Summary of JSC "Concern Rosenergoatom" NPPs performance in Post-Fukushima period. Establishment of Regional Crisis Center on the basis of JSC "Concern Rosenergoatom" Crisis Center

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Impact of accidents on the concept of nuclear safety ensuring

Accident in Three Mile Island, USA, March 1979

- **Reactor core destruction**
- **Partial meltdown of fuel**
- **Radioactive substances are mainly inside**
- **Leak of radioactive water to NPP site**

Chernobyl accident, USSR, April 1986

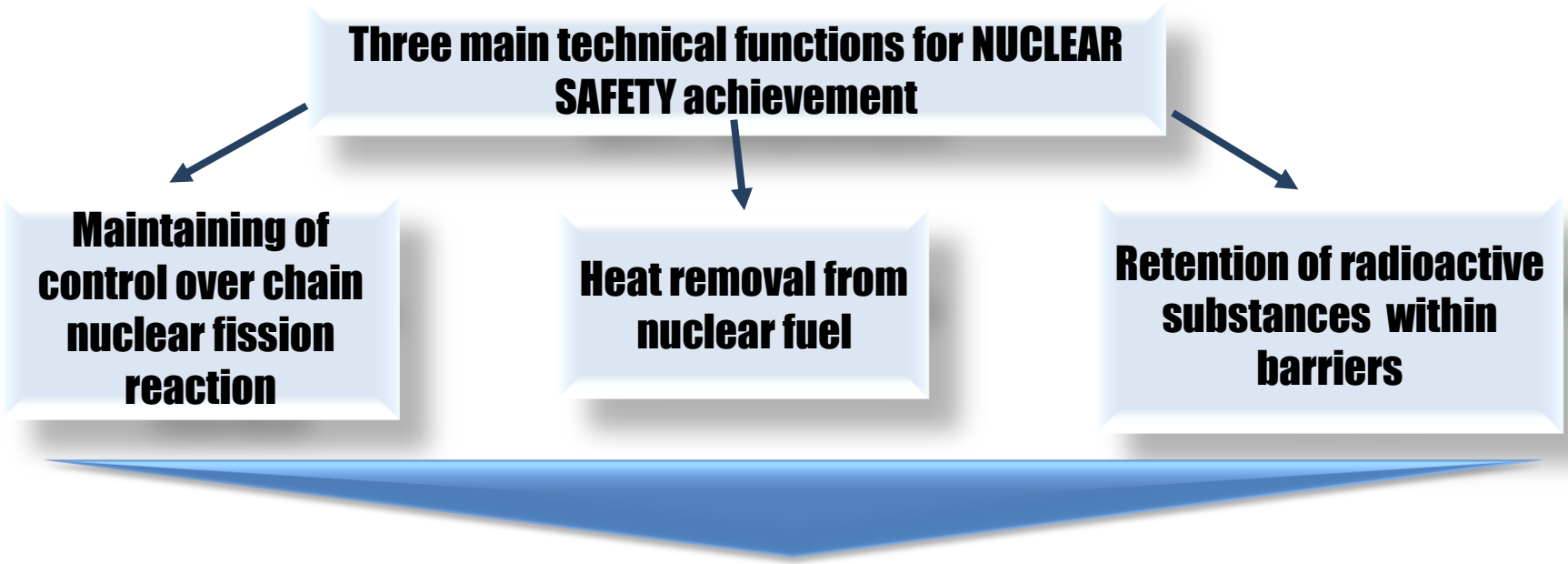
- **Severe destruction of reactor core**
- **Meltdown of fuel**
- **Contamination of large areas with radioactive substances**
- **Long-term negative impact on people health**
- **Psychological impact on society**

Nuclear community response

1. Revision of human factor role
2. PSA introduction
3. Safety systems improvement
4. Emergency planning enhancement

1. Change of approach to regulation of nuclear safety and NPP designing
2. Establishment of international nuclear safety regime (Convention on Nuclear Safety)
3. Development of new principles of safety
4. Introduction of safety culture concept
5. Implementation of new level of protection: Accident Management

GOAL: prevention of hazardous radiation exposure to individuals and the environment in case of an accident



Two main principles of implementation of the functions

Principle of accident prevention

Principle of accident mitigation

Chernobyl lessons learned

- **Safety has become a main priority in activities of the Operating Organization:**
  - **High priority measures aimed at safety improvement were realized in all reactor plants similar to the Chernobyl facility as well as VVER reactors**
  - **Analysis of NPP designs was performed with participation of international experts, safety problems were defined, programs of their solving were drawn up.**
- **Emergency response system has been established.**

