

THE TECHA RIVER: 50 YEARS OF RADIOACTIVE PROBLEMS

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ABSTRACT

In 1948 the first industrial complex obtained plutonium was setting. Today, PA "Mayak" is a modern radiochemical plant. The water system near "Mayak"'s location was incurred to hard technical influence. From 1949 to 1951 about 2.7 mln. Ci was dropped in Techa river. For rehabilitation of the river some steps improved radiation situation made.

INTRODUCTION

In 1948, the first industrial complex that obtained plutonium was in the Chelyabinsk region. Later PA "Mayak" was formed on the basis of this complex. At first, the plant's work let to extensive radioactive pollution of the Ural region. Largest technological load in all ecological systems of the region was sustained by rivers, lakes and reservoirs, entered into the worker systems of the chemical plant "Mayak". There were several steps to the production of plutonium. Some formed great volumes of radioactive waste of medium- and low-level activity. In the beginning waste of high-level activity were put into

special capacities, isolated from the environment. But such depots were not sufficient for great volume of liquid radioactive waste of low- and medium-level activity. Attempts to find methods of decreasing of waste's radioactivity result it in nothing, and it was impossible to decrease the concentration of radionuclides in dump solution less then to 10 millions Curies per cubic centimeter. The Techa was doomed. Our scientists decided to dispose of radioactive waste in the Techa river.

The Techa river rises from the Irtyash lake and empties into the Iset river the joins the Tobol river. (Figure 1).



FIGURE 1. The hydrological system of Techa river

The total length of this river system is approximately 1000 kilometers. The length of the Techa river is 240 kilometers. On the first forty kilometers the Techa flows at marshy bottom land with the span of about 1 to 5 kilometers. The river flows on this way silt and rushy. The bottom is silt, the course is slow. This is an ideal place for sedimentation of radioactivity. Tributaries of the Techa are little rivers and brooks, dried up in the summer. Before the disposal of radioactive pollution there were 38 villages with a total population about 28000 on the riverside of the Techa.

RESULTS AND DISCUSSION

In 1948 the Kyzyltyash lake was included into technological chain, and in 1949 the first radioactive waste was disposed in the Techa. Dumps were realized by special drainage. Waste from radiochemical production and from industrial reactor joined into the river. About 80% of the water volume had low-level activity from the Kyzyltyash lake to Techa and 20% was of medium-level activity from the plant.

Natural question is about why such little river having direct exit into the open hydrosystem was used as gutter channel for removing of radioactive waste. It's explained that for effective decision of the problem neither power nor time was not sufficient. Only in two years this all danger situation was realized. Taken as temporary and forced major measure dump of radioactive sewage into Techa resulted in heavy consequences.

Summarized activity, dumped into Techa is impossible to estimate as documents maintained technological parameters of the production didn't keep. Majority of workers with dump solutions at plant didn't know about subject. Even in official and secret documents sent to Moscow using of such words as radioactivity and irradiation kept out. And it is natural that flow meter and instruments of radioactive level's determination were absent.

On the base of extrapolation of acute data of later time at the period of 1949-1951 years attempts to estimate the summarized quantity dumped into the river were carried out.

From 1949 to 1956, 76 millions cubic meters of liquid waste with a total activity of about 2.75 millions Ci was dumped into the Techa river. At first, the disposed liquid contained about 10^{-7} - 10^{-4} Ci/l. After an accident, the liquid contained 10^{-3} - 10^{-4} Ci/l.

From March 1951 to November 1951, 95% of all activity was dumped daily. The water contained: Sr-89,

Sr-90 – 2.4%; Cs-137 – 12.2%; Zr-95, Nb-95 – 13.6%, Ru-103,104,105,106 – 25.9%. During next five years waste in the Techa river was greatly decreased. There were 9500 Curies dumped in 1952 and 500-2000 Curies in 1953-1956.

2.75 millions Curies dumped at the period from 1949 to 1956 receded in next way:

- In ponds #3 and #4 – 2.37 millions Ci
- In the river between Metlino and Muslyumovo – 283000 Ci
- In the river between Muslyumovo and Zatechenskoe – 63000 Ci
- Endured into Iset 24000 Ci

The radioactive waste, dumped in the Techa, was diluted 5-10 times by the water of the Kyzyltyash lake, having little activity. Further they flowed down to the river and joined to pond #4 with the volume of 2.5 million cubic meters, which used as sump. In the summer of 1951 the next pond-sump #3 was build. It situated between the place of dump and pond #4. Its volume was about 800 thousands cubic meters. After getting into Techa at the second day radioactivity run out from the dump #3, and at the eight's day radioactivity run out from the dump of pond #4. In 20-25 days the water vicious radionuclides got the Iset river. The Mayak's technological ponds system is showed on the Figure 2.

