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Radiation Protection

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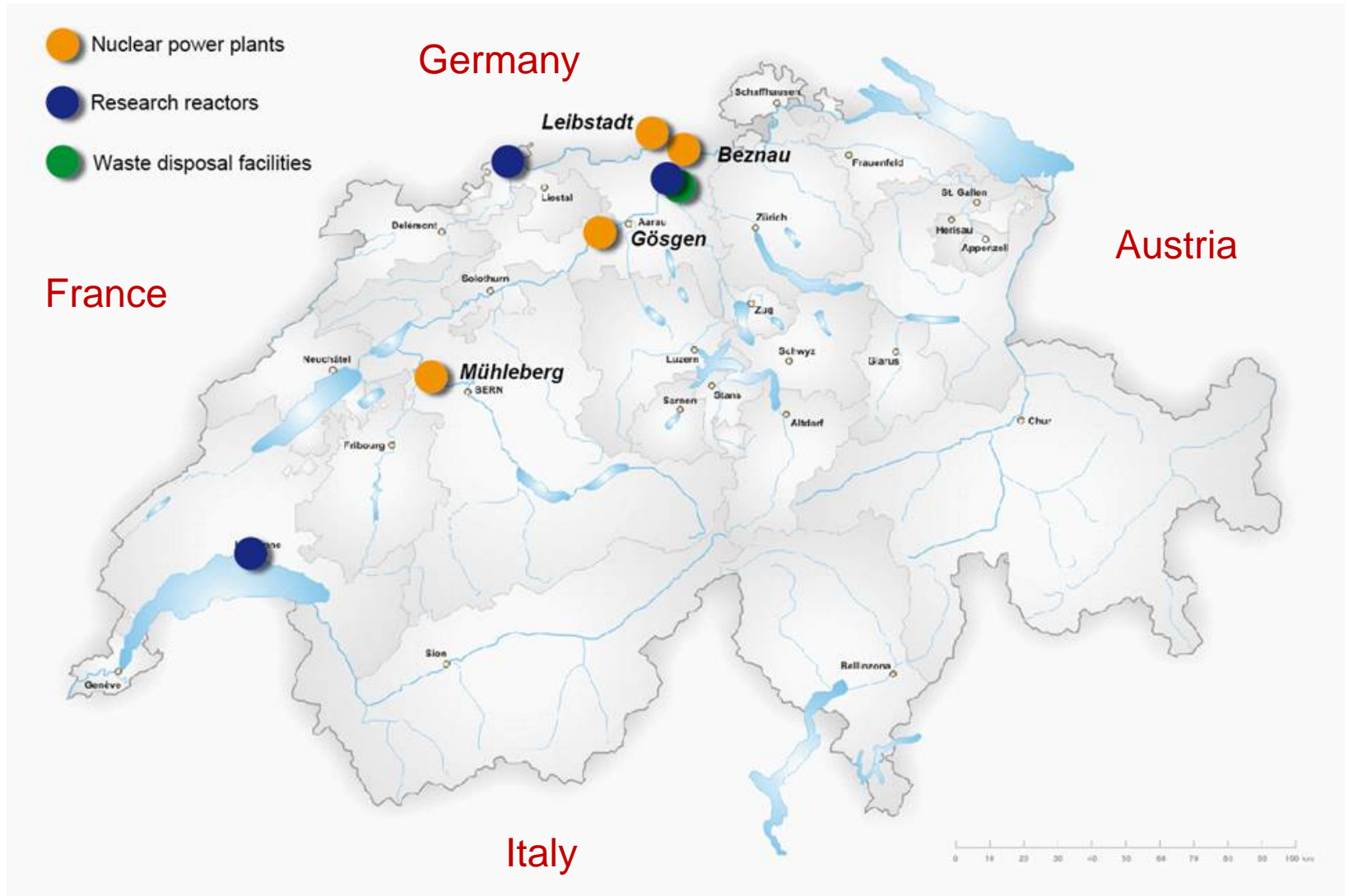
Swiss Nuclear Installations

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Swiss Nuclear Installations





How to Qualify Radiation Protection?

Realization of the Radiation Protection System

Radiation Exposure of Workers

- continuous measurement of individual exposition
- maximum individual dose
- average individual dose
- collective dose

Impact on the Environment

- emission of radioactive substances
- radioactive waste



How to Justify Radiation Exposure?

Exposition to radiation is only justified if:

- below limits
- optimized processes
- ALARA;
- no other way to the goal

collective dose per kWh (QSE) reasonable

benefit for the society

long term risk evaluated

consequences of accidents acceptable



Optimization of Radiation Exposure?

