



RIC 2002

Session W4

Power Upgrades

Power Upgrading at the Leibstadt Nuclear Power Plant

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Leibstadt Nuclear Power Plant

- General Electric BWR
- BWR6/Mk III Containment
- BBC Turbo-Generator (3000 rpm)
- Cooling Tower Plant / River Rhine
- Commercial Operation: December 1984
- Original Thermal Power: 3012 MWth
- Current Licensed Thermal Power: 3600 MWth





Power Uprate Licensing (114.7%; 3600 MWth)

- **First idea** **1989**
- **Feasibility Study** **1990**
- **Licensing and Engineering** **1992**
- **Licensing application** **July 1992**
- **1. Public Review (SAR)** **Fall 1992**
- **HSK Safety Evaluation Report** **Spring 1996**
- **Review by Safety Commission** **Summer 1996**
- **2. Public Review / SAR / Environmental Assessment** **Summer 1996**
- **Receipt of License (3600 MWt) and release of first step by HSK** **Fall 1998**
- **Release for final step (114.7%)** **Winter 2001**



Principles for Upgrading

- **Fulfilment of all Safety Criteria**
- **Consideration of ALARA**
- **No Impact on Reliability**
- **Maintaining Efficiency**
- **Maintaining Operational Flexibility**
- **No Reduction of Plant Life**



Analysis for Power Uprate

- **Safety Analysis**
- **Risk Analysis (Level 1 and Level 2)**
- **Review of Ageing Mechanisms**
- **System Analysis**
- **Evaluation of Operational Experience**
- **Fulfilment of Guidelines of Regulatory Body**



