their homeland. Most of them were transferred to NII-5 in Sukhumi, where they were to spend a "cooling down" period, i.e., work on unclassified projects for another 2-3 years, during which they "would forget everything." The German specialists left then, generally to East Germany (the German Democratic Republic, or GDR), but the majority turned up soon in West Germany (the Federal Republic of Germany, or FRG). K. Zimmer became the director of an institute at the Nuclear Research Center in Karlsruhe; H. Born was named the dean of the radiochemical department of Munich University.

The fate of many of the Soviet scientists who were prisoners was worse. At the site, they received special credit (one day counted as two or three) provided that they did good work. Consequently, their term of confinement generally ended in 1951-1952. They were not released, however, but remained at the site with the status of special residents. Three of these prisoner scientists were Tsarapkin, Timofeev-Resovsky and Luchnik.

Sergey Romanovich Tsarapkin had the most difficulty. He was no longer a young man when he arrived at Sungul with his wife and three children. Sergey Romanovich was a theorist with a narrow specialization in genetics. He had a hard time mastering experimental research. His position in the laboratory was junior research associate. He became withdrawn and, as N. Riehl wrote, "lost the chance of receiving a reduced sentence as a reward for 'useful work.'" N. Riehl, who had "learned from previous experience 'how to serve God and pay the devil,'" could understand Tsarapkin's point of view, but could not share them. "Sometimes it is better to 'give the Kaiser his due,'" wrote N. Riehl (as quoted by B.M Yemelyanov and V.S. Gavrilchenko). S.P. Tsarapkin was dismissed from the laboratory in December 1952 and sent to Kustanay. At the end of his life, he was able to move to Ryazan where his daughters lived. He was frequently seen with Solzhenitsyn during those years, whom he had met in 1946 in Butyrka prison. Solzhenitsyn wrote "The Gulag Archipelago" in Ryazan. S.P. Tsarapkin died there in 1960.

2.5 Timofeev-Resovsky and Luchnik

Neither N.V. Timofeev-Resovsky nor N.V. Luchnik had their rights restored after finishing their work in the laboratory. Nikolay Vladimirovich had to submit requests for reviews of his status by K.Ye. Voroshilov, V.M. Molotov and G.M. Malenkov (Soviet government officials) due to the fact that "he and his family had been sentenced to an unlimited term as resident at his place of work." Owing to the uncertainty of their future, Timofeev-Resovsky's wife, Yelena Alexandrovna, wrote in a letter: "It is very depressing here. Even though I am cheerful by nature, I still fall into despair sometimes. Kolyusha has been in an impossible state recently…" N.V. Timofeev-Resovsky and N.V. Luchnik were prohibited from working and living in Moscow. They and their families were forced to move to the Urals branch of the USSR Academy of Sciences in Sverdlovsk.

From 1955-1964, N.V. Timofeev-Resovsky was the head of the radiobiology and biophysics department at the Biology Institute in Sverdlovsk [now Yekaterinburg—Ed.]. In addition to lab rooms in Sverdlovsk, the department also had a two-story wood house at Bolshoe Miassovo

Lake, which was outfitted with a biological research station. A school formed around Timofeev-Resovsky. Much has been written about this school, summer workshops at Miassovo and "Miassovo University." R.V. Petrov wrote: "Who was it that Timofeev-Resovsky read to? Who ordered him to do so and who sent us to Bolshoe Miassovo in the Urals? No one. We found him ourselves and went there on our vacations. He was ready to teach anyone with a thirst to learn about genetics." (Petrov, 1993) In his memoirs Nikolay Vladimirovich noted that "…throughout my life, I and my colleagues and closest friends from other laboratories have always organized… entirely informal and loose groups, which have always renewed our zest for the scientific life and helped in our work." (Timofeev-Resovsky, 1995) Yelena Alexandrovna Timofeev-Resovskaya led a practical class on fruit flies. N.V. Luchnik gave presentations at many meetings. He shared with his audience the results of his research, and about deciphering the genetic code in particular. The Miassovo schools continued for almost five years. They were replaced in 1965 with schools on radiobiology and genetics.

In 1961, the talented artist Rouben Gabrielian, who was living at the time in Chelyabinsk, went to Miassovo to draw portraits of scientists. He drew portraits of both N.V. Timofeev-Resovsky and N.V. Luchnik. Nikolay Vladimirovich insisted that the drawing include a portrait of Niels Bohr. On a stool on the left is a Kasli-cast figurine of a cast iron bison, a gift to Nikolay Vladimirovich from his laboratory colleagues when he was still in Sungul. Such gifts were the idea of Vera Nikolayevna Streltsova: at their departure, S.A. Voznesensky received a small sculpture of Don Quixote and Timofeev-Resovsky was given the bison. The portrait of N.V. Timofeev-Resovsky, which the wife of geneticist V.I. Ivanov in a light state of mind named the "Bison," depicted, in the opinion of friends, three "bisons": Niels Bohr, Timofeev-Resovsky, and the bison itself. This was the inspiration for the title of D. Granin's book on Timofeev-Resovsky.

In 1964, N.V. Timofeev-Resovsky was invited to head the radiobiology and biophysics department at the Medical Radiology Institute in Obninsk (Kaluga Region). He accepted, saying that he "hailed from Kaluga" and "it will be nice to die at home." The department had four laboratories for radiobiology and radiation genetics research, and for developing the foundation of mathematical evolution theory. Despite the successes of the department, the Communist Party authorities in Obninsk demanded that the Director of the Medical Radiology Institute, G.A. Zedgenidze, fire Timofeev-Resovsky because he had an "undesirable" influence on young people. Zedgenidze defended the talented scientist, who was very much needed by the Institute, as best he could. However, the department was closed in 1970 and N.V. Timofeev-Resovsky retired, although he did work as a consultant for O.G. Gazenko at the latter's Institute of Medical and Biological Problems.

One other calamity struck Nikolay Vladimirovich in Obninsk—his wife died. Yelena Alexandrovna passed away in April 1973. A requiem is completed for her annually at Trinity Church in the Vorobiev Mountains. Nikolay Vladimirovich was ill frequently after her death.

I was on assignment at the Medical Radiology Institute in Obninsk in February 1981. At one of the meetings there, I saw A.K. Guskova, who knew Nikolay Vladimirovich very well. During a break she told me, "Nikolay Vladimirovich is doing poorly… he's here in the clinic. They've tried to make things homey for him in one of the wards. He's been there constantly the last several months…students come to visit him…but he doesn't want to see anyone… was at a meeting there. He's all alone…" "What about his son?" I asked. "The son is in Sverdlovsk. He flies here sometimes." On my next visit to Obninsk I could only lay flowers on the graves of Yelena Alexandrovna and Nikolay Vladimirovich at the cemetery just outside the city.

Nikolay Vladimirovich died 28 March 1981. The priest, Father Alexandr Men, gave him communion and heard his confession before his death. N.V. Timofeev-Resovsky was rehabilitated posthumously in 1992.

Nikolay Viktorovich Luchnik moved to Sverdlovsk after Laboratory B was closed. At the same time that he was graduating from Sverdlovsk University (he did not have a university degree even though he published nearly 40 scientific papers—since scientific reports are considered as such), Luchnik also taught a variance analysis course at the university and wrote a popular science book on genetics, "Why I Look Like My Dad." (out of print) Luchnik received his university diploma in 1960 and had already successfully defended his Ph.D. dissertation in 1961. His conviction was expunged in 1962 and he received a certificate from the Northern Caucus Military District stating that he was fully rehabilitated because there was no offense.

In 1963, Luchnik moved to Obninsk and began working at the Medical Radiology Institute. There Nikolay Viktorovich studied the formation of chromosome mutations; based on the results of his research, he published the article "The Chromosome Cycle of DNA" in an international biology journal (Luchnik, 1971).

I was frequently in Moscow at the time, so Luchnik invited me to visit them in Obninsk. It was a two-hour trip by commuter train to Obninsk. Luchnik's house was distinguished by his abundance of books, its coziness, and the hospitality of its owners. The wide array of food on the table was all vegetarian fare. I found out for the first time that both of them were Orthodox Christians. It was there that I saw Luchnik's portrait by Rouben Gabrielian. Nadezhda Alexeyevna liked the portrait.

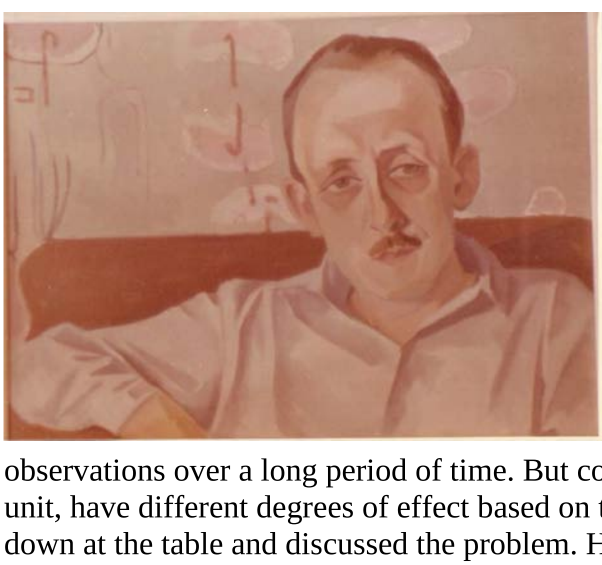

Figure 2.2 Photograph of N.V. Luchnik's portrait by R. Gabrielian (given to author by N.V. Luchnik, 1982)

The main reason for my trip was to seek advice from Luchnik about how to interpret the results of observations in our clinic. I was confused by the differences in radiation risks among different ethnic groups—Russian, Tatar and Bashkir. We knew that Mongols, Tatars and Bashkirs have a higher level of esophageal cancer. It has been documented in our observations over a long period of time. But could the radiation, which is calculated by the dose unit, have different degrees of effect based on the ethnic characteristics of a population? We sat down at the table and discussed the problem. He did not have a decisive answer for me. Luchnik said that he did not have any experience observing the irradiated population and turned to the test data, but he emphasized that it would be wrong to extrapolate directly from the experiment at the clinic.

In the last years of his life, Nikolay Viktorovich Luchnik fought a difficult foe. It apparently began with the publication of “The Bison” by Daniil Granin (Granin, 1987). The author referred to the book as an artistic interpretation of history. Its hero was N.V. Timofeev-Resovsky. “We can’t divine what effect our words will have…,” wrote F. Tyutchev. In stark opposition to these lines, when D. Granin wrote his book, he knew that he was putting his hero on a pedestal and crowning him with the halo of international renown. M. Fonotov justifiably wrote, “I do not know that Timofeev-Resovsky would have achieved such fame if it were not for D. Granin’s ‘The Bison.’ I suspect that it would be much more modest. That short word “bison,” chosen by the author, was just the right one for the time and stuck to Timofeev-Resovsky.”

The “literary hero” required a “literary anti-hero,” said T.V. Kondrashov, an employee of the Obninsk Institute, in his assessment of Granin’s book. The author designates Timofeev-Resovsky’s persecutor in the book with the letter “D.” Granin was certain that readers would figure out who it was that the author called Salieri and Mephistopheles. After all, the anti-hero, slanderer and informer doubtless knew biology, radiobiology and genetics. Granin described his physical features and the history of his arrest during the war with such accuracy that there was no doubt as to his identity: the persecutor of the scientist N.V. Timofeev-Resovsky was N.V. Luchnik.

What was N.V. Luchnik to do? Convince the publisher of the journal that printed “The Bison” to print a retraction? The publication was a *fictional* work, a story created by the author. Simply ignore it? Luchnik’s son, Andrey, insisted on a meeting with Daniil Granin. His first question was whether Granin had any evidence that N.V. Luchnik was in any way malevolent towards Timofeev-Resovsky. Granin said, “No.” Andrey next asked, “In that case what was the purpose of casting aspersions on the man?” The author replied that Luchnik was not “D.” Granin explained that his treatment of Luchnik was based on the “artistic intuition of the writer.” In his book, D. Granin uses the following phrase to his advantage: “A good story does not have to be true, merely plausible,” said the Bison, repeating the words of Niels Bohr, “Do we have to follow the facts too closely?”

Where does the responsibility of the author end, and is there any limit? In his answer, Daniil Granin raises one man high for the destruction of another…

At first Luchnik did not speak of the publication nor mock it, and tried to ignore it. Later he became ill and could no longer walk. The last seven years were the most difficult of his life. On his seventieth birthday (the third of January, 1992), he wrote:

> I greet seventy years almost immobile,
> Five years without walking, I sit and struggle against death.
> Though I cannot write and am practically blind,
> While I live, I will not give up the losing battle.
> Here is an illness that medicine cannot help against,
> Here is an illness that I must myself face on my own,

Every day I shout that evening is not near,
Even if the night is pitch black at the threshold.

Nikolay Viktorovich Luchnik died on Thursday, 5 August 1993.

3.0 Industrial Complex No. 817, Mayak Enterprise, Chelyabinsk-40

Shortly after World War II the then Soviet Union rapidly began work on construction of the production reactor, radiochemical, metallurgical and other laboratory facilities needed for development of weapon fuel. Pressure was on to build a bomb, and several criticality and other radiation accidents occurred. In addition, the radioactive waste materials generated throughout these processes had to be taken care of. Underground tanks were used for high level wastes, but unfortunately "low-level" radioactive wastes were dumped directly into the Techa River.

To understand how for several years people drank contaminated water and absorbed radioactive strontium and cesium, we first have to answer a question: was it the result of an accident or "anticipated as part of the production process?" To answer the question, we have to at least briefly describe the plant, which was located not far from these people's homes. The stories and recollections of the participants about the construction of the plant and the work performed there only came to light in the 1990s, when they were partially declassified. They illuminate the problem in different ways. Some have a patriotic message: "The Americans dropped atomic bombs on Japan in 1945 and we had to create our own atomic bomb. We forged a shield for the Homeland." Some were more critical: "So many victims! Who gave any thought to the people?" Others should be cited too, for the sake of objectivity. As a physician, I was more involved with the medical workers that took care of the plant's employees. So my story about the plant will be a story about the accidents there and the assistance given to those exposed to radiation.

3.1 Construction of Mayak Begins

Figure 3.1. Nuclear plant "Mayak". From Google maps. Access date 13 Sep 2010. http://englishrussia.com/index.php/2006/10/18/russia-from-space/.

Construction of the plant (then called Base № 10) began at the end of 1945. The work was primarily performed by military construction crews and prisoners; interned Germans were also at the construction site. The integrated labor camp system, subsequently best known as "Glavpromstroy," was designated in NKVD Order No. 00932 as "a specialized organization for the construction of enterprises and institutions through the First Main Directorate." Journalist V. Gubarev, in his book "Stalin's White Archipelago," refers to the date of the order, 8 October 1946, as the birthday of the "Atomic Gulag." (Gubarev, 2004) Stalin's directive tasked the First Main Directorate with creating atom bombs, uranium and plutonium, in 1948.

They began digging the foundation for the first reactor when there were still neither residential quarters nor access roads. The workers lived in tents and dugouts; their primary tools were picks and shovels. People were brought in by tanks that had their weapons removed. By the first of

October in 1947, there were already 42,000 workers at the construction site. The hardest work was performed by prisoners, who were promised an early release if they "worked especially hard."

However, in July 1949, obviously at the initiative of L.P. Beria, the USSR Council of Ministers ordered the following: "a) Before 15 August 1949, transport… former prisoners who were convicted of anti-Soviet activities, banditry or robbery, recidivist thieves and repatriated soldiers and special settlers who made contact abroad or cooperated with fascist occupiers, to the Dalstroy of the USSR (i.e. Siberia) to work as civilian employees, signing contracts with them (labor agreements for 2-3 years… c) Make arrangements for persons sent to Dalstroy to reside in a dense, standalone location that precludes their possible association with other contingents and workers at Dalstroy enterprises, as well as the possibility of their moving to any other sites and any possibility of running off from their designated location. Establish thorough controls over the communications of persons taken from special construction sites to Dalstroy." Nothing is known regarding the fate of the prisoners and the probability that they suffered radiation damage. Those people vanished.

The soldiers in the construction units were in a very difficult situation:

> I don't remember their faces. Before my eyes was a faceless crowd sitting on the floor of an extremely long corridor. They were pressed tightly against the wall and one another, in torn jumpers and third-hand shoes, reminding me of gray sparrows with raised feathers in foul fall weather. Conscripted into the army from the Asiatic Republics of the USSR, and barely understanding Russian, they, in a literal sense, walled us out with their bodies. Hundreds of specialists involved in the production of plutonium preserved their health and lives. They did not understand what the term 'workday' and 'shift' meant. Their work was 'admittance.' For a meal ticket they [the soldiers] used rags and buckets to clean up overflows of highly radioactive solutions and washed off equipment surfaces to acceptable levels. Their admittance time was 10, 15, 20 minutes at 5 Roentgens per entry and 45 Roentgens for three month's work. After three months, they were replaced with 'fresh' teams.

