ROSATOM

STATE ATOMIC ENERGY CORPORATION "ROSATOM"

FSUE Mayak PA experience in the field of membrane technology for Liquid Radioactive Waste processing

Atomexpo 2016

Types of Liquid Low Level Waste at FSUE Mayak PA

Trap Water of RT-1:
Cs-137, Cs-134, Sr-90+Y-90, Co-60, Am-241, Pu-238, Pu-239

Trap Water of RIP:
Cs-137, Cs-134, Sr-90+Y-90, Co-60, Am-241, Pu-238, Pu-239, Ir-192, Cr-51, Zn-65

Drain & Ground Water:
Sr-90+Y-90, Cs-137

Industrial Reservoir:
Sr-90+Y-90

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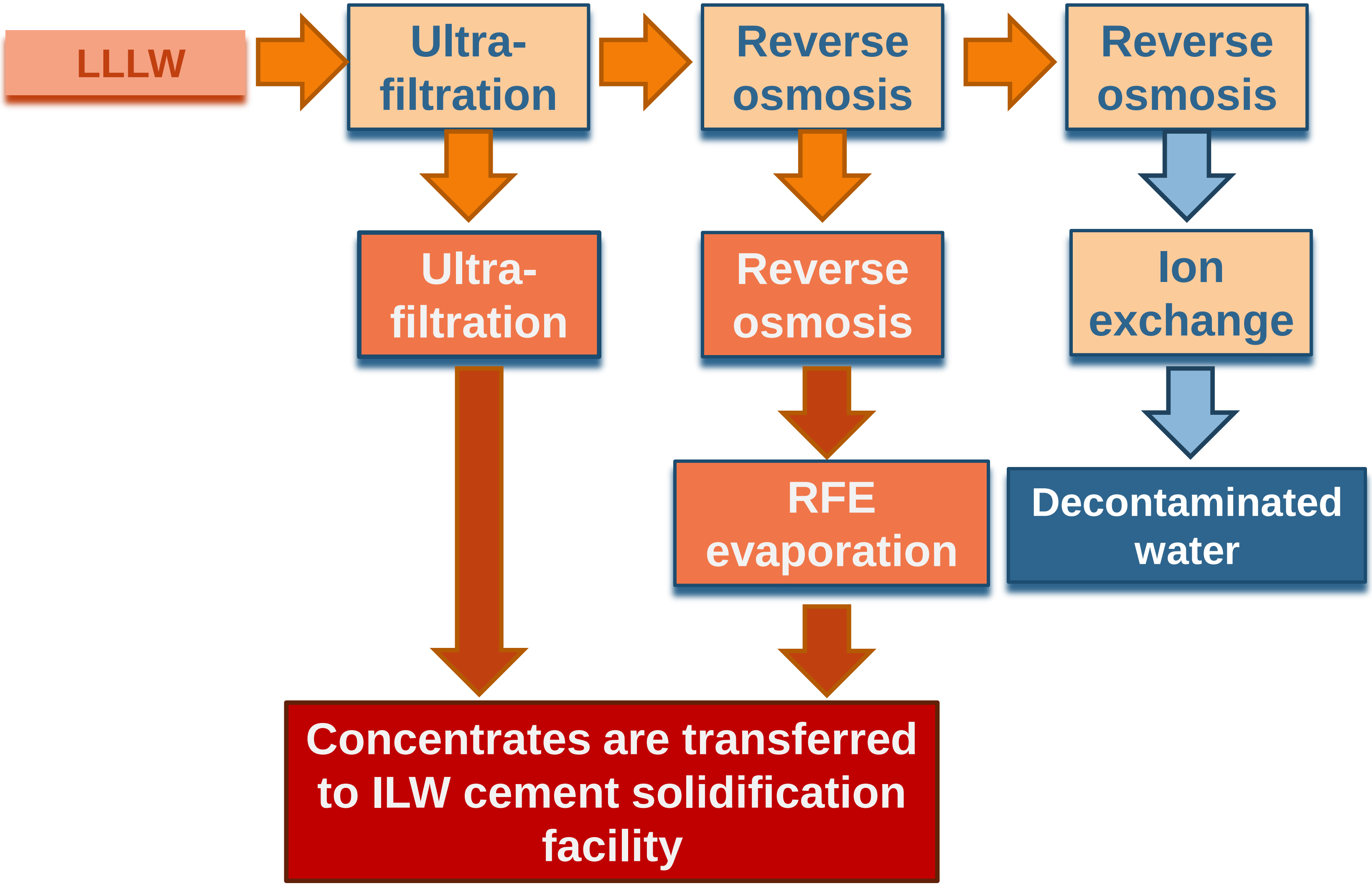
Radiochemical Plant Liquid Waste treatment