Revisiting the safety issues

Events at Fukushima NPP in Japan

Level 7 according to INES scale

Extreme natural impacts and their combination

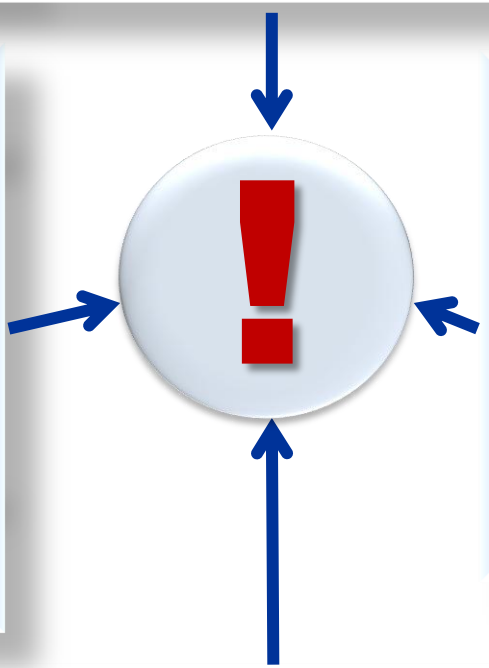
Insufficient efficiency of the measures taken for exclusion of severe accidents

New momentum for NPPs safety review on the global level

Conclusions drawn from Fukushima accident lessons

Staff and management of NPP and Operating Organization should focus on immediate actions to prevent a severe accident and mitigate its consequences

A reserve of technical means resistant to natural disasters should be stocked at each power unit in order to provide power and water supply needed for cooling of reactor and spent nuclear fuel.



Restoration of power and water supply for nuclear fuel cooling down during first hours after station blackout is a key criterion of success

Operating organization, executive bodies, international organizations and general public should be timely informed about the event at NPP. Involvement of external support from government and international community should be ensured.

Safety improvement measures at Russian NPPs focused on resistance to extreme external impacts

Ensuring emergency power supply

- **Development and implementation of supplementary circuits for power supply from mobile diesel generators (N = 2.0 and 0.2 MW) to the following equipment:**
  - Automated process control system
  - Safety control systems
  - Safety systems equipment necessary for reactor shutdown, water feed and cooling down
  - Equipment necessary for water feed to and heat removal from storage pools and spent nuclear fuel storage facilities;
  - Protected command posts, etc.
- **Power supply reliability enhancement**
  - Installation of additional transmission lines from existing power systems;
  - Improvement of internal redundancy by means of provisions for interchange between units

Mobile diesel generator unit (PDGU)

PDGU
2.0 MW

Control module

Heat removal under accident conditions

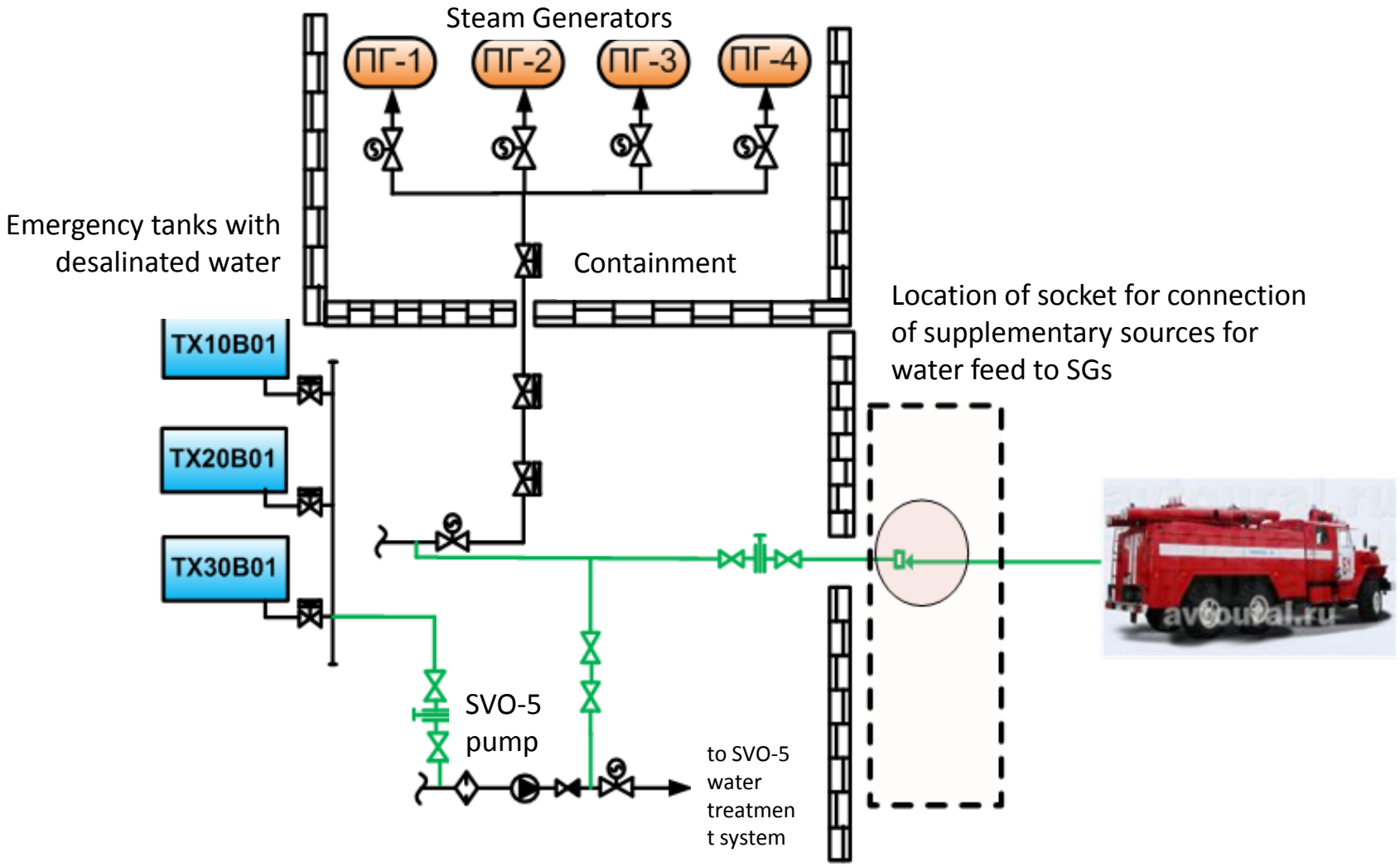
- Development and implementation of additional water supply lines to the reactor, steam generators, at-reactor SNF pools and pools of SNF storage facilities, using:
  - Regular borated water reserves;
  - Natural and artificially created reserve water sources;
  - Mobile HP diesel pumps;
  - LP motor pumps;
  - Fire-fighting trucks with water tanks;
  - Regular water fire extinguishing systems.

