Measures being taken to reinforce Ukrainian old designs NPPs and implementation of IAEA's requirements for new units 3 & 4 of Khmelnitsky NPP

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Complex (summary) program on improving the safety of NPP’s units of Ukraine

Resolution of Cabinet of Ministers of Ukraine _07.12.2011 №1270

Main tasks:
✓ further improving the operation safety of NPP’s power units
✓ reducing the risks of accidents on NPPs during natural disasters or other extreme events
✓ increasing the efficiency of management of design and BDBA at nuclear power plants, minimizing their consequences

Program is aimed to create a permanent system to monitor the progress of measures to improve the safety of NPPs

The basis of the Complex program are:
• measures aimed on realization recommendations of IAEA
• unfinished measures of Concept of improving safety
• measures based on the results of safety analysis reports
• measures recommended by the IAEA experts on the results of evaluations Ukraine NPPs design Safety
• program of modernization of units Kh2/R4 based on service experience
Complex (summary) program on improving the safety of NPP’s units of Ukraine

Measures are divided into groups, each group - to subgroups, as follows:

0 General
  01 Qualifying

1 Reactor core and fuel management
   11 Neutron-physical characteristics of the core
   12 Core design
   13 Fuel management

2 The integrity of the components
   21 The first circuit
   22 Important for the safety systems under pressure
   23 Reactor (including vessel)
   24 Other

3 Systems
   31 Maintenance of reactivity
   32 Maintenance of reserve of coolant in first circuit
   33 Cooling of the first circuit
   34 Maintenance of the pressure in first circuit
   35 Auxiliary systems
Complex (summary) program on improving the safety of NPP’s units of Ukraine

4 Automatic Control Systems
   41 Information systems
   42 The systems of reactor control and protection
   43 Managing safety
   44 Management and control systems

5 Power supply
   51 External sources
   52 Energy distribution

6 Containment and constructions
   61 The risk of containment bypass
   62 Integrity

7 The internal danger
   71 Fire protection
   72 Protection against flooding
   73 The risks associated with pipe breaks and flying objects
Complex (summary) program on improving the safety of NPP’s units of Ukraine

8 External hazards
   81 Seismic
   82 Natural phenomena
   83 External technogenic

9 Analyses of accidents
   91 Safety analyzes
   92 Management of accidents

Priorities of measures are determined in accordance with the following approach:

Priority I - measures with very high and high impact on safety
Priority II - measures with medium and low impact on the safety, as well as analytical studies on safety
Priority III - events with a inappreciable impact on safety

Measures aimed to prevent severe accidents similar to the accident at Japanese NPP "Fukushima-1" is set the Priority I.
Complex (summary) program on improving the safety of NPP’s units of Ukraine

Complex Programme sets the scope of measures to improve safety, that must be implemented at each NPP units.

On the results of the:
- reports of periodic safety re-assessment of units
- inspections SNRIU
- operational experience
- new researches in the field of safety
- taken into account the recommendations of international experts

*the list and the contents of measures may be changed*

In result of realization of measures of the program will be fully implemented measures to strengthen the defense in depth, defined on the results of the developed Safety Analysis Reports, "stress tests", as well as implemented the recommendations of IAEA experts to assess the design safety of NPPs, and experts of IAEA and RISKAUDIT to eliminate of safety problems
Plans of Ukraine for the construction of new NPP units

According to Energy Strategy of Ukraine till 2030:
(order of Cabinet of Ministers of Ukraine, 24.07.2013 № 1071)
The development of nuclear power generation in the period up to 2030 provides:
- Improving the safety of existing nuclear power plants;
- Improving the reliability and efficiency of existing nuclear power plants;
- Continued operation of nuclear power plants in extension period of the operation;
- Construction and commissioning in the period up to 2030 new nuclear power units of a minimum aggregate capacity (can be increased depending on the project):
  - 2 GW in the pessimistic scenario;
  - 5 GW in the baseline scenario;
  - 7 GW in the optimistic scenario;

including:
- Construction of units №3, 4 Khmelnitsky NPP;
- Construction of new units on the other sites;
Plans of Ukraine for the construction of new NPP units