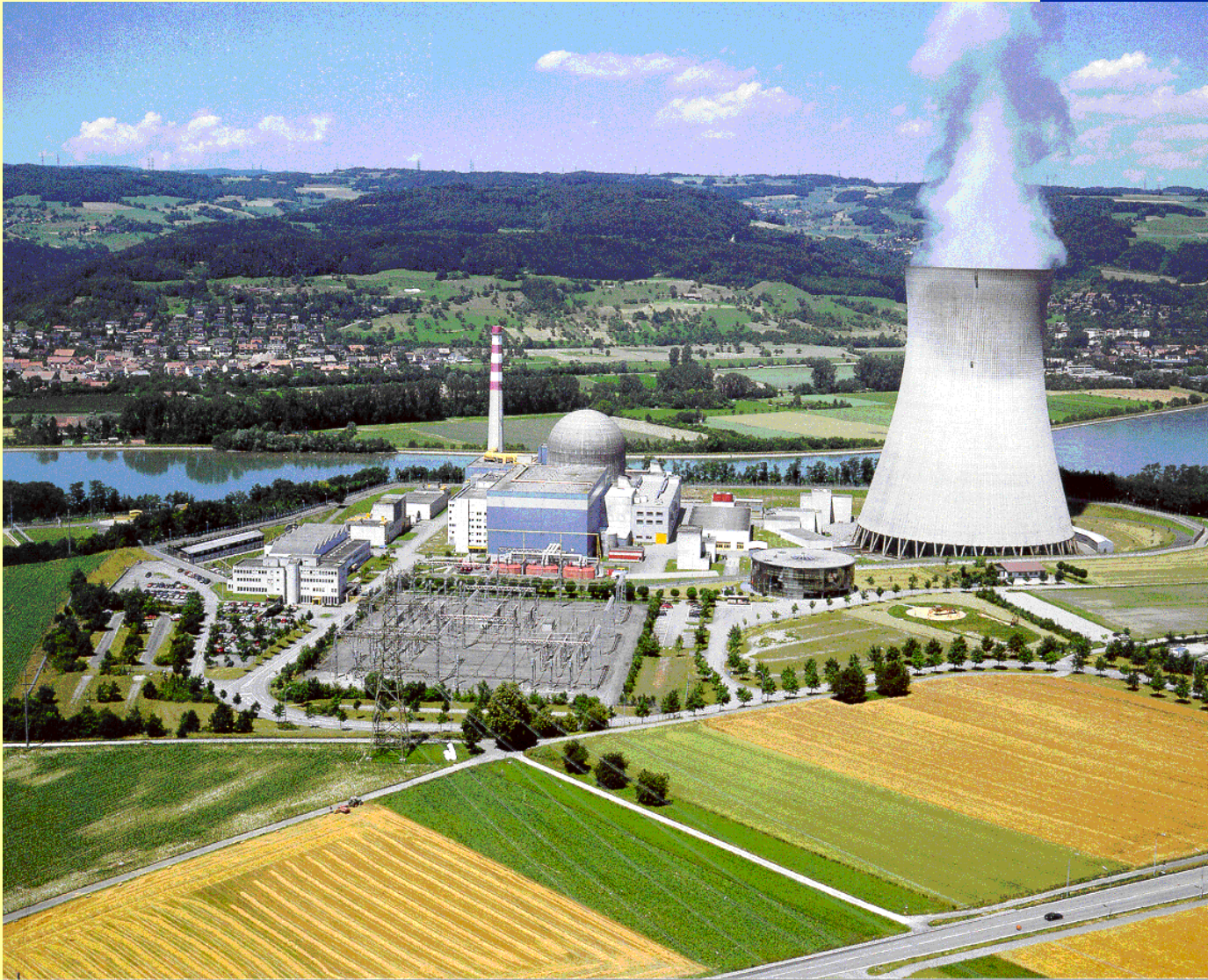
Major Licensing Issues

- **Changes to safety rules since original license**
- **Effect on fuel performance**
- **Power Density**
- **Margin to SCRAM**
- **ATWS Response**
- **Influence on integrated risk**
 - * Level 1 / Level 2 Analysis

Power Uprate Costs

	Costs [CHF]	Power Increase. [MW]	Rp/kWh	CHF/kW installed
Analyses	9 Mio.	-	-	-
LP-Turbines	58 Mio.	40	1.83	1450
Power Uprate (114.7%)	94 Mio.	138	2.77	681
Total	161 Mio.	178	ca. 2.5	904

