

**DRAFT**  
3 Mar

## What we could learn from the Forsmark unit 1 event 25 July 2006

Per Bystedt  
Swedish Nuclear Power Inspectorate

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## Outline

- The Plant
- The Event
- Causes and weaknesses
- About Oskarshamn 1
- Eye openers
- Observations

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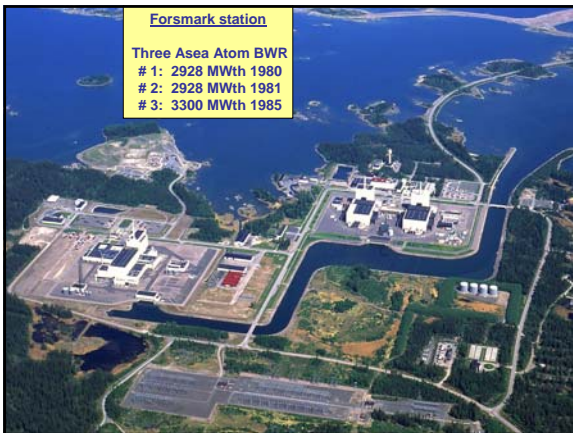
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### Forsmark station

Three Asea Atom BWR  
# 1: 2928 MWth 1980  
# 2: 2928 MWth 1981  
# 3: 3300 MWth 1985



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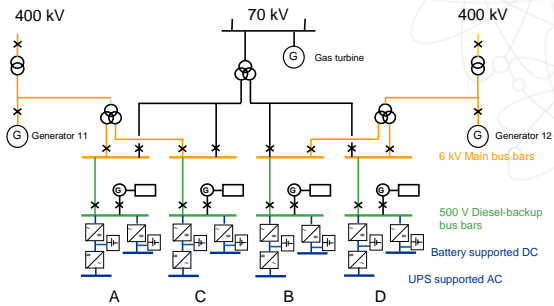
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## Electrical diagram – Forsmark 1



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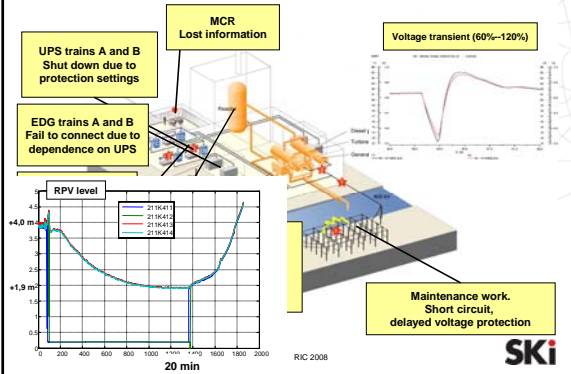
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## Main sequence of event, 25 July 2006



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## Main sequences of event, 25 July 2006. (Text)

- A short circuit in 400kV switchyard occurred during maintenance. Protection on low voltage was delayed
- A voltage transient (between 60% and 120%) was distributed into the onsite-power system
- The protective settings of the UPS were not sufficiently selective. 2 out of 4 UPS stop. CCF
- Connection of EDG was depending on bus bar powered from UPS. 2 out of 4 EDG do not connect
- Essential information lost or ambiguous in MCR
- Excessive steam blow-off from RPV. Some relief valves stayed open. Level turned at +1,9 meter at 20 minutes
- Unit cooled with 2 out of 4 ESF trains with AFW, LHSI and CS powered by EDG:s
- Offsite power to safety bus bars restored at 22 minutes

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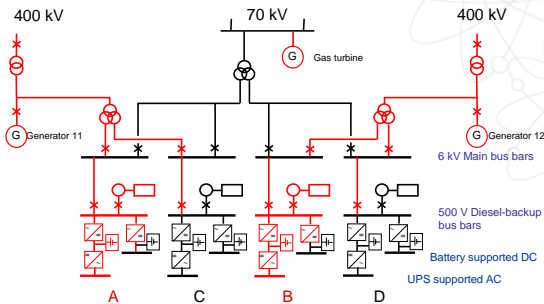
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**Electrical diagram – about 1 minute into the event  
(powered / not powered)**



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**Causes / Weaknesses**

- Design weaknesses
  - UPS were not set to cope with a "design basis" transient
  - EDG connection were depending on power from UPS
  - Information in MCR effected by power loss
  - Unclear "fail safe state" at power loss
- Administrative weaknesses
  - Deficient routine at switchyard maintenance
  - Generator breaker low frequency protection (47,5Hz) not properly installed
  - Start of local gas turbine failed. Testing omissions

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**Concerns found by OKG for Oskarshamn 1  
(Asea Atom BWR, 1375 MWt, start 1972)**

- The unit was extensively modernised between 1999 and 2002
- New 4 train digital RPS/DPS installed, powered from UPS fed bus bars
- OKG considered this modernised design not sufficiently robust in light of the Forsmark event
- Disturbances in UPS power (CCF) could leave RPS/DPS in less well defined states and with a restart time difficult to assess
- OKG concluded that a more thorough own review, independent from the supplier, was necessary
- Oskarshamn 1 was modified again in the fall 2006

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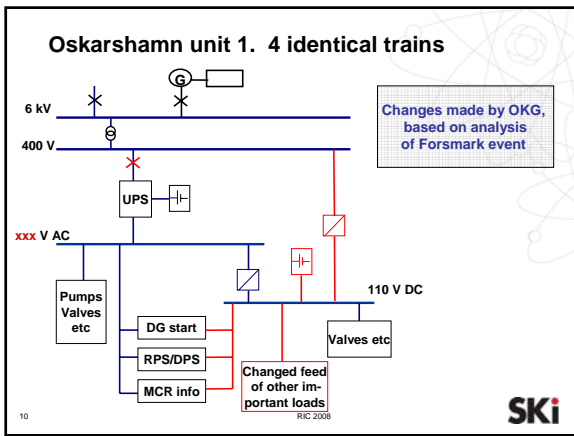
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- ### Eye openers
- Electrical events should be analysed with a broad mind and for combinations of assumptions. Analysis!
  - Plant modernisation should take all relevant design aspects into account. Modernisation management!
  - Digital safety systems need robust power supply, e.g. dual feeding from independent sources. Design!
  - New generations of techniques, as well as of engineers, requires attention. Documentation, configuration management!
  - Communication between Utility and Grid Operator should be sufficient. Communication!
- 11 SKi

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- ### Observations
- Analysis of the event based on DiD concept gave interesting insights that supported other results
  - Enhanced awareness shown on electrical systems in LER:s. More thorough investigations. Better information.
  - Examples of LER where supplier competence could be questioned.
- 12 SKi

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## Final words

- The event resulted from a complex combination of design and operational weaknesses
- It gave us a reminder that a plant strong in redundancy can be severely weakened by CCF
- It is encouraging to note the international interest shown in experience from the event. There are lessons to be learned for both industry and regulators
- Wisely managed, the event will help improving safety.

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