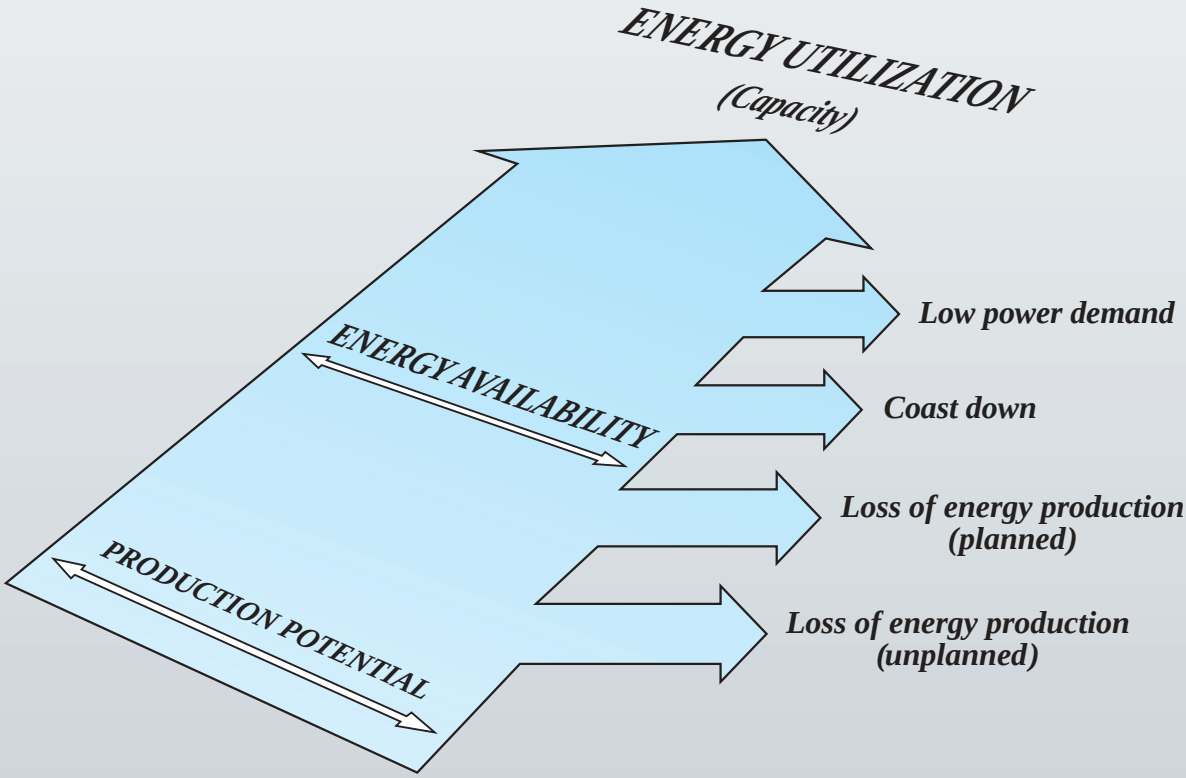
April 2002

Summary of
Operating Experience
in Swiss Nuclear Power Plants

2001

SVA
ASPEA



SWISS NUCLEAR POWER PLANTS

Power station	Type of reactor	Net output (MWe)	Commercial operation
Beznau (KKB)	PWR	365	Unit 1: Dec. 24, 1969
		365	Unit 2: March 15, 1972
Mühleberg (KKM)	BWR	355	November 6, 1972
Gösgen (KKG)	PWR	970	November 19, 1979
Leibstadt (KKL)	BWR	1145[1]	December 15, 1984

DEFINITIONS

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

Energy availability factor – Etg/En
(UNIPEDE definition 4.6.03.f)
Energy utilization factor – Ed/En
(UNIPEDE definition 4.5.01)

En *(Production Potential)*
– energy producible assuming maximum capacity continuously available throughout a specific period

Ed *(Energy Utilization)*
– energy actually produced within a specific period

Etg *(Energy Availability)*
– energy producible assuming available capacity during a specific period

The Swiss nuclear power plants have achieved another successful year of operation: With 25.3 TWh they achieved their highest-ever combined annual net output in 2001. This was 1.3% higher than the previous year's record (24.97 TWh). The nuclear share in overall electricity production was 36%.

Only one automatic reactor scram occurred during power operation at Beznau 2, and one automatic scram was caused by the turbine at Mühleberg. For Gösgen, 2001 was the eleventh consecutive year of operation without unplanned scrams.

With the exception of Beznau 2 (see page 8), all refuelling and maintenance outages were once again kept very short. The Beznau 1 outage lasted 11 days, Beznau 2 68 days, Mühleberg 23 days, Gösgen 22 days and Leibstadt 24 days.

Non-electricity energy delivery by Beznau and Gösgen continued flawlessly. Beznau delivered 150.5 GWh thermal energy to the Refuna district heating system, while Gösgen supplied 177 GWh of process heat to the nearby Niedergösgen cardboard factory.

The nuclear energy division of NOK, the owner of the Beznau twin station, introduced an environmental management system in 2001 based on the international standard ISO 14001. The Beznau station became the first in Switzerland to hold this environmental certification.

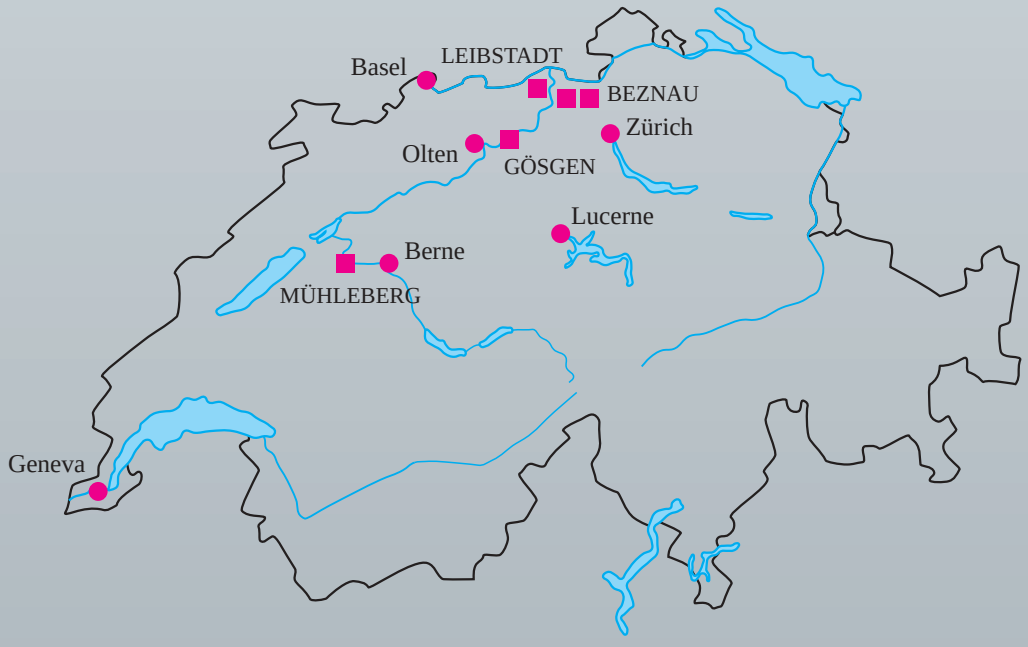
The Federal Nuclear Safety Authority (HSK) has acknowledged the high safety level of Swiss nuclear power plant operations in the past year.

The good operating experience of Swiss nuclear plants constitutes a solid basis for the national energy policy in the context of the Federal law on Carbon Dioxide.

