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ЭЛЕКТРОЭНЕРГЕТИЧЕСКИЙ ДИВИЗИОН РОСАТОМА

Activities on Enhancing Preparedness to BDBA and Severe Accident Management

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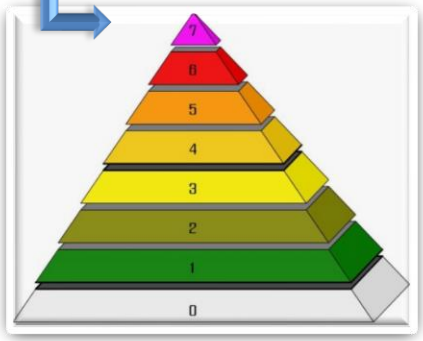
Revisiting safety problems

Events at Fukushima NPP in Japan

Level 7 as per INES scale



Effects of extreme external natural events and their combinations

Insufficient efficiency of measures taken for exclusion of severe accidents

New momentum for NPPs safety review at global level

Lessons learned from the Fukushima accident

The events at Fukushima NPP demonstrate to the global nuclear industry that:

- There is a need to perform a supplementary assessment of external impacts.

- It is appropriate to have mobile equipment available as a backup to standard safety systems.

- Insufficient personnel preparedness to manage beyond-design-basis accidents (BDBAs) leads to essential loss of time during first hours since accident onset.

Analysis of Russian NPPs protection in emergency conditions

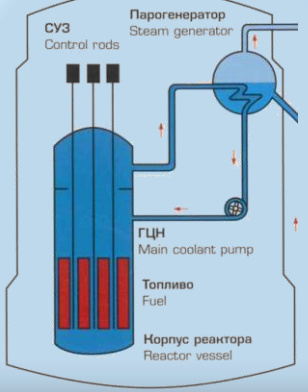
Failure to perform safety functions of regular systems

Supplementary failures of equipment

Unsuccessful emergency response

Reliability

DEFENSE IN DEPTH



Previously accumulated deterministic experience of assessment of consequences of beyond design basis accidents

Supplementary measures for beyond design basis accident management

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Analysis of BDBA progression scenarios

Flooding → Earthquake → Man-made impacts → Fire → **Long-term loss of power**

Management measures	Standard means
Electric energy supply	Standby auxiliary transformers Standby diesel generators Electrical batteries
Heat removal from the reactor core	Standard heat removal systems Water and boric acid solution inventories Fire trucks
Containment integrity	Passive hydrogen recombiners Partial release of containment atmosphere through ventilation systems in emergency

	Possible consequences
VVER	Total fuel meltdown with radioactive substances release to the environment
RBMK	
BN-600	For these scenarios, any accident does not escalate to a severe one
EGP	
SNF storage pool	Total boilout of water with partial fuel meltdown

Supplementary means
Standalone mobile diesel generators
Mobile diesel pumps Motor pumps Emergency inventories of water and boric acid
Means for accident management and control

Measures for enhancing preparedness to manage accidents

- Implementation of additional emergency equipment at NPPs for ensuring water and power supply in an emergency;
- Improvement of reliability of confining systems;
- Improvement of explosion safety;
- Provision of emergency I&C means for NPP units, which are designed for operation under BDBA conditions;
- Introduction of accident and post-accident sampling;
- Analysis of feasibility and appropriateness of implementation of the external RPV cooling;
- Enhancement of MCR and ECR protection;
- Safety equipment qualification for harsh environment conditions;
- Enhancement of emergency response communication system;
- Development and implementation of Severe Accident Management Guidelines;
- Improvement of personnel qualification and preparedness.

Implementation of activities aimed at mitigation consequences of BDBAs at NPPs

Proposals regarding revision of the approaches to Russian nuclear plants safety ensuring

2011 - 2012

Mobile emergency equipment delivery.
BDBA analysis.
Development of supplementary design solutions

2013 - 2014

Component parts procurement.
Implementation of seismic protection systems.
Development of solutions regarding equipping nuclear units with the emergency I&C means.
Design documentation drafting for the supplementary design solutions

2014 - 2016

Implementation of the planned supplementary design solutions directly at nuclear power units.

