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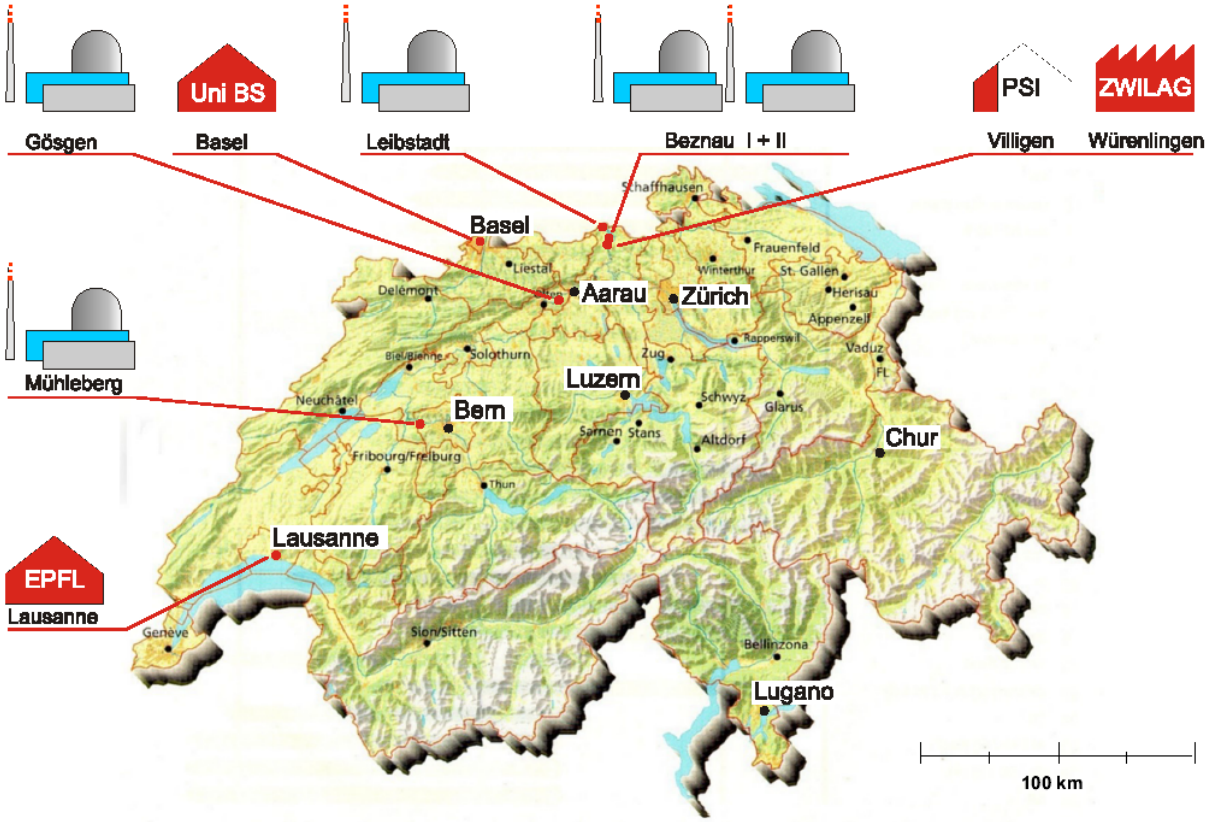
Lessons Learned from Radiological Incidents in Switzerland