Swiss Association for Atomic Energy (SVA)

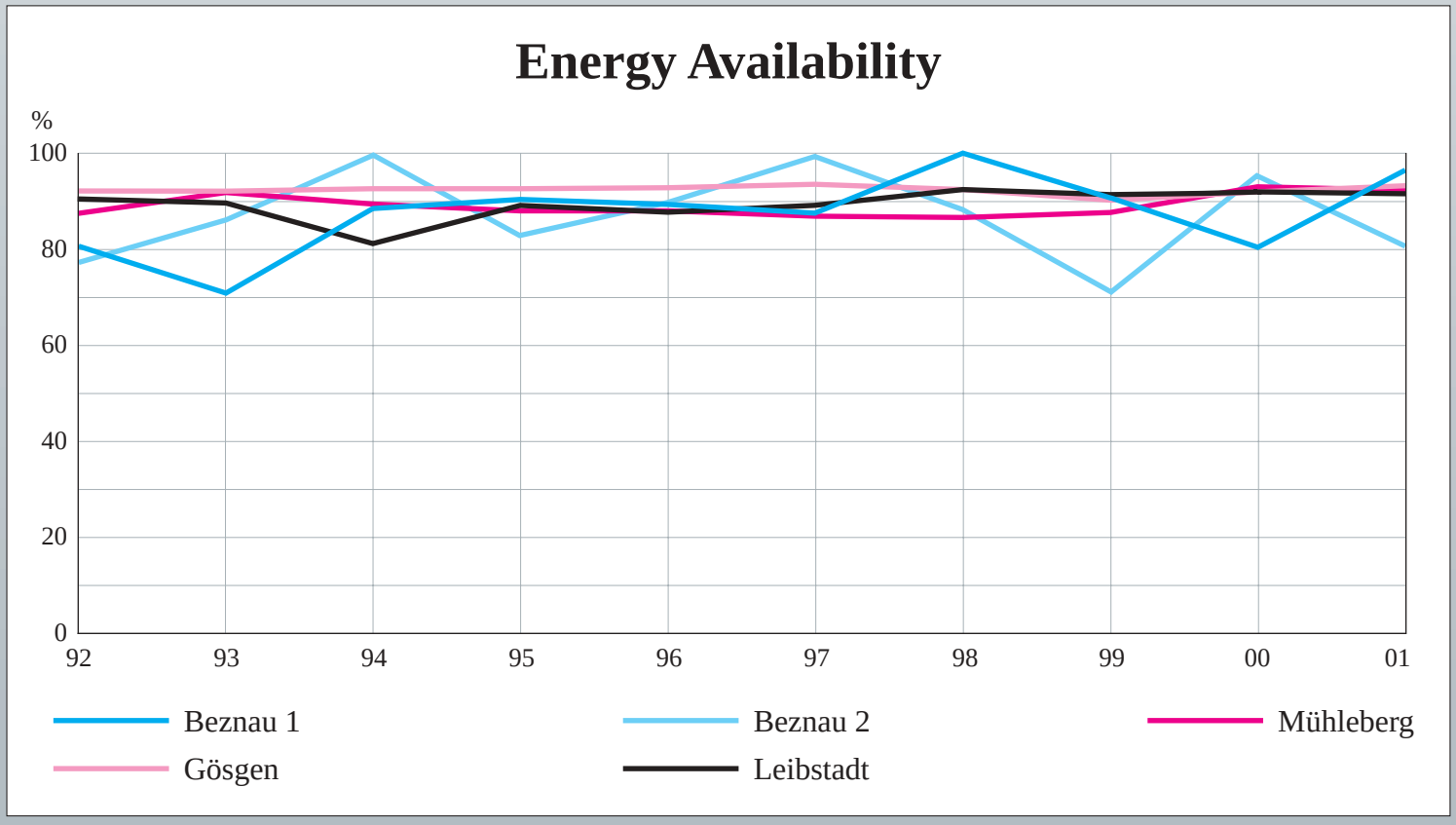
Dr. Bruno Pellaud, President

Dr Peter Hählen, Secretary General

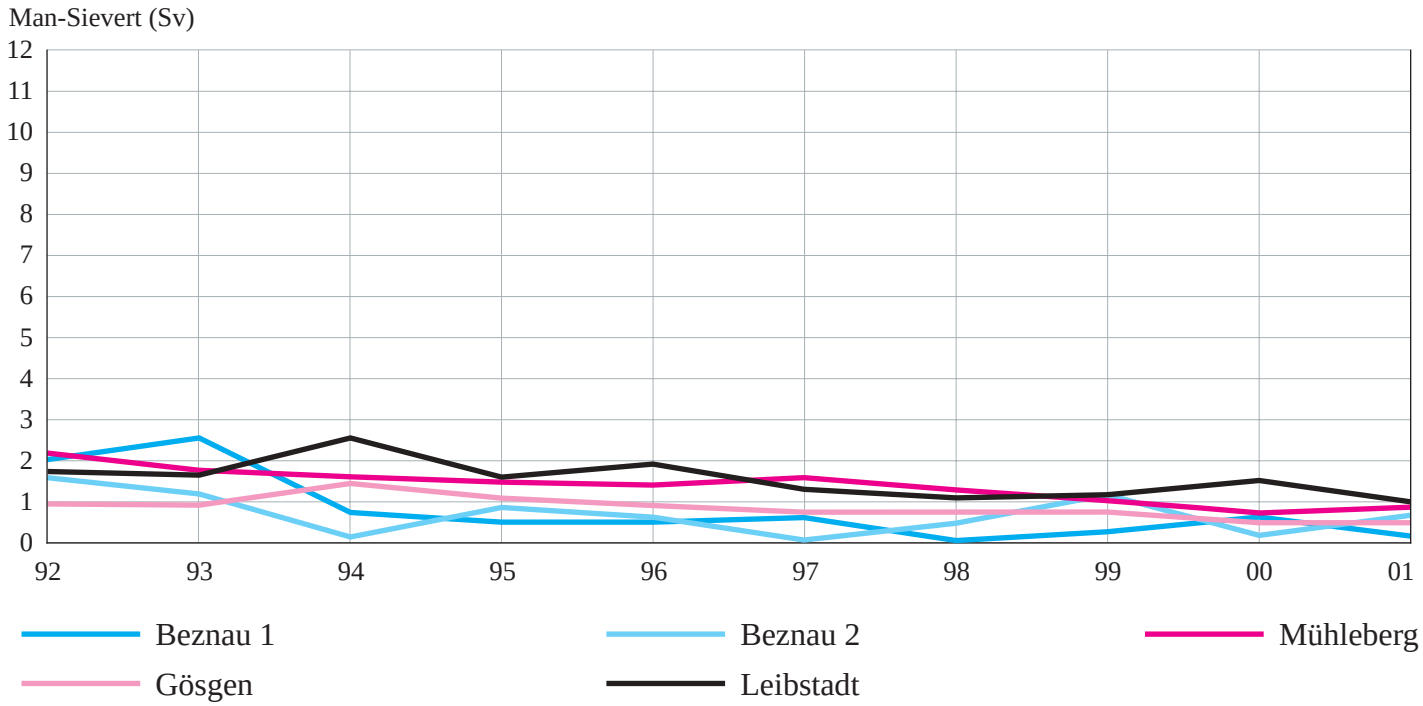


Swiss Nuclear Power Plants: Production Figures 2001 and History

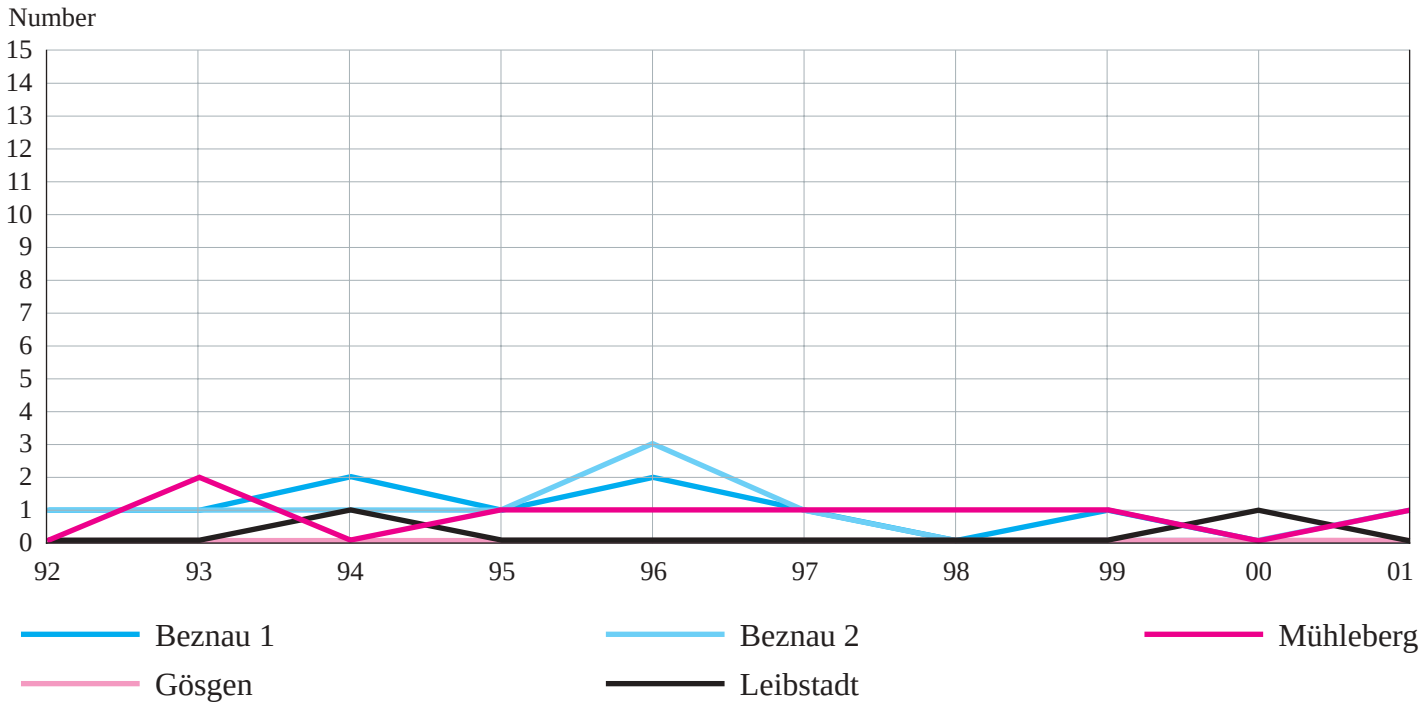
	Gross production MWh	Net production MWh	Total operating time (power production) h	Total gross production since start of operation MWh	Total net production since start of operation MWh
KKB 1	3 221 601	3 090 177	8505	84 072 703	80 415 576
KKB 2	2 677 045	2 567 727	7128	83 374 075	79 874 610
KKM	2 889 140	2 768 733	8195	76 021 513	72 584 488
KKG	8 339 020	7 870 475	8206	171 744 079	161 993 536
KKL	9 546 529	9 089 773	8187.5	139 147 617	131 810 316



