NATIONAL NUCLEAR CENTER OF THE REPUBLIC OF KAZAKHSTAN

STRATEGY OF NUCLEAR POWER PROGRAM AND HUMAN RESOURCES DEVELOPMENT IN KAZAKHSTAN

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BRANCH PROGRAM

"ATOMIC BRANCH DEVELOPMENT IN RK FOR 2011-2014 WITH THE PROSPECT OF DEVELOPMENT BEFORE 2020"

THE TARGET OF PROGRAM

Creation of atomic energy and atomic industry development to provide accelerated industrial and innovative development of the country

MAIN DIRECTIONS OF THE PROGRAM

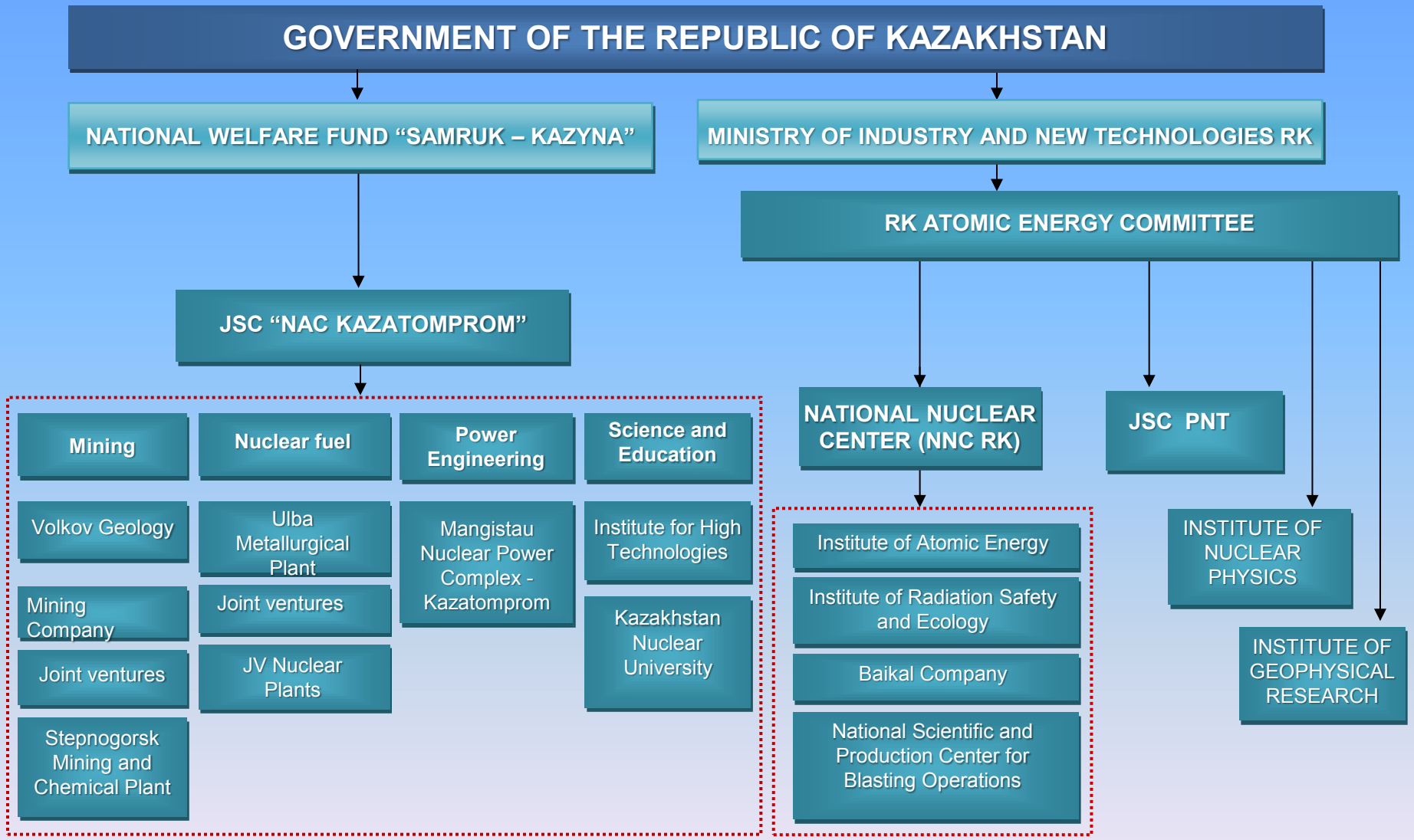
- **ATOMIC INDUSTRY DEVELOPMENT**
  (Creation of vertically integrated company, prospecting, uranium production and processing, high-tech uranium production)
- **ATOMIC ENERGETICS DEVELOPMENT**
  (NPP location and construction at the territory of RK)
- **SCIENCE DEVELOPMENT IN THE ATOMIC FIELD**
  (Development of fundamental and applied science)
- **HEALTH AND ENVIRONMENTAL PROTECTION**
  (Rehabilitation of contaminated territories and its involvement into economic cycling)

POLICY DECISION

"..... At the same time, we must not forget about the prospects of nuclear energy. The need for cheap nuclear power in the foreseeable-term development of the world will only grow. Kazakhstan is the world leader in uranium mining. We have to develop our own production of fuel for nuclear power plants and build our nuclear power plants"

(Address of the President of Kazakhstan, Nursultan Nazarbayev to the people of Kazakhstan, Jan. 17th, 2014)

NUCLEAR POWER MANAGEMENT STRUCTURE

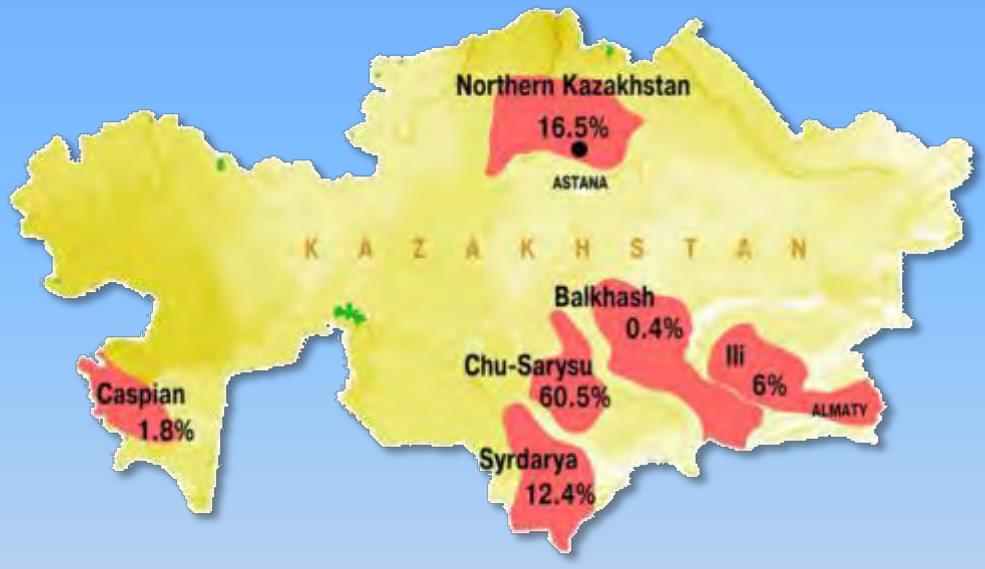


NUCLEAR INDUSTRY

Uranium Resources

- 1 750 000 ton of explored reserves
- 2nd place in the World after Australia

Uranium Ore Provinces



1. In 2009 Kazakhstan came out on top in Uranium mining amounted to 14 214 тU and kept world leadership in production of uranium in the following years (2010 –17 803 тU, 2011 –19 450 тU, 2012 – 20 900 тU).
2. In 2012 the volume of uranium production in Kazakhstan made about 37% from the world volume of uranium production which according to preliminary data made 55,7 thousand tons of uranium.
3. At the same time Kazakhstan has no facilities for conversion and uranium enrichment, fuel rods and fuel assemblies production; it does not produce electricity from Nuclear Power Plants.

NUCLEAR INDUSTRY

JSC “Ulba Metallurgical Plant”

- **Uranium Production:**
  production of natural uranium concentrate, uranium dioxide powder and fuel pellets for reactors VVRK, RBMK, BWR and PWR.
- **Beryllium Production:**
  Unique production at Eurasia, including all types of beryllium containing materials, certified for western producers.
- **Tantalum Production**
  Unique in CIS and one of the world largest enterprises capable to process tantalum and niobium containing materials to ingots, chips, powders, mill products and targets.





