РОСЭНЕРГОАТОМ
ЭЛЕКТРОЭНЕРГЕТИЧЕСКИЙ ДИВИЗИОН РОСАТОМА

Realization of measures on safety enhancement at Russian NPPs on the basis of stress-tests results

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March 11, 2011
Fukushima NPP
Japan

NPP robustness analysis organization

Rosenergoatom Concern OJSC

- General Designer
- General Architect
- Scientific Supervisor

from 21.03.2011 to 26.05.2011

The safety status analysis was conducted taking into consideration all possible extreme impacts

BalNPP, BelNPP, BilNPP, KlnNPP, KolNPP, KurNPP, LenNPP, NvorNPP, RstNPP, SmolNPP

Supplementary actions for NPP safety enhancement

“Reports on conducting NPP safety assessment under extreme external impacts”

15.08.2011

November, 2011 – The Reports were submitted to Rostechnadzor

Lessons learned from the Fukushima NPP Accident

LESSONS

1. The aim of the NPP and Operating Utility personnel and management should be the performing of **immediate** actions for preventing and mitigating the consequences of severe accidents

2. **At each power unit,** there should be a reserve of **technical means** infallible in case of natural disasters to ensure power and water supply for the reactor and spent fuel cooling

3. A key criterion of success should be **the restoration of power and water supply** for the nuclear fuel cooling **in the first hours** after the blackout occurrence

4. The OU, executive power bodies, international organizations, and public should be **informed** on the event at the NPP in a well-timed manner.

   External assistance from the Government and International community should be provided.

Results of NPP Inspections and Stress-Test Completion

Detailed measures at every NPP, ToR and Contracts

Preparation of design documentation

Corporate arrangements to mitigate consequences of BDBA at nuclear power plants

Emergency equipment delivery to NPPs

Implementation o measures at NPPs

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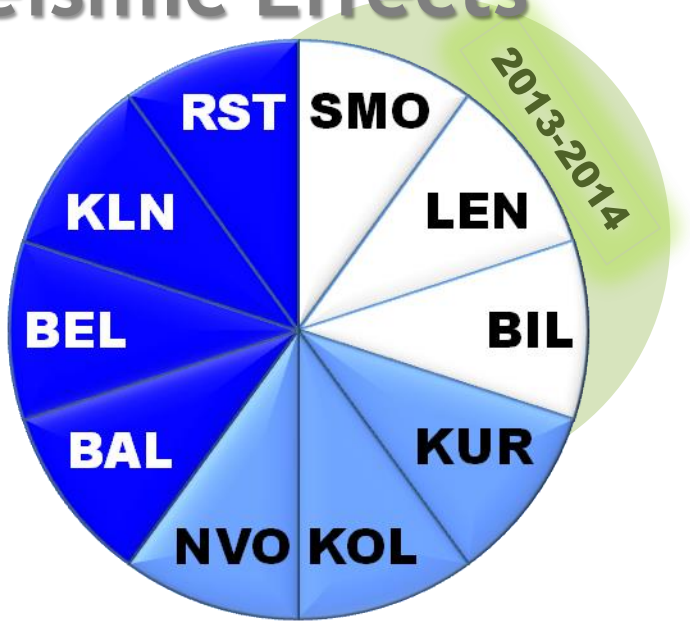
Seismic Effects

- Introduction of seismic protection systems at NPPs



- brought into operation
- brought into pilot operation
- missing

1. •Activities on seismic microzoning for every NPP site to be completed in 2013

2. •Performing calculations using conservative approaches

3. •Implementation, when necessary, of measures for the equipment and piping fixation

FLOODINGS

The sites of all Russian NPPs are not subject to tsunami effects. Extreme water levels in water bodies, extreme weather conditions, non-standard situations at hydraulic engineering structures, as well as combinations of the above factors are not able to induce flooding that could have an impact to safety relevant systems and elements

NVONPP

in case of breaking Matyra and Voronezh water reservoirs' dams and taking into account the maximum possible flooding at the Don River, the water level can reach the value 2.0 m higher than the emergency dike of Power Units 1 to 4, which will cause the flooding of Unit 3,4 Pumping Station for 0.5 m

