LeadCold

Power to the Arctic

eit InnoEnergy

Lead-cooled reactors for electricity generation in Arctic areas

- Canadian market
- Technical status update of SEALER plant
- R&D program
- Demo plant
- Investment

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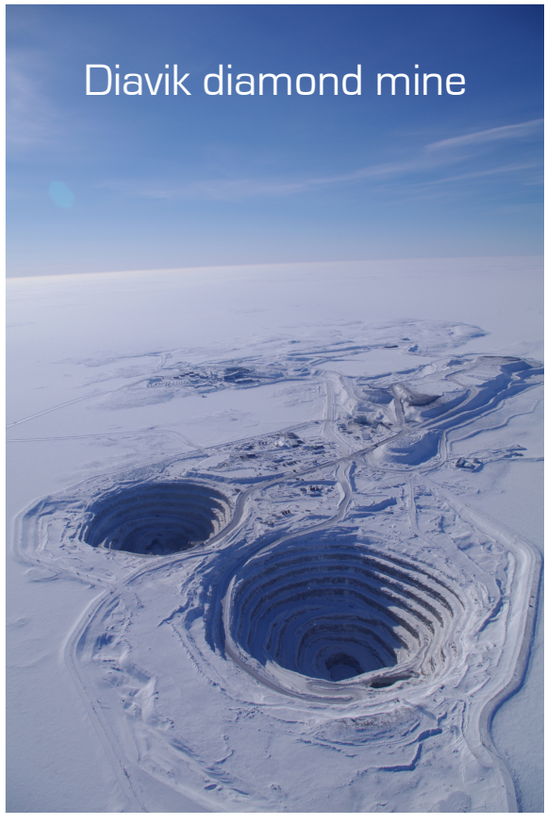
Canadian market for replacing diesel


Rankin power station


Diavik diamond mine

- 10 off-grid communities in Nunavut & NWT with projected power consumption of 2-10 MWe in 2025
- Estimated market: 10 units of 3 MWe
- Arctic mining applications: 2 x 10 MWe
- Economic life of diamond/gold ore: ≈ 10 years
- Estimated market: 4 units of 10 MWe/year

SEALER:
Swedish Advanced Lead-cooled Reactor

- Small lead-cooled reactor
- 19.9% enriched UO_2-fuel
- 3-10 MW electricity
- Core life: 10-30 years
- Reactor vessel: 2.7 x 6.0 m
- Transportable to/from site