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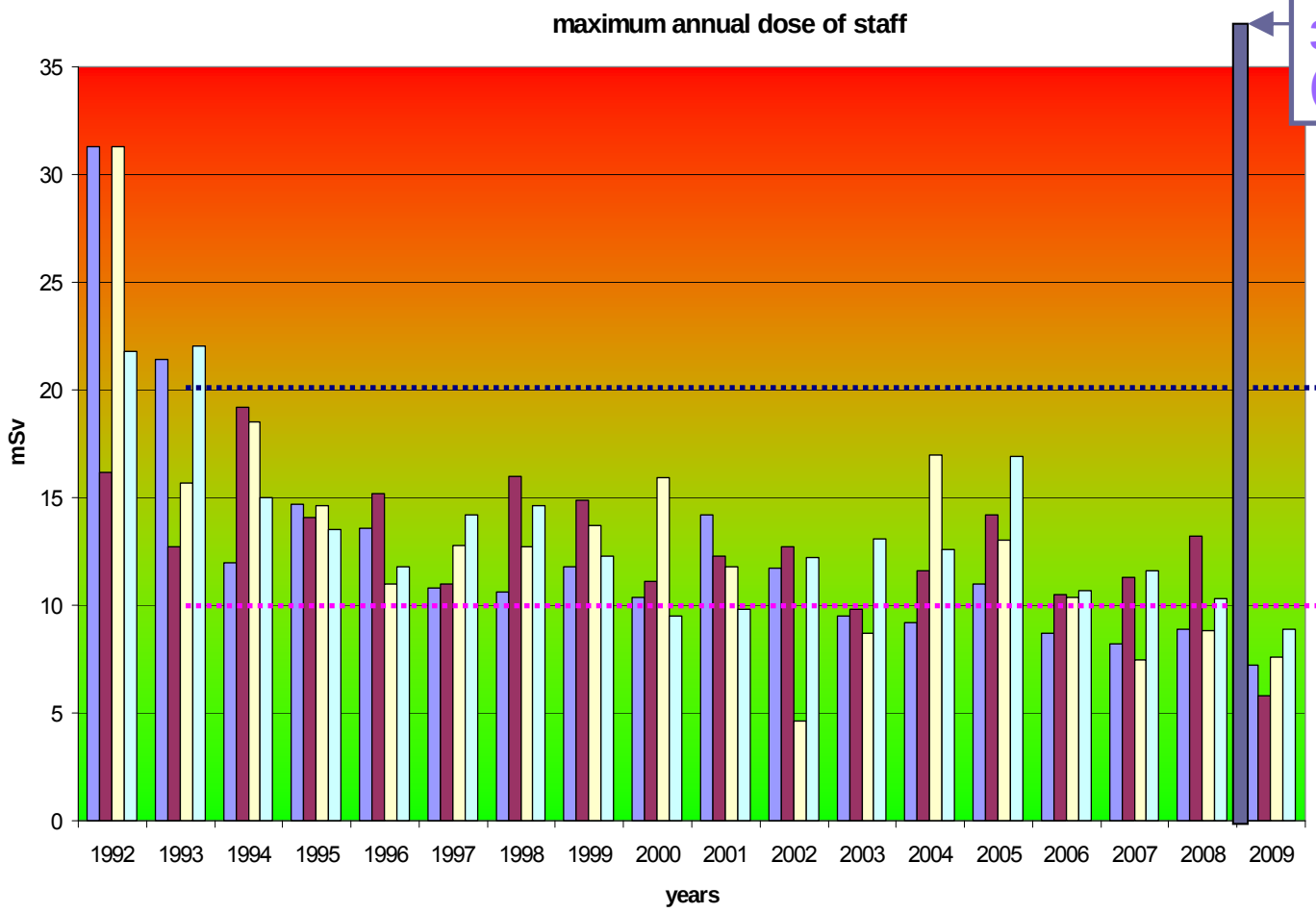
2009 in NPP Beznau:
Exceeding Effective Dose Limit

Franz Wallimann, AXPO AG Kernenergie
Swen-Gunnar Jahn, ENSI

2010 in NPP Leibstadt:
Unplanned Exposure During Diving in the Spent Fuel Pool

Andreas Ritter, Tina Stratmann, Kernkraftwerk Leibstadt AG
will be presented on ISOE Symposium Jan. 2011 in Weston, Florida

Highest Individual Annual Dose 2009 (without event) in all Swiss Nuclear Facilities = 8.9 mSv



dose caused by event on 3.8.2009 = 37,8 mSv (another one = 25,4 mSv)

legal annual dose limit = 20 mSv

operational annual dose constraint = 10 mSv

operational intervention level (outage) = 1 - 5 mSv

operational intervention level (daily) = 0.1-1.0 mSv

Exceeding the Dose Limit in NPP Beznau (KKB 2

Incident on 3 August 2009:

- Irradiation of two workers exceeding statutory annual limit of 20 mSv:
  - Maintenance worker 37.8 mSv
  - Radiation protection worker 25.4 mSv
- Similar event like in an incident at Tricastin-1 in 1999 (IRS-Report 7367)
- Incident shows the failure of many safety measures
- Incident is rated at INES Level 2 because of exceeding the statutory annual limits for radiation worker of 20 mSv per year in two cases
- By a lucky chance the doses didn`t reached any level with deterministic harmful effects because of the intervention by RP-coordinator

