Transition from EOPs to SAMGs

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Overview

- EOP entrance/exit criteria
- SAMG entry/exit criteria
  - Various examples
- References

Principle of Transition EOP-SAMG

APOS

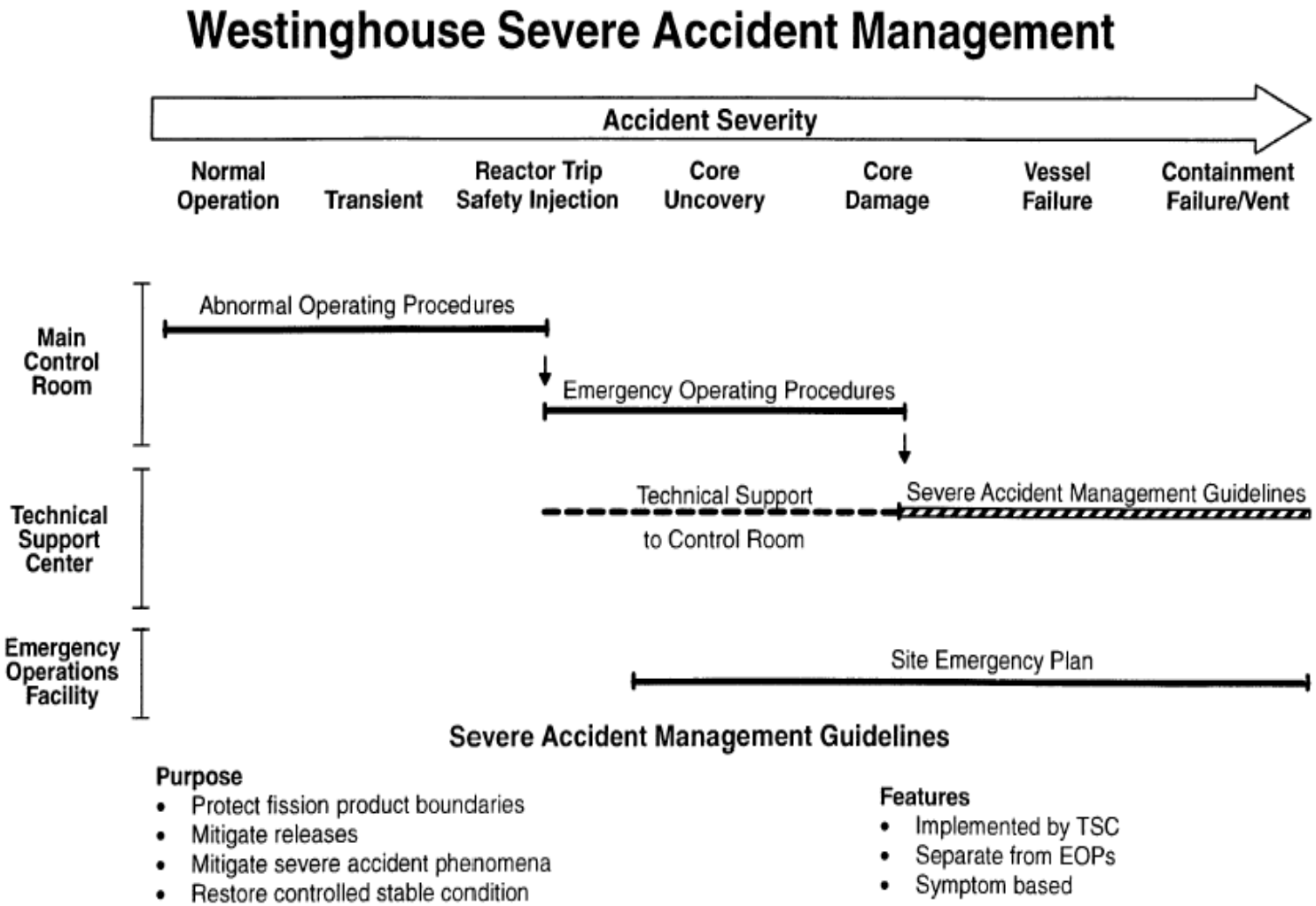
- Accidents are, in principle, covered by EOPs
  - e.g.: LOCA, SGTR, ATWS, SBO
- EOPs go way beyond DBA
  - e.g. up to probability of 1.0E-08 (WOG EOPs)
  - EOPs include non-conventional cooling
    - May include cooling by non-qualified water sources
- But the EOPs may not be able to prevent core damage
  - Operator has done everything he could, there is no way left to cool the core, all is tried but failed
  - THAT is the moment to enter SAMG

