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Release of Tritium in water in Switzerland

ERPAN Meeting 02 June 2008

Nicolas Stritt, Swiss federal Office of Public health



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Topics

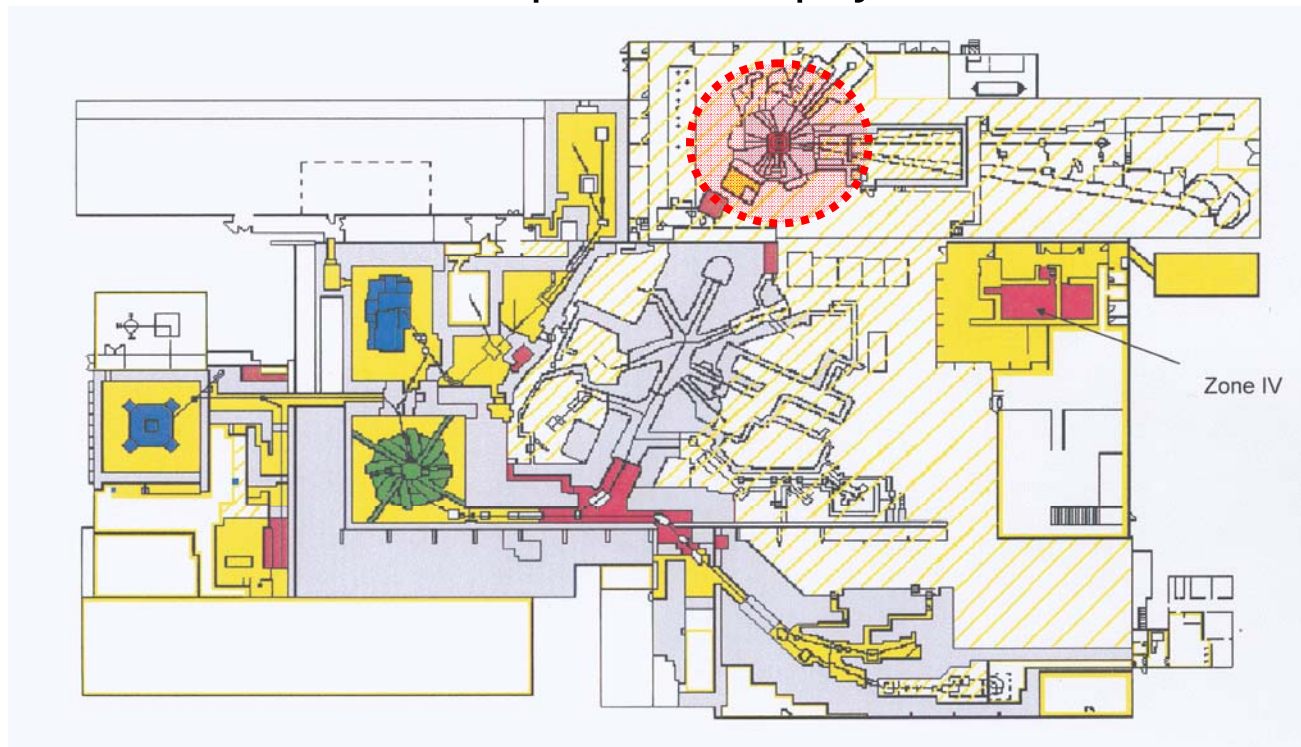
- PSI and the SINQ installation
- Contamination with tritium
- Data and facts
- Role of the regulatory body SFOPH
- Intensification of measurements during the release
- Limit to respect, dose, activity, legal constraints
- Release procedure
- Value of tritium concentration during the release
- Dose to the population
- Lessons learned, measure taken to avoid this in the future
- Information to the press





PSI Paul Scherrer Institut

- Complex installations with accelerator: protons 700 MeV
- 3 accelerators, injector 1 , injector 2 , Cyclotron
- Several beam lines, for experimental physics

