



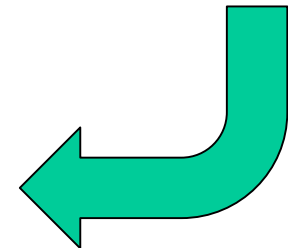
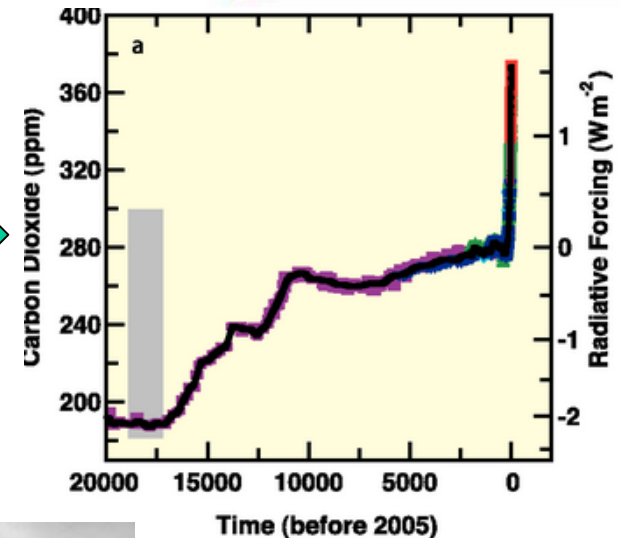
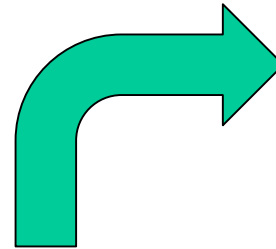
Impact of Climate Change on Safety of European NPPs

N.Müllner, K.Gufler, N.Arnold, C.Gepp, S.Sholly,
W.Renneberg, W.Liebert

Climate change and (nuclear) power plants



- Common way to look at it: Impact of energy technologies on climate change
- But climate change influences energy technologies as well





Impact of climate change on nuclear power plants

- Operation related: temperature increase, scarcity of cooling water
- Safety related: increase in extreme natural events threatening the safety of NPPs (focus of study)



Examples of extreme natural events that a.) could occur more/less frequent due to climate change

b.) could impact the safety of NPPs

- Avalanche, lahars, landslides & mudflows
- Biofouling
- External flooding,
- Extreme precipitation
- Extreme winds, hurricanes, and tornadoes
- Fog
- Frost
- River ice and ice jams

Protection of European NPPs against extreme natural events and stress tests



- European Council asked European Commission and ENSREG to specify “stress tests” in response to Fukushima Accidents
- Focus - extreme natural events, emphasis to earthquake and flooding
- Extreme natural events comprise extreme weather events

Stress Tests – Specification (excerpt)

- Extreme natural events challenging the plant safety
- Flooding, regardless of its origin
- Forest fire
- Large disturbance from the electrical power grid impacting AC power distribution

Stress Tests – Specification (excerpt)

- Presence of spent fuel storage
- Protective measures
- Assumptions on safety systems to control such events
- Provision taken in the design basis of the plant
- Loss of Offsite Power

Stress Tests Specification

Design Basis Flood

- Level of the design basis flood (DBF)
- Methodology to evaluate the design basis flood
- Provisions to protect the plant against DBF
- Combined effects
- General process to ensure compliance

Stress Tests Evaluation for EWE

- **Country**
- **NPP**
- **EWE**
- **Design Basis**
- **Rationale for Design Basis**
- **Evaluation Method**
- **Evaluation Report Year**

Results

- Extreme weather events that are reported
 - Flood
 - High Wind
 - High Temperature
 - Snow

Results

- Floods
 - DBF based on frequency (typically 10-4/y, with singular exceptions in both directions, notably Biblis)
 - Rationale for design basis – typically regulatory requirement
 - Evaluation of DBF typically based on extrapolation of historical data

Results

- Winds, Snow
 - Often based on civil construction norms
 - Constructed to withstand a set windspeed or pressure (exception: Oskarshamn, based on frequency, 10-2/y, and Cernovoda, 10-3/y)



Conclusions

- European NPPs use different criteria to protect themselves against extreme weather events.
 - The design basis events that are defined for various NPPs differ with respect to the frequency.
 - Where the design basis limit is derived from a design basis event frequency, historical data are used and extrapolated, without taking climate change into account. Since it is expected that climate change will influence the frequency of extreme weather events, future evaluations (or reevaluations) of the design basis event will have to consider climate change when they are based on historical data.
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