Post-Fukushima
Stress tests peer review

Public Meeting

Stress Test Peer Review
Topic 3 Severe Accident Management

Jozef Misak
Team Leader – Topic 3
Stress Test Peer Review Board

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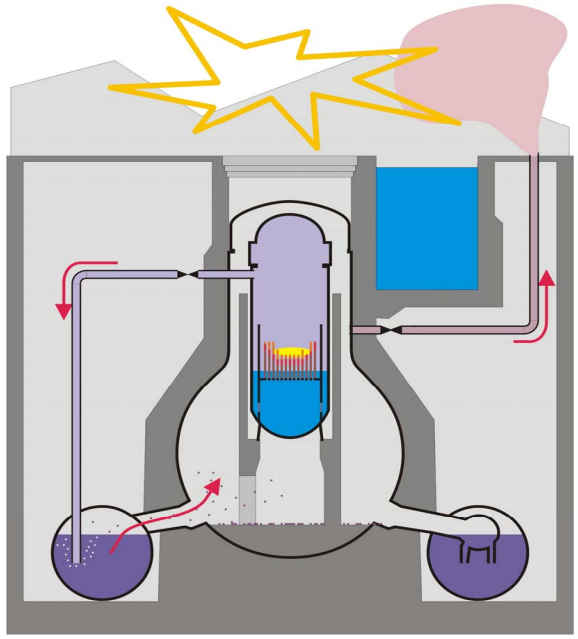
17 January 2012

Scope of presentation

- Lessons learned from Fukushima
- Severe accidents and accident management
- Challenges to containment integrity
- Hardware provisions and strategies to ensure containment integrity
- Areas covered by peer review
- Expected outcome of peer review

Lessons learned from Fukushima

- In spite of prevention, severe accidents can happen and need to be managed to protect public
- Severe accidents may result from common cause failures, possibly initiated also by external hazards (earthquakes, flooding)
- Several reactors and spent fuel pools on the same site can be affected at the same time
- Management of the accident may be needed under conditions of severely damaged infrastructure
- **Robustness of defence in depth is essential for successful management; verification of robustness is addressed by the stress tests**



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Severe accident and accident management

- Severe accident: accident with severely damaged (molten) fuel with potential for large release of radioactive material
- Accident management:
  1. prevention of core damage
  2. termination of core damage once it begins
  3. **maintaining the capability of the containment**
  4. minimizing on-site and off-site effects

  Item 1: preventive part of AM

  Items 2 – 4: mitigative part of AM (severe accident management)
- **Severe accident management**:
  - **Hardware provisions** (plant systems, structures, components)
  - **Actions** (implementation of severe accident management **strategies**)

