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Design implementation of Stress-test measures on Czech and Slovak NPPs

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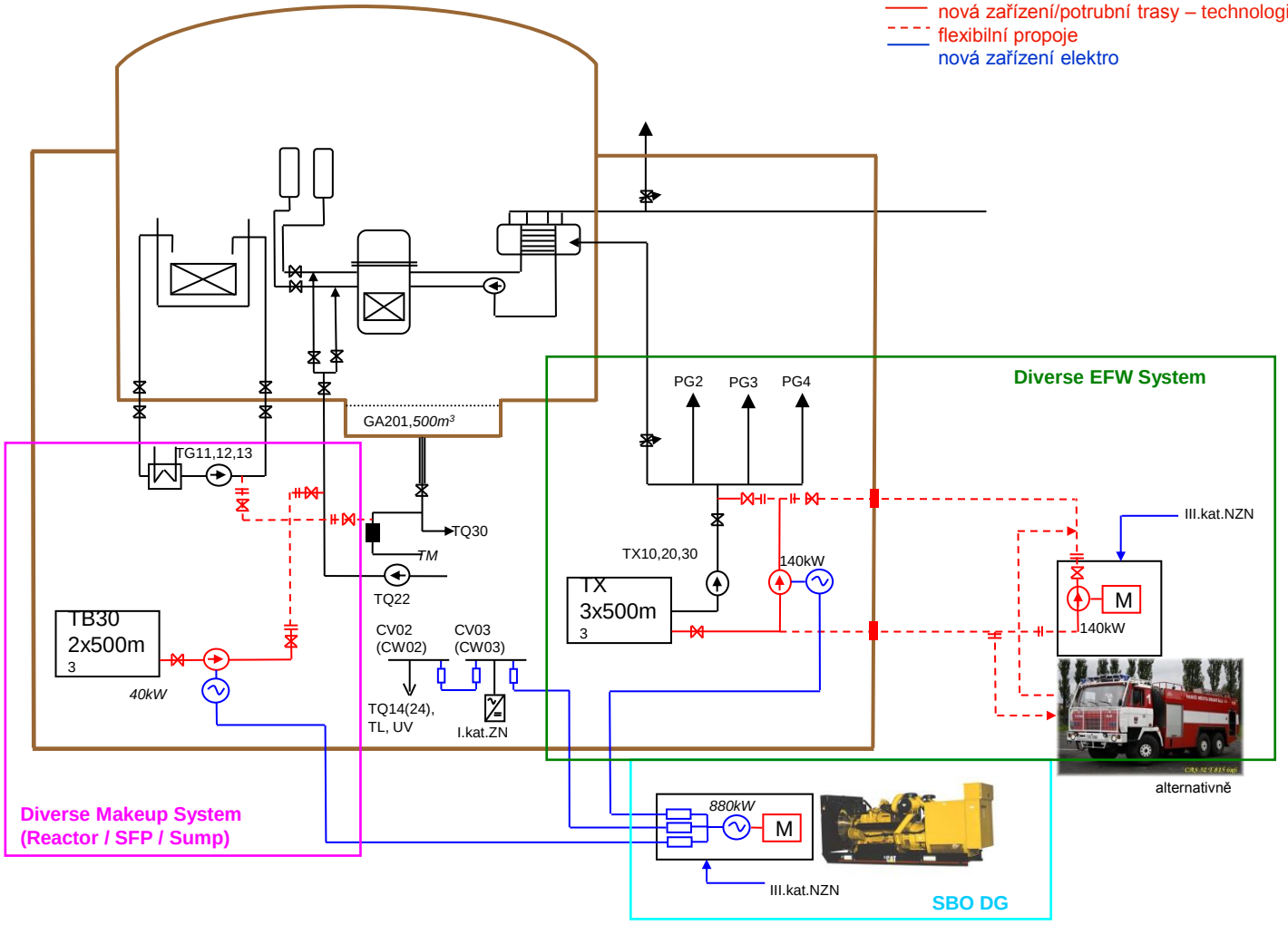
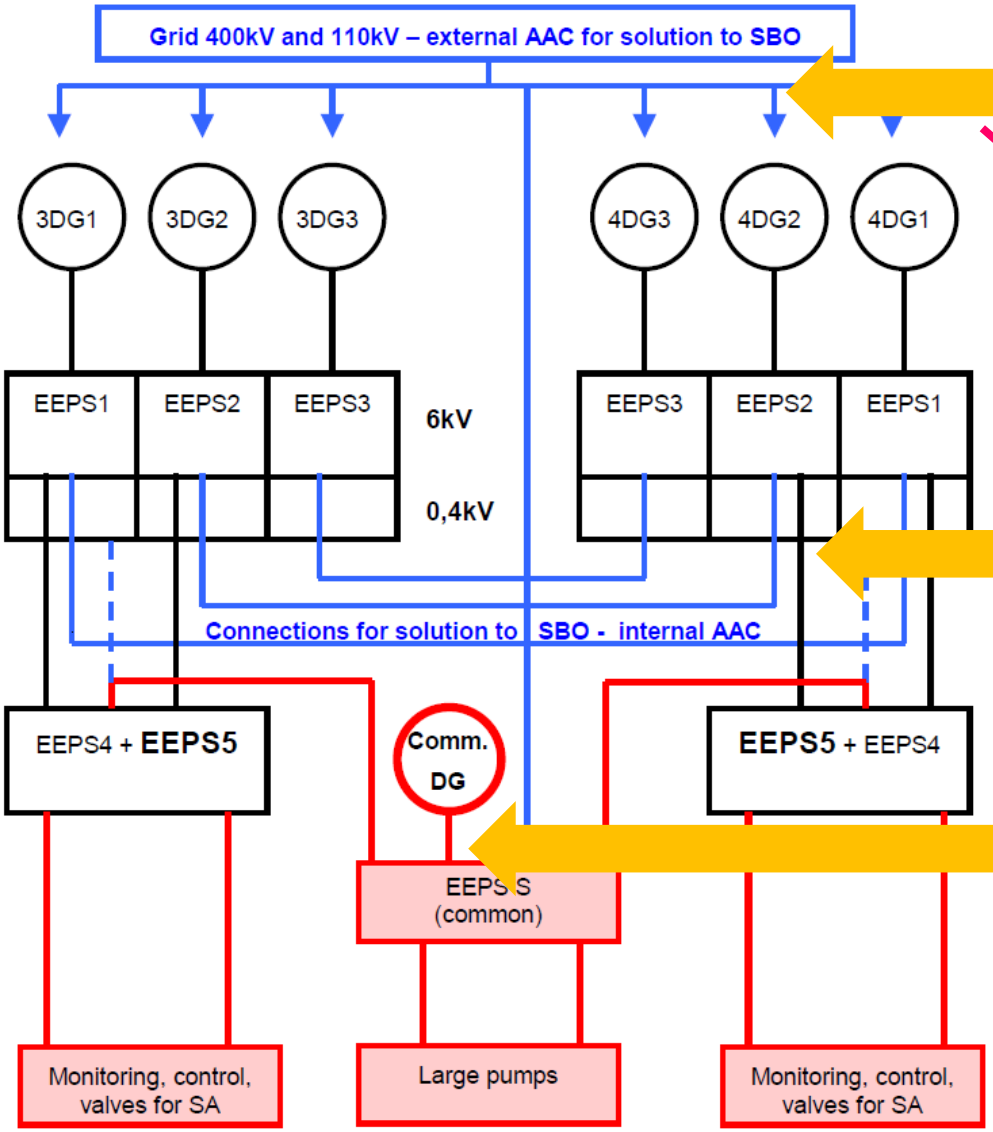
After Fukushima activities – CZ and SK NPPs

