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Modelling using MELCOR1.8.6 for fusion

- DEMO baseline 2017** 16xSEC
HCPB 3xOB & 2xIB / SEC, FW made of Eurofer, pins in BZ with advanced ceramic breeder & Be₁₂Ti in block as neutron multiplier, radiation emissivity 0.3, BB inlet He 8 MPa, 300 – 520 °C.
BB PHTS 8x loops: 3xsingle loop (Loop3, 4, 5); 1xmultipl loop of 5 single loop (Loop 6), inventory of 1.0166E4 kg.
DIV PFU PHTS two loops connected in series, PFTS inlet water 5 MPa, 130 – 136 °C, inventory of 1.66352E+05 kg.
PG loop BB – TER, He 8 MPa & 500 °C inventory of 5.373E+02 kg.

Systems in the tokamak building
VV, VVPSS (wet & dry EV, 6xBL, 3xRD),
cryostat, cryostat space, galleryB3&B4,
PRS, PRV, PRZ.

Tritium BB 4.2 mg, BB PHTS 58 mg
HTO PG loop 8.2 mg

Simulation time steady state 2000 s →
SBO 72 h (long term), results plotted every

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graph LR
    subgraph Real-time
        RT_DS[Data source] --> RT_DP[Real-time data processing]
        RT_DP --> RT_DS
        RT_DS --> RT_DS_S[Real-time data storage]
    end
    subgraph Streaming
        S_DS[Data source] --> S_DP[Streaming data processing]
        S_DP --> S_DS
        S_DS --> S_DS_S[Streaming data storage]
    end
    subgraph Batchwise
        B_DS[Data source] --> B_DP[Batchwise data processing]
        B_DP --> B_DS
        B_DS --> B_DS_S[Batchwise data storage]
    end
    RT_DS_S --> DI[Data integration]
    S_DS_S --> DI
    B_DS_S --> DI
    DI --> DA[Data analysis]
  
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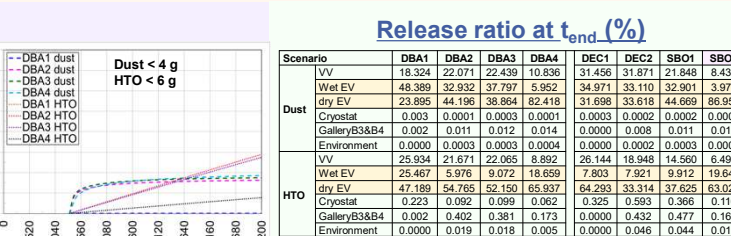
PG loop

The diagram illustrates a multi-stage parallel processing architecture. It consists of a series of stages, each containing a parallel processing block (PPB) and a delay block (D). The PPBs are connected in a chain, and the delays are used to align the signals. The final output is a combined signal.

SBO 72 h (long term), results plotted every 5 s after 600 s.

BB	Breeding Blanket
BZ	Breeding Zone
CV	Control Volume
DIV	Diverter
EF	Eurofer
Env	Environment
FL	Flow Path
HX	Heat Exchanger
IB / OB	Inboard / Outboard
MF	Manifold
PFU	Plasma Facing Unit
PHTS	Primary Heat Transfer System
PRS	Pressure Relief System
PRV	Pressure Relief Volume
PRZ	Pressurizer
S-DS	Stand-by Detritiation System
SEC	Sector
SMS	Single Module Segmentation
ST-VS	Suppression Tank Venting System
TER	Tritium Extraction & Removal
VVPS	VV Pressure Suppression System

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VPVSS	VV Pressure Suppression System



Scenario	DBA1	DBA2	DBA3	DBA4	DC1	DC2	SBO1	SBO2	
Dust	VV	18.324	22.071	22.439	10.836	31.456	31.871	21.848	8.341
	Wet Ev	48.389	32.932	37.977	5.952	34.971	33.110	32.901	3.976
	dry Ev	23.895	44.196	38.864	82.418	31.698	33.618	44.669	86.859
	Cryostat	0.003	0.0001	0.003	0.0001	0.0003	0.0002	0.0002	0.0001
	GalleryB3&B4	0.002	0.011	0.012	0.014	0.0000	0.008	0.011	0.012
	Environment	0.0000	0.0003	0.0003	0.0004	0.0000	0.0002	0.0003	0.0008
	VV	25.934	21.671	22.065	8.892	26.144	18.948	14.560	6.498
HTO	Wet Ev	26.747	26.747	26.747	7.803	9.932	9.932	9.932	9.932
	dry Ev	47.189	54.765	52.150	65.937	32.393	33.314	37.625	63.023
	Cryostat	0.223	0.092	0.099	0.642	0.325	0.593	0.366	0.116
	GalleryB3&B4	0.002	0.402	0.381	0.173	0.0000	0.432	0.477	0.163
	Environment	0.0000	0.019	0.018	0.005	0.0000	0.046	0.044	0.012

Figure 10 consists of two plots showing FW temperature evolution. The left plot shows FW temperature reaching T_{EF} for various loop configurations (DBA1, DBA2, DBA3, DBA4) with and without FW-OB. The right plot shows FW temperature reaching T_{EF} in one BB loop for the same configurations.

Left Plot: FW Temperature reaches T_{EF}

The y-axis is Temperature (°C) from 300 to 850. The x-axis is time (s) from 0 to 11520. The legend includes:

- DBA1 Loop3 FW-OB (solid blue line)
- DBA2 Loop3 FW-OB (dashed blue line)
- DBA3 Loop3 FW-OB (dotted blue line)
- DBA4 Loop3 FW-OB (dash-dot blue line)
- DBA1 Loop4 FW-OB (solid red line)
- DBA2 Loop4 FW-OB (dashed red line)
- DBA3 Loop4 FW-OB (dotted red line)
- DBA4 Loop4 FW-OB (dash-dot red line)

Right Plot: FW Temperature reaches T_{EF} in one BB loop

The y-axis is Temperature (°C) from 300 to 850. The x-axis is time (s) from 0 to 25920. The legend includes:

- DEC1 Loop3 FW-OB (solid blue line)
- DEC2 Loop3 FW-OB (dashed blue line)
- SBO1 Loop3 FW-OB (dotted blue line)
- SBO2 Loop3 FW-OB (dash-dot blue line)

- T_{EF} is reached on the affected FW in the long term → **aggravating in-vessel LOCA** → **aggravating BB LOCA** if $dp > \Delta p_{PG_lim}$.
- The PFU HPTS is intact in all scenarios that there is no water ingress into the VV → **no H_2 production & no release of activated corrosion products**.
- With the PG loop, the **vv pressurization exceeds the design limit**. Increasing the EVs to **4 times** (DBA4 & SB02), the VV pressure is below p_{VV_lim} in the long term. However, its peak pressure after the accident is not efficiently suppressed, which is still an open issue.
- The most dust & HTO are transported into the EVs. Without the PG loop, no environmental release occurs (DBA1 & DEC1). Max. environmental releases of **dust $< 4\text{ g}$ & HTO $< 15\text{ g}$** → the estimated early dose is far below the applicable regulatory limit.