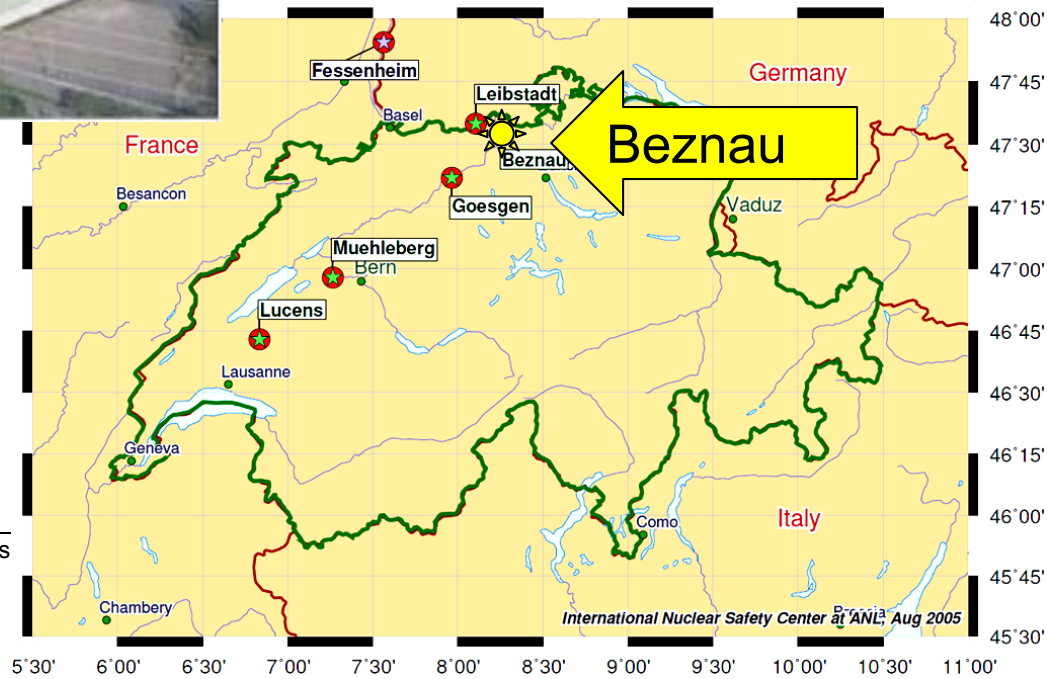
NPP Beznau Unit 2 (KKB2)

Beznau Nuclear Power Plants (KKB 1 & 2):

Two identical two-loop pressurized water reactor units (Westinghouse design).

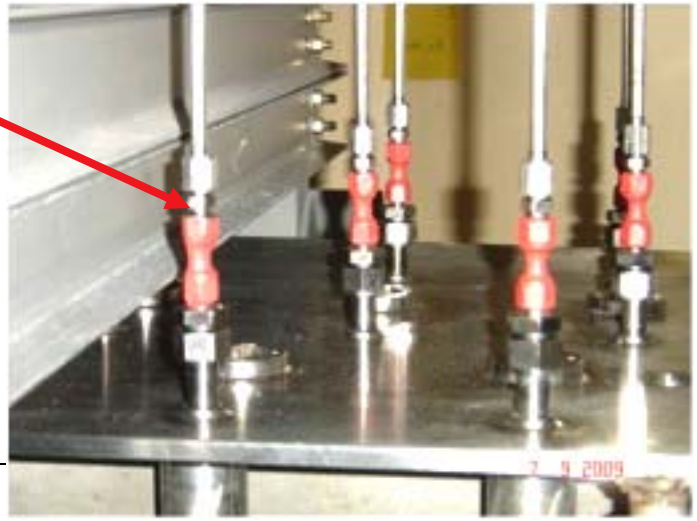
Start operation in 1969 and 1971.

