RIC 2012

The 24th Annual Regulatory Information Conference

Regulatory actions regarding containment venting and filtration

Filtered containment venting systems in Swiss nuclear power plants focus on Mühleberg BWR-4 Mark 1 (KKM)

Patrick Miazza, BKW Energy Ltd, Switzerland

Thursday, March 15th, 10:30 AM – 12:00 PM

axpo kern energie · BKW · Kernkraftwerk Gösgen · KKL Kernkraftwerk Leibstadt www.kkl.ch · swissnuclear Nuclear Energy Section of swisselectric

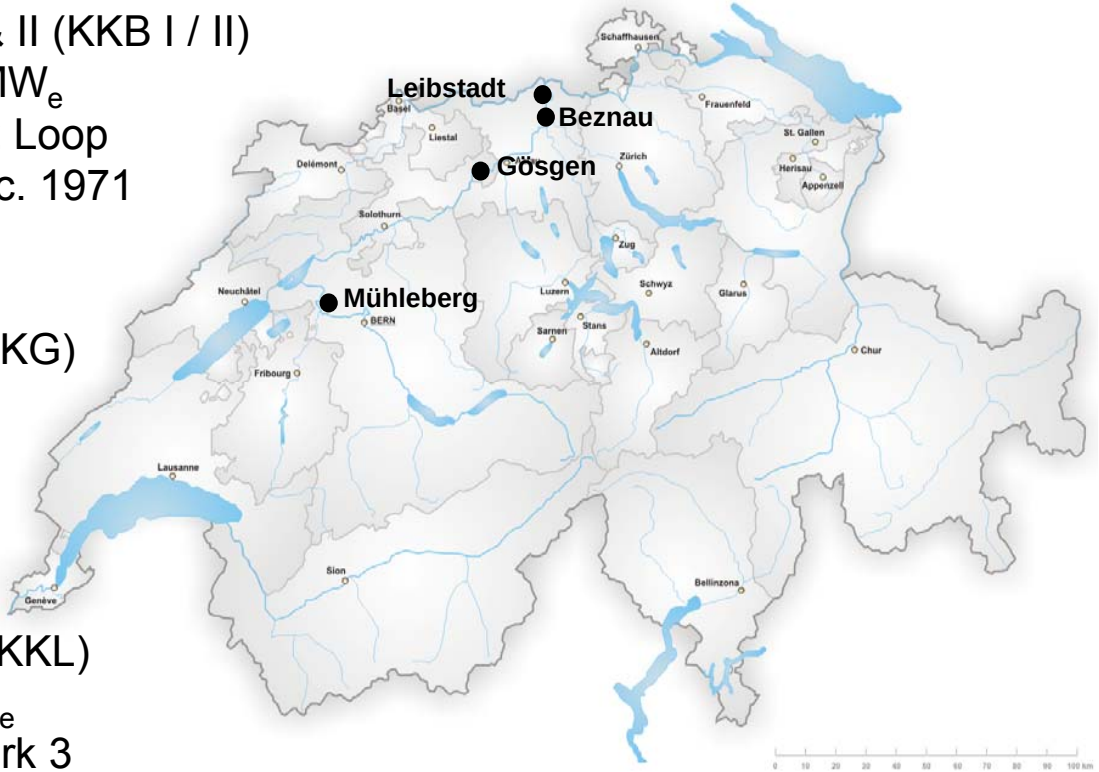
Nuclear Power Plants in Switzerland

NPP Beznau I & II (KKB I / II)
PWR, 2 x 365 MW_e
Westinghouse 2 Loop
Sept. 1969 / Dec. 1971

NPP Gösgen (KKG)
PWR, 985 MW_e
Siemens-KWU
Nov. 1979

NPP Leibstadt (KKL)
BWR, 1165 MW_e
GE BWR 6 / Mark 3
Dec. 1984

NPP Mühleberg (KKM)
BWR, 373 MW_e
GE BWR 4 / Mark 1
Nov. 1972

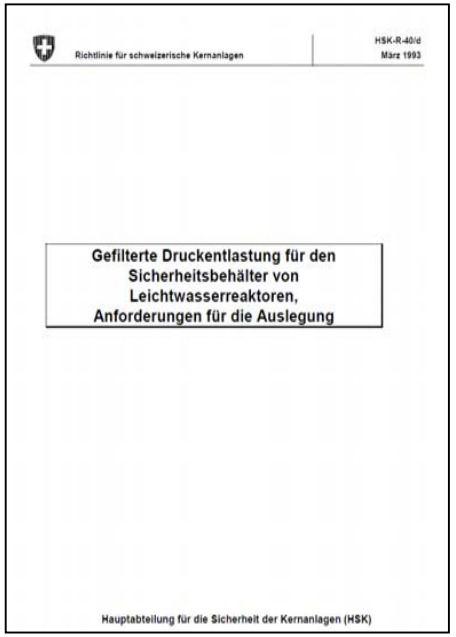


Population 7.8 Mio; Area 15 940 sq mi
Electrical consumption: 60 TWh
40% nuclear power

swissnuclear
Nuclear Energy Section of swisselectric

Swiss Safety Authority Requirements for Containment Venting Systems

- First draft document issued 1988 HSK-AN-2026
- Final guideline (1993) HSK-R-40


Richtlinie für schweizerische Kernanlagen

HSK-R-40/d
März 1993

Gefilterte Druckentlastung für den Sicherheitsbehälter von Leichtwasserreaktoren, Anforderungen für die Auslegung

