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Enhancement of the physical protection of waste storages – a step to maintain the nuclear security regime in Ukraine

Outline of presentation

- Nuclear and radiation objects in Ukraine. Brief excursus on map
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  - Synergy of nuclear and radiation safety and nuclear security
  - Physical protection of radioactive wastes during transport
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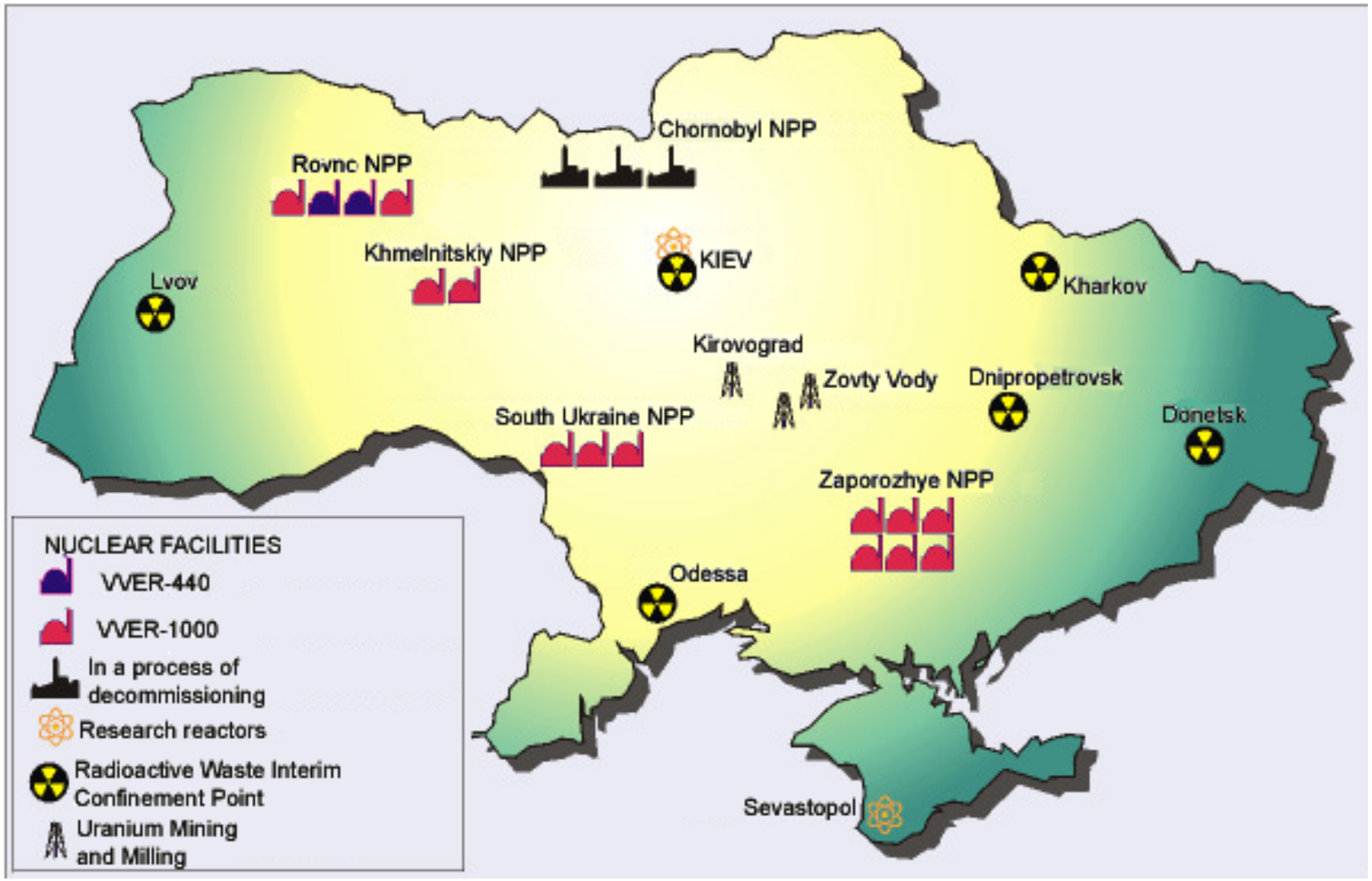
Nuclear and Radioactive Facilities in Ukraine