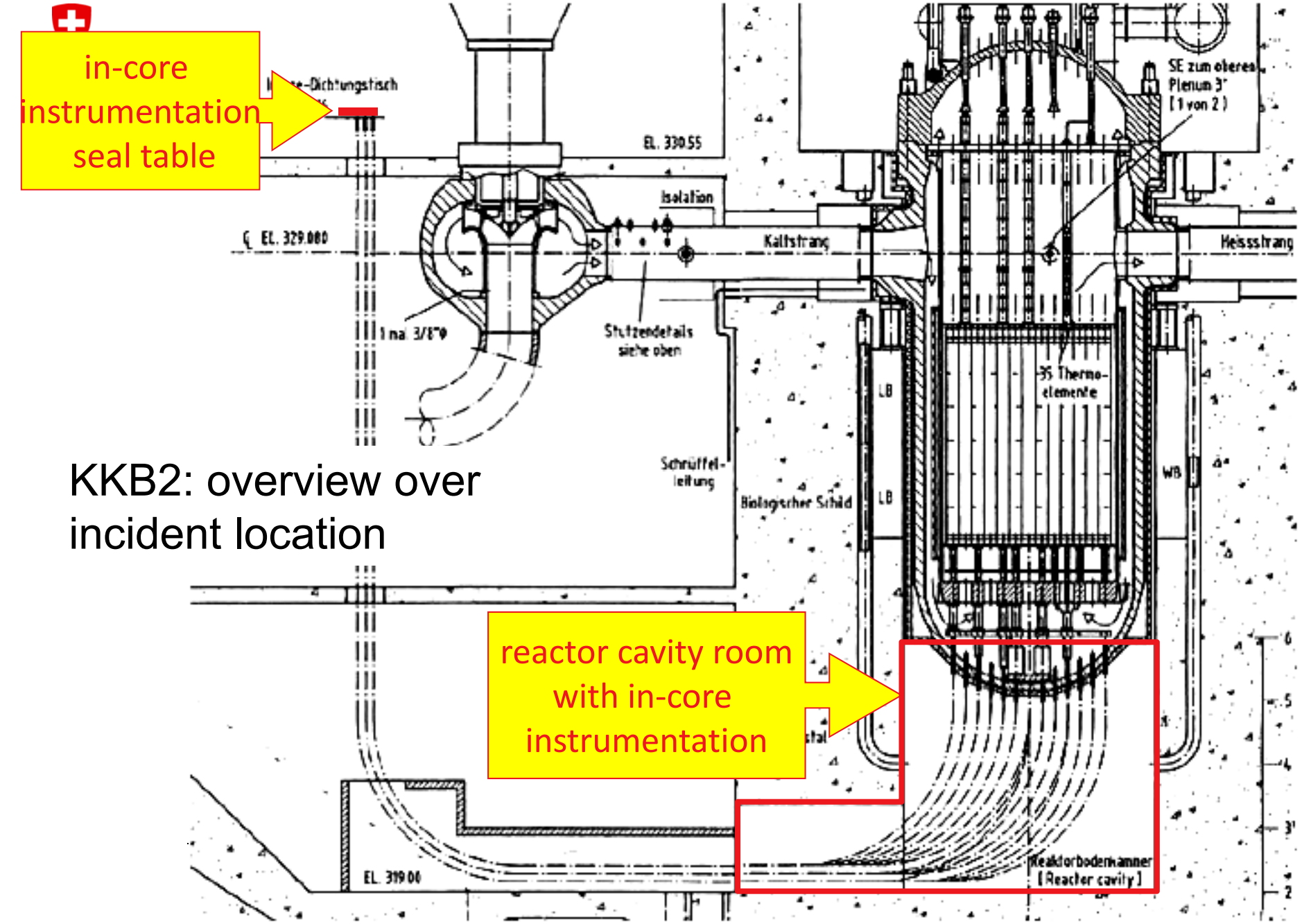
Located in the canton of Aargau, Switzerland on an island in the Aare river and is operated by the Axpo AG Kernenergie



Incident History (1)

- On 31 July 2009, NPP Beznau Unit 2 shut down for annual outage
- In this outage it was scheduled to perform a 10-yearly pressure test of the primary circuit
- Preparation work for this test:
  - Installation of floodlight and camera rails in the room located under the reactor pressure vessel (reactor cavity room)
  - Withdrawing of inner-tubes of the highly activiated in-core instrumentation system from the core and
  - sealing pressured-tight