This story about the soldiers from a former worker at the industrial complex, Anatoly Nikiforov, was cited by A. Mityunin, a veteran of the special risk units, in his book "Atomic Penal Battalion." (Mityunin, 2005) For the epigraph to his book, the author quotes Jean-Jacques Rousseau: "In one country a man is worth so much, in another he's worth nothing, and in a third, he's worth less than nothing."

3.2 Acute Radiation Illness

The first cases of acute radiation illness were diagnosed in 1950 and involved two soldiers—Mezentsev and Andropov.

Professor A.K. Guskova told a reporter, V. Gubarev: “Afterwards the section was refilled with an entire group of the sick. These people had dug a trench at a contaminated area outside the plant. No one knew of the danger. The workers dug the trench and sat on its edge. When nausea appeared—the first sign of illness—they thought it was ordinary food poisoning. After several days’ treatment, the workers returned to the area. Later, after changes in their skin and blood, suspicions of acute radiation sickness arose. When we saw these patients, it was immediately clear that we were dealing with radiation sickness. Radiation sickness was recognizable at the height of the illness when the patients developed skin lesions.” (Gubarev, 2007)

Did the medical workers who treated the workers for “food poisoning” know that their patients were in a high radiation area? Apparently they did not know, just as the workers who dug the trenches did not know. Did these people have a right to be protected against radiation, at least at the dose rate declared by the enterprise administration—15 Roentgens a year? How did the area outside the factory become so contaminated with radioactive material that people received a dose of at least 200 rad? It is impossible to answer these questions. Do not think that the cases of overexposure were isolated or they were limited to only prisoners or military conscripts. Confirmation that this is not true is provided in the letter below, printed in the Russian newspaper “Argumenty i Fakty” (“Arguments and the Facts”) on 11 November 2004.

The following letter was written by V. Chervinsky, who was “contracted” (as he puts it) for construction work at the enterprise (Chervinsky, 2004):

> I was sent to the Mayak Production Association on a pass to pay off my debt to the Homeland. What kind of debt the son of an “enemy of the people” who was shot to death might owe the Homeland, I could only guess. But because we live in a close-knit, multinational family of Soviet peoples, I understood immediately once I reached my destination.
>
> In fact, the multinational collective of soldiers in the ‘“atomic shield’ of the USSR was very motley: repressed Germans from the Volga region; WWII veterans who had been captured because of the stupidity of their military commanders; graduates of factory training programs assigned to the enterprise like serfs to landowners; and prisoners of different classes and nationalities assigned for an unknown term on passes issued by regional Communist Party committees (б).
>
> We were all grouped together in the “contracted” category. Of course, we all differed sharply from the ‘“shokoladniks.’ More about this category later. Fear, uncertainty and the impossibility of returning back home to a normal life hung over us. The one consolation was that we had been sent “to the frontier of science and engineering” and had been promised a good salary.
>
> All the “contracted” were divided into groups: each had specific rules. For example, the Germans from the Volga and former military captives were to be checked morning and evening by the militia, even though they lived behind three rows of barbed wire and the prisoners behind five. The customary limits for working in radiation conditions applied neither to us nor them. Where the

operators remained only a minute, we might spend an hour or more. They sent us and the military construction soldiers to rooms where entry was generally prohibited.

We asked our bosses why this was the case. They answered that since we were temporary "contract" workers, and go out into the fresh air, everything would pass. What pass meant, they did not explain. Please, God, forgive me, a man suffering from radiation sickness, but I am certain that at Mayak, just as in Ancient Rome, people were divided into an upper caste and the unclean.

The upper caste included the "shokoladniks," who were the factory workers and operators (they were issued special tickets for lunch and to buy sweets), and the MVD troops (Chekists). The unclean were the construction soldiers, the repressed Germans, the maintenance workers and the prisoners.

The division into "black"' and "white" did not end here. The operators who had a "professionally-related illness" were transferred to light work in a "clean" location and paid their average salary. They had the right to an examination, two months' treatment in a special hospital ward, and passes to a special resort, also for two months. The contracted had none of this. Today I received a nightmare of a diagnosis—organic lesions on brain cells. Under the law, I am not a creator of the "nuclear shield" but merely one of the "contracted."

I turned eighteen on 3 May 1951. On 16 February 1952, I was "deactivated." That was nine months after I began working. At the time they said, "Burned and discarded like worthless junk." There was no social safety net for me. For the builders and similar people, they had their own medical structure where it didn't reek of radiation pathology specialists. The prisoners could count only on iodine, a green antiseptic and a bit of cotton. Now I remember the past like a nightmare. The Soviet atomic slaves called the "contracted" were not recognized as creators of the "nuclear shield"' for the Homeland, even though they gave it their health and the fate of their descendants.

--Vladimir Chervinsky. Ostrov, Pskov Region

Having read this letter, some might doubt the diagnosis of radiation sickness because there is not an official record of it: V. Chervinsky understood the nature of his illness "from the conversations of doctors." A professional worker may consider unproven the link between "organic lesions on brain cells" with irradiation from thirty years past. But this is a piercing letter from a participant in those events, a man who at eighteen received an unacceptably large dose of radiation that impaired his life. He lived 32 years in Chelyabinsk-40. He knows and accurately describes the practices at that time and place.

3.3 Reactors

When the industrial complex began operating, little was known about the biological effects of external radiation. Information published in some papers indicated that one-time exposure to radiation of approximately 100 R (Roentgens) might lead to radiation sickness. It had been established that the most sensitive organs were those containing rapidly dividing cells: the blood, sexual glands and the skin. There was much less information regarding the effect of radioactive isotopes and internal irradiation.

External dose rates had also been assessed that were designated as "threshold" values, below which no radiation effects presented (excluding remote stochastic effects). Based on the threshold dose rates, a radiation limit was established for routine (i.e., normal, non-emergency) operation of the enterprise. In the first years, the dose rate for the operation of the enterprise was 15 R annually, which was later reduced to 5 R. It would appear that precautions were taken to prevent overexposure of workers to radiation and radiation damage. This, however, proved not to be the case.

The first commercial uranium and graphite reactor (Object A) was launched 19 June 1948.

Figure 3.2. Reactor "A" at Mayak Production Association. Photo from website of VNIINM imeni A.A. Bochvar. An enterprise of the state corporation "Rosatom".

http://www.bochvar.ru/vniinm/history/1944_1949/1948_06_19/, accessed 15 Sep 2010.

Before Industrial Complex № 817 launched the first commercial reactor, an experimental reactor, F-1, was tested (the first physical reactor). In the report to the country's leaders on the operation of the reactor, I.V. Kurchatov wrote, "On 25 December 1946 at 6 p.m. we were able to observe for the first time a self-sustaining chain reaction in a sub-critical uranium graphite furnace with almost complete and, apparently, efficient use of all uranium and graphite slugs." I.V. Kurchatov also referred to the problem of radiation safety: "The radiation of the physical furnace was exceptionally hazardous from a biological standpoint. The tests conducted on mice, rats and dogs by the secret radiation laboratory of the Academy of Medical Sciences, which is headed by correspondent member of the USSR Academy of Sciences F.M. Frank, demonstrated that even when the furnace is run at relatively low power (approximately 150 kW), the animals died in all cases: either instantaneously, within 2-3 weeks, or in rare cases, after several months, due to changes in blood composition and disruption of the exchange phenomena in the body."

Reactor F-1 was much more primitive than the first commercial reactor. It was layered with graphite bricks of 100x100x600 mm and had three cylindrical openings through which the cylinders were inserted. The uranium for it was collected literally in grams. From the uranium metal at the Elektrostal plant headed by German scientist Nicholaus Riehl, they produced cylinders that were 32 mm in diameter and 100 mm in length. As a result, the reactor core of the F-1 furnace contained 400 tons of graphite and 50 tons of uranium.

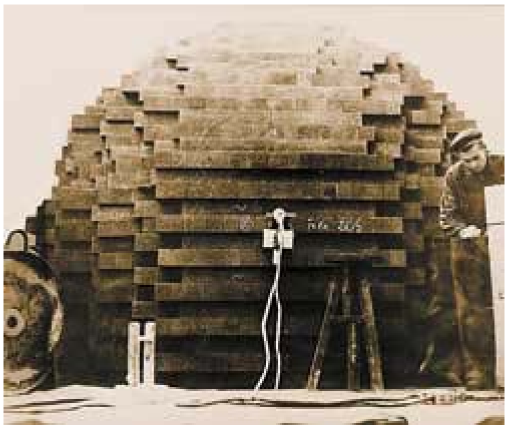

Figure 3.3. F-1: a dome of uranium bricks whose interior contained a neutron source. Sensors recorded the flow which reached to the surface. Photo from Larin I, 2010)

There was no special heat removal system, so the heat accumulated into a large graphite mass. The graphite brickwork was cooled by jets of air from a ventilator. Cadmium absorbing rods were used to control the chain reaction. However, as I. Larin wrote in the "Science and Life" article cited above on the experimental reactor, "Just in case, Igor Vasilievich (Kurchatov) had an ordinary hatchet placed next to the cable on which a cadmium rod was suspended to provide emergency protection: if there was an emergency and the protection tools did not work, the cable would have to be cut, then the rod would fall into the reactor core and stop the chain reaction."

There was also no biological shielding. Next to the building housing the furnace there was a high radiation background level. When the furnace was operating, a large red light on the roof of the building was on. This signal was used to warn laboratory employees that it was dangerous to approach the building.

Of course, the experimental reactor did not allow them to foresee and eliminate in advance all the flaws and issues that arose during the first days and months of the operation of the commercial reactor.

Into the first commercial reactor at Industrial Complex № 817 was placed all the uranium accumulated to that point, including even discarded defective uranium slugs with impurities. But only one day after starting the reactor, they had to shut it down when it was discovered that several uranium slugs were fusing to the graphite and "bears" were forming. The emergency was mitigated by manually boring and extracting the "bears." By special order of the director of the industrial complex, the permissible radiation dose rate for accident mitigators was set at 25 Roentgen. The accident had not been mitigated, yet all the reactor production workers had already been exposed to the accident dose rate. What could they do? It was suggested to "volunteers" that they enter a second and third time into the reactor hall for emergency operations. Prisoners could not be used due to "security considerations." Consequently, soldiers from the construction units were recruited again for accident mitigation.

A new "bear" formed in the reactor a month later. The administration of the First Main Directorate would not authorize the shutdown of the reactor and ordered them to "mitigate the accident using existing equipment."

Removing the “bears” did not mean that the reactor could be operated without interruption. There were many errors in its design. The main design element in the reactor, the fuel element, was a rod several meters long and nearly 2 cm in diameter consisting of a core (nuclear uranium and plutonium slugs) and an aluminum cladding. Aluminum pipes subjected to heavy radiation and high temperatures in the reactor corroded. This led to the “soaking” of the graphite.

On the twentieth of January 1949, five months after startup, it became clear that the reactor could no longer work in such conditions.

Beria, Vannikov (the “People’s Nuclear Commissar”), Zavenyagin (Vannikov’s deputy) and Kurchatov decided to save the nuclear payload. The solution was to use special suction cups and 25-meter long rods to remove the fuel elements in the reactor hall, extract the uranium slugs from them manually, and sort them into slugs that could be used again. The cladding for the fuel elements had to be replaced with new cladding that had a corrosion-resistant coating. The graphite brickwork also had to be manually taken apart, with the bricks dried out and put into place again. In other words, they had to break down a “hot” reactor and reassemble it. The temperature of the uranium slugs being removed was above 100 degrees Celsius. As the specialists note now, they did not know that after five months of operation the uranium slugs in the reactor would be “colossally radioactive, in millions of curies.” (Kurchatov, I.V., quoted in Gubarev, 2002)

Vannikov, Zavenyagin and Kurchatov were at the site continuously and supervised everything. Efim Pavlovich Slavsky, who was then chief engineer for the damaged reactor 1949 and later the head of the country’s nuclear industry, which was known as “Sredmash” (also called “Medium Machine Building”), wrote the following in his memoirs (Slavsky, 1997; publisher unknown):

> That was the first time our reactor failed because of its design. It is channeled and the aluminum conduit corroded quickly and failed. And we could not understand what the problem was… The entire reactor had to be unloaded. It’s difficult to imagine. There was over 100 tons of uranium in the reactor! (We do not have such amounts today). And our people transferred the irradiated uranium bottom-up for loading…
>
> Igor Vasilievich decided to keep vigil that night. The hall was enormous. The reactor was in the middle. The fresh slugs had to be checked and loaded. Then he examined them all through a magnifying glass—was none of them damaged? But since our “beast” was large, we naturally switched off the acoustic alarm and reduced the sensitivity of the optical alarm. Suddenly, it came on! Igor Vasilievich was sitting at the table. In one of the drawers were irradiated slugs. He inspected them and put them down on the other side. They brought the ionization chamber in a flash. We determined that Igor Vasilievich had powerfully irradiated slugs in that very room. If he had sat there while they were sorted, he could have died! That is how dedicated we were…

> It was decided to save the uranium payload (and plutonium production) at the greatest cost: the overexposure of personnel to radiation. All male personnel at the site, including thousands of prisoners, participated in the piping extraction operation. A portion of the slugs was damaged; a total of 39,000 uranium slugs were extracted and manually reprocessed.

The dose that Kurchatov received that night is unclear. These events at the beginning of 1949 are not described in any of the biographies of the famous scientist. The dosimetry conditions in different parts of the central hall above the reactor were not reported. In this case, it is impossible to even approximately estimate the radiation dose to which people were exposed who extracted the uranium slugs from the reactor. What caught the attention of the doctors were the extremely uneven levels of irradiation among most of the patients. A.K. Guskova wrote that dramatically diverse levels of reactor personnel irradiation were caused by direct manipulation in the reactor core or due to direct contact with radiating objects (slugs in their hands). What would a “slug in the hand” mean in such conditions? A burn that sometimes led to amputation, other times to radiation sickness. (Guskova, 1999) V. Larin reports that during the startup of the enterprise, medical personnel received no information on the situations leading to overexposure, nor the dose rates of victims. (Larin, 2001) This information was considered classified. The administration of Medical Department 71 did not have access to these data before 1954.

Angelina Konstantinovna Guskova, a correspondent member of the Academy of Medical Sciences, had been working since 1949 at Chelyabinsk-40 in the Professional Pathology Station (Therapeutic Ward 2) for the diagnosis and treatment of patients with radiation sickness. In the book, “The Country’s Nuclear Industry through the Eyes of a Doctor,” (Guskova, 1999) she wrote, “After such work (accident operations), that same evening or sometimes the next day, the supervisors would send participants for examination and blood work not to the clinic, but directly to us, Therapeutic Ward 2. They would notify us verbally regarding the possibility of overexposure, and we would report the results of the examination orally.”

In 1950-1951, a heavy water reactor was installed at the complex. There were accidents throughout the entire startup and testing phases.

In December 1951, there was an accident in which two workers received dose rates of 2.5 Gy and 4.0 Gy and suffered acute severe radiation sickness. These may be the cases of the first experimental treatment of patients with radiation sickness that A.K. Guskova and G.D. Baysogolov described in 1954 at Geneva. (Guskova, 1955) There was an account of two cases of radiation sickness (acute) that occurred when rules for the operation of an experimental reactor were violated.

3.4 Radiochemical Production, Plant 25

The first radiation injuries diagnosed did not involve reactor production specialists, but workers at the Radiochemical Plant (other names of the enterprise: “Irradiated Uranium Separation Plant”; “Plant B”; “Plant 25”; and “Tocheny Enterprise”, later “Gromov Enterprise”).

At first, all production took place in Building 9. In April 1947, A.P. Zavenyagin approved a site that had previously contained special warehouses for the Main Artillery Directorate of the Navy. The site was attractive because it had several brick buildings, a system of unpaved roads and a rail spur from Tatysh railway station.

The first plan for the building had a room on one side of the corridor for a chemical department and on the other side for a metallurgy department.

The renovated Building 9 was equipped like an ordinary chemical laboratory: wood vent hoods and simple lab tables. There were special requirements for the plaster and wall paint, however. In G.A. Polukhin's book "First Steps: The History of Mayak Production Association," a curator of the Base 10 Capital Construction Department, A.S. Mukhin, relates (Polukhin, 1993):

> The rate of construction grew, first at Building 9, which had been a warehouse for naval ordnance. I did not know the purpose of the building (everything concerning the production technology was a closed book for us), but they had very high requirements for the quality of the finishing work. The reasons for such high requirements, especially for such a plain building, were unclear to me and my coworkers. But once when I was accepting paint work from finishers, a relatively short, nice-looking fellow came up to me and asked, "Young man, have you ever seen the finish work at the old merchant houses in Moscow? That's the quality we need here!" I told him that I had never been in any of the merchant houses, but that high-quality finish work was required in this case and that I knew that from the technical requirements for construction. As to why they had to have such quality here, I said, "I have no idea." Then this nice man plainly and simply explained to me that the walls and ceilings must be so smooth that not even the smallest particles remained on the walls after they were washed off with water from hoses, and that such quality was necessary to protect the people working here… I asked him, "Excuse me, please, but who are you?" "Bochvar, Andrey Anatolievich," he said. That was my introduction to an internationally-known scientist.