→ increase the height of the protective hydraulic structure for the protection of Unit 3,4 Pumping Station

→ implement the project of water pumping-out from lower levels of NPP buildings with the aid of engine-driven pump

BALNPP

in case of breaking the dam of Kuybyshev water reservoir at the Volga River and taking into account the maximum possible flooding, the level margin is 0.65 m

→ implement the project of water pumping-out from lower levels of NPP buildings with the aid of engine-driven pump

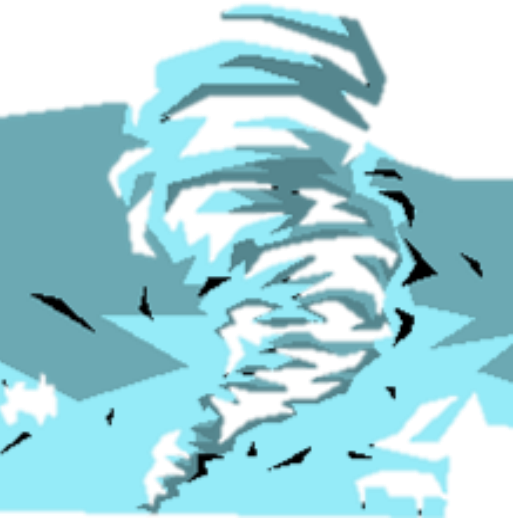
LENNPP

in case of a storm surge, the water level in the Gulf of Finland may reach up to + 4.3 m higher than the rated level

→ during the modernization, supplementary systems of heat removal to the ultimate heat sink were installed, with the use of special equipment functioning under flooding conditions

→ the NPP equipping with mobile emergency means for reactor residual heat removal

AT OTHER RUSSIAN NPPs FLOODINGS ARE IMPOSSIBLE



TORNADOS

For all the 10 NPPs, the examination and calculation of structural units of buildings and facilities is required and, if necessary, their strengthening in the scopes indicated in the reports on stress-test conducting

BALNPP RSTNPP

the loss of ultimate heat sink is possible – water carry-over from spray cooling ponds of the service water system and ponds' pipeline damage

→ **introduce the spray cooling pond emergency make-up systems**

→ **introduce the reactor and spent fuel storage pond cooling, with the water delivery from mobile high-pressure pumping stations, engine-driven pumps, and fire engines**

KURNPP SMONPP

the tornado probability is actual

→ **strengthening structural units at Kursk NPP Power Units 3,4 and Smolensk NPP Power Units 2,3 is required**

Arrangements on safety enhancement of the Russian NPPS in case of extreme external impacts

Provision of power supply

Development and introduction of additional electric power supply schemes from mobile diesel-generators (N = 2,0 and 0,2 MWt) for:

valves and pumps (water supply to RI, by-reactor cooling ponds, fuel ponds of SNF storage facility and standalone SNF storage facility); main control room, standby control board; complex C&PS, process safety control system and for other control systems; «emergency» I&C; emergency lighting

Power supply reliability increase

Installation of additional lines from external sources –electric grids;

increase of internal redundancy

Arrangements on safety enhancement of the Russian NPPS in case of extreme external impacts

