Barsebäck NPP, 1992, Plugging of strainers

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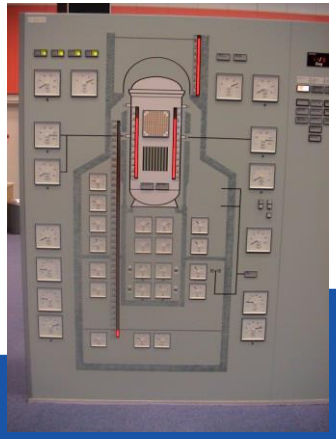
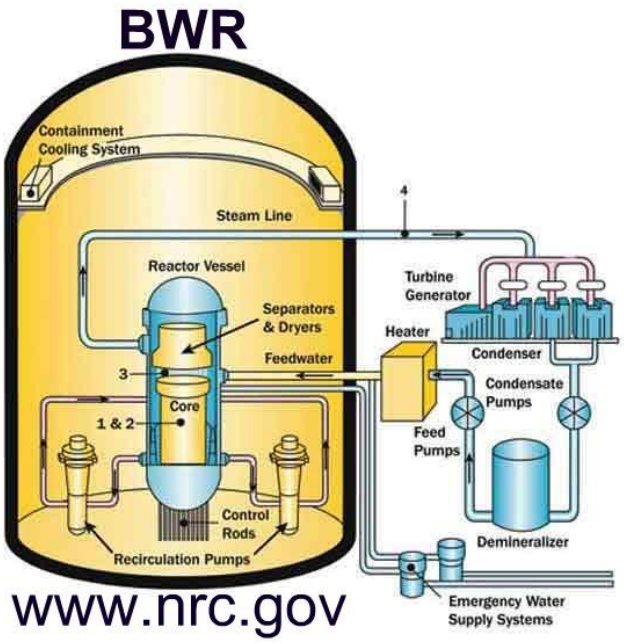
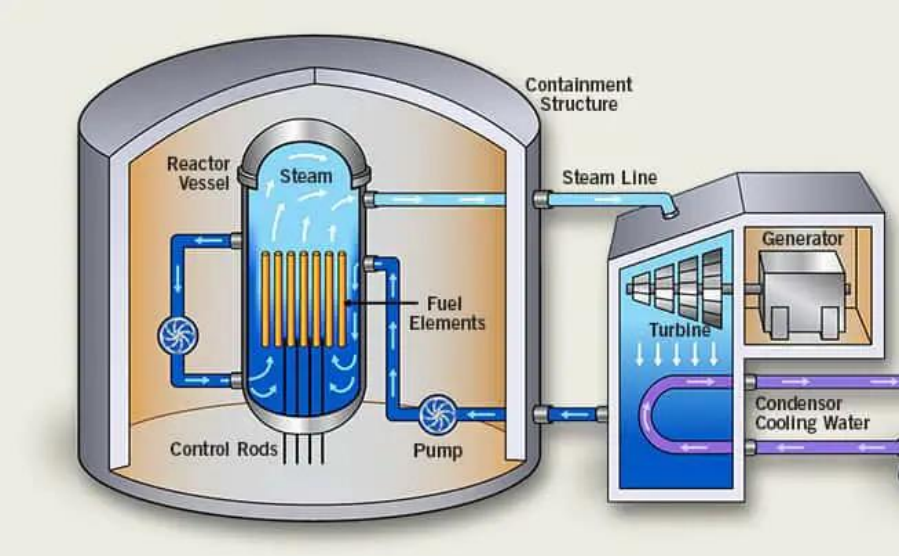
Data	Barsebäck 1	Barsebäck 2
Construction start	1971	1973
Commercial operation	15 maj 1975	1 juli 1977
Gross capacity	615 MW	615 MW
Permanent shutdown	30 november 1999	31 May 2005
Electricity supplied	93,8 TWh	108 TWh