The radiochemical department received irradiated slugs removed from the reactor. To reduce the radiation background for radiochemical production, longer-term storage (over 20 days) was stipulated for these slugs to ensure that short-lived nuclides decayed, and a tall pipe (150 meters) was constructed to reduce contamination in the adjacent area. While still unfinished, the pipe leaned sideways and collapsed, killing several people. They later built a new pipe. As for storing the slugs until they were transferred to radiochemical production, they were in such a hurry to receive plutonium for the bomb that the rule was not always followed.

To extract the plutonium from irradiated uranium slugs, they used chemical methods: precipitation in the beginning, then extraction starting in 1959.

Also in Polukhin's book V.M. Gladyshev, the director of Radiochemical Plant, discussed the difficulties of the initial period of operation: "The surprises came immediately. There were no precipitants from precipitation. They searched for a reason, worried about it, threw their hands up in the air, and had no answer for their superiors who wore a general's braid. Then they saw a yellow liquid leaking from a gap in the exhaust ventilation and realized that they had driven the entire solution into the blowdown, which was recessed in the ventilation shaft. During the test run with water, they set the diffuser air feed too high during precipitation and it carried off all the slurry to the blowdown system… After wrangling over a new setting, they washed off the residue as best they could, in the process contaminating a room (with radionuclides) in which people walked in their street clothes and wore shoes (galoshes) that spread dirt, etc. throughout the other rooms… All these lapses during the design phase were tolerated not out of negligence, but ignorance… Everything was being done for the first time." The walls on which the utilities were mounted were cleaned by hand with metal brushes by A.P. Ratner, B.A. Nikitin, B.V. Gromov, N.S. Chugeyev and M.V. Gladyshev. Dr. Alexandr Petrovich Ratner died three years after startup of the site. V.M. Gladyshev continued, "…technician Alesha Kuzmin and mechanical engineer Alexandr Vedyushin, who had done their part, died quietly. But they were victims of ignorance, of unknown science."

In the chemical department, all the equipment was steel. The plutonium was extracted in special chambers, controlled from outside the chambers manually, with personnel using rubber gloves to reach into the chambers. All the connections were "nominally sealed." A.K. Guskova wrote: "Many operations could only be performed with the chambers open. Moreover, the head of the workers was inside a chamber with a high concentration of alpha and gamma beta radioactive aerosols. In 1950-1952 (and perhaps to 1954), the ionizing radiation in the power control rooms at Plant B was at dose rates of 180 R/hr during routine operation and even higher in the off-normal situations that occurred continuously… The ambient radionuclide content was dozens and hundreds of times higher than the permissible concentration limits, even by the standards of those times." (Guskova, 1999)

3.5 Radiation Casualties

Women and young girls worked in the chemical department. They were assigned there after graduating from chemical institutes. Academician I.V. Petryanov-Sokolov called them the "Ryazan Madonnas" (from V. Gubarev's book "Stalin's White Archipelago") (Gubarev, 2004):

> "Visiting a number of production facilities that worked with plutonium and polonium-210, I was struck by the physical appearance of the female workers (there were usually many young women there). They had a strange, slow gait and their faces were deathly pale. They told me that many had "poor" blood and an irregular menstrual cycle. At the time, I had noticed that these women (and all the production workers) did not have any individual protection; no one was observing elementary radiation safety rules. I was so struck by everything I had seen that I took it upon myself to make every effort to ensure that these people were protected from overexposure. I had no doubt that the primary cause, at least in terms of external appearance of these young women, was radiation. It was then, because of some

> subconscious association, that I named these young woeful beauties 'Ryazan Madonnas.'"

Academy member I.V. Petryanov-Sokolov is known for his invention of highly effective filters and individual respiratory protection equipment: the Petryanov-Sokolov "Lepestok" ("petal"). (cited in Gubarev, 2004)

Plant B received plutonium as a finished liquid in solution. Before it was transferred for further processing, any traces of radioactive impurities had to be removed from the solution. All the processes for extracting these salts from other radiators posed a hazard of personnel. In her book, Angelina Konstantinovna Guskova wrote, "Large units initially stood out in the open in trenches and even had defective walls. They were powerful sources of gamma-beta radiation. I remember this period when units were operated out in the open in the shop, with residues of yellow tetrafluorinated uranium residue and fragments mixing on the floor, and the contamination containment areas in the trenches. Soldiers were assigned to perform several operations near powerful radiation sources. Each soldier assigned from the brigade had to enter an open trench for several minutes in which there were units containing highly radioactive waste after plutonium was removed (Department № 6), where he then had to scoop out the residue from the unit and place it in a containment tray. Each such handling could, in the terminology of the time, "cost" the soldier or equipment operator a dose of approximately 25 R. Our first gravely ill patients, D. Yershov, S. Aliev, M. Gamaziev, etc., worked in Department № 6." (Guskova, 1999)

Dmitry Yershov, born 1926, in 9 months of work was exposed to 172 R of external radiation. Within 5 months he began hemorrhaging, his platelet count decreased, and marrow hematogenesis was suppressed. The patient died from chronic aplastic anemia. Following his death, approximately 1 millicurie of beta particles was detected in his body.

Alexandr Aliev, born 1926, was a worker in the radiochemical plant. In six months of work he received a dose of 668 R from gamma radiation. After three months of work, his peripheral blood platelet count was 163,000 (normal range 200,000 - 400,000); after six months of work it was 46,000. His white blood count was 3,000. During this time he was hospitalized. He had no complaints, but it was established that he had static ataxia. The myelokaryocyte count in his red blood marrow at the time was 30,000. It was noted that there were many young elements and no megakaryocytes. The patient was given blood transfusions. He was designated an invalid and no longer worked at the radiochemical plant.

The next 20 months were relatively good ones, but then the hematological indicators began to worsen and the myelokaryocyte marrow count fell. He died 33 months after beginning work at the enterprise from hypostatic pneumonia and cerebral edema. V.N. Doshchenko, who was A. Aliev's doctor, wrote: "Sasha Aliev, a young, handsome, cheerful Dagestani, died in my arms. He developed acute leukemia as a consequence of massive overexposure. For several months, he lived only because of transfusions. Hemoglobin fell to 20% and the leukocyte count to 1,000. Given these conditions, it appears that all the protective forces of the body were exhausted, and he developed double pneumonia. Sasha became blind from retinal hemorrhaging. My chief, Professor G.D. Baysogolov, recommended enormous doses of penicillin unheard of at the time (1953), both intramuscularly and intravenously, as well as other comprehensive therapy. The pneumonia was overcome and his vision restored. Sasha died several months after that bout of pneumonia… Although forty years have passed, Sasha often still appears before my eyes as a victim of the inhuman arms race.” (Doshchenko, 1993)

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АТОМНЫЙ ОЗЁРСК

Вторая родина

неформальное, но действенное воспитание. Не поверите, Лариса плакала, просила извинения и клялась, что это не повторится. И сейчас такое бывает, но только наоборот.

Хочется рассказать читателям о безусловной жертве гонки вооружений, о молодом, красивом дагестанце Саше Алиеве, за жизнь которого я продолжал бороться после Ларисы Сергеевны. Увы, прогноз был безнадежным – острый миелоидный лейкоз. Самая злая форма лейкозов. Заболев этой формой в те времена, пациенты редко жили больше месяца. Это заболевание встречается везде, в его возникновении определенную роль играет наследственная предрасположенность. Надо подчеркнуть, что с этой предрасположенностью Саша мог бы дожить до старости. Но, возможно, излишне добросовестная ра-

Саша Алиев.
Острый лейкоз.

бота аппаратчиком в самом тяжелом (шес-

го исхода. Всех удалось вылечить. Через 2-4 месяца 13 из них приступили к работе.

Я невольно забежал на 7-10 лет вперед. Продолжу рассказ по порядку. Осенью 1951 года меня срочно вызвали в стационар лагеря заключенных. Врачи не могут поставить диагноз. Приезжаю. Осматриваю больного. Он в тяжелом состоянии. Плохо говорит, все время кашляет, при этом, помимо кровавой мокроты, сплевывает кусочки слизистой языка. На коже туловища много кровоизлияний, в легких – масса влажных хрипов, температура 39 градусов. Выясняю, что неделю назад он в группе заключенных копал траншею на промплощадке, были у всех головные боли, рвота. Ставлю диагноз ОЛБ тяжелой степени. Анализы крови (снижение лейкоцитов до 100 клеток в куб.мм) подтвердили этот диагноз. Всем пострадавшим было назначено комплексное лечение. Однако самый тяжелый из них (Куц) умер на 30-е сутки, остальных удалось вылечить. Почему они работали без дозиметрического контроля в силу секретности, для меня осталось неизвестно. Был ли наказан виновник – не знаю. Примерные расчеты и клиническая картина позволили считать, что доза облучения была порядка 500 бэр. А особая тяжесть болезни определялась тем, что в период облучения Куц выполнял тяжелую физическую работу, не было оказано первой помощи, и необходимое лечение было начато только через неделю. Надо подчеркнуть, что указанные факторы обусловили необратимое подавле-

Figure 3.4. Photo of A. Aliev with the words of V.N. Doshchenko. Printed in “Camer Ton”, Vol. 4 (204), 2003 and presented to author by Doshchenko. (Doshchenko, 2003)

Mikhail Gamaziev, born 1928, in one and a half years of work received an external radiation dose of 198.5 R. In his first year of work, he was diagnosed with chronic radiation sickness. From months 13-22 his condition worsened and he then developed sepsis. V.N. Doshchenko was Gamaziev’s doctor. The patient died from irreversible marrow damage. (Doshchenko, 1991)

Soldiers Mezentsev and Andropov, whose stories are presented above, were treated in 1950 in the therapeutic ward for acute radiation sickness. Both recovered.

There were more than a few accidents at Plant № 25 in the first years.

During the refinement of the “product” to standard norms on 15 March 1953, a criticality accident occurred. The shift supervisor of the finished product department at Plant 25, Alexandr Alexandrovich Karatygin, was manually preparing a finished product solution in vessels before sending it to the customer. Having decided to free up one of the containers for a new batch of product, he poured the plutonium solution from two containers into one. Unexpectedly, a disruptive reaction began in the container, and it began emitting vapor and spewing hot solution. The cause of this criticality accident, as discovered during the investigation, was the presence, unaccounted for, of 5 liters of plutonium solution in the receiving container. (cited in Larin, 1996)

How in the world, at a secret facility where every gram of an invaluable product must be accounted for, could several liters of unaccounted-for plutonium solution form? V. Larin, in his book “Mayak Industrial Complex: An Eternal Problem,” (Larin, 1999) cites the opinion of an unnamed, upper-tier administrator in the Minatom system, who claimed the plutonium development plan was at fault. The mid-level managers of the complex, in case of unforeseen circumstances that might arouse the wrath of their superiors, created a store of product [as replacement in case of loss]. The store of plutonium solution stood unaccounted for in one of the containers. This is what led to the formation of a critical mass of fissile material in the operator work area...

Karatygin’s level of exposure, primarily to his legs, was approximately 1000 Roentgen. He had a severe, acute form of radiation sickness and had to have both legs amputated. He recovered and lived for 35 more years after the accident.

G.A. Polukhin (Polukhin, 1993) quotes verses created in a hospital bed by Vergilia Vladimirovna Vaverova, who had set out on her path to Experimental-Industrial Shop № 9 in 1949:

> By fate it had fallen to us
> To live or die,
> But the homeland
> Must be spared from the fire
>
> Youth is difficult,
> The ardor of Patriots,
> It was 49,
> Was it or was it not?

3.6 Pure Plutonium, Plant 20

Further purification of plutonium compounds and the acquisition of plutonium metal were performed at the chemical metallurgy production facility (plants C and 20).
The first “product,” plutonium concentrate, which was preliminarily refined from uranium and fission products at Plant 25, was obtained 26 February 1949 at twelve midnight for reprocessing in Building № 9.

The initial assumptions of the biological effects of radionuclides were far off the mark. Consequently, so were the required safety measures. M.A. Bazhenov, who began his career at the Mayak complex in Building № 9 and later became head of the laboratory in Plant 20, explained the problem in Polukhin’s book: “After passing through the access control point, I made my way to the front of a common barrack… The barrack was known as “Shop № 9.” My workplace was a 5x9 square meters room containing a desk, chair and an ordinary fume cupboard in the middle with bowls, jars and glasses. Behind the cupboard were metal containers of the “product” covered with plywood (the purpose of the plywood I found out later—the containers were used in place of missing chairs!).” (Polukhin, 1993) The “product” was highly radioactive plutonium concentrate.

The solutions were produced on a machine in metal containers, then poured into “glasses” (it was during the period at the chemical division in Building 9 that I.I. Chernyayev referred to as the “glass period.”). G.A. Polukhin writes that I.I. Chernyayev brought highly radioactive solutions from Building 25 “in glass bulbs that were placed in ordinary buckets without any protection.”

The glasses were made from platinum, the funnels from gold, and the filters also from platinum. On 24 October 1947, Josef Stalin ordered that platinum, gold, silver and other metals be earmarked for the “Atomic Project.” This was “dictated by the fact that highly corrosion-resistant vessels were required… in highly radioactive conditions…" However, the plutonium solution obtained from Plant B, which had high levels of gamma radiation, was poured into a doser by hand, with no mechanization of the process envisioned. Technicians used their eyes or the color of the solution to determine whether the deposits of plutonium oxalate were fully settled. They also visually determined the granularity of the residual crystals. The technology consisted of sticking their head in the fume cupboard and looking inside the vessel.

Refined cake and its improvement were the responsibility of the workers and metallurgical engineers, who worked with aerosols from metal heated to high temperatures. In February-July 1949, in Building Shop № 4 at this site, hemispheres of nuclear charges were created for the first time.

Here are the words of Academician F.G. Reshetnikov, who was interviewed by V. Gubarev (Gubarev, 2004):

> "Metallurgists and chemists were assigned to Shop № 9. It was a random room of light construction, with no decontamination station or showers, and completely unequipped for such serious work. There was never a word spoken about serous dosimetric control. Reduced cake was separated in one room that contained two organic glass chambers. One was used to prepare the stock, which was then loaded into a crucible. The reaction unit was horribly contaminated with plutonium, but they extracted right there in the room. They squeezed the cap in vises and lowered the unit into the furnace, which was located in a corner of the room. After the cake was fused and the unit had cooled, it was opened and placed in the other chamber, where the crucible was extracted, the lining broken with a hammer, and the plutonium ingot removed. The cycle was then repeated. That was the entire safety procedure… Several years later, the heroes of this great epic of labor begin passing on to the next world one after another. By the beginning of 1991, only one person who worked in this accursed Shop № 9 was still alive, and in very poor health too."

3.7 Accidents

The blunders were many. One of the accidents occurred on M.Ya. Trubchaninova's shift. She said, "Since work was slow, Ya.A. Filiptsev suggested that A.V. Elkina, who was preliminarily pulverizing of a clump of dregs, use a different technology and load large portions into the flask. Right at the moment she began pulverizing, there was an explosion and the fume cupboard caught fire. The incandescent particles flew all over the room, and the walls and ceilings were covered with green residue. Specks of the product the size of semolina had rained down on the heads of those present. Ya.A. Filiptsev had flecks in an eye and Ye.V. Elkina had burns on her hand. I ran from the room and told A.A. Bochvar what had happened. He ordered all the women to leave the room immediately, and both he and I.P. Martinov began putting on special suits. After putting on their breathing apparatus, they used filter paper to clean all the plutonium solution from the walls, ceilings and remnants of the fume cupboard. Several containers of filter paper with different quantities of plutonium had to be burned later, and the ‘product’ extracted from their ashes.” (quoted in Polukhin, 1993)

Indeed, as A.K. Guskova told journalist V. Gubarev: “There were improbable instances! I remember one at Mayak that happened in the laboratory of the chemical and metallurgy plant, where mainly women worked. There did not appear to be anything hazardous in the room. Suddenly, however, one woman became nauseous, then dizzy, and began feeling poorly. Another woman began having the same symptoms, then a third… It turned out that, inside the walls against which the laboratory tables were located, there was a pipe with a solution containing a large quantity of radioactive materials. Gradually there was so much accumulated in the pipes that it became a powerful gamma-neutron radiation source. That was in 1957.”