Flow-sheet of Radiochemical Plant Low Level Liquid Waste treatment



Test unit for Low Level Liquid Waste treatment (2005 – 2006)

Output: 1 m^3/hour   Installation area: 20 m^2

Results of Low Level Liquid Waste treatment

	Activity concentration, Bq/l				
	Σα	Σβ	^{137}Cs	^{60}Co	$^{90}Sr+^{90}Y$
Initial LRW	500-10,000	5,000 - 50 000	100-15,000	100-3,000	1200-25,000
Decontaminated water					
A. Economy option	0.2-13	20-120	0.3-3.0	0.3-2.0	2.0-50.0
B. Maximal treatment	0.2-0.1	2-20	0.2-2	0.3-1.0	0.5-3.0
Intervention level	0.55	-	11	40	4.9
Specific activity of industrial water	100	-	100	100	2,000
RAW rating criteria	55	-	1,100	4,100	980

LRW reprocessing volume: 70,000 m^3 Cost of reprocessing: about 120 rubles/m^3 (2012)

As a result of membrane and sorption purification, residual activity of the solutions decreases up to the drinking water standard level.

LRW Concentrate parameters

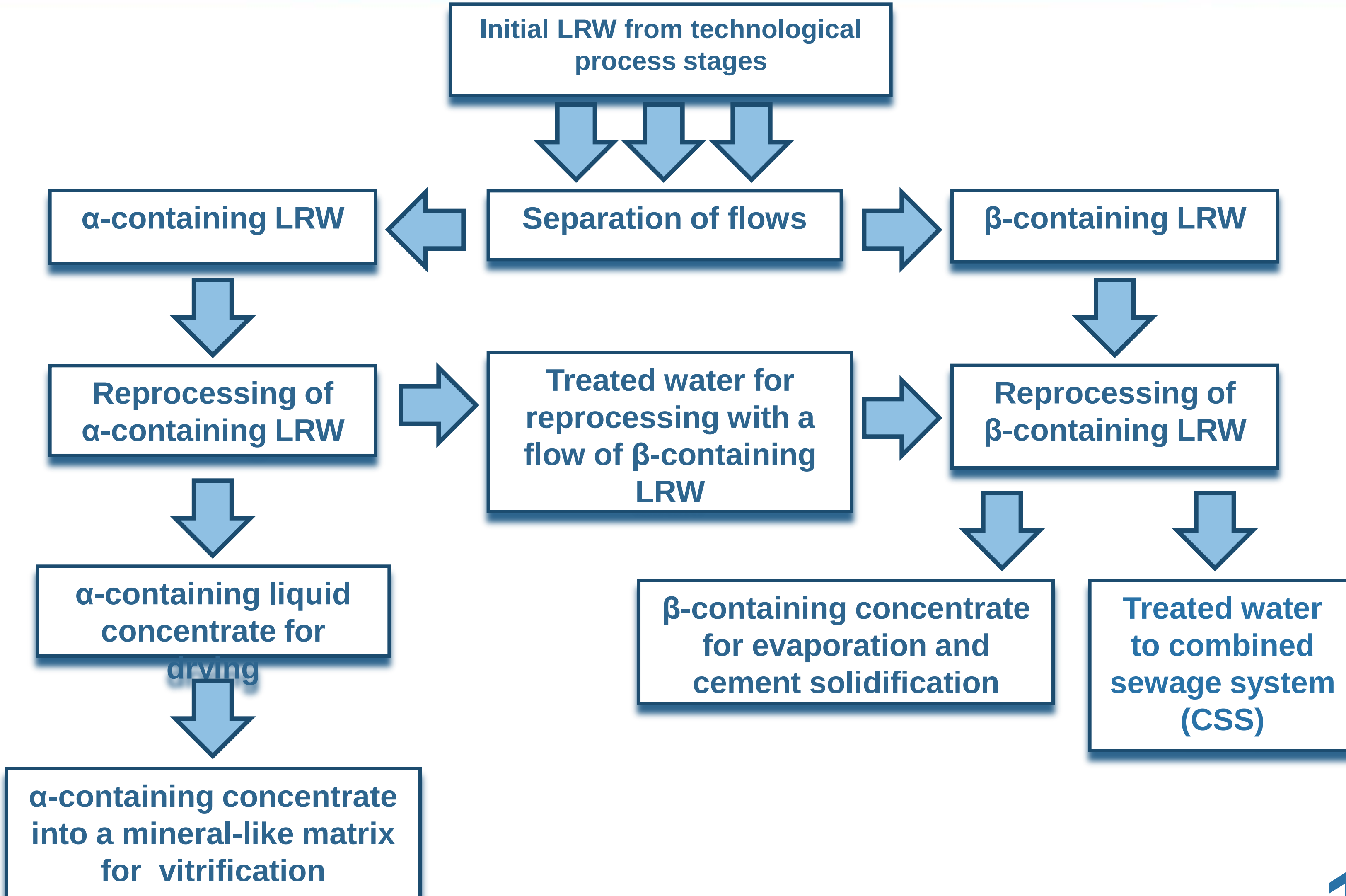
RFE vat residues with various mineralization

