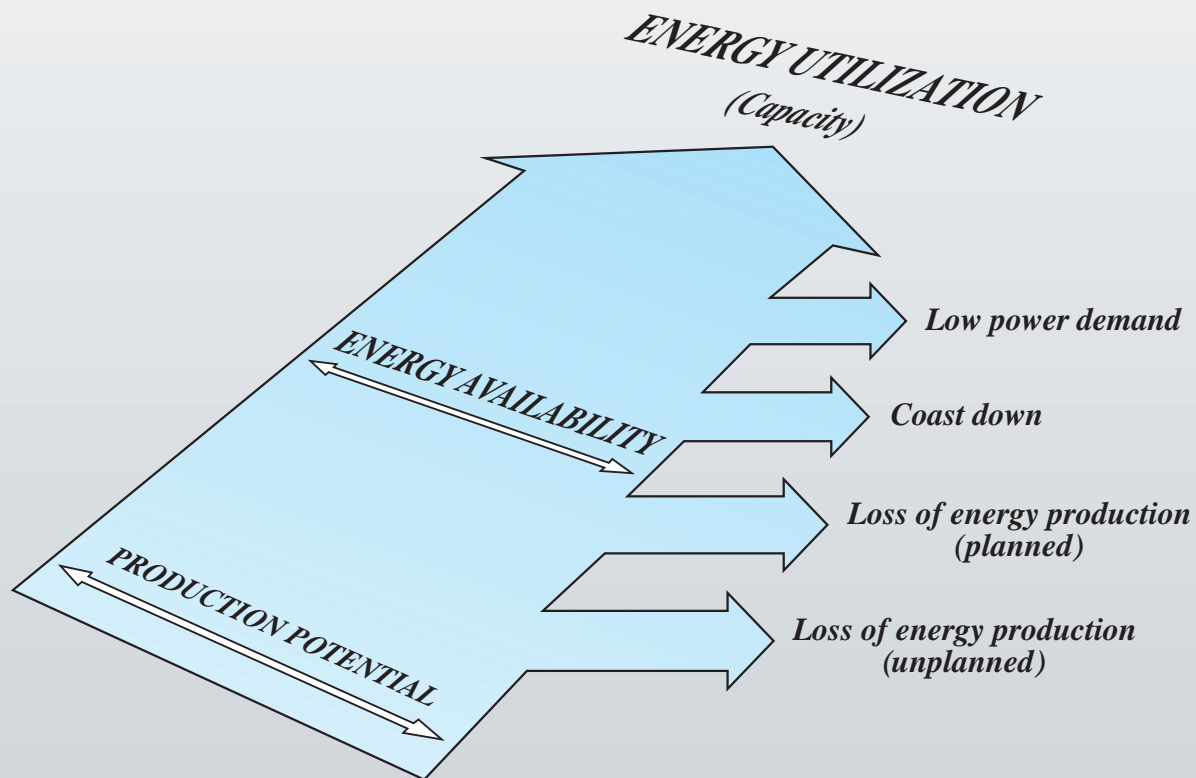


May 2000

Summary of
Operating Experience
in Swiss Nuclear Power Plants

1999





SWISS NUCLEAR POWER PLANTS

Power station	Type of reactor	Net output (MWe)	Commercial operation
Beznau (KKB)	PWR	365 365*	Unit 1: Dec. 24, 1969 Unit 2: March 15, 1972
Mühleberg (KKM)	BWR	355	November 6, 1972
Gösgen (KKG)	PWR	970	November 19, 1979
Leibstadt (KKL)	BWR	1115*	December 15, 1984

* as of January 1, 2000

DEFINITIONS

(Corresponding to the UNIPED classification «Statistical Terminology Employed in the Electrical Supply Industry»)

Energy availability factor – E_{tg}/E_n
(UNIPED definition 4.6.03.f)

Energy utilization factor – E_d/E_n
(UNIPED definition 4.5.01)

E_n (Production Potential)

– energy producible assuming maximum capacity continuously available throughout a specific period

E_d (Energy Utilization)

– energy actually produced within a specific period

E_{tg} (Energy Availability)

– energy producible assuming available capacity during a specific period

The five Swiss nuclear power units produced a net total of 23.6 TWh of electricity in 1999 – not as high as the all-time record (24.45 TWh in 1998), but nonetheless a solid operational performance.

The nuclear share in overall electricity production was 35.3%, again lower than the previous year's 40%.

In general, plant operation in 1999 was practically as undisturbed and as reliable as in 1998, reflecting the ongoing tradition of careful maintenance that contributes so much to keeping the plants in excellent condition.

However, due to exceptional outage activities at Beznau 2 (steam generator replacement) and an unplanned shut-down at Gösgen to replace a hydrogen seal on the main generator, 1999 nuclear production could not match that of the previous year. Also, record hydro power production caused the nuclear share in total electricity production to drop.

With the exception of Beznau 2, all refueling and maintenance outages were once again short. The Leibstadt outage lasted 26 days, Gösgen 33 days, Beznau 1 lasted 29 days, Beznau 2 89 days and Mühleberg 27 days.

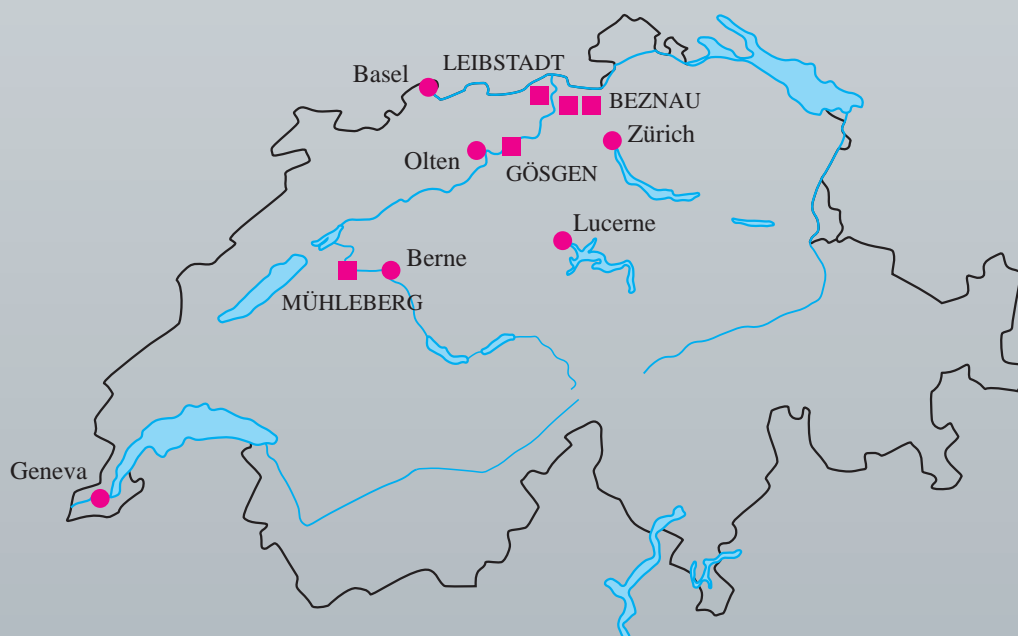
At Gösgen, Mox fuel was loaded for the third time in 1999. Of the 44 freshly-loaded fuel elements, 20 were Mox elements. Non-electrical energy supplies from the Beznau and Gösgen nuclear power plants functioned flawlessly. Beznau fed 143.6 GWh of heat energy into the Refuna district heating system, while Gösgen supplied 169 GWh of process heat to the neighboring Niedergösgen cardboard factory.

At the end of 1999 and the beginning of 2000 all Swiss nuclear units continued to operate flawlessly – notwithstanding the challenges posed by the 'Lothar' storm that hit Western Europe in late December and the so-called Y2K computer bug that threatened to hit shortly afterwards, during the 'millennial' change-over.

Swiss Association for Atomic Energy (SVA)

