Federal Office
for the Safety of
Nuclear Waste Management

Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

Safety Reassessment of German Research Reactors after the Accident at the Fukushima Daiichi NPP – Status of Improvements focused on Emergency Preparedness

Workshop on Safety Reassessment of Research Reactors in the Light of the Lessons Learned from the Fukushima Daiichi Accident

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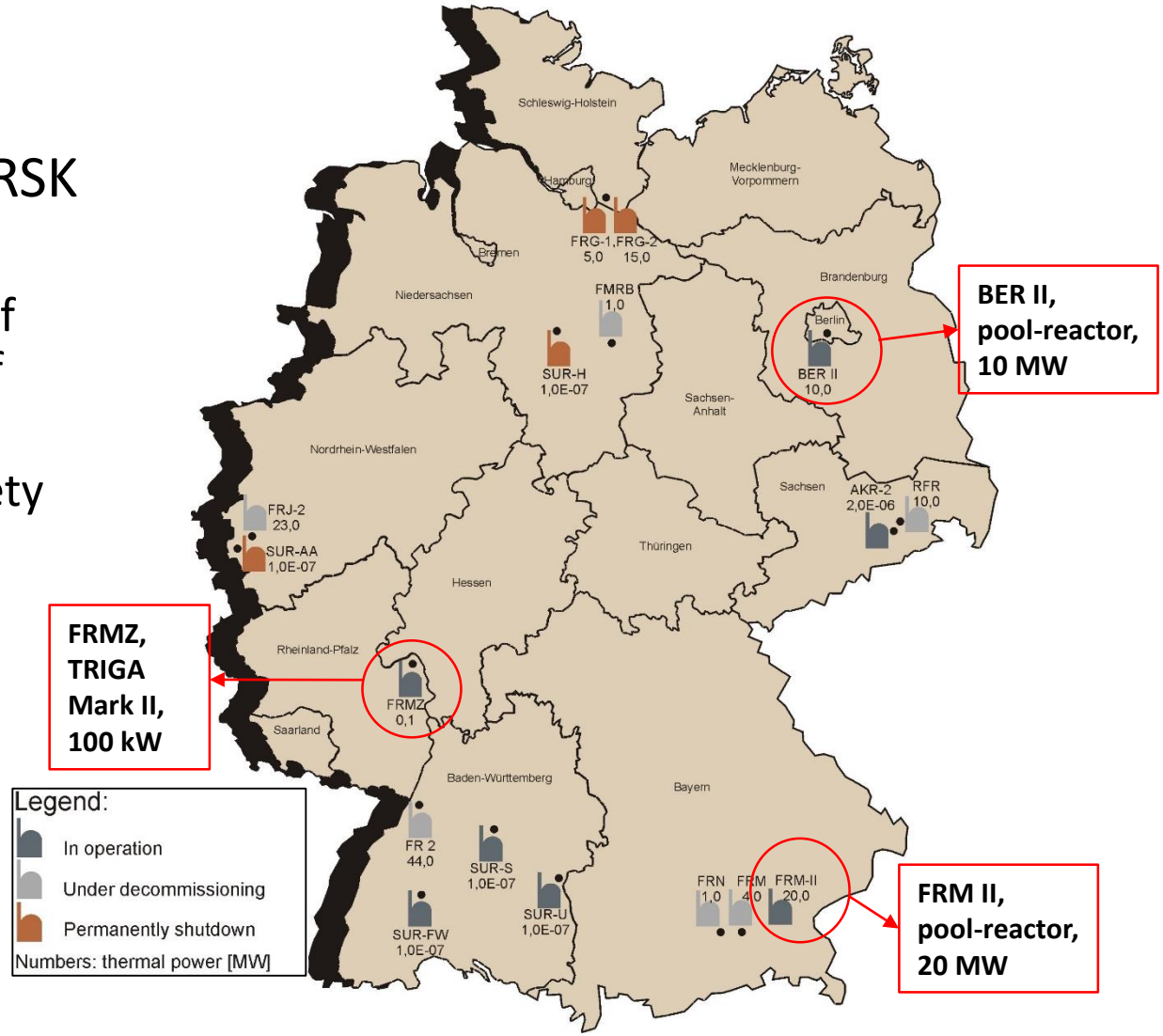
Safety Assessment of German RR after the Accident in Fukushima - Overview