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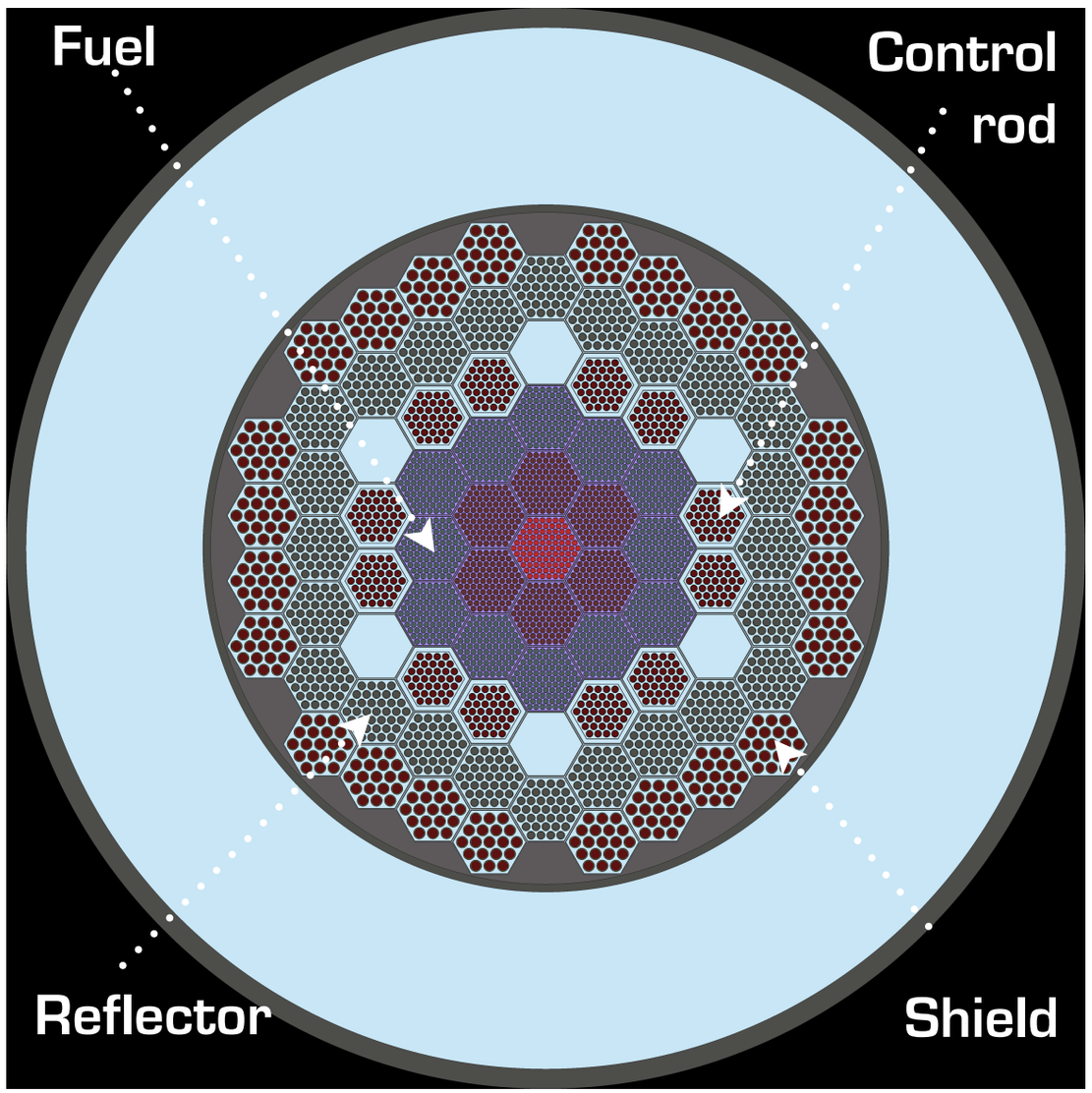
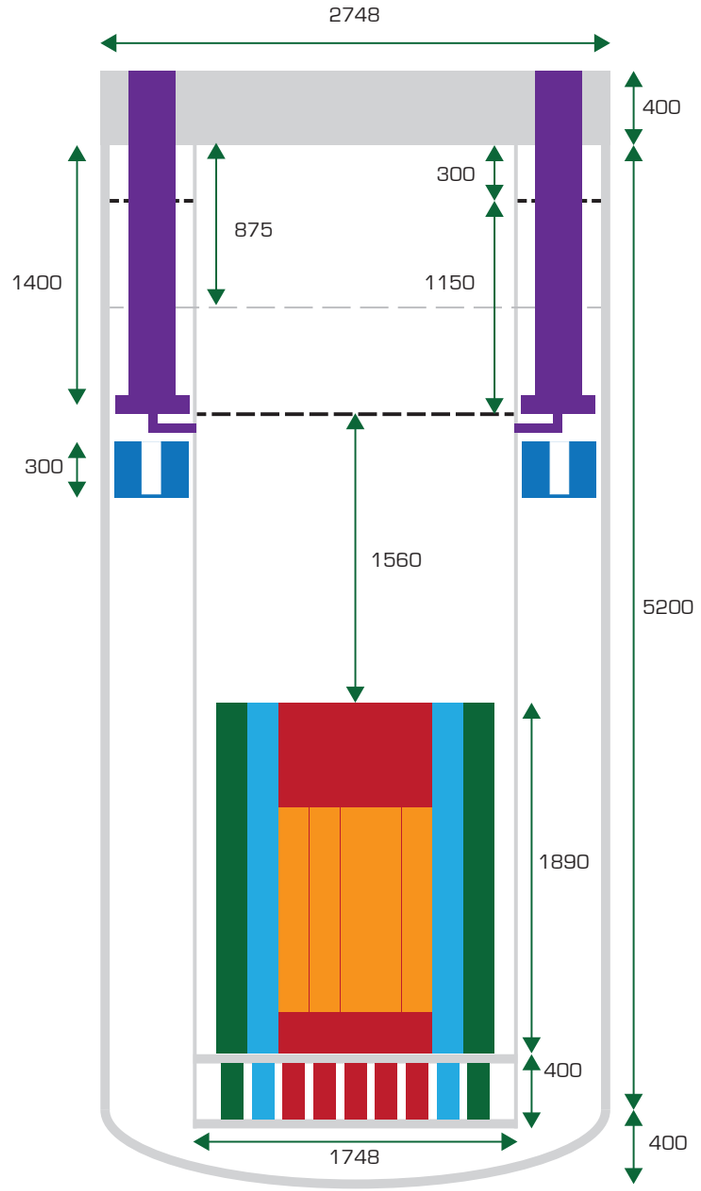
Core