Provision of heat removal

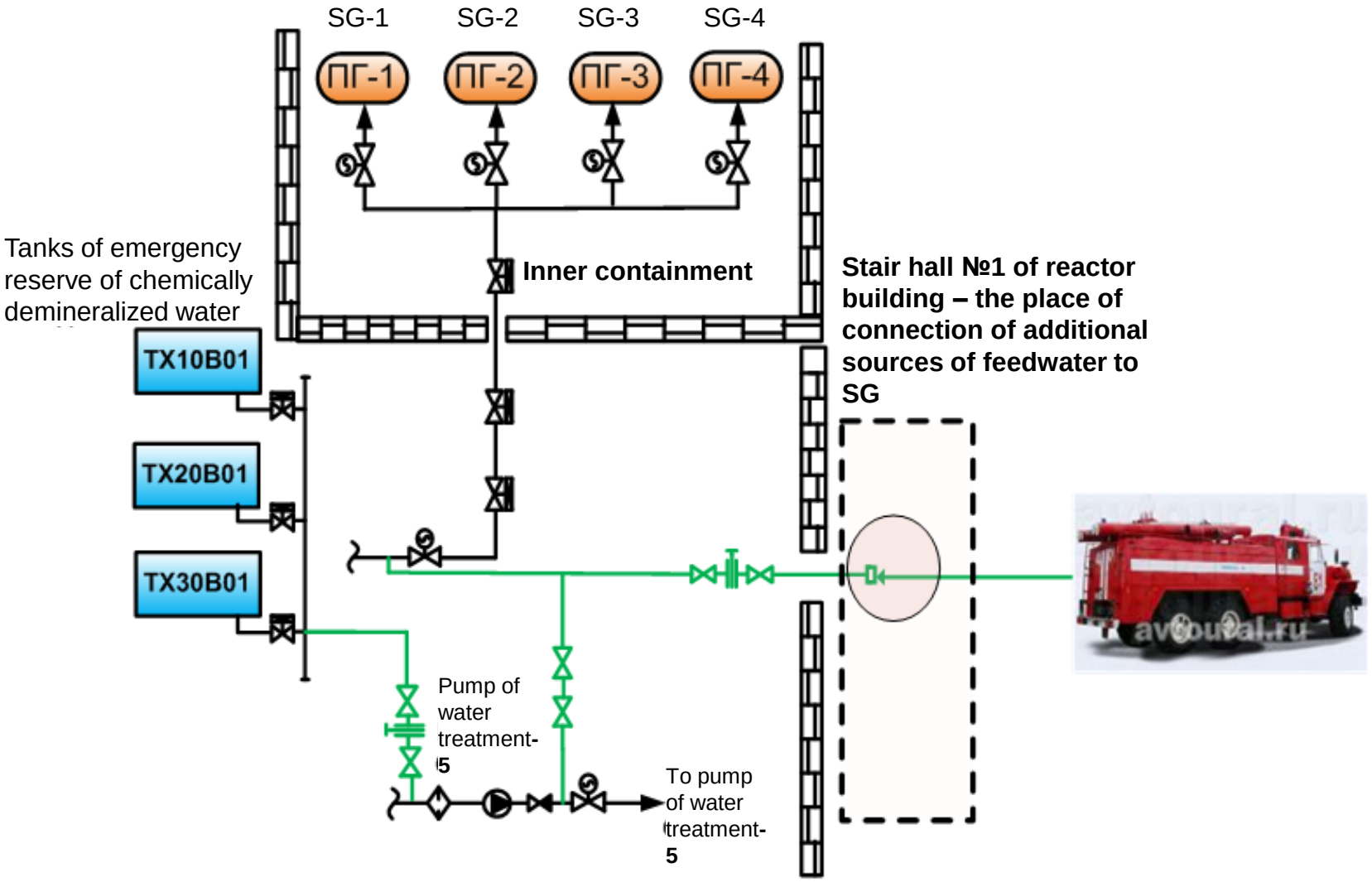
Development and introduction of extra-schemes of water supply to steam generators and boric solution to reactor, at-reactor cooling ponds and cooling ponds of SNF storage facilities with use of:

Mobile diesel pump and motor pumps; fire tank trucks; regular systems on fire -extinguishing; natural and additionally constructed reserve water sources

Introduction of system for cooling of walls metal lining of fuel ponds of SNF storage facility

