Utilities follow up in Sweden

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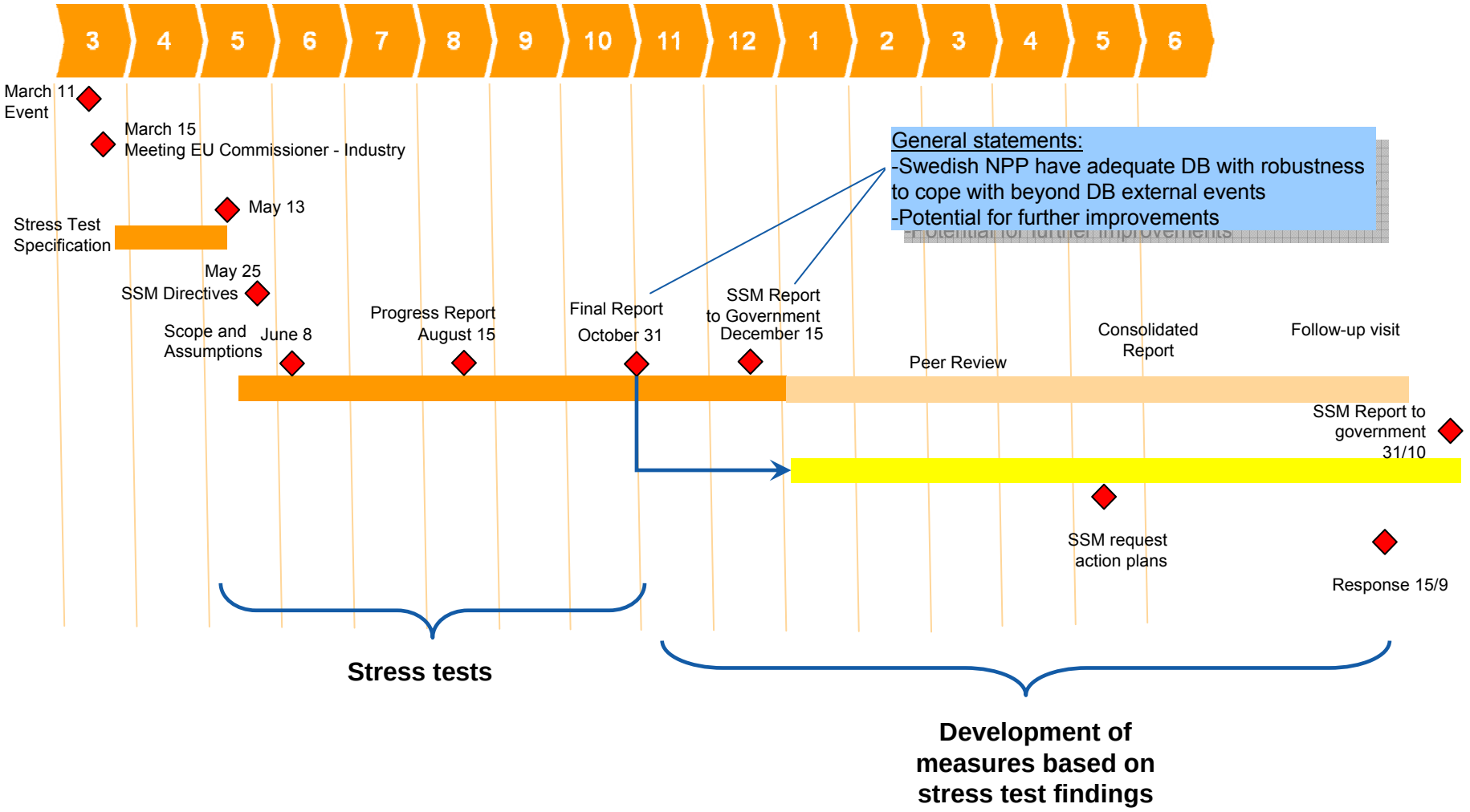
Content

- Stress test performance in Sweden
- Industry cooperation
- Stress test findings and conclusions
- Continued work
- Stress tests in a context