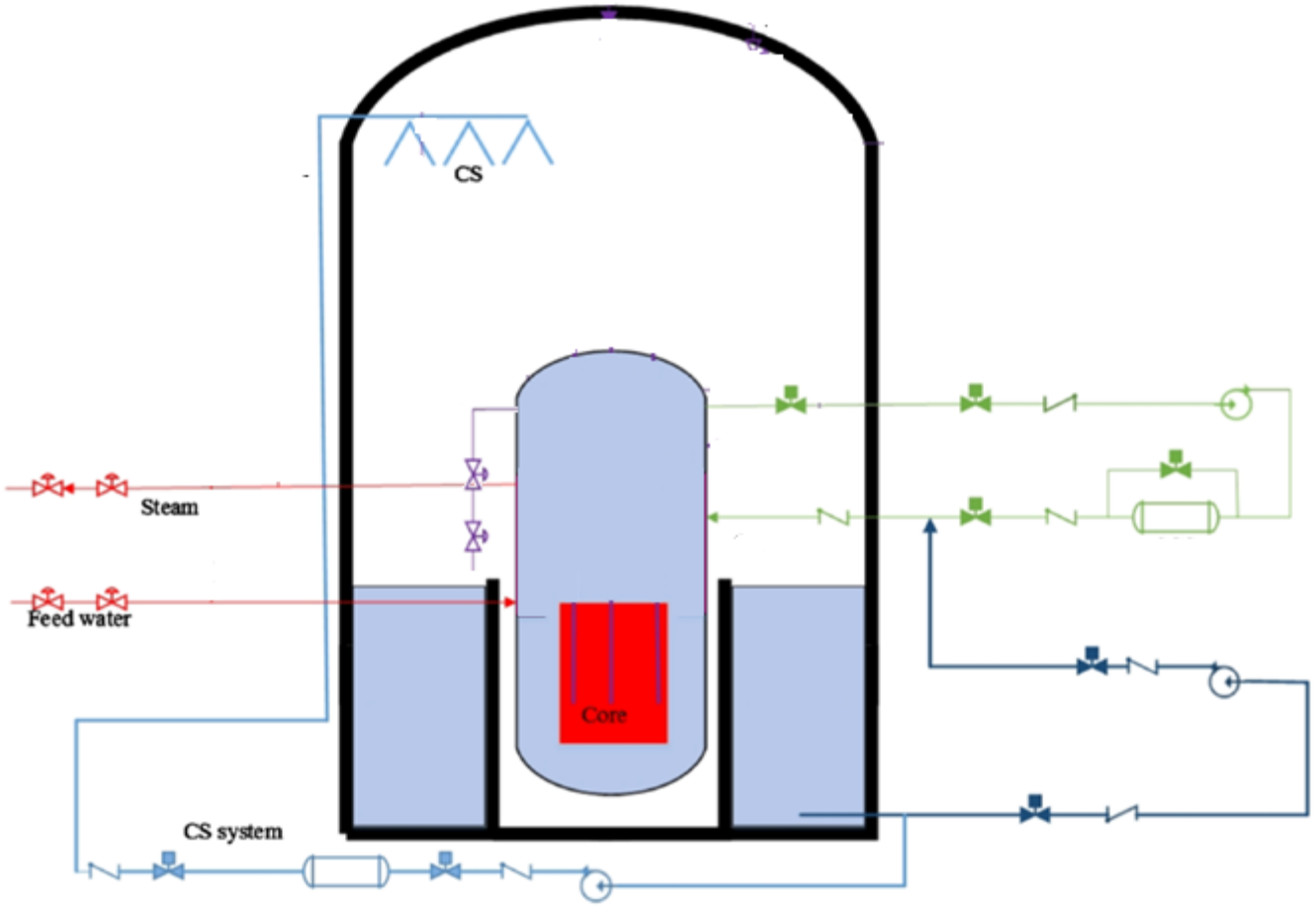
Technical data Barsebäck	
Net output (electricity)	600 MW
Reactor type	Boiling water reactor
Reactor supplier	Asea-Atom
Turbine supplier	Stal-Laval
Commercial operations	B1 1975, B2 1977
Thermal reactor output	1800 MW
Number of circulation circuits	4
Operating pressure	70 bar
Total reactor cooling water flow	7,700 kg/s
Steam flow	900 kg/s
Steam pressure	7.0 MPa
Steam temperature	286°C
Feedwater temperature	184°C
Reactor vessel	
Weight	530 tons
Total height	20 m
Inner diameter	5.45 m
Material thickness	12.6 cm
Fuel elements	
Number of fuel elements in reactor core	444
Fuel weight per element	UO2 181/172 kg
Number of fuel rods per element	100/96
Sealing material	Zr2
Pellet diameter	8.19 mm
Control rods	
Type	cruciform blade
Number	109
Absorber material	hafnium, boron carbide
Control drive type	electro-hydraulic
Circulation pumps	
Type	enclosed centrifugal pumps
Number	4
Flow	2.55 m^3/s
Lifting height	55 m

