Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Nuklearsicherheitsinspektorat ENSI

# Swiss National Action Plan
## Follow up

**2nd NAcP Review Workshop, 20 April 2015**

Georg Schwarz

1969

1980

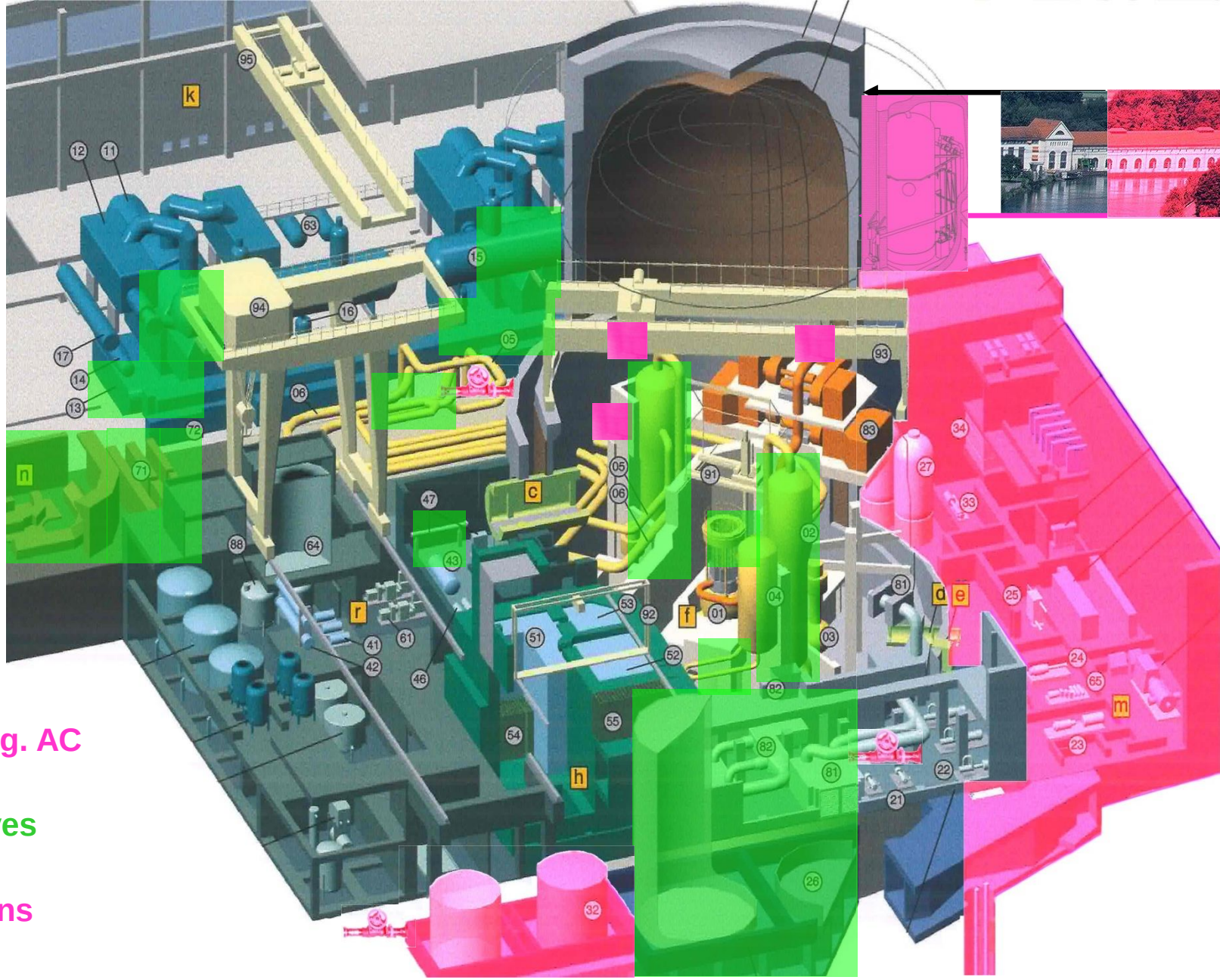
RWST

1990

Bunker
Systems
Cont.
Filtered
Vent
SGs
Condensators
HP-Turbines
2. Hydro Emerg. AC
MCR
Important Valves
Emerg. FW
FW-Connections
RPS