Education in radiation protection: *to understand the risk and to judge radiation exposure right*

planning of radiation protection

evaluation of job doses

maximum individual dose per job

collective dose, better job dose

shielding, limited access, etc.

mock up training

emergency planning (for example fuel element transfer)



How to respect limits?

planning of radiation protection

Personnel

- dose contingency per day
- dose contingency per job
- maximum individual dose
- dosimeters with wireless data transmission

Environment

- source-term-related dose reference value
- regimentation of effluents (liquids & gases)
- clearance process (solid material)



Radiation Protection Results Swiss Nuclear Installations

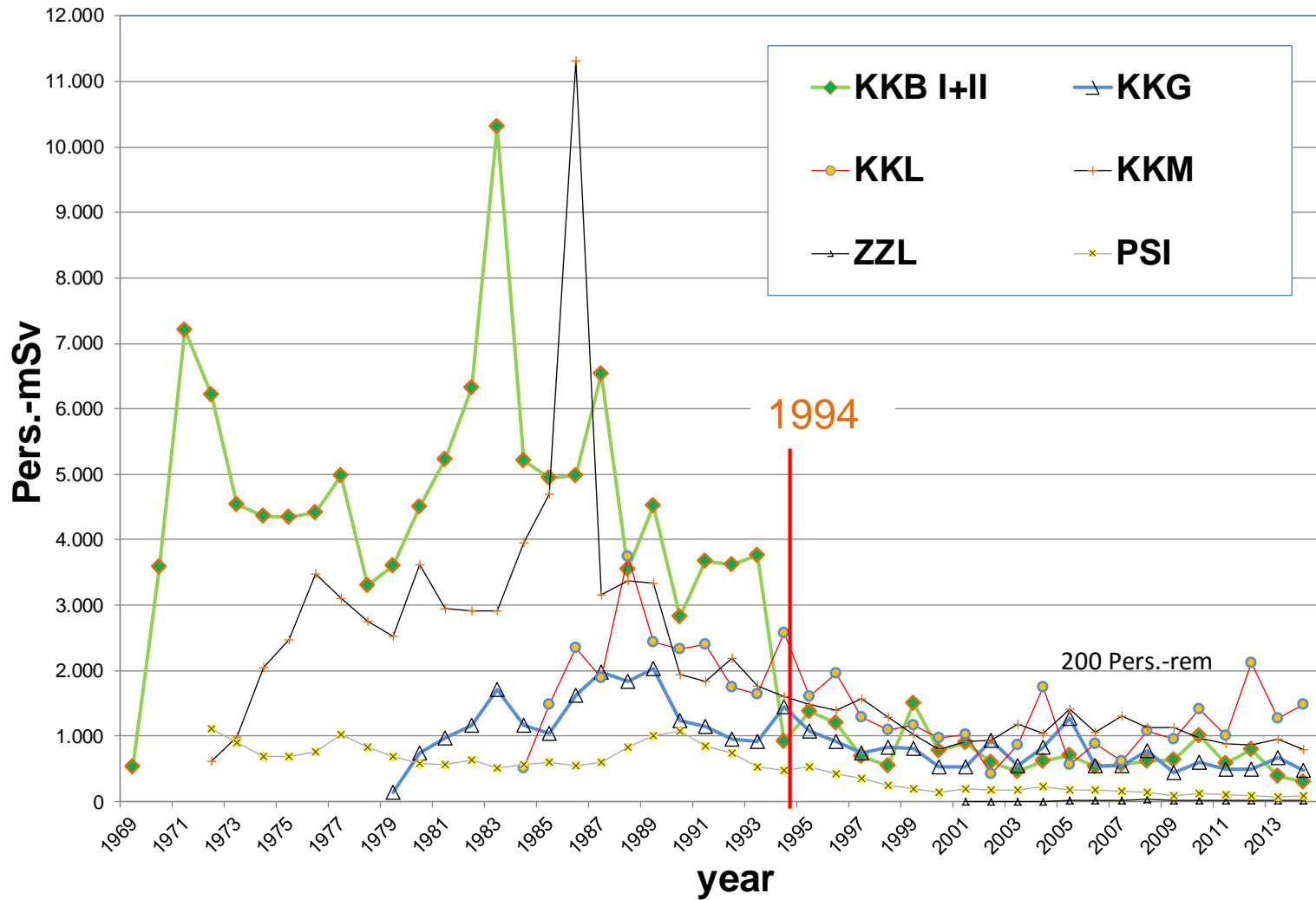
Do we respect the limits?

Sine 1994 about 12000 radiation worker have been or are employed in Swiss nuclear installations. In that time we had:

- three cases of direct exposure over 20 mSv (2 rem) but below 50 mSv (5 rem)
 - no incorporations with significant effective dose
- collective dose is stable (divergences explainable)
number of workers with high doses is decreasing



Swiss Nucl. Inst.: Total Site Doses





Review of Individual Exposure

The exposition of worker is to plan as low as reasonable achievable (ALARA).

