

The image shows a detailed site plan of the Leibstadt Nuclear Power Plant. A large, irregularly shaped area is highlighted in red, representing the Reactor Core Area (RCA). This red area is enclosed by a thick blue boundary. Various rooms and zones are labeled with alphanumeric codes: ZT, ZB1, ZB2, ZC1, ZC2, ZD1, ZD2, ZD3, ZF, ZG, ZH, ZI, ZJ, ZK1, ZK3, ZK4, ZK6, ZL1, ZL3, ZL4, ZL6, ZL8, ZM1, ZM4, ZM6, ZN1, ZN2, ZN3, ZN4, ZN5, ZN6, ZN7, ZN8, ZN9, ZN10, ZN11, ZN12, ZN13, ZN14, ZN15, ZN16, ZN17, ZN18, ZN19, ZN20, ZN21, ZN22, ZN23, ZN24, ZN25, ZN26, ZN27, ZN28, ZN29, ZN30, ZN31, ZN32, ZN33, ZN34, ZN35, ZN36, ZN37, ZN38, ZN39, ZN40, ZN41, ZN42, ZN43, ZN44, ZN45, ZN46, ZN47, ZN48, ZN49, ZN50, ZN51, ZN52, ZN53, ZN54, ZN55, ZN56, ZN57, ZN58, ZN59, ZN60, ZN61, ZN62, ZN63, ZN64, ZN65, ZN66, ZN67, ZN68, ZN69, ZN70, ZN71, ZN72, ZN73, ZN74, ZN75, ZN76, ZN77, ZN78, ZN79, ZN80, ZN81, ZN82, ZN83, ZN84, ZN85, ZN86, ZN87, ZN88, ZN89, ZN90, ZN91, ZN92, ZN93, ZN94, ZN95, ZN96, ZN97, ZN98, ZN99, ZN100. A large circular structure labeled 'ZA' is located in the center of the red area. The plan also shows various pipes, valves, and structural elements.

Inside and outside – A review of the RCA boundary

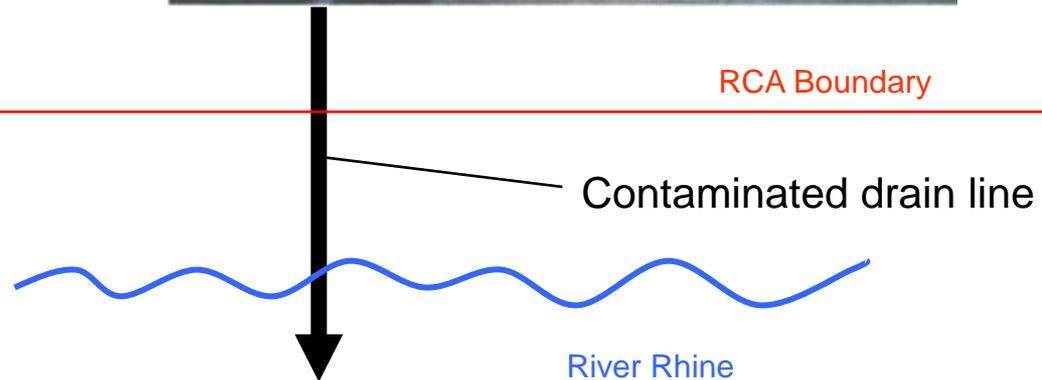
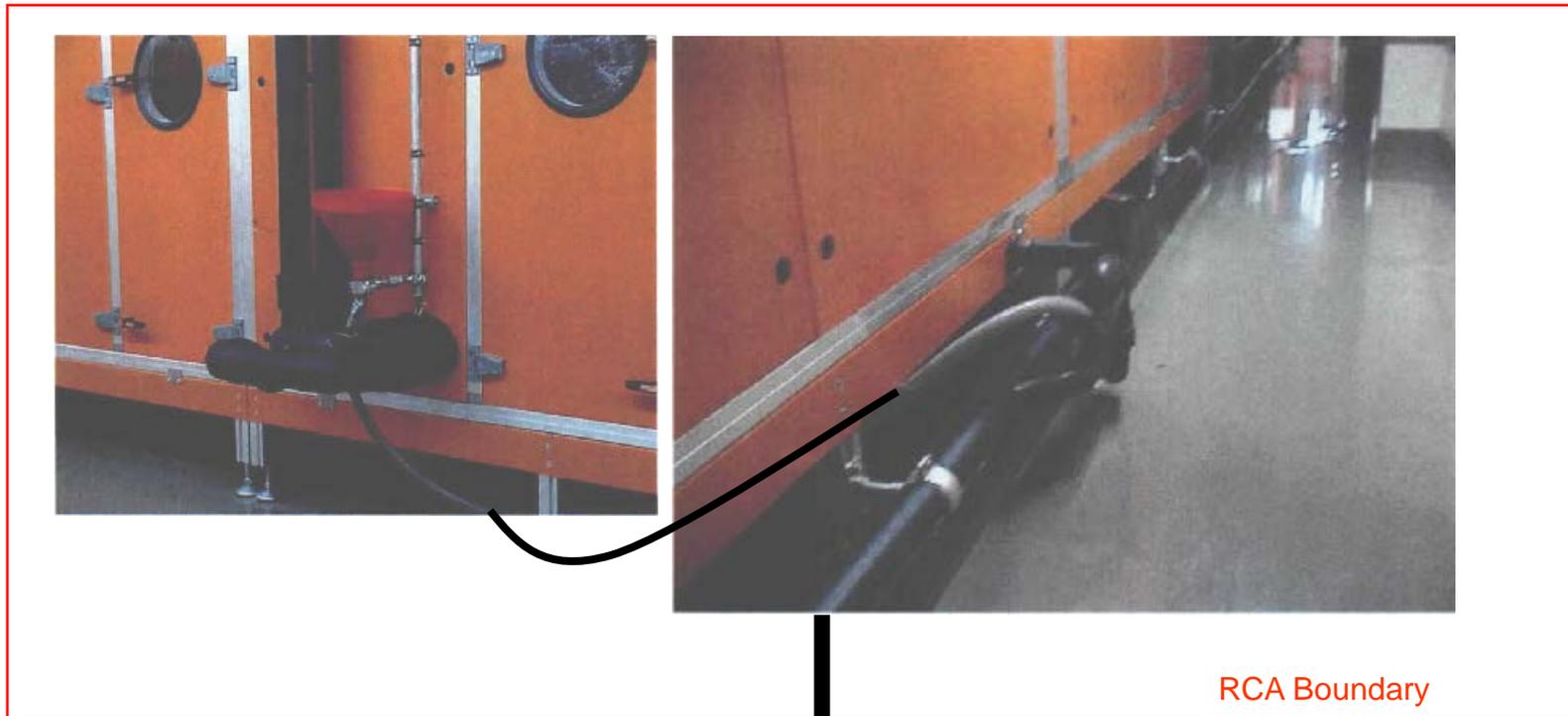
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RP Department**