2000

$H_2$-Recombiners
Turbine Control



Backfits

Renewals

# Implemented before Fukushima

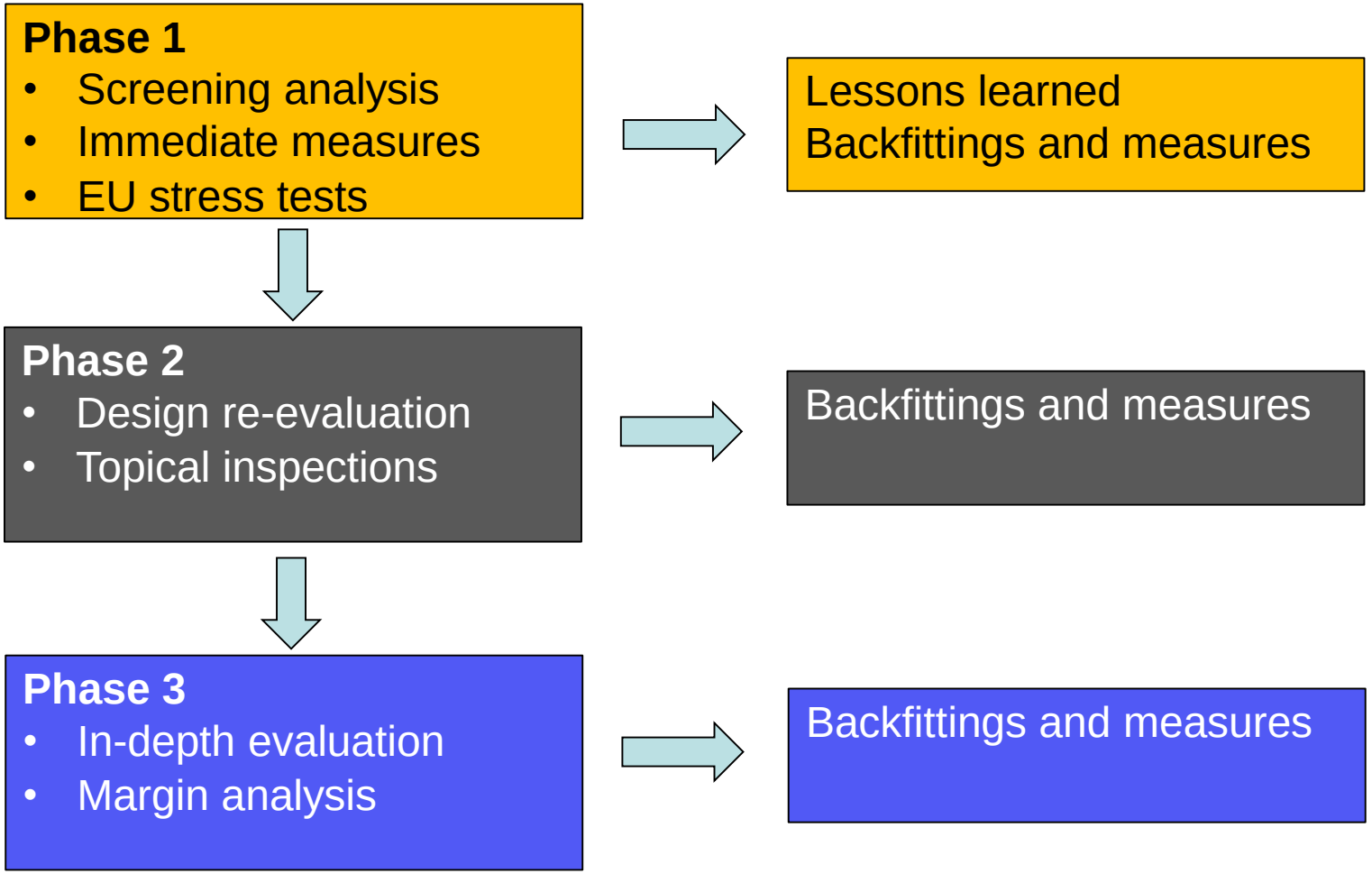
**Loss of safety systems**

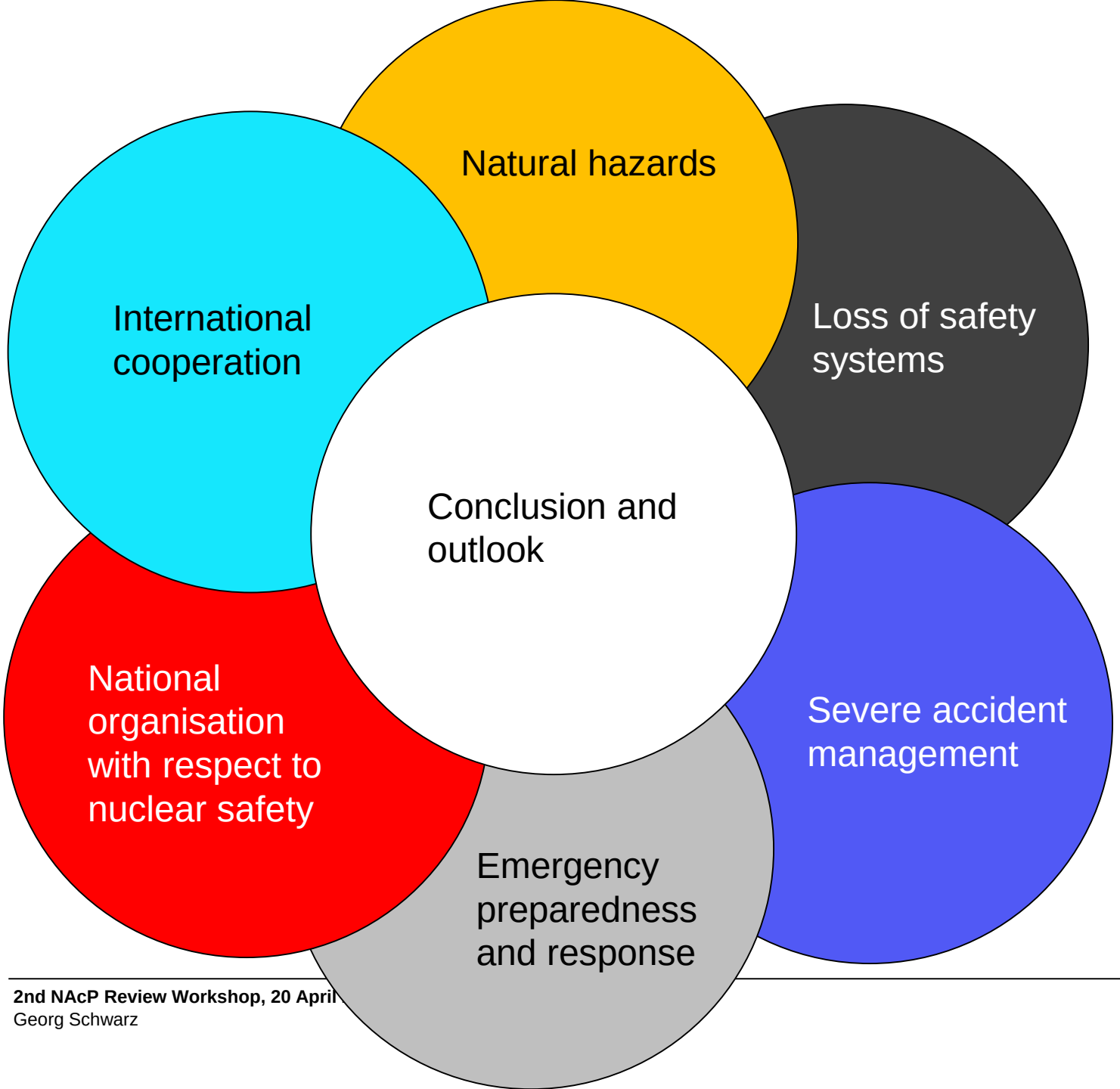
- All Swiss NPPs have bunkered EDG and ECCS (Backfitted in KKB and KKM in the early ‘90s)
- KKB, KKG, KKL have diverse heat sinks