Entry/exit criteria EOP

- Entry into EOP from AOP is usually through occurrence of scram or safety system actuation
  - Entry is followed by diagnosis according to e.g. E-0 (WOG approach)

- Exit from EOP to SAMG is *imminent* or *actual* core damage

Westinghouse AMP Concept



World of SAMG is different!

Domain of SAMG is big drama:

- Plant is lost
- Life maybe in danger – also life of family
- Plant status confusing – what is going on???
  - ´half of instrumentation is red, other half is dead'
- Needed actions can be conflicting, and maybe contrary to ´normal´ actions (i.e. in EOP-domain):
  - EOP-space: spraying the containment is okay,
  - SAMG space: spraying may de-inert containment atmosphere: hydrogen burn??
- Outcome of actions can be uncertain

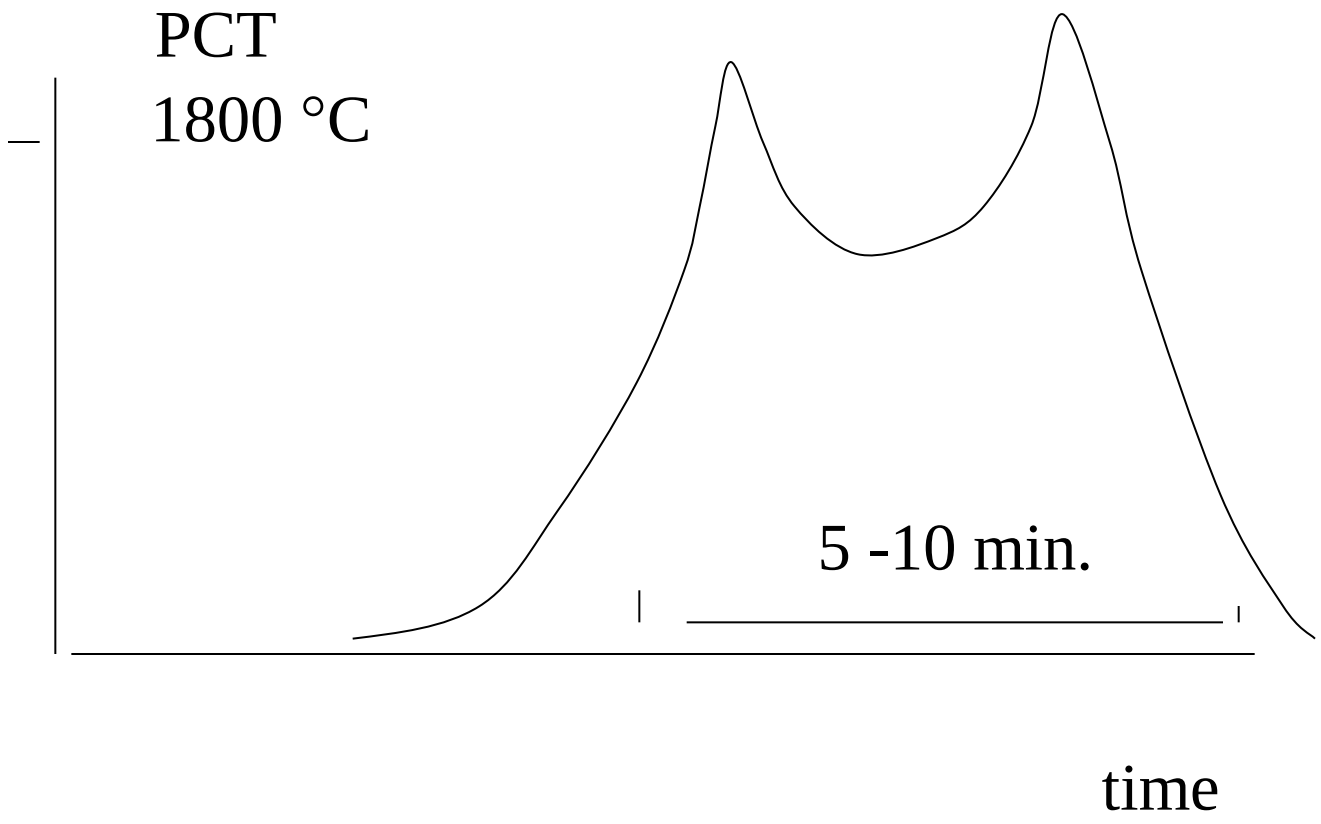
When is there core damage?