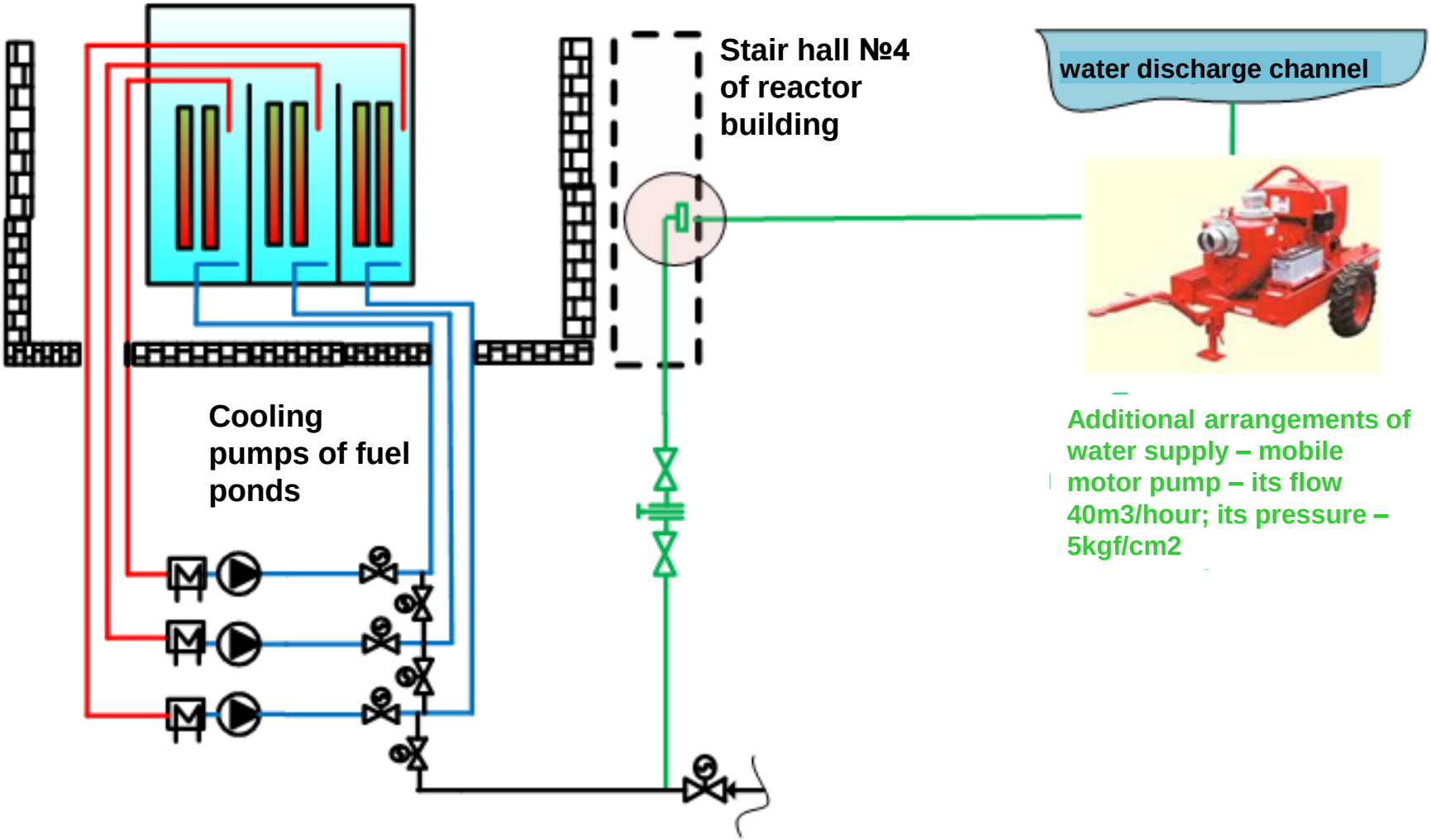
Scheme on water supply to SG for WWER-1000 from fire-engines