Collective Exposure

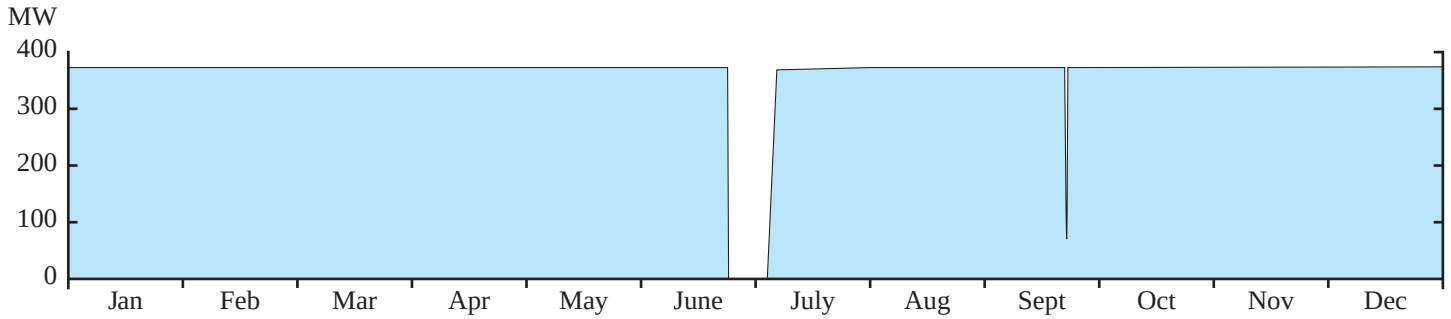


Reactor Scrams



Beznau 1

Operating Experience 2001



Important to Safety

Scrams:

There was no automatic scram during power operation.

Other:

August 20: The Nuclear Energy Division of NOK has introduced an environmental management system that is based on the international standard ISO 14001. In the first half of 2001, the Swiss certifying institute SQS closely examined the basic environmental policy, the chosen objectives and the environmentally relevant processes. Their final report states that the environmental management system meets all the demands of the strict standard. Therefore, as of August 20, the Beznau Nuclear Power Plant became the first NPP in Switzerland, to hold this environmental certificate.

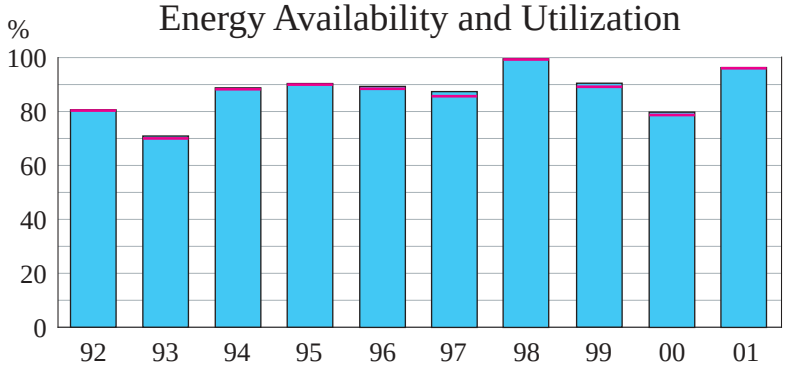
Important to Availability

June 23 to July 4: The refuelling outage, the first short outage within the scope of the so-called hybrid cycle, served primarily for the replacement of the irradiated fuel elements. This allowed resumption of power operation after a period of only eleven days. The hybrid cycle is based on a first operating year ending with a short outage for fuel reloading only, followed in the next year by a full refuelling and maintenance outage. This new approach depends on the long experience of plant operators and contractors concerning the behaviour of components and systems and the use of preventive maintenance aimed at reducing the average outage period without loss of safety.