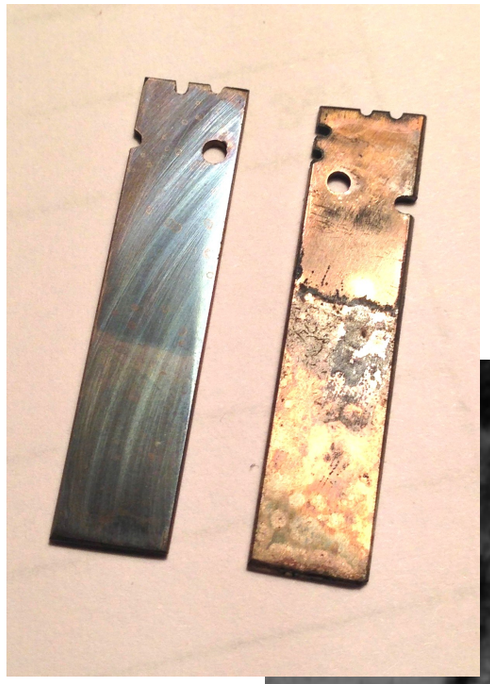
- 19 fuel elements, 1729 fuel pins
- Core height: 110 cm
- Active core diameter ≈ 0.8 m
- 2415 kg of 19.9% enriched UO_2 fuel
- 12 control rod elements (B_4C)
- 6 shut down rod elements $(W,Re)B_2$
- ZrO_2 reflector, $^{10}B_4C$ shield
- Core barrel diameter = 1.7 m

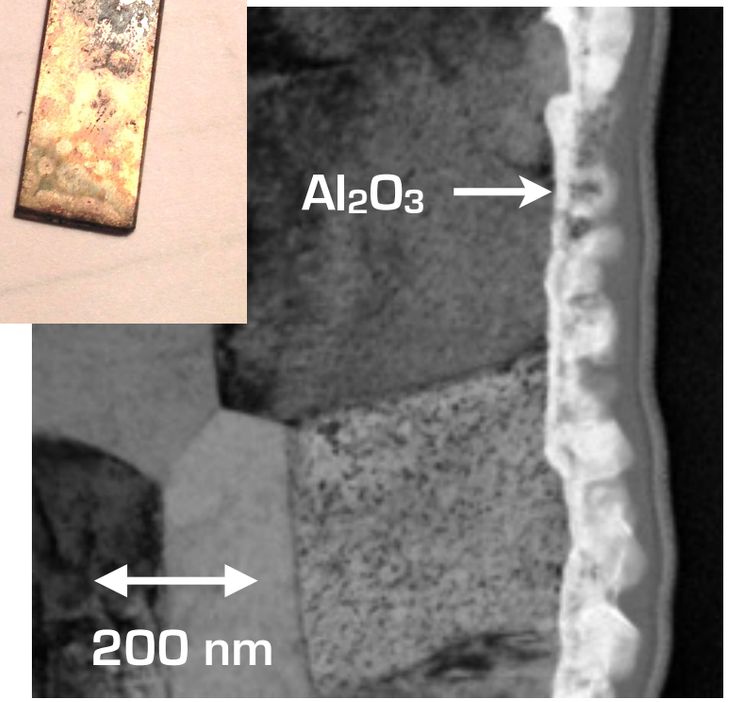
Primary system parameters (3 MWe design)