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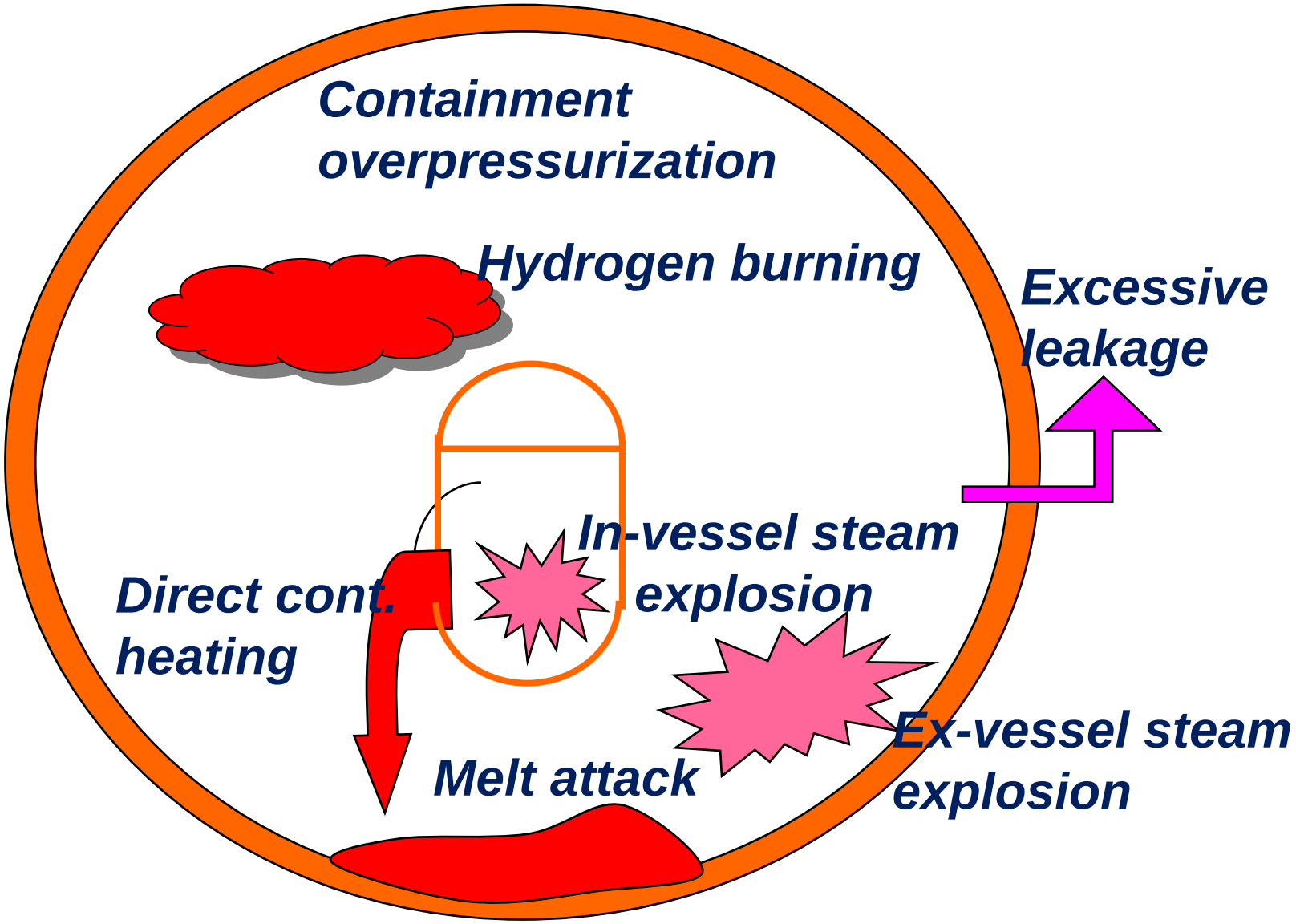

SEVERE ACCIDENT CHALLENGES

- Potential for loss of containment integrity

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Objectives of severe accident management

- **Prevention of loss of containment integrity /protection of people and environment** by means:
  - Monitoring and availability of information in MCR/TSC
  - Habitability of control places
  - RCS depressurization
  - Stabilization of molten corium: in-vessel corium retention or ex-vessel corium coolability
  - Long term containment heat removal
  - Hydrogen control in the containment
  - Prevention of overpressurization: filtered venting
  - Containment isolation/Prevention of by-pass
  - Reducing source term to environment (tightness, isolation, ventilation and filtration, spray system

Hardware provisions for severe accident management

- Any **existing survivable equipment** in the NPP can be used for accident management
- **In addition, various dedicated means** can be implemented
  - Instrumentation
  - RCS depressurization pipes and valves
  - Filtered containment vents
  - Dedicated spray system
  - Containment outer cooling
  - Thermal or catalytic hydrogen recombiners
  - Hydrogen igniters
  - Containment inertization with steam, CO_2, N_2,…
  - Flooding reactor cavity
  - Ex-vessel core catchers