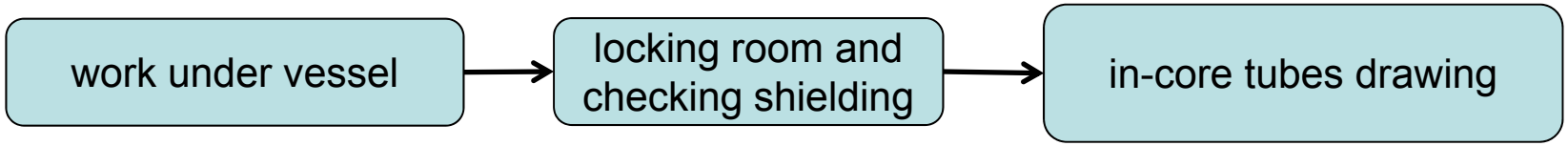




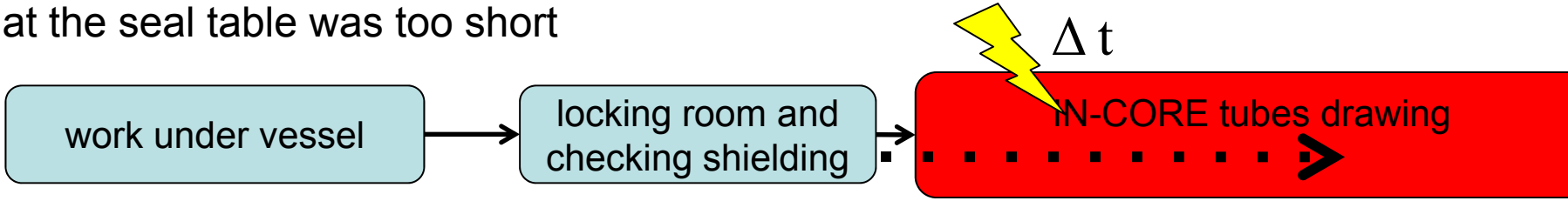
KKB2: overview over incident location

Incident History (2)

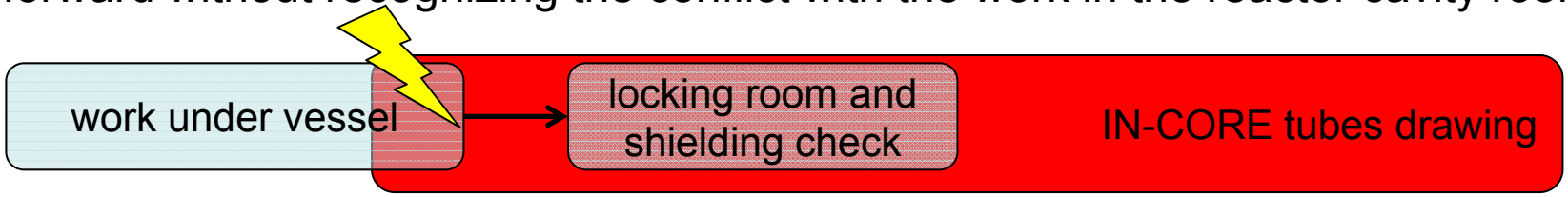
- in the original planning the activities (work in under vessel and withdrawing of in-core tubes) were separated with an controlling step (shielding and lock of room) in between



- planning error: time scheduled for the pressure-tight sealing of the in-core tubes at the seal table was too short



- to fix this problem, the beginning of in-core tube withdrawing was brought forward without recognizing the conflict with the work in the reactor cavity room



Incident History (3)