- Implementation of system for cooling of SNF pool wall metal cladding .

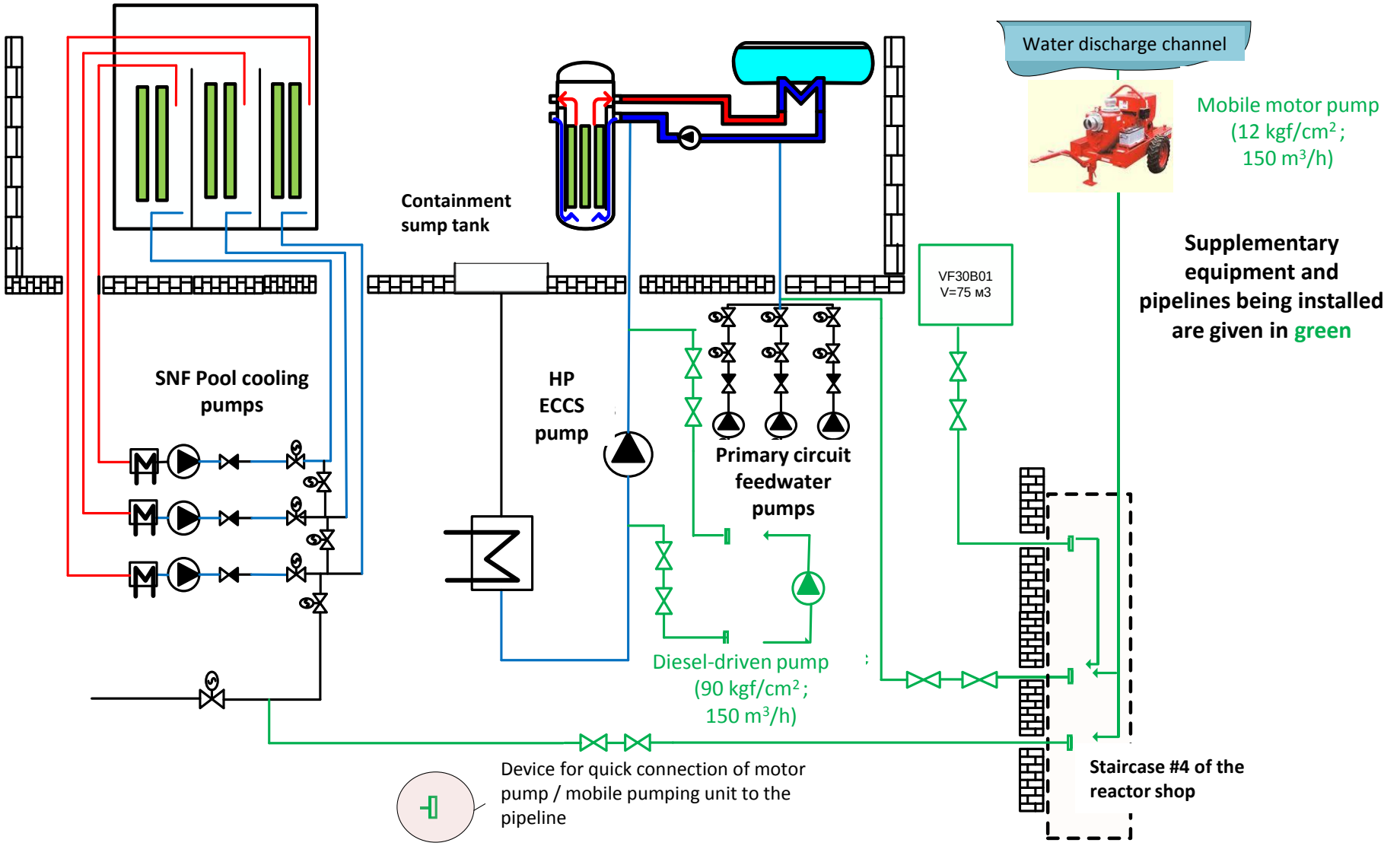
Mobile pump plant (PNU)