- **This presentation focuses design activities on**
  - CZ NPPs (Temelin12, Dukovany1234)
  - SK NPP MO 34 (still under construction)
- **The result of stress test analyses (~National reports) quite well defined needed actions and improvement of safety functions.**
- **Technical solution of safety measures was defined very generally (no feasifibility studies performed), accenting these main aspects:**
  - High withstand level against more **severe extreme external events** (combinations)
  - **All Units** on site can be affected
  - **Reactor and SFP** can be affected simultaneously
  - Various modes of the Unit considered (**power operation, refueling**,….)
  - Added safety measures should be diverse/independent on existing systems
  - Mobile equipment strongly preferred
  - Big press on **short deadlines** (conceptual design, detailed design, commissioning)

Example of original technical ideas



Before Fukushima status of NPPs (example of MO34)



External AAC (Grid) not available for several days – **SEISMICITY**,…

The SBO „After Fukushima“ is not solved !!

Interconnections 6kV cannot be used because **ALL UNITS** are affected by the EVENT

Functionality for SA with just **SINGLE** common DG is under question (for min. 3days, after seismicity ???)

CONSUMERS FOR MITIGATION OF SA

Design considerations

- **Design environment**
  - CZ legislation does not cover DEC (SBO, SA) (–)
  - CZ NPPs are in operation (–)

  - SK legislation includes requirements on DEC (SBO, SA) (+)
  - SK NPP MO34 is under construction – Basic desig level still opened (+)

- **Diversity and independence of new safety measures**
  - New equipment is only partly diverse. No time for technical development of new robust principles.
  - Independence / separation resolved quite well (because it is standard design principle in NPPs)

Design considerations

Targeting of safety measures

- **It is difficult to forecast the type of disaster in Central Europe. New safety measures are therefore focused on improvement of essential safety principles of NPPs**
  - **More robust Defence in Depth** (in all DID levels, main accent to level DID 4 – IAEA system)
  - **Additional safety functions for DEC**

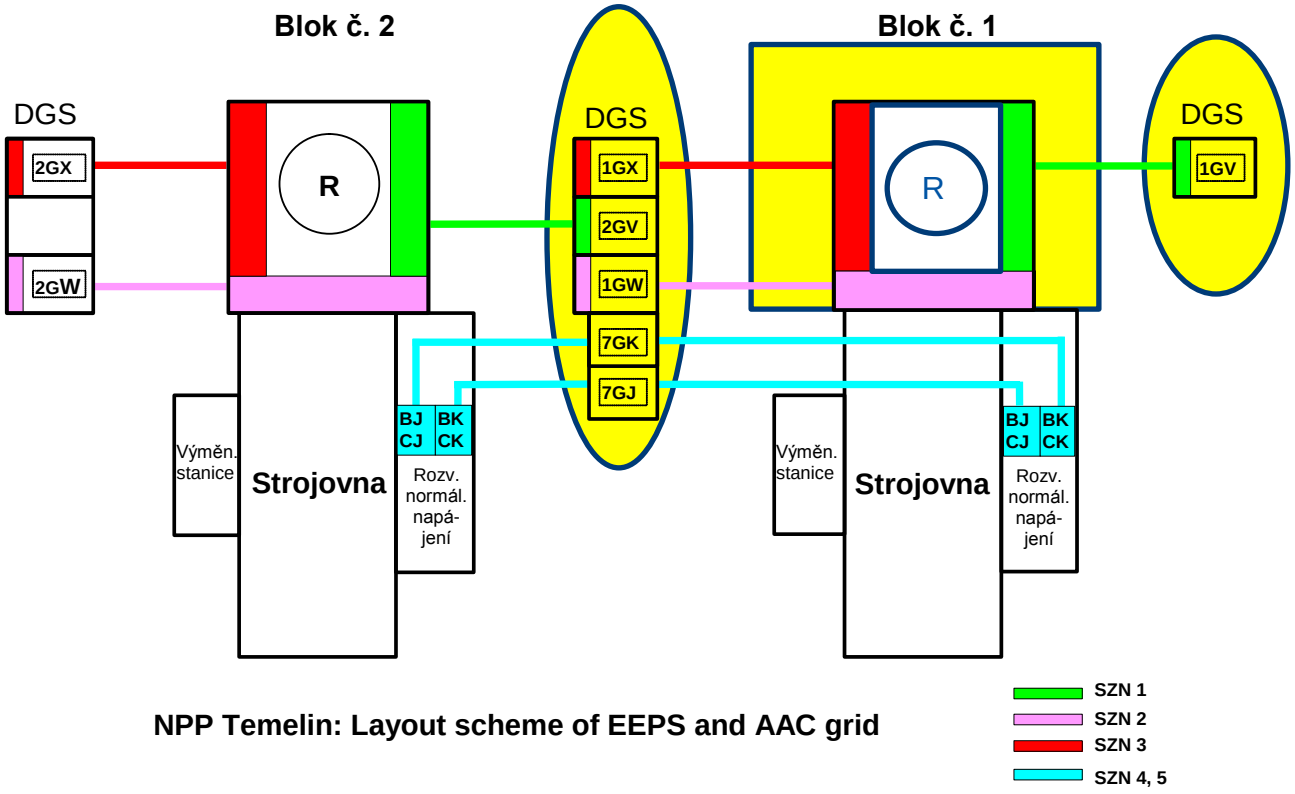
DID sublevel	Purpose	Description	Note	CZ	SK (MO34)
4.1 A	**SA prevention**	**SBO** single unit, other unit in DBC, external AAC	Designed **before** Fukushima		
4.1 B		**SBO** single unit, other unit in DBC, internal AAC			
4.1 C		**SBO** ALL units, internal AAC, with UHS	New **after** Fukushima		
4.1 D		**SBO** ALL units, internal AAC, without UHS			
4.2 A	**SA mitigation**	**SA** single unit, other unit in DBC	Designed **before** Fukushima		
4.2 B		**SA** single unit, other unit in SBO	New **after** Fukushima		
4.2 C		**SA** ALL units, after SBO development			