120 g/L 280 g/L 400 g/L

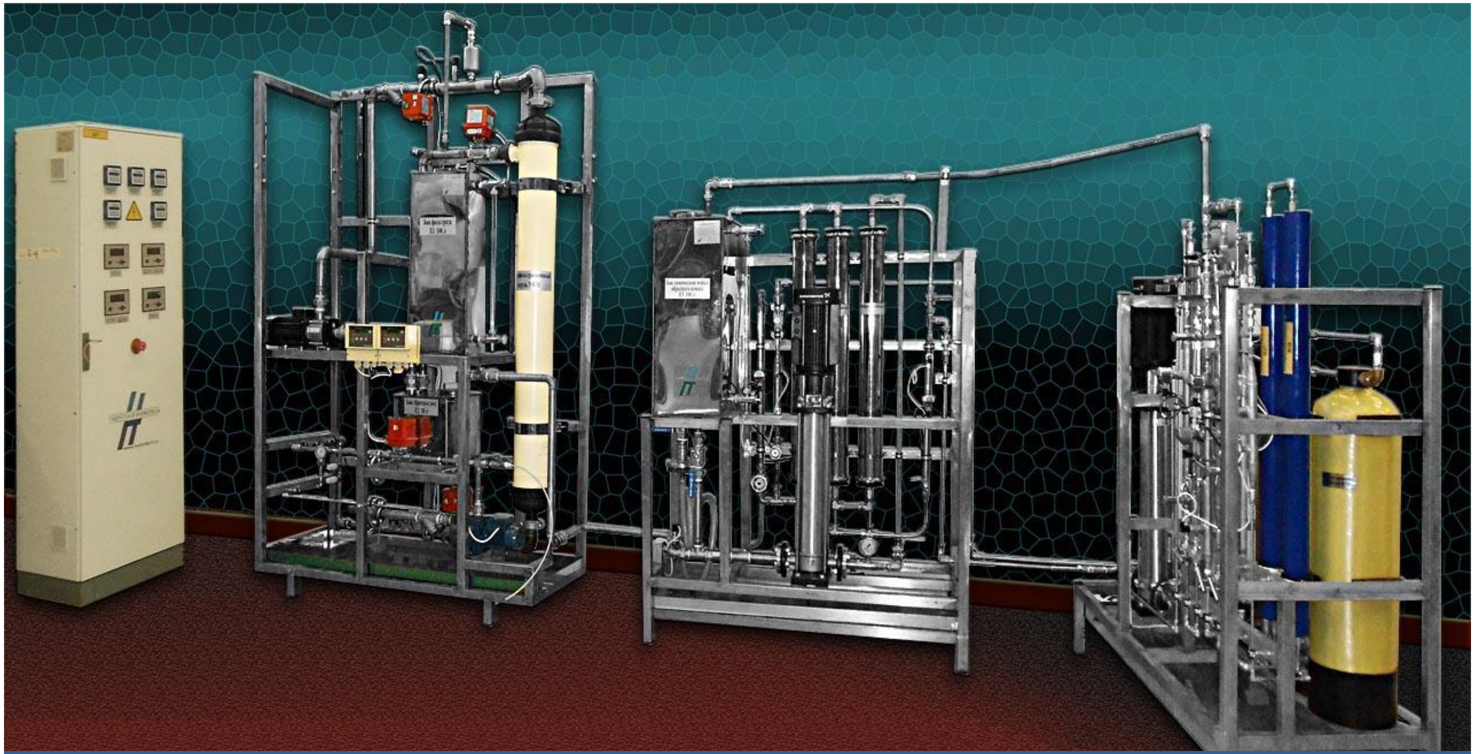
Product	Σα, Bq/L	Σβ, Bq/L	Cs-137, Bq/L	TDS, g/L
UF2 sludge	$2.5 \cdot 10^7$	$2.2 \cdot 10^7$	$1.8 \cdot 10^7$	25
VAT residue	$2 \cdot 10^5$	$1 \cdot 10^7$	$2 \cdot 10^4$	400