Legislation framework for handling radioactive wastes

The issues of management, safety and security of radioactive wastes are considered in a number of Ukrainian laws:

- On Nuclear Energy Use and Radiation Safety;
- On Radioactive Waste Management;
- On Physical Protection of Nuclear Facilities, Nuclear Materials, Radioactive Waste, Other Radioactive Sources;
- On Human Protection against Ionizing Radiation;
- On Protection of Population and Environment against Man-Induced and Natural Emergencies;

and a series of regulatory acts approved mainly by the Ministry of Health or Nuclear Regulatory Authority.

Generation and aspects of radioactive wastes

Depending on the activities wastes originate of :
nuclear fuel cycle:
nuclear power plants (including plants under decommissioning);
uranium mining and processing plants;
production and use of radionuclides beyond the nuclear fuel cycle:

- -industry;
- -medicine;
- -science research programs;

decontamination of facilities and territories contaminated by accidents including the Chornobyl disaster:
Shelter (destroyed unit 4 of Chornobyl NPP);
decontamination enterprises, storages and disposal facilities, places of uncontrollable concentration of wastes in the Chornobyl zone;
functioning, dismantling and decontamination of military objects.

Nomenclature of radioactive wastes

Manufacturing processes	Liquid wastes	Solid wastes
1. Nuclear fuel cycle enterprises: 1.1 Uranium ore mining and processing	Mining waters Mother waters	Mining scrap Uranium processing and leaching tailings
1.2 Uranium processing and production of fuel assemblies	Mother waters and industrial waters	Wastes of consumption Wastes of fuel processing
1.3 Energy and heat production at nuclear power plants	Industrial waters Circuit waters Decontaminating solution Regenerators Pulps	Filters Equipment Outwear Insulation materials First-circuit equipment
1.4 Decommissioning of facilities, dismantling of blocks and structures	Waters of bathing and delousing Industrial waters Circuit waters Decontaminating solution Regenerators Pulps	Outwear Personal protective gear Equipment Control equipment Insulation materials Construction waste Coating First-circuit equipment and parts of reactor vessel
2. Rehabilitation of territories contaminated after operation or accidents 2.1 Contaminated territories after Chornobyl accident 2.2 Shelter	Waters and slimes of cooling and clearing pools. Contaminated ground waters Waters of storage pools Contaminated underground waters Hydroxide pulps of storage pools	Contaminated soil Solid radioactive wastes from decontamination of storages
3. Industrial enterprises, research centers and medical institutions, specialized enterprises for waste handling	Industrial waters of laboratories	Outwear Personal protective gear Organic radioactive wastes Spent radiation sources

Storage of spent fuel

Spent fuel, which is unloaded from the reactor as fission isotopes are burned out, pose the main hazard to nuclear and radiation safety and continue to release heat after unloading from the reactor. So spent fuel is primarily stored in cooling pools and is transferred for dry storage after proper cooling.

In Ukraine there is currently the only one dry storage facility for spent fuel. It is situated at Zaporizhzhya NPP and is intended for spent fuel of only this plant. Spent fuel of other NPPs is transported to Russia in line with contract on fresh fuel supply.

The governmental decision is made for construction of a new dry storage facility for spent fuel (DSF-2) on the site of Chornobyl NPP. The design is completed and came through state expertise.

Shelter

In accident at unit 4 of Chornobyl NPP, a significant amount of radioactive materials was spread. But the major part of radioactive products left in the local zone – in the destroyed unit and surrounding territory. For temporary confinement of radioactive materials, a concrete structure called the Shelter was built over the power unit.

Decontamination measures were provided on the site, including the collection of core fragments, removal of the upper soil layer and placement of concrete, macadam and sand to form a technogenous layer. In such a way, certain amount of wastes was buried directly on the site. However the concrete constructions gradually deteriorate and weaken. At last years were performed works for strengthening of roof and construction of supporting stack.