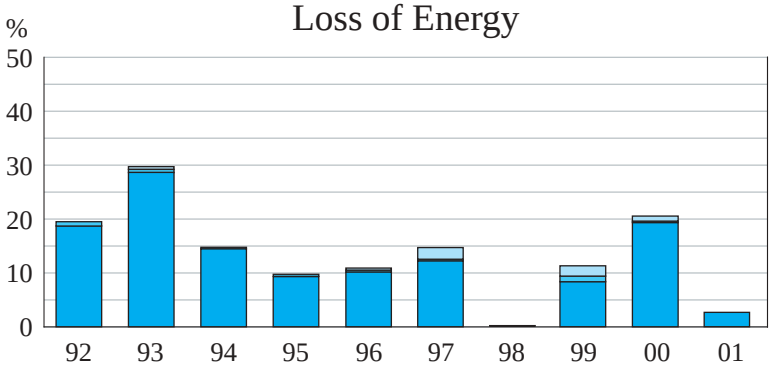
History

Characteristics

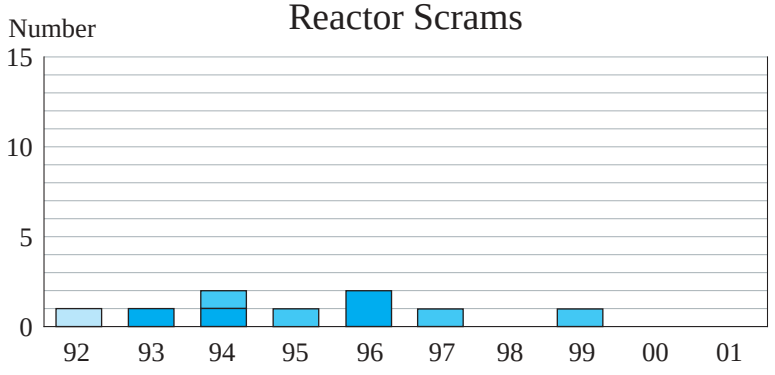
Energy Availability and Utilization



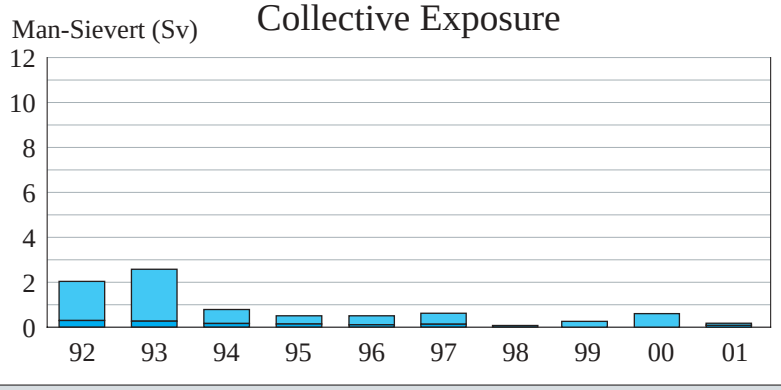
Loss of Energy

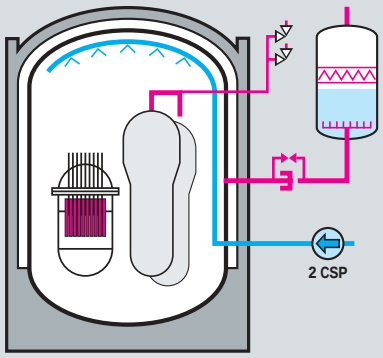


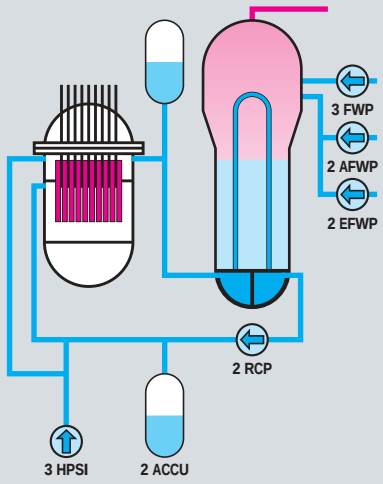
Reactor Scrams

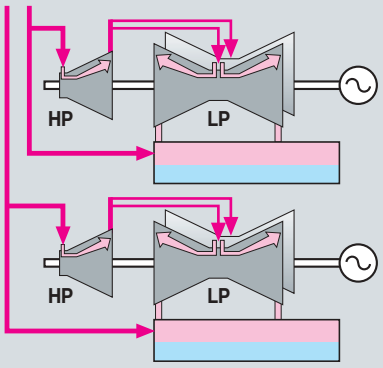


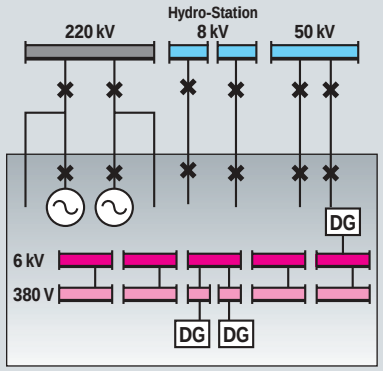
Collective Exposure





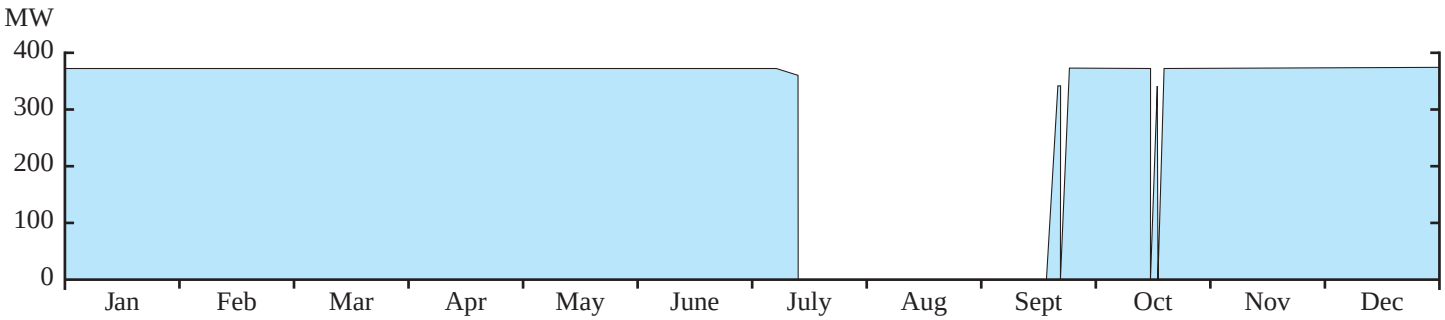






Beznau 2

Operating Experience 2001



Important to Safety

Scrams:

There was one (1) automatic scram during power operation.

October 18: The scram was caused by an interruption of the power supply in a control system for the two feedwater control valves. The scram occurred while dismantling an auxiliary measuring instrument which was – after two years of use – no longer needed. In returning the unit to full operation, a defective controller on the secondary side caused an automatic turbine scram. Realizing that, in order to maintain the level of 50% power, too much boron had been added, the operators in charge shut down the unit according to standard procedures.

Other:

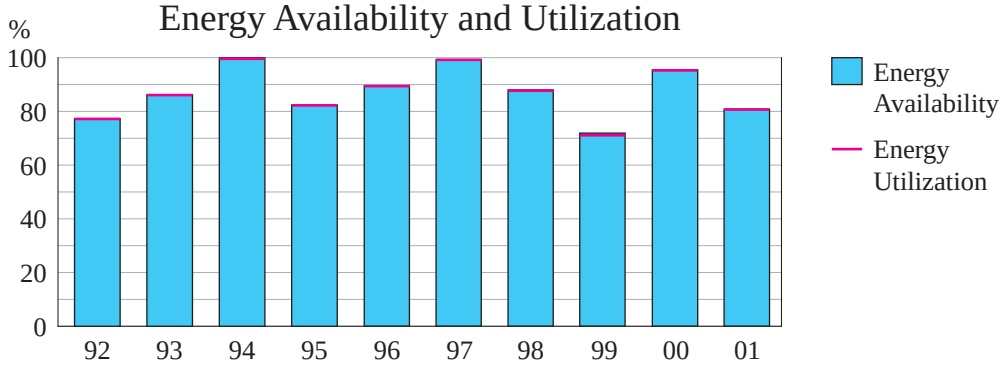
August 20: As for unit 1 the Nuclear Energy Division of NOK also introduced the ISO 14001 certified environmental management into Beznau 2 and for the whole of the Nuclear Division.

Important to Availability

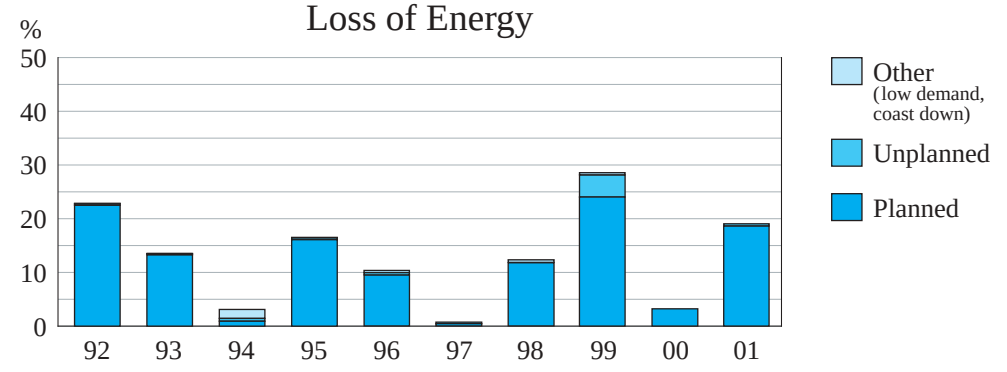
July 13 to September 18: During the refuelling outage, the central control system, which comprises especially the reactor protection system and the reactor instrumentation and control equipment, together with their secure power supply, was completely replaced. On September 18 the plant was put into operation again and synchronised with the grid, initially at 50% of nominal capacity. Up to September 24, when full power was reached, all the necessary tests took place, comprising fast load changes, a load interruption and a turbine outage with succeeding reactor trip. All tests took their normal course; the central control system met all expectations. During the refuelling outage, some further work was carried out, such as the replacement of valves in the main cooling system, a high pressure safety injection pump and a motor of one of the two reactor coolant pumps.