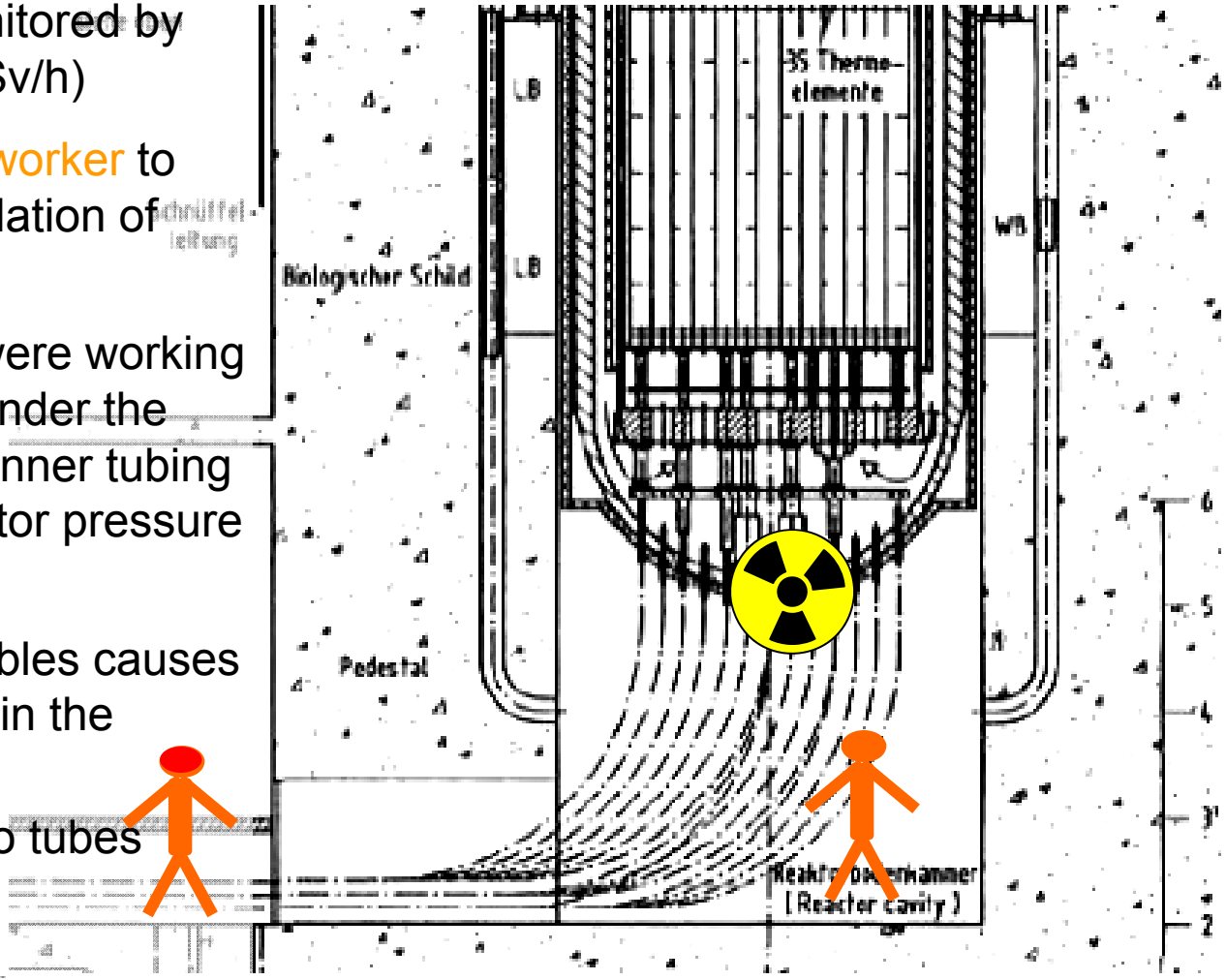
- Before starting the job inside reactor cavity the dose rate was monitored by RP-controller (around 1.5 mSv/h)

- RP-controller admitted the worker to enter the cavity to start installation of light

- Whilst the two employees were working in resp. in front of the room under the reactor pressure vessel, the inner tubing was withdrawn from the reactor pressure vessel

- Withdrawing of in-core thimbles causes rapidly increase of dose rate in the reactor cavity room

- test shows 2.8 Sv/h with two tubes withdrawn



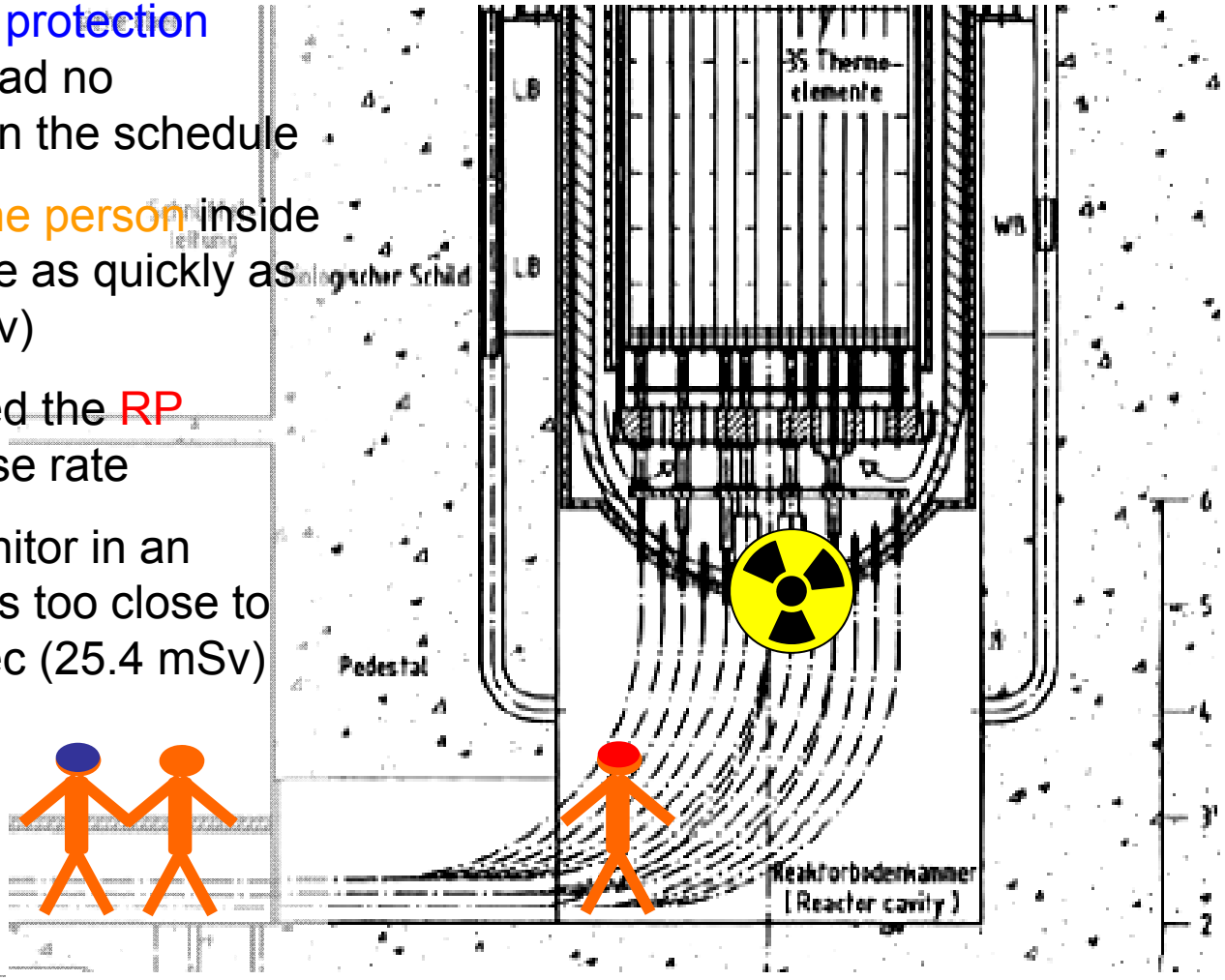
Incident History (4)