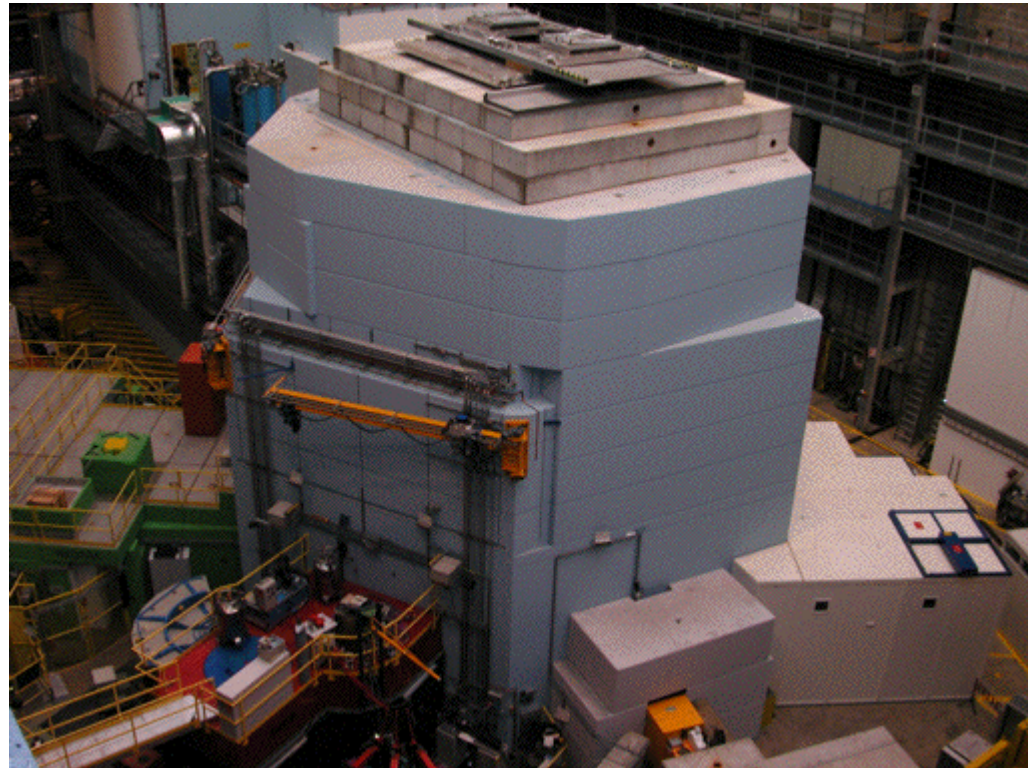




SINQ: Spallation neutron source

- SINQ is designed as a neutron source mainly for research with extracted beams of thermal and cold neutrons

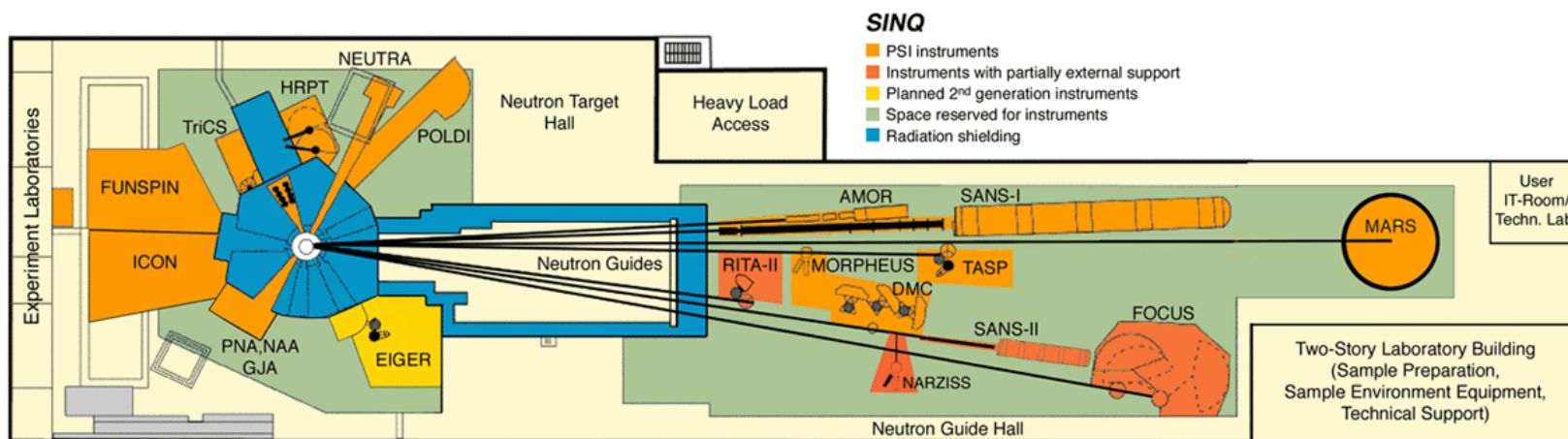
- Solid target
- Zirkaloy and lead
- Shielding of concrete and iron.