Emergency equipment delivery to NPPs

In 2012, the following equipment items have been delivered to 10 Russian nuclear plants :

29 Mobile diesel generators 2.0 MW (6 kV; 0.4 kV; 220 V DC)

37 Mobile diesel generators 0.2 MW (0.4 kV)

36 Mobile HP pump sets of various capacities and head pressures

80 Motor pumps of various capacities and head pressures

In Total : 182 items

Ensuring readiness of the supplementary emergency equipment

Mobile equipment preparation activities

- Tests of the mobile equipment delivered to NPPs have been performed.
- Operational documentation has been drafted.

Ensuring necessary conditions for use of the mobile equipment

- Temporary schemes for BDBA management purposes have been developed. Implementation of design connection schemes.
- Grounds for storage and use of the equipment for BDBA management have been prepared. Personnel have been trained on how to use the equipment

Readiness of the mobile equipment for BDBA management

- The supplementary emergency equipment items are deployed using special-purpose machinery (time for deployment and connection is 1.5 to 3 h).
- Performance of maintenance, periodical checks and tests with water supply, as per the tecspecs.

Electric power supply ensuring measures as part of BDBA management

Designing and introduction of supplementary circuits for electric power supply from mobile diesel generators (N = 2.0 and 0.2 MW) to relevant loads:

Prompt individual power supply to some pumping equipment and valves (necessary for water supply to the reactor, at-reactor SF storage pools, centralized plant SF storage pools and plant dry storage facility); to MCR, ECR; to control & protection systems KSKUZ, USB-T and others; to the emergency I&C; and emergency lighting.

Improvement of electric power supply reliability:

Installation of additional power lines from external sources (power grids); Replacement of batteries (at Balakovo, Kalinin and Novovoronezh NPPs); supplementary power supply to control circuits of PORV SG and PORV of the pressurizer; transfer of a part of the valves YR,YT to the first category of power supply.

Heat removal ensuring measures as part of BDBA management

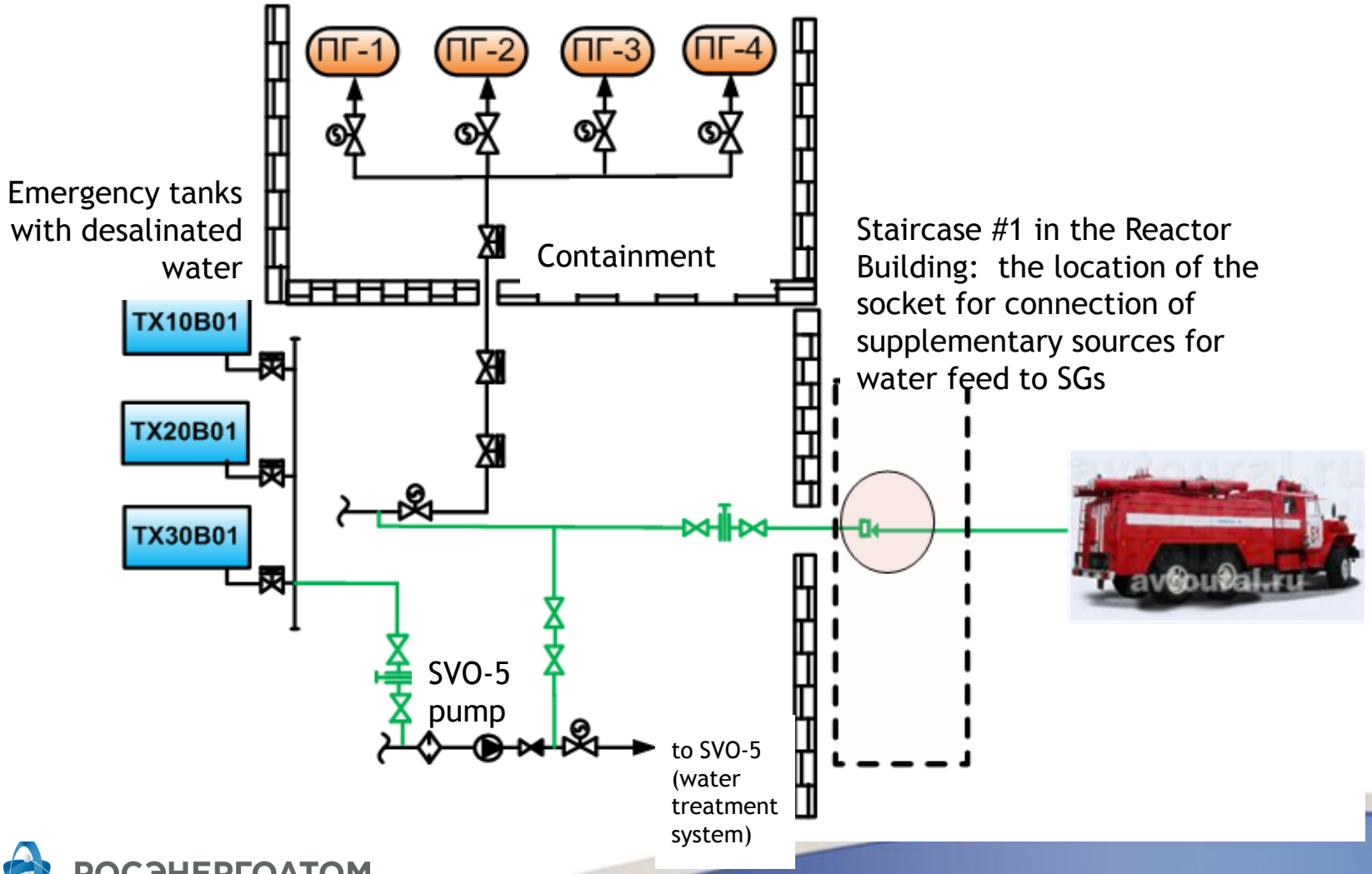
Designing and introduction of supplementary circuits for water supply to SGs and for boric acid solution supply to the reactor, at-reactor SF storage pools, centralized plant SF storage pools, using:

Mobile diesel pumps and motor pumps; fire tank trucks;
standard fire-extinguishing systems; natural and additionally created backup water sources.

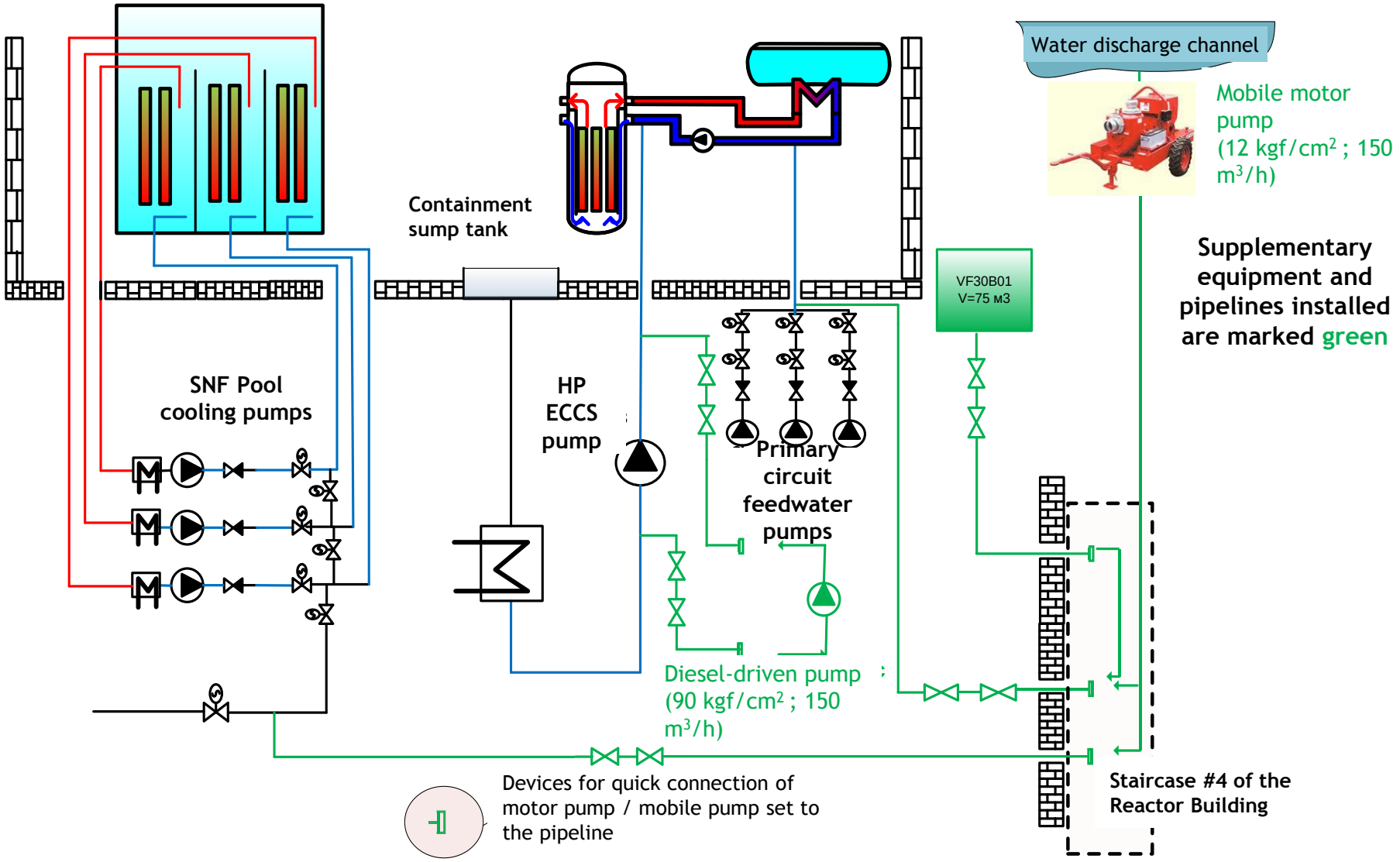
Implementation of a system for wall liner cooling in the centralized plant SF storage pools