Infrastructure for ChNPP decommissioning

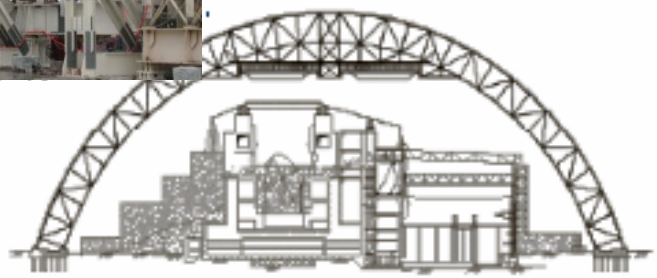
In the framework of ChNPP decommissioning and Shelter transformation into an environmentally safe system the new facilities for waste processing were built:

•Reprocessing plant for liquid wastes. Construction completed, cold checkout in progress. Planned commissioning on 2014.

•Industrial complex for solid radioactive waste management. Construction completed, hot checkout in progress. This complex will include underground storage of V=55000 m^3 for final disposal of intermediate- and low-level wastes.

New Safe Containment

The construction of new safe containment (called Arc) was started to ensure radiation safety of the Shelter and further dismantling of the old structure and retrieval of radioactive materials. The structure will be 85 m high and will fully cover the Shelter. Planned commissioning – November 2015. Next – extraction of FCM and long-lived wastes, conditioning and disposal of them.



Radioactive waste facilities in Chornobyl zone

"Buryakivka" disposal site

The site is intended for intermediate- and low-level wastes. It has dimensions 1200x700 m and consists of 30 ditches of V=25000 m^3 each. Besides, metallic wastes (contaminated carriages) are temporarily placed on the site.

"ChNPP Stage III" disposal site

The site is intended for intermediate- and low-level wastes and is located near the cooling racks of unfinished stage of Chornobyl NPP. It consists of a concrete box of dimensions 145x45x5 m and has two side ditches. Radwaste in storage is located in average 18000 metallic containers, covered by a layer of sand.

"Pidlisnyi" disposal site

This is the only site in Ukraine intended for high-level wastes. It is placed nearby unit 4 of ChNPP and consists of two concrete boxes of dimensions 55x26x8 m. The 22000 m^3 high-active wastes resulting from the Chornobyl accident are placed on the site. The site is currently in long-term storage.

All of the three above disposal sites are now parts of the State Centralized Enterprise for Radioactive Waste Management. Moreover, in Chornobyl zone, there are near 680 ditches and a series of waste temporary confinement plants. They are also under control of the above enterprise.

Storing radwaste at “Radon” enterprises

State Enterprise “Radon” is the operator , appointed for managing of radioactive wastes in Ukraine. It includes the storage enterprises in several regions and in Chornobyl zone.

Special interregional enterprises

Six interregional enterprises (Kyiv, Kharkiv, Lviv, Odesa, Donetsk and Dnipropetrovs'k) were established in 1959-1961 for collection and disposal of radioactive wastes from entities not belonging to nuclear fuel cycle – industrial, medical and scientific.

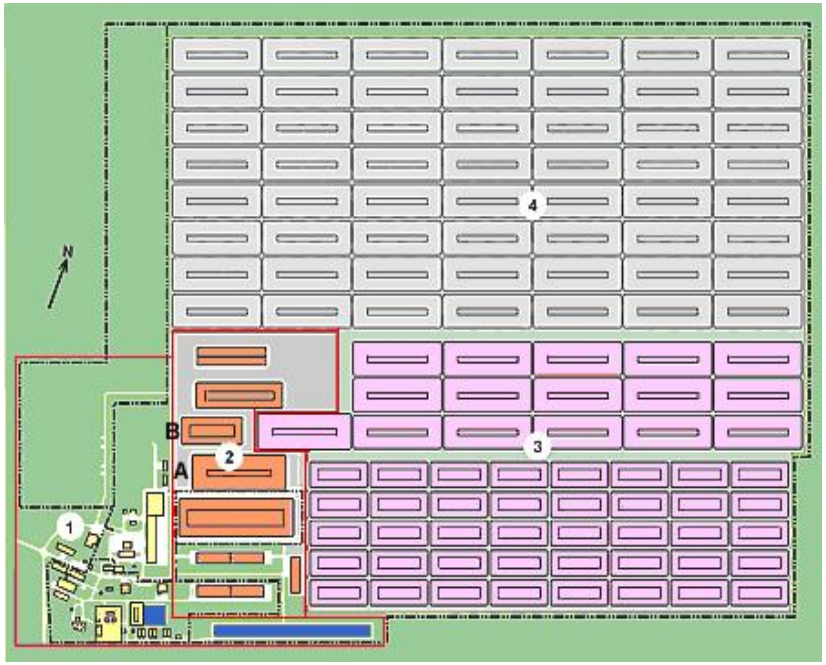
All of them are constructed in compliance with standard design and include near-surface concrete structures for solid wastes, biological wastes and spent radiation sources. The storages are consolidated in disposal centers located mainly in the countryside.

