Status of ATW technology and research needs from the perspective of MINATOM

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STATUS OF NUCLEAR WASTE PROBLEM IN RUSSIAN FEDERATION AS COMPARED TO THE UNITED STATES

Parameter \ Country	Russian Federation	United States of America
Integral rate of nuclear waste production in Nuclear Power		
1. Number of nuclear units:		
under operation	29	110
under construction	5	0
2. Total capacity Gw(e)	21,2	100,7
3. Total amount of discharged spent fuel, ton/year	800	~ 4 000
Included plutonium	~ 4	~ 20
Included minor actinides	~ 0,3	~ 1,5
Storing of discharged spent fuel		
1. Water storage	In water pools at NPP's sites	In water pools at NPP's sites
2. Dry storage	Technical and feasibility studies	Dry storage under construction
Existing reprocessing capacities		
1. RT-1 plant, ton/year	100-400	0
2. RT-2 plant under construction, ton/year	750-1500	0
Storing of radioactive wastes		
1. Low level	At NPP's sites	At NPP's sites
2. High level	At RT-1 plant	-

Russian National Efforts in ADS related R&D

Key issues of program developing by Minatom and Ministry of Sciences and Technologies:

- Investigation of ADS technology and economy
- The assessment of the potential ADS role in future large scale nuclear power
- Comparative analises of critical reactors and ADS safety
- Conceptual design of a demonstration ADS with a fast-thermal "neutron valve" blanket based on 1 GeV, 2-3 mA beam

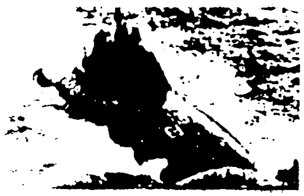
Basic experimental equipment to be used in the Program:

- ITEP neutron generator (ISTRA-36 proton linac coupled with heavy water blanket)
- JINR 660 MeV proton cyclotron and IBR-10 reactor
- VNIIEF facility ABV-F coupled with high current electron linac LU-50
- Pulsed neutron source IN-06 of the Moscow Meson Factory (INR RAS Troitzk)
- BFS -1 assembly coupled with microtron (IPPE)

Key milestones of lead-bismuth technology development

April, 1953	The decision was made on construction 27/VT reactor facility.
1963-1968	Project 645 operation.
1968	Severe accident at NS 645 Project
1968-end of 90-th	Extensive study of Pb-Bi coolant technology (estimated program coast is 200 M$)
1978	Ground prototype operation start-up.
1977-1990	Operation of 7 Navy reactor facilities of Project 705 ("Alpha").
1998	Start-up of 1 MW target (TS-1) development for accelerator in LANSCE
2000	Shipment of TS-1 to LANL
When ?	First in the world Target - blanket system.

Issues resolved from lead-bismuth cooled reactor development and operation



- Lead-bismuth coolant technology.
- Set of design solutions and principles predefined by developed technology.
- Industrial production of special steels and structure materials.
- Technological regulations and experience in comissioning, operation, and decomissioning.

Our goals

New applications

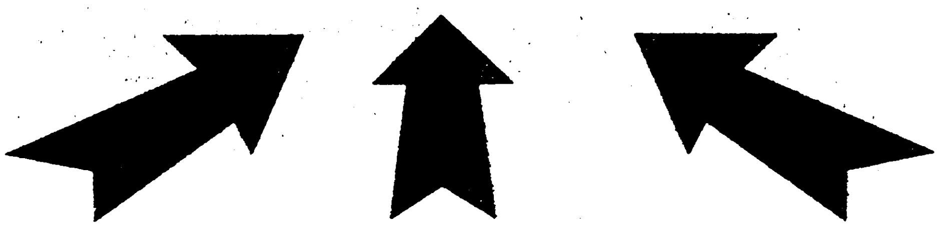
- ☑ **Inherent safety reactor for "New Nuclear Power".**
- ☑ **Accelerator Driven Systems.**
- ☑ **Non-nuclear aplications of developed technologies.**

Background

Experienced team of researches engineers and designers.
Experimental facilities.
Know-how.

Key problems
of target-blanket systems development.

Engineering problems	Comments.	
Coolant type	Pb-Bi	Pb
Target design	With window	Windowless
Target cooling system	Independent circuit	Joint with the one of blanket
Number of circuits	2	3
Circulation system	Forced convection	Natural convection
Fuel type	Depends of implementation scenario.	
Fuel rod and assembly design	Fuel rods with ribs	Fuel rods without ribs
Invessel shielding	Intermediate heat exchangers shielding need in special care	
Equipment protection (radiation shielding) near the ion-guide	Increased activation of equipment (ion-guide, refueling machine etc.) placed at the head of facility.	
Increased gas system radioactivity	Gaseous and evaporating spallation products release.	
Increased thermo-mechanical loading in fuel and equipment	High frequency of beam switching off and high speed of power decrease and increase.	