Hauptabteilung für die Sicherheit der Kernanlagen (HSK)

- Goal: prevention of uncontrolled radioactive release due to loss of integrity of the containment during a severe accident
- Solution: filtered containment venting

Design Requirements for the Containment Venting Systems

- Nominal relief capacity: steam production corresponds to 0.8% of the thermal power
- Max. relief capacity: steam production corresponds to 1% of the thermal power

- Retention factor for aerosols: ≥ 1000 (99.9%)
  Prevention of long-term contamination by Cs
- Retention factor for iodine: ≥ 100 (99%)

Design Pressure for Containment Venting Systems

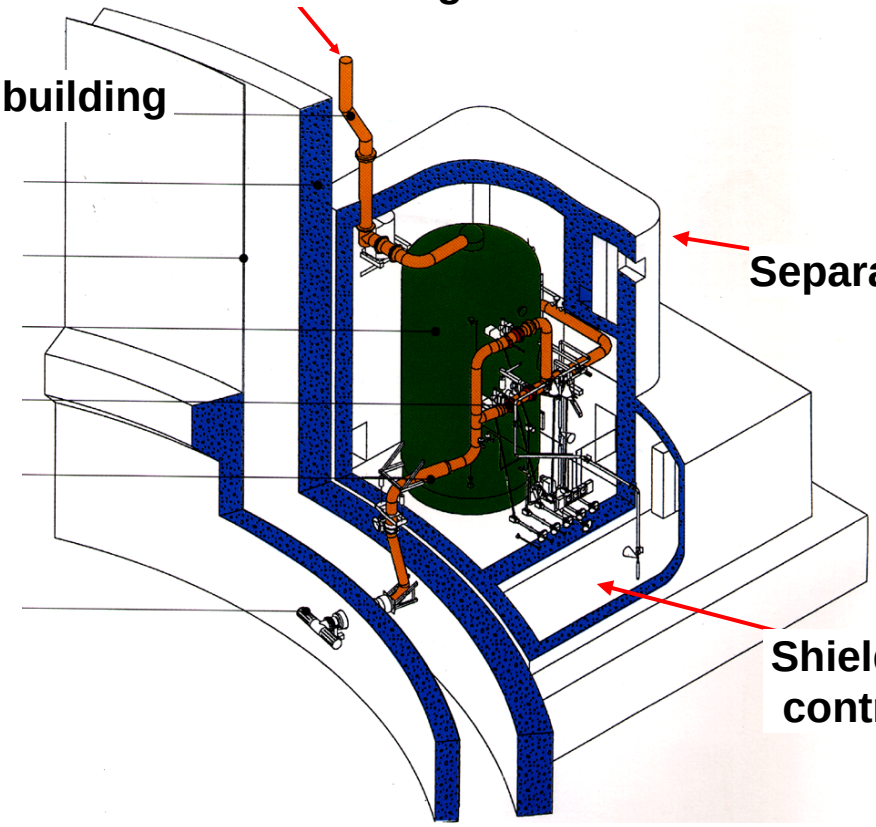
- PWR, non-inerted containment:
  max. 1.0 x design pressure or 0.5 x failure pressure
- BWR, inerted containment:
  max. 1.5 x design pressure or 2/3 x failure pressure
- BWR, non-inerted containment:
  max. 1.0 x design pressure or 0.5 x failure pressure

Failure pressure > 2 x design pressure of Swiss NPPs

Additional Requirements

- Seismic class 1 (highest requirement)
- Efficient at varying pressures and flow rates
- Max. dose for personnel 0.1 Sv
- System availability during station blackout
- 100 hours independent operation of instrumentation
- Passive depressurization (rupture disc)