“Did they all die?” asked V. Gubarev.

“No, of course not! Each time I go to my beloved ‘Mayak,’ I look for my patients. Many of them are still alive, and we run into one another.” (Gubarev, 2007)

In all probability, they are discussing one of the situations on the list of accidents, designated as an incident at Plant № 20, which occurred on 21 April 1957 and involved the oxalate decantation collector after filtration of enriched uranium oxalate residue. Six people received radiation doses of 300-1000 rem. One female operator was exposed to 3000 rem. She died 12 days after the accident.

In answer to questions from V. Kirillov, correspondent with “Argumenty i Fakty”, Guskova said, “The conditions were very difficult. Some may have been minor, but every day there were accidents, next to which Chernobyl was simply a nuisance. At that time, a man might receive 25 Roentgen in one workday. That is the dose limit that was established for the accident mitigators at Chernobyl. A large number were ill, and chronically so, because people were constantly overexposed.” (Kirillov, 2000)

With time came experience. Working conditions at the enterprise improved significantly and personnel dose rates decreased. The name of the enterprise was changed to Mayak Chemical Complex. Nevertheless, none of this precluded the occurrence of individual “off-normal” situations and accidents, which were most often criticality accidents.

On 2 October 1958, tests were being conducted at the chemical and metallurgy plant to determine the critical mass of enriched uranium in a cylindrical vessel at different uranium concentrations in solution. Personnel violated the rules and instructions for working with fissile nuclear material. There was a criticality accident and personnel were exposed to radiation of 7,600-13,000 rem. Three people perished and one was blinded and suffered from radiation sickness.

On 5 December 1960, five people were overexposed to radiation at the same plant due to a criticality accident (ten, according to Bellona, 2004).

In 1961, a criticality accident occurred in Technological Communications. Fourteen people developed radiation sickness with varying degrees of severity. One person died from a critical case of acute radiation sickness.

The last case of a criticality accident occurred on 10 December 1968 at the chemical and metallurgy plant. There were two victims, one of whom died.

These were the conditions under which pure plutonium was obtained.

Following the explosion of the atomic bomb in Japan in 1945, the Americans assumed that the Russians would be able to make their own bomb by 1954-1955. However, the first Soviet atomic bomb was successfully tested at a special proving ground in the Semipalatinsk region of Kazakhstan on 29 August 1949. It was a plutonium bomb.

G.R. Ivanitsky wrote: “We know that the US Manhattan Project cost $2 billion (when a dollar was worth much more than it is today). The Americans say that one person died of radiation sickness during the process of creating their atomic bombs (Little Boy and Fat Man). The cost of our atomic bombs is not measured in rubles, but in human lives.” (Ivanitsky)

4.0 Techa River Turned into a Radioactive Gutter

Immediately after World War II the Southern Urals Mountains became not only the playground for confidential radiobiological research, but, more importantly, the place where nuclear reactors and factories to manufacture weaponized uranium and plutonium were constructed. At the Mayak nuclear enterprise not only criticality accidents occurred, but also major radiation accidents leading to the irradiation of tens of thousands of people. The first of these tragic situations was the dumping of radioactive wastes into the Techa River.

How in the world were my patients—peaceful residents of the many villages in the Chelyabinsk and Kurgan Oblasts—exposed to radiation? As V. Gubarev wrote, “The Russian language is rich in synonyms; perhaps it is better to use ‘occurrence,’ ‘off-normal situation,’ ‘production waste,’ ‘uncalculated discharges’… than ‘atomic pit’ or ‘radioactive gutter.’ But you can escape the truth…”

The plutonium production process that was launched at the beginning of 1949 envisioned a planned discharge of chilled reactor complex water and radiochemical production wastewater into the Techa River after treatment. Highly radioactive waste was to be placed in special containers called “Complex S jars.” V.N. Novoselov and V.S. Tolstikov, in the book “The Atomic Trace in the Urals,” (Novoselov, 1997) wrote that attempts during the design stage of plutonium production to find methods for reducing radioactive waste and means for its storage were fruitless; they had neither the time nor the resources to come up with an effective solution to the problem of waste. The solution treatment system by that time was still being tested in the laboratory. So they adopted a “temporary” option of discharging liquid radioactive waste of 10 curies or less a day into the Techa River. But 10 curies a day was a fiction.

F.G. Reshetnikov, academy member and laureate of the State Prize of the USSR, who was interviewed by V. Gubarev, said, "Our technology was barbaric, the amount of waste was enormous and the quality poor…" (quoted in Gubarev, 2004)

The first weeks that the radiochemical plant was in operation demonstrated that the amount and level of radioactive discharges were many times higher than the design indicators. The secrecy surrounding production was used to explain why the discharge site had no flow meters or instruments to determine the radioactivity of the discharge solutions. Consequently, there was absolutely no monitoring of the liquid radioactive waste poured into the river. The daily level of radioactivity put into the river was 4,300 curies. In addition to the radioactive waste, the river was also the recipient of harmful chemical substances that were left after plutonium processing: sodium nitrate and acetate in high concentrations, iron hydroxide, and organic substances.

With the USSR Council of Ministers demanding a drastic increase in plutonium production, the Complex S jars were overflowing by 1950. Beyond the "planned production process" discharges into the Techa River, there were also unofficial releases of up to 100,000 curies a day instead of the 10 curies that had been authorized!

How much total radioactivity was released in the Techa River in 1949-1951? The question cannot be answered. The correspondence between D.I. Ilyin, the head of the external dosimetry service of the Mayak complex, and the Administration of the First Main Directorate indicates that data were not maintained on the amount of radioactivity discharged into the river during that period. Later estimates are that approximately 76 million cubic meters of wastewater were dumped into the river. The total radioactivity of the discharges into the Techa was almost 3 million curies. Nearly one-quarter of the total radioactivity was from long-lived radionuclides: Sr-90 (a half-life of 28 years) and Cs-137 (a half-life of 30 years). The authors of the abovementioned book wrote that the Techa River "was used as a gutter to remove waste, in the process killing all living organisms within 160 kilometers of the discharge point."

Did the designers and operations personnel know that there were dozens of populated areas along the banks of the Techa? They did. They knew that these villages did not have a single well, and they knew that the only source of potable water for the people living there was the river. They knew!

After declassification discussions of the radiation exposure of the public were held at high levels of authority domestically and at international conferences. The bureaucrats in the atomic ministry maintained that there "*was no accident*"at Mayak that would have led to the contamination of the river. They were afraid to use the word "accident." An accident means the malfunctioning of equipment or a disruption in the production process. Neither occurred during the time the Techa River was contaminated. So what happened? Radioactive waste was poured into potable water "as stipulated by the production process." It was discharged beyond the boundaries of the public health area of the enterprises, i.e., "neighbors don't see anything beyond their own noses."

In the lobbies at high-level meetings, I asked the same operators, “You knew what this would lead to and you discharged anyway? Why didn’t you at least dig wells in the villages?” Their answer: “We hoped that it would all be diluted by water and would be insignificant, imperceptible.” It was not diluted! As later measurements showed, radioactive elements were carried to the river Iset, into which the Techa flows, and then to the Tobol, Irtysh, Ob, and the Kara Sea basin of the Arctic Ocean. Bellona, the Norwegian environmental organization, detected in the Arctic Ocean a mixture of radionuclides that corresponded to the composition of the wastes discharged by Mayak. It has been estimated that the outflow of radioactive material into the Kara Sea from waste discharges into the Techa was nearly 35,000 curies.

This entire river system, nearly 1000 km long, as well as the people who lived on the coast, approximately 124,000 in 1950, was to one extent or another contaminated with radiation. The level of exposure decreased the greater the distance from the discharge site; therefore, from a medical perspective, the number of people who received a hazardous dose is 27,000.

At an international workshop in Tokyo in 1991, the radioactive contamination of the Techa-Iset river system was reported accurately for the first time. After the presentation, a Japanese colleague asked through an interpreter, “Why in the world would you poison your own people?” How could one answer that?

The atomic specialists were so hopeful that the discharge would go unnoticed that the first measurements of the concentration of radionuclides in water were not taken until 5 July 1951, i.e., two and a half years after the contamination of the Techa began.

4.1 Results of the First Measurements of Radioactivity in the Area

Longtime residents have described these measurements. Quasi-military types in ponchos arrived at the villages upstream and set up on the shore of the Techa. They pulled instruments inside their small ponchos and, closing them, measured something or took some kind of samples. In fact, according to instructions, the sampling was to be concealed from the public. The results of the measurements, which showed radioactivity in the river water ranging from 100 to 10,000 microcuries per liter, depending on the distance from the discharge location (0.5-7 km), shocked even the specialists. Radioactive material (primarily strontium-90 and cesium-137) not only contaminated the river water, but also the irrigated gardens in the villages and the grazing sites of cattle at commercial dairy and poultry farms. The bulk of the radiation settled into suspended particles in the water and became riverbed silt, most prevalently in the Koksharovsky and Metlino ponds. The river fish and aquatic birds were contaminated by the radiation.

On the shores of the Techa, before it flows into the Iset River, there were 39 villages with almost 27,000 residents. The coastal villages generally stretched out along the river shore; the closest houses were frequently 70-100 meters from the water. Wells at the upper reaches of the river provided water to only 9% of the population. Others took water from the river for drinking, cooking, irrigation and livestock troughs. The river was used to wash clothing, catch fish and bathe. The level of water contamination in Metlino Pond in 1951 was 2000-3000 times above the permissible concentrations of Sr-90, and 100 times higher for Cs-187 and Sr-89.

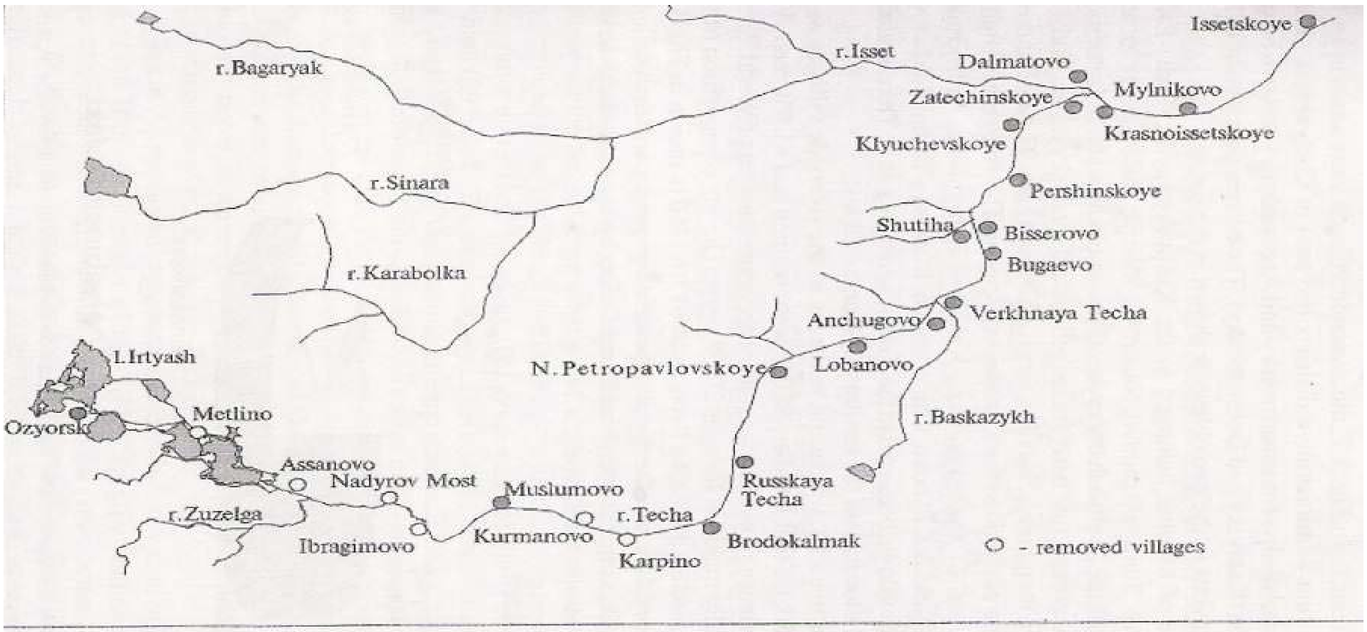

Fig. 1.1. A schematic map of villages located on the Techa River (blank circles indicate re-settled villages)

Figure 4.1. Schematic map of villages along the Techa River. Ozyorsk is the new name of Chelyabinsk-40. (Kosenko, 1994)

The populated areas were also contaminated with radioactive material. The isotopes cesium-137, ruthenium-106 and zirconium-95 created high levels of external exposure. A measurement of external gamma radiation in the latter half of 1952 indicated a dose rate of 5.4 Roentgen an hour on the shore of Metlino Pond, up to 0.4 R/hr in the irrigated gardens in the village of Metlino, which is 7 km from the radioactive waste discharge site, and 0.01 R/hr on the village streets in Metlino and Techa-Brod, the latter of which was 18 km from the discharge site. This means that women washing clothes or children sunbathing on the shore of Metlino Pond received in one hour the same exposure dose, under current standards, that is the annual limit for professional atomic industry workers and the lifetime limit for the public.

The samovars in which they boiled river water for tea and in which deposits built up over time, the bedroom sheets and underwear they washed in river water, the shoes they cleaned and floors that they mopped with river water, all contained radioactive material and were a source of radiation. There were radionuclides in the milk because the animals grazed in the floodplain, and in the vegetables and potatoes, which were watered with river water. These food products were used not only by the villagers, but were sold in the markets of nearby cities. Coastal farms produced thousands of tons of agricultural products.

In 1952, radioactivity in the lower reaches of the Techa was measured. In the villages Upper Techa and Lobanovo, which are located in Kurgan Oblast and are 150 km from the headwaters of the Techa, the radiation in the samovars exceeded the natural background by 150% and more. It has therefore been established that not only were the residents of villages in Chelyabinsk Oblast exposed to elevated doses of radiation, but also people who lived in coastal villages in Kurgan Oblast, up to the point where the Techa flows into the Iset River—237 km from the discharge site.

4.2 Where should the Waste be Discharged?

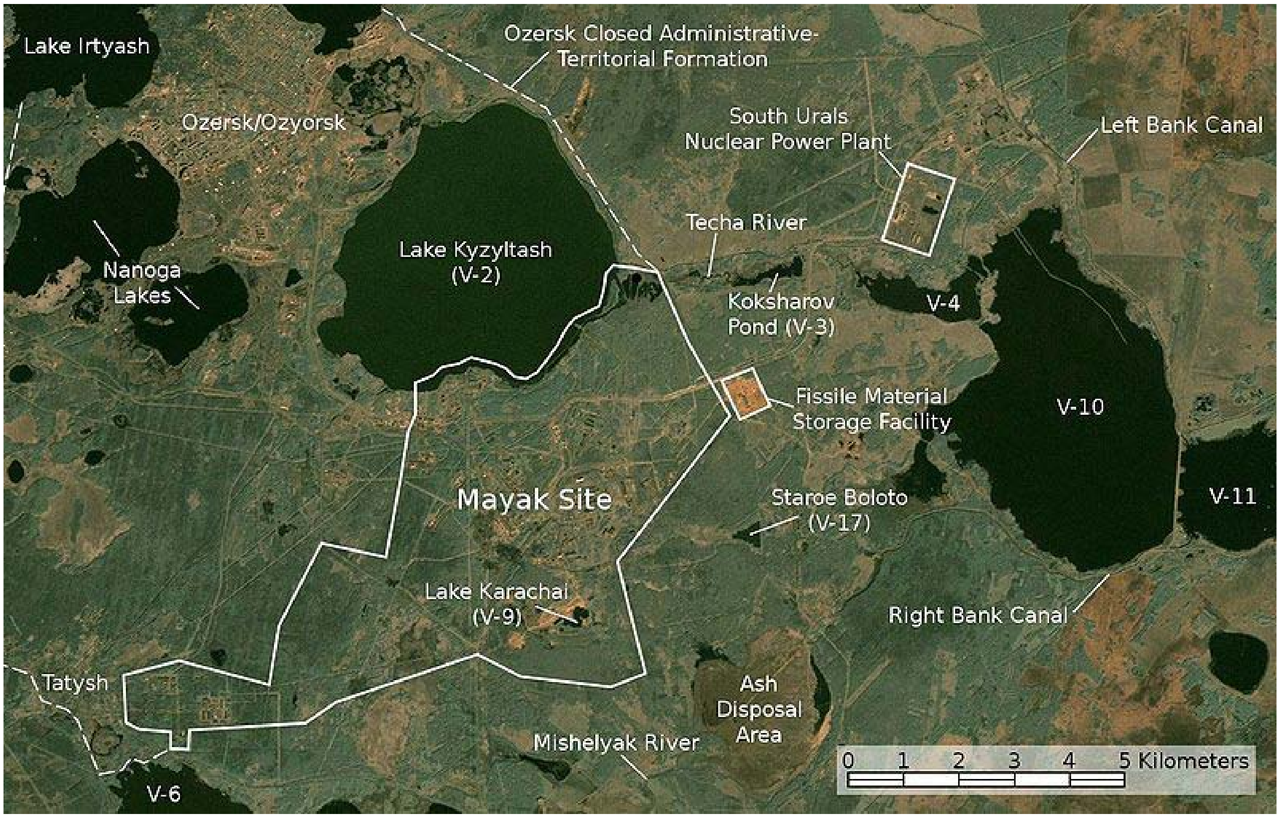

Figure 4.2. Satellite image/map of the Mayak nuclear facility and surrounds. Image accessed 13 Sep 2010. http://en.wikipedia.org/wiki/Mayak

After the results from the measurements of radioactive water in the Techa became known, a committee was created in 1951 under the leadership of Academician A.P. Alexandrov (future President of the USSR Academy of Sciences). The committee was to assess, for the first time ever after three years of discharges, how much total radiation had been released, how far it had traveled, and where it had settled. It was decided to drill boreholes at the bottom of Koksharovsky Pond and measure how deep the radioactive material had penetrated. The drill operators could come up with no better solution than to dry out the reservoir by releasing 75-80% of the water and silt into Metlino Pond. During these operations by the high committee, an additional large amount of radioactivity was released into the Techa on 6 October 1951.