During the flowing of this dirty water about 25% of all activity was embedded in lake bottom sediments. Radioactive background at the banks of the river and reservoirs reached to 3 R/h! The activity that was accumulated in animals living in and around the river exceeded the limited concentration by 75 to 100 times. The specific activity in the mud was about 20 milliCi/kg. In 1951 radioactive water polluted the bottomland of Techa because a flood. The inhabitants used this place as grassland. For inhabitants of Techa's riverside the river was the basic source of matter for food and irradiation. The riverside population incurred external radiation form gamma-background near the river and internal radiation form radioactive isotopes that enter into organisms through water and food. External radiation was determined to be from Cs-137, Ru-106, Zr-95. The largest doses (50 to 100 centiSv/year) were received by the people of Metlino village. (See Table 1). Some people were taken ill because of external radiation. Internal radiation of elderly people mounted to about 4.6 milliCi from the river. Sr-90 and Cs-137 were the major radioactive isotopes.

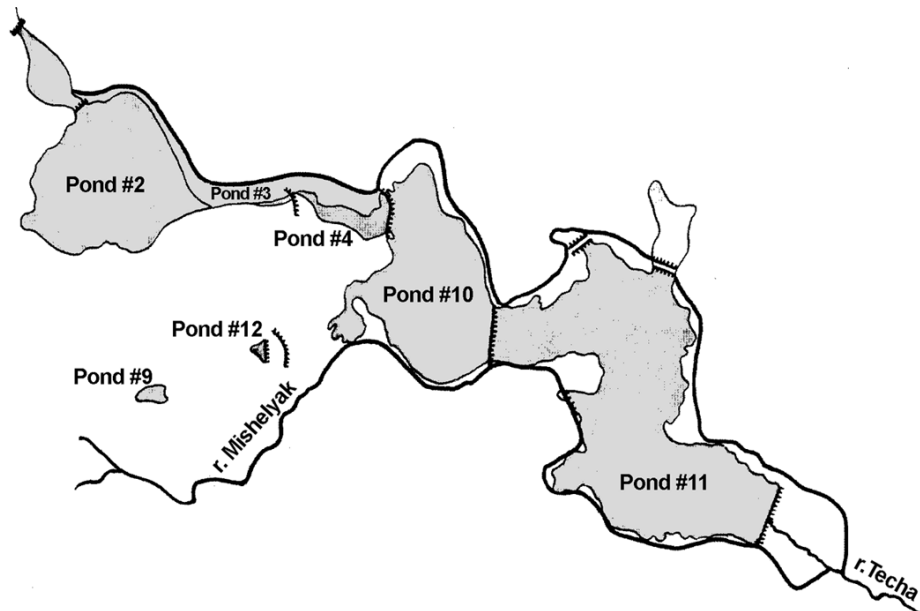


FIGURE 2. The Mayak's technological ponds system

TABLE 1. The doses were received by inhabitants of localities above. (* Moved inhabitants) [1]

Settlement	Distance from the place of dump, km	Equivalent dose of irradiation, biological equivalent of roentgen				EED,ber
		Marrow	Bone surface	Large intestine	other organs and tissues	
Metlino*	7	164	226	140	127	140
Techa-brod*	18	127	148	119	115	119
Asanovo*	27	127	190	104	90	100
Nadyrovo*	48	95	180	62	44	56
Muslyumovo	78	61	143	29	12	24
Brodokalmak	109	14	31	7	3.3	5.8
Russkaya Techa	138	22	53	10	3.7	8.2
Novopetrovavlovskoe	152	28	68	13	4.3	10
Shutiha	202	8	18	2.6	2.2	3.6
Zatechenskoe	237	17	40	8.4	3.2	6.6

The situation was complicated by ignorance of facts not only by population, but regional and local brass. Understanding the disability and wishing to care the population from the damage, technical-scientific council of first main administration made a request to the Ministry of Care of public health "to pollute Techa of unjurant for people substances which would repel when using water". The Ministry covered negative to this decision and didn't answer it.

Simultaneous measures for decreasing of radioactive level of radiochemical production's dumps were taken. There upon the water cleaning at the plant was not very

effective, the pond #3 in which suspended matter with radioactivity sedimentated in the short date was set is motion. The water use for cooling short deports of waste of high-level activity of complex C was one of the source of radioactive contamination.

From the middle of 1951 the dump of such water was stopped. In 1952 the radiochemical plant did not dispose technological waste in the Techa river. Activity of liquid waste contained not more that 20-30 Ci per day.

Special commission, created in 1952 set the next task: to make all dumps of Plant B into Techa to be non-

radioactive by the middle of 1953. Members of the Commission decided that all dumps should be divided in three groups. First group consists of 90% of all dumps. This is the water, which used for the cooling of active zone of the nuclear pile. It's radioactivity has accidental character. That's why it was decided that this water should be dumped into Kyzyltyash. The second group is low-active water. It was the biggest part in 10%. It was decided to put this water to cleaning. The third group consist of high-level liquid radioactive waste a little by the volume. Dumps of last two groups should be obligatory cleaned. Though the Commission decided to put 10% of dumps to necessary cleaning. At that time at first the suggestion to make a reserve of pure water, which could be used for dilution of levels of concentration of radioactivity in Techa, exceeded the norm was fold. For this purpose it should be passed the channel from Irtyash to Techa. Radioactive water from Kyzyltyash and ponds #3, #4 would not get in this channel. The absence of reliable methods of cleaning consolidated positions of adherence of customary slant. This slant was in increasing of reservoirs-sumps. That's why the suggesting to amplify the system of industrial reservoirs was told. This idea entered developed in Leningrad Project of Technical decisions, directed to sanitation of the Techa river. Three lakes were included in it. But common sense of headers of the Ministry of middle mechanical engineering was sufficient for stopping the tendency to extension of radioactive reservoirs.