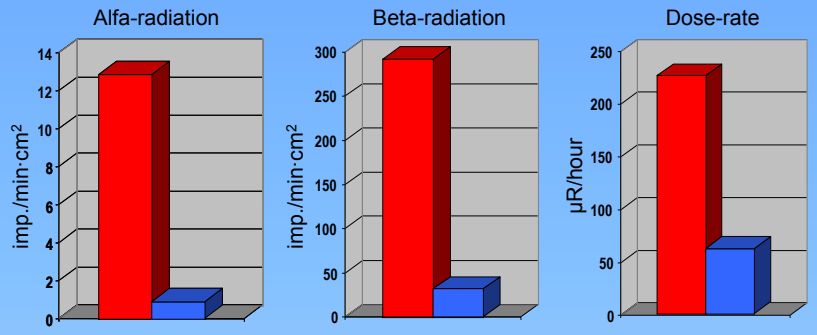
BASIC ACTIVITIES

1. Conversion of the former military industrial complex of the Semipalatinsk Test Site (STS) and use of its research and technical potential in the interests of the Republic of Kazakhstan.
2. Research in support of Atomic Power development in the Republic Kazakhstan, including
   - Nuclear power engineering development and experimental research to substantiate it's safety
   - Development and realization of Innovation Atomic Power Projects
   - Feasibility Studies to substantiate NPP construction in Kazakhstan
   - Investigations in the field of radiative materials study and nuclear physics
   - Application of nuclear-physical methods, radiative and nuclear technologies in economy of Kazakhstan
3. Radioecology of those Kazakhstani regions where nuclear tests were conducted and where atomic industry plants and nuclear facilities are located.
4. Study and elimination of nuclear weapons testing consequences in Kazakhstan.
5. Creation of research-technical, technological and personnel base for development of the nuclear power engineering in Kazakhstan

RADIATION ECOLOGY AND STS

Elimination of Nuclear Tests Consequences

- Closure and sealing of 181 tunnels at the Degelen Mountain Complex
- Elimination of 13 unused boreholes at Balapan testing Field



Average values of radiation parameters
before (red) and after (blue) tunnel's closure

EXPERIMENTAL BASE

Participants of competition-conference of R&D of young scientists of NNC RK

IWG.1M Research Reactor

IGR Research Reactor

RA Research Reactor

WWR-K Research Reactor

DC-60 Heavy Ion Accelerator

EXPERIMENTAL BASE

Isochronous Cyclotron **U-150M**

UKP-2-1 Electrostatic Charge-Exchange Accelerator

Small Size Cyclotron

ANGARA Test-bench

EAGLE Test-bench

EAGLE facility

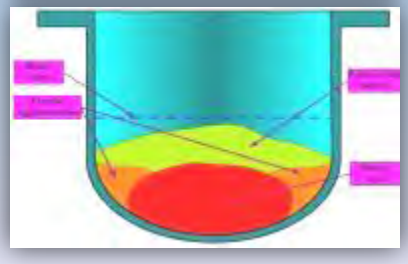
INVESTIGATIONS TO SUBSTANTIATE SAFETY OF NUCLEAR UNITS

Out-of-pile experiments are performed to study of nuclear power water-cooled reactor core melt with

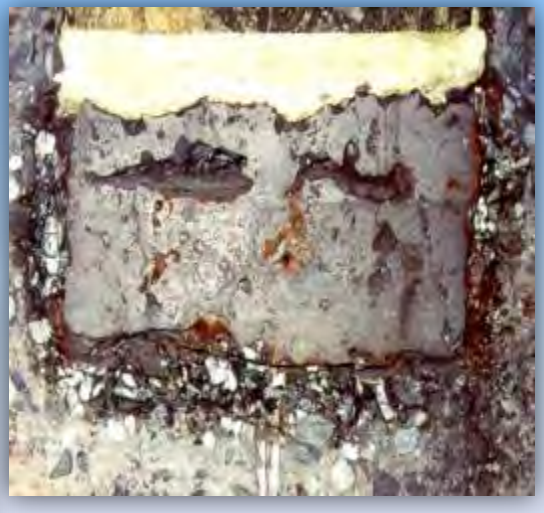
- coolant (while melt discharging into the water),
- Concrete with¥without water on concrete foundation before melt discharge, while cooling a melt surface with water and while simulation decay heat in discharged melt,
- Reactor bottom steel .

Quantitative and numerical data are obtained to foresee severe accident development and choice of measurements on limitation and localization of its consequences. Investigation results confirmed a possibility to control severe accidents. These data were recognized worldwide.

Melt discharge

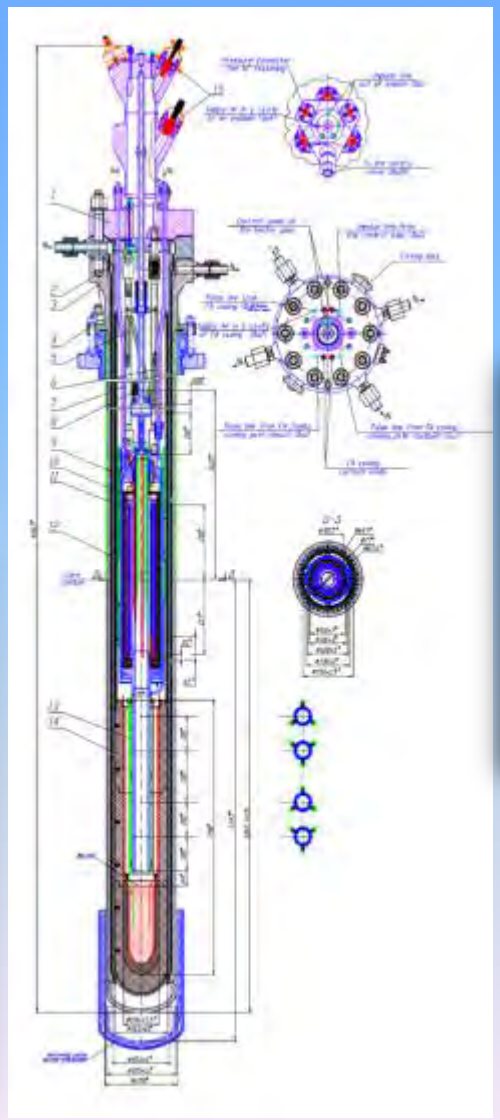


Bottom mockup after melt interaction



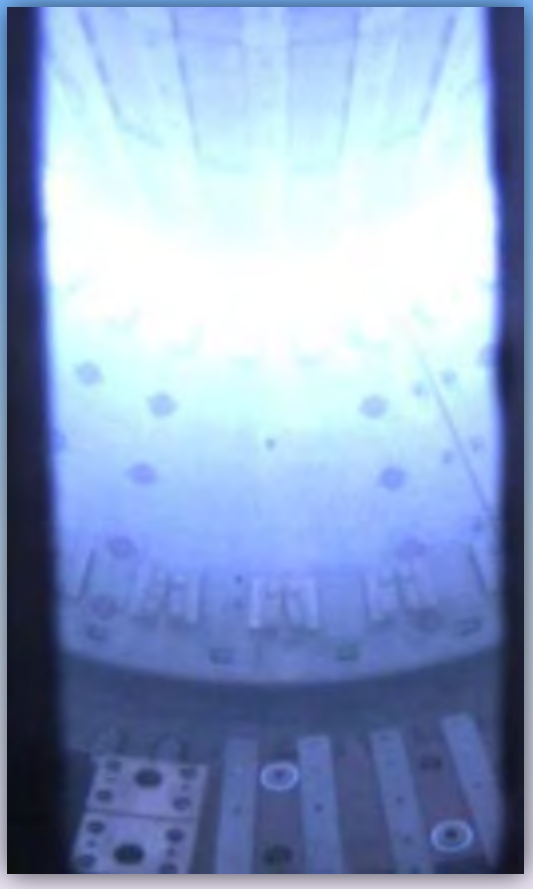
Solidified melt in concrete trap

IN-PILE EXPERIMENTS TO SUBSTANTIATE NUCLEAR UNITS' SAFETY (EAGLE PROJECT)



KAZAKHSTAN MATERIAL TESTING REACTOR KTM

On September 05, 2010 KTM Tokamak pilot startup was realized under which plasma cord ("first plasma") with max current 25kA during 40ms was achieved in KTM vacuum chamber



BN-350 REACTOR SAFETY DECOMMISSION

BN-350 Reactor

Cesium trap

Model device for reactor drilling

Transfer and packing cask and railway carrier to transport SNF for storage

Commencement of Sodium cleanup facility construction

BN-350 SPENT FUEL TREATMENT

In fully conformity with USA- RK Agreement and under RK Governmental Decree, sixty casks with BN-350 spent nuclear fuel were successfully transported from Aktau to Long-term Storage. Physical protection and status monitoring were provided in order to balance nuclear and radiation safety

NUCLEAR SCIENCE AND TECHNOLOGIES

Production of ampoule gamma-sources on the basis of reactor and cyclotron isotopes

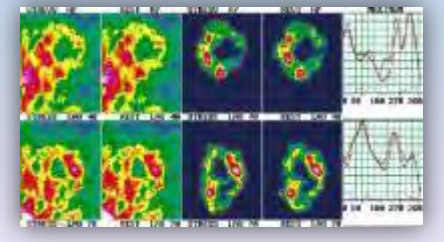
- for nondestructive defectoscopy
- for technical control devices (level meters, densimeter)
- for industrial analytical instrumentation
- for sterilizing medical materials and instruments

- Cobalt-60
- Cadmium-109
- Cobalt -57
- Iridium -192
- Palladium-103
- Selenium-75

Production of radiopharmaceuticals on the basis of reactor and cyclotron isotopes

Possessing an operating research reactor and cyclotron with controlled ion energy, Kazakhstan is capable of producing almost the entire range of radioisotopes for medicine.