Construction of Khmelnitsky NPP power units №3,4
The decision on construction of power units №3 and №4 of Khmelnitsky NPP was adopted by the Law of Ukraine "On location, design and construction of units 3 and 4 of the Khmelnitsky NPP." Construction units №3, 4 Khmelnitsky NPP is planned with the reactor type VVER-1000. Unit №3 is scheduled for commissioning in 2018, the unit №4 – 2020

Construction units at new sites
Was planned creation and approval of Cadastre of sites for construction of new nuclear power units and units that replace existing nuclear capacity.
Nuclear power plants at new sites is planned to be commissioned during the 2023-2029 years.
Timing of construction can be accelerated in case a significant increasing of demand for electricity compared with forecasted.
Plans of Ukraine for the construction of new NPP units

By the end of 2015, is necessary to make a choice of type of nuclear facilities which will be used in new units.

Fundamental decisions regarding capacity and new types of units will be based on:

- Additional assessment of the national energy system
- Comparison of technical and economic parameters of different projects to meet the requirements of safety and efficiency
- Assessment of world experience of construction and operation
- Assessment of the possible involvement of domestic industrial capacity to manufacture equipment for the new units
Construction of Khmelnitsky-3,4
During the years of independence, Ukraine completed and commissioned 3 units:

- unit №6 of Zaporizhzhya NPP - in 1995
- unit №2 Khmelnitsky NPP - in 2004
- unit №4 of Rivne NPP - in 2004

Was obtained important experience on using of existing building structures for the completion of construction of units.

The decision about construction of the Khmelnitsky NPP (KhNPP) with four power units (total power of 4000 MW(e) was taken in the March 1973.

1973÷1978 - design for KhNPP of 4 VVER-1000/V-320 units was developed

Construction of the start-up facilities began in:


At the time of suspension of construction in 1990 were:

- Unit №3 - 75% of construction readiness
- Unit №4 - 28% of construction readiness
During 2006-2009 were performed inspection and evaluation of technical condition of construction structures of buildings and power units №3, №4.

Opinion of expert organization confirmed the possibility of compliance with design durability and reliable operation of existing building structures, taking into account a complex of repairs and recovery works.

On unit №3 were mounted about 85 pieces of equipment (tanks, heat exchangers, filters etc.). About 20 000 items of equipment are in the warehouses.

To complete the construction of units №3, №4 of Khmelnitsky NPP in 2008 was held competitive selection for choosing the design of reactor type. Competition Commission defined the best offer - design VVER-1000/V-392B, which was submitted to CJSC "Atomstroy-export" State Concern "Rosatom".

In 2011-2012 the Russian side refused to finance the project and changed the design of construction of units on design "AEC-92", which increases the cost of construction from 4.6 billion USD to 10.5 billion USD and requires the dismantling of existing building structures.
2012 - the readiness to start work on the design was achieved.

During 2010-2014 funding was not provided.

At present time is excluded the possibility of constructing in accordance with the variant proposed in Feasibility Study and supplies of equipment for VVER-1000/V-392 because Russian Federation excluded the possibility of implementing the Intergovernmental Agreement. In 2014 contacts with representatives of "Rosatom" on the construction units KNPP Nº3,4 were completely stopped.

2014 - "Energoatom" had considered the alternative variants of construction of the reactor VVER-1000 by alternative production, which could provide construction units as soon as possible (3rd Unit in 2019) with minimization of expenses.
To implement the new approach to the construction of KhPP-3,4:

- Ministry of Energy and Coal Industry of Ukraine
- SNRIU
- Ministry of Regional Development, Building and Housing and Communal Services of Ukraine

adopted a conceptual solution "Construction №3,4 units at Khmelnitsky NPP», which allows to achieve the necessary level of safety, economic benefits and localization of production of equipment in Ukraine.