History

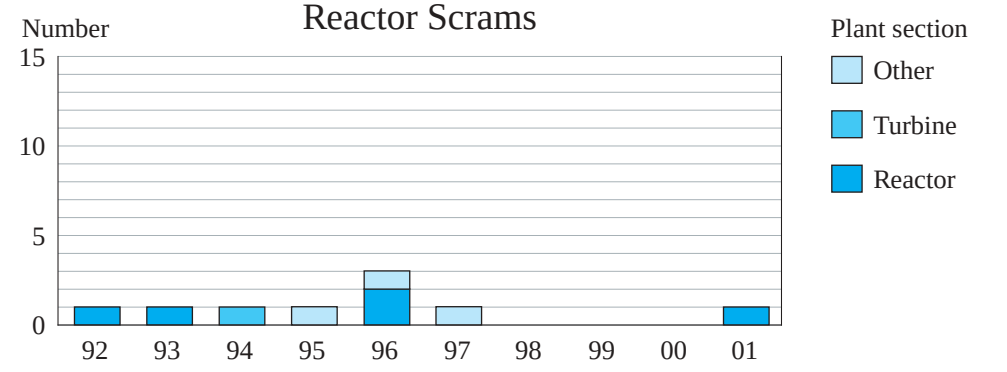
Energy Availability and Utilization



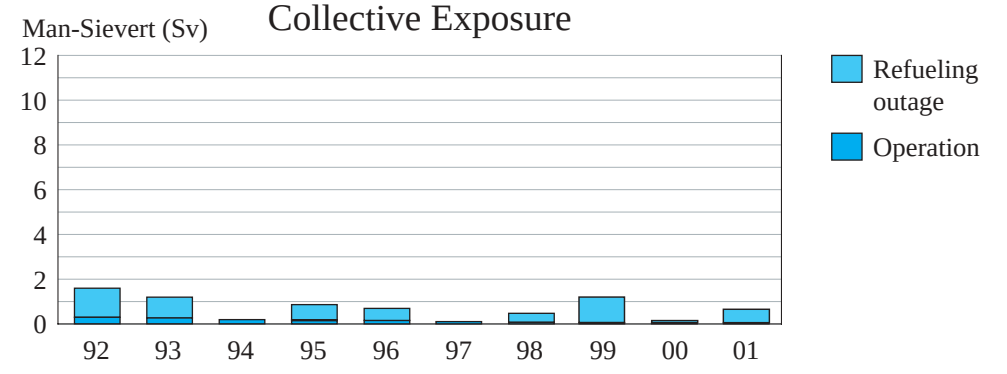
Loss of Energy



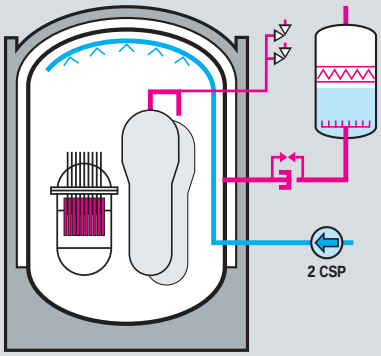
Reactor Scrams

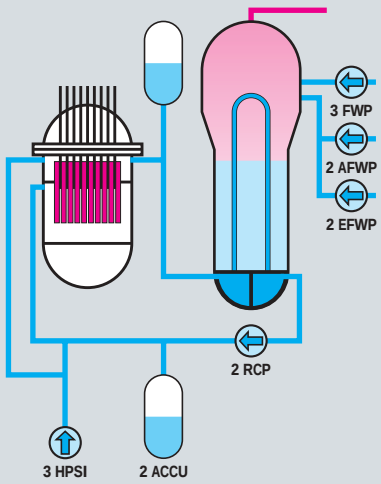


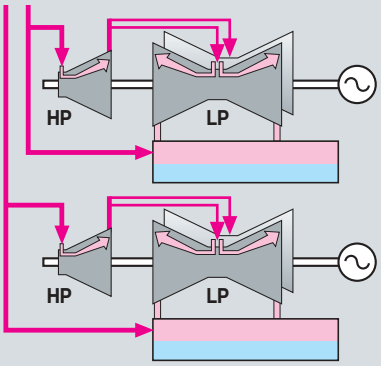
Collective Exposure

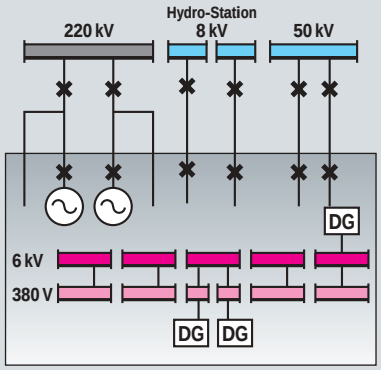


Characteristics



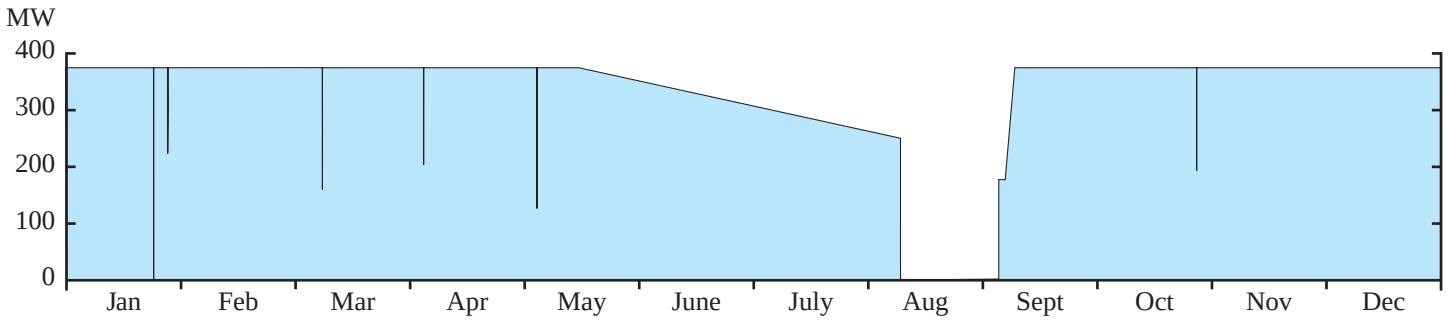






Mühleberg

Operating Experience 2001



Important to Safety

Scrams:

There was one (1) automatic scram during power operation.

Others:

The continuous hydrogen injection in feedwater, which started October 2000, stayed in operation throughout 2001. During the refueling outage, in-service inspections and ultrasonic controls of the reactor pressure vessel were successfully carried out. As usual, inspections of the core shroud were also performed. Further, one of the four built-in tie rods for core shroud stabilization was inspected.

Important to Availability

May 16: The planned coast-down operation began. The power at end of cycle reached 68%.

Refueling outage August 12 – September 4:

The planned outage lasted 23 days. The inspection of one of two high-pressure turbines and one of two generators confirmed excellent equipment conditions. 40 out of 240 fuel elements were replaced.

Load reductions:

A total of five load reductions (> one full power hour) occurred.

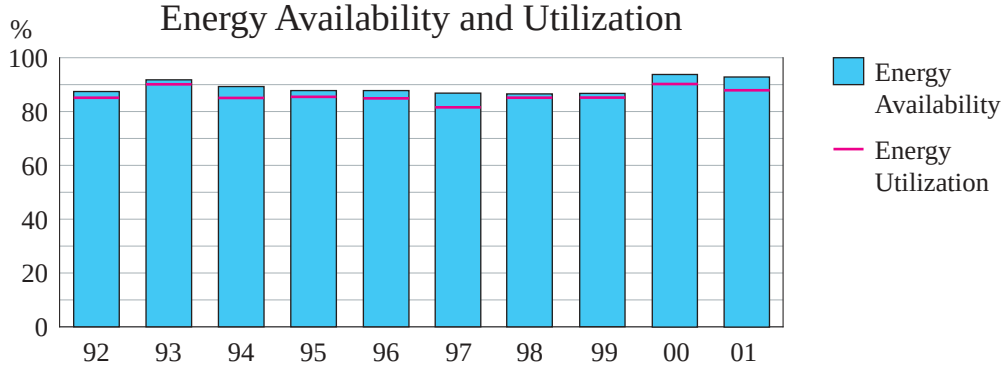
Four planned load reductions were required for periodical surveillance tests. Two of these tests were combined with required control rod pattern changes and the two others with preventive maintenance.

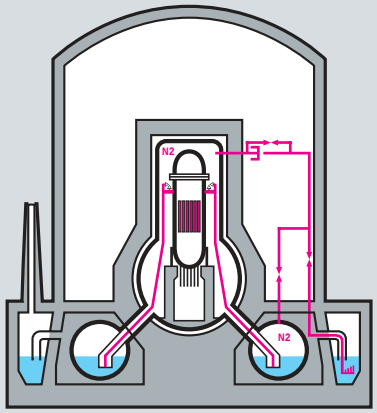
One planned load reduction was performed for preventive maintenance.