Quality of preparations meets requirements of the European Pharmacopoeia and is controlled by means of the most-up-to-date analytical equipment.



CREATION OF THE CENTER OF NUCLEAR MEDICINE AND BIOPHYSICS IN ALMATY

The purpose: development and introduction in practice of public health services of RK of the newest methods of diagnostics and the therapies, developed in recent years at the interface of a medical science, the nuclear physics and information technologies.

Radioisotope production: ~ 42 300 GBq/year
Radiologic exclusion in vivo: ~ 6 800 procedure/year
Immunodiagnostics in vitro: ~ 24 000 tests/year
Radioisotope scan: ~ 1 150 procedure/year
Irradiation sterilization: 137 mil. units/year

WILL BE CREATED

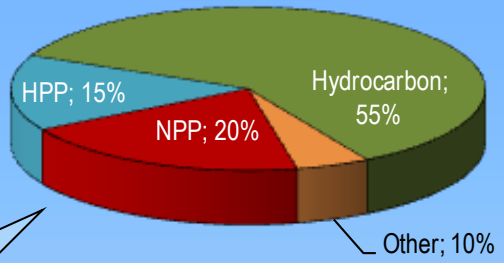
- **Building of production of radiopharmaceutical**
- **Medical-diagnostic complex**
- **Building of irradiation sterilization**

DEVELOPMENT STRATEGY OF POWER ENGINEERING

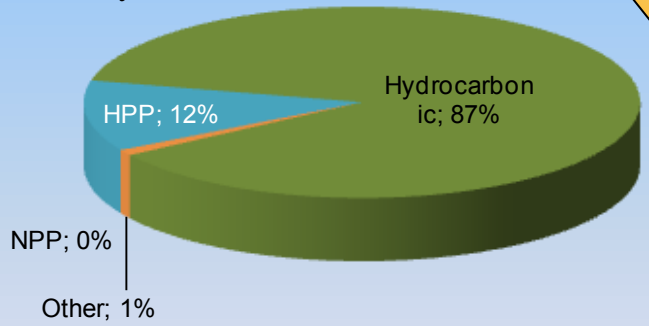
Currently, nuclear power provides about 15% of the volume of electricity produced in the world.

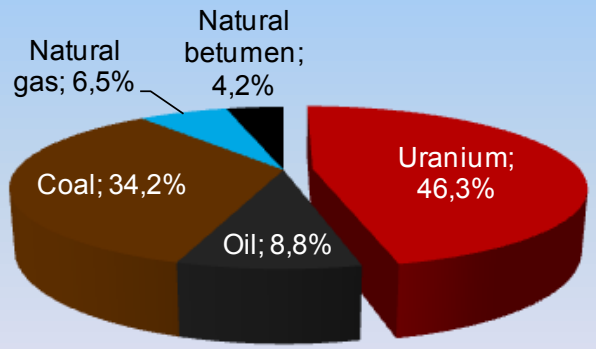
Kazakhstan possesses a significant amount of explored reserves of uranium (~ 19% of the world reserves) and it is on the first place of uranium mining in the world in 2009.

Optimal alternative of RK power industry structure taking into account the diversification of energy sources



Current status of Kazakhstan power industry





Energy reserves in Kazakhstan in terms of conventional fuel

CONSTRUCTION OF NEW SOURCES OF POWER BASE TO COVER THE SHORTFALL OF ELECTRICITY IN REGIONS OF RK

The maximum capacity of new power stations of basic power by 2030 is to be equal to 6600 MW (e), including:

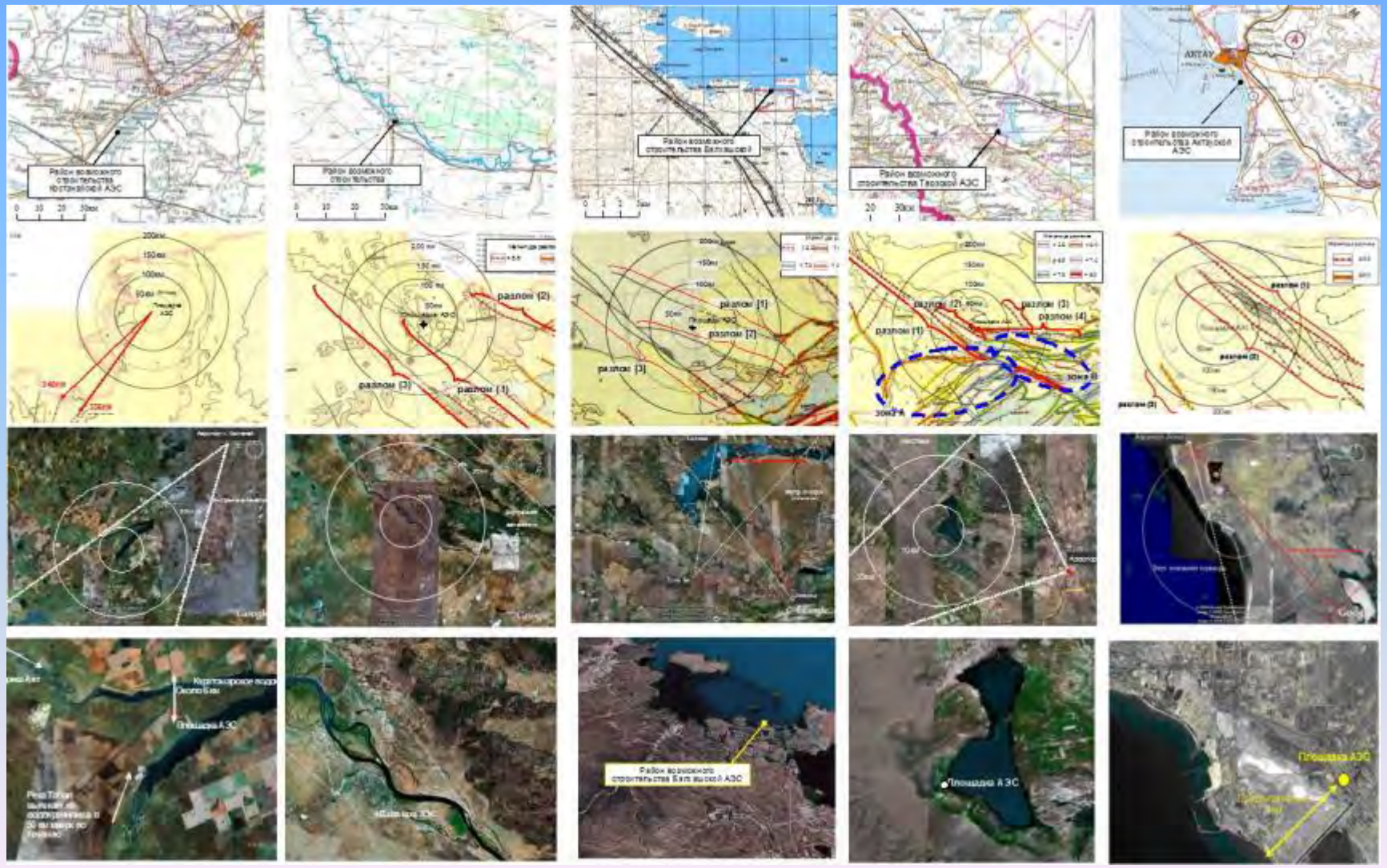
	The maximum basic power, MW			
	2015	2020	2025	2030
The need for new sources of primary power in the regions of Kazakhstan	600	2200	4500	6600
North - East Kazakhstan	0	1600	2100	2900
South Kazakhstan*)	1320	2640	2640+1500	2640+2500
West Kazakhstan	600	600	900	1200

*) These rates of power input for the Southern region of Kazakhstan took into account that the construction of two modules **Balkhash TPP** with total capacity of 2,640 MW operated with coal, with the construction beginning of the first module of capacity 1320 MW (2×660 MW) in 2016.