NPP Beznau Containment Filtered Venting



Designer: Sulzer

Actuation pressure of rupture disc [bar_a]**:** 5.2

Operating pressure [bar_a]**:** 3.6

Commissioning date: 1992/1993

Max. flow [kg/s]**:** 7.2

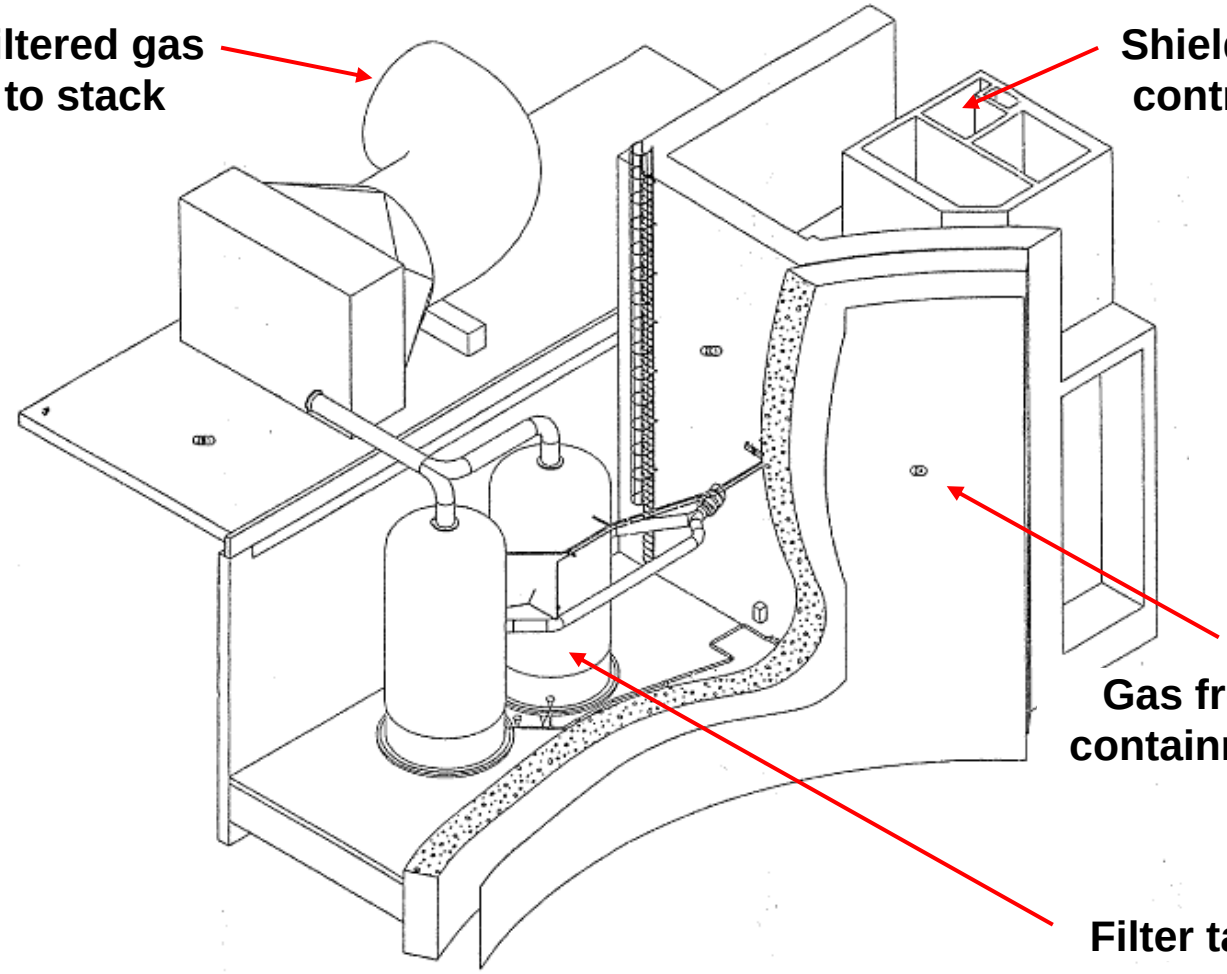
Nominal flow [kg/s]**:** 4.8

axpo kern energie

swissnuclear

Nuclear Energy Section of swisselectric

NPP Leibstadt Containment Filtered Venting



Designer: Sulzer / EWI