External Pump BWR

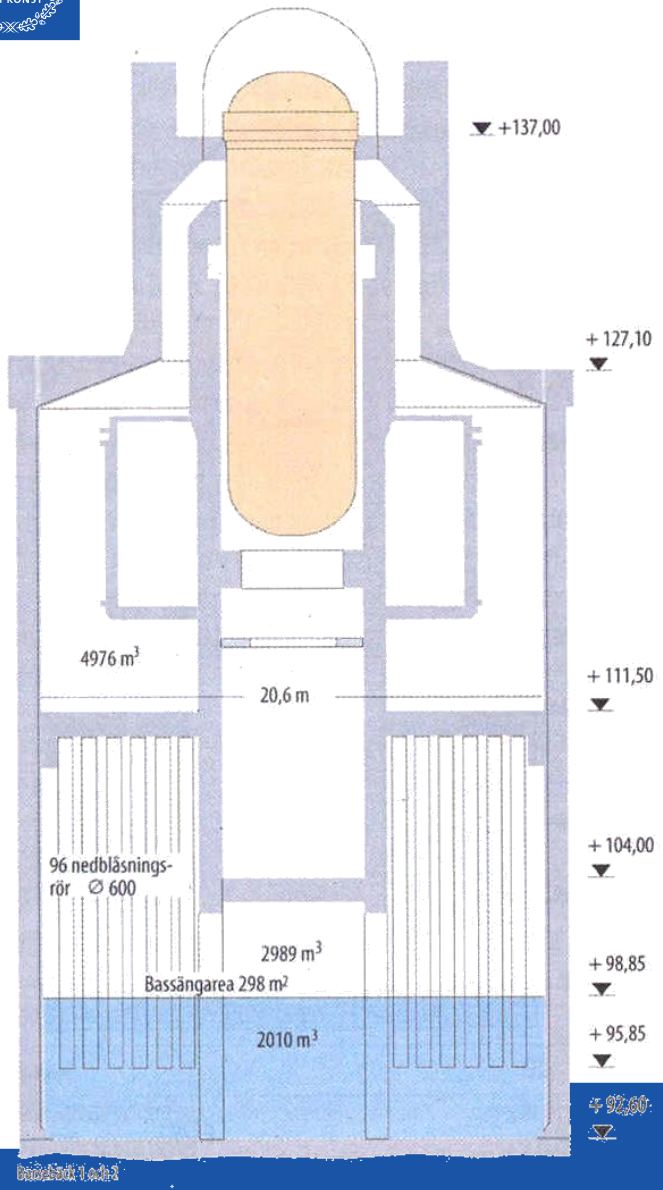




Containment Spray and ECCS



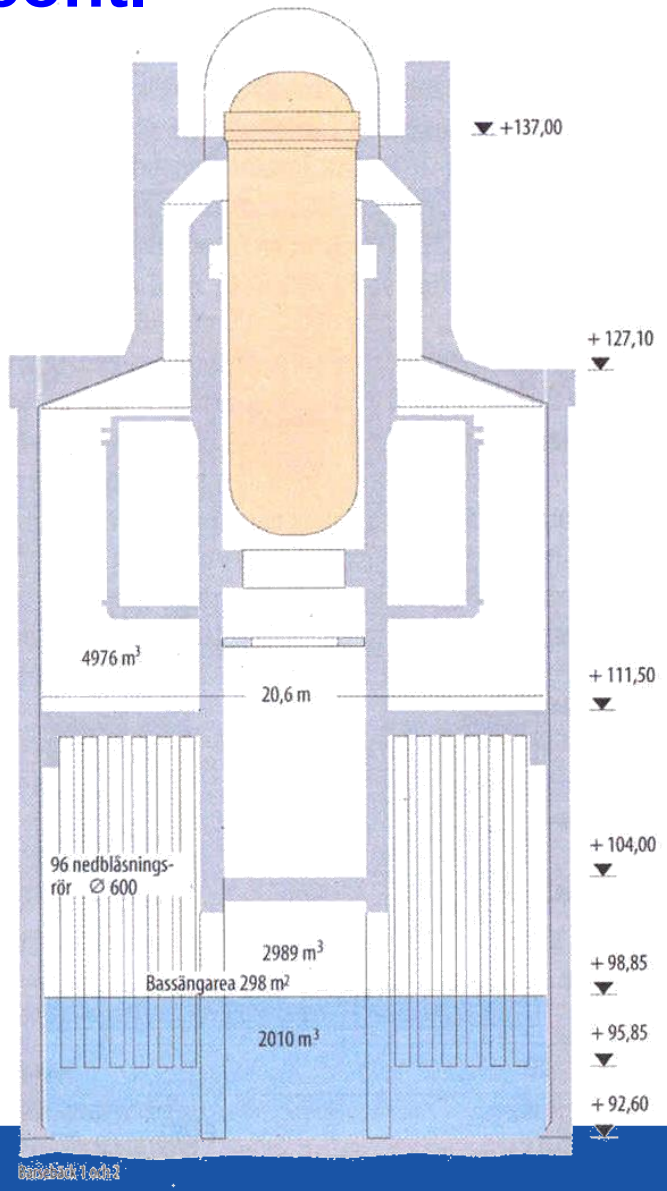
The Event, On July 28, 1992



- Reactor was restarting after a planed maintenance and refueling.
- A pilot-operated relief valve opened unauthorized at 3100 kPa (~30 bar), resulting in steam release into the containment.
- Mineral wool insulation was dislodged by steam from the ADS valve.
- Reactor SCRAMs and start the safety systems. Including two (containment vessel spray system) CVSS Pumps of which one acted as LP-ECCS pump.
- The pressure inside the RPV were too high for the LP-ECCS resulting in the water from the ECCS pump to be redirected to the pressure suppression pool

The Event, On July 28, 1992, cont.

- Two strainers on the suction side of the operating CVSS pumps, which were in service partially plugged with mineral wool.
- ~200 kg of mineral wool was dislodged by the containment spray system and added to the pressure suppression pool
- Barsebäck had installed a large mixer in the pressure suppression pool to mix the water and avoid the thermal stratification which can results in pumps not being able to work efficiently.
- Mixing in the pool water due to the ECCS recirculation and the installed mixer caused the old mineral wool insulation to sink and clog the strainers very efficiently
- Operators shut down the pumps and backflushed the strainers following an indication of high differential pressure across both suction strainers 70 minutes into the event.



Perry Nuclear Power Plan incident

- On January 16 and April 14, 1993, two events involving the clogging of ECCS strainers also occurred at the Perry Nuclear Power Plan in USA
- The first Perry event involved clogging of the suction strainers for the residual heat removal (RHR) pumps by debris in the suppression pool.
- The second Perry event involved the deposition of filter fibers on these strainers.
- The debris consisted of glass fibers from temporary drywell cooling unit filters that had been inadvertently dropped into the suppression pool, and corrosion products that had been filtered from the pool by the glass fibers which accumulated on the surface of the strainer.