Kernkraftwerk Leibstadt

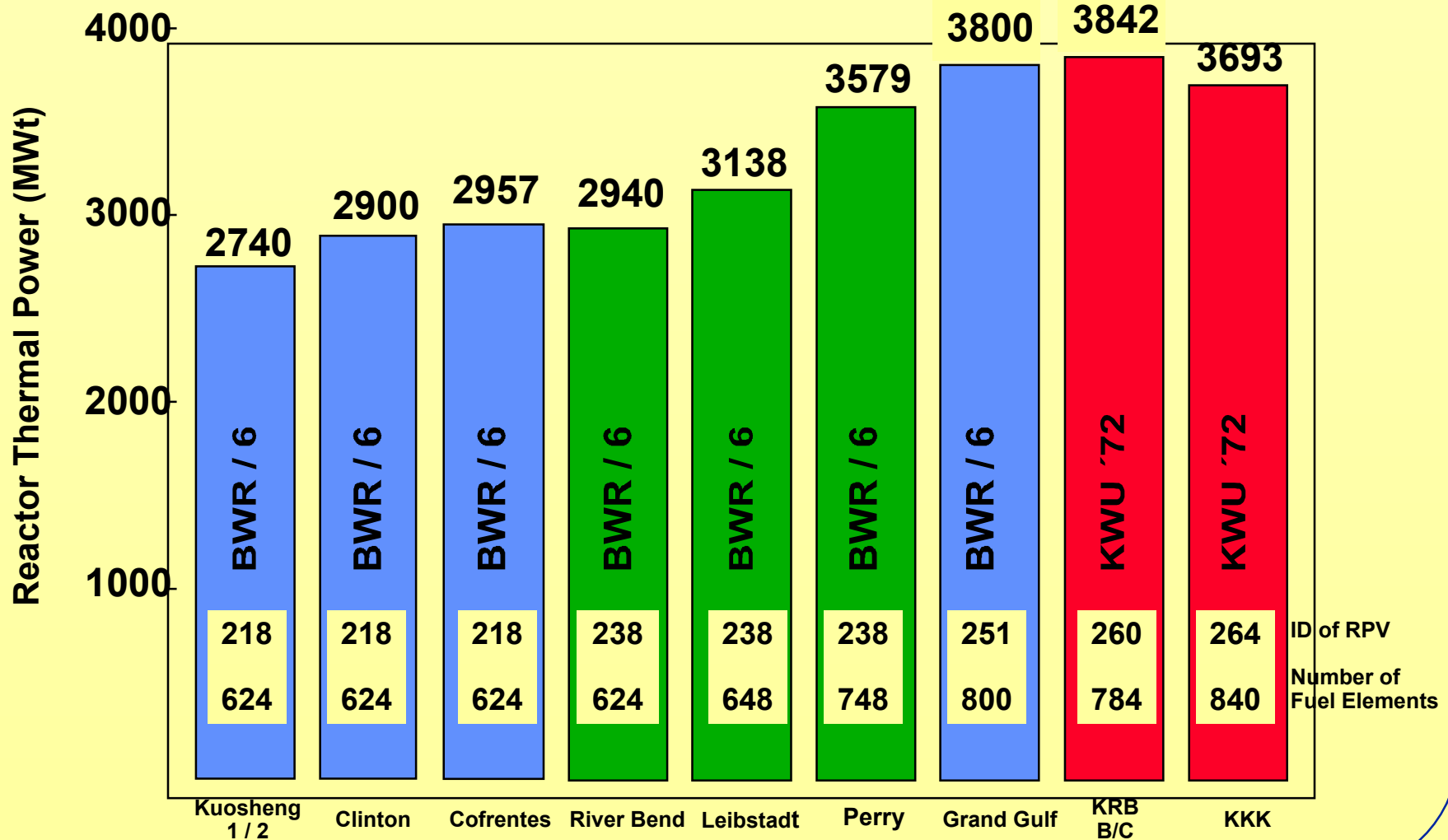




	MW_t	MW_e		Schedule
		(brutto)	(netto)	
Start up	3012	990	950	1984 – 1986
100 % (after LE 1, 104%)	3138	1045	990	1986 – 1993
100 % LP Mod.	3138	1085	1030	1994
100 % HP Mod.	3138	1060	1005	1996
LS1 = 106 %	3327	1135	1080	Oct.1998
LS2 = 109%	3420	1170	1115	Sept. 1999
LS3 = 112 %	3515	1200	1145	Sept. 2000
LS4 = 114.7 %	3600	ca. 1225	ca. 1170	Sept. 2002