Actuation pressure of rupture disc [bar_a]**:** 3.1

Operating pressure [bar_a]**:** 2.55

Commissioning date : 1993

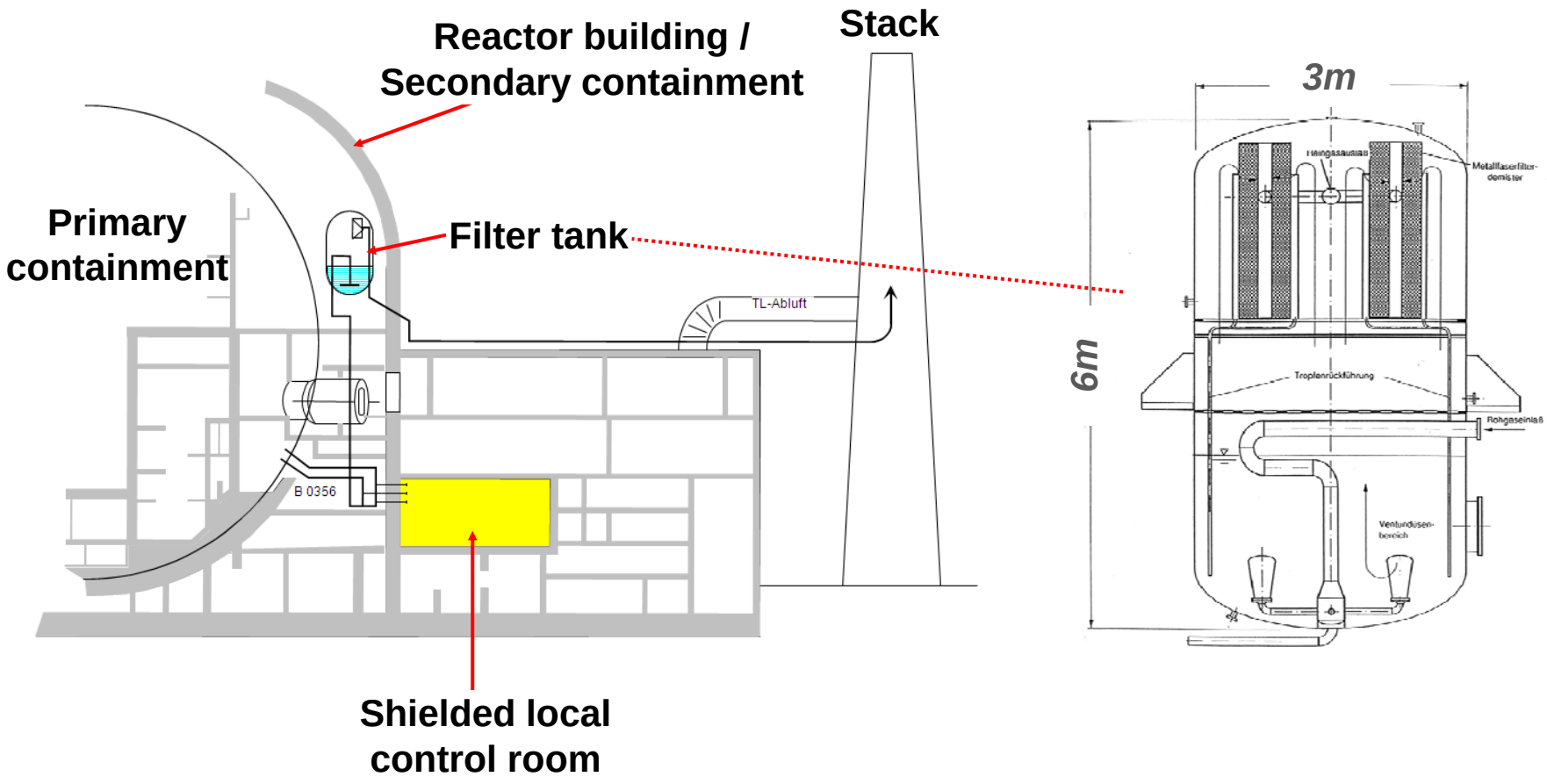
Max. flow [kg/s]**:** 20.66

Nominal flow [kg/s]**:** 13.77

Kernkraftwerk Leibstadt
www.kkl.ch

swissnuclear
Nuclear Energy Section of swisselectric

NPP Gösgen Containment Filtered Venting



Designer: Siemens KWU

Actuation pressure of rupture disc [bar_a]**:** 6.2

Operating pressure [bar_a]**:** 4.9 - 6.2