Schedule – stress tests until Q3 2012



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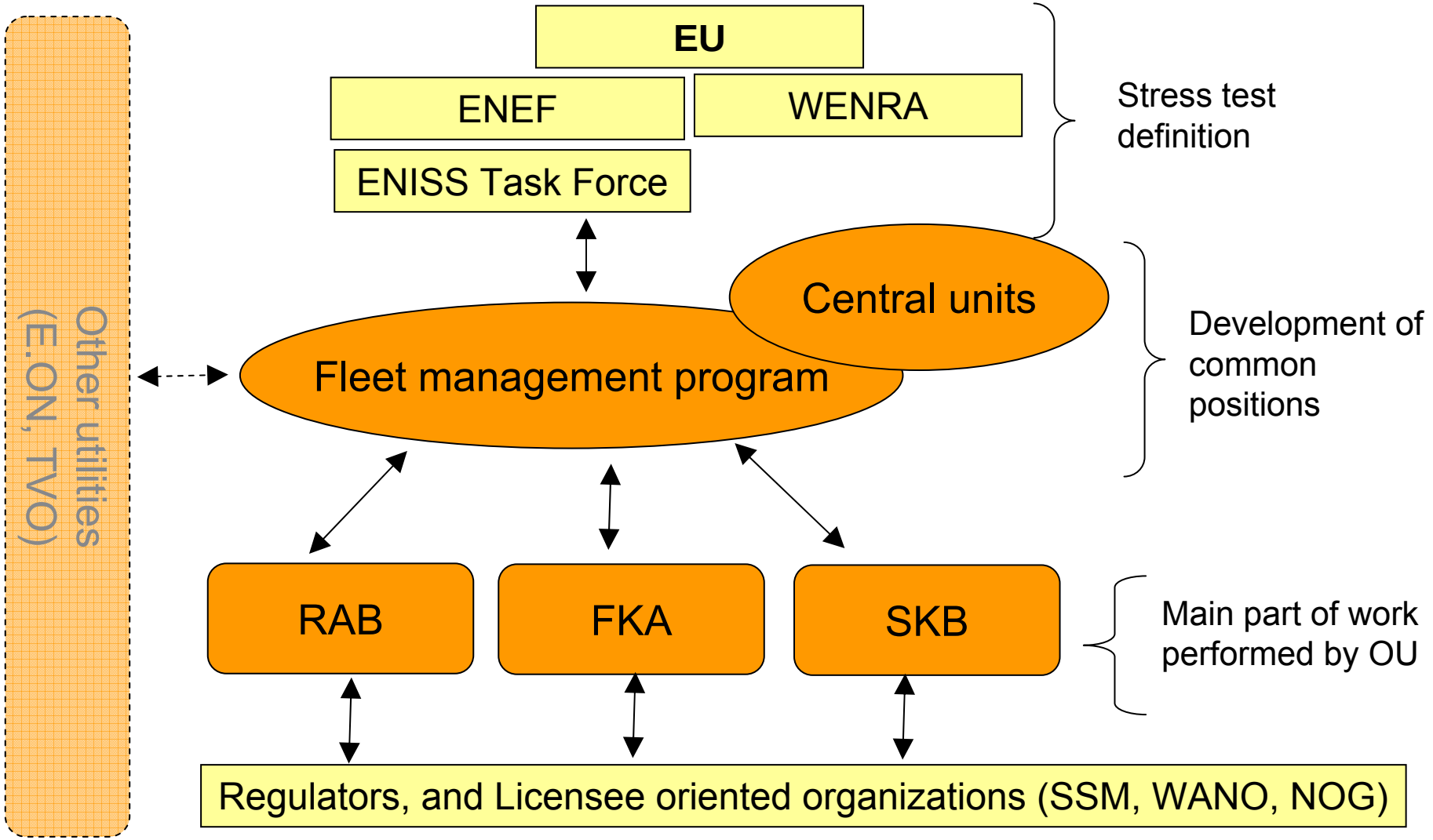
Industry cooperation



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Industry positions: Events & Margins

Managing two new postulated events

- ELAP – Extended Loss of Alternation current (AC) Power)
- LUHS – Loss of normal acess to the Ultimate Heat Sink

Managing an event occuring at several units

0-8h	8-24h	24-72h
"Reasonable" grace period for man. actions - Pre-planned - Instr.	Activation of mobile systems credited. Actions to be driven by instructions and credited equipment be stored in a protected and accessible way	Actions in existing plant and added mobile system beyond what's driven by instructions

Demonstration of margins beyond design basis values for earthquake and flooding

Industry positions: Questions to resolve

- Classification and acceptance criteria of new events
- Single failure?
- Equipment classification and qualification
- Multiple units = all units at a site?