SINQ Spallation neutron source

- Several neutron lines and experiments

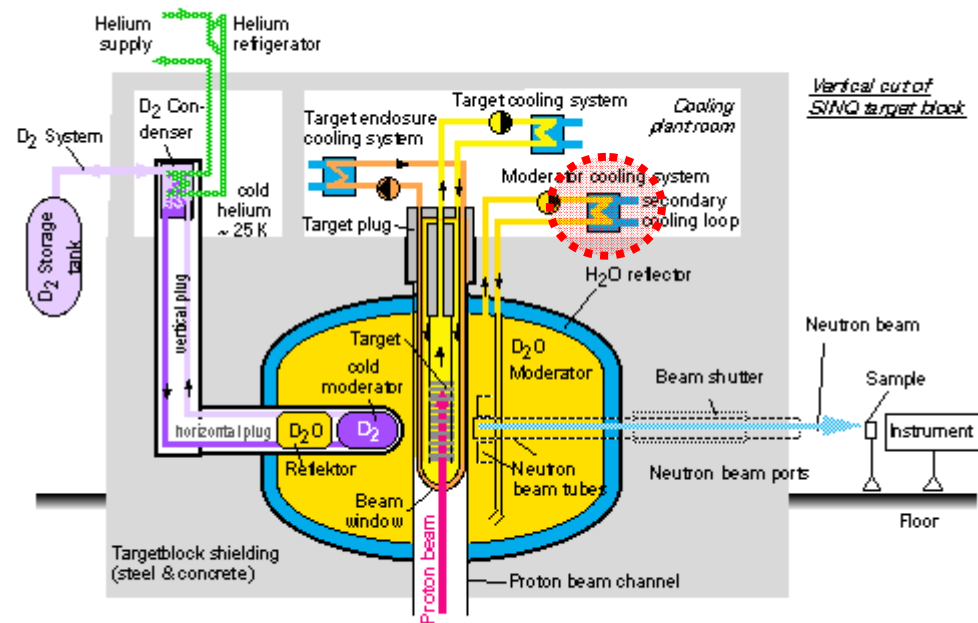




SINQ Spallation neutron source

- Moderator tank D₂O (5000 l)
- Target cooling system
- Target enclosure cooling system
- All of these are close circuits
- Liquid in contact with proton beam and neutron beam, production of tritium and short lived nuclides
- Leak in heat exchange system between moderator tank and another secondary cooling loop H₂O (100'000 l)

Principle of the Spallation Neutron Source SINQ



Section 50:

Contamination with Tritium

- Leak from heavy water (D_2O) contaminated mainly with tritium in a heat exchange
- Contamination of cooling water circuit (H_2O) (KK6) with tritium
- Contamination of a circuit which goes all around the PSI installation, cooling of accelerators, bending magnets, experiments
- Risk for maintenance
- Risk for users (physicist, workers)
- Solution to get rid of the tritium in the cooling circuits



Dada and facts

- Activity: 5.0 TBq Tritium
- Volume of water contaminated (cooling loop): 100 m³
- Solution to get rid of the Tritium:
 - Separation of the two cooling circuits
 - Replacement of the heat exchanger
 - Addition of distilled water in the contaminated circuit (cooling loop) to bring the specific activity under a reasonable limit
 - Evacuate the surplus of water (volume of cooling loop is constant) in the river Aare according to the allowed limits