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Leibstadt NPP**

Overview

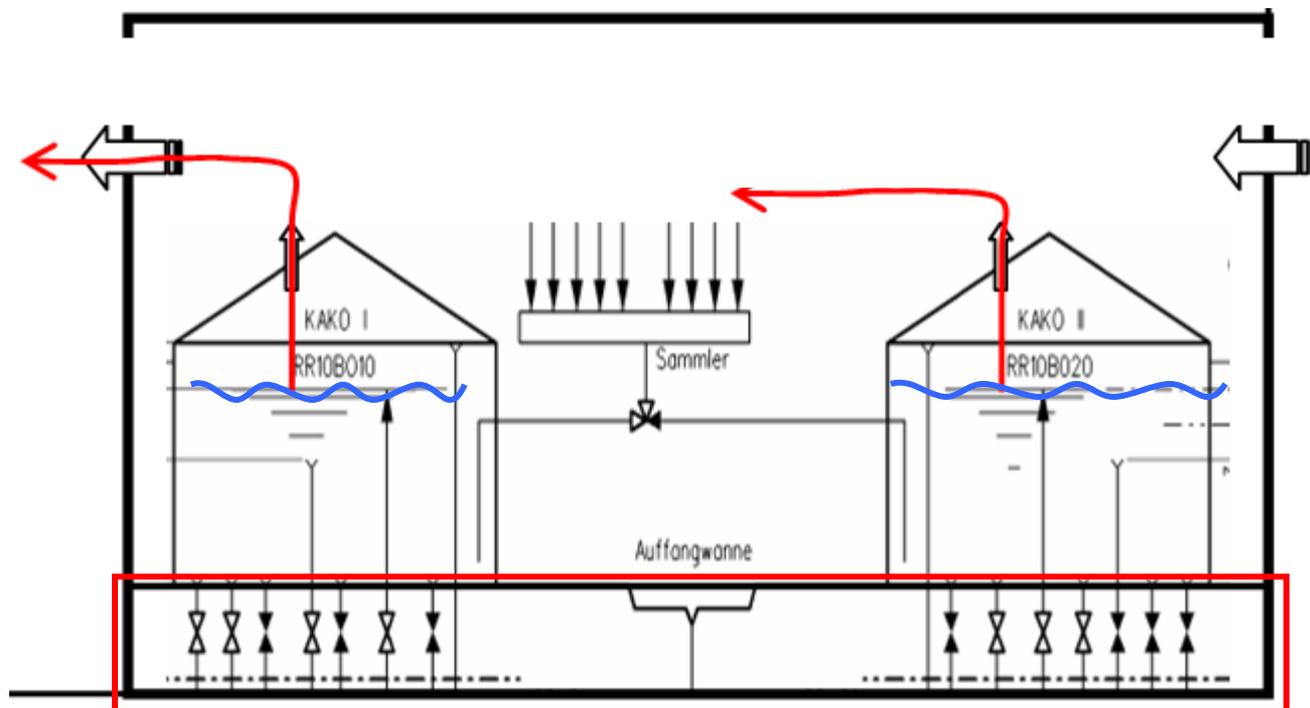
- **Initiating events**
- **Requirements**
- **Procedure**
- **Results**
- **Conclusions**