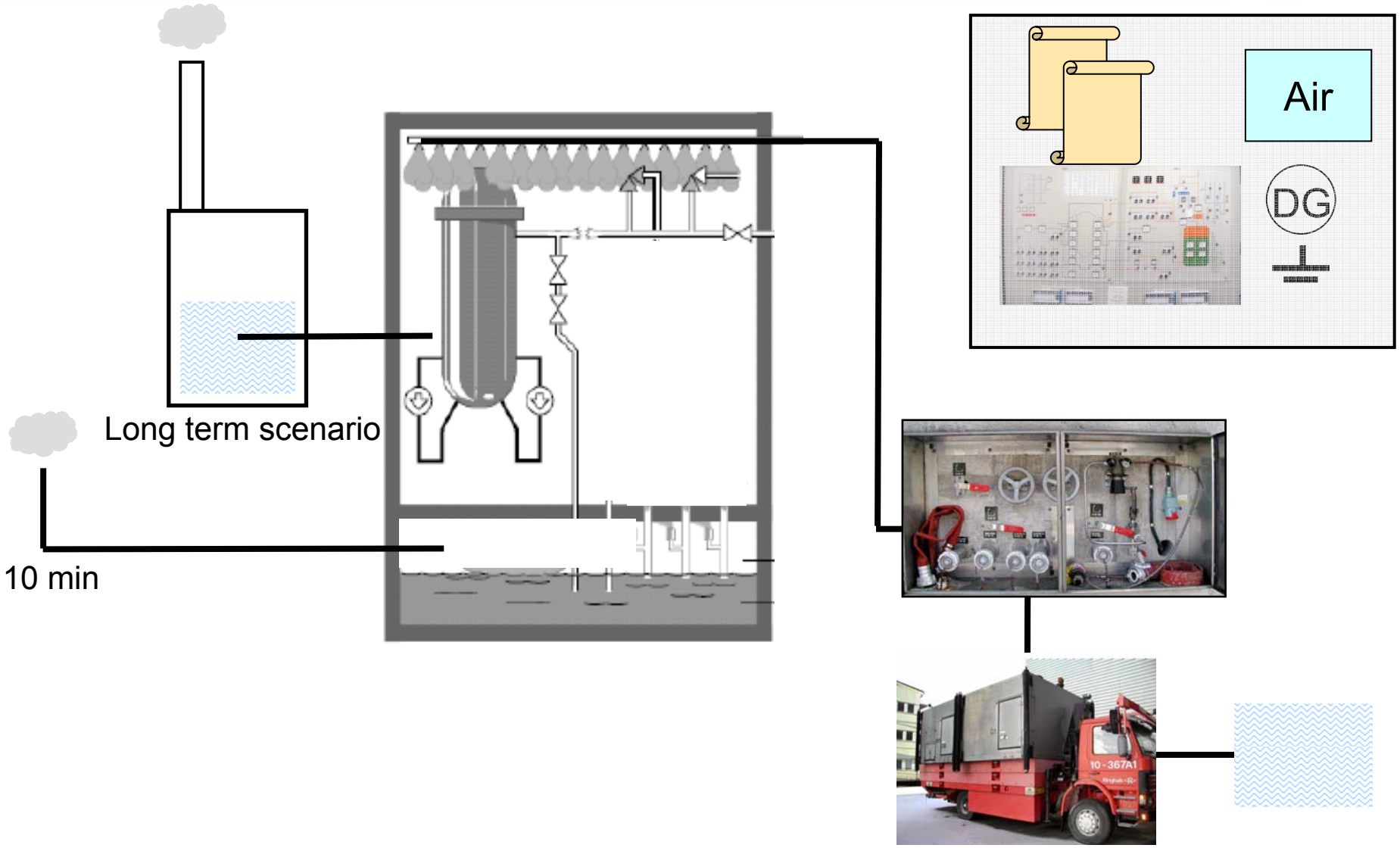
Stress test findings: Summary of results

- Coping with events considered in design verified for Vattenfall plants (’Design Basis’ compliance)
- Chosen ’Design Basis’ confirmed to be adequate, i.e. no missing external events identified
- Stress test highlights areas where plant improvements deserve further assessment, e.g.:
  - Cooling systems independent from external electrical power (incl. emergency diesels)
  - Organization, management strategies and equipments to handle long term accident scenarios impacting several units at a site.
  - Prepared options for recovery of cooling path to/from sea
  - Fuel pool cooling
  - Battery capacity (coping time) for monitoring and control
  - Earthquake qualification of equipment

Already implemented severe accident mitigation systems in SE provide significant benefits