Comparison KKL / other BWR



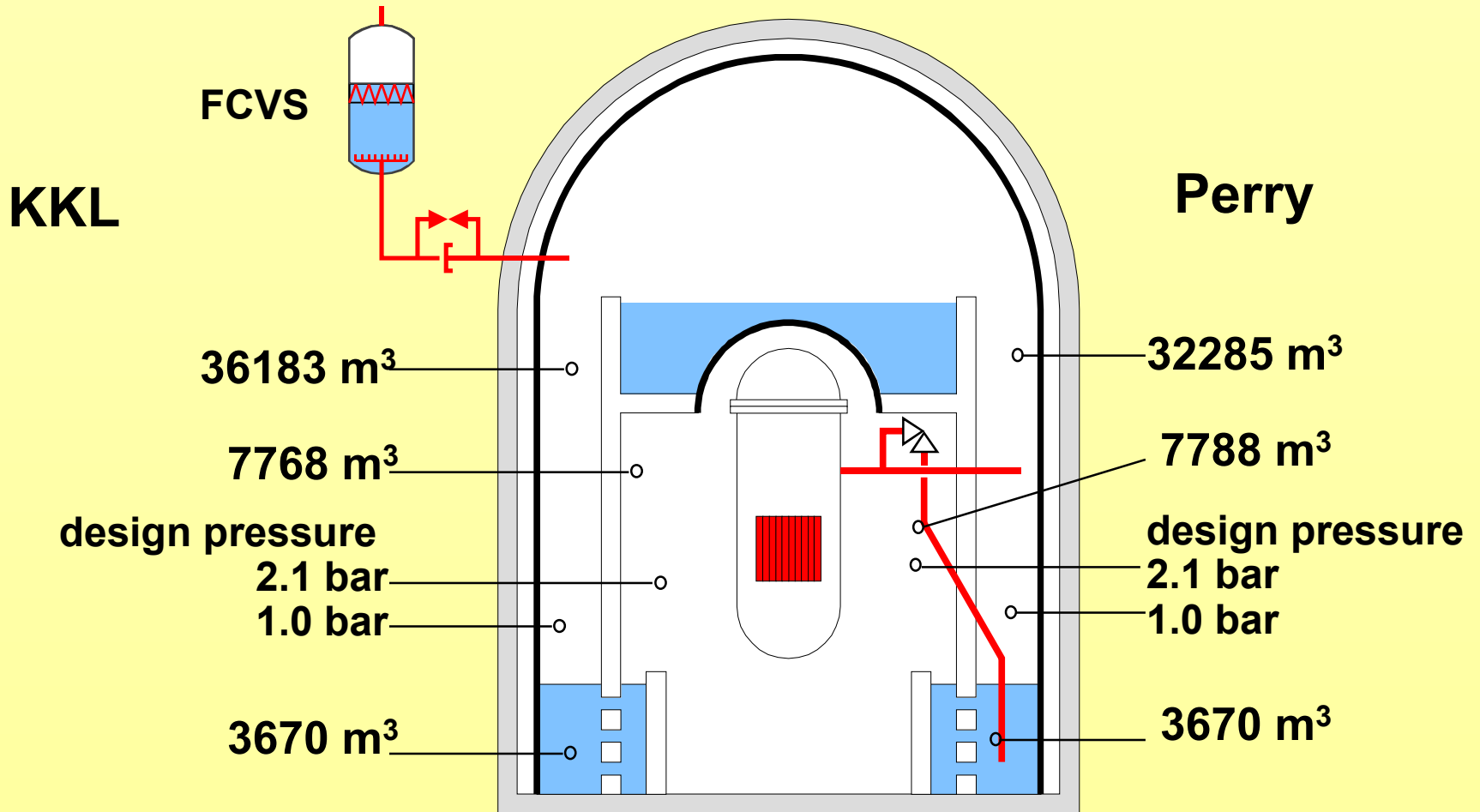


Design for LOCA

Parameter	KKL	PERRY
Reactor Power	3600 MW	3579 MW
LOCA Analysis	$\geq 1.02 \times \text{Power}$	$\geq 1.02 \times \text{Power}$
Heat Removal Capacity		
2 RHR Systems	2 x 36.1 MW	2 x 54.7 MW
1 SEHR System	43.0 MW	---
Total	115.2 MW	109.4 MW
Capacity of ECCS		
Number of Pumps	7	5
Total Pump Capacity	2.52 m ³ /s	2.11 m ³ /s