Initial event 1: Hot workshop intake air chiller drain



Initial event 2: Cold condensate storage tank vent

- Cold condensate containing I-131 after fuel failures
- Changes in water level push Iodine-air out of tank vents
- Contamination found outside RCA



RCA Boundary

Kernkraftwerk Leibstadt

A review of the RCA boundary ?

- **ENSI = Swiss Federal Nuclear Safety Inspectorate**
- **ENSI-requirement: „A comprehensive review of the entire RCA boundary has to be performed“**
- **Guideline requirement: „Radioactive effluents may cross the RCA-boundary only on licensed pathways, controlled and compared to release limits“**
 - ⊗ **Licensed pathways: Ventilation to stack, Radwaste discharge**
 - ⊗ **Controlled: Any instrument reading [cps]**
 - ⊗ **Compared to release limits: qualified sampling and counting reading [Bq]**

Agreement with ENSI

- **Identified unlicensed pathways with existing release: reportable event**
 - ⊗ Existing release = contaminated pathway
 - ⊗ Amount of release doesn't matter. Everything above background.
- **Identified unlicensed pathways without release**
 - ⊗ Reporting on a monthly basis
 - ⊗ Not a reportable event
 - ⊗ Aim: No penalty for serious review

Interfaces between radioactive and non-radioactive systems

- **Self-Assessment: „Some interface do not have isolation provisions to prevent contamination of the non-radioactive system“**
- **What is an „isolation provision“ to provide a „safe“ interface?**
- **A safe interface consists of two barriers (two-barrier-concept):**
 - ⊗ A Check-valve
 - ⊗ A reliable pressure difference
 - ⊗ Integrity of component (like a tight heat exchanger tube)
 - ⊗ Radiation monitor in non-radioactive system (Only under certain circumstances)

Additional tasks:

ENSI-Requirement: RCA-boundary review

original

additional

Review of RCA-penetrations

Are there penetrations through the RCA-boundary carrying radioactive material?

Corrective actions

Review of system interfaces

Are there „unsafe“ interfaces between radioactive and non radioactive systems?