2 Radioisotope Plant Liquid Waste treatment

Flow-sheet of Radiisotope Plant Low Level Liquid Waste treatment



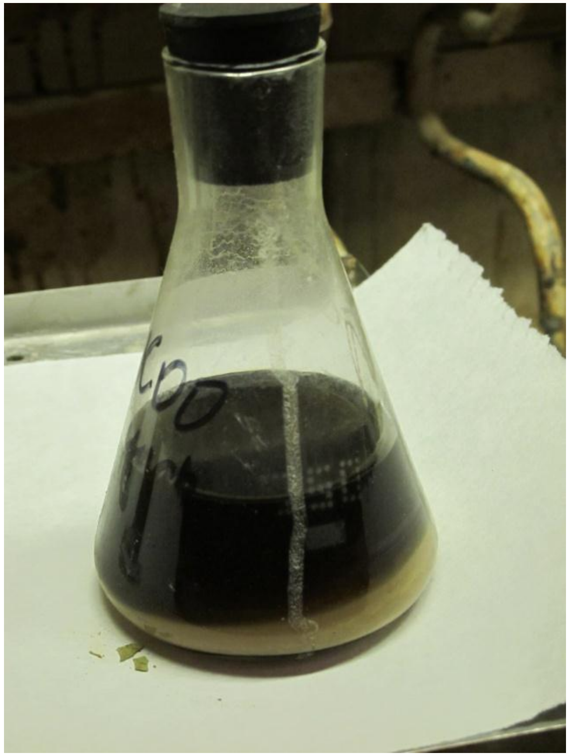
Results of Beta Stream Liquid Waste Treatment



Product	Activity concentration, Bq/l	
Initial LRW	Σα (5-12)·10^5 Bq/l	Σβ (2-4)·10^5 Bq/l
Treated water	0.5-0.8 Bq/l	2-5 Bq/l