- Inside DBA: ECCS design criteria to be observed (1200 °C, 17% clad oxidation)
- Outside DBA: higher temp. / oxidation can be accepted, but mass of molten corium should still be around 0 kg.
- Investigation of amount of molten mass in TACIS/PHARE project, using MELCOR calculations

Estimate of core damage (VVER - example)

Entrance into FR-C.1	Amount of molten mass in vessel	Strategies
550 °C	0 kg	All C.1 strategies effective
650 °C	0 kg	Sec. depressurisation not effective
750 °C	150 kg	None of C.1 strategies effective

PWR transient at threshold of FR.C-1 (example)



Engineered transition criteria

- Must have observable criteria
  - No time to do calculations
- There is a wide scatter in such criteria
  - Each vendor / Owners Group has its own criteria
  - Examples: WOG, CEOG, B&WOG, EdF GIAG (~ SAMG in French), Areva (EPR)

WOG - transition criteria

Westinghouse Owners Group SAMG:

- Entry conditions SAMG defined by exit of EOPs:
  - FR-C.1: core exit T_{max} **AND** all recovery failed (i.e., core damage unavoidable)
  - FR-S.1: core exit above T_{max}
  - ECA 0.0: core exit above T_{max}

    T_{max} = ca. 550 – 650 °C, is plant specific

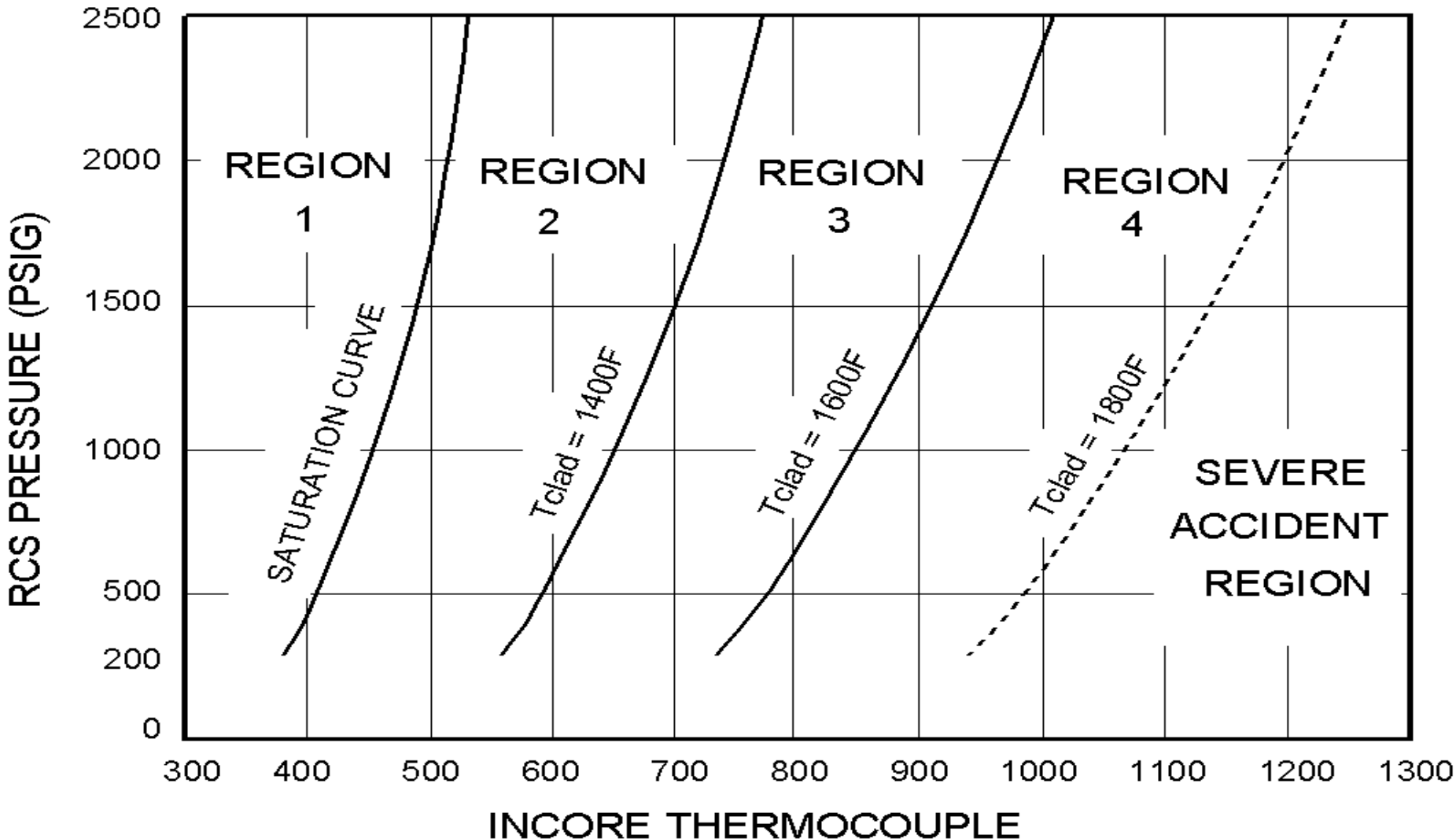
    T_{max} is ‘red entry’ into FR-C.1 (but there recovery is available)

EOPs exited; all actions that remain useful are also in SAMG.

Combustion Engineering Owners Group SAMG:

- EOPs are not formally exited! SAMG executed in parallel, but consistency checked, priority always with SAMG
- Entry into SAMGs is decision of Site Emergency Director (SED), not MCR, basis is not just CET (core exit T)
- Basis:
  - flow insufficient to cool the core
  - level indication ~ 0%
  - CET 10 °C superheat and rising