- 8 pumps operating @ 160 kg/s
- 8 steam generators @ 1 MWth
- Nominal lead flow rate: 1300 kg/s
- Max lead velocity in core: 1.6 m/s
- Max lead velocity relative to pump: 2.0 m/s
- Core inlet temperature: 390°C
- Core outlet temperature: 430°C
- Max cladding temperature: 450°C

Steam generator tube material

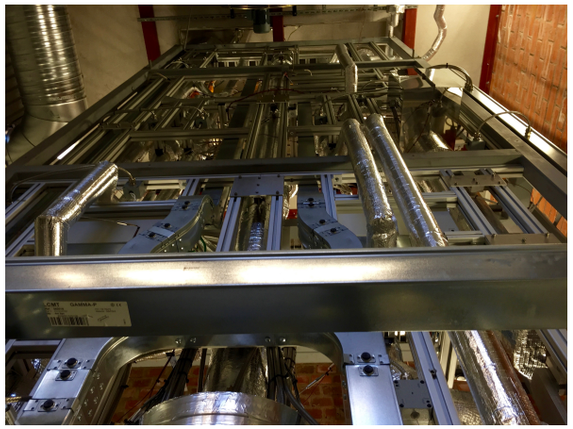




- PhD thesis of J. Ejenstam
- Close collaboration with Sandvik
- Fe-10Cr-4Al-0.2Zr is in perfect condition after 19 000 h of exposure to lead at 550°C!
- 600 h test at 750°C successful.
- Model Fe-10Cr-5Al alloy irradiated to 1.8 dpa by Oak Ridge. No hardening!
- To be codified with ASME

R&D program

- 5 year long stagnant corrosion tests of Fe-10Cr-4Al-materials
- Pump test facility for test of impeller endurance (target: > 2 years)



- 1:1 scale electrically heated mockup for integral system test
- Irradiation test of steels and absorber materials in materials test reactor

Electrically heated mock-up

- One-to-one non-nuclear prototype of SEALER
- 8 MW power supply
- Validation of design & computer codes
- Life-time of pumps & steam generators
- Training facility for operators
- Engineering design: Hatch & Promation
- Potential location: Pinawa/Whiteshell
- Start of operation: 2019