Scheme of water supply to SGs of VVER-1000 from fire fighting vehicles

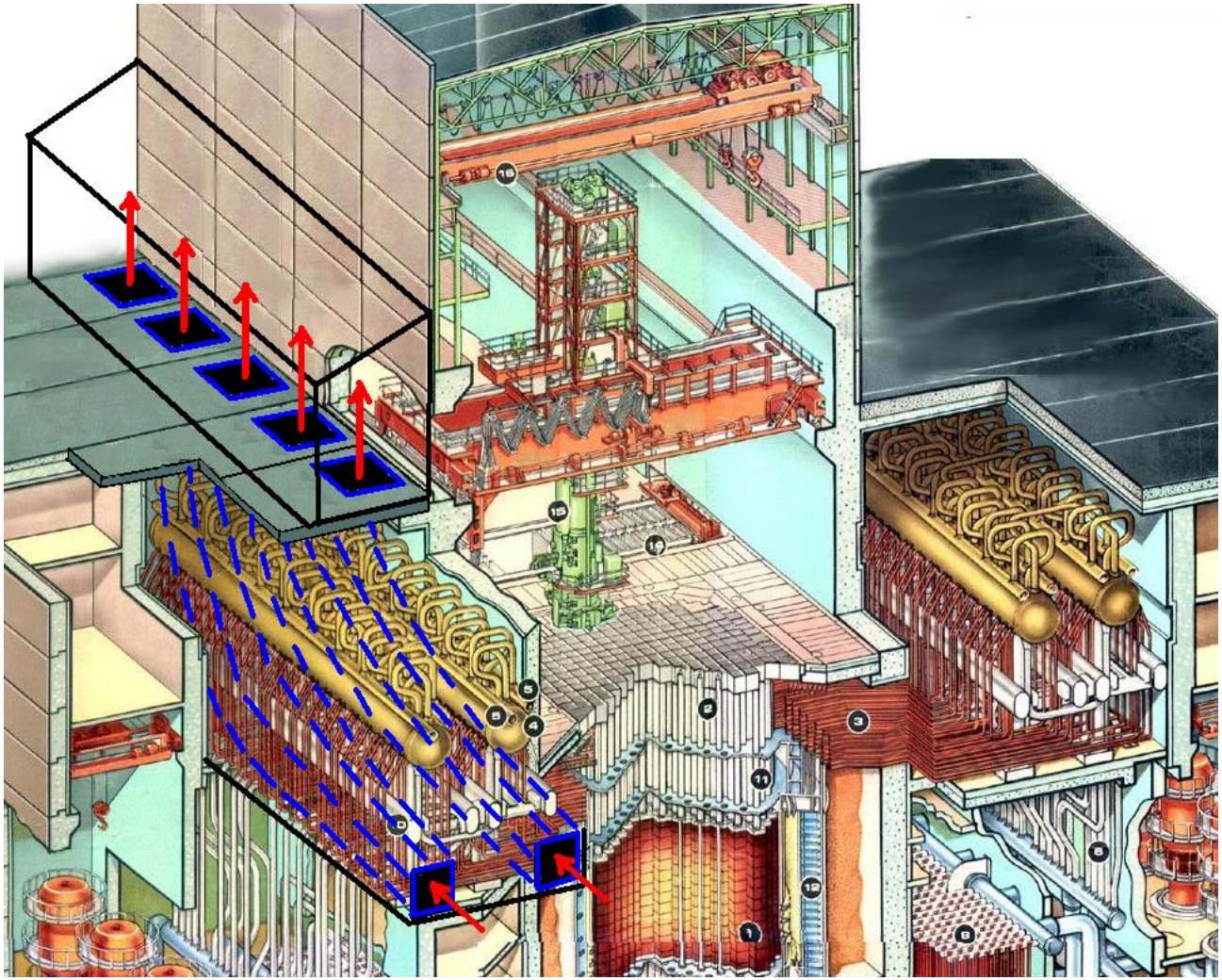
Backup system for water supply to SGs from fire fighting vehicles, motor pumps



Scheme of primary circuit makeup and heat removal provisions for VVER-1000 using supplementary sources and mobile means



Air cooling of RBMK



Passive system principle.

Natural air circulation.