Commissioning date : 1993

Max. flow [kg/s]**:** 8.6

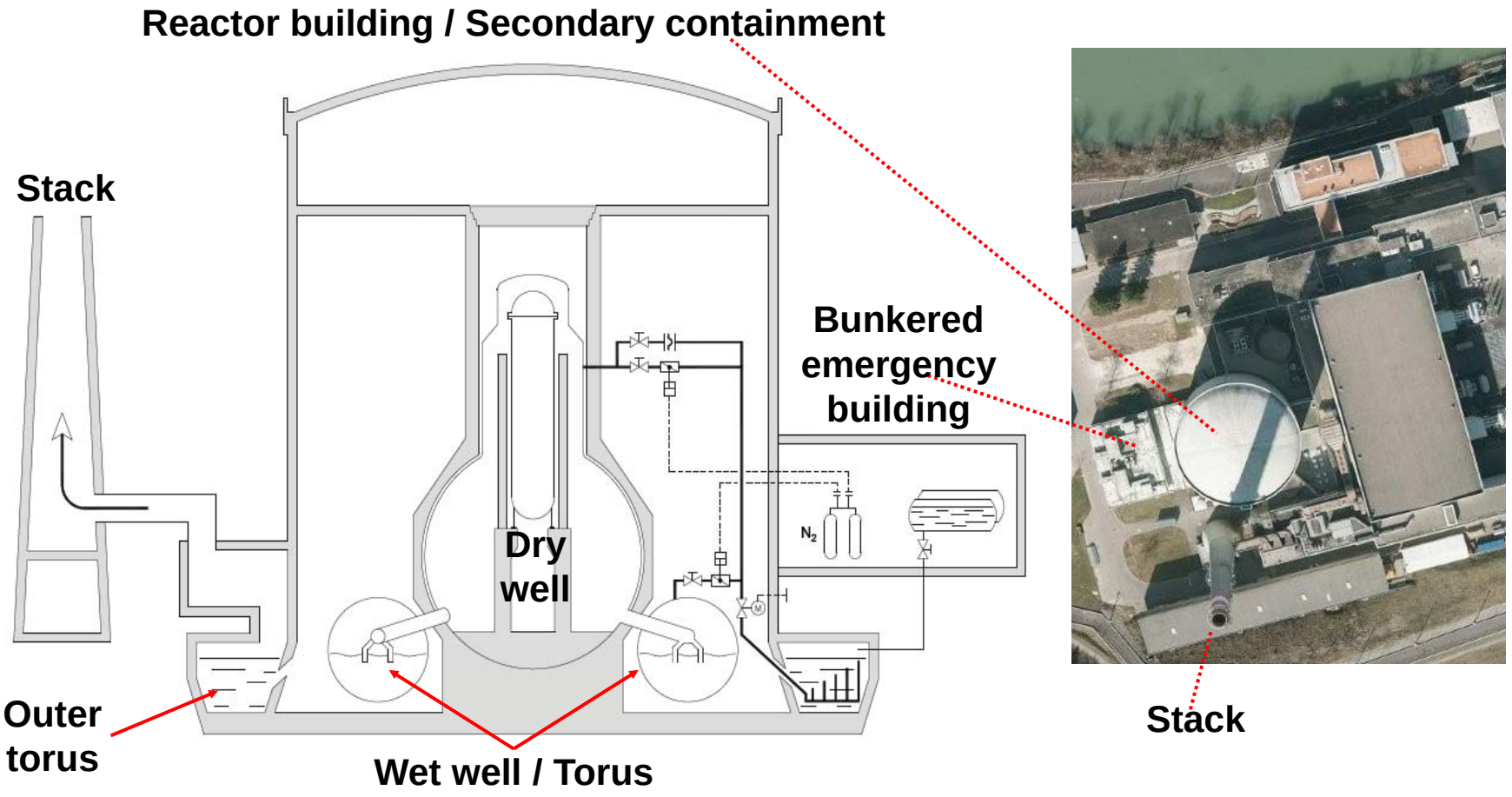
Nominal flow [kg/s]**:** 6.8

Kernkraftwerk Gösgen

swissnuclear

Nuclear Energy Section of swisselectric

NPP Mühleberg (KKM) Containment Filtered Venting



Designer: ABB Atom

Actuation pressure of rupture disc [bar_a]**:** 7

Operating pressure [bar_a]**:** 5

Commissioning date : 1992

Max. flow [kg/s]**:** 4.1

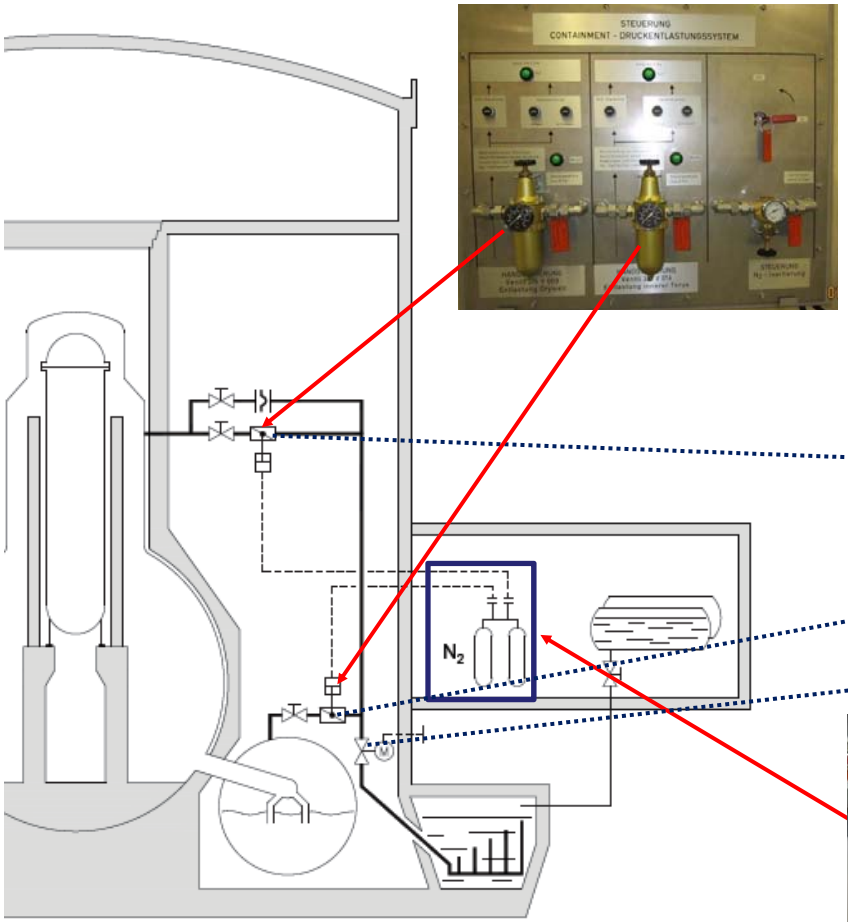