**Severe accident management**

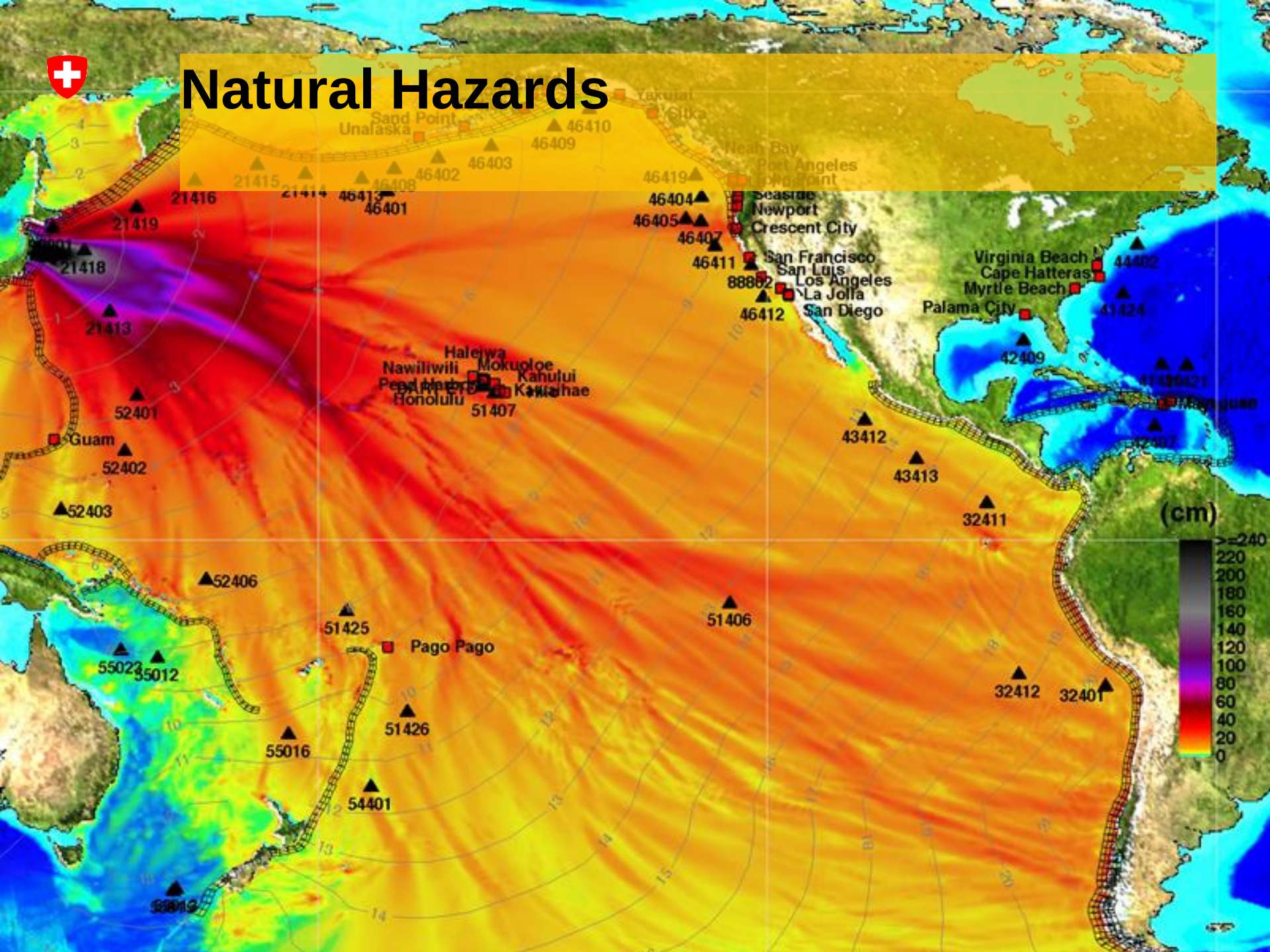
- All NPPs have backfitted FCVS in the early ‘90s
- All NPPs have SAMGs for all plant states
- SAMGs are regularly validated, trained and exercised
- All NPPs have Level 1 & 2 PSAs for all plant states
- Severe accident studies for all NPPs

# Post Fukushima actions




Natural hazards
Loss of safety systems
International cooperation
Conclusion and outlook
National organisation with respect to nuclear safety
Severe accident management
Emergency preparedness and response

# Natural Hazards



# Seismic hazard

**Reassessment of the seismic hazard**

- SED77: First probabilistic study (1977)
- PEGASOS: PSHA SSHAC Level 4 (2004)
- PRP-IH:  PRP Intermediate Hazard (2011)
- PRP:  PEGASOS Refinement Project (2013)