- 07.07.2011 – BMU (Federal Ministry for Environment, Nature Conservation and Nuclear Safety) requested the RSK (Reactor Safety Commission) for a safety assessment of all research reactors with a continuous thermal power P_{th} > 50 kW
- 03.05.2012 – First statement of the RSK on the robustness of German RR published
- 14.01.2015 – Safety reassessment of research reactors by the RSK on ministerial behalf began – status of implementation of improvement actions identified in 2012
- 22.03.2017 – Second statement of the RSK on the robustness of German RR published

Facility Specific Safety Approach

- Catalogue of requirements developed by the RSK based on the stress test for NPPs
  - Adjustment of assessments criteria in a meaning of graded approach, accounting for a risk potential of individual research reactors
  - Verification of compliance of the fundamental safety functions
  - Identification of safety margins
  - Robustness of instrumentation for monitoring of reactor and radiological parameters



Assessment Criteria

- Natural hazards
  - Earthquake
  - Flooding
  - Extreme weather conditions
- Events combinations and expanded postulated events
- Precautionary measures
- Emergency preparedness

3 Robustness Levels ↑

- Man-made hazards
  - Blast wave
  - Explosive materials
  - Toxic gases
  - Terrorist hazards / aircraft crash

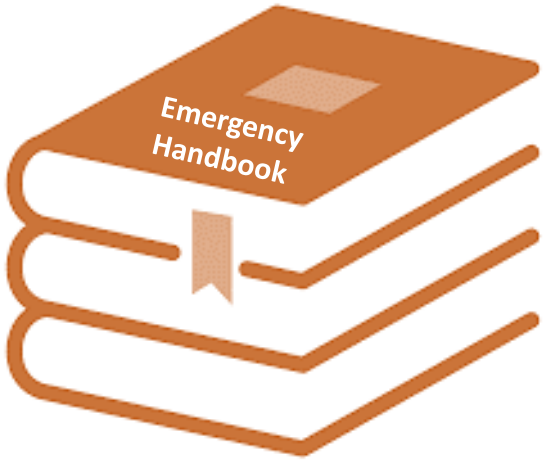
3 Degrees of Protection ↑

Safety Assessment of German RR – Outcome

- Robustness of RR confirmed, but safety margins differs depending on the facility and assessment criterion
- Major potential for improvements: preventive and mitigative emergency control measures
- Need for (further) development of plant-specific measures independently from the external disaster measures, e.g.:
  - Emergency preparedness part of operating regulations
  - Establishment of emergency response team
  - Consideration of aggravated boundary conditions (e.g. damaged infrastructure and communications equipment, increased dose rate, hydrogen generation)
  - Failure of the monitoring instrumentation
  - Loss of power supply
  - Loss of coolant → supply alternatives and/or sealing of the reactor tank
  - Limitation of activity release in case of core meltdown

Emergency manual and response team

- Preventive and mitigative emergency control measures elaborated in emergency manual
- Concept consistent with the guidance for nuclear power plants, measures adequate to the risk potential of the individual research reactors emergency manual



- Emergency response team
  - Primary reactor staff
  - Management of research centre/university may be involved
  - Consideration of external organisations

Description of emergency response team easily understandable in any case?

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Emergency water supply and sealing of reactor pool

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Redundant, divers and physical separated systems for emergency water supply

FRM II and BER II

- Multiple water feeding: system for back-feeding for “normal" operational leakage, pipe connection, mobile fire pumps
- Various water reservoirs available, e.g.: drinking water system, storage tank, local lake / stream
- Sealing of reactor pool – individual actions depending on the leakage position
- Large leakage in the reactor pool – replacement of the fuel element into the set-down pool

FRMZ

- Recriticality of the core due to loss of coolant – practically excluded
- Divers cooling – air
- Emergency core cooling – mobile fire pumps

Measures for water supply without entering the reactor hall?