LRW reprocessing volume: 60 m^3

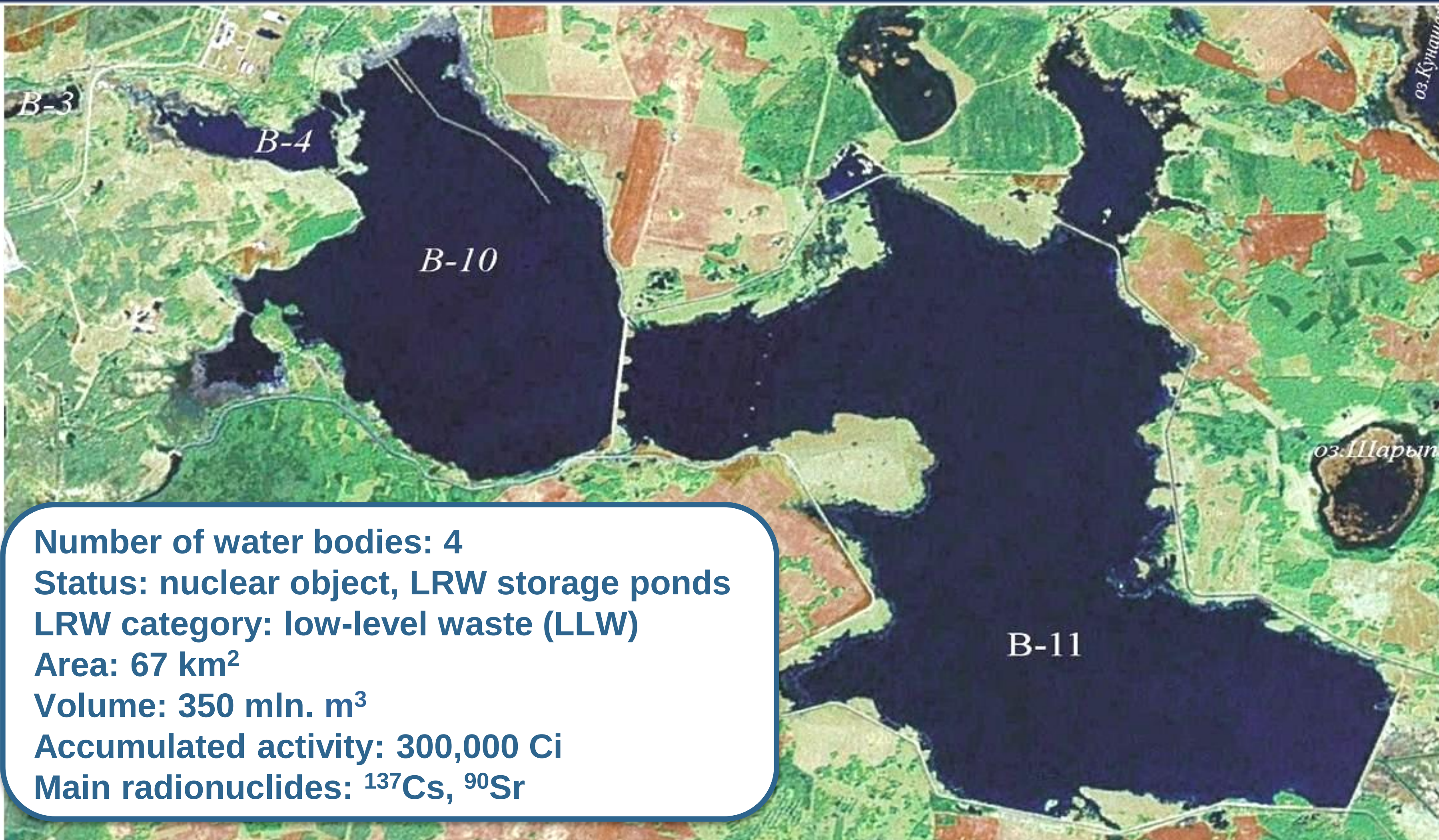
Parameters of Concentrates from Radioisotope Plant LRW Treatment



Product	Σα, Bq/L	Σβ, Bq/L	Cs-137, Bq/L	TDS, g/L
Vat residue	$2 \cdot 10^7$	$8 \cdot 10^7$	$2 \cdot 10^4$	220