- Installed passive features for:
  - Filtered containment pressure release
  - Short term pressure release at large LOCA
  - Hydrogen recombination (PWR's)
- Possibility to flood containment
- Prepared recovery options in case of lost heat sink
- Mobile independent systems (e.g. for electrical power and hydrogen recombination)
- Transition plans (SSMFS 2008:17) add capability to mitigate effects of extreme external events
  → Swedish plants in a way already 'stress tested'; implementation of safety enhancements on-going in 'transition plans' (SE: övergångsplaner)

Overview of main functions



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RAB: Hydrogen control

BWR (R1):

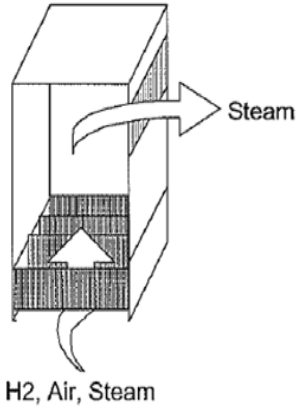
- N_2 filled containment during operation
- In case of accident and H_2 release, venting via scrubber.

Possibility to re-fill with N_2 (though some limitations due to radiation levels)

- Existing recombines not qualified for accident conditions

PWR (R2, R3, R4):

- Passive catalytic recombines ensure safe levels of H_2 concentration in all ere accidents



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Ringhals – EU Stress Test Summary

- Earthquake

- Design base earthquake 10^{-5} occurence
  - Structures, systems will be intact
  - Reinforcement of the spent fuel pool cooling required

- Stress test earthquake 10^{-7} occurence
  - Containment will be intact
  - The containment filtered vent will be intact
  - Fuel pools and fuel pool buildings will be intact
  - CRDM's needs reinforcement
  - Reinforcement of the spent fuel pool cooling required

Ringhals – EU Stress Test Summary

- Flooding

- Design base flooding is a sea level rise of 2,65 m
  - Ground level is at 3,0 m

- Stress test flooding level 3,3 m, 4m and above 4 m sea level rise
  - No tsunamis assumed
  - Up to 3,3 m leakage into buildings will occur, manageable amounts
  - Up to 4 m, significant leakage, resulting in internal flooding, possible fuel damages
  - At 4 m, doors will break, flooding will occur, fuel damages

Ringhals – EU Stress Test Summary

- Loss of power

- Three cases studied
  - LOOP case, grid is lost
  - LOOP case with diesels lost, gas turbines remains
  - SBO case, only batteries available

- Two first cases: power available for long time

- Third case
  - Cooling by steam driven auxiliary feedwater system
  - Batteries depleted, power for monitoring supplied by existing mobile units
  - RCP leakage will finally cause fuel damage, ~ 3 days
  - Spent fuel pool uncovery will occur after 3-5 days

Ringhals – EU Stress Test Summary

- Loss of ultimate heat sink

- Three cases are studied
  - Blockage of the intake buildings (possibility to use the discharge as intake)
  - Blockage of the intake buildings and discharge tunnel (possibility to re-circulate the cooling water)
  - Total loss of the UHS (no water available to the salt water system, 715)

- Two first cases: cooling can be maintained for long time

- Third case:
    - cooling chain lost
    - reliance on auxiliary feedwater system,
    - water sources limiting factor
    - 280-420 hours available until fuel damage occurs