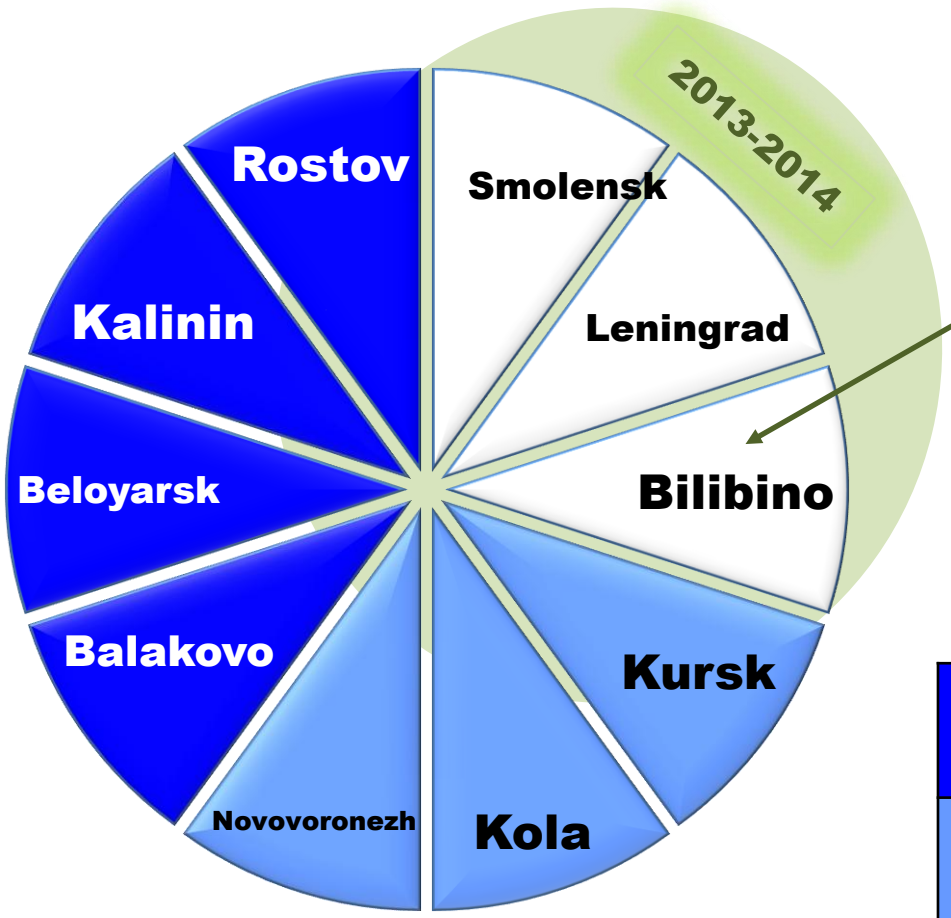
Input: via Steam Drum premises.
Output: via system of blowout panels on the roof of main building.

Safety improvement measures at Russian NPPs focused on resistance to extreme external impacts

Seismic safety improvement

- Introduction of seismic protection system of reactor unit (reactor trip in case of earthquake);
- Refinement of seismic micro zoning data for NPP sites;
- Performing of qualified analysis of data specified in the design for seismic loads onto reactor unit, storage pool, SNF storage facility pools, safety systems and systems important for safety;
- Implementation of measures to improve seismic resistance of equipment and plant building structures (detachment, reinforcement, etc.).

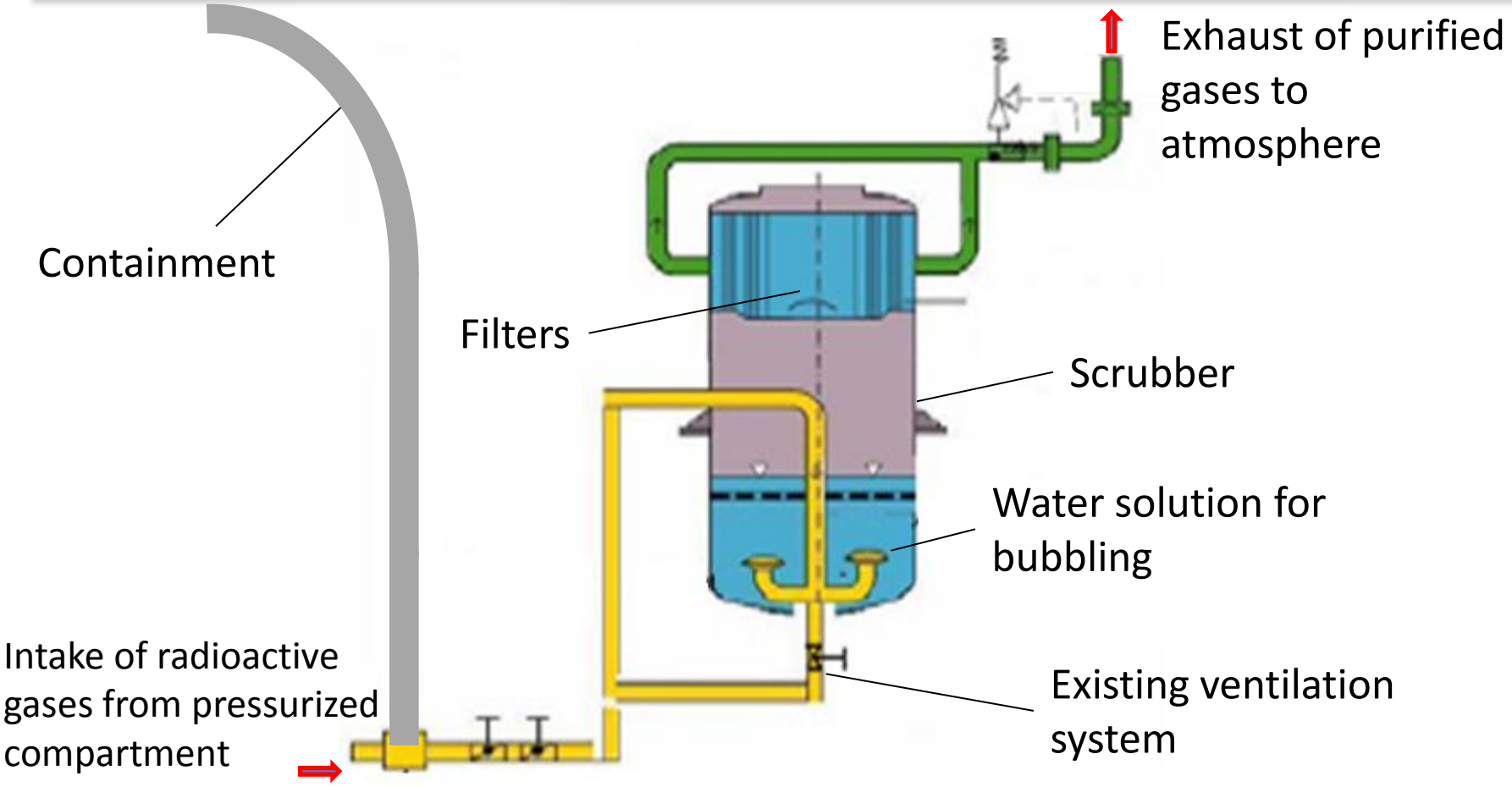
Implementation of seismic protection (SP) systems at NPPs