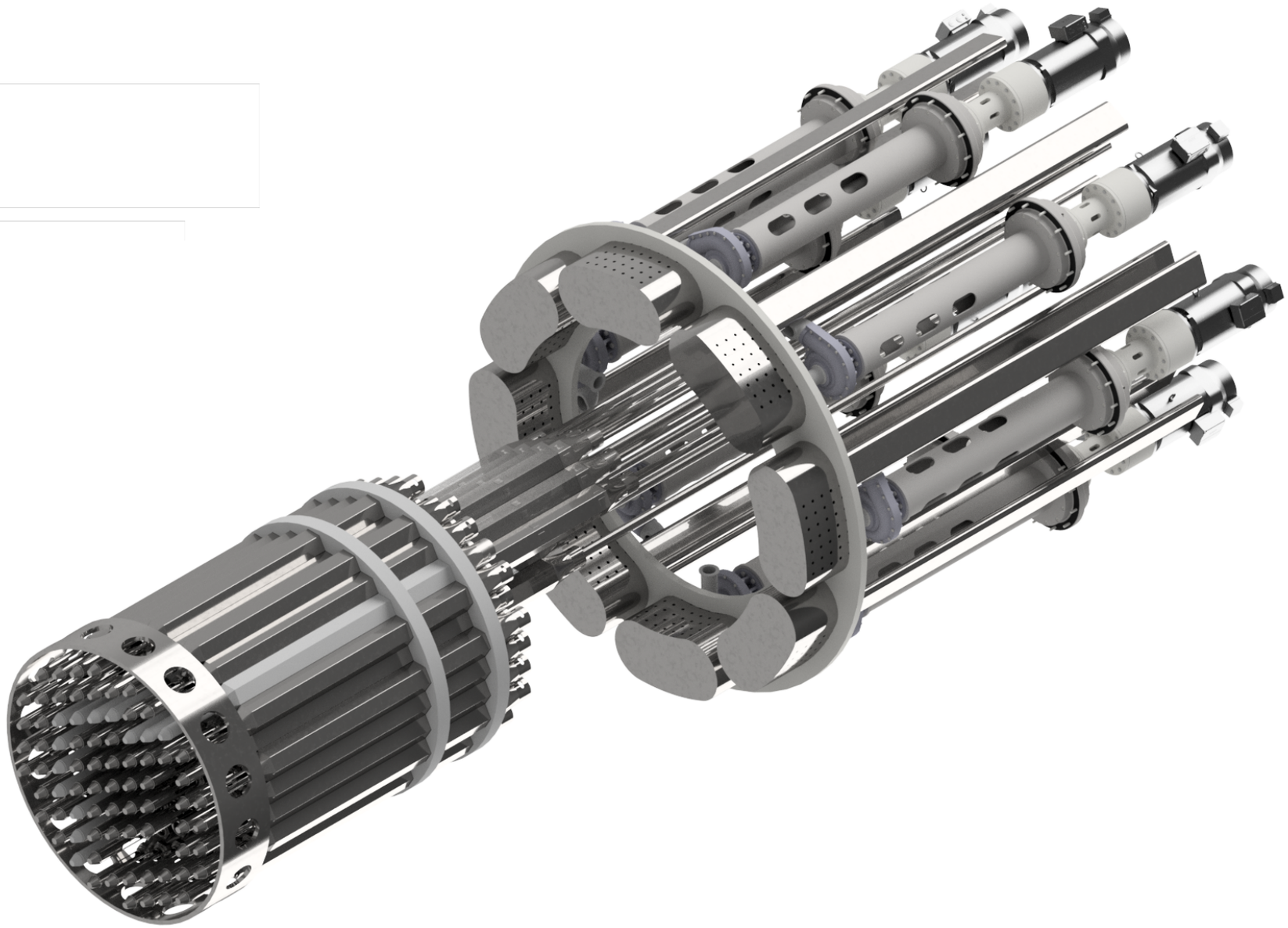
Demo-plant

- Customers request operation of demonstration plant
- To be built on a nuclear site in Canada
- Option to replace fuel elements
- Power uprating scheme: 1 MW_e ⇨ 3 MW_e ⇨ 10 MW_e
- Business model: Power to site & Advanced fuel qualification
- License to build: 2021
- Operational: 2025

Investment from Essel Group ME

- On January 20, Essel Group ME signed an investment and financing agreement with LeadCold of ≈ 200 MUSD
- Indian owned media, mining & energy conglomerate
- Operates 4 mines in Africa
- Funds commercialisation of SEALER, including R&D, licensing, engineering and construction of demo-plant.