History

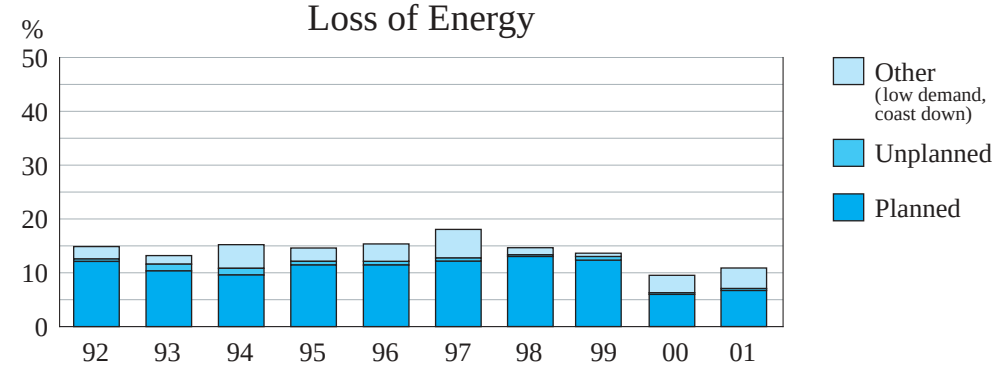
Characteristics

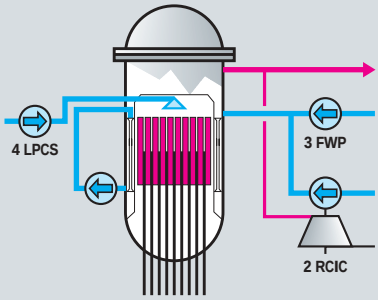
Energy Availability and Utilization



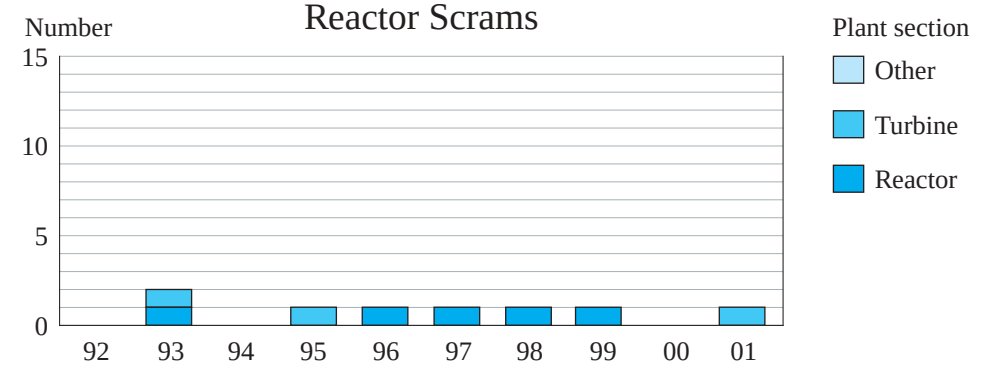


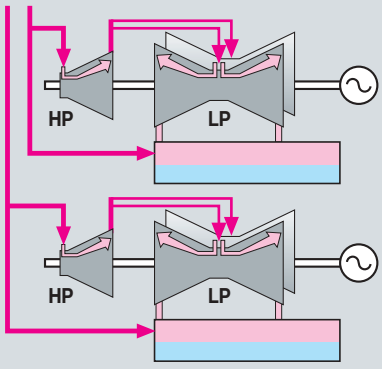
Loss of Energy



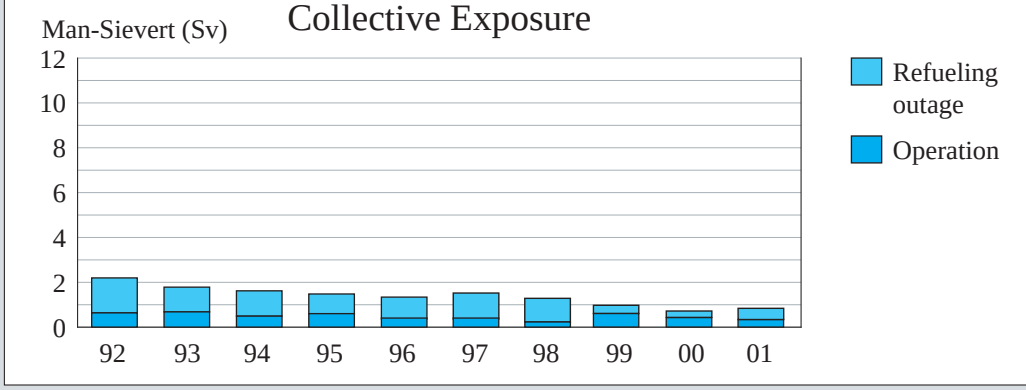


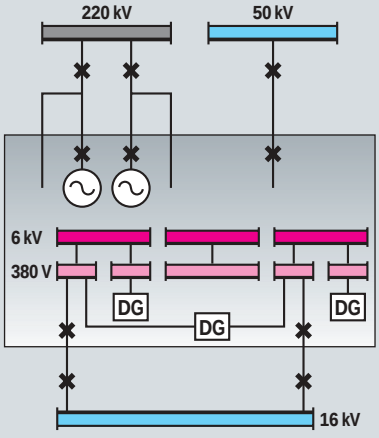
Reactor Scrams





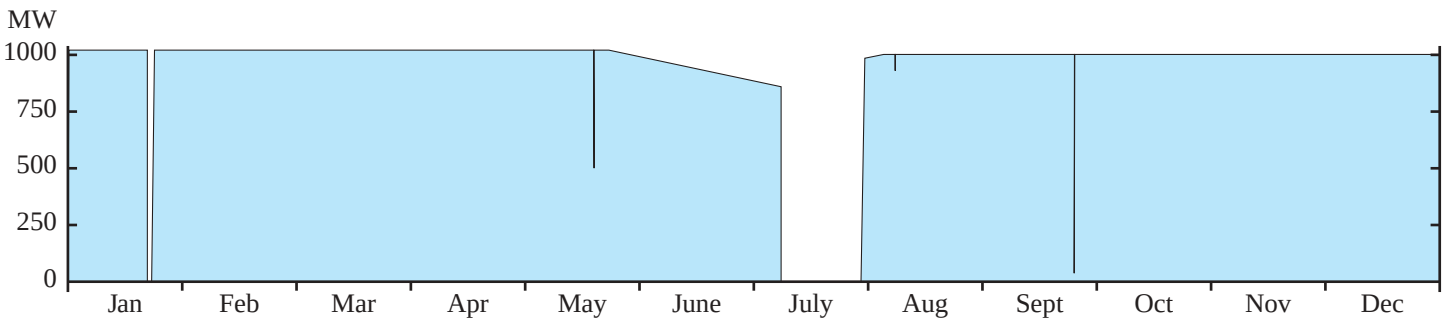
Collective Exposure





Gösgen

Operating Experience 2001



Important to Safety

Scrams:

2001 was the eleventh consecutive year of operation without unplanned scrams.

Important to Availability

January 22/23: Cold shut-down on the plant for the repair of a steam leakage on a drain line of the main steam line in the turbine building. The leakage was caused by wear of a insulation-shroud-screw.

May 19: Automatic load reduction after trip of one main cooling water pump due to low suction head. The strainer on the suction side was clogged by algae.

May 21: Start of coast-down operation. The power level at the end of the cycle was 88%. Coast-down operation led to a production loss of about 3 equivalent full power days.

July 06: Planned load reduction to 700 Mwe for helium leak test on a condenser.

August 08: Manual load reduction to 930 Mwe after actuation of the reactor power limitation system.

September 24: Unplanned automatic load rejection to house load, caused by a fail signal from the offsite 400 kV switch-yard.

Refuelling outage, July 07 to July 29:

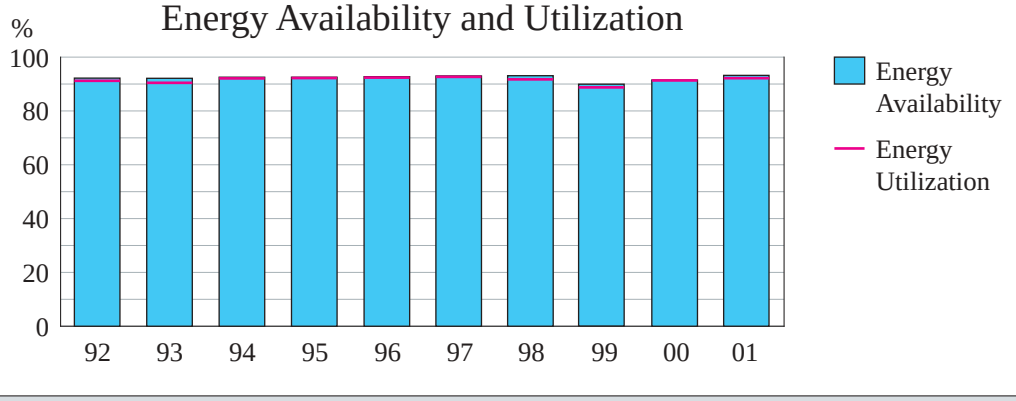
The duration of the refueling outage was 22 days as scheduled.