Freezing / Melting	Coolant technology	Loss of Heat Sink	Intercircuit leakage	Beam off accident

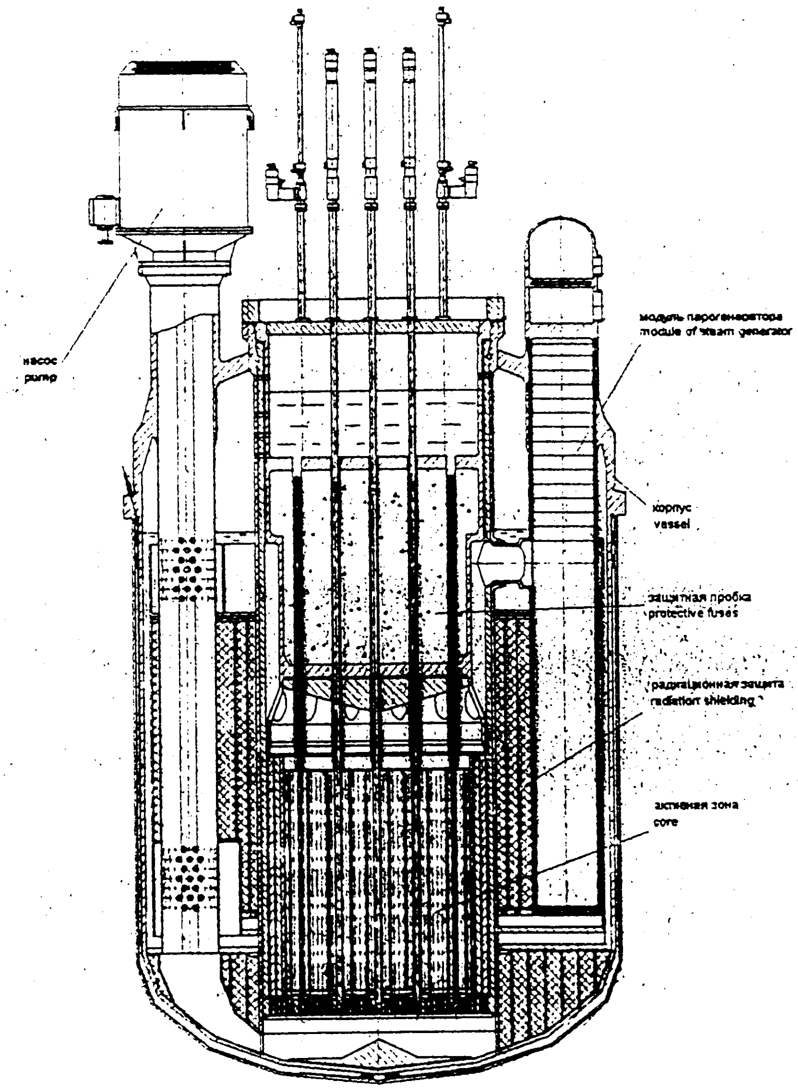
The Key design issues of Pb - Bi cooled nuclear facilities

No areas with stagnant coolant	Not pool-type but integral-type primary circuit arrangement
Invessel shielding	Protection of secondary circuit against coolant activation
Stable parameters in "cold" part of circuit	Control of admixtures
Good capabilities for technological gas mixtures injection, transportation and separation	Complex coolant technology issue
Sectioned circuit heaters arrangement	Freezing / defreezing mode control
Pumps in the cold part of circuit	Corrosion / erosion limits
Prevention of fuel bundles buoyancy	Special design solutions necessary
Cold Primary vessel (streamed by coolant with core inlet temperature)	Use of austenitic steels as structure materials for primary vessel and internals
Metal fuel with alkaline metal filled gap	Promises to be a solution on fuel performance capability under beam trips

Main technical characteristics of NPHP Angstrem

Parameter	Value
Rated heat power, MW	30
Electric power, MW	6
Steam supply, t/h	40,2
Steam parameters: — pressure, MPa — temperature, °C	3,5 435
Feed water temperature, °C	150
Water-steam circulation factor	2.5
Primary coolant flow rate, m^3/h	382
Primary coolant temperature, °C: — core outlet — core inlet	465 280
Core cycle, effective hours	about 30 000
Fuel: — type — U-235 mass loaded, kg	UO_2 ~405
Primary coolant inventory, m^3	~3,0

SVBR-75 reactor module



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