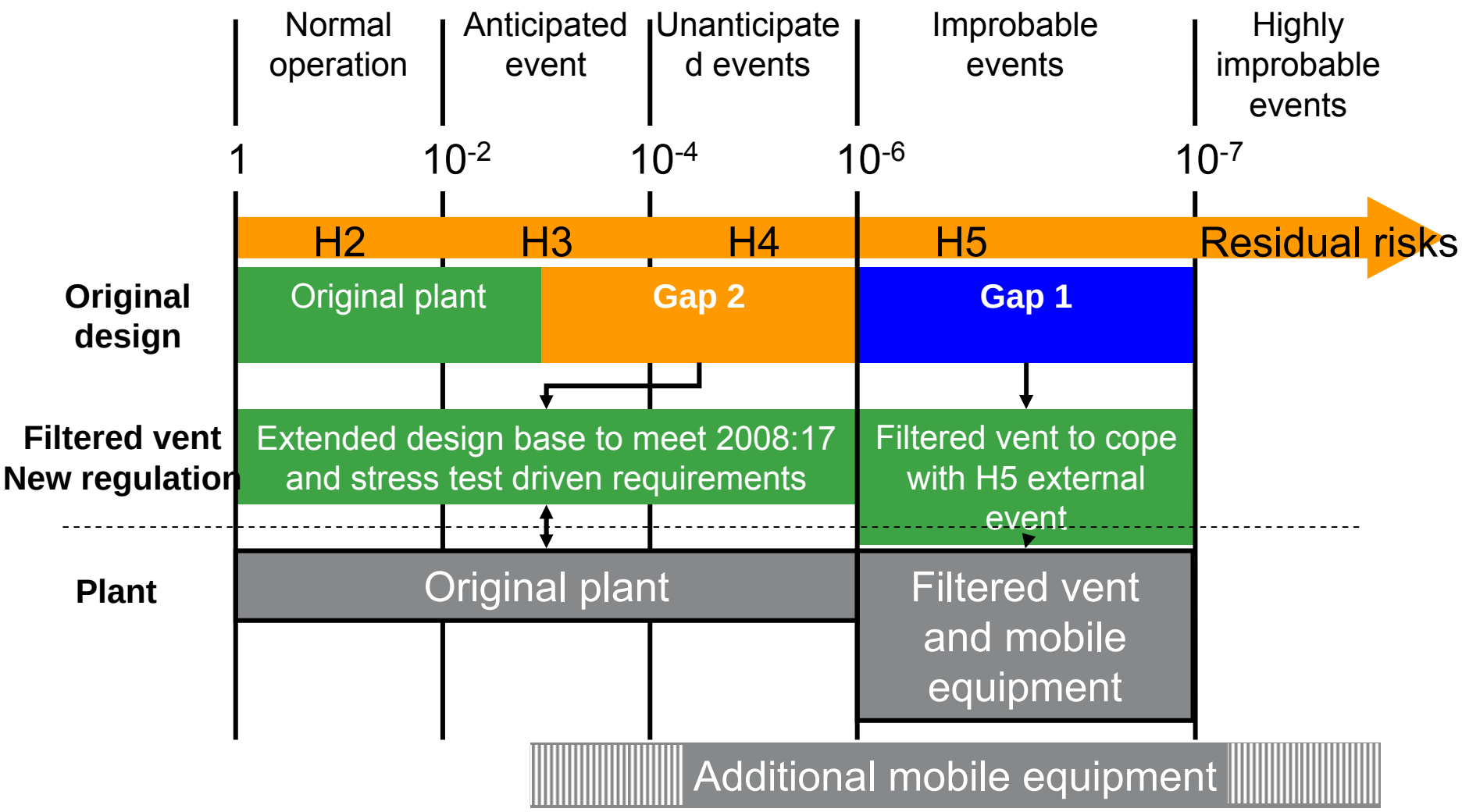
RAB: Immediate actions

1	Stress test
2	Improved power supply system for the on-site emergency control centre
3	Walk-down • Clarifications of EOP • Improved training with regards to mobile equipment • Improved adaptors for feeding SG using fire water system • New portable lights and torches • Improved licensing of operations supervisors • Renewed training in handling of SAMG
4	Spent fuel pool cooling • Clarification of maintenance procedures • Improved EOP regarding SFP
5	Analyses • External events, station blackout, spent fuel pool cooling and hydrogen control • Station electric accumulator capacity • Extended station blackout analyses

RAB: Short term actions

1	Improved emergency preparedness organization • Improve routines regarding food supplies • Improve training of the emergency preparedness organization • Prepare plans in order to terminate site isolation at severe site conditions
2	Technical improvements • Adaptors allowing fire trucks to feed filtered vent equipment • Flooding protection improvements
3	Operator instruction • Modernize site supervisor plan concerning severe weather • Improved plans for replenishing supplies • Improve instructions for re-starting a unit from complete blackout (including DC blackout) • Improve action plan for OBE

Long term overall approach



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RAB FLEX approach

- Assure adequacy of permanently installed equipment
  - Re-affirm plant design base