NUCLEAR POWER ENGINEERING

Regions of Kazakhstan perspective for NPP construction as basic electric power source

Kostanai | Kurchatov | Balkhash | Taraz | Aktau



DEVELOPMENT OF ATOMIC INDUSTRY IN RK

Uranium mining		Increase in volume of Uranium mining in accordance with Resolution of the RK Government
Uranium conversion *Canada Co-Project*		Feasibility Study Design for Uranium hexafluoride conversion production
Uranium enrichment *Russia Co-Project*		Joining a going isotope separation concern to obtain guarantee services on uranium enrichment
Fuel Pellet Production		JSC “Ulba Metallurgical Plant” capacity utilization
Fuel Assembly Production *France Co-Project*		Developing the FS and design estimate documentation; construction of Fuel Assembly Plant for Nuclear Power Plant
Nuclear Reactor Industry		Establishment of Specializing Engineering Company related to NPP construction. Production of NPP goods and equipment by RK Companies

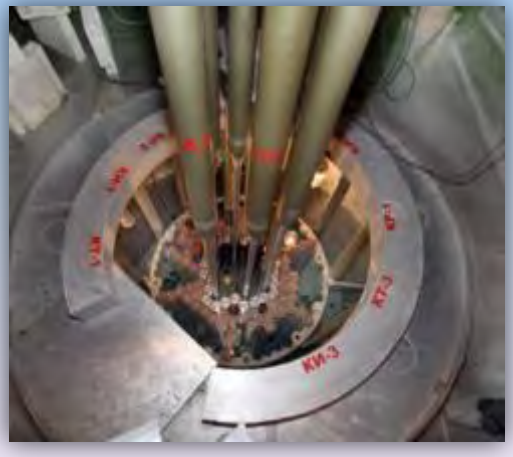
MODERNIZATION OF COMPLEXES OF RESEARCH NUCLEAR REACTORS WWR-К , IVG.1M AND IGR

IWG.1M Research Reactor

WWR-K Research Reactor

IGR Research Reactor

IWG.1M Research Reactor console

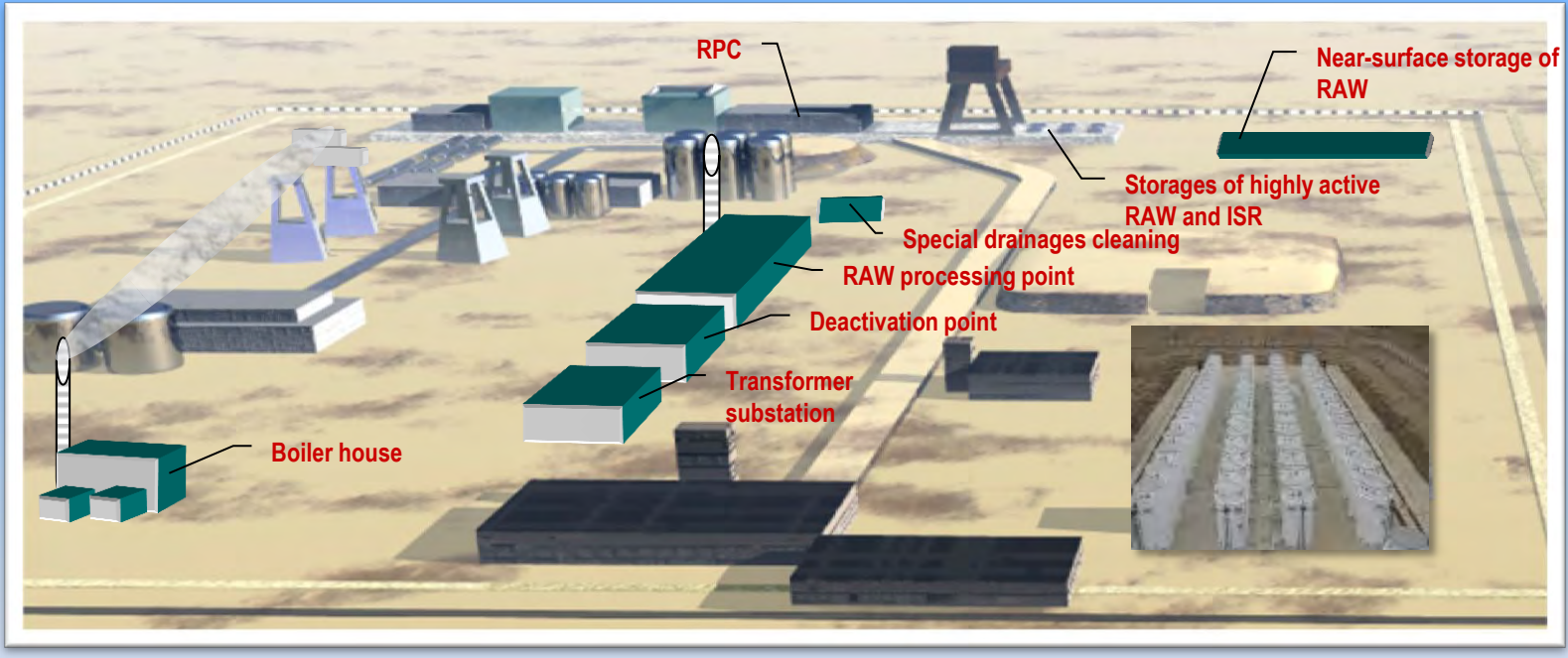


WWR-К Reactor critstand

IGR- Research Reactor console

REPUBLICAN CENTER ON PROCESSING AND LONG-TERM RAW STORAGE

To increase the volume and range of waste taken to the processing and storage, feasibility study of the project “Creation of a radiation-protective chamber and the long-term storage of SRW at CRR "Baikal-1“ IAE NNC RK” have been developed.



PROCESSING

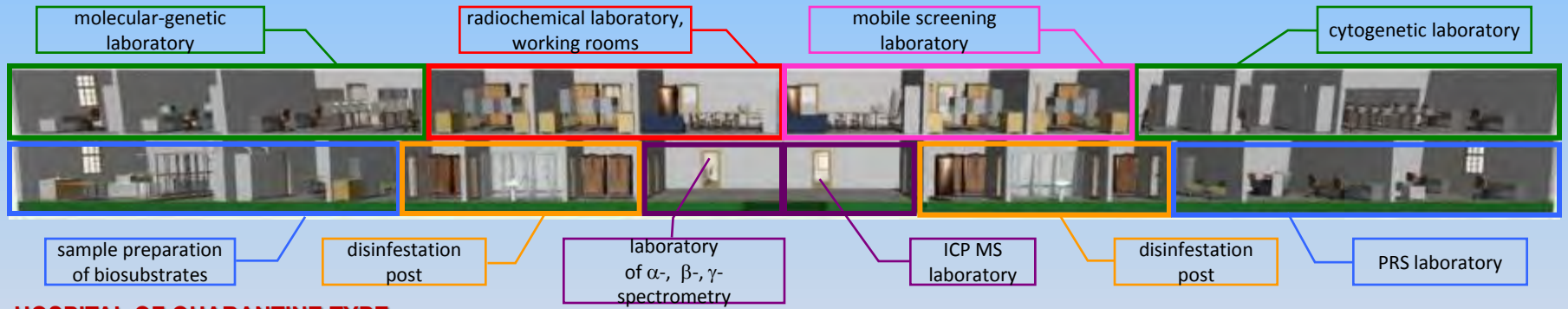
- **Of solid radioactive wastes – 1200 tones a year (including up to 20 tones of highly active wastes)**
- **Of liquid radioactive wastes – 200 tones a year**

STORAGE

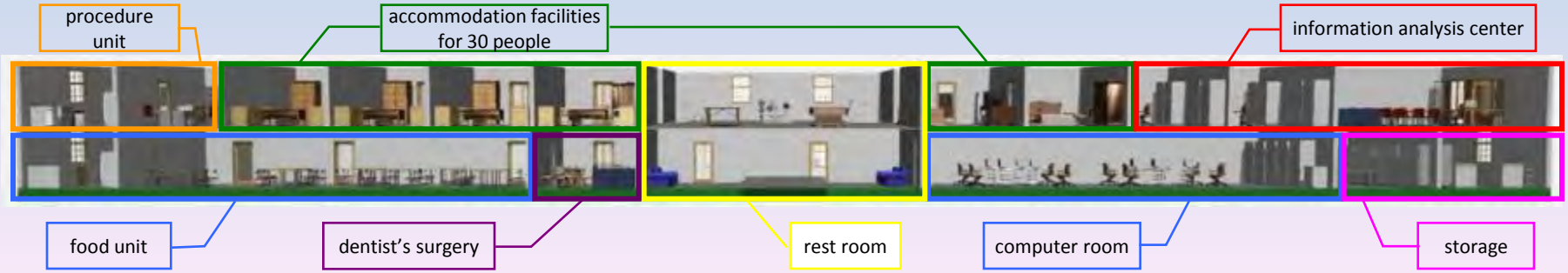
- **Of spent ionizing sources of radiation – 5000 pc. a year; total activity $2{,}25 \cdot 10^{16}$ Bq**
- **RAW storage capacity – 9000 tones of RAW; total activity $8{,}4 \cdot 10^{13}$ Bq**

CREATION OF THE REPUBLICAN CENTER OF THE COMPLEX DOSIMETRY

LABORATORY BUILDING



HOSPITAL OF QUARANTINE TYPE



HUMAN RESOURCES. KAZAKHSTAN EDUCATION REFORM

- In 1994, the State Standard of Higher Education of the Republic of Kazakhstan on the introduction of a multi-level structure of higher education, academic bachelors and masters degrees is approved (Ministry of Education of Kazakhstan on August 25, 1994 #327)
- Since 2004, multistage structure of higher and postgraduate education is introduced: Bachelor - Master - Doctorate (PhD). The structure found its legal consolidation in the new Law of the Republic of Kazakhstan "On Education" from Jul. 27, 2007 #319.
- In 2011, Kazakhstan has developed and implemented a new classification of higher education institutions: the national research universities, national universities, research universities, academies and institutes.

A NEW STATE EDUCATION DEVELOPMENT PROGRAM

- State Education Development Program in the Republic of Kazakhstan for 2005-2010
- The concept of 12-year general secondary education
- State program of development of technical and vocational education in the Republic of Kazakhstan for 2008-2012
- The concept of improving the system of training and certification of scientific and pedagogical staff in the Republic of Kazakhstan till 2010
- State Education Development Program 2015
- State Education Development Program for 2011-2020.