Standby water supply system to SG from fire engines,motor pumps

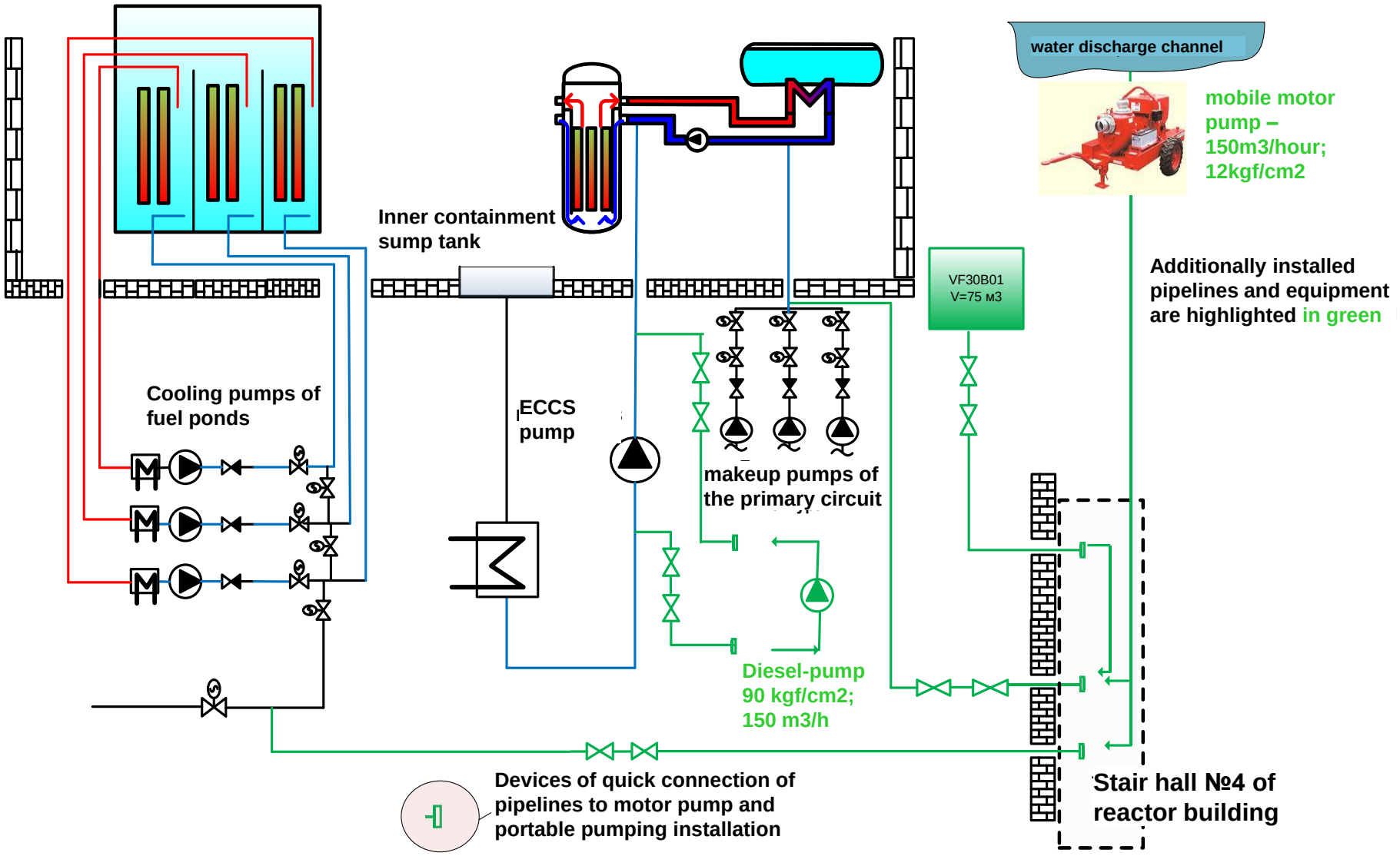


Scheme for makeup of cooling pond of WWER-1000 from motor pump

Standby system for cooling pond makeup from motor pumps



Scheme for primary circuit makeup and provision of heat removal for VVER-1000 owing to additional sources and mobile devices