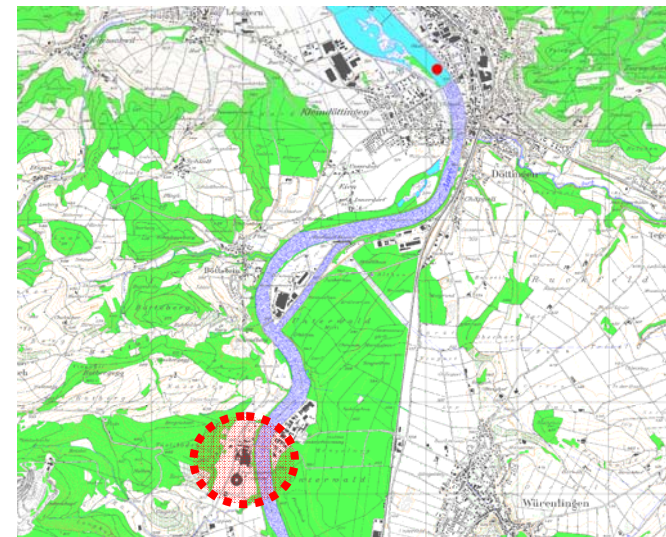
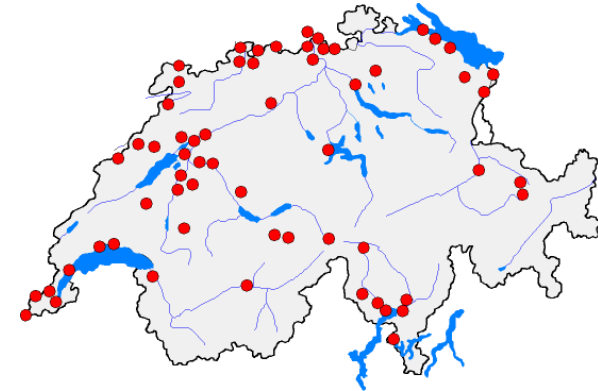
Role of the regulatory body

- Make sure that the population is not put at risk and ensure that the procedure is safe for the population
- Evaluation of all pathway to solve the problem (solid waste, liquid waste, burning of waste, release in river...)
- Inform the population about the danger and risk
- Inform the organizations, institutes dealing with water of Aare river (drinking water supplier, survey organization, etc.)
- Information of neighboring countries (Germany)
- Control of the activity in water during the release



Intensification of measurements during the release

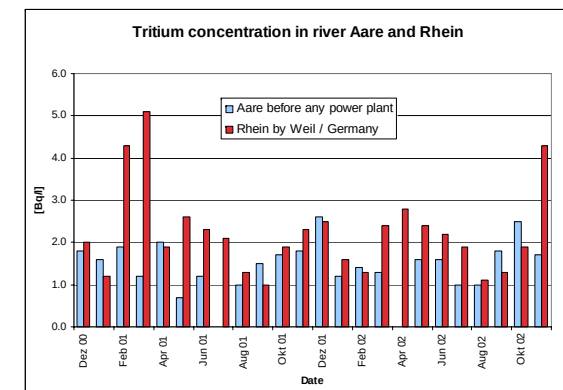
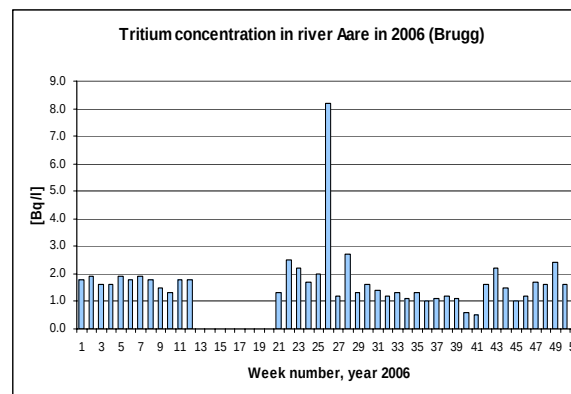
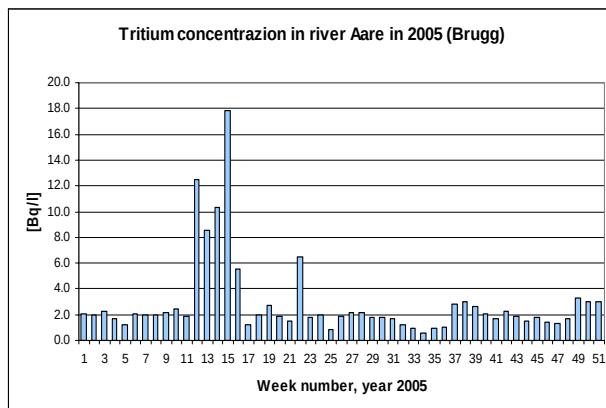
- Regulatory body has increased its measurements
- Measurements of Tritium in Klingnau 6.4 km from PSI
 - Continuous System
 - On sample per day from 08. August till 08. September 2007
 - Once a week in september
- Other sampling points every month
 - Rhein by Weil (Germany)
 - Pratteln (Basel)
- When needed other stations possible
- Randomize analysis near the PSI (hundred meters)
 - 5 positions near PSI
 - 5 samples of ½ liters each