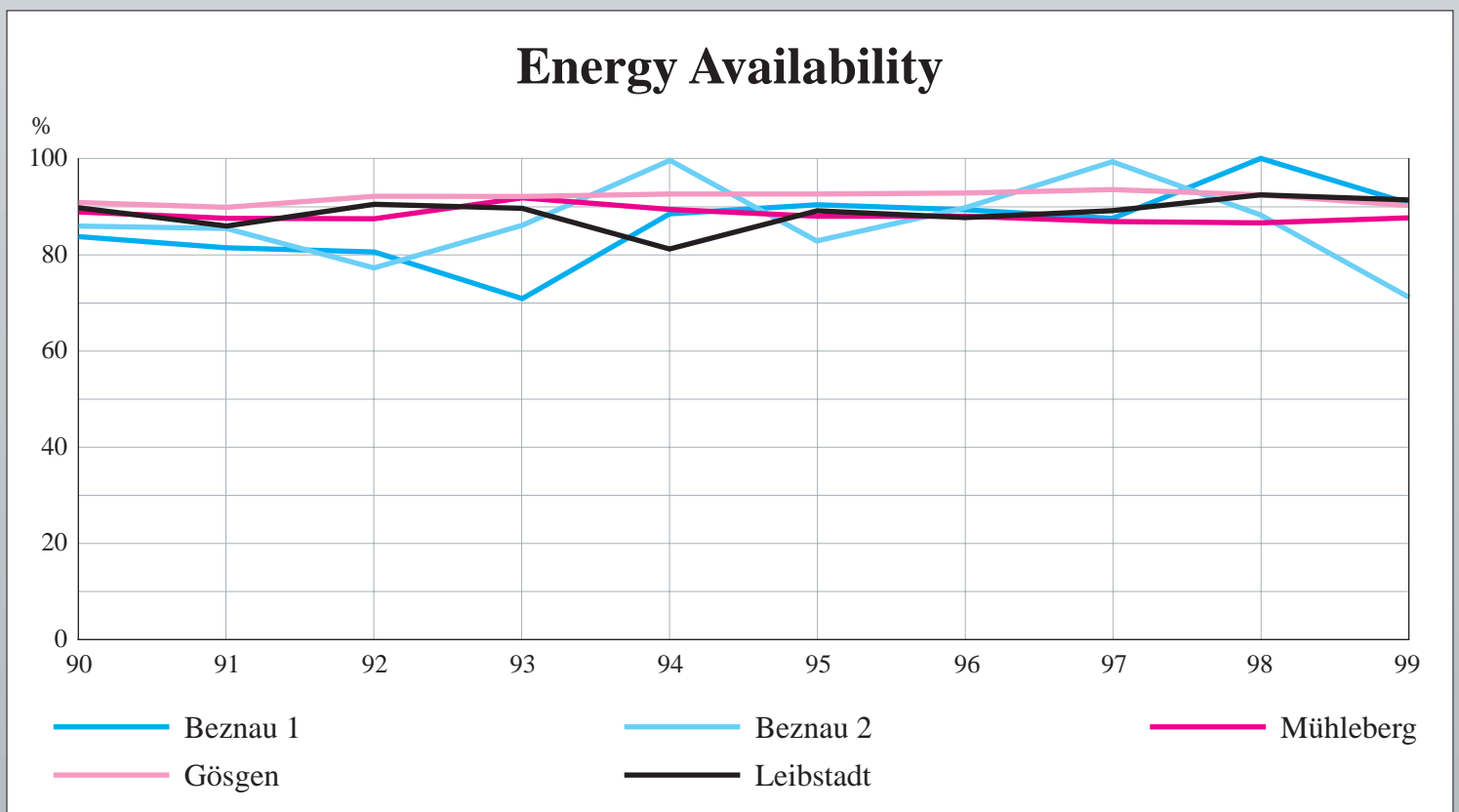
Dr Hans Jörg Huber, President

Dr Peter Hählen, Secretary General



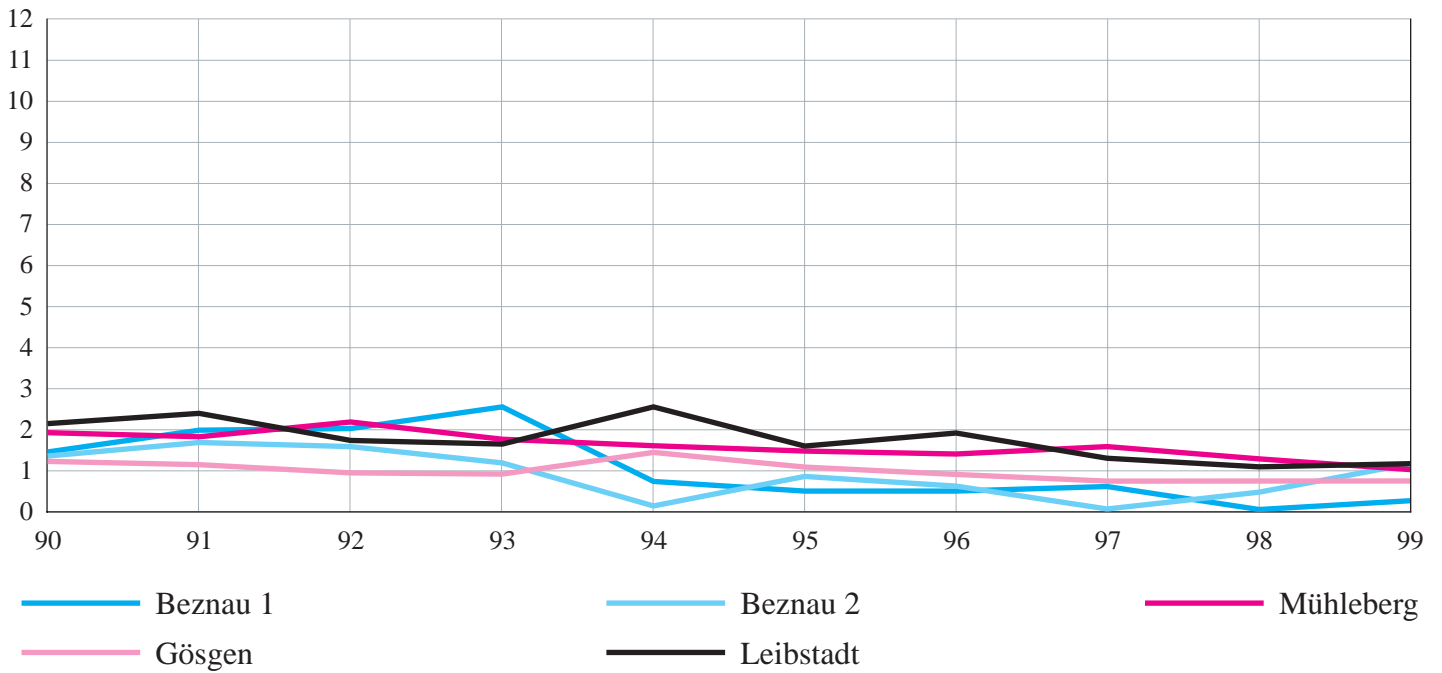
Swiss Nuclear Power Plants: Production Figures 1999 and History

	Gross production MWh	Net production MWh	Total operating time (power production) h	Total gross production since start of operation MWh	Total net production since start of operation MWh
KKB 1	2 965 871	2 841 266	8074	78 201 010	74 787 203
KKB 2	2 316 813	2 217 194	6322	77 498 603	74 235 857
KKM	2 818 960	2 702 818	8066	70 195 693	66 998 724
KKG	7 981 957	7 533 930	7887.5	155 137 467	146 318 816
KKL	8 752 385	8 319 987	8126.25	120 328 154	113 897 354



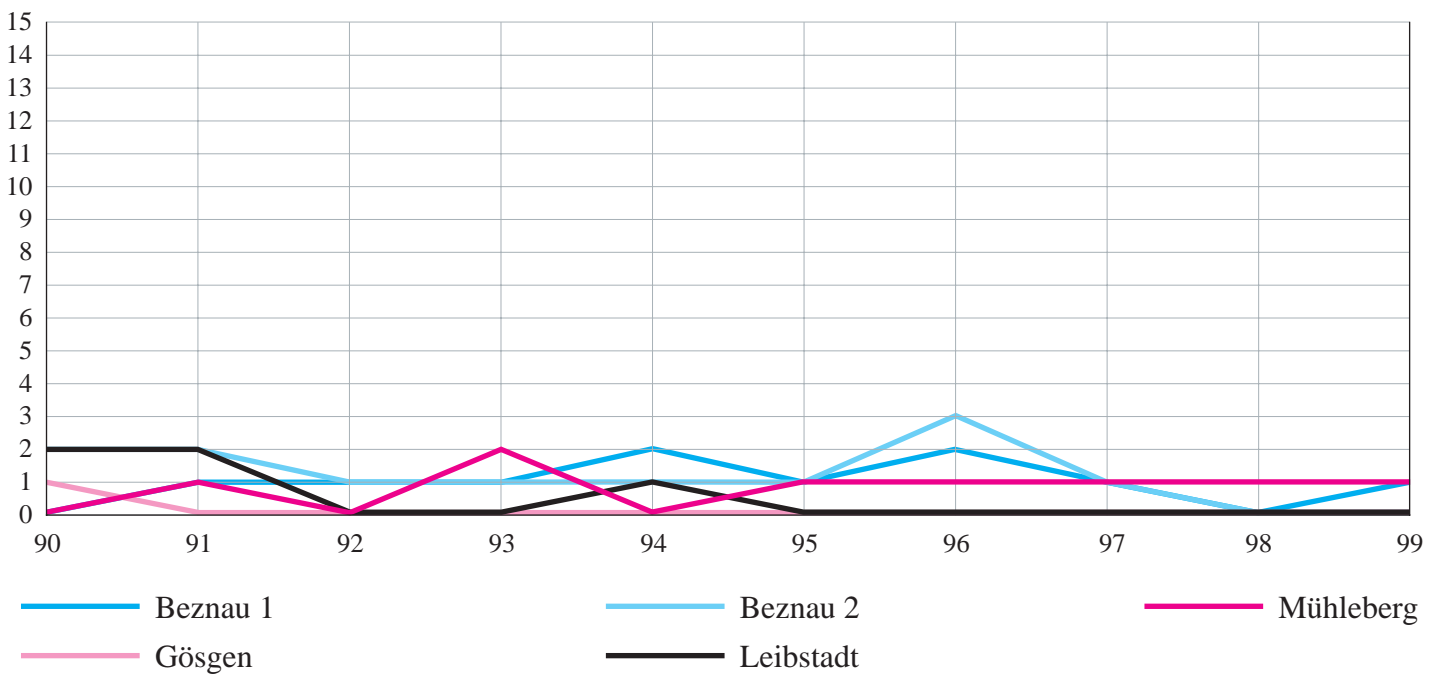
Collective Exposure

Man-Sievert (Sv)