The committee demanded that the discharge of radioactive waste into the Techa be decreased (not stopped!) and set up a discharge monitoring system. If all the waste from the enterprise could not be dumped into the Techa, then where could it be released? One proposal was to contaminate new reservoirs, the Kaldy, Chebarkul and Shugulyak in the Urals, which were still clean. Fortunately, the proposal was rejected. But the question remained—where can it be discharged?

Another proposal was to switch the discharge of highly radioactive production waste into Karachay Lake. This led to many arguments and objections, the principle one being that Karachay Lake was located on the premises of the Mayak complex. However, the recommendation to use Karachay Lake was approved.

Karachay Lake is not actually a lake but a drainless bog with a depth of 1.25 meters and nearly 400 thousand cubic meters of water. Because the bottom of this reservoir is clay, it would presumably limit the penetration of radionuclides into groundwater.

The restriction of the waste discharges into the Techa did not decisively solve the problem of radiation safety. A large quantity of radioactive material, which had already accumulated at the muddy bottom of the Koksharovsky and Metlino ponds, flowed into the river.

In 1954, they started building Dam № 10, which blocked the Techa. However, radioactive water began leaking from the body of the dam and they had to install special pumps to remove and return the water that travelled through the dam. The amount of waste produced by the complex was not reduced and a large amount of radioactive water began to build up above the dam. The height of the dam grew periodically, but that did not reduce the danger of its failure. In addition, an examination of the bottom of the dam revealed, as the specialists put delicately, the "presence of weakened areas." Finally, substantial repair of the structure began in 2007. An "impermeable membrane was embedded" in the body of the dam. Reconstruction was completed in January 2008. However, according to Gennady Podtesov, the Minister of Environmental Safety for Chelyabinsk Oblast, "crisis prevention measures at the Techa cascade of reservoirs will continue to 2015."

All these hydrological measures significantly reduced the flow of radionuclides into the Techa. The problem of using Karachay as a radioactive waste repository grew over time. Presently, the radionuclide build-up is so great that total radioactivity is estimated to be 120 million curies. Karachay is the most contaminated spot in the world. The radioactive water permeating through the bottom of the reservoir formed a lens 100 m thick with an area of nearly 10 km^2, which is greater than the size of the reservoir itself. The danger that the lens will reach the groundwater that supplies the large cities of the Urals is very real.

4.3 Futility of Banning the Use of River Water

The first decision to completely prohibit public use of water from the Techa and Iset was made 12 December 1952, i.e., a year after the radioactivity in the water was measured. Orders to this effect were issued by the director of the Mayak complex and the Chelyabinsk Oblast executive committee in 1953, 1954 and in later years. The orders were issued but never carried out. First of all, these orders were classified and no one knew about them, or they were disseminated to the public evasively and inarticulately. Not one word about the radioactive contamination of the river was shared with the public. They first explained that using the river water was prohibited because it contained bacteria that caused brucellosis. Next it was because of "unclear epidemiological conditions”, and then it was due to “acid-base releases.” There is a document, issued by the Chelyabinsk Oblast on 16 August 1960, stating that public health rules must be implemented in areas through which the Techa flows. It was based on an order of the National Central Executive Committee from 1931!

There were various rumors of the water’s harmfulness to the public. Residents noticed behavioral changes in wild ducks, which became so weak they could no longer fly. But official explanations regarding the state of the river did not satisfy the residents at all; they did not understand them and did not see any reasons to depart from their customary housekeeping and farming practices.

Moreover, in the summer of 1953 the collective farms of the coastal area organized large truck farms, ran pipes to the Techa, and set up pumps to irrigate thousands of hectares with river water. In 1951-1953, a casing and drill unit built a new town for its workers on the shores of the Techa. Approximately 1,600 people moved there. While working on their book, V.N. Novoselov and V.S. Tolstikov uncovered documents that demonstrated the powerlessness of the official authorities to prohibit the use of river water. The Science and Technology Council of the First Main Directorate, which was in charge of atomic issues, appealed to the USSR Ministry of Health to “deliberately contaminate the Techa with substances that would be harmless to humans but make them averse to using water from it.” The Health Ministry responded negatively to such suggestions.

It was clear that the prohibitions were not working. Next they began erecting a barbed wire fence around Koksharovsky and Metlino ponds and installing radioactive waste collectors, but they never completed the project. The next decision was to erect guard posts that would prevent the public from approaching the flood plain. In 1954-1955, when local councils assumed responsibility for it, they hired local residents as the guards. The latter did not have any administrative rights, so the solution fell entirely apart. It was not until 1956 that employees of the Ministry of Interior began guarding the Techa, and that policy did not continue for long.

Figure 4.3. A milling plant in Metlino on the banks of the Techa, 1956 (from the archive of V.N. Doshchenko). Photo given to author by Doshchenko.

Figure 4.4. Muslyumovo village. Photo taken by author.

One has to bear in mind that coastal residents essentially had no alternative to using the water from the river. The "well problem" is described in the aforementioned "Atomic Trace in the Urals." There were an adequate number of wells in only four villages. The larger population centers needed a public water supply system and it was estimated that the villages required 286 cribbed wells. At the headwaters of the Techa in the village of Metlino, they built 30 wells, but they were shallow and contained little water. Due to design errors, 15 wells were dry. In several areas, they did not begin drilling the wells for a long time. Then a special representative of the First Main Directorate of the USSR Council of Ministers was appointed to verify that the public had clean water. He was forced to acknowledge that even at a number of villages at the source of the Techa, no one knew that the river was contaminated and that wells had to be built. The attempt to build two wells in the Gerasimovka Village was abandoned when they struck solid rock. In the Brodokalmak Rayon, the “well equipment” was used to meet other needs. And the representative from the Directorate was unable to reach Kurgan Oblast because the roads from Chelyabinsk Oblast to Kurgan Oblast were totally useless in the fall (even for tractors); the trip would have to wait until it began to freeze and sleds could be used. During this time, not only the villages along the Techa River, but also the city of Shadrinsk in Kurgan Oblast, continued using the river water.

In 1954, the state allocated 1.5 million rubles to provide clean water to the public. The amount was sufficient to retrofit the water supply system at the Muslyumovo station and to provide water to the residents of casing and drill settlement and the villages Bugayevo and Upper Techa, i.e., four of thirty-nine villages on the Techa River. And this was only one small part of what should have been done.

Fifty years passed after the retrofit of the Muslyumovo station water supply. Techa, an environmental organization, managed to get a copy of a Rospotrebnadzor (Russian Agency for Health and Consumer Rights) document dated 25 May 2007 that prescribed “stopping the use of potable water” from underground sources in the centralized potable water supply systems of the village Muslyumovo and at Muslyumovo station.” The reason was that alpha-emitting isotopes had been discovered in the tap water. In this case, it is clearly referring to plutonium. That can mean only one thing—that radioactive elements have seeped through the bottom of the Karachay or the bottom of the Techa into the underground hydrological system, which is used for the water supply system. Local authorities do not have the resources to comply with Rospotrebnadzor’s order and provide clean water to Muslyumovo’s residents from any alternative sources. To this day, they drink “radioactive water,” which now flows from the tap.

4.4 What about the People?

Figure 4.5. The author by a bridge over the Techa River, near Muslyumovo village, 1989

No one could say what the extent of the radiation exposure of the public was. Radioactive contamination of the river began in 1949, and to all appearances, at the beginning of that year. By the time the radioactivity in potable water was first measured in the summer of 1951, people had already been exposed for two or two-and-a-half years. It was impossible to determine after the fact what dose of external gamma-radiation they had received. Beyond the external dose, there was also the appearance of radionuclides in the body. Which isotopes? How many? What was their level of radioactivity? Judging by the isotopic composition of the river water, the primary isotopes in question were cesium-137, strontium-89 and strontium-90. The half-life of these radioactive elements is in decades. Strontium accumulates in the bones and cesium is uniformly distributed throughout the body's tissues.

Medical examinations of the public needed to be conducted immediately. The ministry ordered the formation of a 15-man team (health physicists, doctors and lab technicians) from the employees of Chelyabinsk-40, which in June-September of 1951 traveled to the villages of Metlino and Nadyrov Most to examine dozens of residents there. Another 210 residents from the headwaters of the Techa were examined in the summer of 1952.

Records on the results of these examinations were kept at the Urals Research Center for Radiation Medicine (URCRM). It was impossible to establish an individual exposure dose. The doctors had to be guided by the answers to their questions: How long have you lived in the littoral area, how far is your home from the river, and for what purposes do you use the river water? The examination included a peripheral blood analysis, a checkup by a general practitioner (or pediatrician for children) and checkup by a neurologist. For examinations in subsequent years, several people had their immune resistance assessed, and some individuals had their gastric secretions evaluated. Since no one had checked the health of the people before they were exposed, it was very difficult to determine whether changes in their health were due to exposure or to common diseases they had had prior to 1949. There is no specific symptom for radiation damage, i.e., a symptom that could not have appeared because of a common disease such as brucellosis, chronic infections, consequences of trauma, etc. For professional workers at an atomic enterprise, the diagnosis of radiation disease is established based on follow-up monitoring and comparing their blood indices before beginning work and at the time of the examination. This could not be done when examining residents of populated areas along the Techa. Before their exposure, medical assistance to village residents was minimal and provided by physician assistants and midwives. It was difficult, if not impossible to diagnose an individual who had been examined in field conditions.

"Atomic" and medical supervisors ordered the establishment of a distribution limit for radiation exposure to the public. In principle, they needed not only to examine 27,000 people, but also provide them qualified medical assistance. There simply were not enough medical personnel or equipment to do it. The head of Med Unit 71 reported to the ministry that his team could not simultaneously handle the workload of examining atomic plant personnel and travel to the villages on the Techa.

The task was reformulated: to identify in 1953 whether the health of the public had worsened in comparison to 1952. In the summer of 1953, teams from Moscow institutes of biophysics and occupational health carried out the medical examinations. In addition to general practitioners, the teams included gynecologists. In Metlino, 250 residents were examined. Not only were examinations conducted in the villages at the head of the river, but in areas 80 km from the radioactive waste discharge point. In all, 578 villagers were examined. Clearly, most of the people were being examined for the first time and only a small percentage for the second time. In general, the blood indices were worse and there were a high percentage of miscarriages and birth defects. Several of the people examined had symptoms of organic damage to the nervous system. The final report stated that 98 residents of Metlino had signs of radiation damage, and of the 578 villagers examined, 200 had symptoms consistent with radiation exposure. Thus, one-third of the people examined had radiation damage. It was acknowledged on the basis of this information that symptoms of radiation were growing. It should also be noted that these were the results of random, non-systematized studies, and that there was practically no treatment at the time.

In 1953, it was acknowledged that the "only efficient means of preventing new cases and mitigating current cases" was resettlement. The administration of Complex № 817 proposed resettling all residents along the Techa from the source to the mouth of the river (a distance of 237 km). It was suggested that residents of the small villages be resettled first, then the five large population centers: Brodokalmak, Muslyumovo, Kurmanovo, Russkaya Techa and Novaya Petropavlovka.

It all began with the inspection of approximately 500 homes in the villages along the Techa. Most of the buildings were considered unsuitable for relocation "due to economic considerations." At the end of 1954, the Council of Ministers allocated 570 standard wooden homes, 50 of which were three-room and the remainder single-room. What was a single-room house? Two layers of thin plank, filled in between with ash. Opening the door, without an entry or mudroom, you immediately find yourself in a narrow kitchen, mainly taken up by the stove. One side of the stove faced a room, 10 m^2, neighboring the kitchen. Wide sleeping benches are nailed to the wall that are used by the family to eat, for the children to do their lessons, and on which blankets are spread at night for the family to sleep, as they say, "side-by-side." There was only a narrow space between the sleeping benches and the stove. The walls did not hold their warmth, even if the stove burned all day and night. A family of six to eight was resettled into such a home. Representatives of the Chelyabinsk Oblast Executive Committee later acknowledged that these homes were unsuitable for winters in the Urals and asked the Ministry of Medium Machinery (Sredmash, later Minatom and now Rosatom) to construct a new type of home. However, the people who had already settled in the "unsuitable" houses never received new homes; they have been freezing in them for 50 years.

In the spring of 1955, they began resettling people from the eight small population centers whose total population was 1,755. The explanation for the relocation of these people was that the collective farms needed to be expanded. A one-time benefit was paid to the families: 400 rubles for each able-bodied member and 100 rubles for each disabled member. The relocation of the residents of Metlino, 961 persons, began in 1953 and was completed in 1956. They moved them to a densely populated village on the shore of Kazhakul Lake. In 1957, they began resettling people from the village of Gerasimovka and the geological explorers' settlement (approximately 800 persons).

It was tough psychologically on those relocated. They were banished from the permanent place of residence, where many generations of their families had grown up, and where their ancestors had been buried. They had to abandon their homes—more often than not, log cabins—and relocate to tiny, hollow-walled houses. The monetary compensation for the loss of their property was totally inadequate. These people understood that they were being lied to about the reasons for their eviction.

To confine them to the collective farms, the government did not issue domestic passports to the village residents. They could not even move to small cities since they could not be registered there or be hired for another job. The village residents were only authorized to take short trips from the village to visit the relatives. For these visits, they had to request a personal ID from the village council. It was the Soviet form of serfdom. Those relocated to the littoral villages were not given domestic passports either. Because they had signed the equivalent of a "nondisclosure agreement" with regard to their previous place of residence and the reasons for their resettlement, they were deprived of the opportunity to appeal to administrative authorities to protect their interests. These people keenly felt their powerlessness.

The country had no personal or surname information on the village residents. It gave the impression that the country was interested only in collecting taxes. The only documents by which one could try to create a register of the irradiated population (should anyone have the desire to) were household ledgers and tax registers. To collect the different types of property taxes, the government documented the last name of the head of the family and whether he or she had a home and other property such as outbuildings and livestock (cows, calves, sheep, goats, etc.). Underneath, on the same page of the register, they listed the surnames of the family members and their kinship. The registers were updated every three years. A register of those who had been exposed to radiation was not created until the 1980s, through the efforts of employees with the URCRM in Chelyabinsk. Not all of the registers from the fifties were still available by that time. Just as the villages had disappeared, so had their household ledgers.

The resettlement project was stopped in 1957 for two major reasons: a catastrophic radiation incident in September 1957 (which deserves its own special chapter), and the recommendation of the previously mentioned D.I. Ilyin, the one who reported that no data had been kept on the amount of radioactivity discharged into the river. D.I. Ilyin was the head of the external dosimetry service of Complex № 817. In March of 1957, Ilyin forwarded a report to the Ministry of Medium Machinery, in which he wrote, "the demolition of the populated areas and the relocation of their residents from Muslyumovo and lower portions of the river should not be continued." (in Novoselov, 1997) He based his recommendations on the results of a recent analysis of the water and sediments of the Techa River, and on the startup of a northern diversion canal that would now rinse the waters of the Techa. The strategy would save at least 70 million rubles. It did not clean the Techa. The recommendation of one man led to grave consequences for the fates of thousands of people. But the plan suited the interests of the heads of the complex and the ministry, so it was approved.

This year (2010), however, house owners in Muslyumovo village got financial compensation from Russian government funds, sufficient for buying new properties. The majority of Muslyumovo residents purchased new real estate properties for living either in the city of Chelyabinsk or in Muslyumovo station. The village of Muslyumovo is finally going to vanish after almost 60 years have passed since radioactive contamination of the Techa River occurred due to Mayak chemical plant accidents.