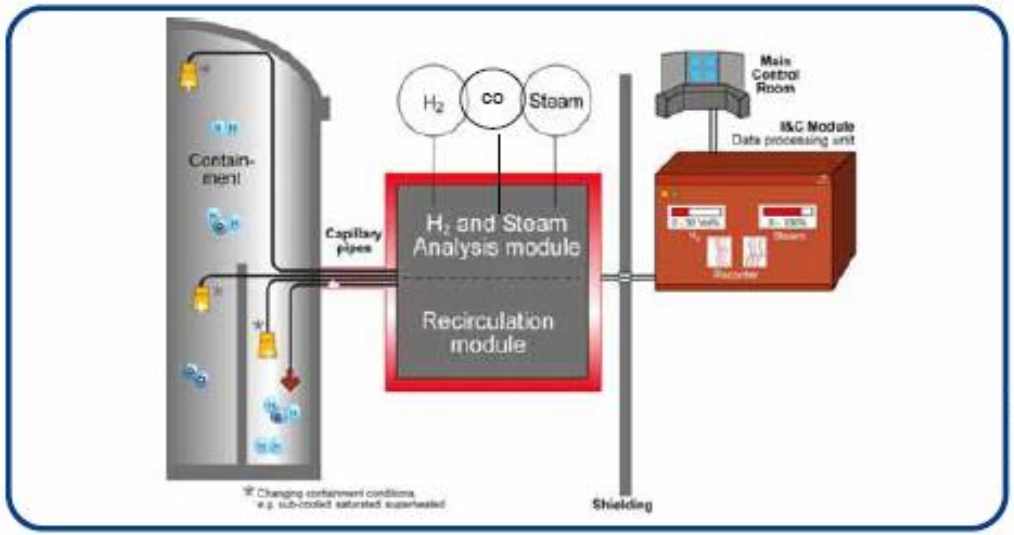
Arrangements on safety enhancement of the Russian NPPS in case of extreme external impacts

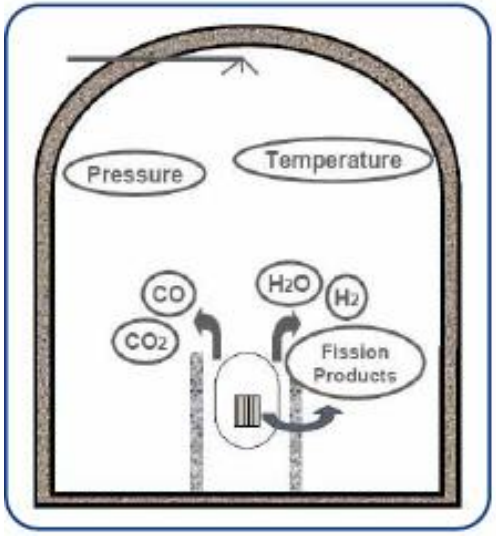
Control and operation ensuring:

- Increase of localizing systems reliability;
- Upgrading of NPP power units with «emergency» I&C, optimized for operation within BDBA conditions
- Introduction of emergency and post-accident sampling
- Increase of robustness of MCR and standby control board
- Development and put into effect of Severe Accidents Management Guidelines

Explosion safety arrangements

WWER-type power units shall be equipped with hydrogen concentration control system





WWER-type units are to be equipped by passive catalytic hydrogen recombiners

Exclusion of hydrogen explosion initiation sources in containment

Revision of the Available Emergency Documentation and Development of New Documents

- Operations personnel action charts have been developed at all NPPs
- Revision of the existing procedures for design-basis accident management (ILA) is in progress
- Revision of the existing manuals for beyond-design-basis accident management (RUZA) is under way
- Standard guidelines for severe accident management (RUTA) for NPPs with VVER-1000 reactors have been introduced
- RUTAs based on the generic document are being developed at all Russian NPPs

Delivery of mobile emergency equipment to NPPs

In 2012, the following equipment was delivered to the 10 Russian NPPs:

29 Units

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

36 units

Mobile diesel-generators 0.2 MW (0.4 kV)