Average value of tritium in Switzerland

- Average value of tritium concentration in river Aare: 3 Bq/l
- Peak by release from power plants (5 power plants in Switzerland, one release pro year of tritium) up to 18 Bq/l, depending on the location of measurement
- The river Aare goes afterwards in the river Rhein and then to Germany. Measurement in Germany shows value of 3 Bq/l





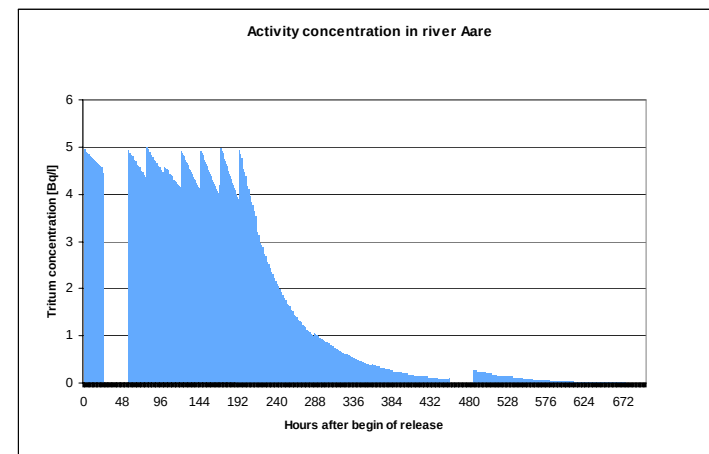
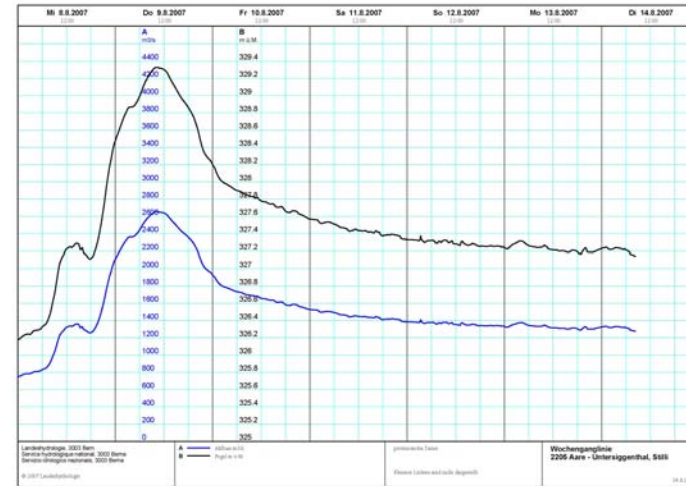
Limit to respect, legal constraints

- Dose to the population (0.3 mSv/year)
- Maximal concentration in drinking water (1000 Bq/l)
- Maximal release per week (12'000Bq/l)
- Limit fixed according to discussion between PSI and regulatory body: addition of tritium concentration during the release:
 - Addition of maximum 5 Bq/l to the normal tritium concentration present in the river (3 Bq/l), the values should therefore not be over 8 Bq/l.