- Only by chance the conflict was recognized by the radiation protection coordinator on duty - who had no knowledge of the changes in the schedule

- RP coordinator alarmed the person inside the cavity who left the scene as quickly as possible (resulting 37.8 mSv)

-RP coordinator commanded the RP controller to monitor the dose rate

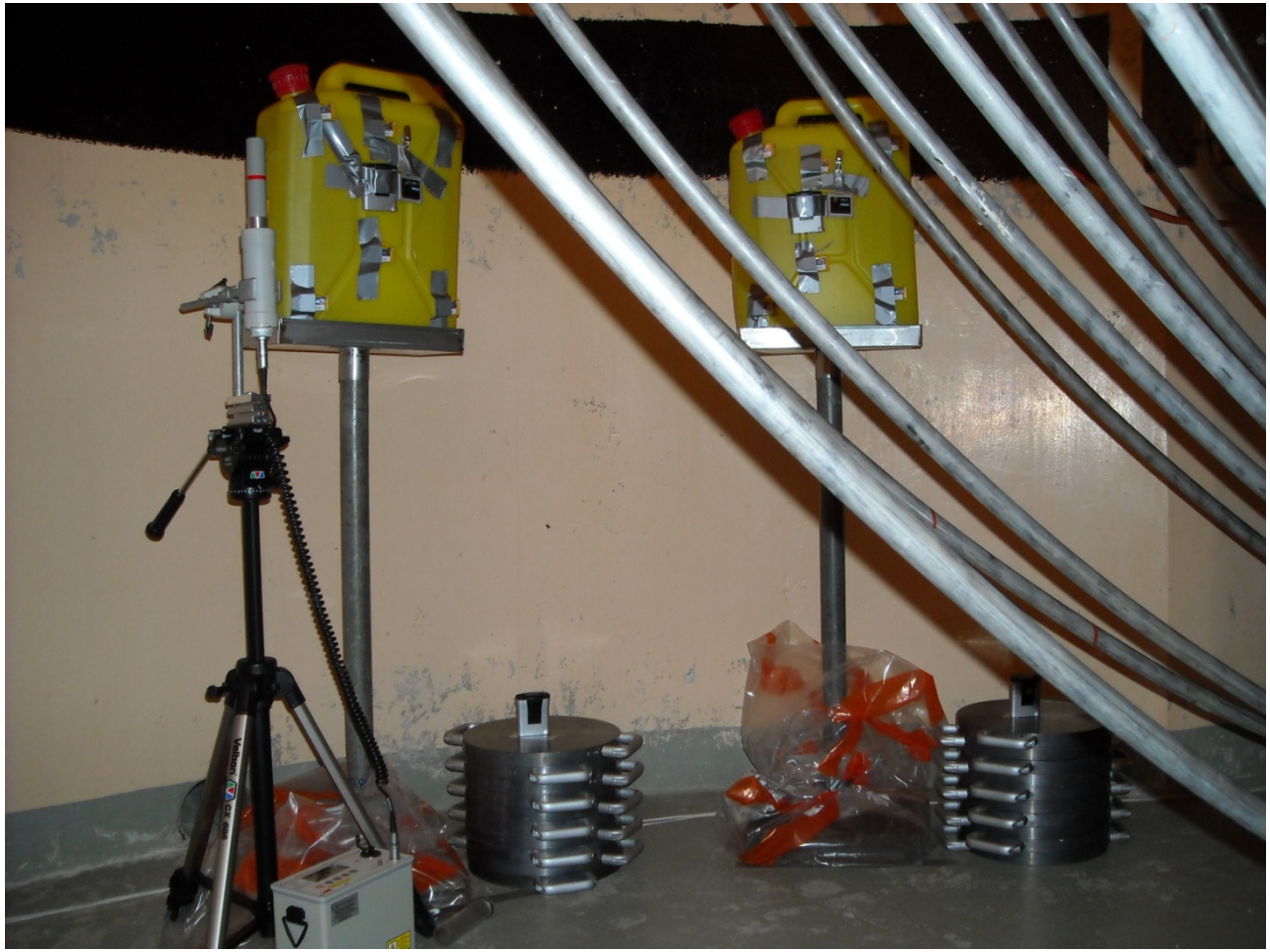
-RP controller used the monitor in an inadequate manner and was too close to the source for around 20 sec (25.4 mSv)