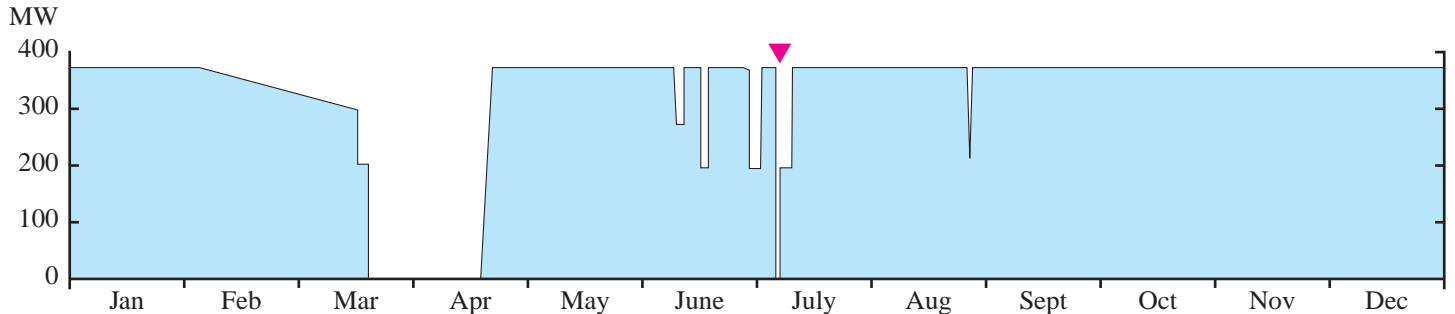
Reactor Scrams

Number



Beznau 1

Operating Experience 1999



Important to Safety

Scrams:

End of June, beginning of July: The inlet for the (river) cooling water was partly blocked by washed up wood, sand and gravel following a flood of the river Aare. This restricted the passage of cooling water to the condensers and oil coolers and led to a shutdown of one of the two turbines. Following a manual intervention in the feed-water system an unplanned scram occurred because of a high level steam generator trip. The unit was then run at 50% capacity for several days, until the alluvial materials in front of the cooling water inlet were removed.

Other:

December 31: Neither the hurricane of December 26 nor the calendar change caused any defects or breakdowns in plant operation worth mentioning. The careful analysis and preparations carried out at the technical level over a period of several years bore fruit. The combination of internal precautionary measures and arrangements made within the energy sector as a whole resulted in an incident-free millennium changeover.

Important to Availability

February 11: End-of-cycle coastdown due to core reactivity reduction. The power level was eventually decreased to 77%.

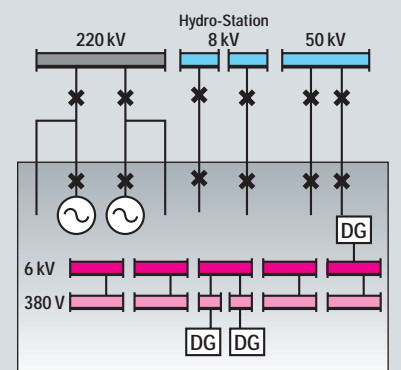
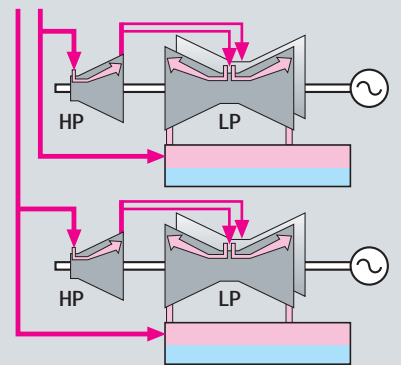
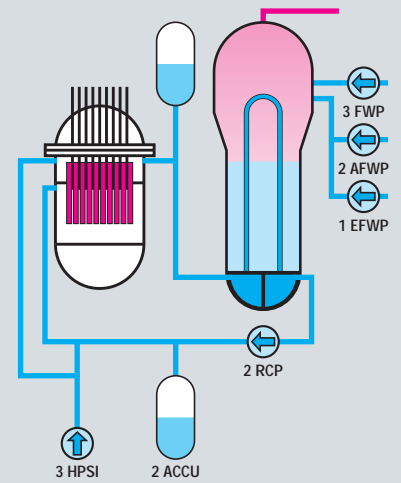
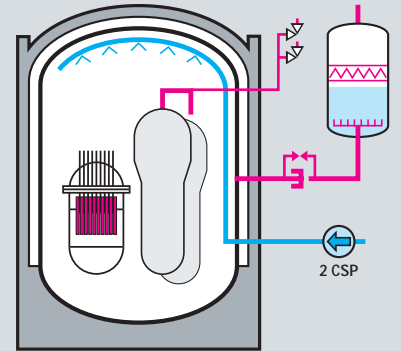
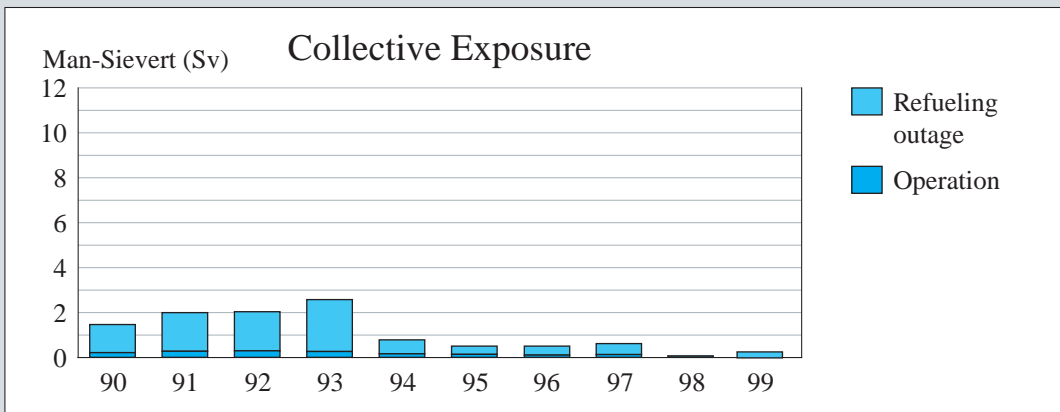
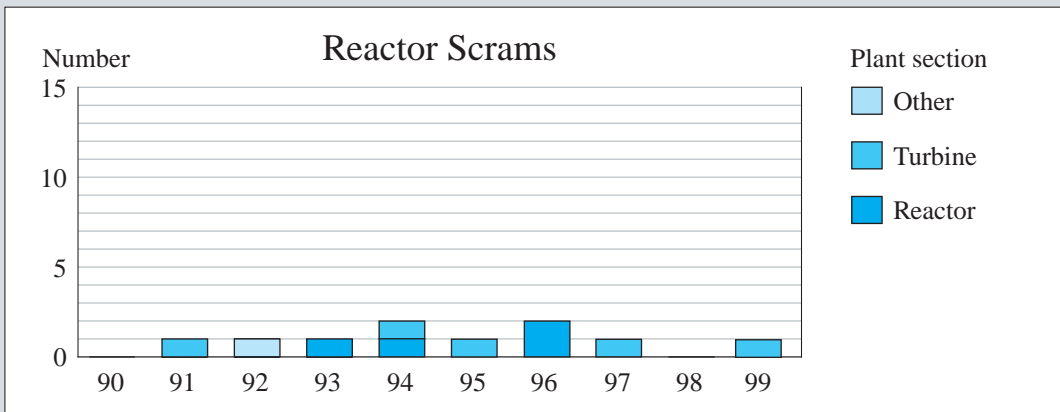
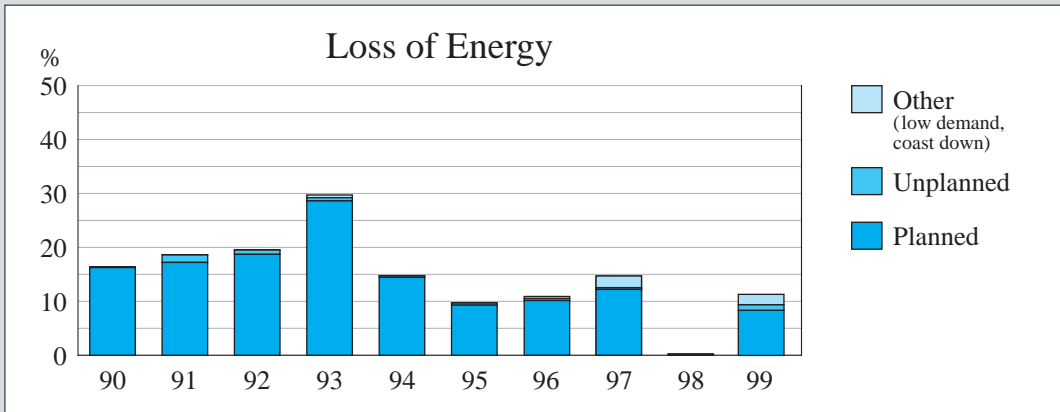
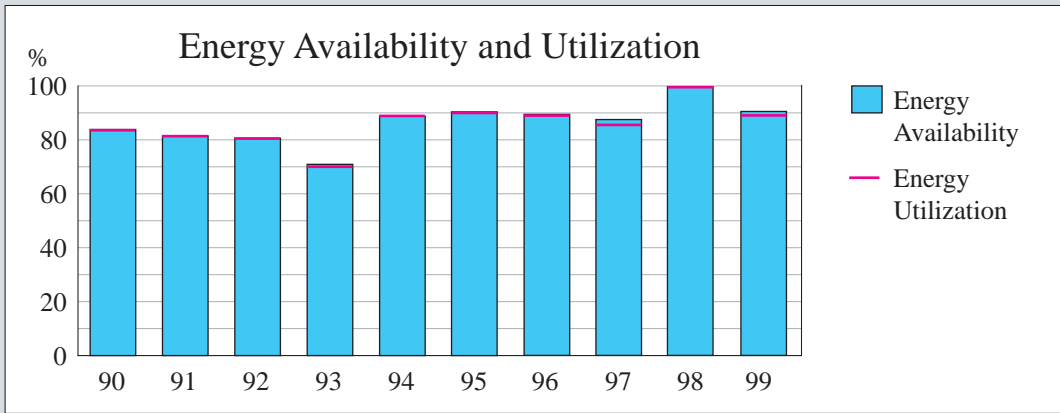
March 19: Disconnection from the grid for a refueling outage after 470 days of uninterrupted electricity generation. During the refueling outage, which lasted until April 21, the instrumentation for measurement of the neutron flux in the reactor was replaced and the piping for a new additional feedwater system was connected.