35 units

Mobile high-pressure pumping units of various capacity and head

80 units

Engine-driven pumps of various capacity and head

TOTAL: 180 units

Delivery of emergency technical means to NPPs

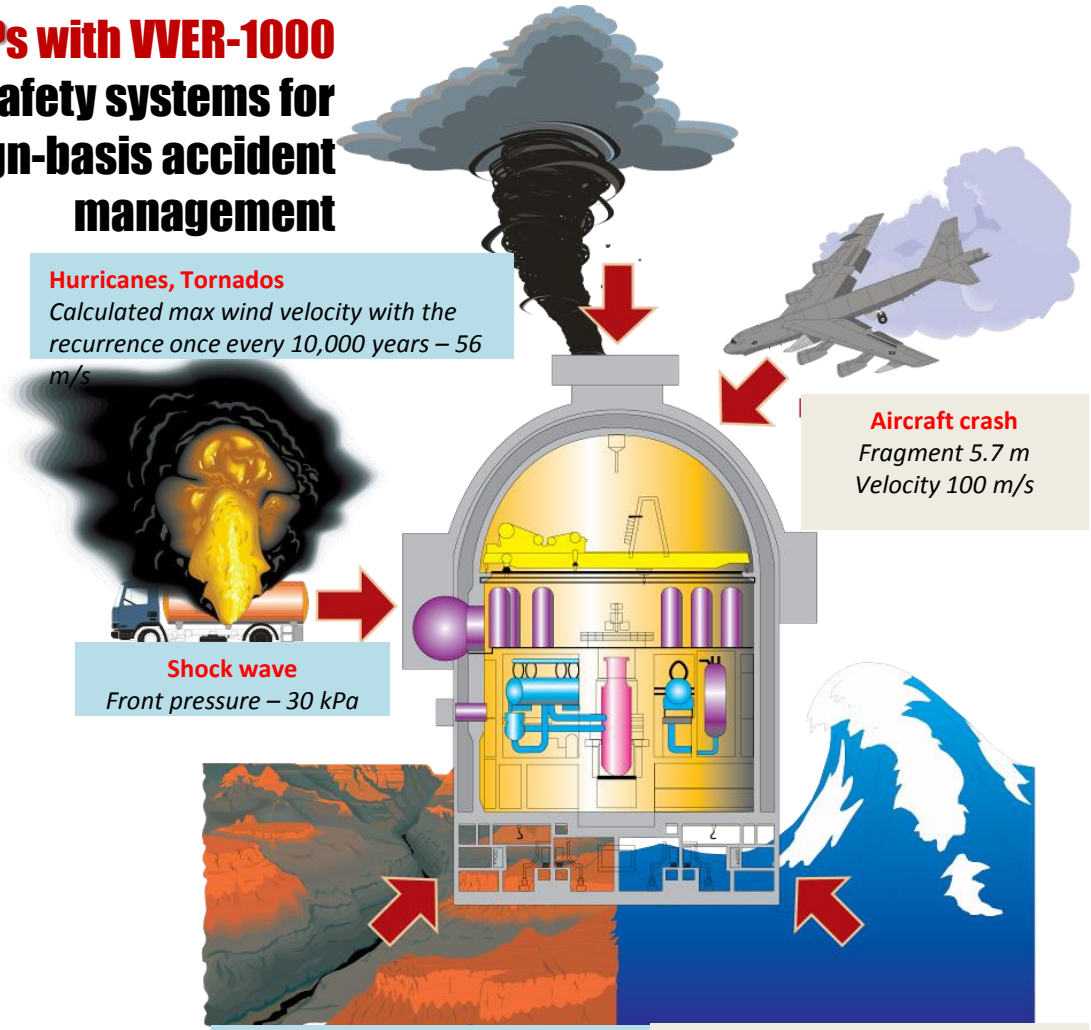
Measures aimed at improvement of emergency interaction system

- Modernization of communication infrastructure of Technical Support Centers, Crisis Centre and NPP
- Equipping of all NPPs with modern digital communication system of TETRA standard
- Creation of mobile control units and communication stations at NPP
- Organization of Regional Crisis Centre of WANO (Moscow Regional Centre)

Necessary Safety Level Provision, Considering External Impacts for Power Units of New Generation NPPs

NPPs with VVER-1000

Use of safety systems for design-basis accident management



Hurricanes, Tornados
Calculated max wind velocity with the recurrence once every 10,000 years – 56 m/s