Scheme for water supply to VVER-1000 SGs from fire trucks

The backup system for water supply to SGs using fire trucks, motor pumps

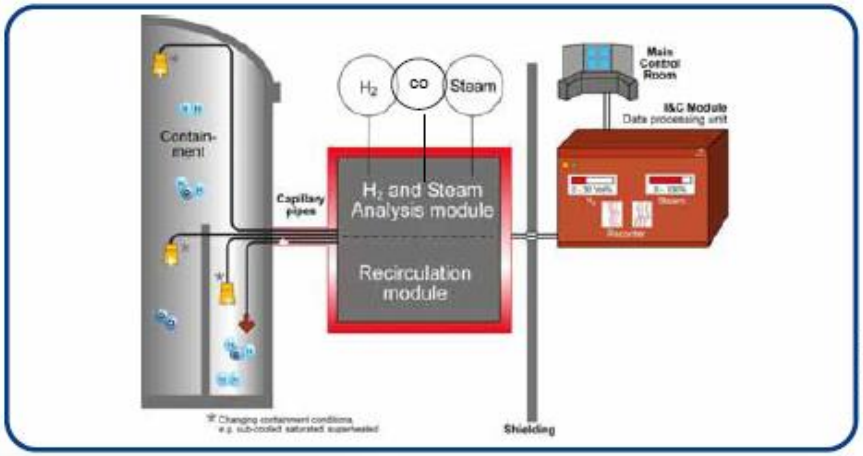


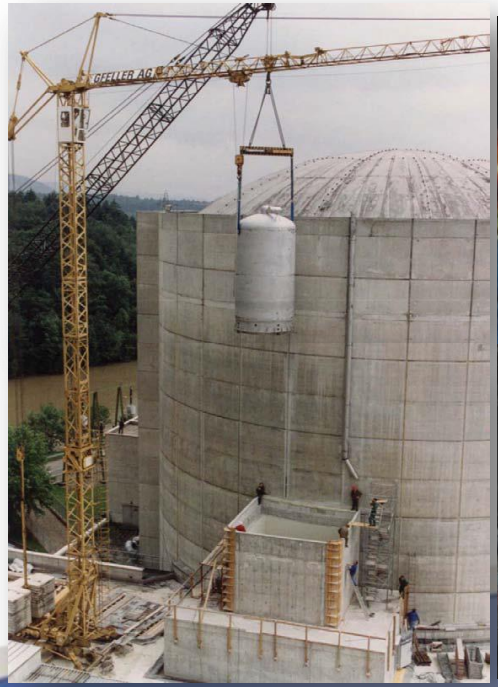
Scheme for heat removal from the reactor unit and SF pool for VVERs using the mobile means