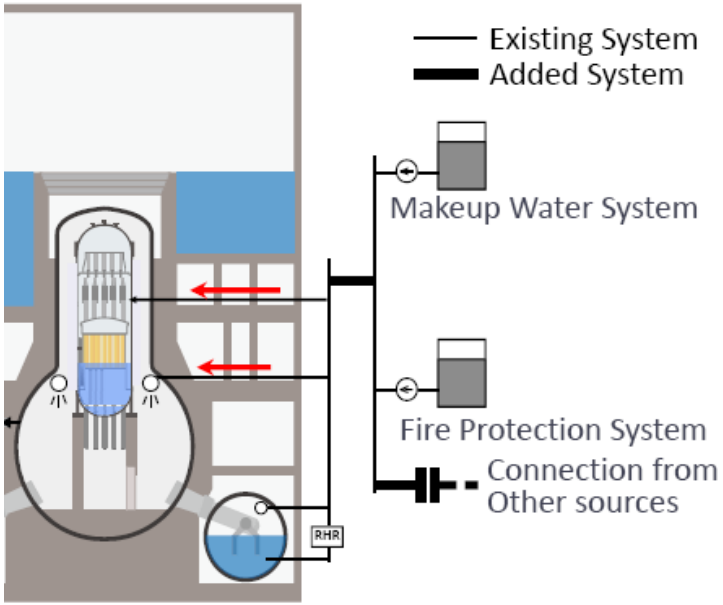
Examples of severe accident management strategies (PWRs)

- RCS depressurization to prevent HPME
- Coolant injection to the degraded core (from any source)
- External RPV cooling to avoid ex-vessel effects
- Operation of hydrogen recombiners/igniters
- Containment inertisation
- Secondary circuit feeding to protect SG tube integrity
- Spraying of the containment to wash-out FPs from containment atmosphere and to reduce the pressure
- Containment filtered venting to protect integrity
- Operation of containment fan coolers
- Containment injection to submerge RPV and to cool ex-vessel core debris

Providing cooling water to the RCS

Injection of seawater and fresh water through :

- **Fire protection system (FPS): fire pumps powered by diesel engines**
- **System of make-up of condensate**
- **Tanks of the fire trucks**



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Providing cooling water to building and SFP

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Temporary contaminated water storage

TEMPORARY STORAGE TANKS
Transfer of water accumulated inside buildings in temporary tanks.

MEGAFLOAT
10,000 m3
Transfer of water from temporary collection tanks to megafloat

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Prevention of dust dispersion

Dispersion of resins to prevent the spread of radioactive material on the ground

Dispersion of inhibitors in the Power Station (slope)

Dispersion of inhibitors around buildings of Units 1 to 4 by crawler dump

After dispersion of inhibitors in the Power Station

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Robotic removal of debris

Before removal

Around the street at the ocean side of T/B of Unit 1

After removal

Encapsulation of damaged units

Unit 1 – Coverage of reactor building to prevent the spread of radioactive materials into the atmosphere and to protect the building from weather

Aug 14: Status of steel-frame work (north side)

Sep. 9: Completion of steel-frame work (northwest side)

Sep 15: Status of wall panels (northwest side)