Recorder of seismic signals is installed

- SP is put into operation
- SP is put into trial operation
- SP is not available

Measures to prevent explosion inside reactor containments



Introduction of emergency exhaust of gases from reactor containment at VVER-1000 power units.

Introduction of a system for hydrogen control and recombination inside VVER reactor containment s

Updating of existing emergency documents and development of new ones

- Updating of existing documentation on DBA elimination (as the supplementary design solutions are implemented)
- Updating of existing BDBA management manuals (as the supplementary design solutions are implemented)
- Generic severe accidents management guidelines for VVER-1000 and RBMK NPPs have been developed and put into force;
- Development and implementation of specific severe accidents management guidelines for all Russian power units.

VVER-TOI NPP

Defense against external effects

TORNADO, HURRICANE

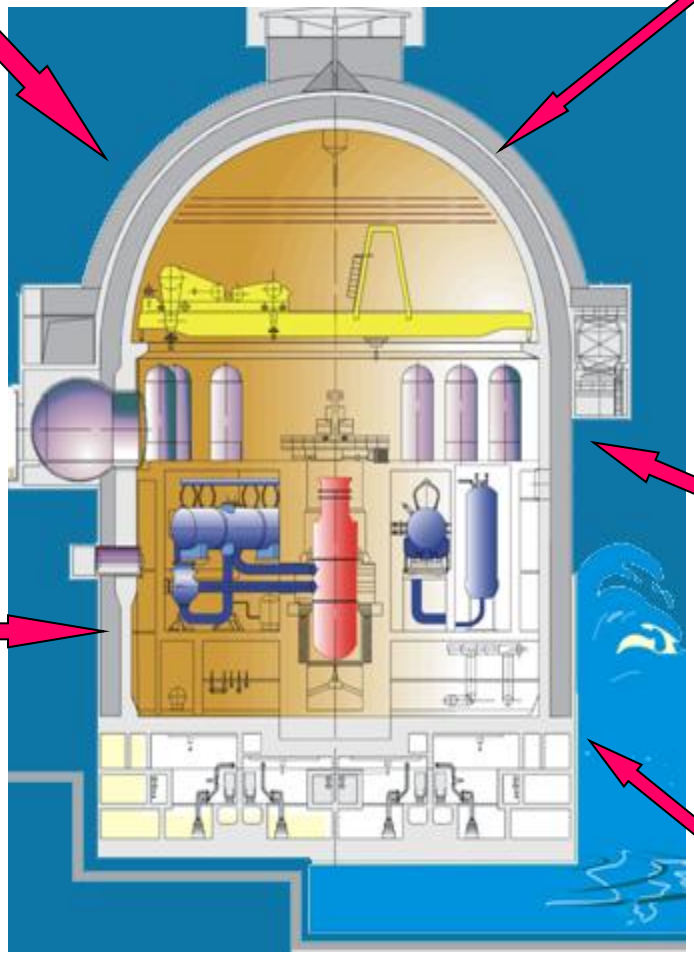
Maximum design wind velocity of 56 m/s (tearing off roofs, uprooting big trees, overthrowing railway carriages, blowing out cars off-road)

AIRCRAFT CRASH

Basic impact:
20.0 tons with 200 m/s velocity
Option: 400.0 tons

SHOCK WAVE

With frontal pressure of 30 kPa



SEISMIC IMPACTS

Basic impact:
MDE – 7 point as per MSK-64 scale
DE – 6 points
Option:
MDE – 9 point as per MSK-64 scale
DE – 8 points