Corrective actions

Review of RCA - Penetrations: Procedure

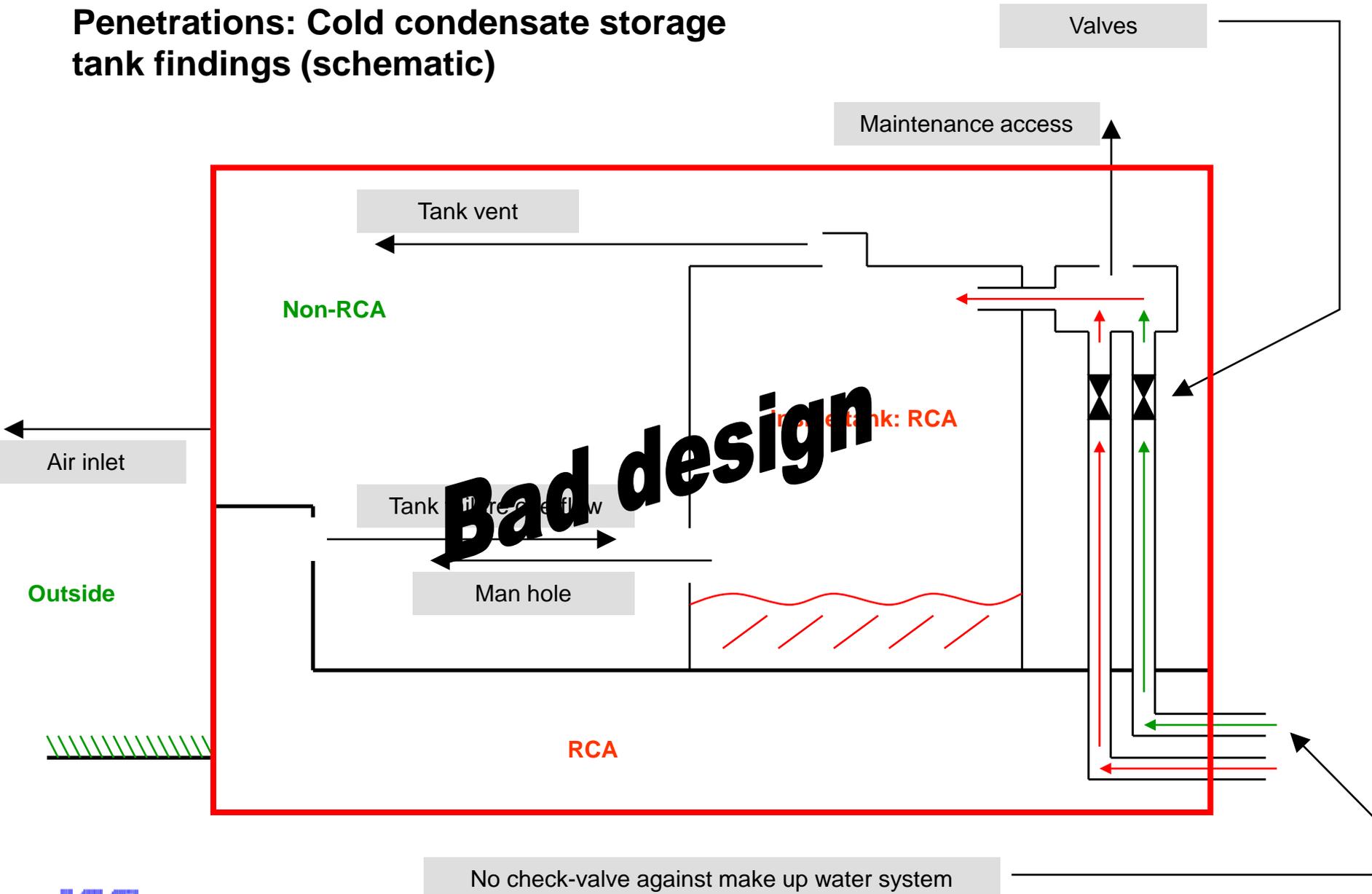
1. **Search and identification of penetrations through RCA - boundary**
 - 1) Walk - Downs in the field
 - 2) Discussions with RP/Engineering-staff to gather operational experience
2. **Verify the the identified penetrations in the as-built documentation**
3. **Assessment of the findings**
4. **Suggest technical solutions to improve unacceptable situations**
5. **Report to Plant Safety Committee and ENSI**
6. **Follow – up of plant modifications**

Penetrations: Turbine building findings

- A total of 205 penetrations were evaluated
- Rainwater drain lines crossing the RCA