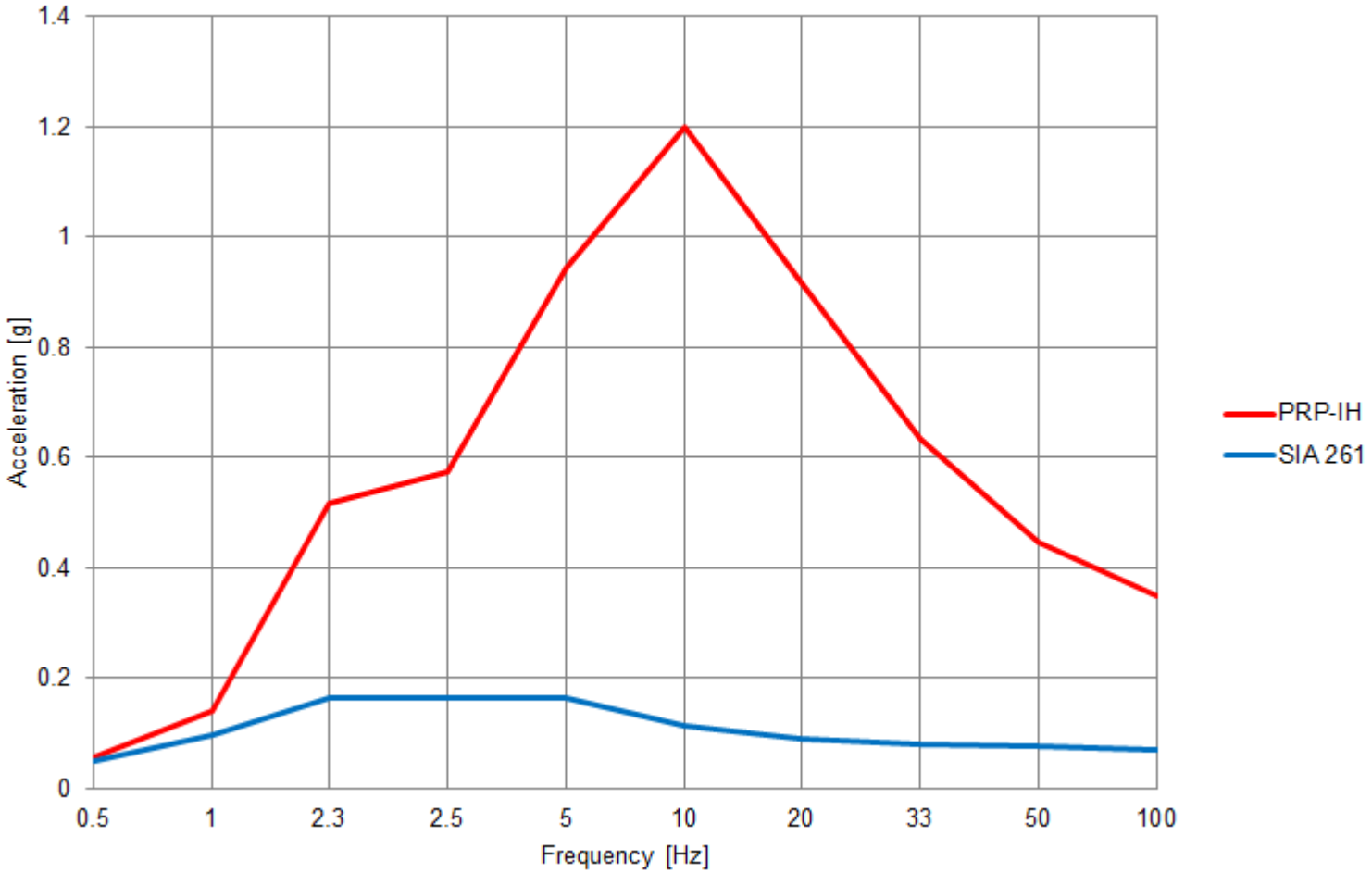
**Definition of the new design base hazard**

- Review of the PRP results (2015)
- Regulatory order (End of 2015)

**Definition of the methodology**

- Detailed definition of the methodology for the safety case demonstration (2014)

# Comparison of Spectra PRP-IH with SIA 261



# Seismic design reevaluation

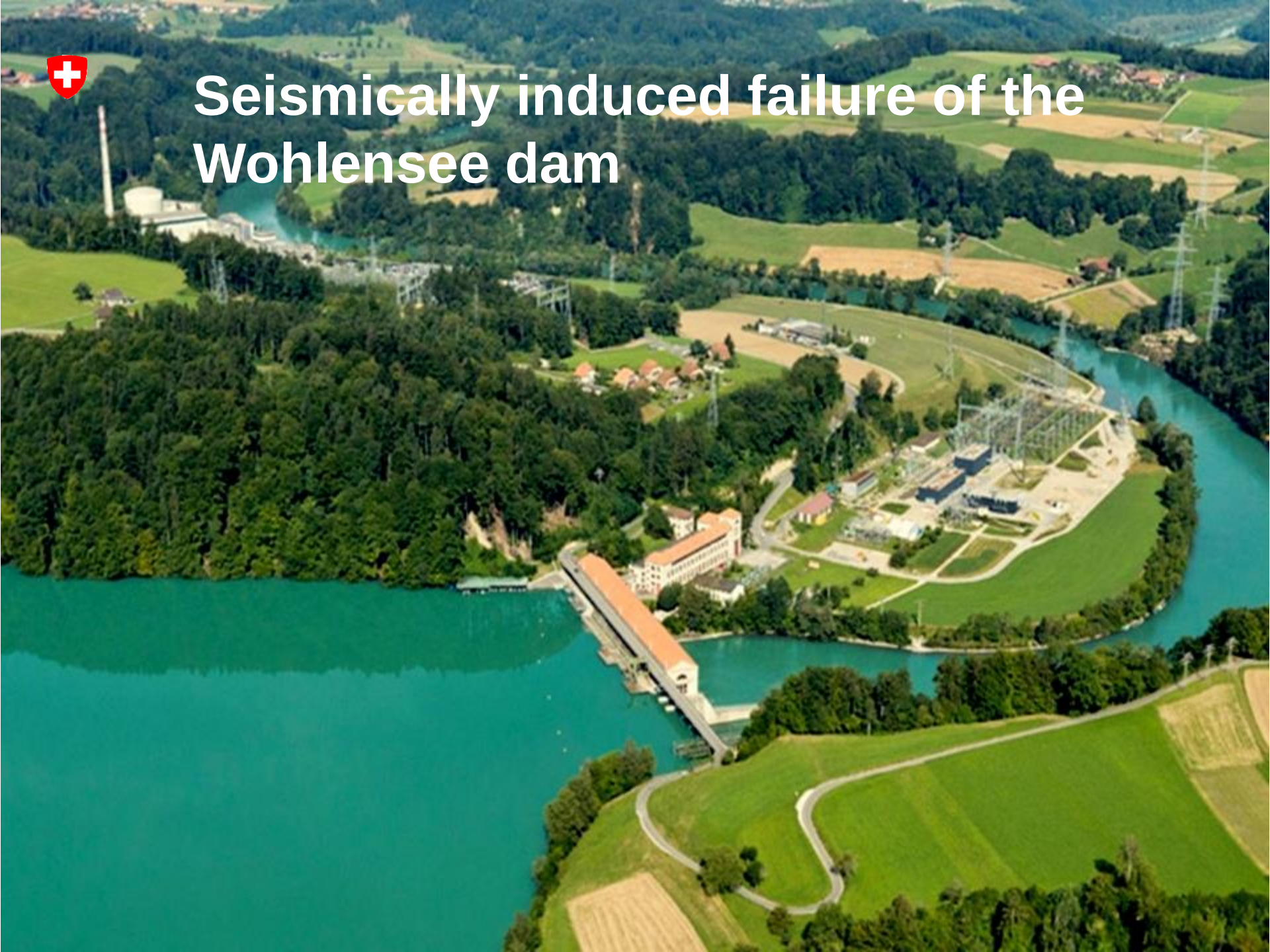
**Seismic safety case**

- Seismic safety case for reactors and SFPs with 10’000-year earthquake (2012)
- Seismic safety case for the Wohlensee dam (2012)