THE REPUBLIC OF KAZAKHSTAN IN THE BOLOGNA PROCESS

On March 11, 2010 the Committee of Ministers for Education of countries-members of the Bologna process (46 countries) made decision to join Kazakhstan with the Bologna process.

The Bologna Process is an ongoing dialogue between the higher education systems of different countries aimed at creating a single European Higher Education Area.

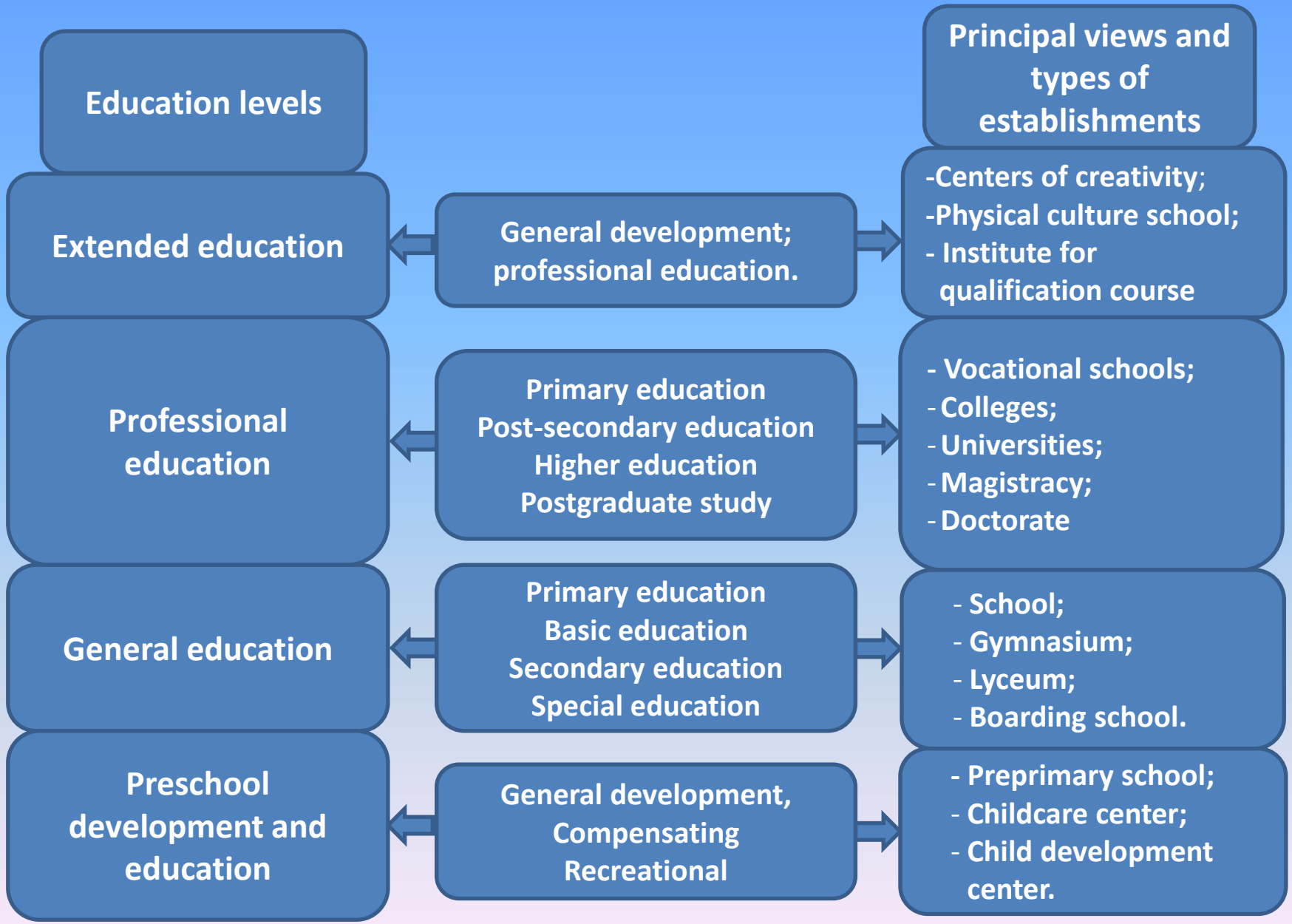
The aim of Kazakhstan's participation in the Bologna process - improving access to European education, further enhancing its quality, increase the mobility of students and teaching staff by taking comparable steps of higher education system; the use of a credit system, issuing the European Diploma Supplement for Kazakhstan graduates.

Republic of Kazakhstan is the first Central Asian State admitted as a full member of the European educational space.

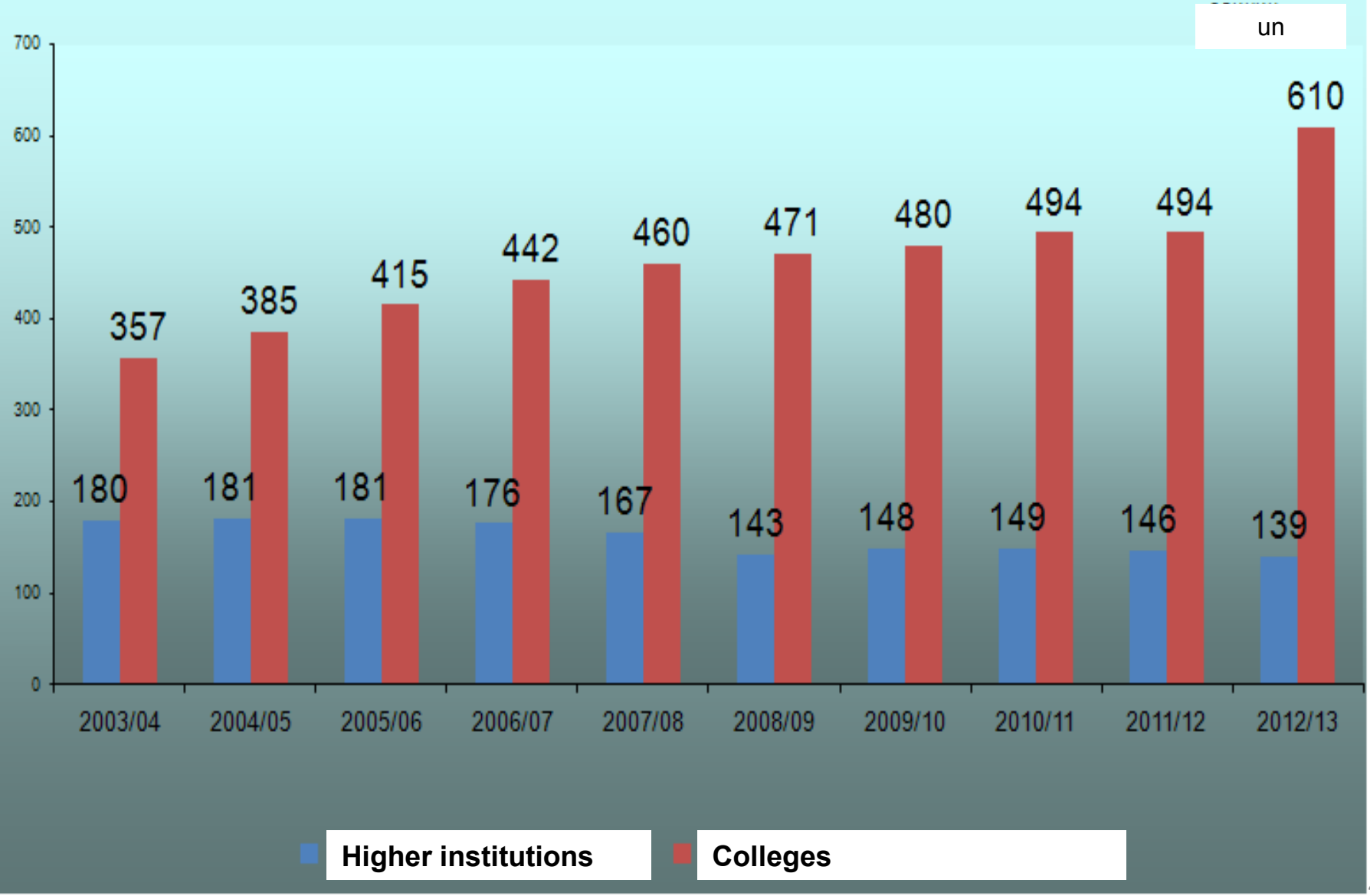
BOLOGNA PROCESS IMPLEMENTATION

Required parameters of the Bologna Process	Bologna process implementation in Kazakhstan
Three-level system of higher education	Successfully realized by RK universities
ECTS Academic credits	Credit education technology is adopted
Academic mobility of students, teachers and administrative staff of universities	Realized by RK universities
The European Diploma Supplement	Realized by some RK universities
Quality control of higher education	Successfully adopted and applied
Creation of a single European Research Area	Project are under way to enter the single European Research Area