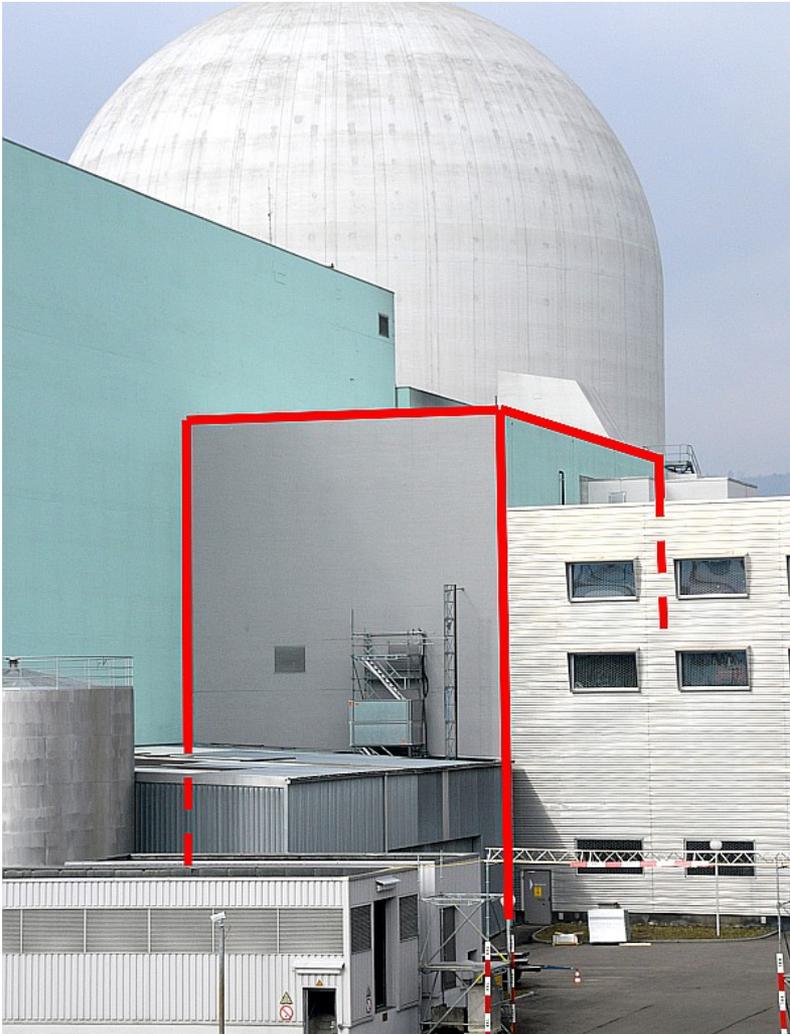


Penetrations: Cold condensate storage tank findings (schematic)

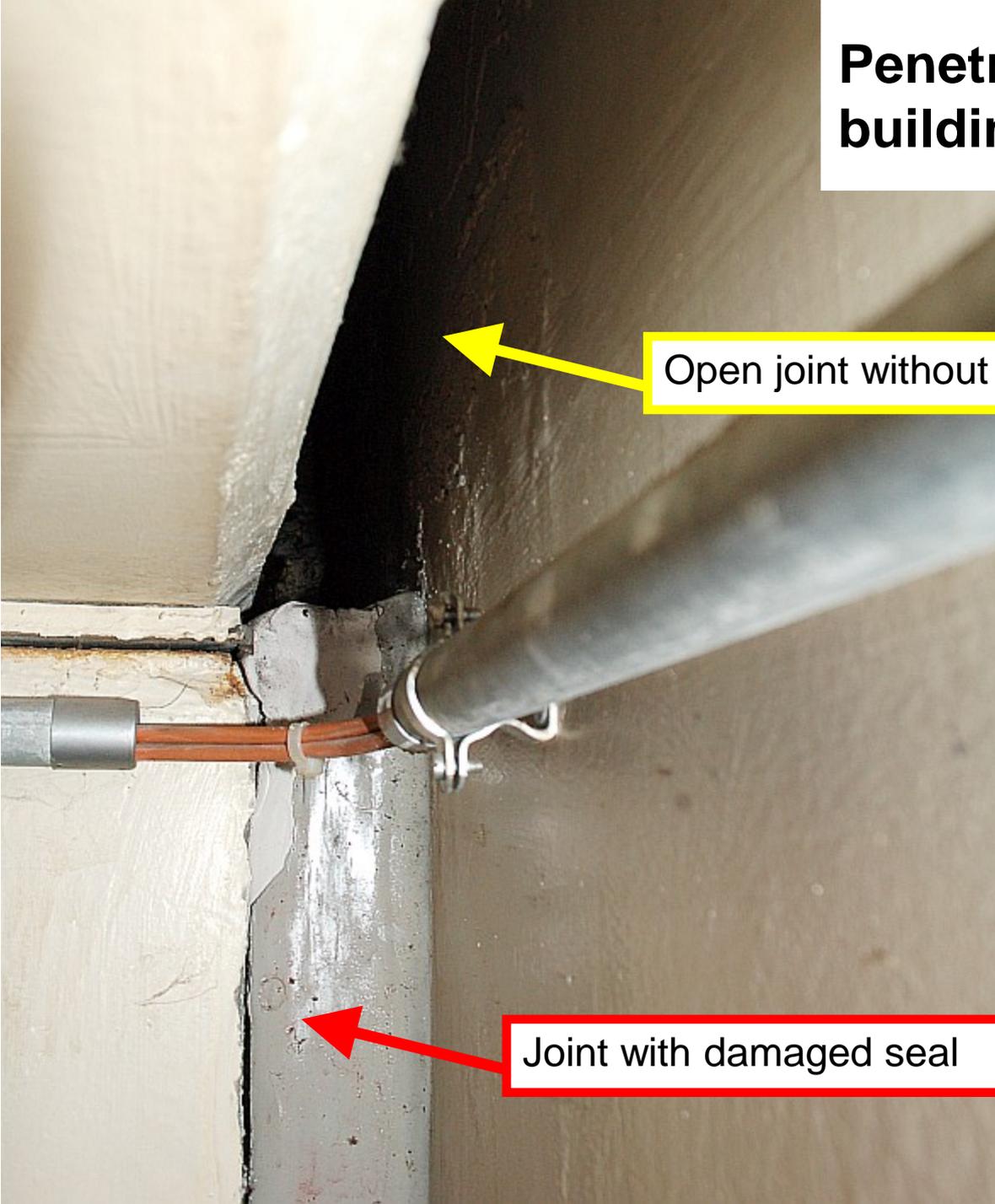


Penetrations: cold condensate storage building

- New roof
- New ventilation
- New coating inside
- 2 million Euros
- New part of the RCA