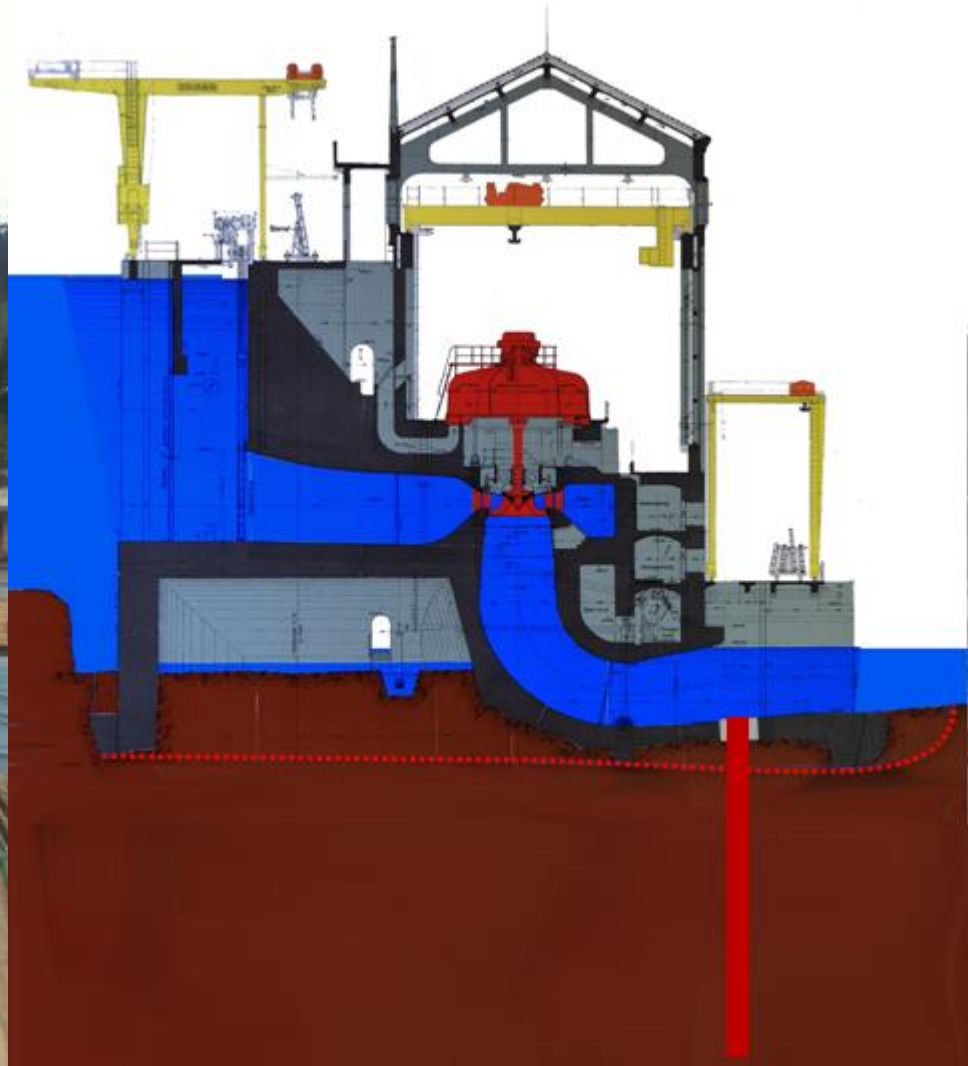
**In depth analysis**

- Reevaluation of seismic robustness of containment isolation, primary circuit isolation and FCVSs (2013)
- Report on pros and cons of automatic SCRAM on earthquake signals (2014)
- Evaluation of the safety margin analyses and order of improvement measures (Spring 2015)

# Seismically induced failure of the Wohlensee dam



# Increasing the seismic capacity of the Wohlensee dam



# Increasing seismic robustness

## Backfittings

- Reinforcement of the Wohlensee dam (KKM, 2014)
- Reinforcement of containment isolation and FCVS (KKL, KKM, 2014)
- Reinforcement of EDG (KKG, 2015)
- Reinforcement of buildings (KKB, 2015)
- Measures against seismically induced internal flooding (KKM, 2015)
- Backfitting of a fixed motor driven pump to feed river water into the RPV (KKM. 2016)
- Reinforcement of electrical cabinets (KKG, 2017)

# Flooding hazard

## Flooding design reevaluation

- Flooding safety case with 10’000-year flood (2011)
- Additional safety cases considering clogging and debris transport (2013)
- Evaluation of the safety margin analyses and order of improvement measures (Spring 2015)

## Backfittings

- Reinforcement of the water intake structure (KKM, 2011)
- Mobile flooding protection (KKG, KKM, 2011)
- Flood protection wall (KKG, 2014)
- Reinforcement of protected volume (KKB, KKM, 2015)

# Flood protection

# Extreme weather design re-evaluation

**Screening analysis**

- First qualitative, conservative safety case within the EU stress tests (2011)

**Extreme weather safety case**

- Update of 10’000-year hazards for extreme wind, tornado, rain, snow and high/low temperatures (2014)
- Safety cases for extreme weather conditions (2015)

**In depth analysis**

- Safety margin analysis for the instantaneously acting hazards (wind, tornado, rain) (End of 2015)
- Strategies to handle long lasting extreme weather situations e.g. periods of extreme heat (End of 2015)

# Loss of safety systems

# Station blackout

**Immediate measures**

- Backfit of various Accident Management DGs for battery charging and feeding of a safe shutdown path (2012)
- Backfit of external hook-up points for DGs (2012)

**Design reevaluation**

- Topical inspections on long lasting SBO (2011)
- Measures for increased autarchy of electrical power supply (2013)

**In depth analysis**

- Analyses on restoring containment integrity during outage in case of SBO (Summer 2015)