Mobile or stable equipment?

Feature (vlastnost)	Mobile	Stable
Protection against event -On site (close) -On site (distant)	**By transport** Bunker Bunker	**By distance** Bunker Bunker
Transport	Expected **problems** (mainly with heavy, powerfull equipment)	N/A – stable equipment
Connection (připojení)	Where? How? Who? (difficult in real disaster situation)	Permanently connected, prepared
Start of function (Náběh funkce)	After connection, **with large time delay**	**Fast** (minutes), automatic
Voltage and Power (Napětí a výkon)	**LV (400V)** close to consumers **Low power** - (sensitive on behavior of consumers and failures in distribution)	**MV (6kV)** – protection by distance possible **High power** – non sensitive, tolerates mistakes, transients
Compatibility with EEPS Kompatibilita s SZN	**Incompatible** (selectivity corrupted)	**Compatible** (selectivity is kept)
Testing – for functionality in real disaster situation Testovatelnost – pro funkčnost v reálné situaci	Test of transport, connection … **impossible** (simulation will be demanding for operation staff – **military skill needed**)	Regular **periodical tests possible** (similar as for design EEPS)

Design considerations

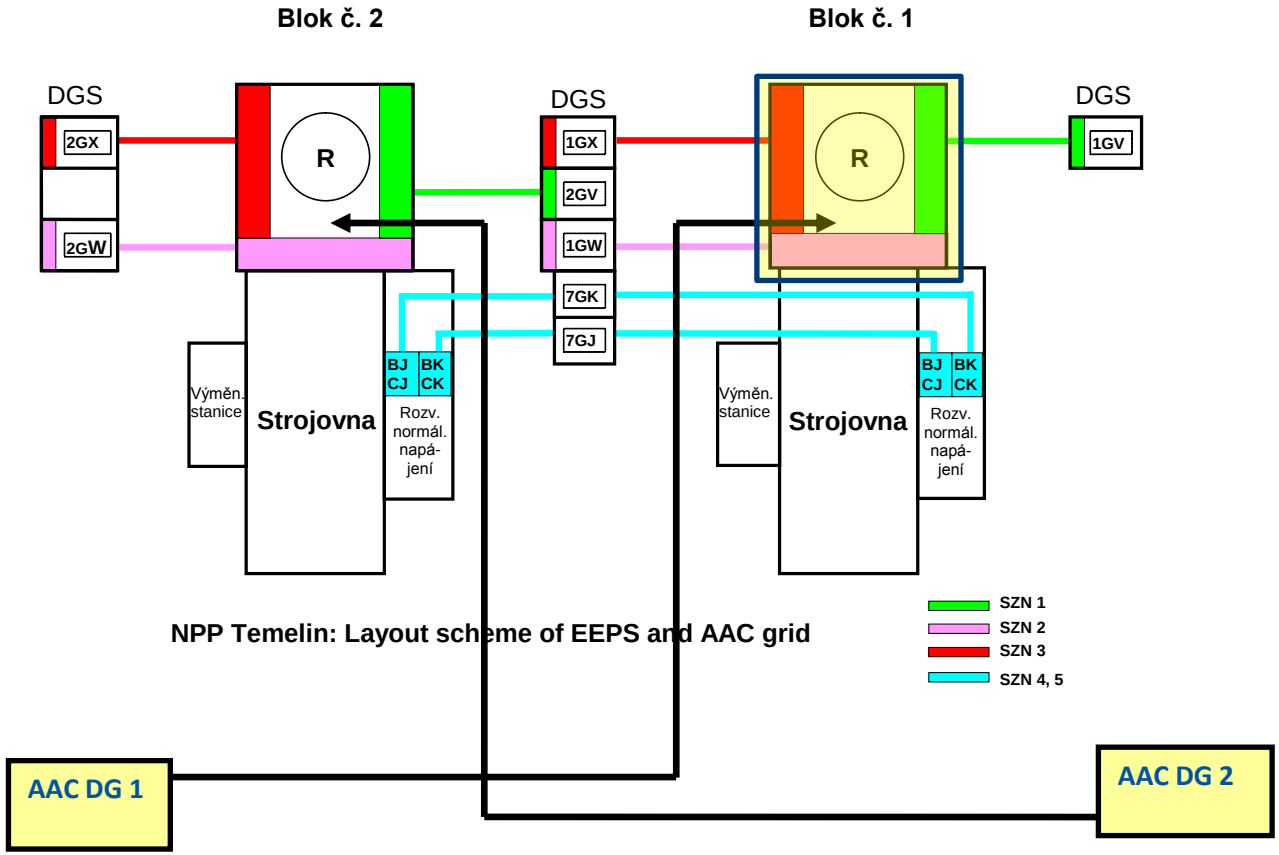
Location of stable equipment



NPP Temelin: Layout scheme of EEPS and AAC grid

Design considerations

Location of stable equipment



NPP Temelin: Layout scheme of EEPS and AAC grid

Design considerations

Common features of stress tests safety measures-1

NPPs will have following significantly improved safety features after design and implementation of stress test measures:

- Increased robustness of DID (further independent sublevels in relation to every detected “cliff edge” effects).
- Wider scope of NPP accident operating modes and accident scenarios addressed. DEC considered even at all Units on site.
- Previous safety measures and procedures sufficient for coping with less difficult events are usually preserved
- New safety measures must not decrease performance of design basis safety functions
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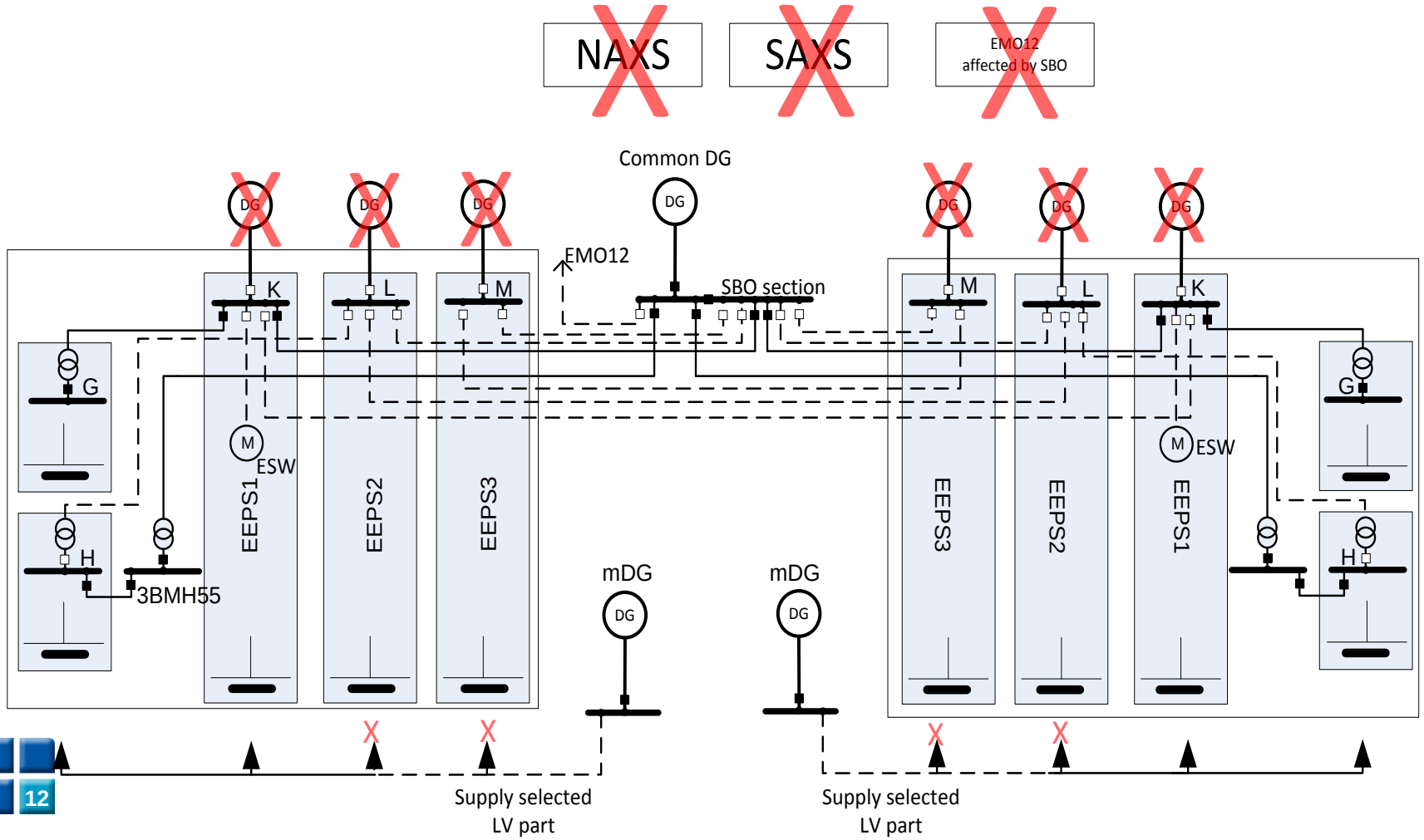
Common features of stress tests safety measures-2

- Minimization of the need of human intervention during the first phases of accident scenarios declared in some cases is not realistic. Particularly due to effort for more economical design significant scope of direct human actions is needed.
- Higher preference is given to “passive” or manually operated systems (i.e. storages of coolant, longer battery autonomy time, battery supplied or manual actuations, etc.)
- Emphasis was given to keep the plant in “safe” conditions within 72 hours from the accident onset, also with the support of in-site contributions. Later is assumed effective external help and repair of some portion of DBC systems.
- The combination of mobile and stable means is used. Hardened stable means are more essential, mobile more backup. Use depends on the event and scenario of solution. Flexibility is accented.
- Design solution enables fulfillment of safety functions even upon failures of equipment. The principle of functional groups (FSK) is used. Preventive measures (coping with SBO) have higher ability to cope with failures. For SA mitigation measures is this ability at least partial.

Mochovce 3,4 – „stress test measures“



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THANK YOU FOR YOUR ATTENTION