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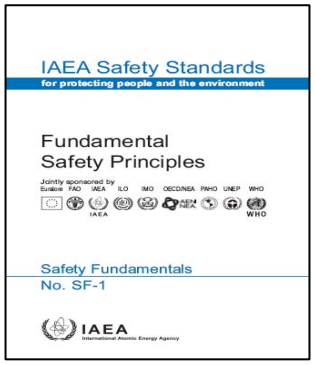
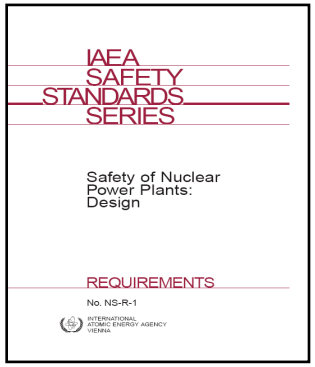
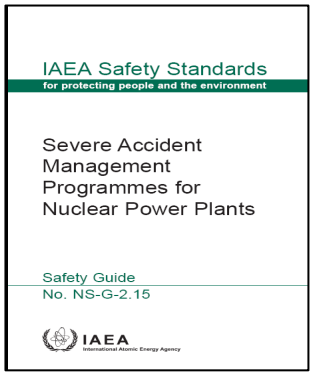
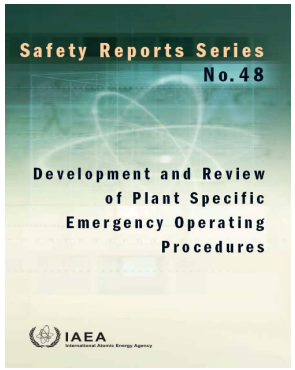
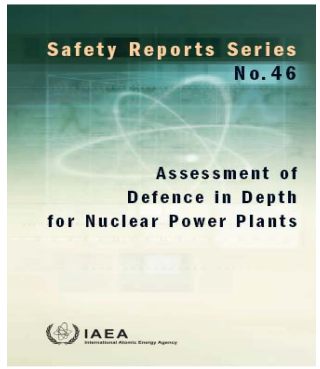
Background documents – WENRA Reference Levels and IAEA Safety Standards

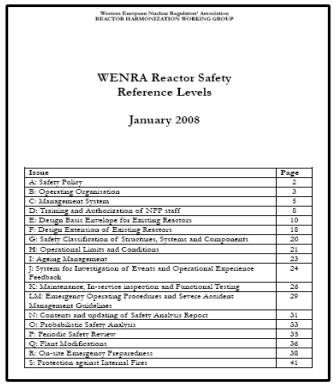


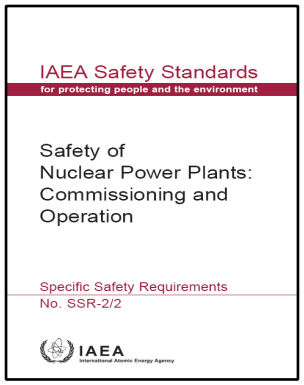


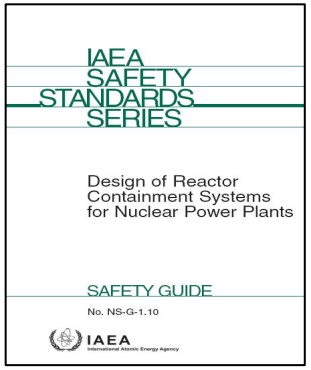


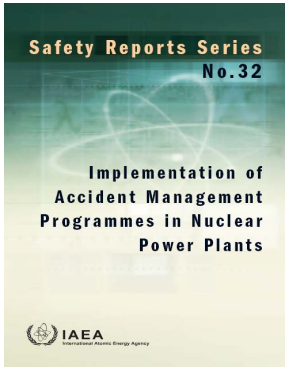


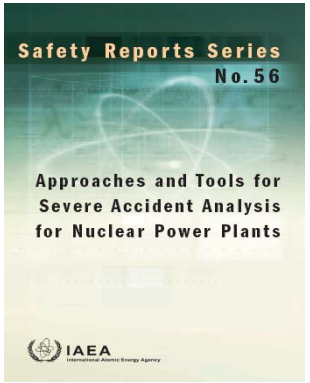












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Areas covered by the peer review

- Comprehensiveness and quality of assessment
- Organization and arrangements of the licensee to manage accidents
- Hardware provisions and strategies for protection of containment integrity and protection of people
- Accident management measures for spent fuel pools
- Capability for accident management at multiunit sites
- Capability of accident management under conditions of damaged infrastructure including radioactive releases

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Expected outcomes of the peer review

- Confirmation of availability of accident management programmes
- Robustness of hardware provisions
- Consistency of strategies with available hardware provisions
- Capability of provisions to address issues of multiunit sites and severely damaged infrastructure including radioactive releases
- Identification of feasible improvements to enhance safety

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