Release procedure

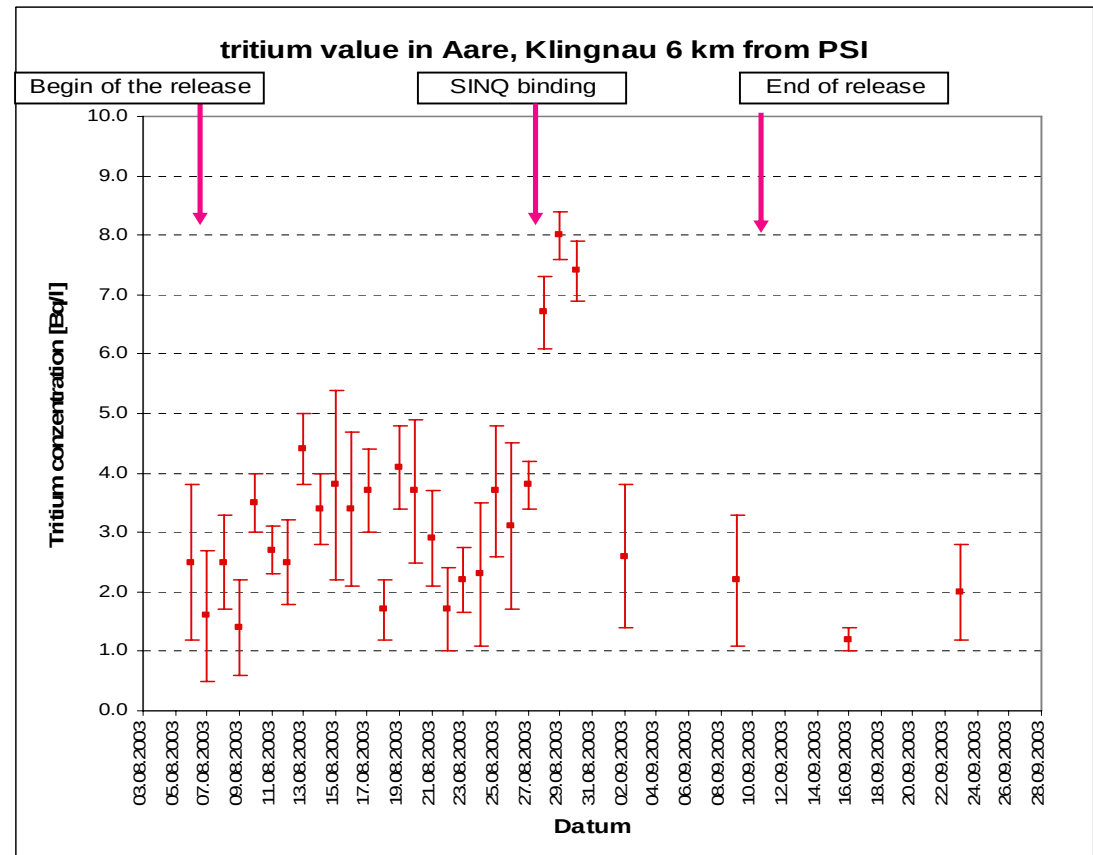
- Measurement of the water flux in the river Aare
- Definition of the allowed discharge every day
 - According to the water flux
 - Respect the value of 5 Bq/l
 - Definition of discharge volume m³/h
- Release done per day (activity, amount of water added)
- New evaluation of the situation
 - River water flux
 - Stop during 3 days because of flood
 - Activity remaining in circuit
 - Amount of water added