FLOODS, STORMS

As applicable to specific site conditions

PROLONGED LOSS OF POWER AND WATER SUPPLY

Emergency response system for Russian nuclear power plants

NPPs

- BalNPP
- BelNPP
- BilNPP
- KlnNPP
- KolNPP
- KurNPP
- LenNPP
- NvoNPP
- RstNPP
- SmoNPP

National emergency management center of EMERCOM of Russia

SCC of Rosatom

Situational analytic center of RF Ministry of Energy

Crisis Center of REA

Protected command post of Crisis Center (ZPU KC)

Technical support centers

- VNIIAES
- EDO GP
- RDIPE
- OKBM
- NSC KI
- SSC PhEI
- AMRDC FMBA
- NPO Typhoon
- IBRAE RAS
- AEP
- NIAEP
- SPbAEP
- AER
- ATE

Information analytic center of Rostekhnadzor

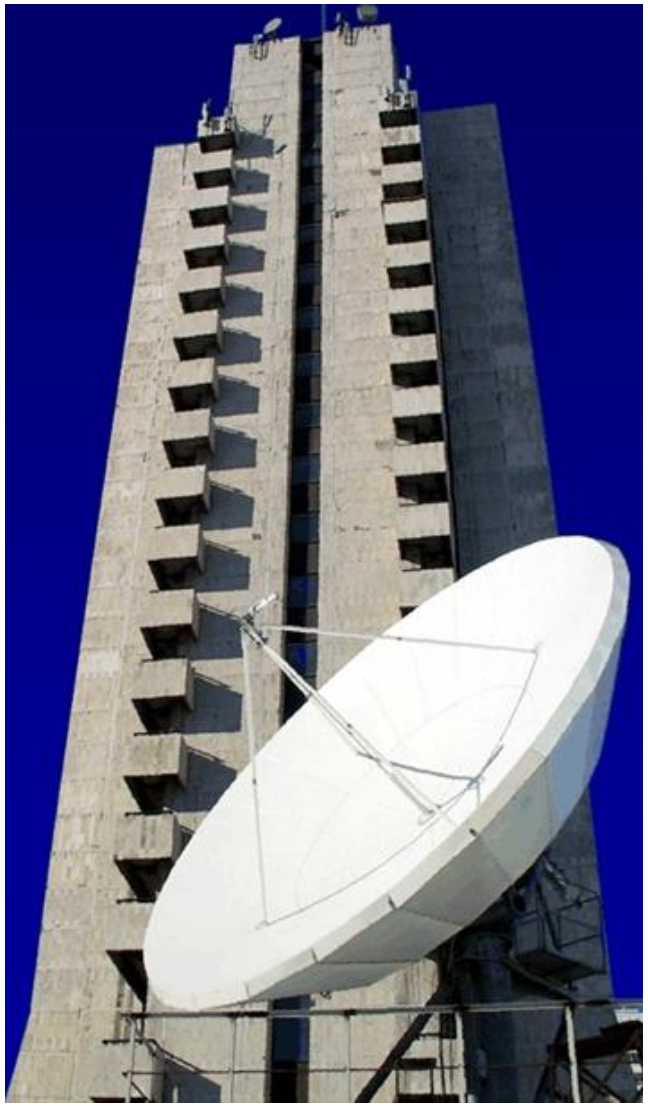
NVF ATC SPb

SO CDU UES

System of video conference communication

Data transfer system

Measures to enhance the emergency response system



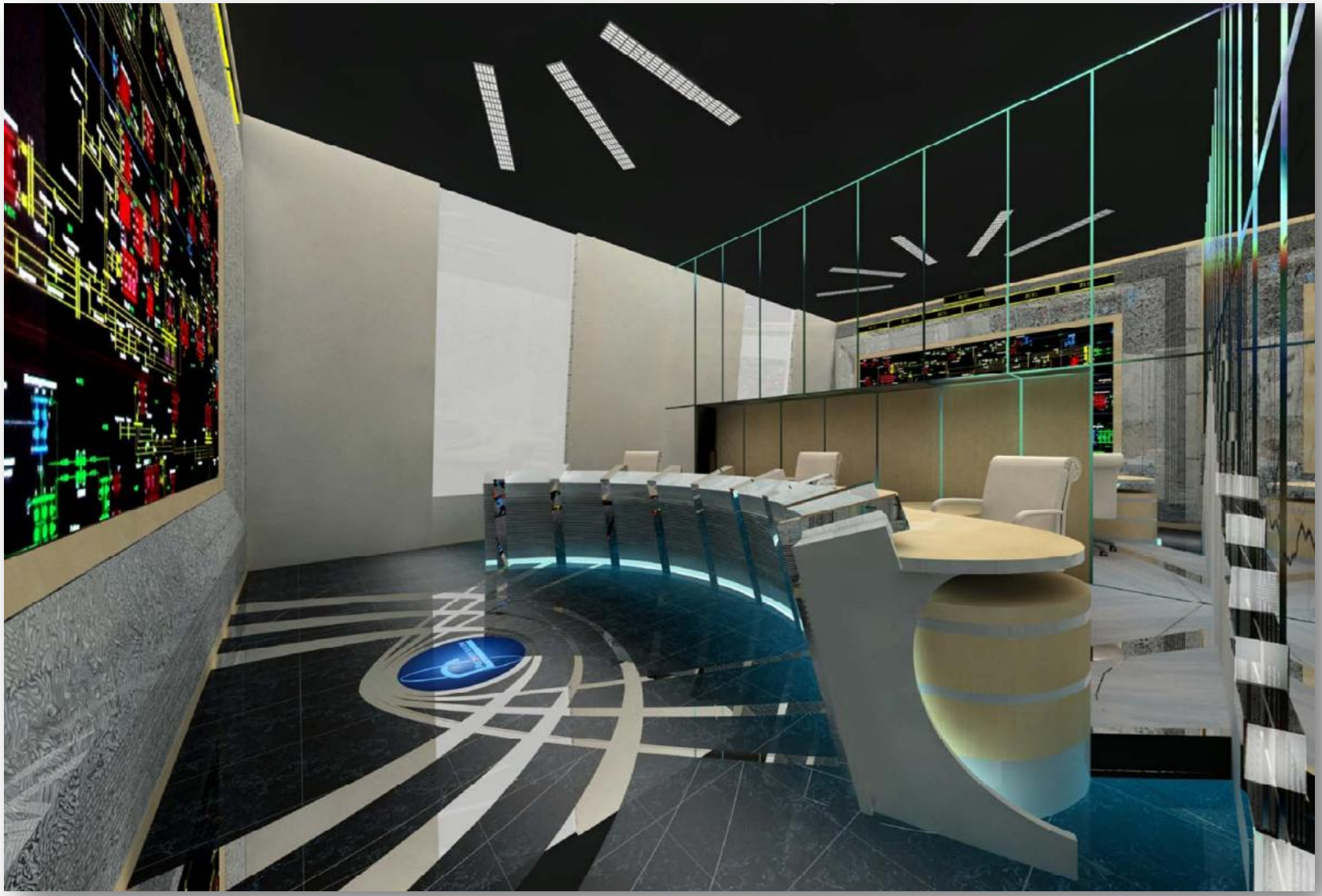
- Modernization of communication infrastructure of Technical Support Centers, Crisis Center and NPPs;
- Organization of mobile command posts and mobile communication stations at NPPs;
- Establishment of regional Crisis Center of WANO-MC

Establishment of Regional Crisis Center of WANO-MC for NPPs with VVER reactors

In April 2012, Board of Governors of WANO Moscow Center has approved establishment of Regional Crisis Center (RCC)

- **RCC shall operate on the base of JSC "Concern Rosenergoatom" system for prevention and elimination of emergencies that comprises:**
  - **Group for provision emergency support to NPPs (the OPAS group);**
  - **Crisis Center;**
  - **Technical support centers.**

Central dispatching board of Regional Crisis Center of WANO-MC



Goals and tasks of Regional Crisis Center :

- to ensure RCC permanent readiness to emergency response;
- to ensure provision of expert / advisory assistance and engineering support in an event of emergency or accident situation at a VVER power unit affiliated with WANO-MC;
- to form a single pool of information and expertise to ensure operations of the OPAS group.