Emergency power supply

Redundant, divers and physical separated systems, despite of a very limited demand

FRM II

- Operational demand for power supply – first 3 hours after the reactor shutdown
- Emergency power supply systems: distribution grid, diesel generators, power system supplied from a third grid/mobile emergency diesel generators, emergency transformer on the site

BER II

- Operational demand for power supply – first 10 minutes after the reactor shutdown
- Emergency power supply systems: emergency diesel generators, batteries, redundant connection points for mobile emergency diesel generators

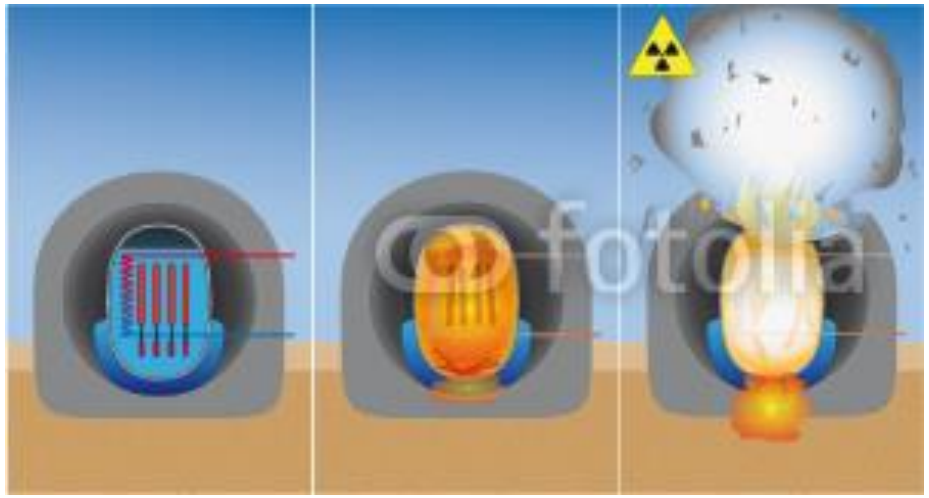
FRMZ

- Maintenance of fundamental safety functions requires no power supply
- Emergency power supply only for instrumentation for monitoring of the reactor and radiological parameters – diesel generators foreseen

Mobile diesel generators in place or rental contract with an external company?

Mitigation of radioactivity release in case of core melt down

- Covering of the reactor core entirely under water, inkl. measures for long-lasting situations
- Confinement of radioactive material in means of, e.g. containment isolation, negative pressure in the reactor hall, exhaust air filtering and ventilation isolation system
- FRMZ reactor - core melt down practically excluded



Aggravated boundary conditions

- FRM II and BER II – no power supply needed to maintain the fundamental safety functions
- FRMZ – neither power and water supply nor personnel needed to maintain its fundamental safety functions

- Adequate measures for emergency water and power supply
- Diverse systems for reactor shutdown, where appropriate
- Clearance of major infrastructural damages with support of technical assistance organizations

Instrumentation and equipment for emergency preparedness

- Monitoring of reactor and radiological parameters
  - Instrumentation designed to withstand high temperatures, humilities and radiation dose rates
  - Reactor and radiological parameters measured continuously
  - Parameters displayed in both, the control room and in the emergency control room (FRM II, BER II)
  - Redundant battery supplied and mobile instrumentation equipment available

Robustness verification incl. hypothetical effects of internal and external DEC?

- Communication
  - Large number of adequate communications systems available at all facilities, e.g.:
  - Telephone system equipped with emergency batteries
  - Dedicated lines
  - Emergency alarm button to alert the police or fire department

Emergency secured priority line for the public telephone network?

Education and training

- Regular training courses and emergency exercises including theory and practice of radiation protection and emergency preparedness
- Participation of the external organisations, e.g. fire departments, to ensure their knowledge about the facility and the site

Suggested minimal frequency of emergency exercises:

- At least one per year for the on-site emergency preparedness, including the entire emergency response team
- At least every five years big exercises under assumption of severe scenarios and requiring participation of external disaster control organisations

Conclusions

- Reassessment process finalized in March 2017
- Recommendations of the RSK from 1st step of the safety assessment principally implemented
- Measures of emergency preparedness strengthened accounting for severe scenarios, including long-lasting situations and aggravated boundary conditions
- Robustness of German research reactors generally at the high level, but further optimisation is possible, as always

Any questions?

Thank you for your attention!