Aircraft crash
Fragment 5.7 m
Velocity 100 m/s

Shock wave
Front pressure – 30 kPa

Seismic impacts
MCE 8 points by MCK-64

Floods
With the recurrence level of more than 0.01%

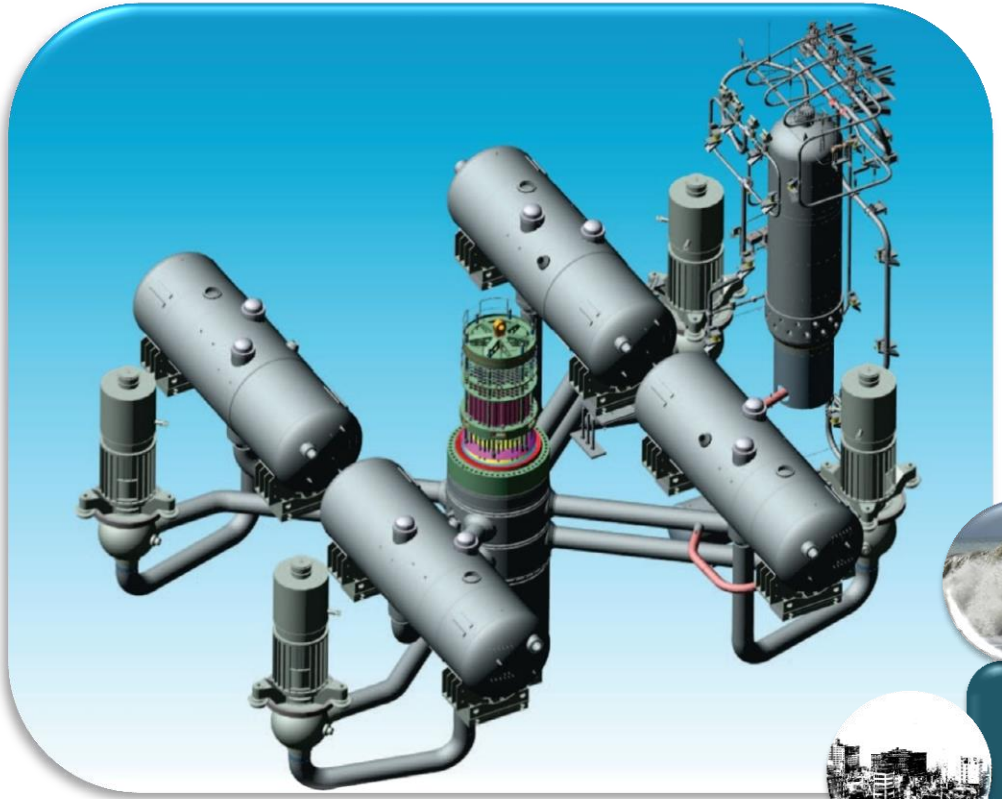
AES-2006 (VVER-1200)

Use of passive means in safety systems - air PHRS .

Use of the beyond-the-design-basis accident management means – second containment, corium trap

Protection from external impacts

VVER-TOI NPPs



AIRCRAFT CRASH BASIC VERSION: 20.0 tons with the speed of 200 m/s
OPTION: 400.0 tons

LONG-TERM LOSS 0F POWER AND WATER SUPPLY

FLOODINGS, STORMS as applied to specific site conditions

SEISMIC IMPACTS BASIC VERSION: MCE - 7 points by MSK-64, DBE - 6 points
OPTION: MCE - 9 points BY MSK-64 DBE - 8 points

SHOCK WAVE with the front pressure of 30 kPa

HURRICANES, TORNADOS calculated maximum wind velocity is 56 m/s (house roofs are blown away, large trees are rooted out, railway carriages are upset, cars are blown off from the roads)

CONCLUSION

Supplementary design solutions planned to be introduced will enhance safety, “durability” and autonomy of the Russian NPPs to 5÷10 days in case of a beyond-design-basis or severe accident

Technical solutions in the modern Russian designs aimed at the safety enhancement comply with the post-Fukushima requirements and are based on relevant references

THANK YOU FOR ATTENTION!