Penetrations: joint between buildings without seal

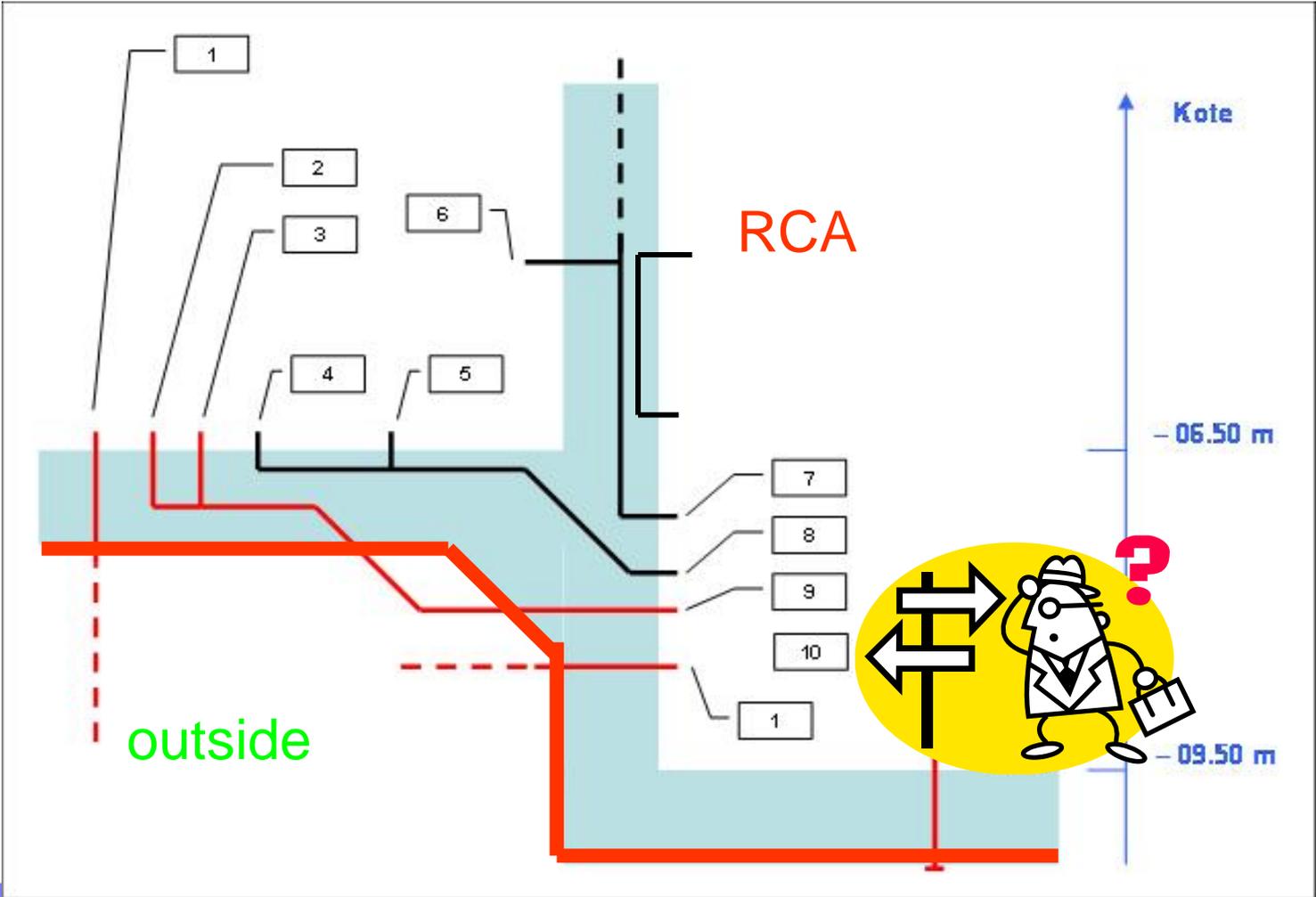


Open joint without seal

- Due to the negative pressure inside RCA an inward flow could be demonstrated
- Joints were repaired