June: Two load reductions due to requirements of (external) grid load management.

August: Unplanned load reduction caused while calibrating nuclear load channels.

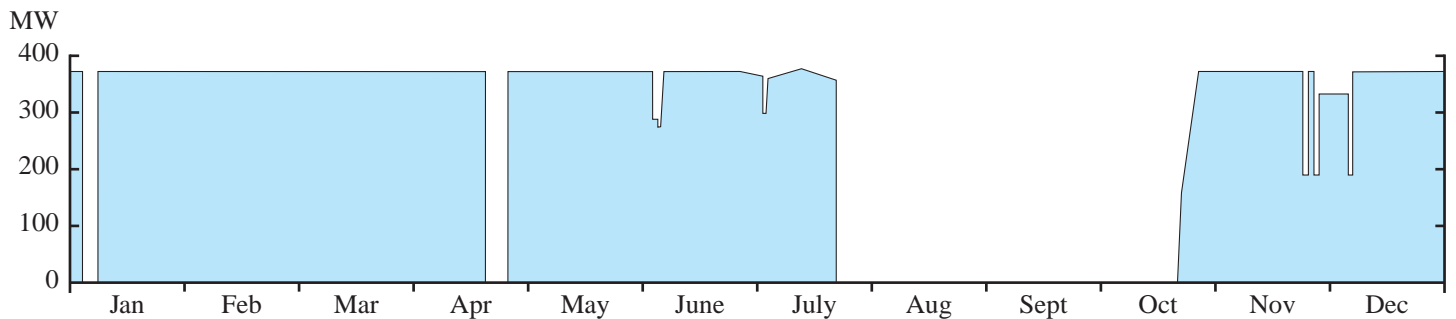
History

Characteristics



Beznau 2

Operating Experience 1999



Important to Safety

Scrams:

There were no automatic scrams during power operation.

Other:

December 31: Neither the hurricane of December 26 nor the calendar change caused any defects or breakdowns in plant operation worth mentioning. The careful analysis and preparations carried out at the technical level over a period of several years bore fruit. The combination of internal precautionary measures and arrangements made within the energy sector as a whole resulted in an incident-free millennium changeover.

Important to Availability

January 2: An unplanned shutdown was necessary in order to plug three tubes in one of the two steam generators scheduled for replacement in the second half of the year.

April 19: A planned shutdown allowed inspection and repair works to be carried out at the shaft packing of one of the main reactor pumps.

June 5 to 6: Load reduction due to requirements of (external) grid load management.

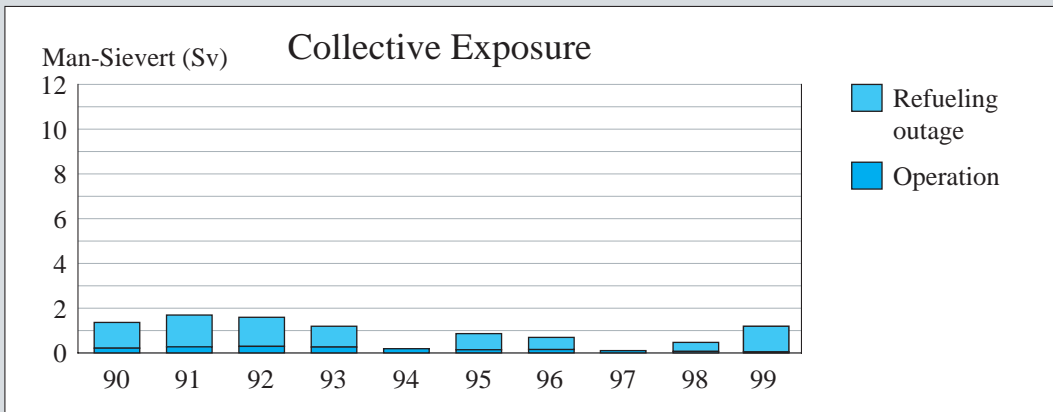
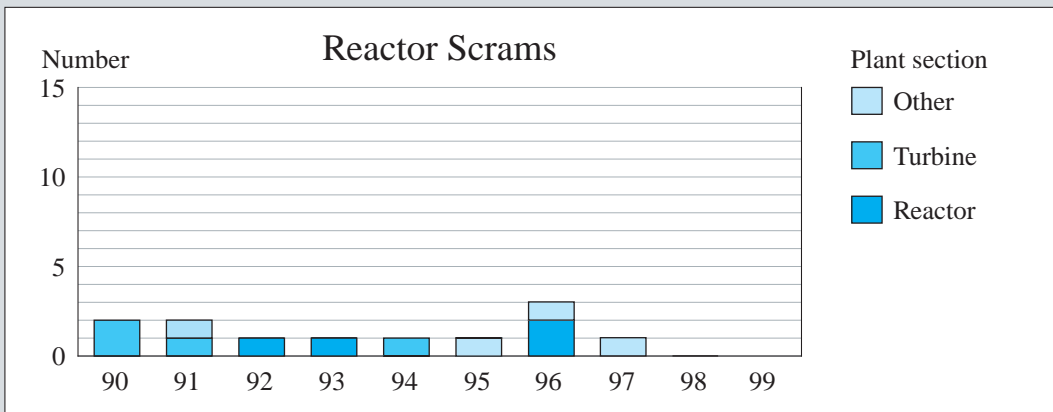
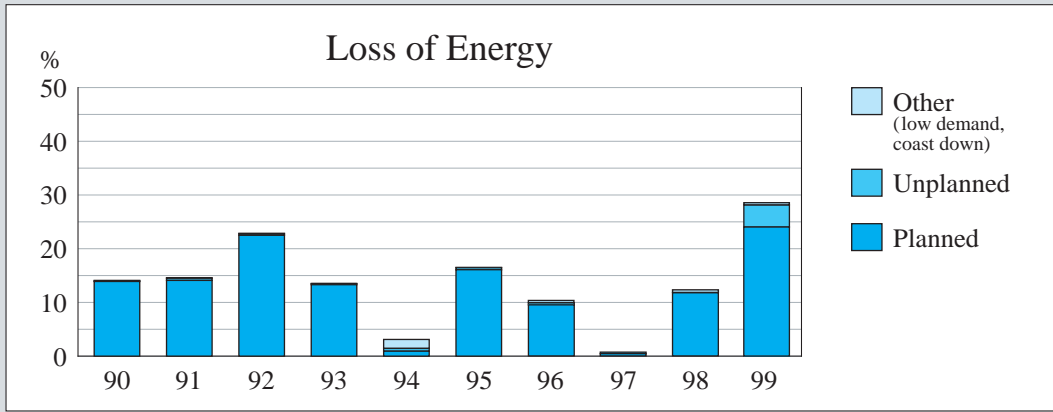
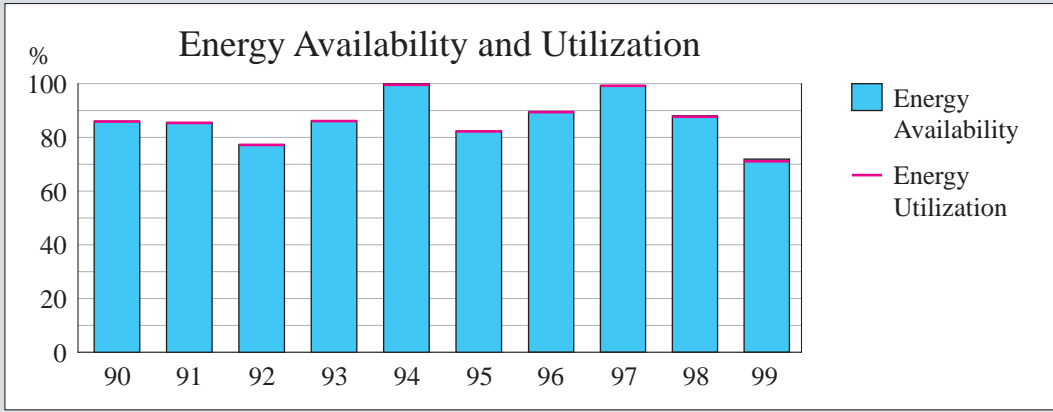
July 3 to 4: Load reduction in order to locate and repair a condenser leakage in the turbine cycle.