Storing radwaste at “Radon” enterprises

“Vector” site

The “Vector” site is the start-up complex of factories for reprocessing, conditioning and storaging of wastes and is located in the Chornobyl zone. It includes four repositories and one near-surface disposal facility intended for solid wastes, especially for bulky scrap.

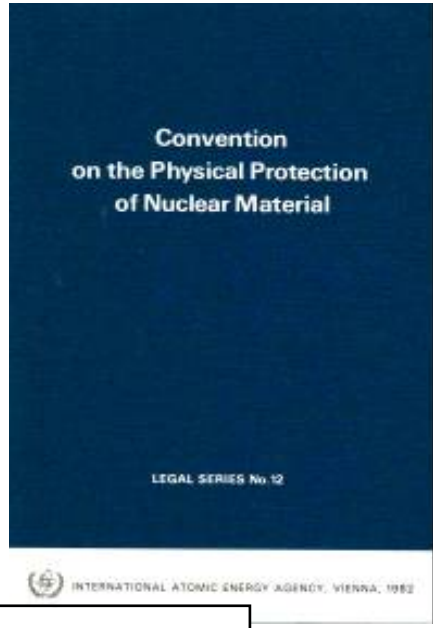
The site also include a processing plant for compaction, cementation and conditioning of radioactive waste.

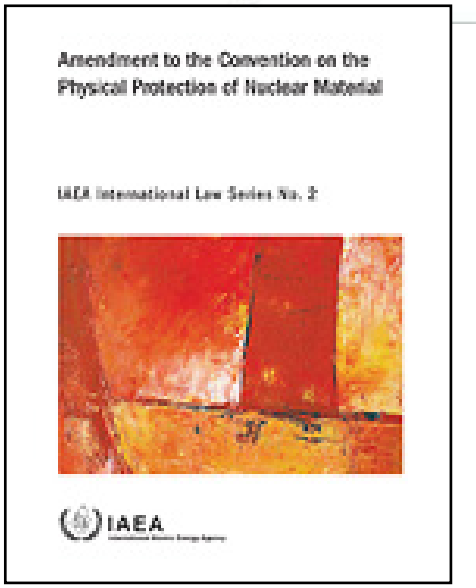


Establishing and maintaining nuclear security regime

Ukraine was amongst the initiators of amending the Convention on the Physical Protection of Nuclear Material and undersigned the Amendment to the CPPNM in 2005. Ratification of the Amendment by the dedicated law in 2008 was the most important step in physical protection improvement. This law and associated, specially amended law “On Physical Protection of Nuclear Facilities, Nuclear Materials, Radioactive Wastes and Other Radioactive Sources”