Joint with damaged seal

Different types of penetrations



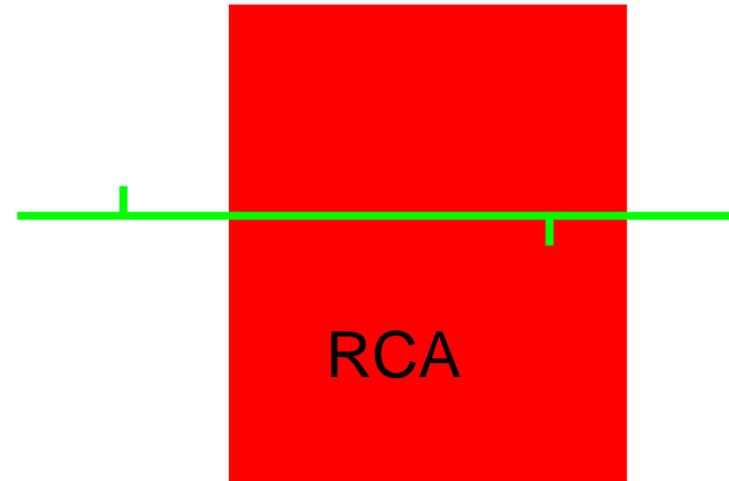
Penetrations: Conclusions

- **1007 penetrations were examined**
- **84 penetrations needed corrective action, 52 of them completed**

Interfaces: Findings in the turbine building

- **Make up water outlets:**

- Coupling fits to various types of hoses
- 1. Barrier = pressure difference
- 2. Barrier = non existent
- Possibility to inject contaminated water into the make up water system
- Solution: Additional check valve for each outlet



- **Underlying problem:**

- Non radioactive systems, whose content is used inside and outside of RCA
- Examples: fire water, make up water, aux steam, compressed air, service air

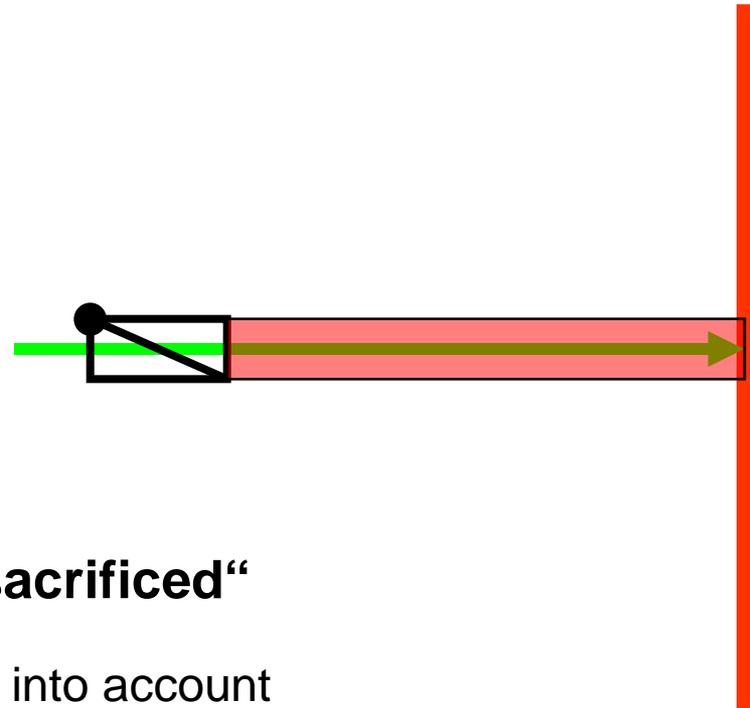
Interfaces: Findings in the Radwaste

- **Interface between cold condensate (radioactive) and make up water (non-radioactive):**
 - 1. barrier = non existent (similar system pressure)
 - 2. barrier = non existent
- **Valves are not considered to be a barrier, because their position can be „open“ or „closed“**



Interfaces: Special situations

- **Some parts of systems can't be protected with reasonable effort**
 - ⊗ Drinking water system inside Hot Lab
 - ⊗ Water supply of Hot Laundry
 - ⊗ Parts of Auxiliary steam system



- **Those parts of systems are „sacrificed“**
 - ⊗ Possible contamination is taken into account
 - ⊗ Documentation for future modifications and decommissioning

The next significant plant modification

- Piping with radioactive content outside RCA
- Flange = Risk for leakage
- Drain to river
- Solution: reroute ventilation and drain discharge towards RCA