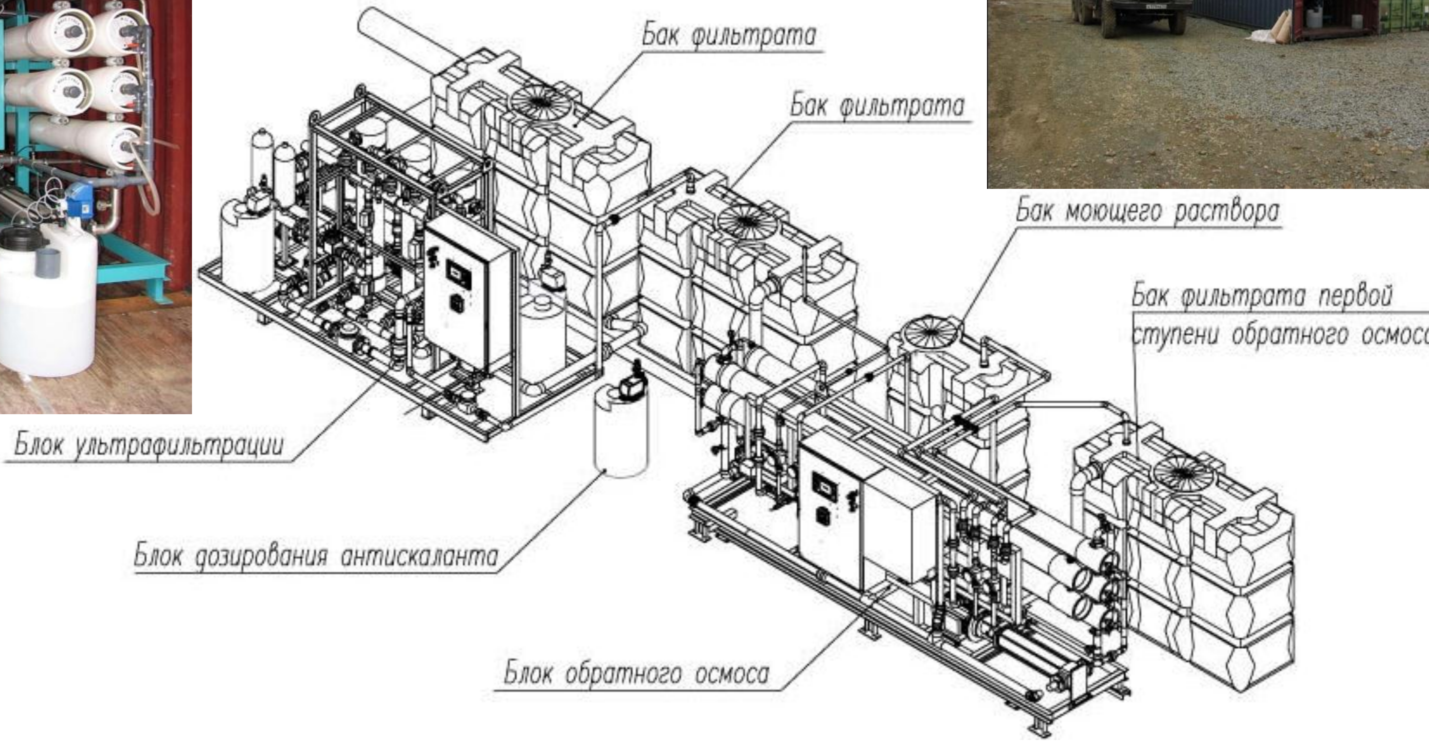
3 Industrial Reservoir Water treatment

Development of TRC water treatment process



Number of water bodies: 4
Status: nuclear object, LRW storage ponds
LRW category: low-level waste (LLW)
Area: 67 km^2
Volume: 350 mln. m^3
Accumulated activity: 300,000 Ci
Main radionuclides: ^{137}Cs, ^{90}Sr