# AM emergency diesel generator

# Loss of ultimate heat sink

**Immediate measures**

- Reinforcing the water intake structure of the bunkered emergency systems (KKM, 2011)
- Backfit of an external hook-up point for cooling water (KKM, 2011)

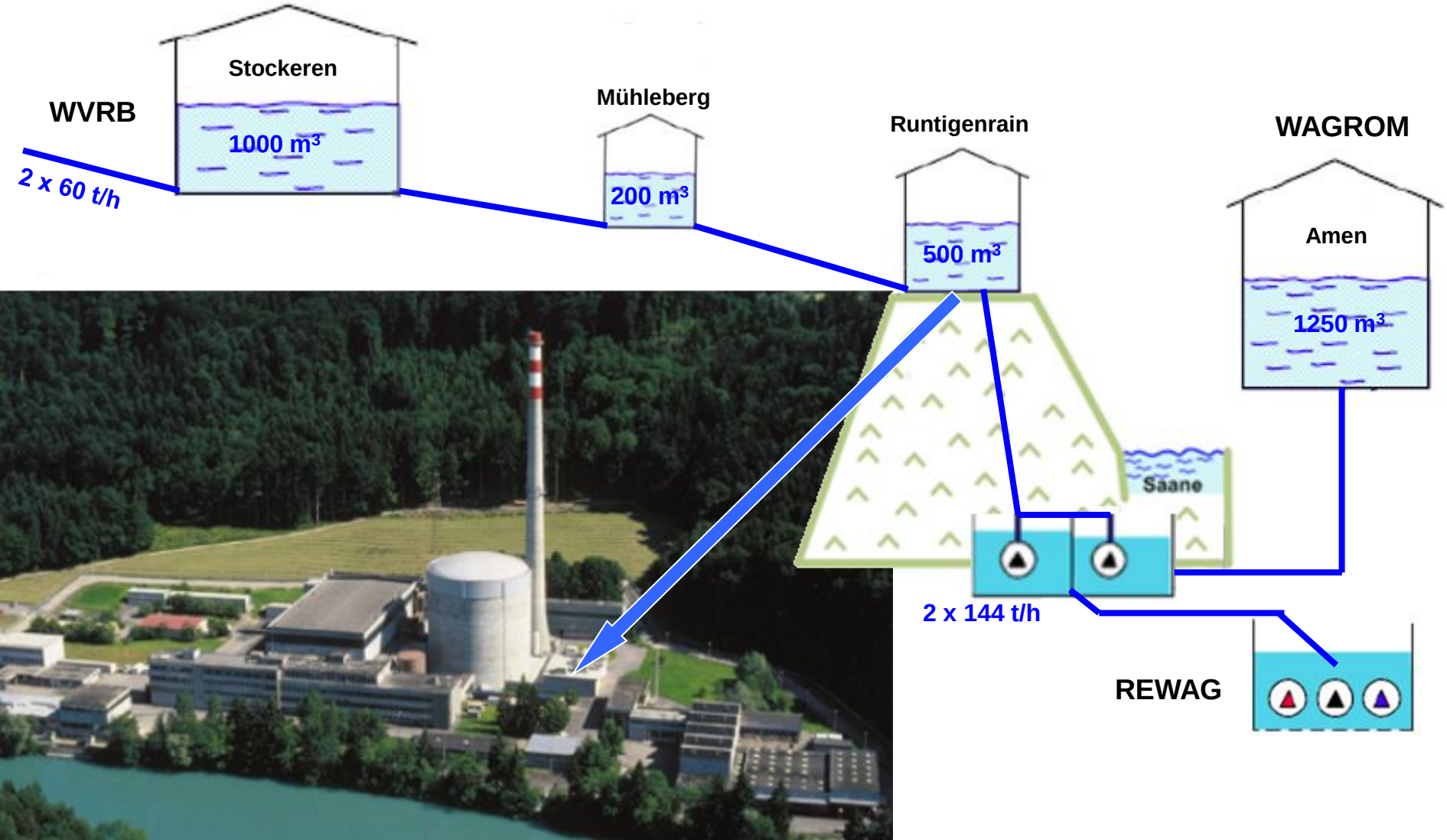
**Design reevaluation**

- Reevaluation of the cooling water supply (2011)

**Backfittings**

- Backfitting of a diverse cooling water supply (KKM, Summer 2015)

# Water supply by drinking water network



# Spent fuel pools

**Immediate measures**

- Backfit of external hook-up points for water injection (2012/2013)

**Design reevaluation**

- Reevaluation of the SFP cooling systems and the protection of SFPs against external events (2012)

**Backfittings**

- Backfit of additional temperature and level measurements for the SFPs (2014)
- Backfit of additional SFP-cooling systems designed against DBE and DBF (KKB, 2017, KKM, 2020)

# Severe accident management

# Mobile equipment

## Immediate measures

- Set up of the external storage facility Reitnau (2011)

## Concept review

- Review of the operational concept for Reitnau (2012) and optimization of the storage concept for mobile equipment (including on site storage of equipment, 2014)
- Definition of design requirements on AM equipment (2014)
- In depth review of the timing of operator actions (2015) and effects of non-nuclear hazardous substances (End 2015)

## Testing

- Testing of the Reitnau equipment and procedures during the general emergency drill (2013)

# External storage facility Reitnau

- Operational 1 June 2011
- Tested during drills




# Filtered containment venting system and hydrogen management

## Design reevaluation

- Topical inspections on filtered containment venting systems FCVS (2011)
- Protection against hydrogen in the SFP area (2012)
- Safety case for hydrogen hazard (Containment and reactor building) (2014)

## Backfittings

- Improvements on hardware and procedures for FCVSs (2012) and SAMGs (2015)
- Upgrading of the FCVS of KKG (Iodine filter. seismic robustness (2017)
- Backfitting of additional PARs and $H_2$ instrumentation (2017)

# Long-term operability of the emergency organizations

## Concept review

- Topical inspections on the habitability of the on-site emergency centers (2012)
- Review of the updated concepts for the long-term operability of the emergency organizations (2013)
- Review of the availability of sufficient radiation protection personnel (2015)

## Improvement measures

- Provisions for additional work and protection equipment for the emergency organizations (offsite, 2011 and onsite, 2014)
- Fall-back communication system (2014)
- Set up of external emergency centers (2016)