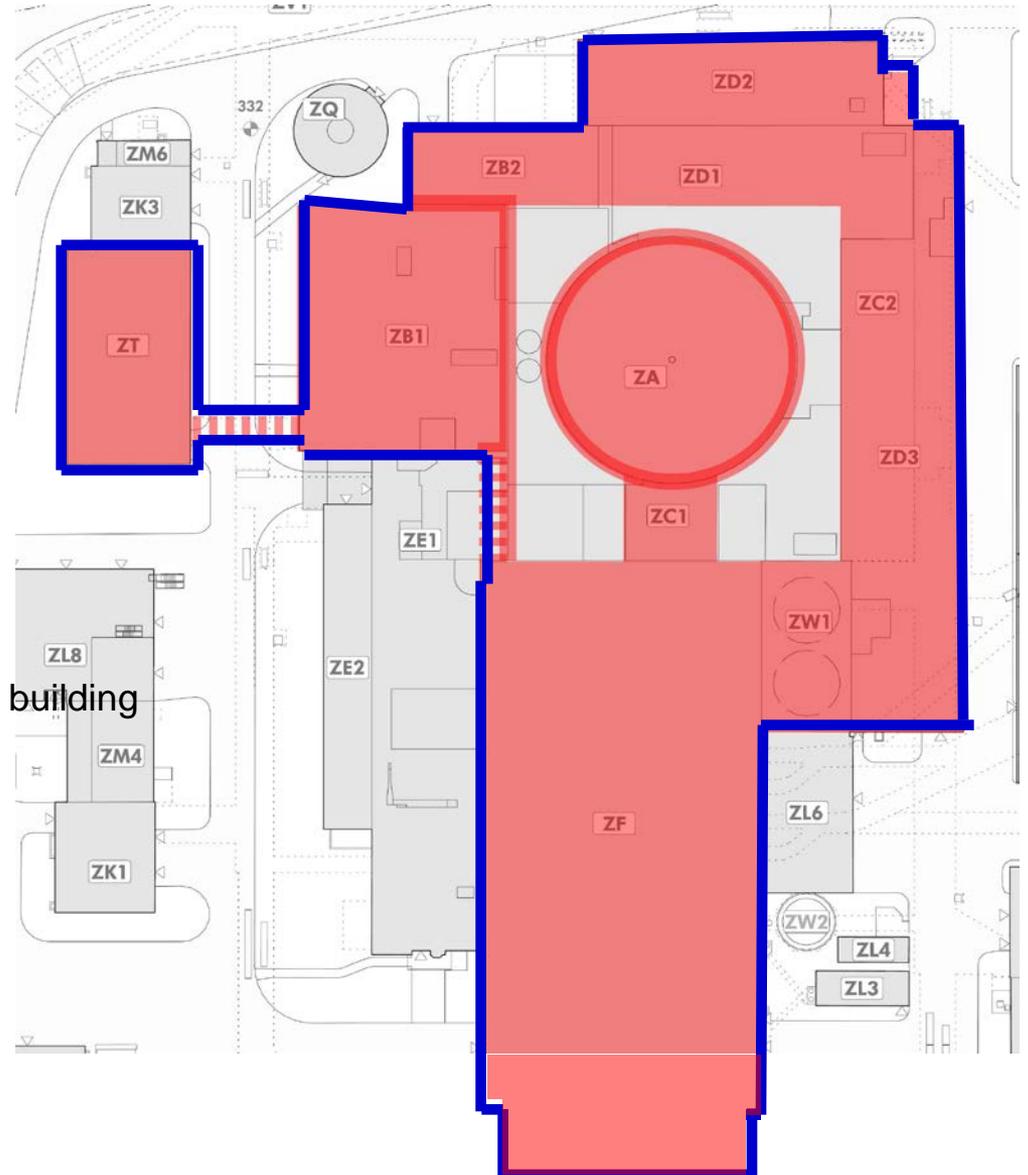
Work progress

- **Review completed**

- Hot workshop
- 10 kV-Switchyard
- Cold condensate storage
- Turbine building
- Seismic gap between buildings
- Steam tunnel
- Off-gas building
- Radwaste building
- Special Emergency Heat Removal building
- Reactor building
- Fuel handling building
- Waste storage building

- **Review in progress**

- Auxiliary building



Conclusions

- Until now a workload of 7 man-years was generated
- Approx. 93 % of the project is completed
- Two dozen of plant modifications has been triggered
- The understanding in plant and systems design has improved among engineers and Radiation Protection
- KKL has become safer with regard to inadvertent release of radioactive material
- Next time we do it better:
 - ⚙ New waste storage building