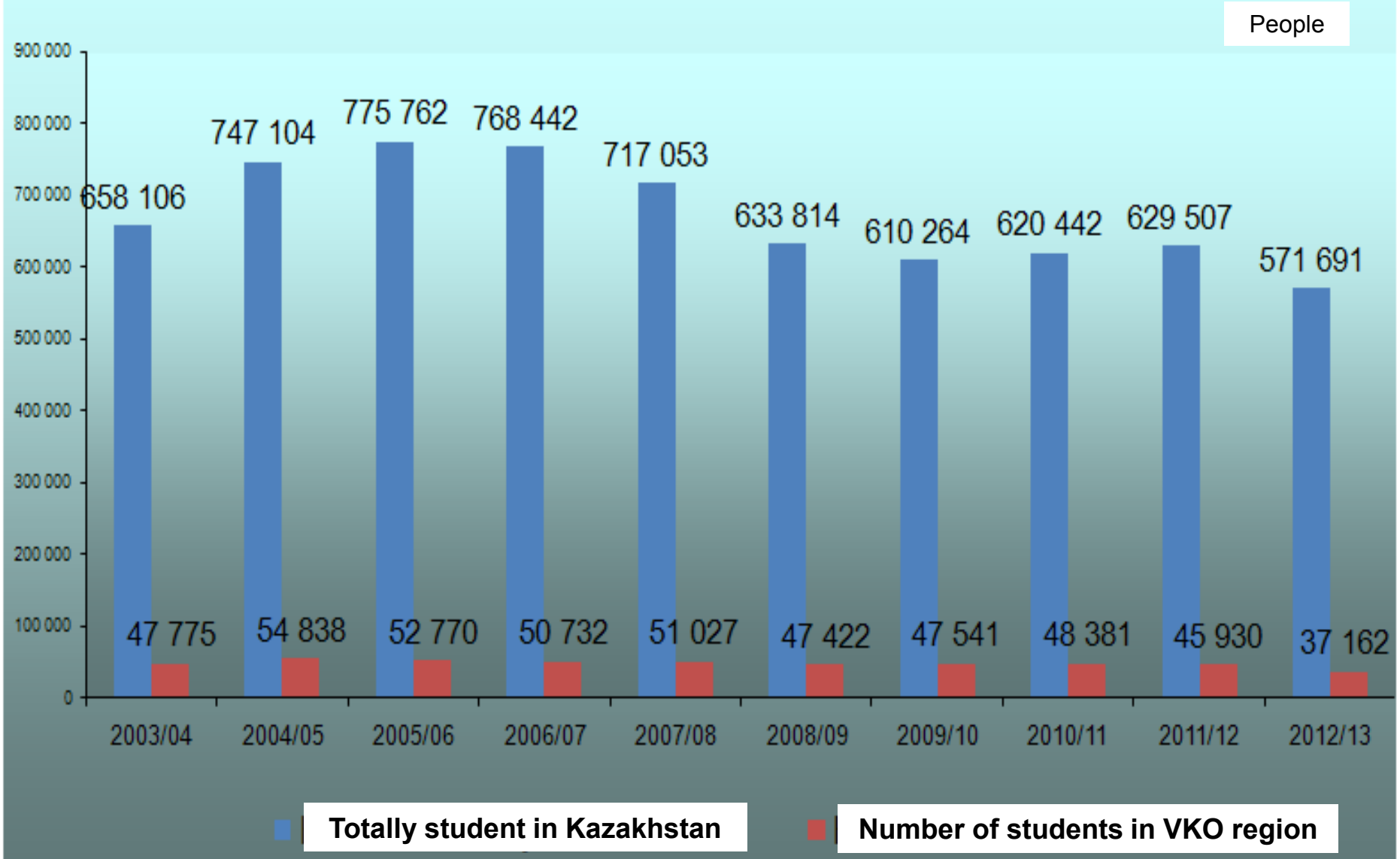
KAZAKHSTAN EDUCATION SYSTEM



Totally educational institutions

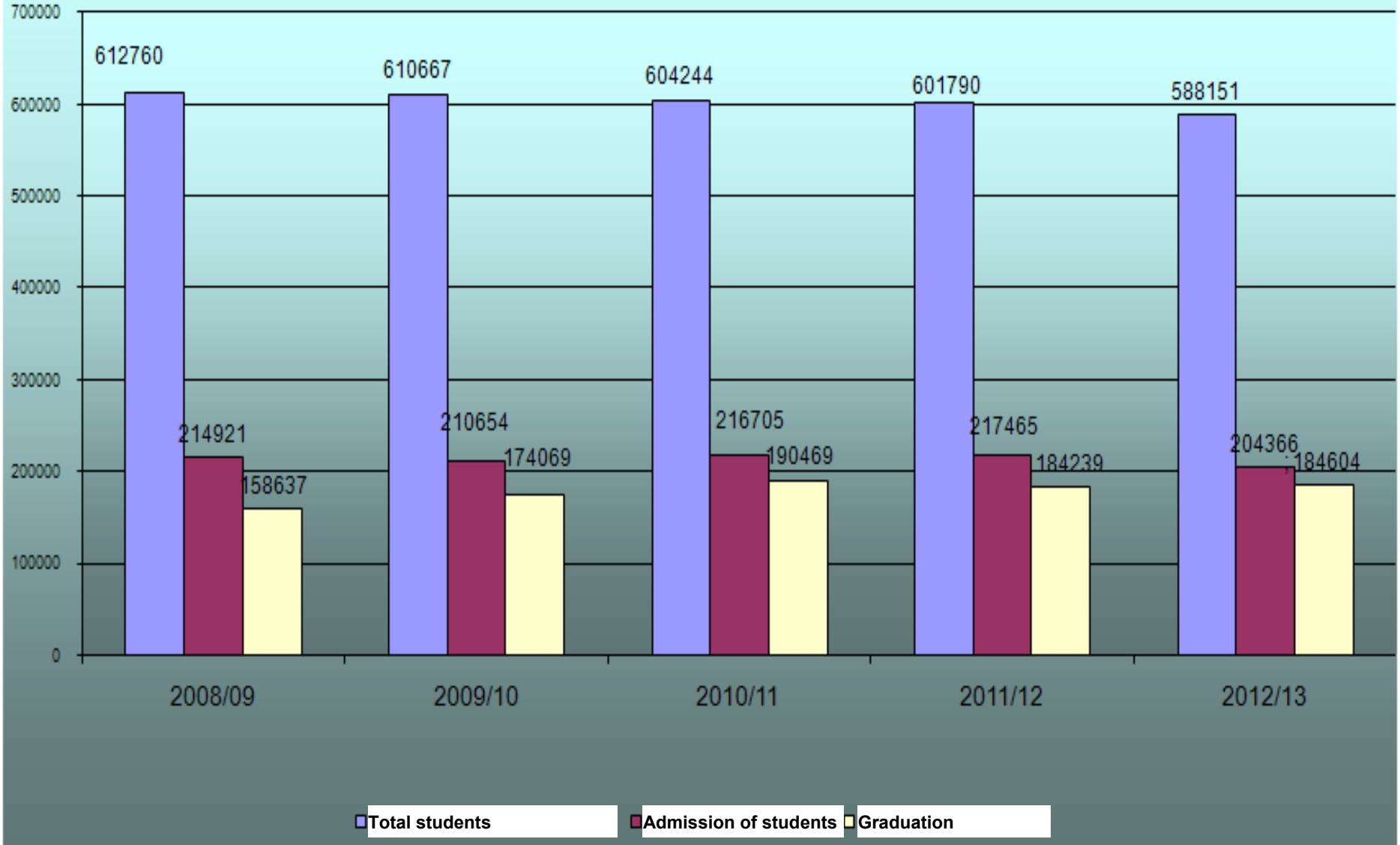


Total number of students

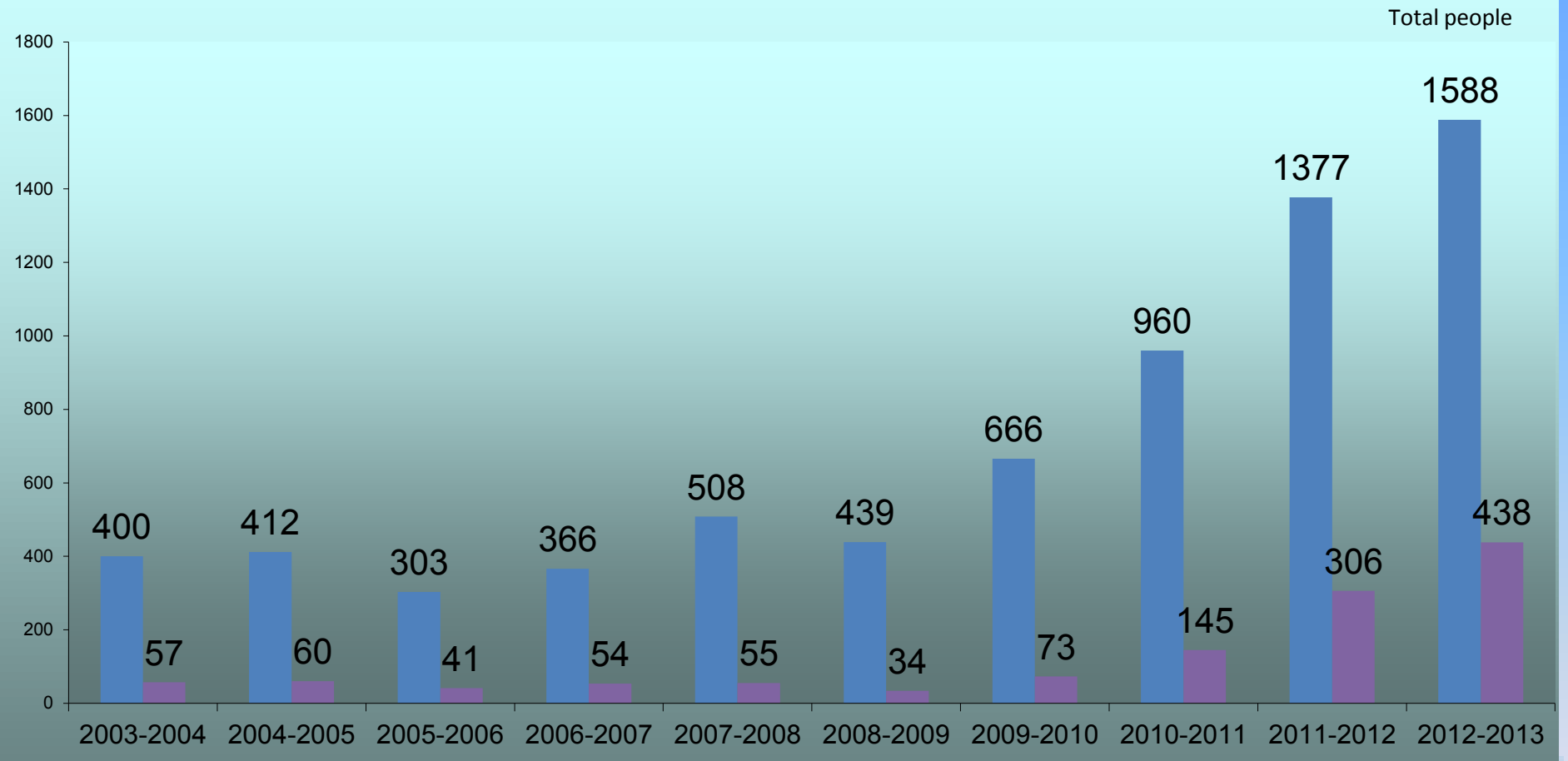


Number, admission and graduation of technical and vocational students

At the beginning of academical year, people

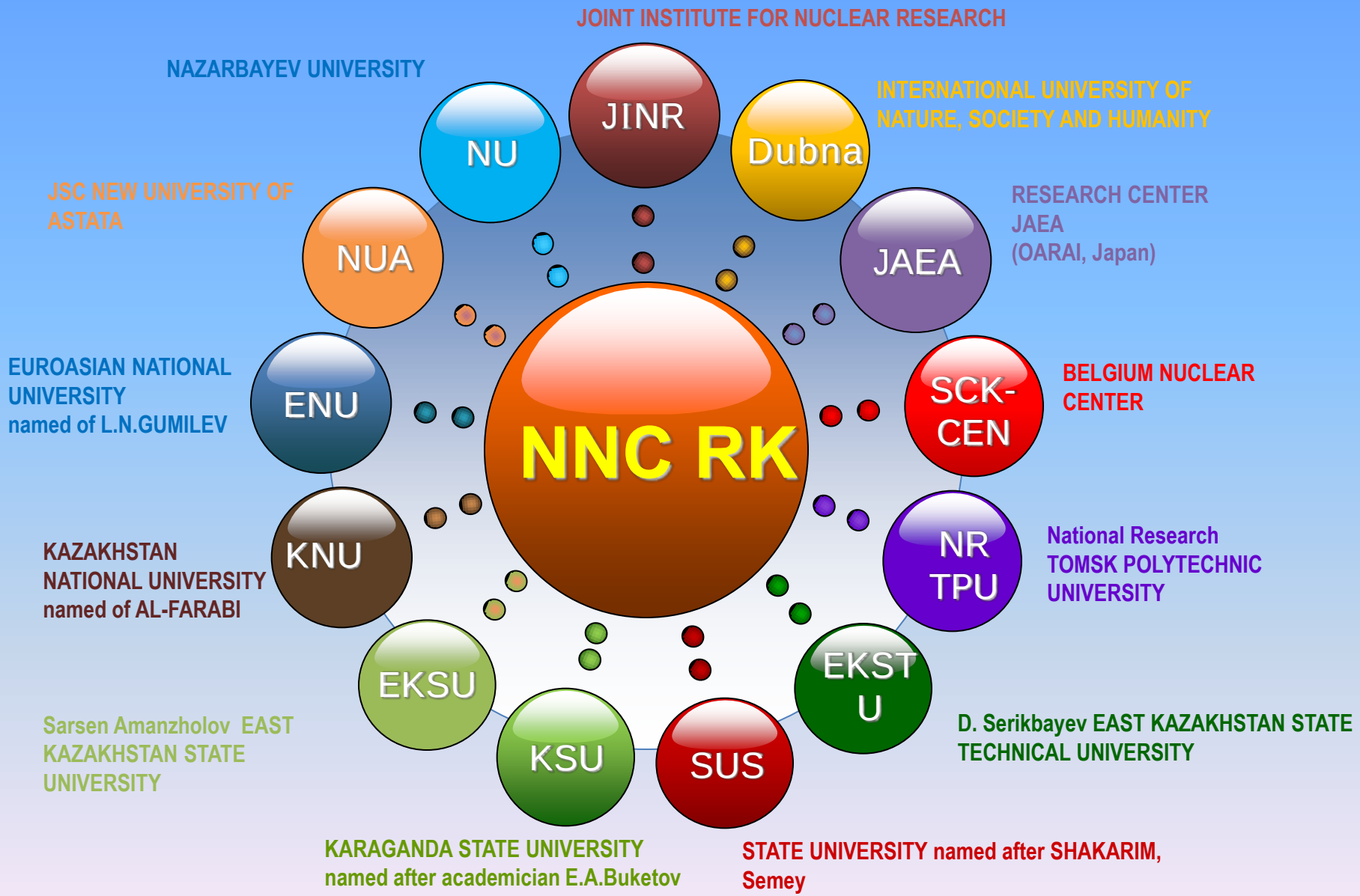


Ph.D. candidates



- Total number of Ph.D candidates
- Number of candidates in Engineering Science and Technologies

PROFESSIONAL TRAINING FOR ATOMIC BRANCH



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NUCLEAR DISCIPLINES IN KAZAKHSTAN UNIVERSITIES

Discipline code	Name of the University	Interning
5B060500 – Nuclear physics	Eurasian National University named of I.N.Gumilev Kazakhstan National University named of Al-Farabi	NNC RK, JINR
5B072300 – Engineering Physics	Kazakhstan National University named of Al-Farabi D. Serikbayev East Kazakhstan State Technical University Euroasian National University named of I.N.Gumilev Satpayev East-Kazakhstan State University	NNC RK Branch of the Department of Technical Physics in NNC RK
5B072300 – Nuclear-power installations	State University named after Shakarim , Semey	Branch of the Department of Technical Physics in NNC RK
5B060400 – Physics	Kazakhstan National University named of Al-Farabi Eurasian National University named of I.N.Gumilev South Kazakhstan State University named after Auezov H.A.Yasavi International Kazakh-Turkish University Sarsen Amanzholov East –Kazakhstan State University State University named after Shakarim , Semey	NNC RK Branch of the Department of Technical Physics in NNC RK