Babcock & Wilcox Owners Group transition criteria EOP - SAMG



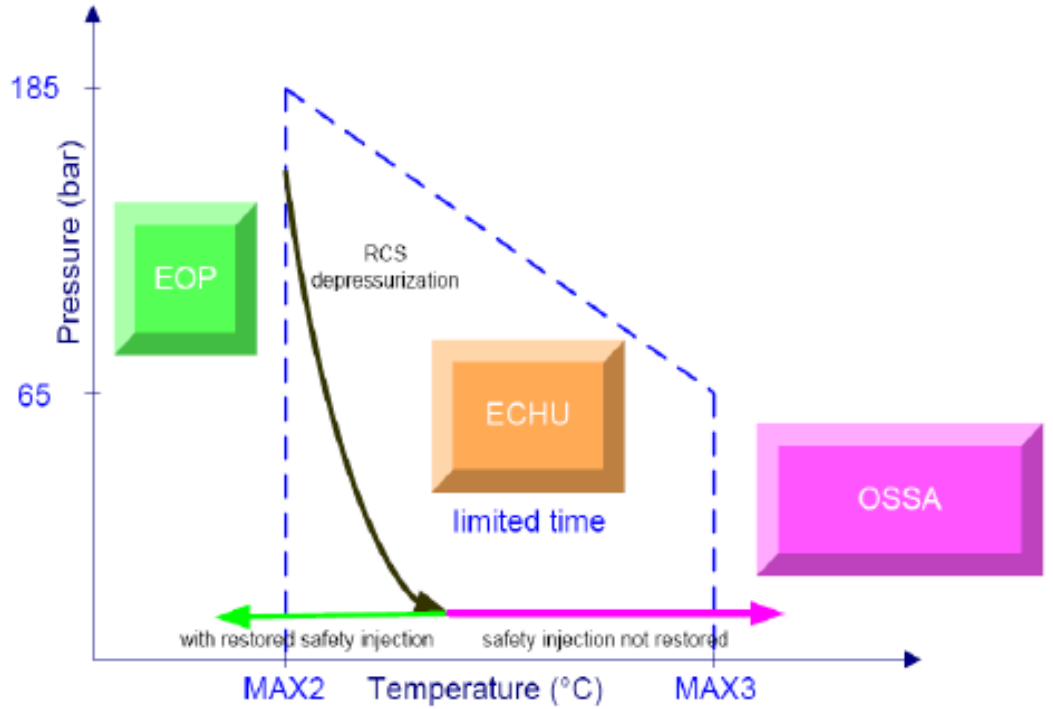
EdF - transition criteria

- CET 1100°C or activity inside containment according to table
  - prevents too early transition
- Decision by plant headquarters

Time after Scram	Setpoint
t < 1 hr	s = 500 Gy/hr
1 hr < t < 6 hrs	s = 100 Gy/hr
6 hrs < t < 5 days	s = 50 Gy/hr
5 days < t < 1 month	s = 10 Gy/hr
t > 1 month	s = 5 Gy/hr

OSSA (Areva, France)

- **OL3: EOP** → **ECHU** *(Emergency Core Heat-Up)* → **OSSA**
  - *° COT = 650°C at any pressure*
  - *° Containment dose rate*
  - *° COT = 1000°C (less for high P RCS > 65 bar)*
  - *° Hydrogen concentration*
  - *° Containment dose rate*