RCC functions in the Routine operating mode:

- ensuring permanent availability of the software & hardware complex (SHC), data transfer channels and communication facilities;
- storage and updating of information on the VVER power units affiliated with WANO-MC;
- provision for interactions of duty & dispatch services for NPPs, operating organizations and the Crisis Center;
- organization and conduct of emergency response exercises and drills.

RCC functions in the Higher alert mode

- deployment of the SHC;
- notification of OPAS group and Technical support centers (TSCs) on the switching to the Higher alert mode;
- assembly of OPAS group members and TSC experts in case of receiving of the relevant OPAS group leader's order;
- collection and analysis of available information about the emergency at NPP;
- provision for communication of dispatcher services of the RCC participants.

RCC functions in the Emergency mode

- assembly of OPAS group members and TSC experts;
- collection and analysis of available information about the emergency at NPP;
- coordination of TSC expert teams operations, analysis and summary of TSC recommendations and provision of consolidated expert evaluations and recommendations to the NPP;
- arrangement s for transportation of expert group to the affected NPP.

Conclusion

- Supplementary design solutions scheduled for implementation will contribute to NPP sustainability and self-supportability up to 5 – 10 days in case of a BDBA.
- Engineering solutions implemented in modern Russian designs in order to ensure safety comply with Post-Fukushima requirements and have references to existing units.
- JSC “Concern Rosenergoatom” Crisis Center and communication systems enhancement goes on.
- There is going on enhancement of existing protected command posts at NPPs, in satellite towns and evacuation areas.
- Decision has been made regarding establishment of Regional Crisis Center of WANO-MC in Moscow, on the base of JSC “Concern Rosenergoatom” Crisis Center.

THANK YOU FOR ATTENTION!