140800 – Nuclear Physics and Technologies	National Research Tomsk Polytechnic University	NNC RK "Mining and Chemical Combine" Zheleznogorsk; "Siberian Chemical Plant", Seversk; IAE NNC RK

JINR-NNC COOPERATION

Since 1992 The Republic of Kazakhstan is a member state of the **JOINT INSTITUTE FOR NUCLEAR RESEARCH (JINR)** .

They jointly perform research in the following areas:

- theory of particles and nuclei
- nuclear properties and mechanisms of reactions induced by heavy nuclei
- fundamental interactions in nuclei at low energies
- radioanalytical and radioisotope studies at LNR accelerators
- study of multiple processes under 4π- geometry
- study the properties of nuclear matter and structure of the particles at the collider of relativistic nuclei and polarized protons
- development of accelerators for radiation technologies
- development of the JINR experimental base for intense heavy ion beams and polarized nuclei
- mathematical support of experimental and theoretical studies conducted by JINR.

Within recent years many young specialists from Kazakhstan received valuable practical knowledge in the laboratory of the Joint Institute for Nuclear Research (JINR) in Dubna.

From 1995 to 2010 by specialists from Kazakhstan in the JINR was defended 7 theses, including 6 PhD thesis and one - doctoral dissertation.

NNC-JINR COOPERATION RESULTS

NNC –JINR cooperation lead to the establishment of the International department of nuclear physics, new materials and technologies of ENU named of L.N. Gumilyev and Multi-disciplinary scientific and research complex in 2008. Laboratory of nuclear reactions named of G.N. Flerov, JINR in collaboration with the Institute of Nuclear Physics NNC RK designed cyclotron DC- 60 for abovementioned Complex.