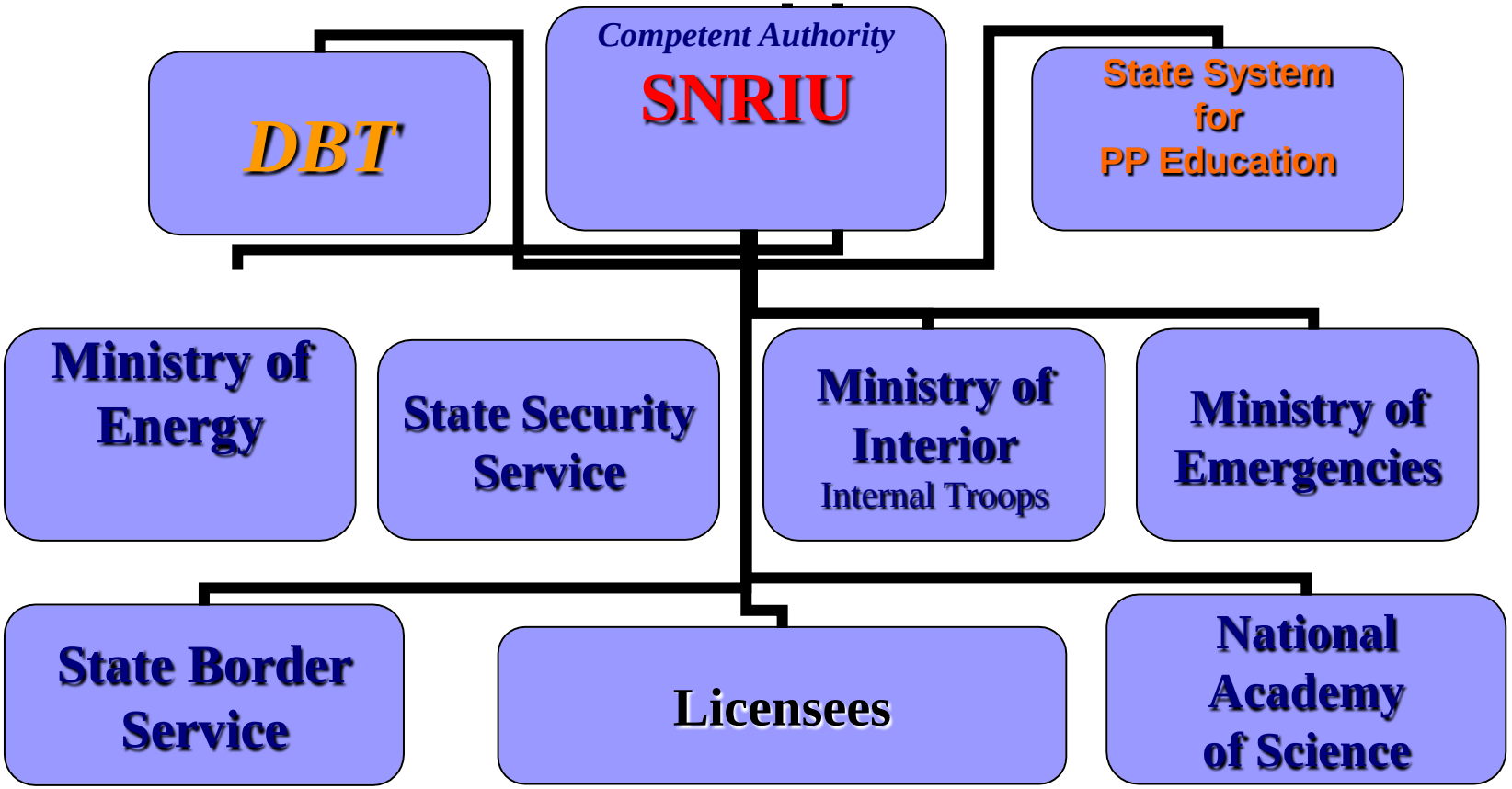
- implemented12 fundamental principles of physical protection
- identified concepts new for Ukraine such as nuclear security, physical protection regime, design basis threat.





State physical protection system and physical protection regime

The responsibility for the establishment, implementation and maintenance of a physical protection regime within a State rests entirely with that State.



The objective of a state's nuclear security regime is to protect persons, property, society and environment from harmful nuclear security events

Defining threats and risks for radioactive wastes

DBT embraces all the objects of nuclear sphere in Ukraine including radioactive wastes and associated facilities. Based on state DBT, all operators and other licensees define and approve the design basis threats of their facilities. This is provided by the State Enterprise “Radon“, Chornobyl NPP, facilities in construction and all other entities handling radioactive wastes mentioned above.

For the purpose of reducing the risks of malicious acts, structured risk management is followed. The main risks are:

- theft or other unlawful acquisition for subsequent sale when the offender does not intend to apply materials by himself;
- theft or other unlawful acquisition for production of a radiological dispersal device – so-called dirty bomb;
-risk of sabotage at facilities directly.

