2nd MDEP Conference
Paris, 15-16 September 2011

DESIGN ISSUES TO BE CONSIDERED ON THE BASIS OF FUKUSHIMA LESSONS

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Need for design improvements in GEN III reactors?

- The current safety standards written for Gen III reactors, such as
  - IAEA NS-R-1 *Safety of Nuclear Power Plants: Design,* as approved by the IAEA Commission of Safety Standards in May 2011, and
  - WENRA *Statement on safety objectives for new nuclear power plants*, issued in November 2010,

  seem to be valid and do not need changes.

- Nevertheless, their application in a more strict manner and interpretation as concerns safety margins needs to be reconsidered:
  - accounting site specific features and hazards
  - protecting from/avoiding common cause failures

Need for design improvements in GEN III reactors?

- Design specific WG's of MDEP provide an excellent platform to discuss on the possible needs for design improvements.

- In addition to regulators, also respective vendors and possibly utilities constructing or planning to construct certain reactor should attend the discussions.

Site specific features and hazards

- Increased robustness might be a general answer to some hazards but a careful site analysis is necessary to address adequately all conceivable hazards of a specific site
  - Japan has tsunamis, do others have something else to be considered more carefully than in the past (dam failures causing large flood, large earthquakes, oil spills to sea, ...) ?
  - different hazards should result in differences in the design

- Also positive site features could be utilised, such as the high hill next to Flamanville plant
  - emergency coolant by gravity?
  - enhanced physical separation/protection of some redundant equipment?

Avoiding common cause failures – physical protection and separation

- Strong and possibly leak tight barriers to protect vital equipment from external influence
- Double walls separated by adequate distance to avoid propagation of vibrations
- Improved lay-out
  - redundant subsystems/equipment separated by distance
  - redundant subsystems/equipment protected differently to account for different hazards (e.g., some located at low elevation to protect from seismic events, others located at high elevation to protect from floods)
- Thoroughly verified safety margins against exposure to internal fires or floods

Avoiding common cause failures – increased diversity

- At least two fully diverse means should provide each safety function
  - Passive systems
  - Active systems not needing any electrical power
    - diesel driven pumps,
    - hydraulic valve actuators,
    - manually remote operated valves,
    - (but not much credit should be given to steam turbine operated pumps)
  - Air cooling with small “cooling towers” as a secondary heat sink, at plants where the sea or river water cooling provides the primary heat sink

Protecting from common cause failures – transportable equipment for safety functions

- Incorporation of easily accessible (also in accident conditions) hook-ups for connection of transportable equipment
  - Clean water to primary and secondary circuit, to the containment and to the spent fuel pools
  - Borated water as needed to ensure sub-criticality
  - Electrical power of various voltage levels and currencies
  - Electrical power for charging batteries
  - Robust instruments for use in harsh operating conditions
- Several alternative and optimally selected connection points to plant systems should be available
- Well protected storage for transportable equipment and vehicles