Nominal flow [kg/s]**:** 3.3

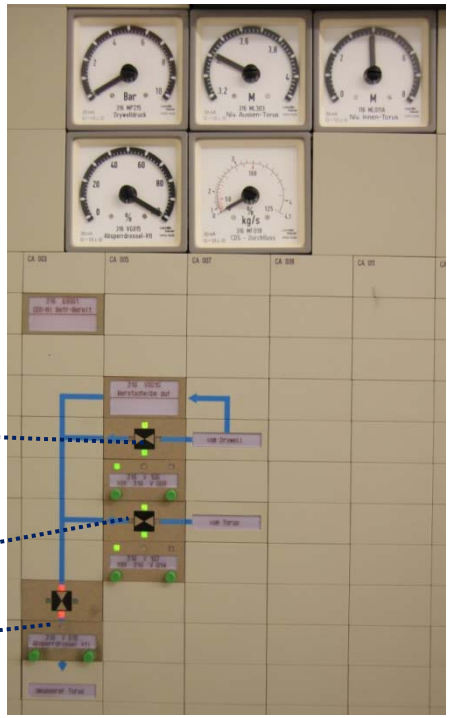
BKW

swissnuclear

Nuclear Energy Section of swisselectric

KKM Control Panel (Pneumatic and Electric)





Panel in bunkered emergency control room

N_2 bottles

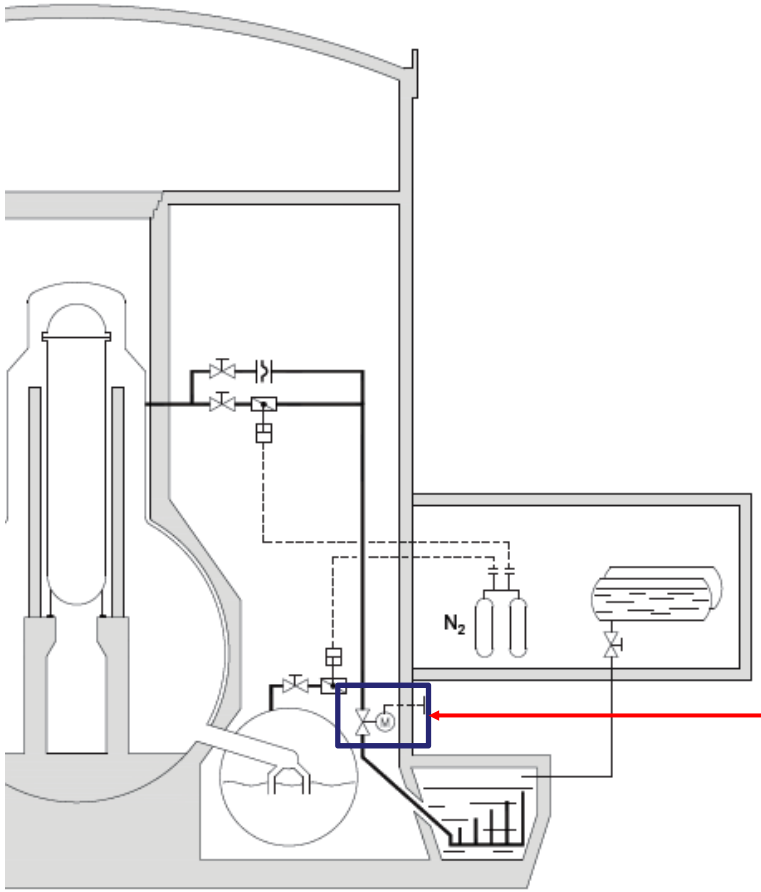
Normally closed spring loaded valves can be actuated either through the control panel or by directly accessing the nitrogen driven pneumatic system (two different locations).