- **FA3: EOP** → **OSSA**
  - *° COT = 650°C*
  - *° Containment dose rate*

Transition Criteria EOP – SAMG, organizational aspects

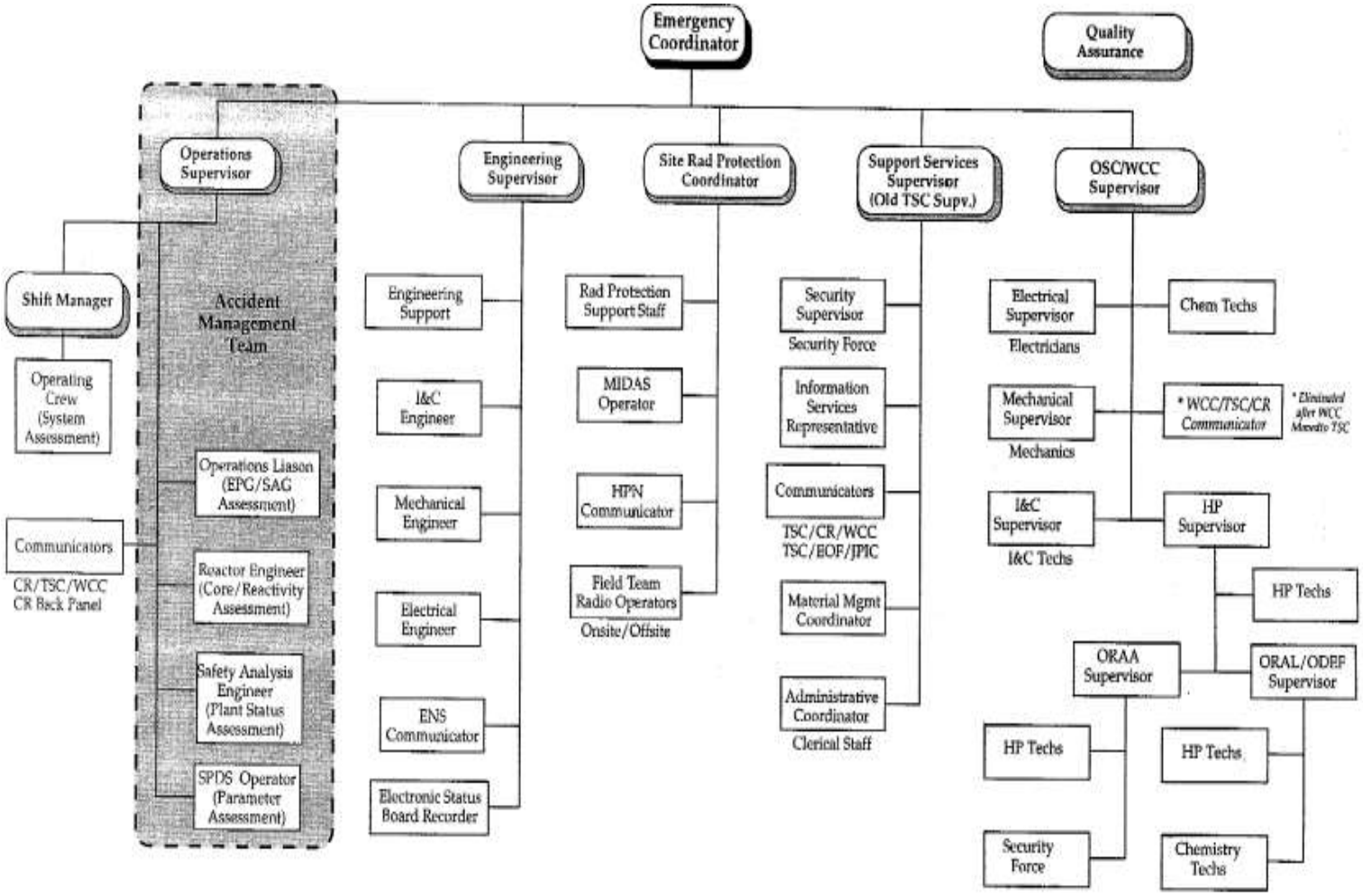
Not only system parameters are relevant, also ***readiness of organisation*** :

- ERO (TSC) must be operational

- Operational means: TSC understands the situation and is ready to give its **first recommendation**; NOT: TSC has arrived and has assembled in their room!

- Make sure guidance is in place if TSC is not yet operational (needed for e.g. ATWS); in WOG: SACRG-1

Example of ERO, note the Accident Management Team



Exit from SAMG

- SAMG is not a long-term concept

- Dependent on accident evolution decisions on long-term provisions
  - cooling
  - power
  - treatment of run-off water
  - decontamination

Exit of SAMG (cont'd)

Example from Westinghouse:

- Core temp. < [x] AND stable or decreasing
- Site releases < [y] AND stable or decreasing
- Containment pressure < [z] AND stable or decreasing
- Containment hydrogen < [u] AND stable or decreasing

Conclusions

- Various approaches for the transition EOP-SAMG, basis: imminent or actual core damage
- Transition includes not only a change in guidelines, but is a fully different approach – be aware of this!
- Transition should be clearly described, including all organisational changes
- Avoid any time gap in the transition – no pause in the handling of the accident
- Exit to long-term provisions: also needed

References

[1] „Transition from EOPs to SAMG„, George Vayssier, IAEA SAMG workshop, 10-14 December 2012, Islamabad, Pakistan

Questions?
Comments?

Thanks for your attention!