July 15 to 22: End-of-cycle coastdown due to core reactivity reduction. The power level was eventually decreased to 95%.

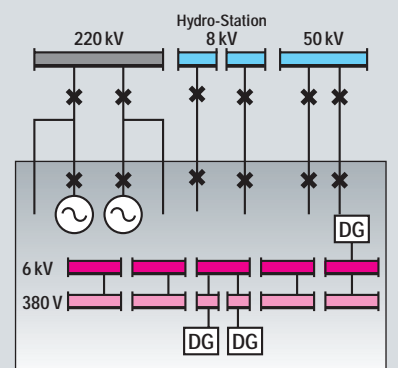
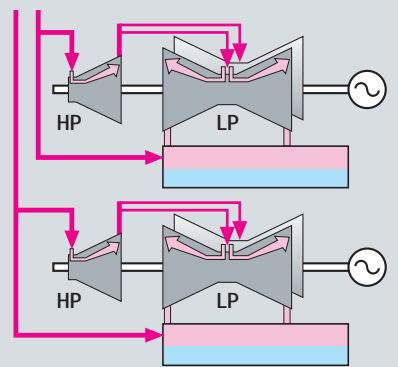
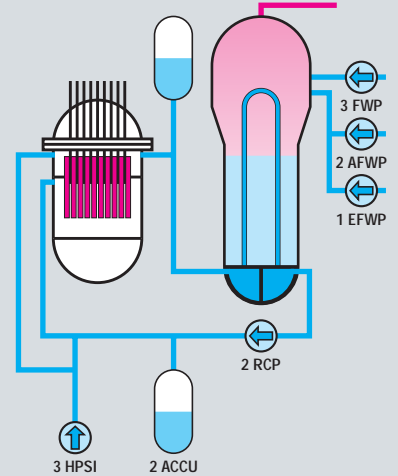
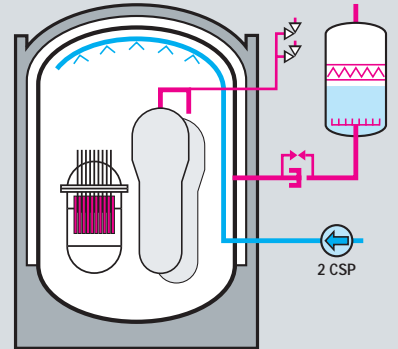
July 22 to October 19: During the refueling outage, the two, almost 30 year old, steam generators and some other important steam circuit systems were replaced. These projects can be seen as major investments in plant lifetime extension. The new steam generators, which took 42 days to replace, also increase capacity by about 8 MW. During the outage, an extended inspection program was carried out involving a reactor vessel pressure test at over 200 bars; the containment had to pass a leakage test.

End of November, beginning of December: The turbines had to be shut down one at a time, resulting in an automatic load reduction to 50%. In one case, a monitoring instrument for the turbine shaft had to be replaced. The other disturbance was caused by a defect in the secondary heat recovery system.

History

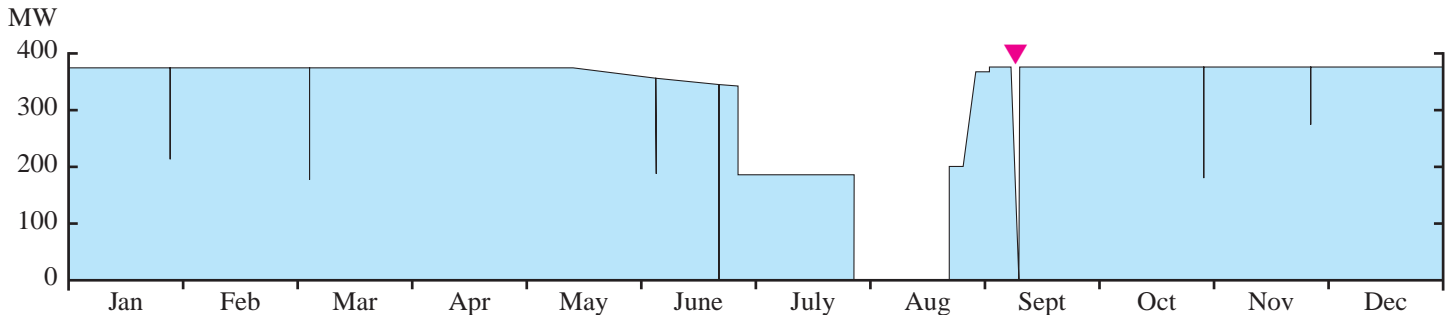


Characteristics



Mühleberg

Operating Experience 1999



Important to Safety

Scrams:

September 7: While one turbine was in shutdown mode, there was an inadvertent closure of the fire protection valve within the hydraulic control system of the other turbine, initiated by a steam leak. This led to the loss of the primary heat sink, followed by a reactor high pressure scram.

Other:

June 21: Dual turbine load rejection due to a short circuit in the nearby 220 kV switchyard. Both generators successfully switched on home load.

Important to Availability

May 28: The planned coastdown operation began.

June 27: The power level reached 88% and the load was reduced to 50%. Turbine B was shut down in order to begin the planned condenser retubing. The brass tubes were replaced by titanium bulk tubes and stainless steel boundary tubes.

Refueling outage, July 26 to August 21:

The planned outage lasted 27 days. Besides extended in-service inspections, an enlarged ultrasonic control program of reactor pressure vessel weldings was successfully carried out. The core shroud tie rods installed in 1996 were also inspected. The electronic control system of one turbine was replaced. Forty out of 240 fuel elements were replaced by new ones.

Load reductions:

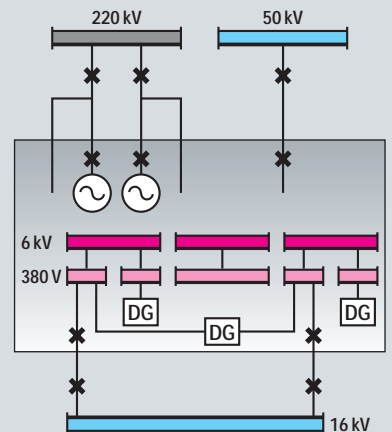
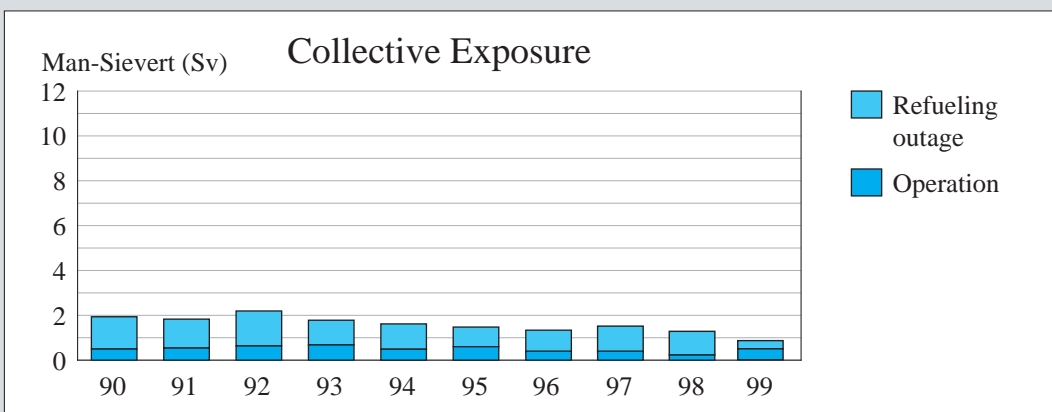
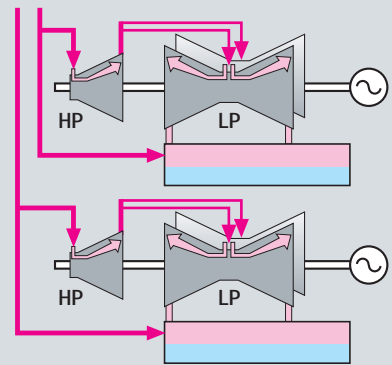
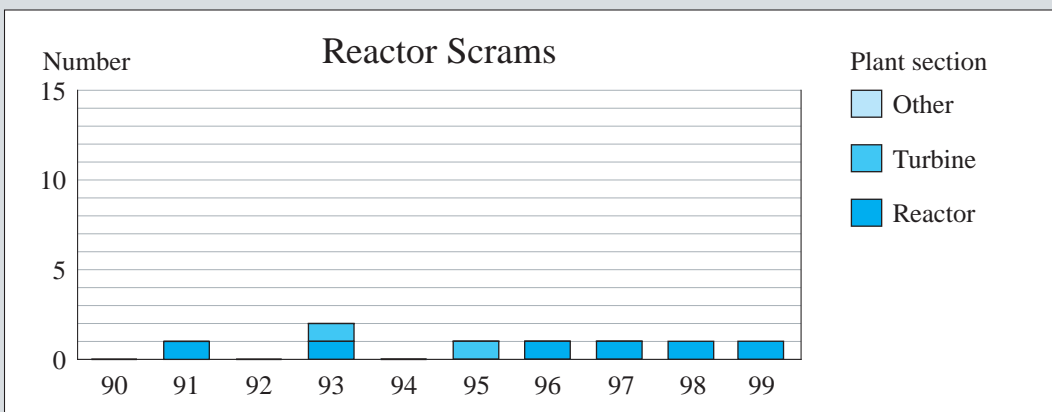
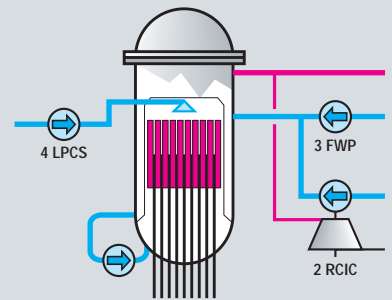
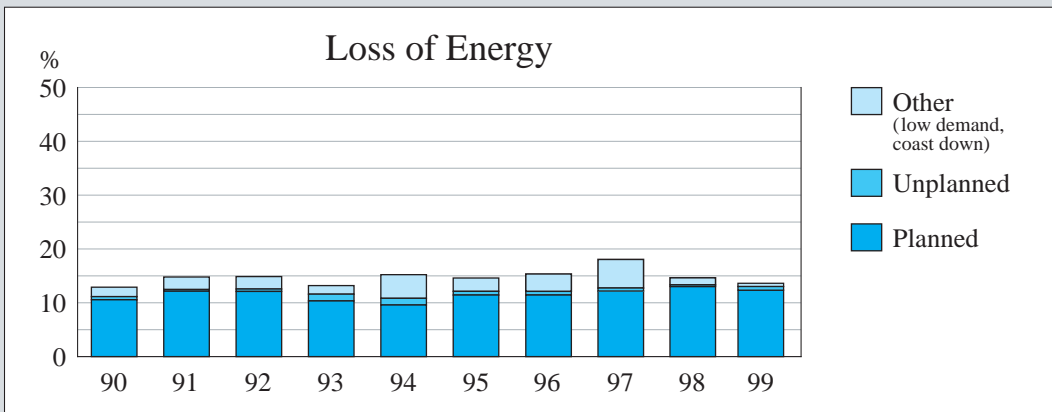
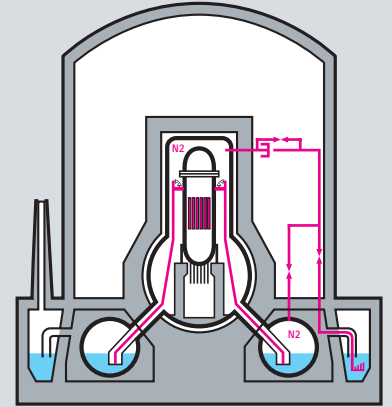
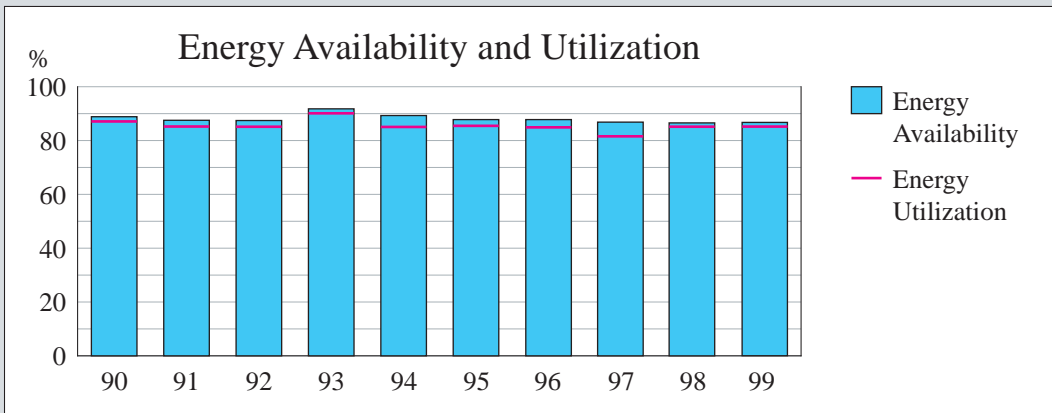
A total of seven load reductions (> one full power hour) was required.

Three unplanned load reductions occurred. The first was due to a steam leak from one low pressure reheater valve. The second was due to a defective seal in the auxiliary vessel of a steam reheater. The third was due to a dual generator load rejection.

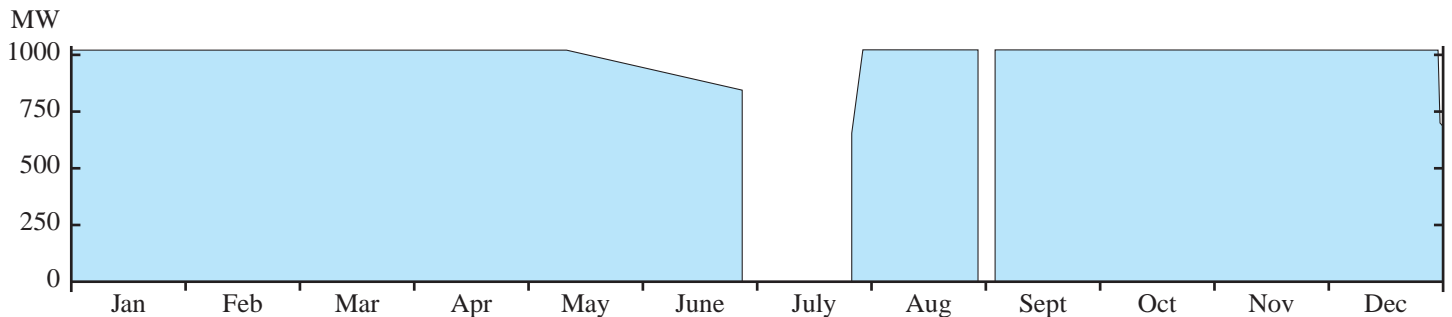
Three planned load reductions to 50% were required for periodical monitoring tests. On June 27, the load was reduced to 50% for the planned shutdown of turbine B.

History

Characteristics



Operating Experience 1999



Important to safety

Scrams:

1999 was the ninth consecutive year of operation without unplanned scrams.

Other:

At the request of the Swiss federal government, an IAEA Operational Safety Review Team (OSART) of international experts visited Gösgen Nuclear Power Plant, from 8 to 25 November 1999. The purpose of the mission was to review operating practices in the areas of management organization and administration, training and qualification, operations, mechanical maintenance (including plant technical support), electrical maintenance (including plant technical support), radiation protection, chemistry and emergency planning and preparedness.

The team commended the excellent operating history, the plant's condition, and the level of qualification, ownership and motivation of plant staff. It also made suggestions for further improvements in operational safety, as well as recommendations in several other areas.

Important to availability

May 9: Coastdown operation began. The power level at the end of the cycle was 82%. Coastdown operation corresponded to a production loss equivalent to about four full power days.

Refueling outage, June 26 to July 28:

The refueling outage was scheduled to last 23 days but was extended to 32 days.

In addition to general preventive maintenance and inspection work, the following major work was performed:

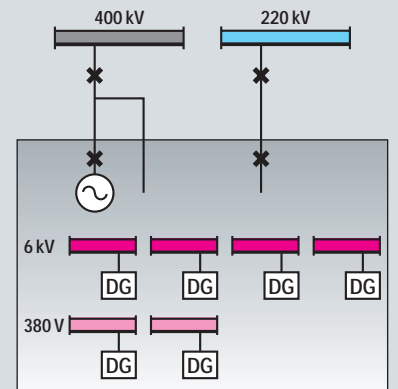
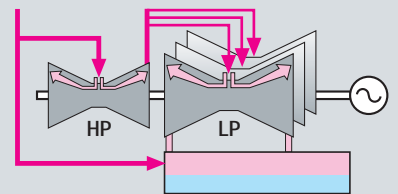
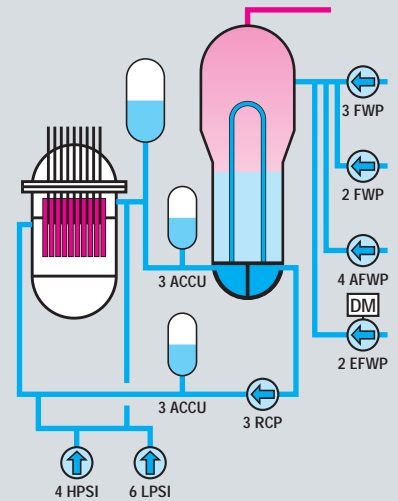
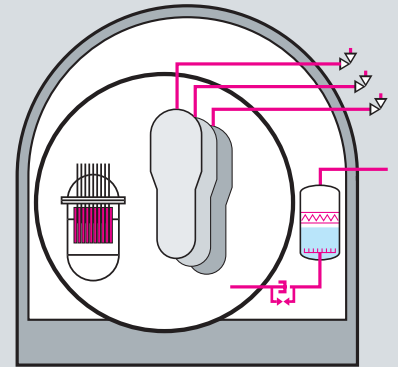
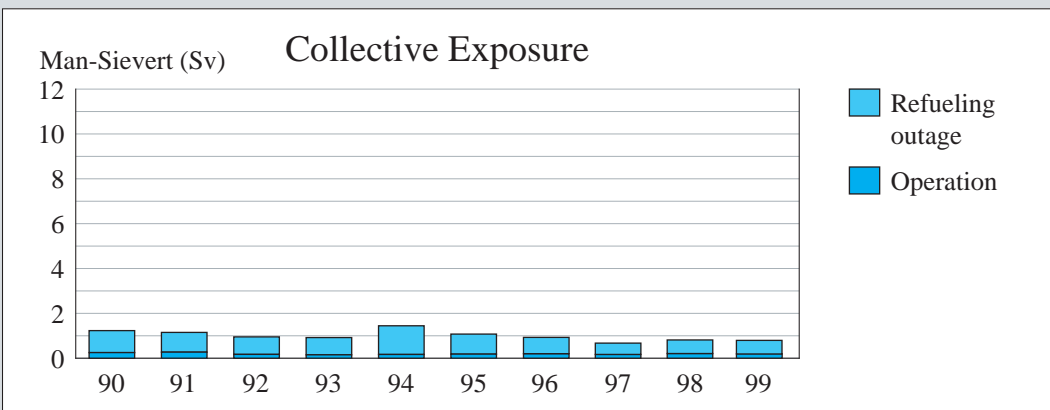
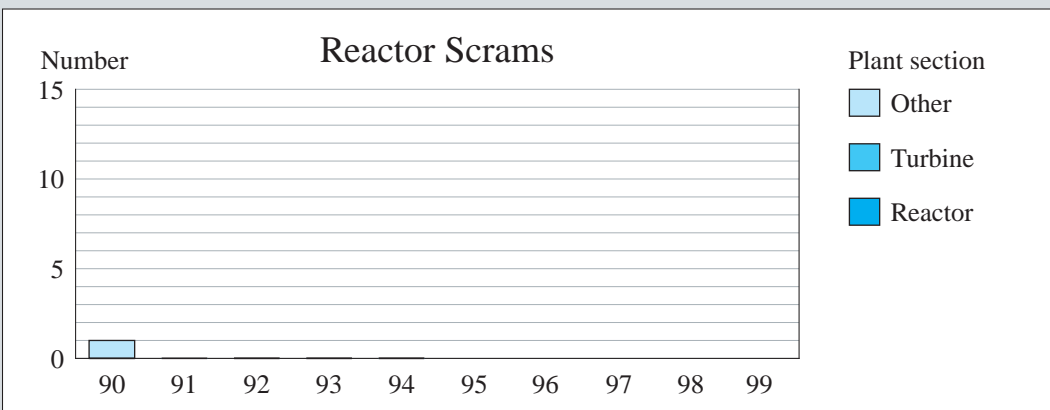
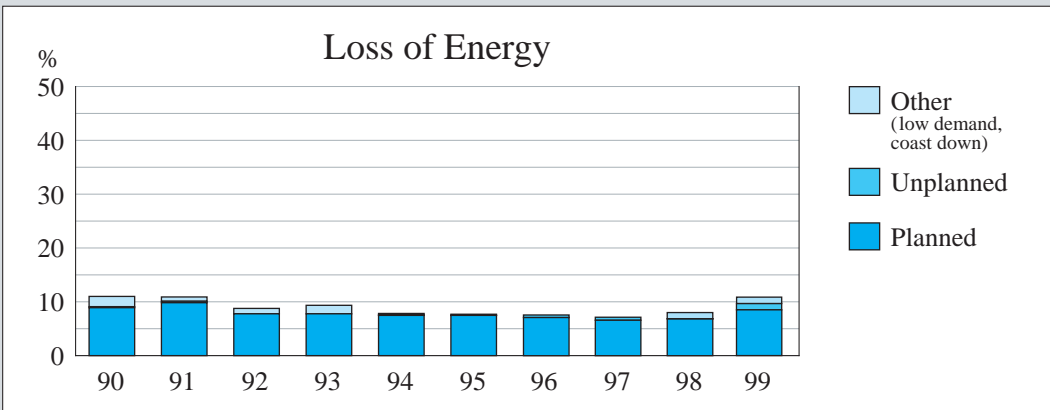
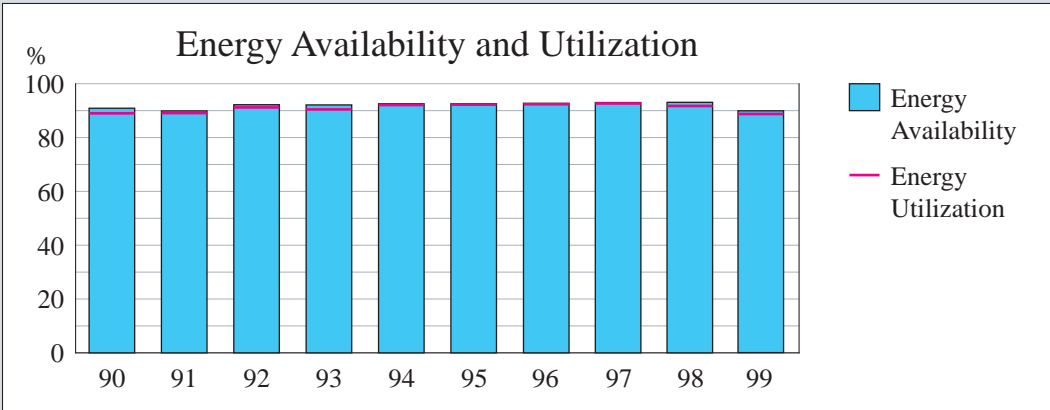
- 100% eddy current testing of two steam generators, plus 50% of the third.
- For inspection of the main generator stator core, the generator rotor had to be pulled. This unplanned work caused a seven-day extension of the refueling outage.
- Replacement of one main steam pressure relief valve. The valve did not work properly during the functional test at operating temperature. The repair work resulted in a two-day extension of the refueling outage.
- Loading of 44 new fuel elements. The newly loaded fuel includes 20 MOX fuel elements.

August 28 to September 2: Shutdown of the plant for replacement of one hydrogen seal on the main generator.

December 31: Load reduction to 70% due to low power demand.

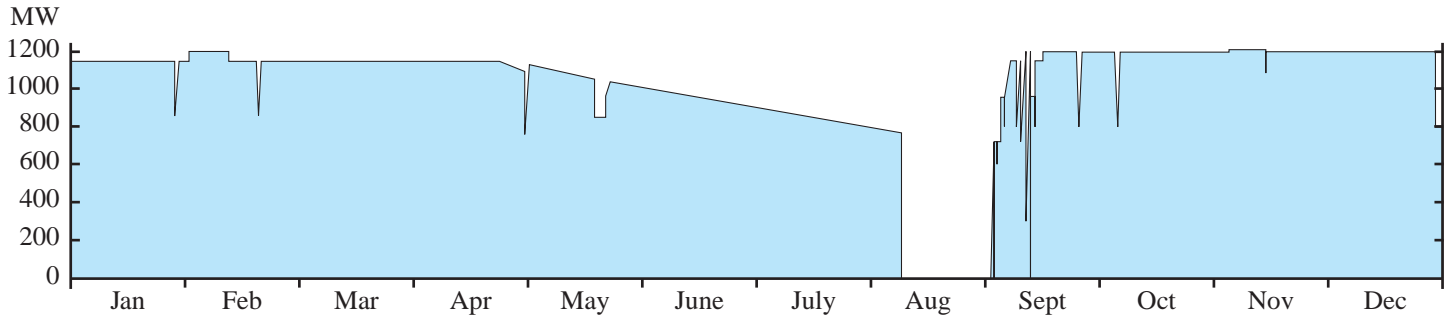
History

Characteristics



Leibstadt

Operating Experience 1999



Important to Safety

Scrams:

There were no automatic scrams during power operation (for the 5th consecutive year).

Important to Availability

January 30: Control rod pattern adjustment and main steam isolation valve (MSIV) monitoring.

February 1 to 14: Power increased to 109% for power uprating 'test operation'.

February 20: Control rod pattern adjustment.

April 22: Began end-of-cycle coastdown.

April 30: Unplanned replacement of reactor core isolation cooling (RCIC) injection valve motor; planned MSIV monitoring.

May 21 to 24: Load reduction due to low electrical demand.

August 7: Planned turbine trip test at 65% power; resynchronized to the grid.

August 7 to September 2: 15th refueling outage

Duration was 26.1 days (scheduled 26.0). Loaded 136 new fuel bundles (out of 648).

September 3 to 12: Plant startup; various preplanned power uprating transient tests.

September 6, 8, 12, 25: Control rod pattern adjustments.

September 16: Power raised to 109% following Swiss nuclear safety authority approval.