Figure 4.6. Only a dilapidated church and milling plant remain of the village of Metlino. (photos taken by V.N. Doshchenko and given to author, 1982).

4.5 "Special Clinics"

In 1955, "special clinics" were established in Chelyabinsk and Shadrinsk (Kurgan Oblast) to "identify and treat residents in areas contaminated by radioactive waste who show they have radiation disease." There were no buildings specially customized for this purpose; they were constructed later. The staff was made up of dosimetry specialists, nurses, junior personnel, doctors and drivers. Most had no experience in nuclear medicine. This was, however, not merely an attempt to examine the public, but also to provide specialized medical assistance.

In the summers of 1956 and 1957, the medical field teams worked in the major population centers that remained on the Techa: Brodokalmak, Muslyumovo and Nizhnaya Petropavlovka. In these villages, 80 km and less from the location of the radioactive waste discharges, several of those examined gave cause to suspect radiation disease. A number of these patients were sent for further examination and treatment in Moscow at Special Clinic 6; several were given a follow-up examination in Chelyabinsk or Shadrinsk. The Moscow specialists generally confirmed the cases as chronic radiation disease.

There are two major principles in radiation protection: time and distance. [Editor's note: shielding is considered the third major principle, though clearly it wasn't applicable to these situations.] If a radiation source is unsealed (as in an explosion or manmade accident), people should be immediately isolated (removed) from the source. Efforts to mitigate the source must be calculated in minutes for participants to avoid overexposure. Unfortunately, observance of these principles does not prevent individual, rare cases of acute accidental exposure to large doses. In such instances, acute radiation disease may occur, treatment for which is provided in special clinics in several cities in Europe and the USA.

Chronic radiation sickness (CRS), as defined by Soviet specialists A.K. Guskova and G.D. Baysogolov, (Guskova, 1971) is an illness caused by extended external exposure or both external and internal exposure to radiation in significant doses. What is a significant dose? The International Commission on Radiological Protection defines this dose as 40 centiSieverts in one year [1 cSv equals 1 rad or Roentgen] with extensive exposure for several years [sic]. Accumulated doses of more than 100 cSv may lead to the development of chronic radiation disease, which is not listed in the "International Classification of Disease." This is likely because there is no such illness in the rest of the world. It is the privilege of the USSR. Chronic radiation disease was diagnosed only in the Urals, owing to the operations of Mayak, an atomic enterprise. The presence of such an illness was difficult for Western specialists to comprehend. When given the opportunity, they began to ask questions (Kosenko, 1990):

> "Why weren't these people removed from the source of exposure?"
> "How could these people have accumulated such large doses in a year?"
> "Is it not absurd, when professional workers—who are aware of the deleterious effects of exposure and receive benefits for it—are not subjected to lengthy exposure, but nothing is done for the public?"
> "Where and under what conditions could such an unforeseen situation occur?"

CRS is difficult to diagnose. The authors noted above, who have described the illness, say, "none of the symptoms of chronic radiation disease are specific to radiation exposure. They are of diagnostic value in the aggregate." In other words, these symptoms are present in many illnesses unrelated to radiation exposure: chronic infections, helminthiasis, immune disorders, etc.

A diagnosis of CRS can be verified if there is a documented, continuous decrease (compared to the point at which the patient began working, i.e., pre-exposure) in the number of leukocytes and platelets, and increased disability. The dynamics of these symptoms were observed among young reactor or radiochemical production workers who received a significant exposure dose during each shift. How is it possible to confirm this diagnosis for village residents of different ages who have a number of ordinary diseases, whose exposure dose is unknown, and whose state of health pre-exposure is also unknown?

In the years 1949-1952, when people were subjected to the largest exposure doses, not one case of CRS was diagnosed because no one was examined by a specialist. When they were ill, the inhabitants received diagnoses of brucellosis, hepatitis, anemia, leukemia, alcoholism, etc. from the medical assistants. When they died, the same diagnoses figured prominently in the causes of death in official documents. However, six to seven years after exposure began (when external irradiation had essentially ceased) and these people should have begun recovering their former state of health, is the period when large numbers of people began being diagnoses with CRS. It was during this time that mass examinations of the public were conducted by specialists who knew that radiation exposure had taken place.

Judging from the reports, there were 1,159 cases of CRS. In several villages at the headwaters of the river (Metlino), 60% of those examined received this diagnosis. CRS was also not infrequently the diagnosis for mid-river residents and even those living along the shores of the Iset. In 85% of the cases, the diagnosis was made in 1955-1958, i.e., six to nine years after the patients began receiving the highest annual doses. (Kosenko, 1994; Kosenko, 1998)

Many of those examined complained of bone pain, frequent headaches, unusual weakness, and the rapid onset of fatigue. Several individuals were determined to have, relative to the norm, reduced leukocyte, platelet and red blood counts, as well as increased liver size, and abnormalities in their nervous systems and neurovascular regulation. Should radiation exposure be considered the cause of these symptoms? It is impossible to answer this question unambiguously because during the examinations the patients with these symptoms were also discovered to have illnesses clearly unrelated to radiation exposure: helminthiasis, giardia in the gallbladder, furunculosis, chronic ear inflammation, skin diseases, chronic bronchitis, and mouth infections. Practically all those examined need dental treatment. These illnesses can also cause anemia, enlargement of the liver, and reduced physical ability. A very high percentage of the men smoked. The children had insufficient vitamin levels.

The situation was compounded by the fact that the districts in which the exposed population lived had local cases of goiter and brucellosis. For 30-40 years, the villages along the Techa had maintained flocks of sheep and herds of cows with brucellosis. The most common disease found among milkmaids, veterinary workers and cowhands was brucellosis. This was the background against which the effects of radiation developed. Once the diagnosis was established, we proceeded from the assumption that the patient may be simultaneously presenting the consequences of radiation exposure and somatic illnesses.

The first attempts to establish individual exposure levels was reduced to determining whether strontium-90 was present in the body of the person being examined. Strontium is a beta-emitting isotope; it is ingested into the body via water and food, enters the bloodstream, accumulates in tissue and, to some degree, is excreted through the kidneys and intestine. Studies were focused primarily on measuring the amount of beta-radiation activity in the excretions. This method is extremely time-consuming and very imprecise.

The radioactivity measures in the lower reaches of the Techa, the estimates of the external doses created by the water and silt, and the measurements of beta-activity in the excretions of specific individuals gave grounds to believe that the residents of the lower Techa and coast of the Iset were exposed to less than one sievert, i.e., below the dose threshold at which radiation disease might develop.

The diagnoses were reviewed. The report on the results of medical examinations in 1959 contained a note, signed by Professor A.N. Marey, which stated, “Considering the relatively low amount of radiation present in those examined, as well as the fact that chronic radiation sickness—especially first-degree—does not have any specific symptoms that are its exclusive domain, such a high incidence rate for the disease is dubious.” (Marey, 1961) As a result, the committee acknowledged that the diagnosis of chronic radiation disease was made in a number of cases without sufficient grounds. Specifically, the decision immediately addressed 128 cases of diseases among residents on the coast of the Iset.

It was much later, after accumulation of a sufficiently large registry of exposed individuals (27,000) on the Techa, did it become clear that only 50% of those exposed had a checkup (at least one examination). Nothing is known about the health of half of those exposed. In the situation outlined above, how is it possible to assess the frequency of CRS?

5.0 Kyshtym Nuclear Disaster

The second situation that led to the exposure of thousands of people also involved radioactive waste. It occurred on 29 September 1957 and is known as the “Kyshtym Accident” or “Kyshtym Nuclear Catastrophe.”

If it was slightly and moderately liquid radioactive waste that had been flowing into the Techa, it was highly radioactive waste that began appearing at the Complex S storage in 1953. There were enormous containers that they called “pots” or “cans”. The containers were kept in concrete cells and buried underground in a canyon.

There were twenty stainless steel containers in all. The capacity of each can was 250 cubic meters. The waste not only contained radionuclides, but also alkalis and acids. The chemical processes taking place within the containers were essentially unmonitored. The objective was to produce plutonium; the waste storage process at the enterprise was a secondary concern.

The containers were hot, so they were initially lowered into water for cooling. But as the solutions in a can began to evaporate, they gradually rose to the surface and the seal failed; the radioactive solutions seeped into the coolant water. Later the coolant water circulated between the walls of the can and the canyon. The entire system was to have been outfitted with instruments to measure the level and temperature of the solutions in the cans. However, several of the measuring instruments failed during the first years of operation.

Container № 14 was filled with radioactive waste from 9 March-10 April 1957. A total of 256 cubic meters of radioactive solution had been poured into it. The duty technician, V.I. Komarov, noted at approximately 3 pm on 29 September 1957 that "there was a great deal of yellow smoke coming from the cans in the third complex." (quoted in Mityunin, 2005) They assumed it was an electrical problem. Four workers on the duty team, wearing gas masks and sealed jumpers, were lowered into the relevant corridor below with a lamp. They had to make their way by touch because of the smoke. Nothing out of order with the wiring was discovered, but they noted it was terribly hot in the corridor. They turned on the ventilation system and were lifted back up.

In their book "Atomic Trace in the Urals," V.N. Novoselov and V.S. Tolstikov write that the duty team did not measure the radiation background in the storage facility, and were unconcerned with the smoke and high temperature. (Novoselov, 1997)

5.1 The Explosion

A thunderous explosion was heard at 4:22 pm. Container № 14 had exploded. The blast tore through a 160-ton concrete slab. Identical concrete covers above two adjacent cans were also demolished. By that time, the workers were all safely above the canyon and no one on the team was seriously injured.

Here's how the duty technician V.I. Komarov describes what he saw after the explosion: "In the place where the hill of Complex S-3 rose, there was a high column of white cinders, beyond which nothing was visible. It was dark from the rising cloud. Against the background of a 150-meter plant pipe, I saw a multi-ton concrete cover flying, torn from the container by the blast." (Mityunin, 2005) The barracks of the interior troop regiment, military builders regiment, firefighting team and labor camp were located approximately one kilometer from the site of the explosion.

In his memoirs, Colonel I.F. Serov noted that the military unit of the interior troops was lucky that the duty officer was the commander of the regiment's chemical service. He immediately decided that it was a major accident or an act of diversion at the main site involving a radioactive release. Glass was blown out of every window in the barracks that faced the front of the shockwave. The metal gates had been torn off. All the soldiers immediately ran into the street; believing a war had started, several ran to the arms depot for a weapon. The duty officer decided to take the following actions: all soldiers, excluding those on guard duty, were to go immediately to the barracks to shutter the shattered windows with all available materials and pour water on the floors so that no dust became airborne; the cafeteria was forbidden to serve meals, and all food-related units were sealed. The soldiers followed the orders scrupulously, silently and quickly without any panic. The fallout from the radioactive material was very intense during the first hours. Rather large particles fell like snow upon the ground and buildings, and continued to fall for the next several days. (cited in Mityunin, 2005)

The situation was reported to the Minister of Sredmash, Ye.P. Slavsky, who suspected that a nuclear explosion had occurred. Since the Secretary-General of the Communist Party, N.S. Khrushchev was on vacation, Slavsky reported the explosion to Mikoyan. In A. Mityunin's book (Mityunin, 2005), Slavsky said: "On the evening of 29 September 1957, N.S. Khrushchev called, infuriated, and began very coarsely cursing me about the Kyshtym base, and threatened to 'stomp' everyone for the incident. I said, 'Nikita Sergeyevich, when Mayak-40 calls me with the details of the accident, I'll deal with it and report to you.' Khrushchev became even more incensed and it seemed that the receiver turned white-hot. 'Are you playing me for a fool? The 40^{th} October anniversary is in a month. There will be guests from all over the world. This is the surprise you prepared for me?! Fly right there and immediately report back to me with news that the accident is being mitigated or what the situation is there… No excuses! They obviously didn't teach you anything at the June plenary session!' Cursing and promising again to 'stomp everyone,' the impulsive Khrushchev hung up the phone."

As established by the Technical Committee of Sredmash, which arrived from Moscow three days after the explosion, a 70-80 ton mixture of dry sodium nitrates and acetates exploded in container № 14. The mixture exploded exactly like gunpowder. The yield of the explosion was estimated to be equivalent to 70-100 tons of TNT.

5.2 Eastern Urals Radioactive Trace (EURT)

The explosion destroyed Container № 14 and released material into the environment with a total radioactivity of 20 million curies. This is approximately equal to the release from the explosion of a 10-20 kiloton nuclear bomb; that was the amount dropped on Hiroshima. However, in comparison to an atomic bomb, the storage facility explosion released many more long-lived cesium and strontium isotopes in the air. As shown by the calculations and measurements conducted much later by foreign scientists, the small radioactive particles and dust resulting from the 1957 accident traveled three times round the globe.

Most of the radioactivity (90% or 18 million curies) was at the production site. Two million curies were elevated one kilometer in the air. At the moment of the explosion, there was a gusty southwesterly wind blowing in the area of the complex. Its speed at the surface was 5 m/s and 10 m/s at 500 m high. A radioactive cloud covered Chelyabinsk and Sverdlovsk Oblasts, and then reached Tyumen Rayon in 6-8 hours. The formation of the radioactive trail was completed entirely in 11 hours.

The trace extended to the northeast from Mayak for approximately 300-350 km. It crossed the catchments of four rivers and 30 lakes.

The cloud bypassed the city of Chelyabinsk-40. There was some contamination later because the radioactive dirt from the production site was spread by car tires, shoes and clothing. Fortunately, the radioactive cloud also bypassed other cities close to the complex, such as Kyshtym, Kasli and Kamensk-Uralsky.

The night after the explosion the health physicists made a map of the contamination in the premises. Especially contaminated was a building under construction at the second plutonium plant. Within 12 hours, the gamma dose rate 100 m from the explosion was over 100,000 microroentgens a second (the approved standard for exposure was 2.5 microroentgens a second).

All the decisions in this situation were made and executed much more expeditiously than was the case with the radioactive contamination of the Techa River. People were first evacuated from the production site.

After the initial dosimetric examination, it was clear that it would be impossible to leave the soldiers in their barracks. Permission to move the soldiers was granted by Moscow; within 10 hours after the explosion, people were evacuated from the danger zone in open trucks and on foot in formation. All personal belongings had to be left behind.

Somewhat later it was decided to set the boundary of the radiation trace (the area of fallout from the cloud of radioactive precipitates after the explosion) based on a contamination density of 0.1 Ci/km^2 strontium-90. The area within the isoline was 23,000 km^2, with a population of 270,000. There was a more dangerous zone within the area where the strontium-90 fallout density was two Ci/km^2 and higher. The area of this zone was nearly 1000 km^2—105 km long and eight to nine km wide—with a population of nearly 10,000. Beyond the boundaries of this zone it was considered safe for the public.

5.3 Who Were the Mitigators?

The first accident mitigation task was to cool the radioactive waste cans to prevent any new explosions. Since the utilities that provided water to the storage facility were destroyed, they began drilling slant holes. The radioactivity next to the storage facility was so high that mitigators could only work for several minutes in order to avoid overexposure. They had to provide drilling instruction immediately to a team of 400 men. They adopted interim accident standards for radiation safety: no more than 2 roentgens a shift and 25 roentgens total. After 25 roentgens, they were released from mitigation efforts for three months.

As mentioned previously, it was very contaminated at a building being constructed at the second plutonium plant. The radioactivity on the roof of the building was over 10,000 µR/s. Should the building be scoured or built anew? They had no experience cleaning surfaces, especially walls, ceilings and roofs. Nevertheless, it was decided to clean the building. They begin by using street cleaners and fire trucks to decontaminate the road leading to the reactor plants. They washed it with special solutions, but in several spots they had to remove the upper layer of dirt and take it to repositories. Then they cleaned the walls; the plaster had to be removed in several places with picks.

Clearly, the most accurate information about who participated in the restoration work and cleaning of the area has been provided by Senior Research Associate Nina Alexandrovna Koshurnikova of the Institute of Biophysics Branch № 1 in Chelyabinsk-40. In 1992, she and her employees attempted to create a registry of persons participating in accident mitigation in 1957. It was established that the most complex tasks, such as the washing and decontamination of contaminated machinery, were performed by employees of the complex. The total number in the registry is 5,029, or 14.7% of the total number of mitigators. These individuals underwent thorough medical examinations. There are no documented cases of radiation disease among them. (Koshurnikova, personal communication with author)

A total of 4,264 men from Interior Troop Military Unit № 3273 (now Units 3445 and 3446) participated in the accident mitigation. The average dose for the group was 24.45 rad. However, 11% of these individuals received a dose higher than 75 rad. They were examined. Twelve had abnormal blood indices and were placed in a hospital for further examination and treatment.