Incident Reports

- the preliminary finding (measured dose on electronic personal dosimeter > annual dose limit) **was reported internal to the RP-management and to the chief operator** in charge (Pikettingenieur)
- The RP-Management took the necessary steps to analyse the thermoluminescence dosimeter ➔ confirmation of exceeding the dose limit ➔ **declaration of reportable incident**
- **The chief operator reported the incident to the authority ENSI** (within a few hours after the event occurred)
- NPP Beznau started to analyse the causes and send a **preliminary report** (at the some day)
- ENSI analyzed the root causes by interviews and started a verification of dose rate inside reactor cavity
- A **final report** with corrective actions was send by NPP Beznau
- ENSI asked other Swiss NPP to investigate the risk of high dose rates

verification of dose rate and dose inside the reactor cavity room



Incident Findings (1)

- **The safety checks** offered by the computer based **planning tool were not used**
  → No interlocking of tasks with conflict potential

- **Misleading declaration of task chronology**
  → predecessing tasks as a successor with negative time interlacing
  → conflict with predecessor was not recognized with manual checking

- **No update of outage schedule** was performed with the planning tool at the actual change
  → outage schedule was different to the actual task chronology

Incident Findings (2)

- **No involvement of all relevant departments** in the safety check when changing the outage schedule
  → in particular no consulting of radiation protection department
- **Bad documentation and distribution of the change information**
- **Not enough on-the-job experience** by RP controller
  → he finished training course some month before he worked the first time at KKB
- → all other persons working in the reactor building are relying on the overview of RP-coordinator
  → the RP-coordinator responsible for those tasks inside reactor building got no information about changes

Incident Findings (3)

- **inadequate use of electronic personal dosimeter**
  → no adjusting of the alert level (normal setting 1 mSv/h) to actual dose rate (around 1.5 mSv/h)
  → the dosemeter alerts from beginning of work
  → no reaction on emergency signal

- **missing technical measure** to avoid withdrawing whilst the cavity room is open

- **missing permanent dose rate sensor** with optical and acoustical signalisation of high dose rate

- **inadequat use of handheld dose rate monitor to verify radiological situation** → RP Controller went with handheld dose rate monitor into radiation area instead of using a telescopic dosimeter.
  (maybe wrong human reaction under stress condition)

Questions?

Thank you for your attention !

EPD - Signals

- Dose Rate Warning: 1 Beep per 0.1 µSv/h

- Dose Rate Alert: In KKB 2 set on 1 mSv/h

→ ‚Normal' dose rate under reactor pressure vessel is around 1.5 mSv/h, so the Dose Rate Alert sounds from the beginning of work. There was no procedure to set the alert on a higher threshold

- Dose Alert: In KKB 2 individual up to 18 mSv

→ Dose Rate Alert override Dose Alert, so there was no alarm signal change when reaching preset dose limit.