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

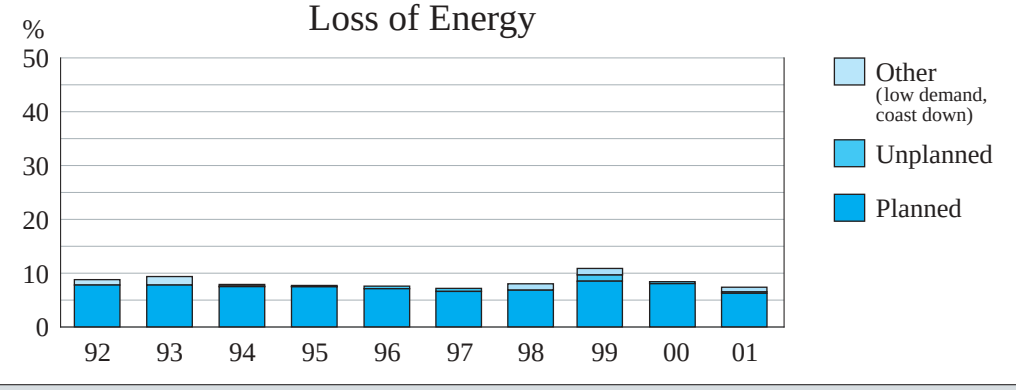
- Inspections on reactor internals.
- Integral leak-rate test of the steel containment.
- Replacement of the shaft seals on one main coolant-pump.
- Modifications on main steam pressure relief valves.
- Replacement of one fine mesh drum screen at the cooling water inlet.
- Improvement of the anchorage on the main generator stator.
- Loading of 36 new fuel elements. The newly-loaded fuel includes 20 MOX and 4 ERU fuel elements.

History

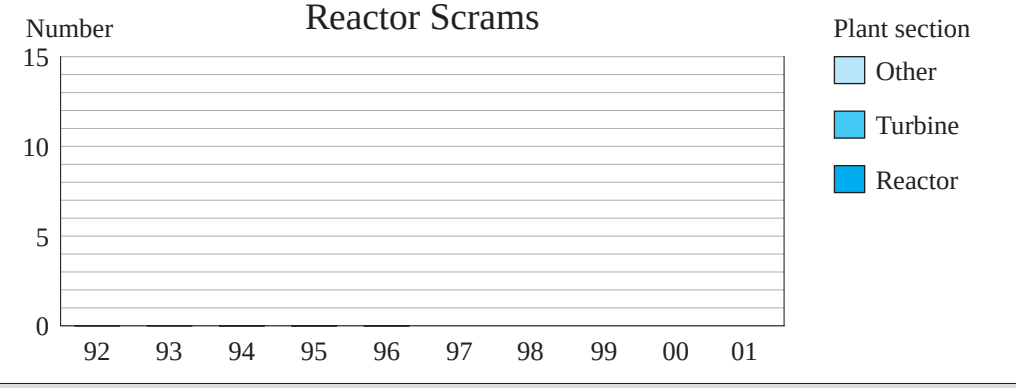
Energy Availability and Utilization



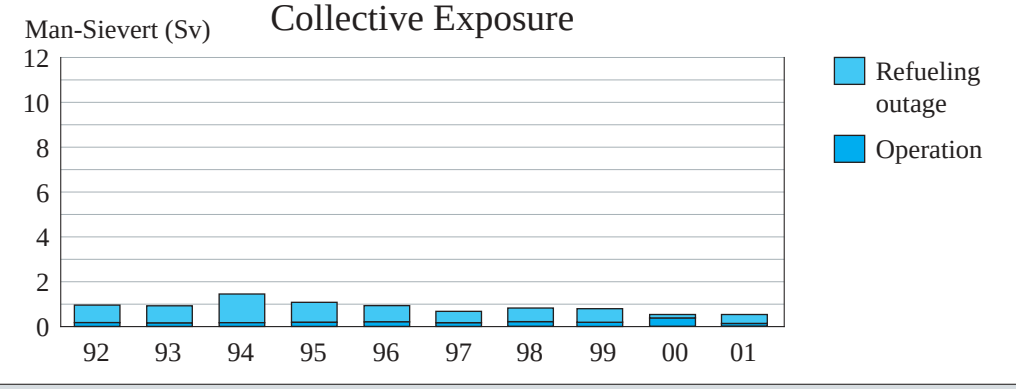
Loss of Energy



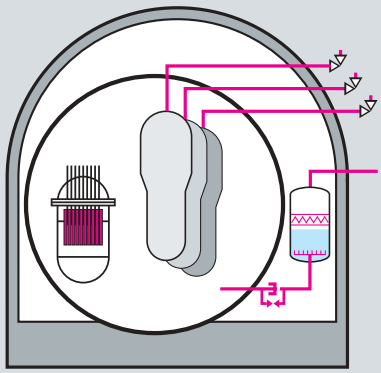
Reactor Scrams

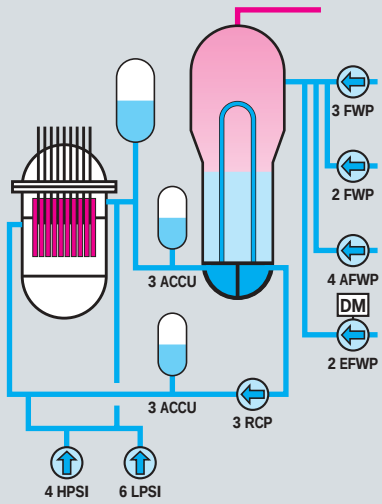


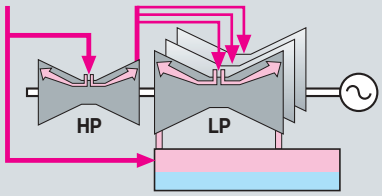
Collective Exposure

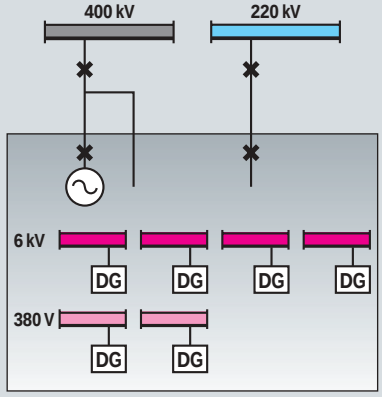


Characteristics



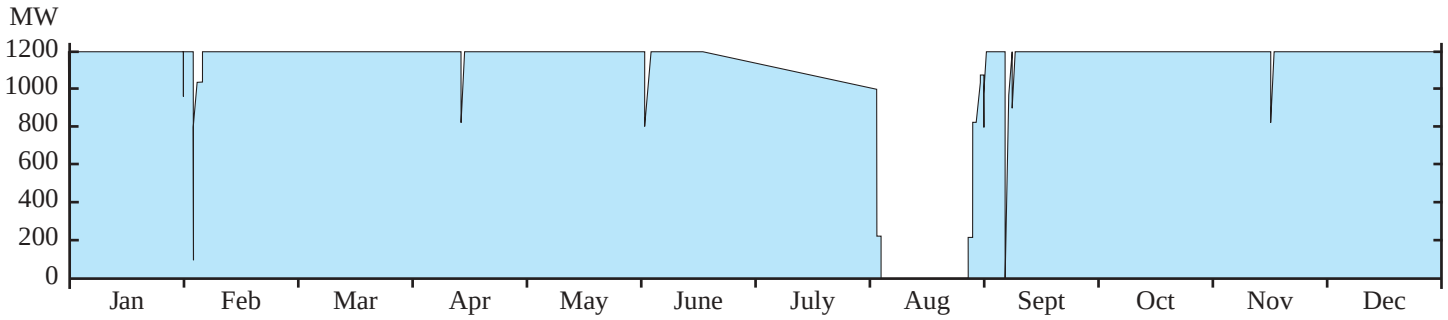






Leibstadt

Operating Experience 2001



Important to Safety

Scrams:

There were no automatic scrams during power operation.

Important to Availability

February 1 – 3: Disturbance in the moisture separator (MSR) drain control system. Repair the MSR drain control system; main steam isolation valve (MSIV) monitoring; and control rod pattern adjustment.

April 14: MSIV monitoring and control rod pattern adjustment.