Except of this variant in 1954 it was decided to built a dam #10 at Techa for the reservoir with the volume of 29 million cubic meters, in which radioactive water should be accumulated and evaporated naturally. But the volume of 10th reservoir was not enough. Every day the plant dumps more than 40000 cubic meters of water, 15 millions cubic meters per year. That's why to the autumn of 1959 the reservoir would be filled in till water mark. The decision of the problem found in building-up of the dam #10.

In 1956 radioactive waste disposal in the river stopped. So, in 1956 and in 1963 dams were build on the Techa river. This dams insulated technical objects of the plant from contaminating the bottomland at the source of the River. Cascade of ponds were build to prevent leakage of radionuclides. In addition, about 8000 hectares of bottomlands that were polluted because of floods were drawn from land settlement. These steps led to an improved radiation situation in the region. But the idea to evacuate people from some villages was accepted. From 1955 to 1960, about 7500 people from 19 villages were evacuated. But evacuation of people was untimely and this step was not effective because the people had already received a large dose of external and internal radiation. Some of Metlino' people received the biological equivalent of about 200 Roentgens per hour. Cluster sampling should about 235 cases of radiation sickness.

There were many problems with exploitation of hydro-technical objects. So, in the winter 1958-1959

because of defect of dump #3 the water from pond #3 got to pond #4. It resulted in denudation of bottom sedimentations with high-level of radioactivity. That case showed the danger of hope of only the dam #10, the most lower in the cascade and damming back many tenths millions cubic meters of radioactive water. Breaking of the dam could be lead to irreparable heavy consequences. Dam #10 was heightened and raised higher. But this step didn't remove the sharp problem of filtration of radioactive water through the dam into Techa. Pumps, returning drained into pond #10 were installed. But that step didn't solve problems. Plant's administration and specialists put the question about building of one more dam N11 and reservoir of bigger of volume. When built, the full isolation (not only hydrosystem of PA "Mayak" but of marshy dirty bottomland in sources of Techa from its low course) was achieved.

But in first decade of exploitation of new reservoir serious difficulties were appeared. Instead of project 70 mln cubic meters there were about 116 mln cubic meters of radioactive water. The yield from the situation was traditional. The dam N11 was built up and the volume of reservoir was increased. At first the version of repair dumps of about 20 mln cubic meters water into Techa from the reservoir was worked up. That measure provided for the case of direct danger of breaking the dam as the most last way of accident's prevention.

By the middle of 17th the cascade of reservoirs for keeping of low-level activity waste was formed. Thanks to it dumps in to Techa significantly decreased. In sources of the river at present time the concentration of

Sr-90 is about $2 \cdot 10^{-10}$ Ci/l.

During exploitation of reservoirs and passed channels two technical tasks appeared. First of all there is about 380 million cubic meters of the water with the whole radioactivity of about 200000 Ci in reservoirs #10 and #11. The necessity of building up of the dams and cleaning of reservoirs from radionuclides arose. The second problem is filtrated discharge of the water from reservoirs into passed channels because of rising of the level.

In the case of unexpected discharge of reservoirs into Techa the danger of breaking of dam N11 growing. Water level in last reservoir in 1990 fell behind maximum project only on 1 meter. In the middle of 1990 situation did not improved. To say more, the filtration of radioactive water from reservoirs into Techa was about 10 million cubic meters per year.

Some specialist and students of our institute, studying possible consequence of dam's breaking established that head of wave would be about 10 meters and millions cubic meters go into the river and nearest settlements . So creating Techa's cascade ponds posed several problems such as rehabilitation (cleaning water, reduction and utilization of radioisotopes) and stabilization of closed ponds.

Problems can be solved only after start of Sought Ural NPP, which building was suspended. Using of

reservoirs with radionuclides for cooling of turbine's condensates at NPP will maintain normal level in these reservoirs. So the danger of their depletion decrease. After starting of NPP an ecological situation in the region will improve, the danger of further radioactive contamination will disappear. Further the energy of NPP can be used for cleaning of the reservoirs from nuclides.

CONCLUSIONS

The PA "Mayak" solves the complex problems of the industrial ponds on the Techa river using the following:

- Hydrological and hydro-geological studies of the Techa cascade ponds, and
- Development of methods and technologies for cleaning the bottoms of the ponds.

So, the final solution to Techa's problems is possible only with the collaboration of South Ural NPP.

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