Contaminated equipment made of nonferrous metals is most attractive. The acquisition of spent highly active sources for production of a dirty bomb is also possible.

Synergy of nuclear and radiation safety and nuclear security

To ensure the effectiveness of safety and security measures, it is not sufficient to exclude the negative mutual influence. The objective is to ensure that the synergy of safety and security outweighs the ordinary sum of functioning of each element. They should mutually increase the effect of measures completed in every sphere.

E.g., combined use of physical barriers or simultaneous application of the defense-in-depth principle in physical protection and radiation protection in designing a radwaste facility should not only provide economical result but also improve safety and security of wastes.

The synergy approach for ensuring nuclear and radiation safety and nuclear security is now followed in all new designs of nuclear facilities as well as of radioactive waste storages and processing facilities starting from the selection of the site location.

The regulatory document for these matters is now in preparation.

Defining the level of physical protection of radioactive wastes and associated facilities

Objects and materials	Category	PP Level	Requirements
Solid wastes $D>10^4$ µGr/h Liquid wastes $A>10^6$ PC_B^{ingest} Facilities for I cat. wastes	I RW	II	Confinement in protected area
Solid wastes $D=10^2 \div 10^4$ µGr/h Liquid wastes $A=10^2$ $PC_B^{ingest} \div 10^6$ PC_B^{ingest} Facilities for II cat. Wastes	II RW	III	Confinement in area of controlled access
Solid wastes $D=10^2 \div 10^4$ µGr/h Liquid wastes $A=1$ $PC_B^{ingest} \div 10^2$ PC_B^{ingest} Facilities for III cat. Wastes	III RW	IV	Protecting with prudent practice. Use of fences with intruder alarm
Spent nuclear fuel	II NM	II	Confinement in protected area
Spent high-level radiation sources ($A>3,7 \times 3,7 \times 10^{13}$Bq, lifetime≥5 years)	I RS	III	Confinement in area of controlled access
Spent high-level radiation sources ($A>3,7 \times 3,7 \times 10^{13}$Bq, lifetime≥5 years)	II RS	IV	Protecting with prudent practice. Use of fences with intruder alarm

PP level is the set of regulated minimal conditions necessary to establish PPS capable to resist to DBT. PP level for facility is defined by operator.

Physical protection of radioactive wastes during transport

During transportation the radioactive wastes are mostly vulnerable, especially for the acts of sabotage. So for each case of transportation, a special physical protection system is developed and established. It operates only for the period of conveyance till delivery to the last consignee. The level of physical protection measures depends on type, activity and amount of transferred radioactive material.

Requirements of physical protection are complied with during domestic as well as international transportations. Ukraine removes the large part of spent fuel to Russia and in future wastes of reprocessing of it will be returned.

Ukraine as well is a transit country for car and railway transfer of spent fuel and radioactive wastes from other countries.

Transportation of radioactive wastes requires fulfillment of physical protection measures as well as of accountancy and control and radiation protection.

Physical protection of spent fuel

Spent fuel of nuclear power plants is kept on their sites, mainly in wet storage (cooling pools). Thereafter all spent fuel is subject to physical protection systems of NPPs and is secured in compliance with state regulations and recommendations of IAEA.

The special dry storage facility for spent fuel is placed only at Zaporizhzhya NPP. Now there are stored 80 ventilated concrete containers. Total capacity of storage is 380 containers, sufficient for 50 years. PPS of storage is in process of modernization and automatization that will decrease the time of response to events and improve nuclear security significantly.

Now a new dry storage of spent fuel (DSF-2) is in construction on the site of Chornobyl NPP. It will include a facility for treatment of spent fuel before storage and a storage area for spent fuel. The plan developed for construction of DSF-2 takes into consideration the establishment of a comprehensive and robust physical protection system starting at the first stage of construction.