# Large volumes of contaminated water

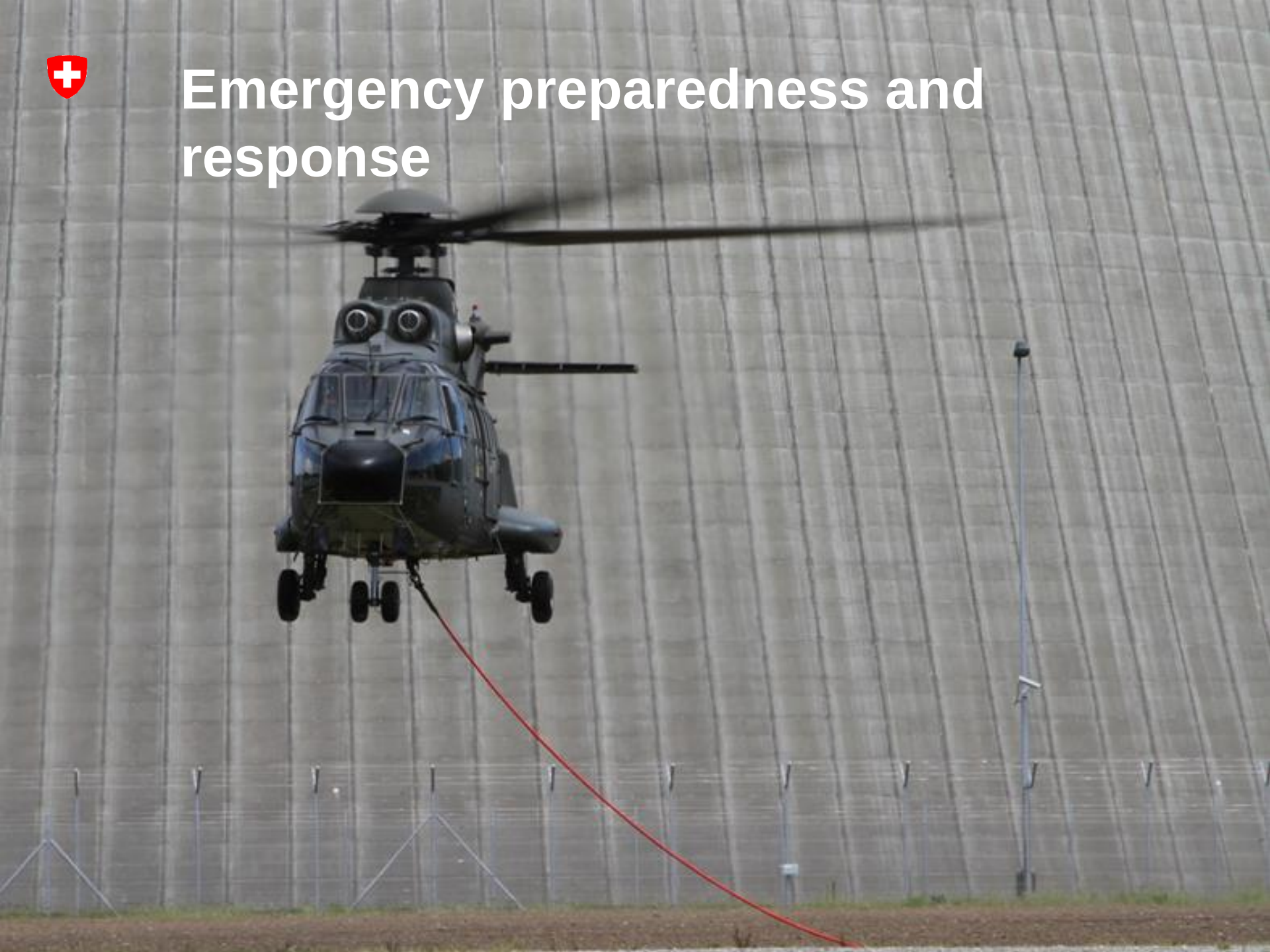
**Concept review**

- Review of post accident contamination and treatment of large volumes of contaminated water in DBA (2013) and BDBA (End of 2015)
- Review of conventional hazards during BDBA (2015)
- Review of the reporting channels of the Cantons and the alarming criteria (2015)

**Improvement measures**

- Installation of a new monitoring system of the river water below the NPPs (2015)
- Backfitting of extinguishing water retention pools (KKG, KKL, 2014)