BKW

swissnuclear

Nuclear Energy Section of swisselectric

KKM Flow Control Valve



Motor operated valve

Motor or manual operation of MOV inside reactor building

Handwheel outside reactor building

MOV unlocking lever

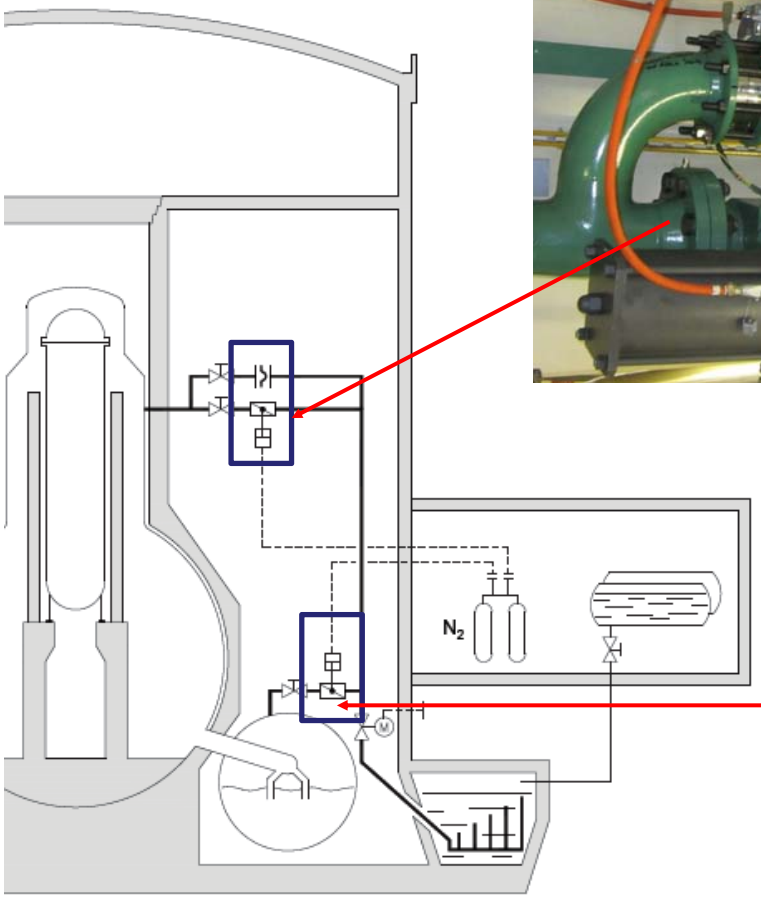
The flow control valve can be actuated either through the control panel or manually.

BKW

swissnuclear

Nuclear Energy Section of swisselectric

KKM Containment Connections



Drywell connection

rupture disc [7 bar_a]

pneumatic valve

Wet well connection

Pneumatic valve

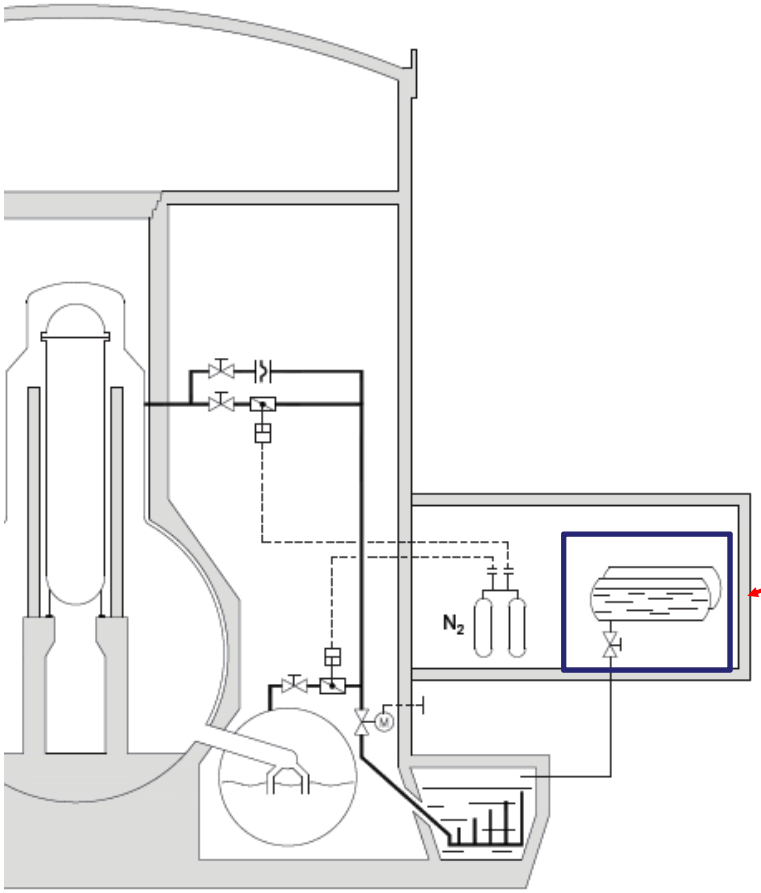
The pneumatic valves and the rupture disc are located in the reactor building (secondary containment).