Pilot Facility for TRC Water Treatment



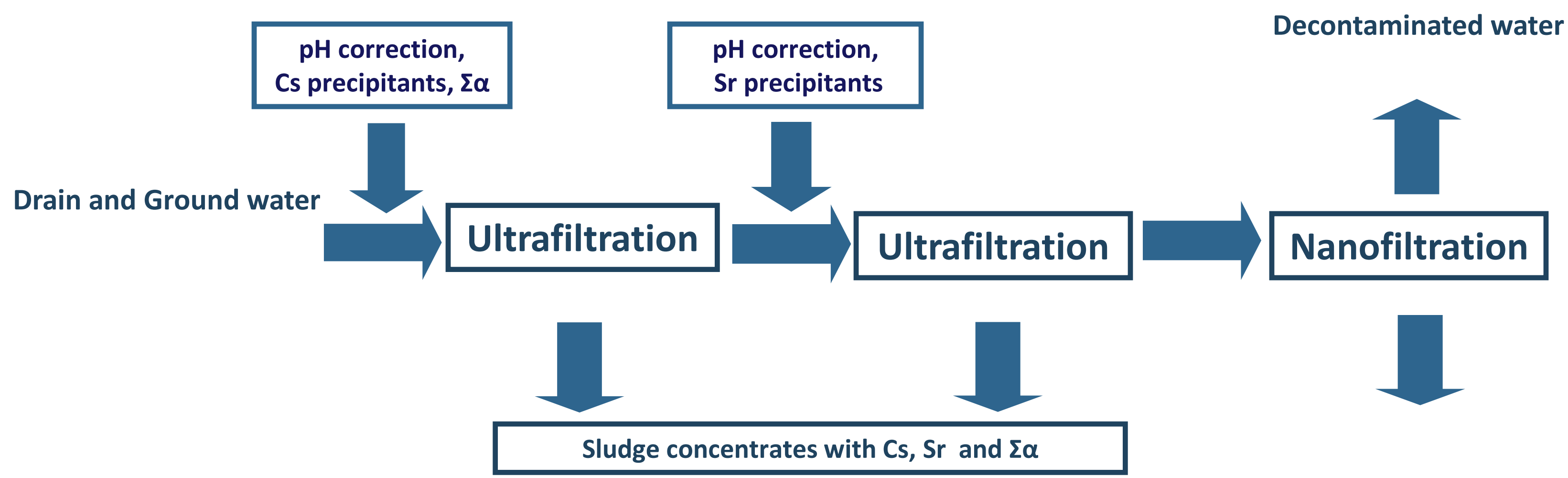
Results TRC water treatment process

Parameters	Initial water	Ultrafiltration permeate	Reverse osmosis filtrate	
			I stage	II stage
Transparency, cm	45-70	> 300		
Turbidity, ftu	17-22	0.3	< 0.2	< 0.2
TDS, mg/L	1,050-1,150	1,100	5-9	1-2
Σβ, Bq/l	2,900-3,150	2,600-3,000	0.2-4.0	0.04-1.20
Purification efficiency, %	-	16	99.9	99.99

As a result of membrane filtration, residual activity of the solutions is decreased to the drinking water levels.

4 Drain & Ground Water treatment

Development of drain and ground water treatment process



Drain and ground water treatment results

Product	pH	∑β, Bq/L	∑α, Bq/L	Hardness, mg-eq/L	TDS, mg/L
Initial drain and ground water	8.3	$2.25 \cdot 10^5$	50	73.2	9,800
Clarified water	9.2	9,410	<20	1.0	8,880
Ultrafiltration filtrate	9.2	6,050	<20	1.0	8,800
Nanofiltration filtrate	8.7	540 – 850	<20	0.20	1,190
Ion-exchange filtrate	8.7	400 – 420	<20	-	750

As a result of chemical reprocessing with subsequent membrane filtration, residual activity of the solutions is decreased below MSSA level, which changes the category of drain and ground water from liquid radioactive waste to liquid waste contaminated with technogenic radionuclides.

Conclusions

1 R&D activities are underway at the Mayak PA to develop and test innovative technologies of LRW treatment based on reagentless energy-efficient processes.

2 Pilot facility tests confirmed efficiency of the main engineering solutions regarding LRW treatment.

3 Design solutions on modular equipment layout, use of new materials and process-flow automation were tested.

4 Designing of the liquid LLW reprocessing facility was accomplished in 2015.

5 Good progress of activities makes it possible to commence constructing a liquid LLW reprocessing facility in 2020 – 2025.

Thank you for your consideration!