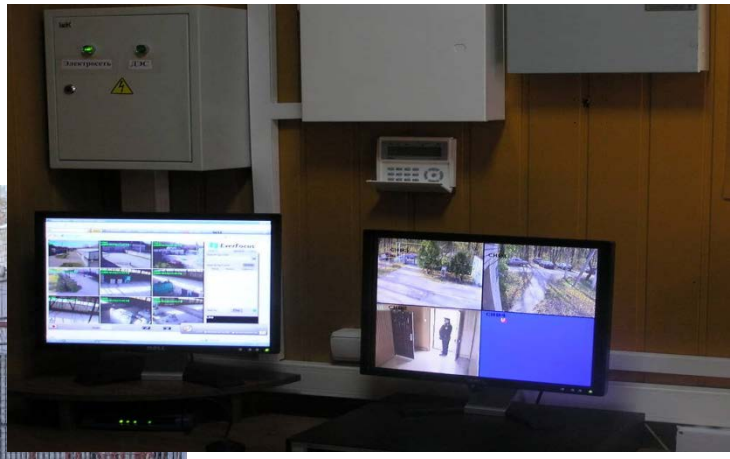
Modernization of physical protection system of Chornobyl NPP

The physical protection system of Chornobyl NPP was established simultaneously with construction of NPP in 1972. During plant's operation and especially after the 1986 accident, it was changed many times. Last changes in the configuration of perimeter of protected area were made in 2010-2011 due to changes of site territory. The special platform for installation of arc constructions for the new safe containment was included to protected area of NPP. Now modernization of system equipment for intrusion detection and surveillance is in process.

PPS of the ChNPP is prepared for accessing as sub-systems the automatized PP complexes of new facilities constructed on its site, e.g. of new dry storage of spent fuel (DSF-2), waste facilities. These sub-systems will be operated by local alarm stations and controlled by central alarm station. This will improve the nuclear security of new facilities and of NPP in whole.

Modernization of physical protection systems of "Radon" interregional plants

Taking into consideration that physical protection systems of all six interregional plants were established at the beginning of 1960s, their renovation started in 2005. Now they are up-to-date, consistent and regulatory compliant automatized systems of disposal sites, with equipped perimeters of controlled areas and means of detection and surveillance of intruders.



Ensuring physical protection of spent radiation sources

After disintegration of the Soviet Union, economy of Ukraine underwent significant changes. Some large enterprises utilizing radiation sources went bankrupt and cannot ensure safety and security of their facilities. Ukraine with international technical assistance implemented program for removal and disposal of spent and other radiation sources. A list of such enterprises was developed and inventory of sources was carried out. For disposal of removed sources, the new facility was constructed in Dnipropetrovs'k disposal site. To ensure the nuclear security of the disposal facility, the effectiveness and status of physical protection system were evaluated and the needed renovations were made. The average number of spent radiation sources disposed during these activities was near 4000 pieces.

Ensuring physical protection of radioactive waste facilities in Chornobyl zone

"Vector" site

The "Vector" site is provided with robust up-to-date physical protection system protecting the perimeter of controlled access area and storages and processing facilities inside. It covers the significant territory and consists of physical barriers as well of equipment for detecting, surveillance and access control.

"Buryakivka", "Pidlisnyi", "ChNPP Stage III"

Licensee responsible for physical protection of these three disposal sites is State Centralized Enterprise for Radioactive Waste Management. Especially "Pidlisnyi" as storage of high-active wastes needs the advanced physical protection system. Now PPS for it is provided but not on full scale – is luck of surveillance and communication. PPSs of other two facilities also need the improvement.

Ensuring physical protection of uranium mining and processing wastes

In accordance with legislation, physical protection of uranium industry should be provided. In Ukraine there are three uranium mines and uranium ore processing enterprises. The wastes of these processes are not of high activity but are in significant amounts and can contaminate large territories. To eliminate this threat, measures of physical protection for mines and tailing storages were provided during last years – fences along perimeters were built and security measures were taken.

CONCLUSIONS

- The presence of a substantial number of radioactive wastes and other radioactive sources in Ukraine poses threats of malicious acts – sabotage, theft and dissemination of radioactive materials, which could result in inadmissible radiological consequences.
- The threats for radioactive wastes are real and are taken into account at the State level as threats to national security.
- The principal instrument of counteraction to these threats is nuclear security.
- Modernization of physical protection systems for radioactive wastes and associated facilities and other physical protection measures reduce the threat and improve the nuclear security in Ukraine.