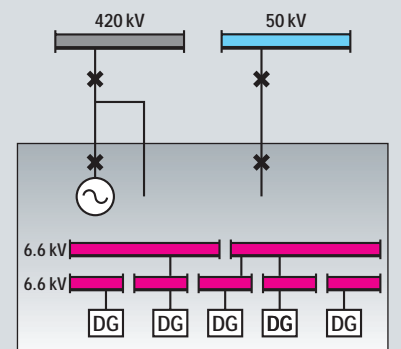
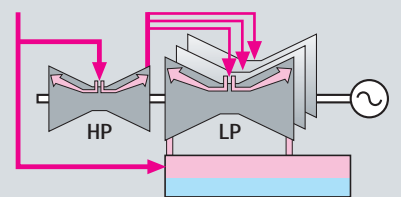
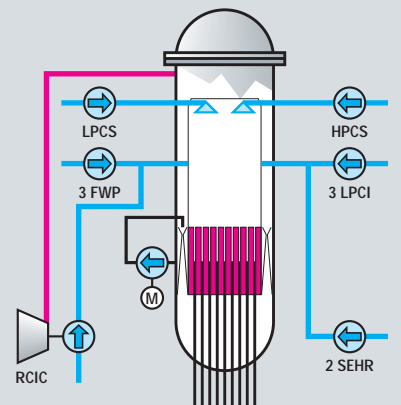
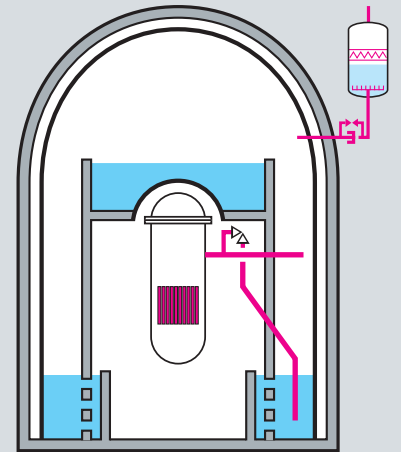
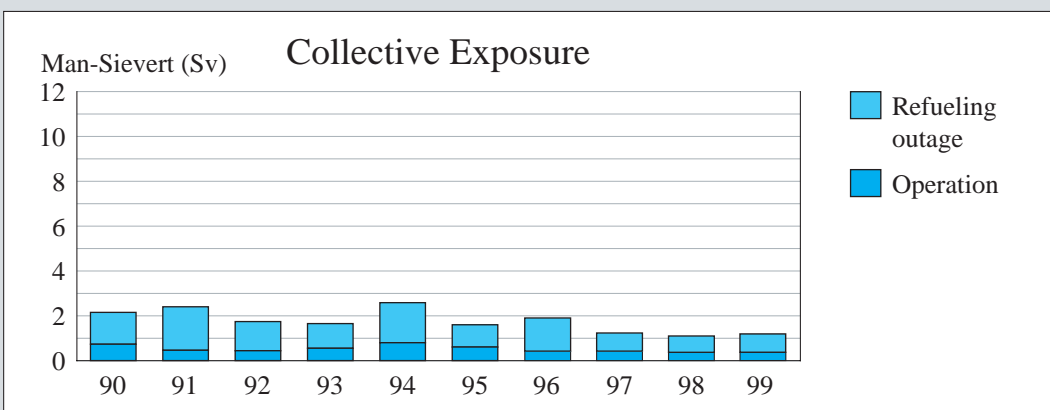
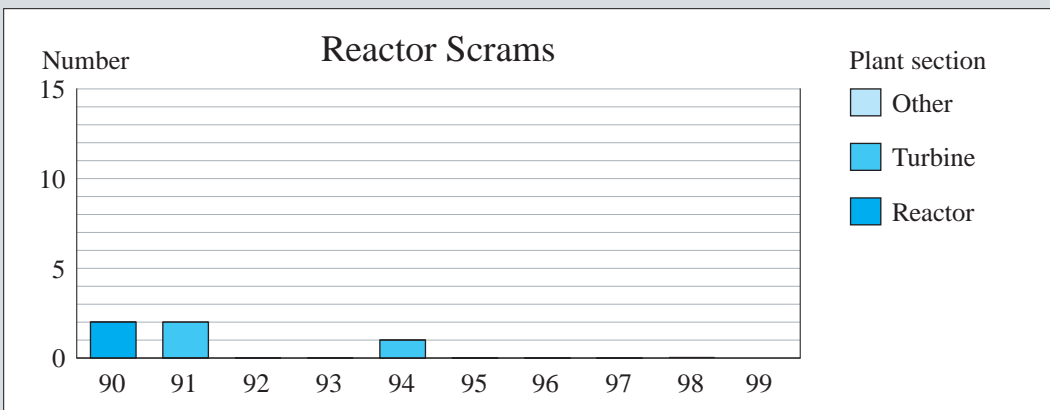
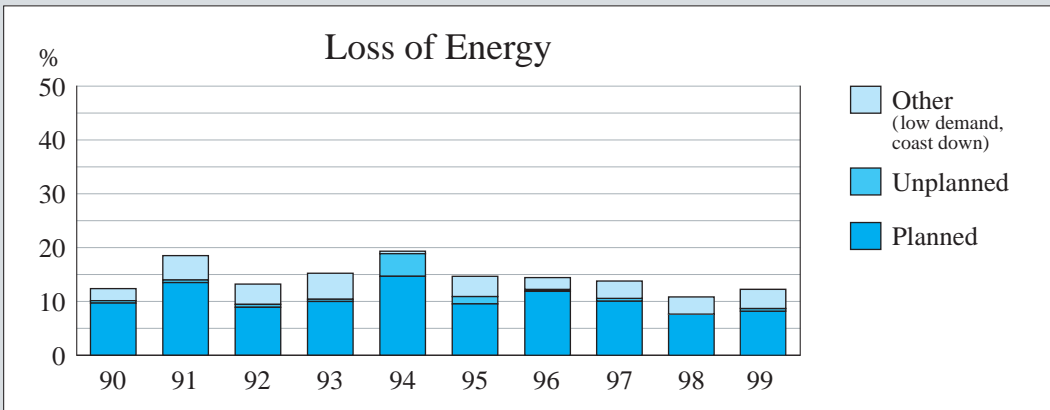
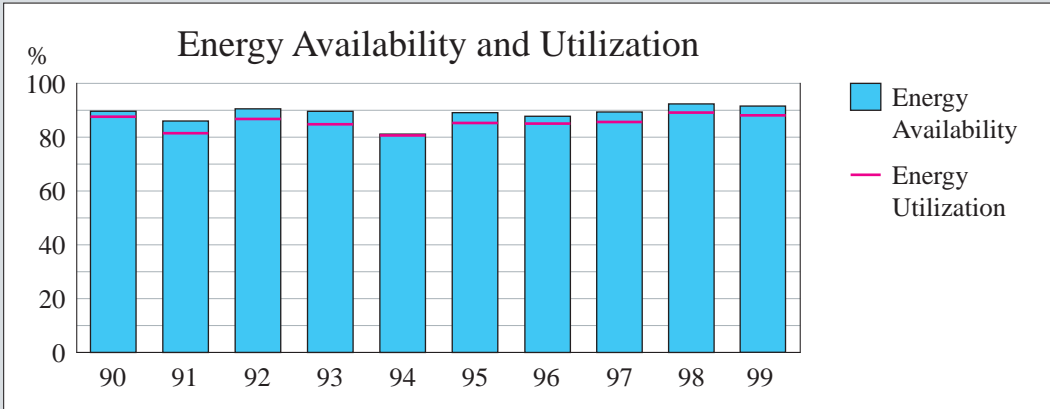
October 9: Control rod pattern adjustment and MSIV monitoring.

November 16: Unplanned load reduction for repair of MSR drain line flange leak.

December 31: Power raised to 70% for Y2K contingency.

History

Characteristics



The first two Swiss nuclear power plants, Beznau and Mühleberg, each belong to a single large public electric utility, whereas the two later plants, Gösgen and Leibstadt, are partner plants of several electric utilities and public service companies. The concept of partner nuclear power plants made it possible, when they were set up in the seventies, for medium-sized and smaller organisations to share in economically attractive, large-scale power generation plants and to gain access to the latest technology. In each case one of the partners has responsibility for the business management on behalf of the others.

The Beznau nuclear power plant is fully owned by its operator, Nordostschweizerische Kraftwerke.

Likewise, the Mühleberg nuclear power plant belongs fully to BKW FMB Energie AG.

The partners of Kernkraftwerk Gösgen-Däniken AG (KKG) are:

- Aare-Tessin AG für Elektrizität (ATEL, 35%, managing partner)
- Nordostschweizerische Kraftwerke (NOK, 25%)
- the City of Zurich (15%)
- Centralschweizerische Kraftwerke (CKW, 12.5%)
- the City of Berne (7.5%)
- Swiss Federal Railways (SBB, 5%)

Kernkraftwerk Leibstadt AG (KKL) is owned by the following partners:

- Elektrizitäts-Gesellschaft Laufenburg AG (EGL, 15%, managing partner)
- Aare-Tessin AG für Elektrizität (ATEL, 21.5%)
- Aargauisches Elektrizitätswerk (AEW, 5%)
- Badenwerk AG (BW, 7.5%)
- BKW FMB Energie AG Beteiligungsgesellschaft (BKW/BG, 7.5%)
- Centralschweizerische Kraftwerke (CKW, 12.5%)
- Watt AG, Zürich (5%)
- Kraftwerk Laufenburg (KWL, 7.5%)
- Nordostschweizerische Kraftwerke (NOK, 8.5%)
- S. A. l'Énergie de l'Ouest-Suisse (EOS, 5%)
- Swiss Federal Railways (SBB, 5%)

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