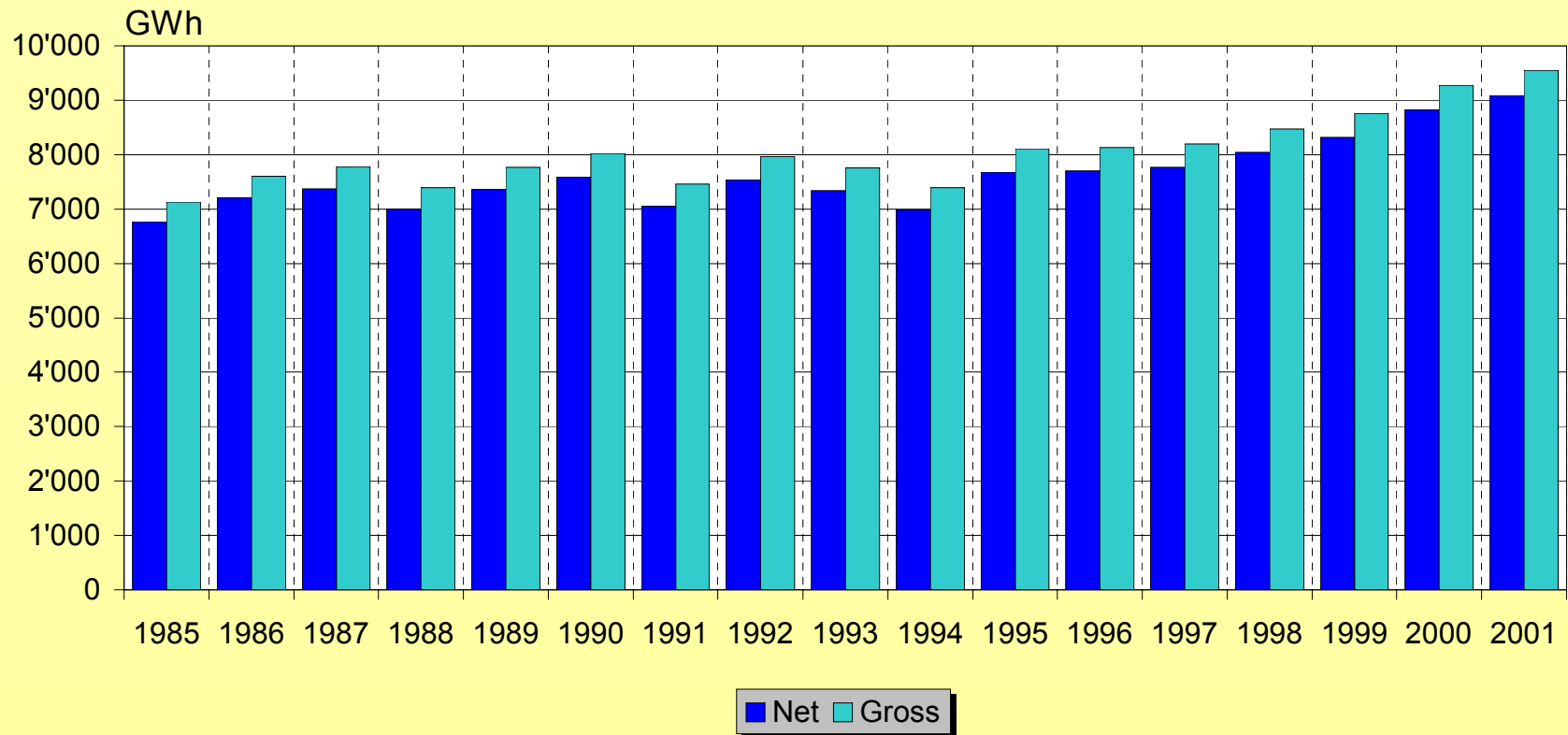


KKL compared to Standard BWR/6 238





Net - and Grossproduction 1985 -2001



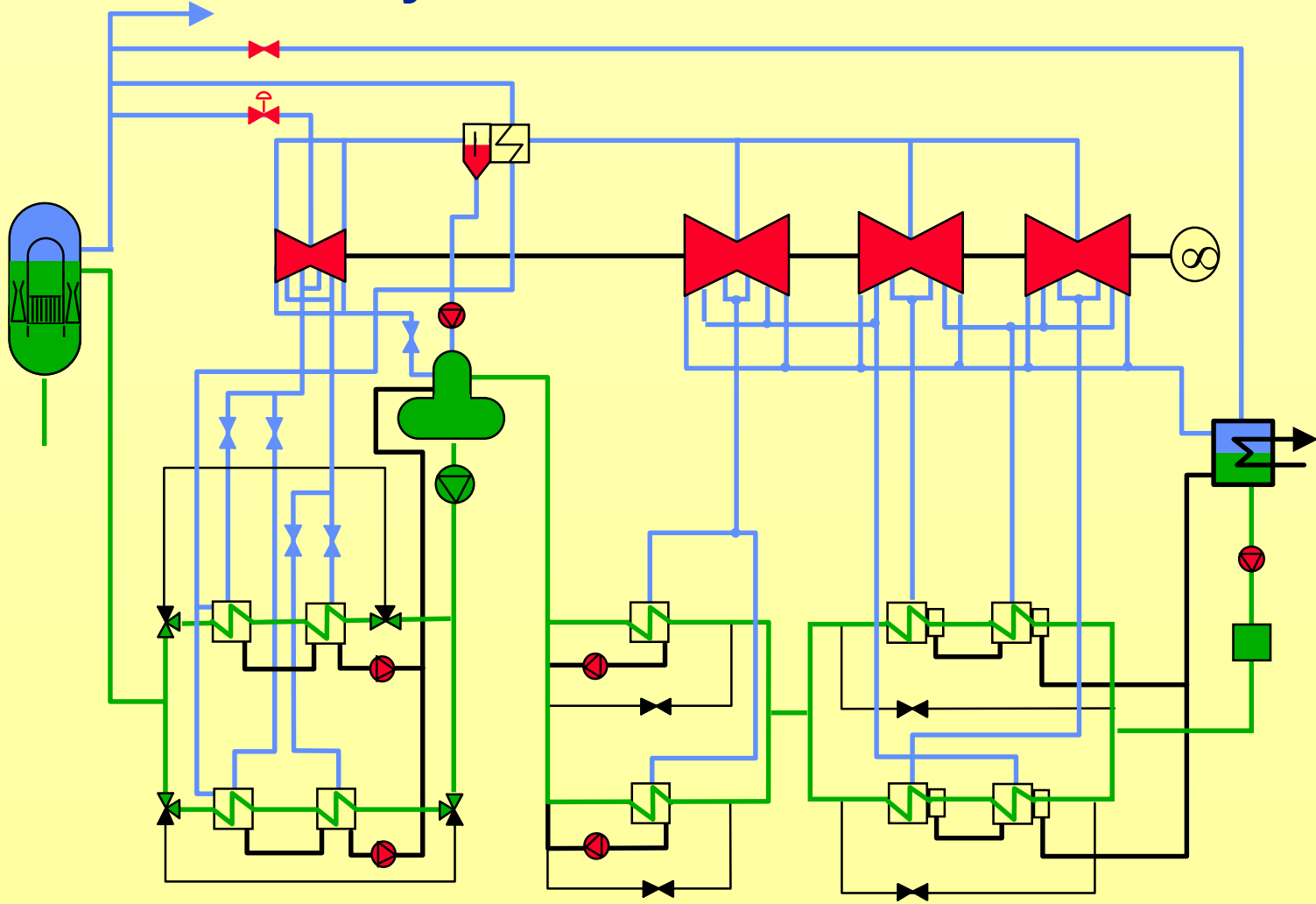


Plant Performance 1985 - 2001

Year	Generator on Grid h	Gross Production MWh	Net Production MWh	Availability %	Gross Capacity Factor %	Capability Factor %
1985	7'233.00	7'125'790	6'761'954	82.57	81.02	81.95
1986	7'669.50	7'604'460	7'202'176	87.55	83.07	85.62
1987	7'917.00	7'780'661	7'367'850	90.38	85.00	88.57
1988	7'534.50	7'393'908	6'995'344	85.78	80.55	83.18
1989	7'671.50	7'768'006	7'354'478	87.57	84.86	85.81
1990	7'905.50	8'020'302	7'596'233	90.25	87.61	88.90
1991	7'580.50	7'458'671	7'051'956	86.54	81.48	86.01
1992	7'985.50	7'964'710	7'537'618	90.91	86.77	90.54
1993	7'957.50	7'757'558	7'338'055	90.84	84.74	89.59
1994	7'227.00	7'388'636	6'988'215	82.50	80.71	81.11
1995	7'886.50	8'103'956	7'673'833	90.03	85.26	89.07
1996	7'790.00	8'134'756	7'705'133	88.68	85.35	87.58
1997	7'866.50	8'192'680	7'762'496	89.80	86.20	89.23
1998	8'139.00	8'473'325	8'046'205	92.91	89.15	92.35
1999	8'126.25	8'752'385	8'319'987	92.77	88.03	91.96
2000	8'159.25	9'272'934.00	8'823'189	92.89	90.23	92.32
2001	8'187.50	9'546'529	9'089'773	93.46	90.82	92.16



Heat Cycle KKL



■ for Power Uprate modified Components



Safety Analysis

- **Heat Balance / Power Flow Map**
- **Examination of all Power-dependent Safety Criteria**
- **Core and Fuel Design for 3600 MW (GE10, SVEA 96)**
- **Power Density, Core Stability, Slow Transients**
- **LOCA / ECCS Analysis**
- **Containment Analysis**
- **Radiological Analysis**
- **Structural Analysis of RPV Internals and NSSS**



System Analysis

- **Safety Systems analyzed for**
 - * 3600 MW (114.7%)
 - * Reactor Pressure 74.3 bar
- **Turbine Systems analyzed for**
 - * 3515 MW (112%); 3600 MW (114.7%)
 - * Reactor Pressure 73.1 bar (no change)
- **All Modifications designed for 3600 MW**
- **Filtered Containment Venting System designed for 3600 MW**