Only Mayak employees who participated in accident mitigation were given mitigator status. The only persons eligible for mitigator benefits were individuals whose professional duties were to ensure nuclear production safety, and who were to some extent or another at fault for the accident. The others recruited to decontaminate the areas, buildings and soil and remove debris, etc., did not receive any special social protections. This "undocumented contingent," as they were called, were not recognized as mitigators.

The bulk of the workers were military builders. Their precise number is unknown, but is believed to have been at least 20,000, or more than 60% of all mitigators. Construction troops from Military Unit № 01013 (now Units 20156 and 25529) were assigned to accident mitigation. No information was found regarding their exposure doses. The fate of 92% of these individuals is unknown. Many participants were immediately transferred to the reserves after the area was cleaned.

In addition to the soldiers from this military unit, soldiers from other units deployed in Chelyabinsk Oblast were also recruited "for one-time accident mitigation activity." They brought them to the area without telling them it was contaminated with radioactive material. According to several publications, there were fewer than 5,000 of these soldiers. The construction unit soldiers filled in the explosion crater, removed the upper layer of soil in the area of the explosion, re-roofed damaged buildings, and washed off the walls with brushes. After each shift, the contaminated jumpers and rubber boots were destroyed immediately and buried in the ground. Judging by the fact that the permissible dose of 25 roentgens was exceeded by 11% of the recognized mitigators - whose dose rate was monitored and who had a relationship with the complex - it can be assumed that the exposure above the permissible dose rate was more frequent among soldiers.

Three kilometers from the epicenter of the explosion, along the axis of the trail, was the labor camp of prisoners [YaV 48/24, 10th Labor Camp Division]. The 1,002 prisoners and 98 service personnel only participated in the mitigation efforts in the first hours after the explosion. By the end of the first day, they were evacuated from the camp and were not recruited for subsequent mitigation work.

People were contracted for accident mitigation without preliminary medical certification. No individual dosimeters were issued; in the best case, a team of soldiers had one to three dosimeters. The dose, if accounted for, was estimated as the "total for the sites," but not for individuals (recalling the old story about the patients whose temperatures were assessed "by the ward"). The designated work time in the most contaminated hot spots was violated.

By sending these soldiers into the reserves, the state freed itself of taking care of them. For the "nuclear" administrative bureaucrats, recruiting temporary workers was a simple decision, the "best solution" in an emergency situation. The soldiers returned to cities or villages, possibly suffering the effects of exposure, but none of the medical workers there could properly diagnose and assist them.

In 1992, our clinic (Urals Research Center for Radiation Medicine, Chelyabinsk, Russia) received the following letter (now in author's personal archives):

> Hello, dear Medics! I, Vasily Alexandrovich Utkin, born 1937, am a Cclass-2 invalid. I have lived in Chelyabinsk-65 since 1956. From 1956 to November 1959, I served in the Interior Troops, guarding the site now known as the Mayak Chemical Complex. In 1957, at the time of the explosion, I was in a military unit 4 km away. The blast shattered all the windows in the soldiers' barracks. After the explosion, we were immediately ordered to protect a site in the area of the explosion. That night, our unit, the prison labor camp and construction soldier regiment were evacuated, but we soldiers were still on duty. Throughout the two days on duty, we were never relieved and went without food. After 24 hours, we would again begin guarding sites in the contaminated area. All our personal belongings and the uniforms we were wearing were taken from us immediately and incinerated… For 10 years now, my head hurts all the time and all my joints hurt and ache. More than once I have turned to doctors, treated frequently in the hospital, first for my heart, then for an ulcer, always telling them about my joints. They are indifferent to it; they treat stomach or heart problems in the hospital and ignore everything else. They x-rayed my head and joints, then say there have been no changes in my joints. I've turned to doctors everywhere here, but they don't want to do anything. If they find something, benefits will have to be set up and something added to my pension. There are many like me, and everywhere they brush us aside. I think that we'll soon all die off anyway. Our bureaucrats live only for themselves, setting themselves up with high salaries and living in luxury. It is of no concern to them that we ruined our health in our youth.
>
> Therefore, I am turning to you with an earnest request for an examination in your clinic, since the doctors here will not send me to you.
>
> --12 March 1992. Sincerely, V. Utkin

Of course we examined him. However, we did not have the right to link his illnesses to his exposure in 1957. That was the reason why V. Utkin requested help. Everything resumed its normal course and V. Utkin "camps out" at the medical institutions in Chelyabinsk-65.

In addition to the area at the complex, the surrounding area, where village residents lived, was also strongly contaminated. As became clear sometime later, part of the village had to be demolished and the people relocated. There are no documents that identify who destroyed the houses and outbuildings, buried the debris, and dug up the soil. In 2003, after all materials on the accident were declassified, residents of the village Tatarskaya Karabolka filed suit in the city of Ozyorsk [formerly Chelyabinsk-40]. In the sixties, while still schoolchildren, they were sent to tear down structures in the villages being mitigated in an area contaminated with radioactive material. No one asked for their consent, no one entered them on trip sheets, no one documented their exposure dose. If complex workers were recognized as mitigators and receive benefits for it, then why does no one remember them? Only 50 are still alive. In court, they were prepared to prove their right to be regarded as mitigators and receive compensation from the state for damage to their health. On 30 July 2003, almost 50 years after the accident, the Ozyorsk Municipal Court found in favor of the "young mitigators."

5.4 Residents of the Adjacent Villages

They began to assess the radiation situation beyond the Complex the second day after the accident. The results of the measurements were reported to M.A. Demyanovich, who was the director of the complex at the time. (cited in Novoselov, 1997) He did not believe the figures could be so high and asked them to repeat the measurements. However, the dose rate in the village of Berdyanish, located 12.5 km from the explosion, was almost 400 microroentgen a second; in the village Saltikovo, 18 kilometers from the explosion, it was 300 microroentgen a second; in the village Galikayevo (23 kilometers), it was 170 microroentgen a second; and in Yugo-Konevo (55 kilometers), it was six microroentgen a second. The calculations showed that if the residents of Berdyanish remained at their previous location, they could have received an absorbed dose of approximately 250 rad in the first month and nearly 850 rad in the first year.

In the populated areas within the main part of the EURT, there were contaminated plants, farm and domestic animals, well water, lakes, three small rivers and the people.

The Moscow committee, led by Minister Ye.P. Slavsky, could not decide whether or not to resettle the residents of the above-named villages. The final decision was to evacuate the people (primarily Tatars), but not destroy the buildings in the villages. They did not explain the reasons for the decision to the people. The residents of Berdyanish, Saltikovo, Galikaevo and Kirpichiki were evacuated 7-14 days after the explosion. During those days, the average estimated exposure dose for these 1,100 residents was 52 cSv.

Iran Khayrullovich Khaerzamanov, a former resident of Berdyanish, told the following story to correspondent F. Nigmatulin in 2007, fifty years after the accident (I have translated the story, retaining the orthography) (Nigmatulin, 2007):

> The military and civilians gathered the residents of the village at the kolkhoz administration building the next day. No one openly discussed the extent of the

danger. It was clear they didn't fully understand the situation. In general, the area and buildings were decontaminated; contaminated articles were destroyed. On the fourth day, we noticed the young livestock had bloody diarrhea. The children also began having problems with their gastrointestinal tract. I had my own misfortune. My 10-month old daughter came across a dark cloud in the vegetable garden with her grandmother, who was gathering potatoes. The little one began to have diarrhea and died several days later. My baby is still buried at the cemetery in Berdyanish. And that happened to a lot of the little children. The bodies of the grownups were stronger.

Then the first steps were taken to prepare for the relocation. First, they moved people from the western half of the village to the eastern half. Clearly they hoped to avoid complete resettlement. They shot all the dogs. Destroyed the cats. Checked the clothes of residents with dosimeters and seized the clothing and incinerated it if it had high background radiation. We, who didn't have any protective equipment, took our simple, contaminated personal belongings to the edge of the village, and loaded, unloaded and burned them ourselves. The only water we drank was imported.

Next they began destroying the livestock and birds. The animals they shot right before our eyes didn't die immediately. There was a danger of people being killed by a ricochet bullet. The women and children cried and a small panic set in. When someone started a rumor that the people would be shot after they finished the animals, the panic increased. Realizing that the situation was getting out of control, we, the activists, decided to interfere and began persuading the commander of the submachine gunners to leave the destruction of the animals to us… Until the evening came, we killed our contaminated breadwinners with our own hands. They were members of the family. So you can understand the dismal state we were in when we came back after such barbarism to the village that evening, which was as quiet as a cemetery. The next day, they announced that people would be relocated the 12th of October. Until then, we were to sit inside the house and not go out on the street. They drove German Studebakers. We were allowed to take only a few things, only metal household goods. We had only the clothing on our backs; they took that away too afterwards.

First they took us to Soviet collective farm № 1 in Agrayash Rayon. They had already evacuated the residents there. In terribly close and sweltering quarters, there was only room for some of our fellow villagers; the rest, generally with children and infants, were stuck out on the street. Then they drove us to a bathhouse for decontamination. Moreover, it began wildly. They started forcing naked men and women into the steam room simultaneously. Of course, this was quite a shock to most of the village women since they had been brought up with Muslim traditions.

It was the great uncertainty that weighed on people. How is one supposed to feel, finding oneself within absolutely strange walls, without clothing, without a

> kopeck in one's pocket, anticipating when they'll give you government-issued food, and not knowing where they will take you tomorrow? The old women had a very difficult time of it because the female Muslims were without their undergarments and their daily trousers. Taking care of one's natural needs for female Muslims is a special and holy ritual with mandatory ablution of intimate places on the street. This rite is part of their genes, passed down through the centuries by our ancestors.
>
> For compensation they gave us a panel house, necessary clothing and money to set up housekeeping. But it was miserly compensation for everything we had lost, not even speaking of emotional distress, nor the loss of our health and our loved ones.
>
> At the beginning of May, they finally took us to a new place of residence in the village Khalitovo. It's almost steppe; cold in the winter and a penetrating wind that blows away all the warmth from the little stoves in these little houses. We began life anew in illness and depression.

It was not until 12 November 1957 that the Council of Ministers issued an order stating that "as a consequence of contamination by production wastes, [the residents of] Berdyanish, Saltikovo, Galikaevo and Kirpichiki of Chelyabinsk Oblast must be resettled in new locations." On the twentieth day after the accident, the level of radioactive contamination in the villages of Berdyanish, Saltikovo and Galikaevo reached 30000 Ci/km^2. This meant that all the structures in the villages had to be destroyed. In windless weather, the homes and farm structures in the abandoned villages were burned down.

The fates of the resettled residents were very difficult. They lost all that they had, could not farm in their new location, and did not have any work. The families also had many children—six to eight in Tatar and Bashkir families was customary at the time. Driven to despair, in 1958 they decided to write to Soviet authorities N.S. Khrushchev and K.Ye. Voroshilov. Part of the letter is presented in "Atomic Trace in the Urals": "We were subjected to nuclear poisoning due to some kind of accident in the closed city of Chelyabinsk-40. Many of us are ill and we sit here idly and wait. What we are waiting for, most likely, is a disastrous demise."

Only after this was the compensation determined for the residents of the four population centers for lost property. It was the same amounts as for the residents relocated from the villages on the Techa: 400 rubles for each able-bodied family member and 100 rubles for each disabled member. The settlers were exempted for two years from agricultural taxes and were to be provided a new home or receive an amount equal to the assessed value of the residence from which they were relocated.

The residents underwent a medical examination after their relocation. The examination was performed by specialists of Medical Clinic-71, who had professional expertise in diagnosing radiological pathologies. There was not a single case of radiation disease. Approximately 20% of them had lower-than-normal leukocytes and platelets, but the changes were not dramatic. Less than half were deemed healthy. The majority were diagnosed with common diseases such as chronic infections of the mouth, atherosclerosis of the heart and brain, hypertension, bronchitis, emphysema of the lungs, gastritis, cholecystitis, worms, visual impairment, etc. These diseases were explained by the difficult living conditions and unsatisfactory medical assistance provided to a rural population.

5.5 Resettlement Deferred for Years

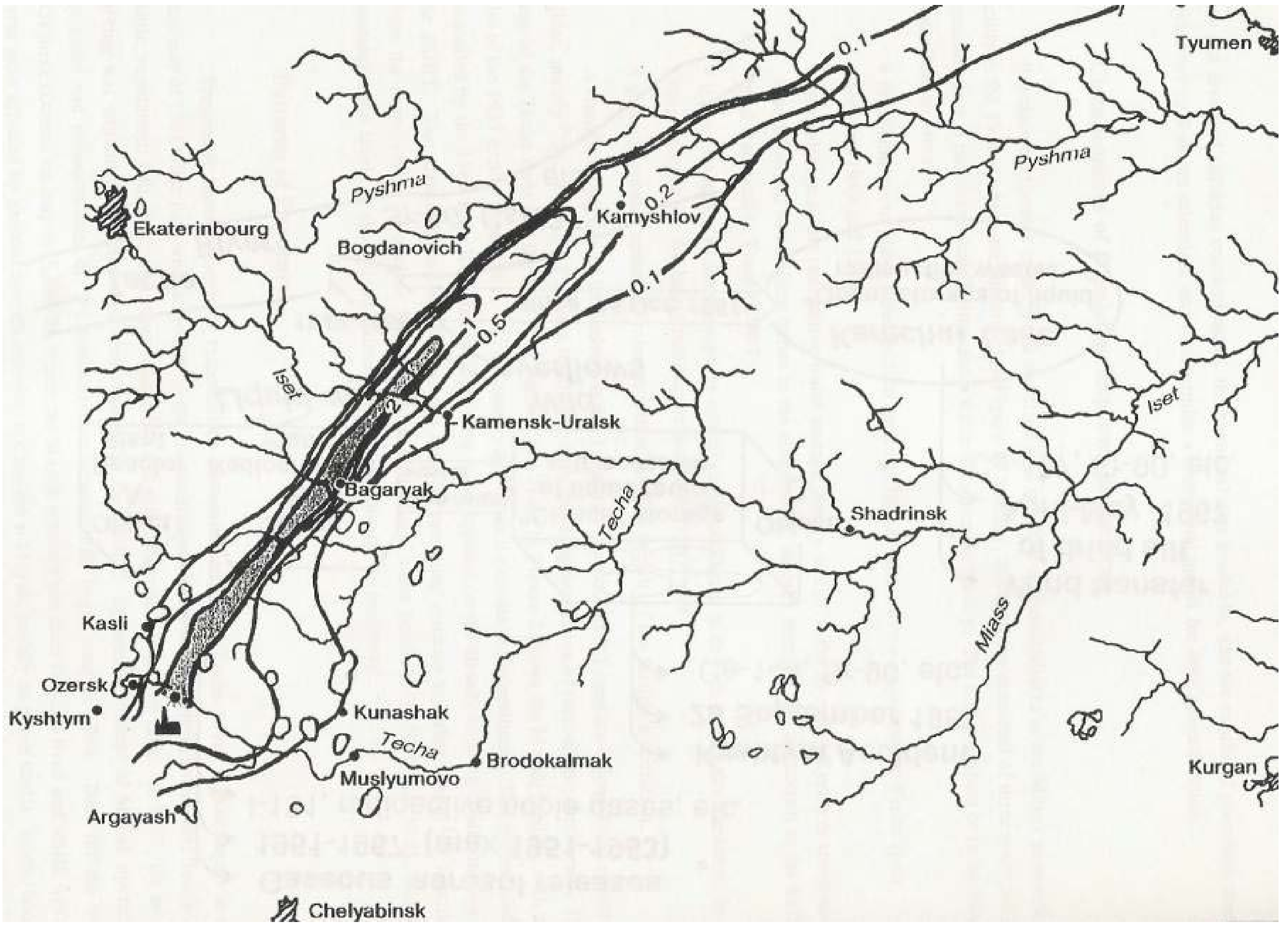

Figure 5.1. Eastern Urals Radioactive Trace (EURT). Isopleths (isolines) of the areas contaminated by strontium-90 are in curies per square kilometer. Taken from Degteva MO et al., "Population Exposure Dose Reconstruction for the Urals Region", article in Kellogg SL and Kirk EJ (eds.), "Assessing Health and Environmental Risks from long-Term Radiation Contamination in Chelyabinsk, Russia", American Association for the Advancement of Science, Washington DC, 1997.

These urgent evacuation measures affected only four villages and their 1,100 inhabitants. In actual effect the EURT had a contamination density of 0.1 to 1.0 curie for strontium-90. It stretched 300 km and had a total area of 23,000 km^2. Within the trail lived 270,000 people in Chelyabinsk, Sverdlovsk and Tyumen Oblasts. There were no cities along the swath of radiation; the radioactive cloud generally passed over small agricultural areas. The area with a contamination density greater than one curie per square meter contained 87 villages and 21,000 villagers.