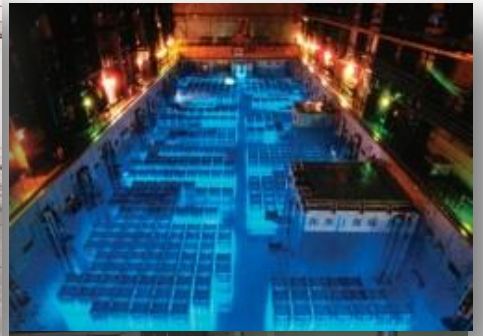


Explosion safety measures

- Hydrogen concentration control system has been implemented at 12 of 17 VVER units;
- 12 of 17 VVER units have been equipped with passive catalytic hydrogen recombiners;
- Implementation of a system for emergency pressure relieve and filtered gases release from the containment is under way at NPPs with VVERs.







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Activities aimed at drafting and improvement of emergency documentation

- The emergency documentation has been analyzed with a focus on completeness and adequacy of the actions specified
- Adjustment of the emergency procedures as result of the analysis and in course of implementation of the supplementary design solutions;
- (2012) Action charts for operators' actions in case of severe BDBAs have been drafted and put in force.
- Generic Severe Accident Management Guidelines (SAMG) for NPPs with VVER-1000 reactors have been drafted and put in force.
- Schedule has been drafted for SAMG development for each power unit in operation (SAMG is introduced at Balakovo Unit 4 in 2012, for other power units it is scheduled for 2014-2015).
- It is planned (for 2015) to develop generic SAMGs (and on this basis, SAMGs specific for each power unit) for shutdown mode and for SF pool.

Activities aimed at improvement of personnel preparedness to accident management

- Operators' aid system (the Safety Parameters Display System - SPDS) has been implemented at all nuclear power units ;
- Personnel is being trained on how to perform accident management actions using simulators;
- Number of regular emergency drills at NPPs concerning personnel actions under BDBA conditions has been increased twice.

Activities aimed at improvement of personnel preparedness to accident management (cont'd)

- Plant FSSs are being equipped with a module for severe accident simulations;
- Emergency drill scenarios have been updated by inclusion of scenarios of a severe BDBA affecting the whole plant, with simultaneous use of all available mobile emergency equipment units;
- Annually, Rosenergoatom conducts, at one of its NPPs, an integrated emergency exercise involving the use of all mobile emergency equipment units available at the NPP.

Emergency exercises and drills





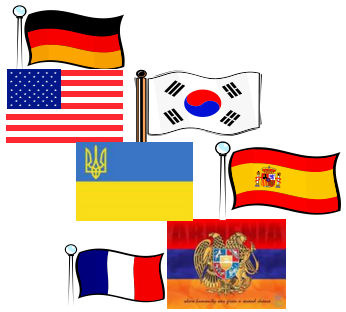

Emergency exercises and drills involving the OPAS (group for provision support to NPP in an emergency) are used in order to train :

- ✓Actions in response to events similar to that at Fukushima NPP;
- ✓The use of emergency equipment at NPPs;
- ✓Actions in case of loss of communication channels between the Crisis Center and NPP.

2013 Integrated Emergency Exercise at Kalinin NPP

In course of the IEE:

- "Provisions for Regional Crisis Center" and "Regulation on Information Exchange" have been exercised;
- All the purchased mobile equipment units have been tested;
- 15 international observers have taken part.



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Conclusion

- Measures for enhancement of NPP resistance to extreme external impacts and for increasing preparedness to accident management ensure 5 to10-day duration of isolated operation of Russian NPPs in case of a beyond-design-basis or severe accident
- Qualification and preparedness of personnel to accident management actions is maintained

Thank you for your attention !