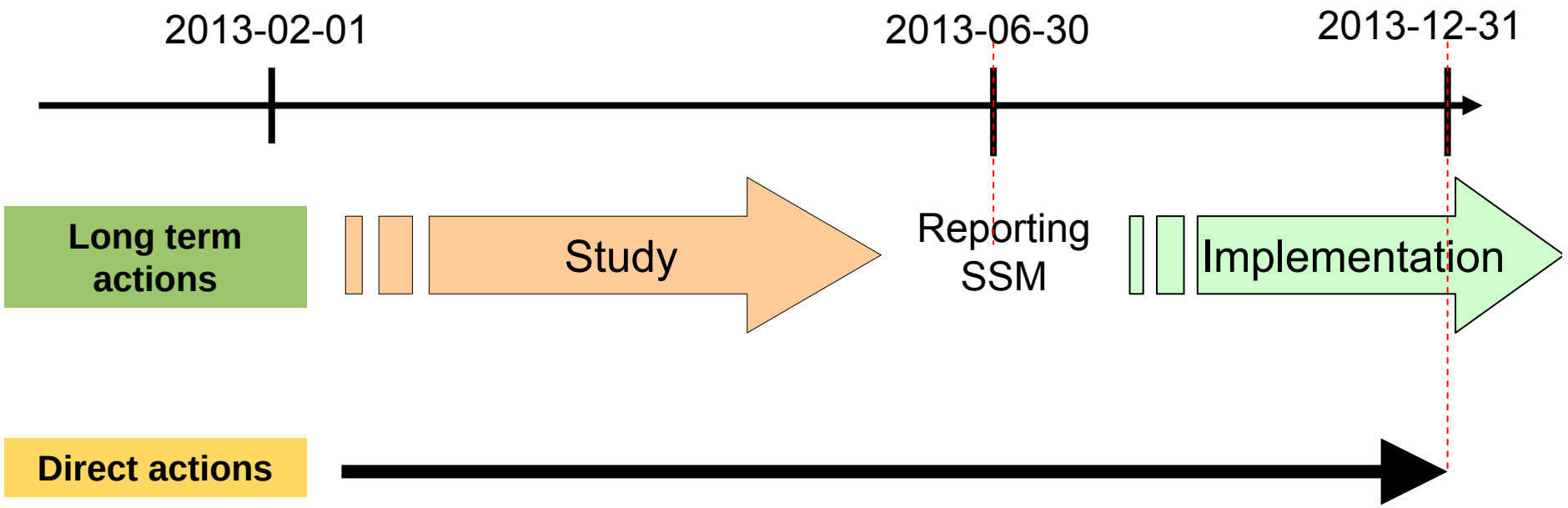
- Strengthen plant capability to handle a situation when auxiliary system operability is significantly impaired (not available)
  - Long term complete loss of AC power
  - Long term complete loss of ultimate heat sink (unavailable sea)

Add mobile equipment capability to handle other scenarios than core melt

RAB: Long term actions

1	Addition of mobile flexible equipment and adjust/strengthen emergency organization
2	R1-4 Re-qualify buildings and equipment to cope with H4 external events. Analyses and possibly some plant modifications
3	R1 – 4 Re-qualify containment and PMR – buildings to meet H5 external events. Analyses and possibly some plant modifications
4	R3 – 4 Increased station DC coping time
5	R1 – 4 Improve DC charging capability
6	R2 – 4 Install low leakage RCP seals
7	R2 – 4 Install CRDM rigging
8	R1 – 4 Install additional means for SFP charging

Long term actions: Project analysis phase



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Stress test context: Regulation SSMFS 2008:17

- Until 2004
  - Development of regulation by authority
  - Review and consequence analysis by industry
- 2005-01-01
  - Regulation in force
- 2005
  - Development of transition plans, defining measures required to meet the regulation and an implementation schedule
- 2007
  - SSM agreement to transition plans by decision. Final year of implementation 2012.
- 2010
  - Application for revised time schedule
- 2011
  - SSM decision on new schedule, including revised completion times for previous measures, expansion of content in some measures and addition of new measures previously not part of transition plan. New final date **2015**.
- 2012
  - All measures scheduled for 2012 in new decision completed
  - Scrutiny of remaining scope and completion ability

SSMFS 2008:17 content

- Regulation providing design requirements on NPP's.
  - 28 paragraphs on 24 pages (interpretation advice included)

Require safety functions*) to:

1. Be robust vs:
   - Single failure → Redundancy
   - Common Cause Failure → Diversity
   - Internal & **External events** → Separation (phys. and functional)
     → Environmental qualification (e.g. seismic)
     → Component protection and/or relocation

2. Be functional in all plant conditions
   - Current plants are "hot standby" plants by original design, with safety functions implemented to reach hot standby only. Non-safety functions used for further cooldown.

*) Reactivity control, RCPB integrity, Emergency core cooling, Residual heat removal, Containment integrity