Was provided the following priority actions:

- Development and submission to the CMU a new draft of legal act on the construction units 3, 4 KhPP
- Implementation of the Feasibility Study and making adjustments to the draft of CMU order on approving the basic technical and economic parameters of modified FS
SNRIU together with SSTC analyzed the current international requirements and recommendations was provided by:

- IAEA’s Action Plan on Nuclear Safety
- Recommendations of WENRA
- Plan of further actions of ENSREG
- Requirements of European operating organizations to design of new generation of NPP with pressurized water reactors

and was developed additional criteria and regulatory requirements that must be applied in the design of new reactors.
Implementation of additional safety requirements for new units design

Based on results of:

- review and establishment of more stringent safety reserves in relation to the extended range of possible extreme natural and technogenic impacts / effects combinations
- providing of continuous performance of safety functions in the conditions of blackout and LOCA
- review of the approach to the management of severe accidents, review and establishment of criteria of acceptability

SNRIU recommended "Energoatom" to apply developed additional criteria and regulatory requirements in the design of new power units (including for №3 and №4 KhNPP).
Review and establishment of more stringent safety reserves

The project should be justified safety reserves in relation to the extended range of possible extreme natural and technogenic impacts / effects combinations.

Existing reserves on seismic, flooding, extreme temperature impacts, etc. should be reviewed in the direction of a significant increase (seismic margin not less than 100%).

The established safety reserves should consider climate forecast of the situation at least for a period covering project term of operation, the potential period of long-term of operation and potential term of decommissioning.

Providing of continuous performance of safety functions in the conditions of blackout and LOCA

The project should be provide technical means of ensuring of extended performance of fundamental safety functions with full blackout and loss of coolant agent.

Methods of ensuring of extended performance of basic safety functions should be based on the using of alternative and autonomous means and sources of water and energy.
Implementation of additional safety requirements for new units design

Review of the approach to the management of severe accidents, review and establishment of criteria of acceptability

For new nuclear power plant project must demonstrate that severe accidents do not lead to radiological consequences outside of sanitary protection zone that require evacuation of population.

The project must provide a set of measures to implement the safety features by confining system in conditions of severe accidents:

- *implementation prevention of channeling effect of Containment due to leakage of molten mass of the core of the reactor vessel*
- *preventing the creation of explosive concentrations of gases in the localization zone rooms*
- *preventing failures of containment due to increase static pressure during severe accidents*

The project must be provided a set of measures to manage severe accidents aimed to achieving the established criteria for all possible states of reactor installation and all the potential locations of nuclear materials.
Additional safety requirements for new NPP's units design supplement the requirements of "Safety Regulations for nuclear power plants, NP 306.2.141-2008 and were formed on the basis of the provisions / requirements of the following international documents:

► WENRA Safety Reference Levels for Existing Reactors (2014)
► Safety Objectives for New Power Reactors (WENRA, 2009)
► Report on Safety of new NPP designs (WENRA, 2013)

Also, additional safety requirements for new NPP units formed on the basis of updated specific requirements of the IAEA SSR-2/1 «Safety of Nuclear Power Plants: Design Specific Safety Requirements»
Implementation of additional safety requirements for new units design

Additional technical equipment must be designed taking into account principles:

- *Diversity*;
- *Physical separation*.

The need to take account of the principle of reservation is grounded in the design.

With taking into account additional technical means should be provided implementation of the basic safety functions in case of failure of systems important to safety within a reasonable time, but not less than 72 hours.

For each NPP's unit are provided additional technical means regardless of availability of such means for other units on the NPP's site.
Implementation of additional safety requirements for new units design

On NPP's site should be provided availability and preservation during extreme impacts needed to implementation of the basic safety functions reserves of working environments, lubricants, etc. in case of destruction of external NPP infrastructure due to external impacts and the inability to access NPP site a long time (at least 14 days).

For each NPP's unit are provided additional technical means regardless of availability of such means for other units on the NPP's site.

Sharing using of additional technical means for several units at the NPP's site allowed provided justification for this decision in the project taking into account the possibility of providing safety functions for each of the units at the NPP's site in full.

For mobile additional technical means should be provided the storage that provide their safety and efficiency, as well as delivery vehicles to and from workplaces, taking into account possible damage to access roads due to external impacts.
THANK YOU FOR ATTENTION!