June 2: MSIV monitoring and control rod pattern adjustment.

June 19: Start end-of-cycle coast-down.

August 4 – 28: 17th refueling outage:

Duration was 23.7 days (scheduled 22.5). Loaded 133 fuel bundles (out of 648).

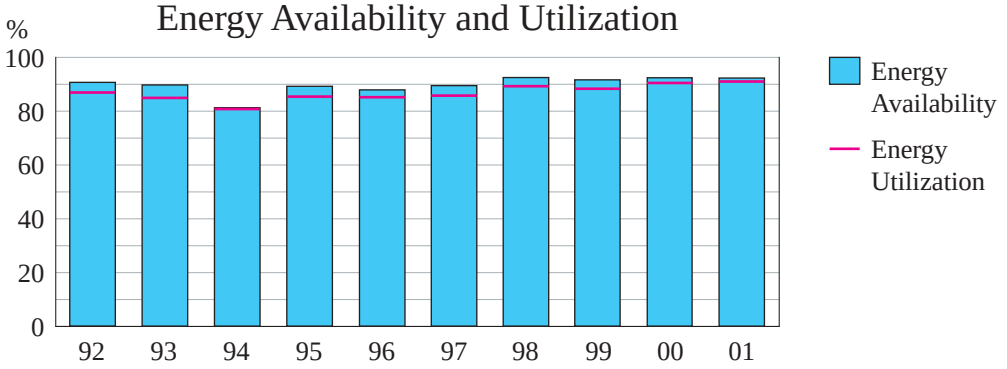
August 28 – 31: Plant startup; power ascension; and control rod pattern adjustment.

September 7 – 9: Planned main turbine trip test for post-modification testing purpose; resynchronization to the grid; power ascension; and control rod pattern adjustment.

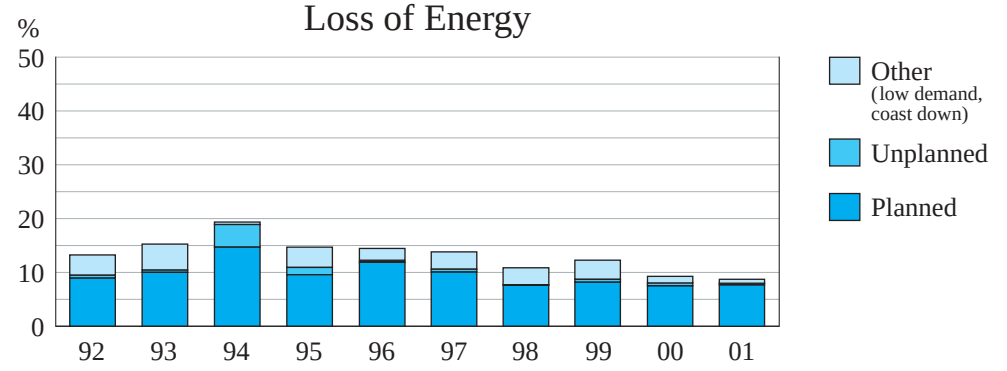
November 17: MSIV monitoring and control rod pattern adjustment.

History

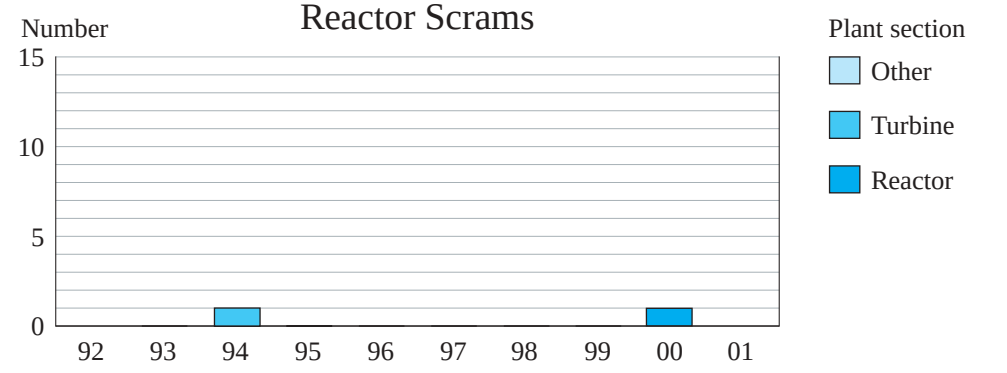
Energy Availability and Utilization



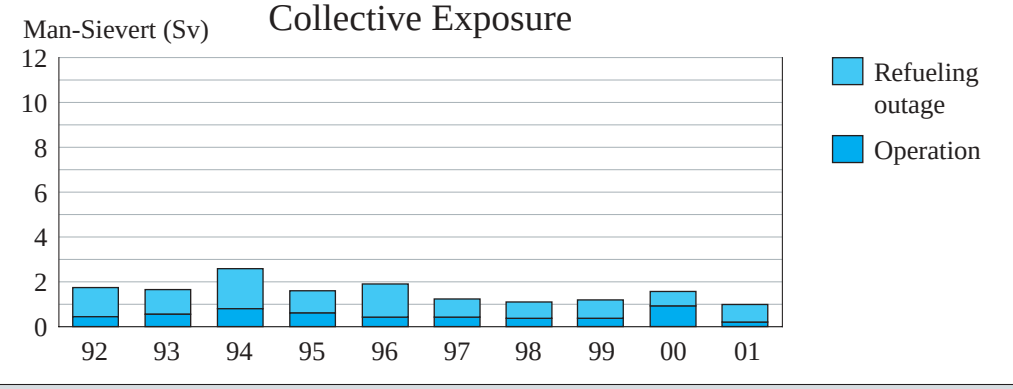
Loss of Energy



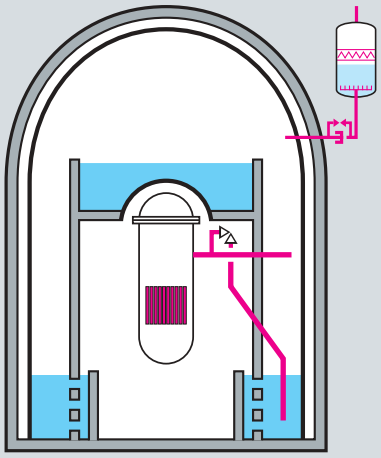
Reactor Scrams

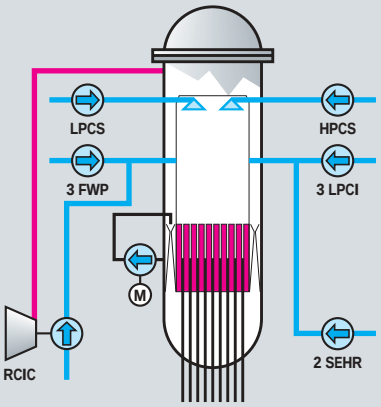


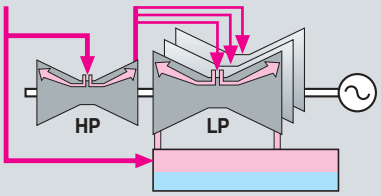
Collective Exposure

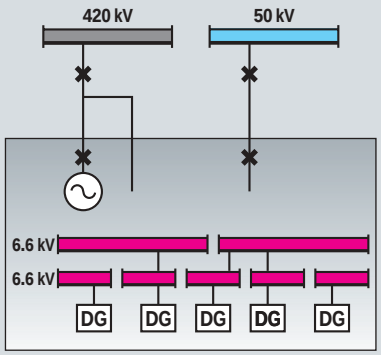


Characteristics









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, 40%, managing partner)
– Nordostschweizerische Kraftwerke (NOK, 25%)
– the City of Zurich (15%)
– Centralschweizerische Kraftwerke (CKW, 12.5%)
– the City of Berne (7.5%)

Kernkraftwerk Leibstadt AG (KKL) is owned by the following partners:
– Elektrizitäts-Gesellschaft Laufenburg AG (EGL, 15%, managing partner)
– Aare-Tessin AG für Elektrizität (ATEL, 25.2%)
– AEW Energie AG (5%)
– EnBW Kraftwerke AG (7.5%)
– BKW FMB Energie AG (8.8%)
– Centralschweizerische Kraftwerke (CKW, 12.5%)
– Watt AG, Zurich (5%)
– Kraftwerk Laufenburg (KWL, 7.5%)
– Nordostschweizerische Kraftwerke AG (NOK, 8.5%)
– Energie Ouest Suisse, Lausanne (EOS, 5%)

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