BKW

swissnuclear

Nuclear Energy Section of swisselectric

KKM Chemical Injection System

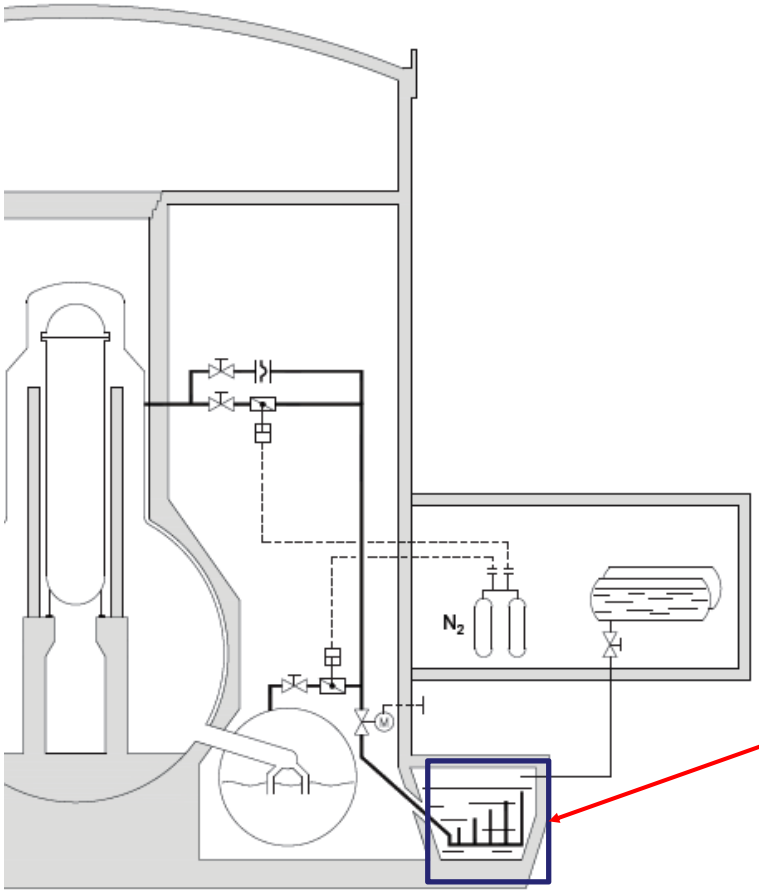


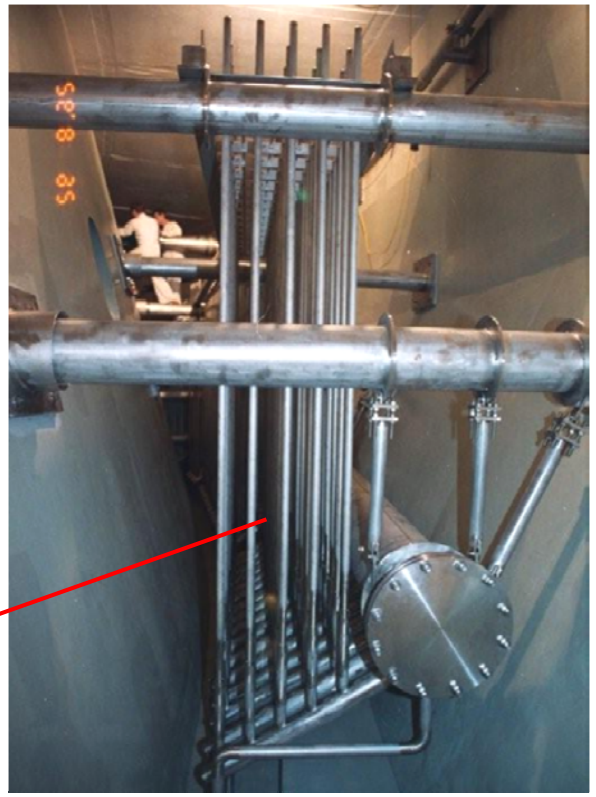
Sodium carbonate / Bicarbonate
and
sodium thiosulfate mixture

The chemical mixture flows through gravity to the outer torus.

BKW
swissnuclear
Nuclear Energy Section of swisselectric

KKM Multi-Venturi Scrubber System





Drywell volume [m^3]**:** 3100	**Secondary containment volume:** [m^3]**:** 40'000
Wet well water volume [m^3]**:** 2100	**Secondary containment pressure:** [bar_a]**:** 1.3
Wet well free volume [m^3]**:** 1900	**Outer torus water volume** [m^3]**:** 1'000

BKW

swissnuclear

Nuclear Energy Section of swisselectric

KKM Staff Training on Containment Filtered Venting

- Basic operator training (field and licensed operators)
- Advanced technical courses for licensed operators
- Advanced training for shift leaders and safety engineers with focus on functional and procedural aspects
- Periodic training of shift personnel
- Training of emergency staff

Accident Management & Containment Filtered Venting Timeline (example Mühleberg)

1990/00/05/10
Severe accident analysis part of probabilistic safety analysis (PSA)

SAMG

1980 **1990** **2000** **2010**

1980's: SAM international research

1990's : development of owners'group general guidance

2000: Swiss Authority requirement for SAMGs

2001: commitment to implementation

2002: concept report

2004 verification & validation emergency drill

2007: extended SAMGs to address shutdown

Containment Filtered Venting

1992 **2000**

1992: commissioning of containment filtered venting system

1993: part of emergency procedures

1994: specific accident management procedure

2004: fully embedded in SAMG & other procedures

swissnuclear
Nuclear Energy Section of swisselectric

Containment Filtered Venting Inspections since March 2011

Containment filtered systems had to be re-evaluated for all Swiss NPP's after Fukushima.

In every plant, an in depth inspection was performed by the Safety Authority (ENSI).

The detailed results of the inspections are expected to be published soon.

Thank you for your attention!

axpo kern energie BKW Kernkraftwerk Gösgen KKL Kernkraftwerk Leibstadt www.kkl.ch swissnuclear Nuclear Energy Section of swisselectric