Primary system internals



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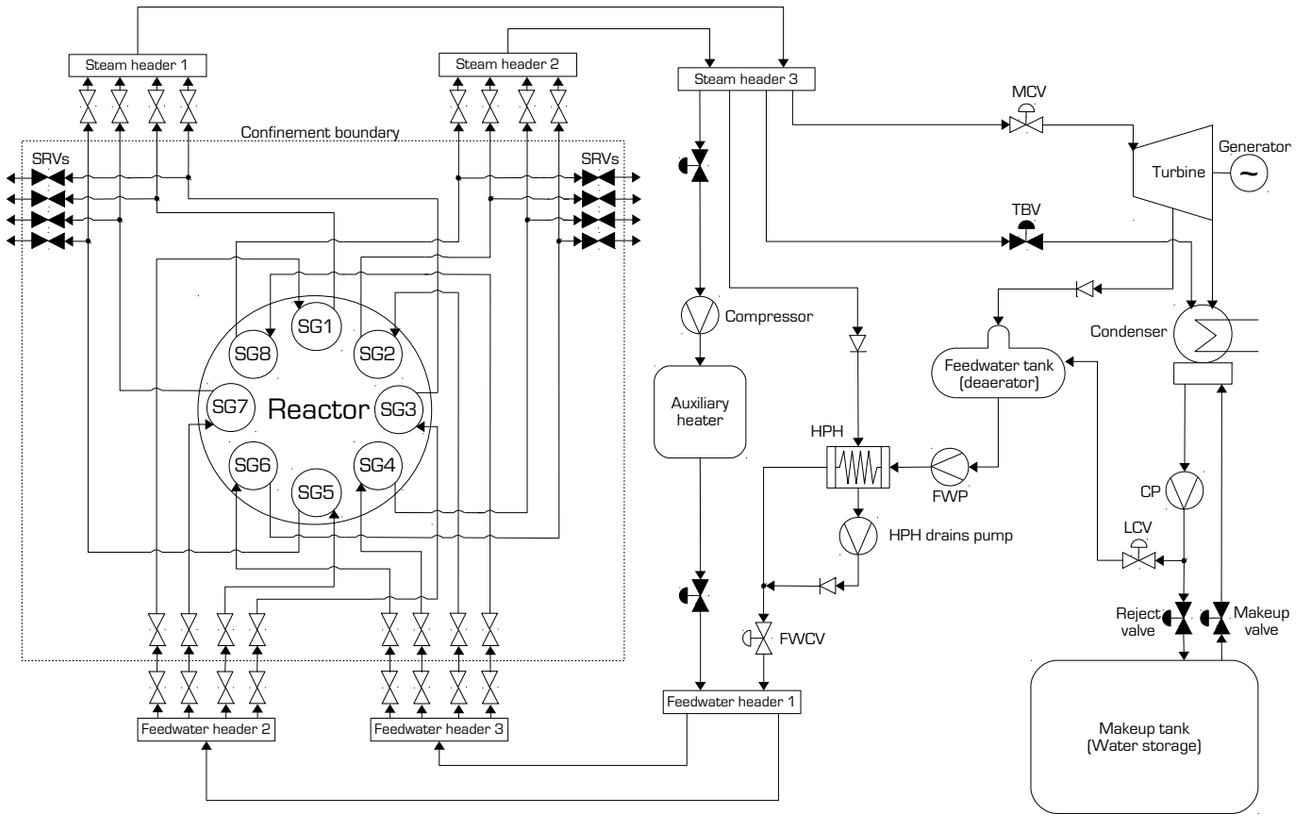
Balance of plant (3 MWe version)



- Steam flow rate: 5.5 kg/s
- Live steam (1.8 kg/s @ 390°C) used for high pressure feed water pre-heating
- On-shelf turbine capacity: 7 MW_e
- Turbine inlet pressure < 130 bar
- One turbine extraction (1.0 kg/s) for feed water tank heating to 180°C.
- Conversion efficiency = 36%

Transient analysis: UTOP

- LeadCold's BELLA transient analysis code was extended with model of secondary system.
- Control rod withdrawal without scram (Δρ = +0.5$) reveals increase in asymptotic power & fuel temperatures (relative to case without SG). No consequence for safety case.