# Emergency preparedness and response



# Concerted review of the Swiss emergency protection measures

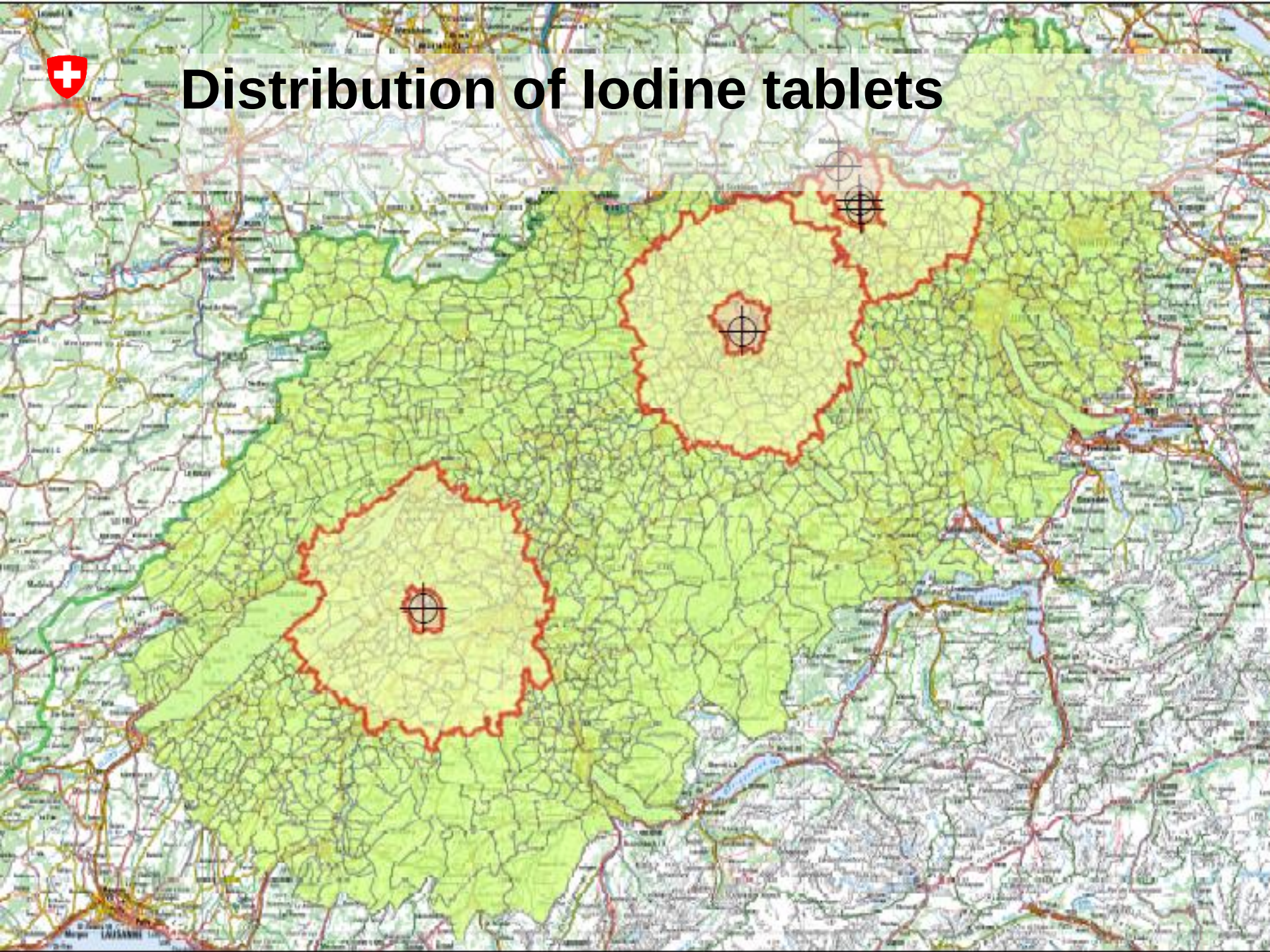
**Interdepartmental working group IDA-NOMEX**

- Mandated by the Government (2012)
- Experts from 6 federal departments, the federal chancellery, cantons and ENSI
- 56 organizational and legislative measures identified, tasks assigned to the lead of different authorities

**Tasks under ENSI's lead**

- Treatment of severely irradiated persons (2012)
- Availability / redundancy of measurement and forecasting systems (2013)
- Assessment of the reference scenarios (2014)
- Assessment of the zone concept (2014)

# Distribution of Iodine tablets



# National organisation with respect to nuclear safety

# Regulatory body

## Functions and responsibilities

- Establishment of ENSI as a formally and effectively independent regulator for nuclear safety and security (2009)
- Tightened independence requirements for the ENSI board and the Nuclear Safety Commission (2012)

## Openness, transparency and communication

- Proactive communication strategy (2012)
- Increase of communication staff (2012)
- Information provided on a comprehensive web platform and social media (2013)
- Establishment of the Technical Forum on NPPs (2013)

# Human and organizational factors

## Safety culture

- Technical discussions with the operators on safety culture (2012)
- Report on ENSI's oversight of safety culture (2014)

## Oversight culture

- Self assessment of the safety culture of the regulatory body (2013)
- Development of a new mission statement and a code of conduct for ENSI (2014)
- Measures to improve competence and professionalism (HCM, accreditation as inspection body, 2015)
- Fostering collaboration and self reflection (ongoing)

# International cooperation

# International peer review missions

## International Regulatory Review Service (IRRS)

- Full scope IRRS mission to ENSI (2011)
- Follow up IRRS mission (2015)
- 24 out of 30 issues resolved
- Reports published

## Operational Safety Review Team (OSART)

- OSART mission to Mühleberg NPP (2012)
- Follow up OSART mission (2014)
- All issues resolved
- Reports published

# Global safety regime

## Swiss Proposal to amend the CNS

- 2nd extraordinary CNS meeting (2012)
- CNS WG on Effectiveness and Transparency (2013)
- 6th CNS Review Meeting (2014)
- Diplomatic conference about the Swiss proposal (2015)
- Vienna declaration on nuclear safety (2015)

## International communication mechanisms

- Bilateral agreements with all neighboring countries
- Participation in all relevant international information exchange networks

# Operating experience feedback

**OEF of operators**

- Topical inspections on the operators process for the evaluation of international OEF (2012)

**OEF of ENSI**

- Member of the European Clearinghouse on NPP Operational Experience
- Review of ENSI's process for the evaluation of international OEF (2014)

# Conclusion and outlook

# Conclusions

## Systematic approach

- Stepwise refinement of the analyses in order to identify backfitting and improvement needs
- All topics of EU stress tests and 2nd extraordinary CNS meeting covered
- Tracing, planning and reporting in annually updated action plans

## Results

- Because of the systematic backfitting programmes of the past, all Swiss NPP were on a good safety level
- The Fukushima follow up helped to identify remaining design weaknesses and has led to a significant increase of safety margins

# Core damage frequency Mühleberg NPP

| PSA model | CDF [1/year] |
|---|---|
| Base model 2012 | **1:40’000** |
| Base model 2014 | **1:120’000** |
| Model with backfittings | **1:160’000** |

# Completion of the action plan

**Assessments**

- All screening analyses, design re-evaluations, in-depth evaluations, margin analysis) are planned to be completed and reviewed by ENSI by end of 2015

**Backfittings and improvement measures**

- All backfittings and improvement measures are planned to be ordered ENSI by end of 2015

**Reporting**

- ENSI will issue a concluding report on the Swiss Fukushima action plan by mid of 2016

# Implementation of backfittings and improvement orders

## Completed backfittings and improvement measures

- All backfittings improvement measures identified so far are basically planned to be completed by end of 2015

## Exceptions

- Backfitting of a fixed motor driven pump to feed river water into the RPV (KKM. 2016)
- External emergency centers (2016)
- Reinforcement of electrical cabinets (KKG, 2017)
- Additional PARs and $H_2$ instrumentation (2017)
- Upgrading of the FCVS of KKG (Iodine filter. seismic robustness (2017)
- SFP cooling systems (KKB, 2017; KKM, 2020)

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