Release and values measured

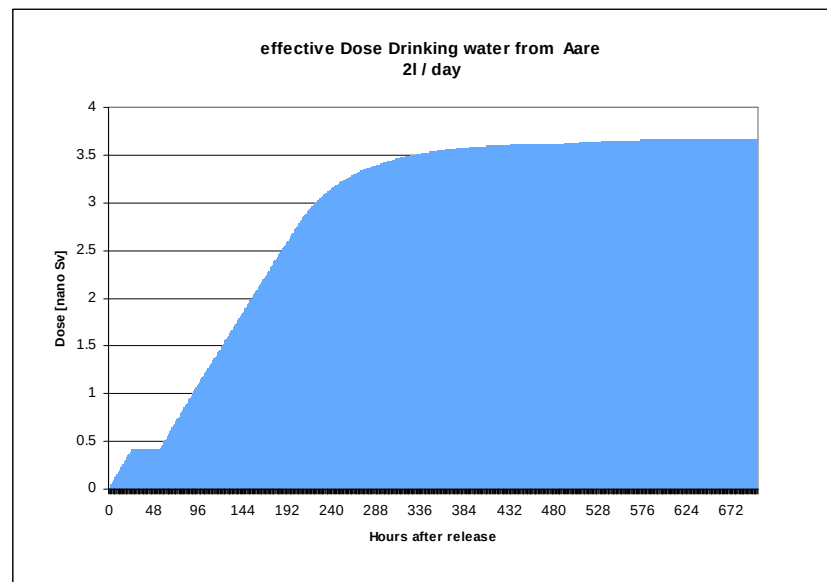
- Release lasted 2 month
 - August until September
- Limits fixed by regulatory body not exceeded: addition of 5 Bq/l to the normal tritium concentration ($3 + 5 = 8$ Bq/l)
- Higher value when the SINQ moderator cooling circuit was connected again to the circuit (8 Bq/l)
- All other measurement, no increase of the concentration along the river Aare, Rhein





Dose to the population due to the discharge

- Conservative assumption :
 - A person drinks 2 liters of water directly from the river Aare every day
 - Dose resulting from ingestion of this quantity of water
 - Concentration of activity decreases with time
 - Resulting dose to the population from total release: < 5 nSv





Other measures to avoid this kind of incident in future

- Replacement of the damaged heat exchanger
- Construction of a new cooling circuit between moderator tank and cooling circuit (new D₂O circuit in between)
- New cooling circuit built and operational since April 2008
- New concept for the release in river Aare (dilution in river not optimal)
- New water pipeline planned for such incident
- Continuous measurements of the activity in water in the different cooling circuits of PSI



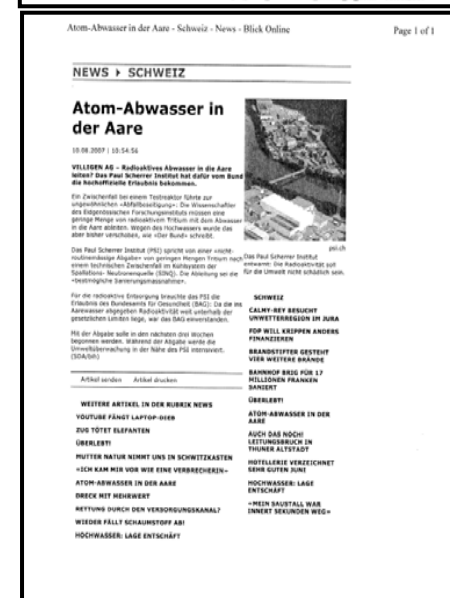
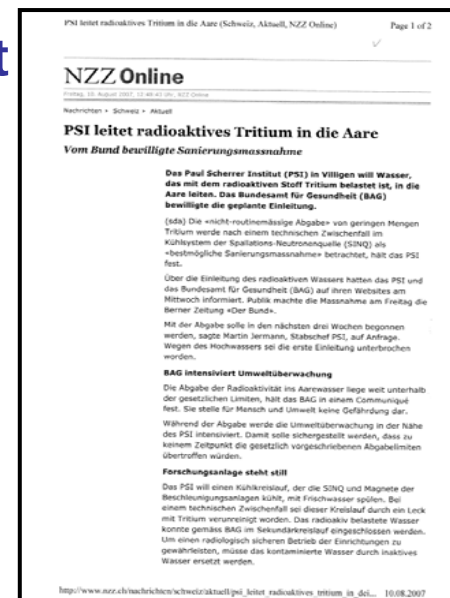
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Information to the press, communication concept

- No press release was made because:
 - Risk was very low
 - Nuclear power plant routinely discharge every year larger activity (tritium) without any press release
- Passive Communication on the Internet with fact sheet on the web site of the SFOPH and PSI
- Questions from the press (TV, radio, written press) kept the SFOPH very busy for a whole week.
- More than 20 articles published in Swiss newspapers
- Population and Swiss government (canton) asked questions
- Government of Germany asked questions
- After one week it was back to normal, good preparation of the SFOPH
- Answer clear: no risk

ERPAN
N. Stritt, SFOPH, 2nd June 2008





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Thank you for your attention