At a meeting in Moscow a month after the accident, “interim standards” were established for major food products. These standards, of course, were higher than the Union-wide public health standards. They did not begin measuring radioactive products grown in contaminated earth until six months after the accident. As it turned out, the products did not even meet the “interim standards.” They had to be removed and replaced with uncontaminated food products. However, people continued using vegetables, potatoes, milk and meat in their food that did not comply with any standards. After one and a half years, their bodies had accumulated uranium fission products. If they prohibited the use of local products and brought in clean products from other regions, then it made no sense for people to live in these villages. Not everyone left though. At the end of 1958, the interim standards were extended for another year.

The radiation situation showed that it was impossible to leave people in the villages farther from the explosion site. But nearly 9,000 people would have to be evacuated from 24 villages where on the twentieth after the accident, the radiation contamination reached 4,500 Ci/km^2 in Russkaya Karabolka and 1,000 Ci/km^2 in Yugo-Konevo. It was decided to evacuate the villages where the contamination density for strontium-90 exceeded 4 curie per square kilometer. That was the density recorded 94 km from the source of the discharge. The additional resettlement began eight months after the accident and was completed eighteen months later.

The USSR Council of Ministers ordered the Chelyabinsk Oblast Executive Committee and Sredmash to relocate the residents of Alabuga, Russkaya Karabolka and Yugo-Konevo by 1 May 1958. Those evacuated were to be housed in tents during the summer and 850 homes were to be built immediately in “clean” areas at large Soviet collective farms. The villages were demolished more quickly than the new ones were built. The village Russkaya Karabolka was demolished in several days. It contained over 130 homes spread out along one street on the Chelyabinsk-Sverdlovsk road. Along this street, they dug a trench in which bulldozers pushed all the structures. For a long time only the church stood; later it was torn down by residents of nearby villages, who used the bricks for their own buildings.

People were not informed of the danger of radiation. They were forbidden to drink water from the wells, but with no reason given. The contaminated products were taken and replaced with uncontaminated ones. However, there were defective products that were eaten or sold in the markets before they could be replaced. The radiological service organized monitoring of the markets in the cities nearby, but the service itself acknowledged that the number of products removed was only 2-3% of all the products grown within the radioactive trail. The use of products contaminated by radiation stopped only after the evacuation of the residents, i.e. eighteen months later.

As to the effectiveness of evacuation measures, it was acknowledged that the emergency evacuation of four villages, which took place over 14 days, lowered the exposure dose 15 times in comparison to the dose people could have received had they remained in the contaminated area. The deferred evacuation, which took eighteen months, was calculated to reduce the potential exposure dose by 6-24%.

The village of Russkaya Karabolka fell within the compulsory resettlement area, but the residents of the neighboring village, Tatarskaya Karabolka, did not. [Editor’s note: The names of these villages can be translated as “Russian Karabolka” and “Tatar Karabolka”, reflecting the ethnic composition of these two villages both named “Karabolka”.] A guarded area was established 200-300 m from the homes in Tatarskaya Karabolka. All the primary agricultural land used by the residents of the village was located within the “dirty area.” To a significant extent, this determined the future fate of the village, which had a population of 500. The villagers could not work on the lands they used earlier. As time passed, the population of the village fell. A substantial fraction of the villagers died from malignant cancers, and cases of retardation and schizophrenia were diagnosed in some of their offspring. Officials at Minatom tried to claim that this was the result of widespread alcoholism so it would not have to pay compensation to people who had lived 50 years on land contaminated by radiation. This explanation did not satisfy the public, who insisted on their rights and used every possible means, including their ethnicity, referring to it as the “Tatar genocide.”

The poet Yu. Sedov wrote the poem “Evening in Karabolka” to mark the 50th anniversary of the radiation accident (Sedov, 2008):

When the fog drops into the lowlands,
Covering all that was visible in the afternoon,
All we have left is the home and courtyard,
The light in the windows and the creak of the gates. It’s as if you remove
Everything familiar. The words and thoughts of prose
Suddenly acquire the taste of distant days,
When as a youngster you drove horses to the river,
And it was good fortune to live as a strong son of the soil…
....
Those days, those years? ... In the quiet of the fog
The days passed and the sun was carried off.
And a black whirlwind strode along the earth,
A terrible battering ram rolled through life...
The firefly windows recede,
Buried in our memories,
And unnoticed, the heart is surrounded by
Sick people along a sick river.

Figure 5.2. Mosque in Tatarskaya Karabolka. Access to link 13 Sep 2010. http://nuclear.tatar.mtss.ru/photo-K.html

5.6 View of the Kyshtym Accident from the West

The Sredmash Commission, which flew in to Chelyabinsk-40, did everything possible to conceal the accident, its scale, and its consequences from the public and the mass media. All official correspondence and orders of the committee regarding the 1957 accident were classified as "secret" and "top secret." But it was difficult to hide such a large-scale accident. There were rumors of an explosion and an accident accompanied by radioactive contamination. The public did not have any precise information, however.

Six months after the accident, the Copenhagen newspaper "Berlingske Tidende" reported a nuclear disaster in the USSR that caused radioactive fallout in the USSR and neighboring states. It was suggested that an accident during Soviet nuclear testing in March 1958 was the reason for the radioactive contamination.

The West received more detailed information from scientists who had left the USSR, primarily Zhores Medvedev.

A few words, at least, have to be devoted here to Zh. Medvedev. After he graduated from the agricultural academy, Zhores Medvedev was told he should go to the newly opened test station in the Urals to study the effects of radiation on living organisms. He did not go to the Urals, but he knew the last names of several researchers who had begun working at the secret station. He began working in Obninsk at the Institute of Medical Radiology and wrote several books that were published in the West. One described in detail for the first time the destruction of biology by the Lysenkoists; the other laid bare the mechanism used by the KGB to open and inspect private correspondence. In 1969, Zhores Medvedev was fired from his job for "noncompliance with [the duties] of his designated occupation." He was committed to the Kaluga Psychiatric Hospital in 1970 for his political activities.

Here, it is best to turn to the words of Andrey Dmitrievich Sakharov in his "Memoirs" (Sakharov, 1996):

> Roy Medvedev called me on May 29th. He was extremely agitated and told me that his brother Zhores had been forcibly committed to a mental hospital in Kaluga. The diagnosis was 'sluggish schizophrenia,' based on an analysis of his work, which ostensibly demonstrated a split personality (both biology and politics). In fact, it was revenge of powerful Lysenkoists for his articles and books against them.
>
> For me, it was an important new problem (following the Grigorenko affair), the use of psychiatry for political purposes, and an old one, the struggle against the Lysenkoists. And finally, it was a matter of solidarity after the joint memorandum with his brother Zhores. So I 'jumped into action.'
>
> The next day I went to the Institute of Genetics, whose director, N.P. Dubinin, was already a member of the Academy by that time.
>
> An international symposium on biochemistry and genetics was being held there the same day. There were many guests from socialist countries and twenty to thirty from the West. I walked up to the board and wrote the following announcement before the meeting began:
>
> "I, A.D. Sakharov, plan to collect signatures for a request to protect the biologist Zhores Medvedev, who was forcibly and unlawfully committed to a psychiatric hospital for his published work. You may contact me here during the meeting break and at my home address (I posted my address and phone number)." I gathered many signatures.

A.D. Sakharov further wrote:

> In the first few days it became clear that my unusual actions surprised the authorities and caused them a great deal of worry. Soon other protesters aided my efforts, including the poet Tvardovsky, who was an acquaintance of R. Medvedev, the writer Dudintsev and other artists and scientists. After several days, I was summoned by President Keldysh of the USSR Academy of Sciences, who began to rebuke me for impermissible actions. I demurred. He said that he would consult Academician B. Petrovsky, the USSR Minister of Health. On June 12th, I was summoned to a meeting at the Ministry of Health, as were

> Academicians Astaurov and Kapitsa, who had also called for the protection of Medvedev. Academy member Alexandrov (now President) represented Keldysh at the meeting. Petrovsky opened the meeting by saying it was to address the case of the ill Medvedev. Director G. Morozov of the Institute of Forensic Psychiatry gave a medical report (worded very conservatively) and was followed by Kapitsa, nimble and cautious as always, Astaurov and me (both decidedly in favor of release). After I finished speaking, Alexandrov retorted that Sakharov's appeal to the West shows that he needs treatment to restore his mental health. Petrovsky ended the meeting, promising to reach a decision regarding [Medvedev's] release in due course. A week later, the 19^{th} day after he had been forcibly committed, Zhores Medvedev was released.

Medvedev described his time in the psychiatric hospital in his book "Who's Crazy?" In January 1973, he received permission to travel to England (for one year). Not long after his departure, he was stripped of his citizenship, whereupon he stayed in London and continued to work.

In 1976, Zhores Medvedev gave the first brief report on the accident in the Urals in the English journal "New Scientist." (Medvedev, 1976) As he told journalist A. Illesh: "A detective's interest in this affair has taken hold of me. The only thing I know to be true regarding this situation is that it occurred where scientists were working. I knew precisely three names. I went to the library and found an author's index, i.e., a reference book that listed all their publications. There were articles on radioactivity beginning in 1966. My bibliography already totaled 70 articles. I began with the articles, and then moved to the book. It was from these publications that I was able to restore the whole picture." No doubt, Zh. Medvedev remembered the recommendation that he go work at the newly opened biostation in the Urals, as well as the names of those who went there. (see also Medvedev, 1991)

In his article, Medvedev notes that between Sverdlovsk and Chelyabinsk in the Urals, there had been widespread radioactive contamination in Kyshtym Rayon at the end of 1957 or the beginning of 1958. He assumed this meant an explosion occurred in the radioactive waste repository. Chairman John Hill of Great Britain's Atomic Energy Authority and his colleagues expressed their doubts regarding this story and said the article was "science fiction" and not to be taken seriously.

In 1978, Zh. Medvedev was invited to Los Alamos Laboratory, which conducts classified work on nuclear weapons. In the auditorium where Zh. Medvedev spoke was an audience of 600 people, including Edward Teller, the Deputy Director of the laboratory and primary creator of the atomic and hydrogen bombs. Zh. Medvedev recalled they spent three hours discussing whether or not an explosion of radioactive waste was possible. The employees of Los Alamos Laboratory were more inclined to believe that a nuclear weapon had been tested on Novaya Zemlya, and that a radioactive cloud was carried to the Southern Urals. Zh. Medvedev did not agree with this scenario and continued reviewing available sources on the situation in the Urals. In 1979, Medvedev's book "Nuclear Disaster in the Urals" was published in the USA. It presented additional facts regarding the 1957 accident.

Besides the publications of Zh. Medvedev, there was biophysicist L.A. Tumerman, who emigrated to Israel and described, in letters published by the Jerusalem Post and London Times in 1976, his own impressions from a trip to the Urals. Lev Abramovich Tumerman (called "Tum" by his colleagues) worked at the Physics Institute of the Academy of Sciences. Later, as Professor V.I. Ivanov recalled, "He spent several years in custody and exile on a false charge of setting fire to the Academy of Sciences Physics Institute (Lev Abramovich was smoking a pipe and a window-blind caught fire). The real reason was that his wife was an acquaintance of Stalin's wife Alliluyeva." In exile, Tumerman became familiar with the work of the Weismann-Morganists and grew very interested in biology. He tried to explain several unknown areas of biology through physics. After his exile ended, V.A. Engelgard invited him to work at his institute, the Institute of Radiological, Physical and Chemical Biology (later the Institute of Molecular Biology of the USSR Academy of Sciences). L.A. Tumerman later immigrated to Israel. In his letters to the aforementioned newspapers, Tumerman wrote, "Approximately one hundred kilometers to the south of Sverdlovsk, there was a road sign: 'Do Not Stop for the Next 20 (30?—I can't remember) Kilometers! Drive at Top Speed!' Everything appeared dead on both sides of the road: no villages or towns, only the stovepipes from gutted homes. There were not any crops, pastures, grasses, people…nothing." He guessed it was a consequence of radioactive contamination.

However, the West had information about the radioactive contamination of the Urals even before Zh. Medvedev and L. Tumerman. According to a document from the CIA dated 1959, the agency knew that an incident in Kyshtym Rayon that had disrupted agricultural operations there. The CIA did not make the incident public, however. In 1977, a group of nuclear power protestors requested information on atomic enterprises in Chelyabinsk Rayon and obtained documents that the CIA had by that time declassified. Articles appeared in newspapers stating that the CIA confirmed a disaster had occurred.

Two major laboratories in the US also tried to piece together what had happened in the Urals. One was Oak Ridge. The entire laboratory had been part of the Manhattan Project. During that project, before the detonation of the first atomic bomb, Robert Oppenheimer and Enrico Fermi had come to work at the laboratory. They lived in Oak Ridge at a small hotel, as noted by a commemorative plaque. There is a small but noteworthy museum there, whose narrative sense is diametrically opposed to that of the museum in Hiroshima. The materials assembled by the Oak Ridge museum demonstrate that America needed an atomic bomb at the end of the war. The weapon helped force Japan to capitulate and helped prevent losses in the US army. In Hiroshima, where I went before Oak Ridge, the museum shows the horrors of the atomic bomb, including the victims of the blast and radiation exposure. The idea of the composition there is to demonstrate the senselessness of such sacrifices. The historical events—whether the atomic bomb was necessary—are evaluated from two perspectives.

In becoming acquainted with the history of the laboratory, it became clear how interested its employees were in learning what happened in the Urals in 1957. There is an article in front of me from the journal "Science" in 1980, written by J.R. Trabalka, L.D. Eyman and S.J. Auerbach of Oak Ridge National Laboratory. (Trabalka, 1980) The index contains references to 119 articles, primarily concerning the work of Soviet researchers. The laboratory hired translators and began to review open Soviet publications that appeared in specialized environmental journals in the

1960s. As the article noted, “We have reviewed a large number of contemporary Soviet articles on radioecology devoted to field research that indicate, perhaps, accidental contamination, such as in Kasli Rayon, for example.” The report notes that these materials in the original Soviet articles are presented as the results of experiments. The locations of the studies are characteristically classified. Additionally, work by Pitkyanen, Safronova and Shvedov (employees of our institute) discuss the contamination of 13 stagnant lakes, and other papers by Alexakhin and Krivolutsky state that strontium-90 had entered the canopy of two different types of forests. The authors of the review conclude that it would be unrealistic to believe that such large-scale experiments had been planned. Moreover, the high levels of radioactive contamination given in the Soviet articles are not required for experiments. Such levels are toxic and cause genetic damage. They therefore concluded that the radiation was introduced into the environment not by a test, but because the area had been contaminated from an accident.

In addition to the review of the articles, employees at Oak Ridge Laboratory also compared high resolution maps produced in 1936-1954 and in 1973-1974. The comparison showed that more than 30 population centers between Chelyabinsk and Sverdlovsk had disappeared: Bayevka, Yugo-Konevo, Russkaya Karabolka and others located along the same axis. The authors arrive at the conclusion that an “accidental explosion of a large nuclear installation” occurred in the Urals, and that the people exposed to it had been evacuated from several dozen villages. Because the radionuclide composition of the contamination was consistent with the radioactive waste components of the Soviet atomic enterprise (which were also learned from Soviet articles), they assumed that a large waste storage container exploded in the Kasli Rayon in 1957 or 1958.

The pages containing this article had been torn from the copy of the journal “Science” that I found in the Chelyabinsk Library of Foreign Literature.

To reconstruct the events in the Urals, employees D. Soran and D. Stillman of Los Alamos National Laboratory compared the technologies used to create atomic weapons in the USA and USSR. These specialists linked the “Urals phenomenon” to radioactive waste problems. In a 1982 report, they described the appearance of new manmade reservoirs for waste at the sites of the former villages. The authors of the Los Alamos report were also able to use CIA data indicating that the area of radioactive contamination was 40 square kilometers. “The perimeter of the contaminated area was surrounded with barbed wire and had warning signs that said ‘Exclusion Area. Do Not Enter!’ After approximately one kilometer, there was a second row of barbed wire with signs saying ‘Exclusion Area’ and ‘Life-Threatening Radiation!’ There was yet another fence one kilometer farther. The entire fenced-in space had been plowed.”

French researchers also tried to make a realistic assessment of the radiation situation in the Urals based on published articles. In 1988, employee Pierre Ballero of the Radiation Protection Service of France concluded that a radiation incident occurred at the end of 1957 or the beginning of 1958 that formed a dead zone of at least 40 square kilometers, and that nearly 30 villages with a population of 2,000 had disappeared from the maps.

The radiation accident in the area of the Soviet atomic enterprise could not be kept secret for long from the CIA and Western specialists. They could argue, “What exploded? A reactor? A radioactive waste storage site?”, but they knew a large-scale radiation accident had occurred that forced the evacuation of people and had serious environmental consequences.

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