Kazakhstan National University participates in the educational program of the JINR. A quadripartite agreement on joint training of bachelors and masters in nuclear physics was signed in Astana, November 2009. This will allow students of the Eurasian National University named after Gumilev studying at the Department of Nuclear Physics at the University "Dubna", using the experimental basis of Flerov Nuclear Reactions Laboratory for preparation. Dubna students will be able to pass pre-diploma practice on the basis of the accelerator DC-60 and protect diploma in ENU.

COOPERATION BETWEEN THE NNC RK AND JAEA AND JAPC

In February 2013, in Tokyo the NNC RK signed:

- ✓ Memorandum of Understanding with the Japan Atomic Energy Agency (JAEA) for cooperation in the field of research and development of the future of nuclear power industry and creation of infant industries

- ✓ Memorandum of Understanding for cooperation with the Japan Atomic Power Company (JAPC) and Marubeni corporation (MUS, Ltd), which will provide long range planning and solution of problems in the field of long-term development of atomic energy industry in Kazakhstan

- ✓ In August of 2000, Kazakhstan Economic University named of T.Ryskulov and Japan International Cooperation Agency (JICA), acting within the framework of the program official extension work, provided by the Government of Japan to Kazakhstan, signed a protocol of discussions about creation of Kazakhstan - Japan center for development of human resources.

COOPERATION BETWEEN THE NNC AND BELGIUM NUCLEAR CENTER

In October 2010, during an official visit of Nursultan Nazarbayev to Brussels, the Memorandum of Understanding was signed between the National Nuclear Center of Kazakhstan (NNC), JSC “NAC” Kazatomprom” and the Belgian Nuclear Research Centre of Energy (SCK-CEN).

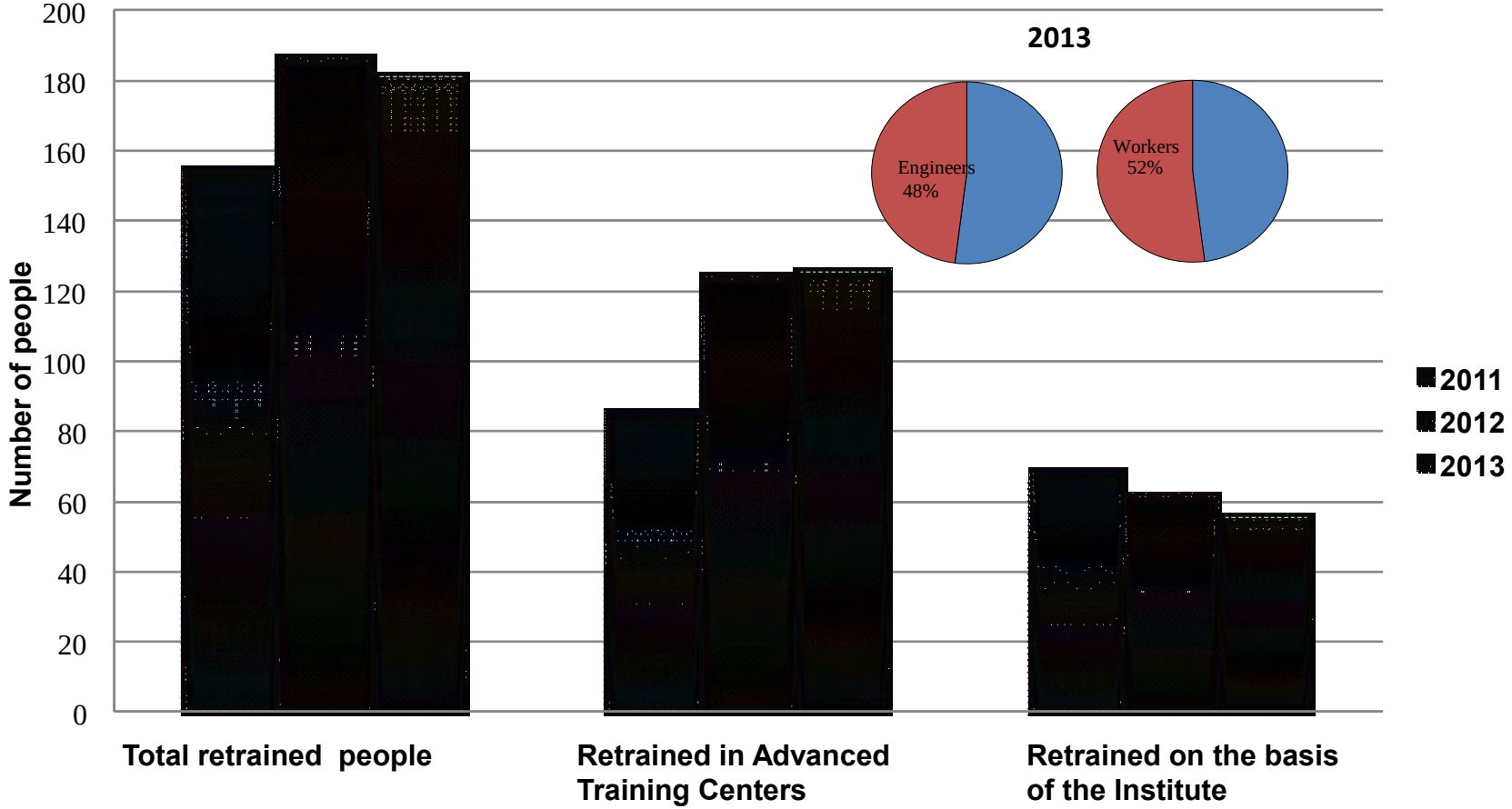
PROFESSIONAL RE-TRAINING OF NUCLEAR MANPOWER

❖ **LLP "Kazakhstan Nuclear University"** is a specialized center for training and retraining of personnel of the National atomic company «Kazatomprom».
Since November 2004, totally 11718 specialists got further training in various educational programs.

❖For several years **the Training Center** on the basis of the Japan Atomic Power Company (JAPC), Tokay city, organizes training courses for specialists from a number of developing countries in Asia, including Kazakhstan, aimed at training personnel for the nuclear industry.

❖In 2002, **Geotechnology Company** was created for training and retraining the manpower for Kazakhstan uranium mining.

PROFESSIONAL RE-TRAINING OF NUCLEAR MANPOWER IN KAZAKHSTAN



PROFESSIONAL RE-TRAINING OF NUCLEAR MANPOWER IN KAZAKHSTAN (BY WAY OF EXAMPLE IAE NNC RK)

Staff office of the Institute of Atomic Energy NNC RK is organizing retraining courses hosted by Institutions of Further Training in Kazakhstan, CIS countries and non-CIS countries. The table below provides the list of training and re-training courses and workshops attended by our specialists:

Place of re-training	City	Topic of training courses
"State University named after Shakarim" Semey	Semey, Kazakhstan	Laboratory control of air of the working area and the indoor air on health and safety at the plant; working with gas burner G-4 for Roofing; training on occupational safety and tudovomu legislation on industrial safety training and certification for operators of forklift truck, industrial safety at hazardous production, training and recertification of welders
LLP "Istok Training Center"	Ust-Kamenogorsk, Kazakhstan	health and safety at the plant; working with gas burner G-4 for Roofing; training on occupational safety and tudovomu legislation on industrial safety training and certification for operators of forklift truck, industrial safety at hazardous production, training and recertification of welders
LLP "Training Center" Alsas"	Ust-Kamenogorsk, Kazakhstan	training for drivers of vehicles carrying dangerous goods (class 2, 3, 7)
LLP "Tehprommontazh LTD"	Ust-Kamenogorsk, Kazakhstan	Industrial safety at hazardous production facilities
Establishment of "Kazakhstan training and research center for non-destructive testing and technical diagnostics"	Pavlodar, Kazakhstan	"Physico-chemical control of water and soil" and "Physical and chemical control of air" Ultrasound, capillary, radiation, visual and optical inspection methods
LLP "Kazakhstan Institute for Advanced Studies on technical regulation, metrology and management systems"	Almaty, Kazakhstan	Verification and calibration of measuring electrical quantities Verification and calibration of measuring pressure, vacuum, flow of liquids and gases, thermal and thermal values, re-training of verification officers and calibrators of measuring time, frequency and radio units; training the verificators and calibrators of measuring ionizing units
LLP "Kazakhstan Center for training and consulting"	Almaty, Kazakhstan	calibration of measuring pressure, vacuum and flow of fluids and gases, thermal and temperature values
National Training Center for Civil Protection MES RK	Almaty, Kazakhstan	Education of experts in the field of civil defense
Evaluation Center TNIITMAS Ltd.	Russian Federation	rules of certification of welders equipment and pipelines of nuclear power plants;
National Research Nuclear University "MEPhI"		Nuclear Energy and Nonproliferation
IAEA	Austria	commercialization of scientific developments
Karlsruhe Technology Institute	Germany	on legislative applications to nuclear safety
the National Commission for Nuclear Activities (NCNA)	Rumania	management and licensing of nuclear fuel, security, fuel consumption and licensing of out-of-pile nuclear fuel cycle
Japan Atomic Power Committee (JAPC)	Japan	training of nuclear manpower
Japan Atomic Energy Agency (JAEA)		design for irradiation capsules
Physics and Technology Institute	Ukraine	training course as part of US-RK Energy Partnership Programm
Albuquerque National Training Center, DOE	The USA	vulnerability analysis

THANK YOU FOR ATTENTION!

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