- The Perry events demonstrated the deleterious effects on strainer pressure drop caused by the filtering of suppression pool particulates (corrosion products or "sludge") by fibrous glass materials entrained on the ECCS strainer surfaces

Modifications based on leasons learned

- **Strainer modifications**
  - The modifications of the strainers have been performed after exhaustive studies and experiments. The modifications have resulted in new strainer designs with significantly enlarged filtering area. These modifications are summarized in Table in next slide.
- **Replacement of insulation materials**
  - Replacements of large fractions of the thermal insulation materials utilized on piping and other components inside the containment have taken place. The newly installed insulation materials vary both within and between countries. They are primarily RMI (Reflecting Metallic Insulation), nuclear grade fiberglass, mineral wool and calcium silicate
- **Administrative measures**.
  - The administrative measures include, e.g., a periodic cleanup of the suppression pool and the containment sumps, with the aim to minimize the presence of foreign materials, and the control and eventual betterment of the containment coating.
- **Emergency Operating Procedures (EOPs)**
  - Several plants have revised their EOPs and other operating procedures, as well as the operating personnel training programs, including presently simulator training on back-flushing measures.

ECCS and CSS strainer modifications in different countries after the B2 event (2001)

Country	PWR	BWR	ECCS & CSS strainer modifications
Finland VVER-440/213 (modified)	2 out of 2 units modified	2 out of 2 units modified	About 10-fold area increase New strainer design with significant area increase
Hungary VVER-440/213	4 out of 4 units modified		New strainer design with about 50-fold area increase
Japan	None of the 23 units modified	None the 28 units modified	More than 95% of the insulations are replaced by nonfiber type ones (e.g. Reflective Metal Insulation).
Spain	None of the 7 units modified	2 out of 2 units modified	New strainers with significant area increase
Sweden	1 out of 3 units modified	9 of the 9 units modified	New strainers with 15 to 40- fold area increase New strainers with > 7-fold area increase
USA	None of the 69 units modified	34 out of 34 units modified	New strainers with significantly increased area