The average exposition of the Swiss population is about 5,5 mSv/a (550 mrem/a).

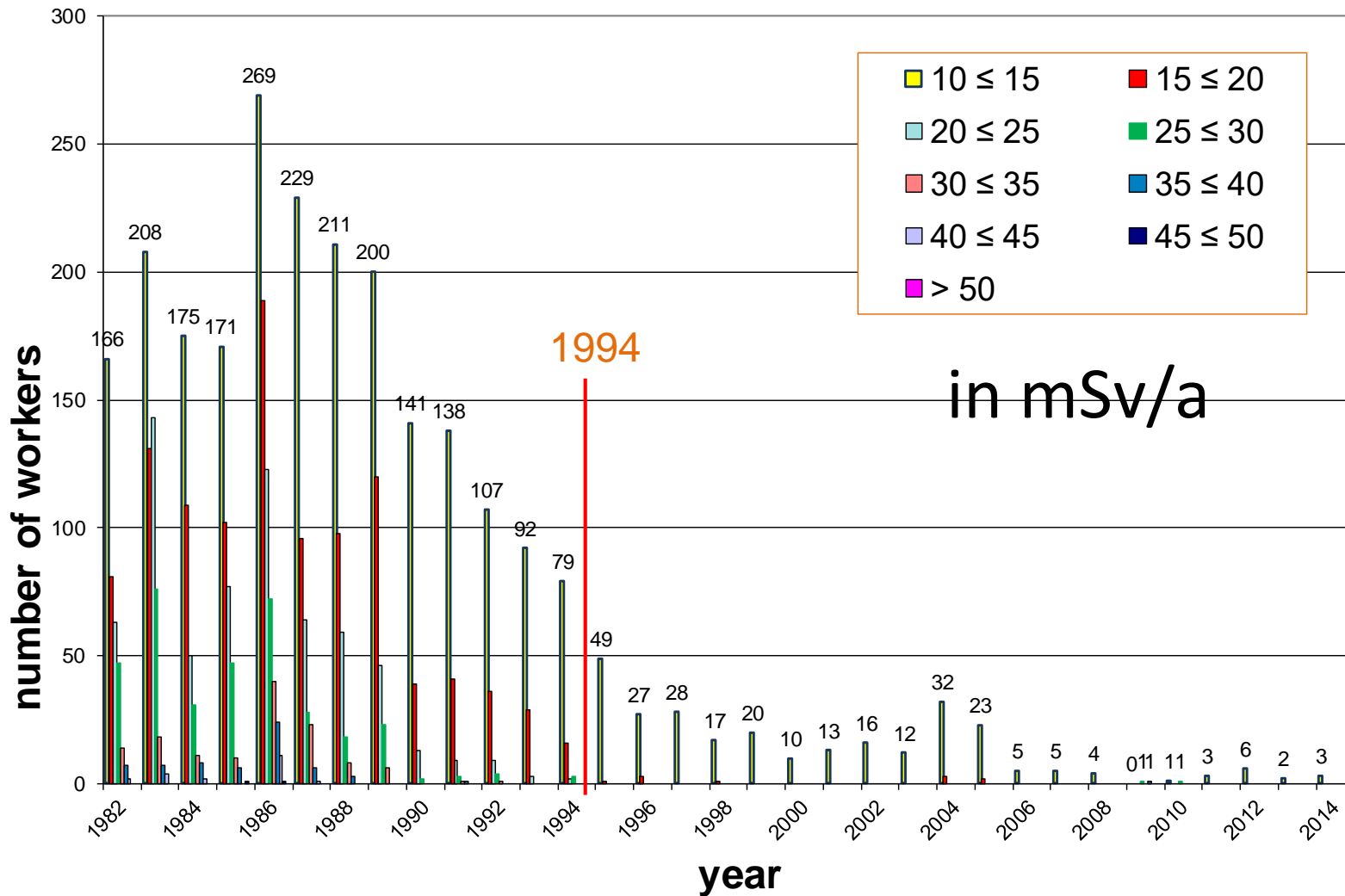
The limit for occupational exposed individuals is 20 mSv/a (2 rem per year).

The reached maximum individual dose shows the gap to the limits.

In the majority of cases the individual dose is below 10 mSv/a (1 rem).



Dose Distribution beyond 10 mSv (1 rem)





Average Individual Dose

simple to generate parameter

low expressiveness

guidance for worker and management

average exposure of flight personnel is around 2,5 mSv/a (250 mrem/a)

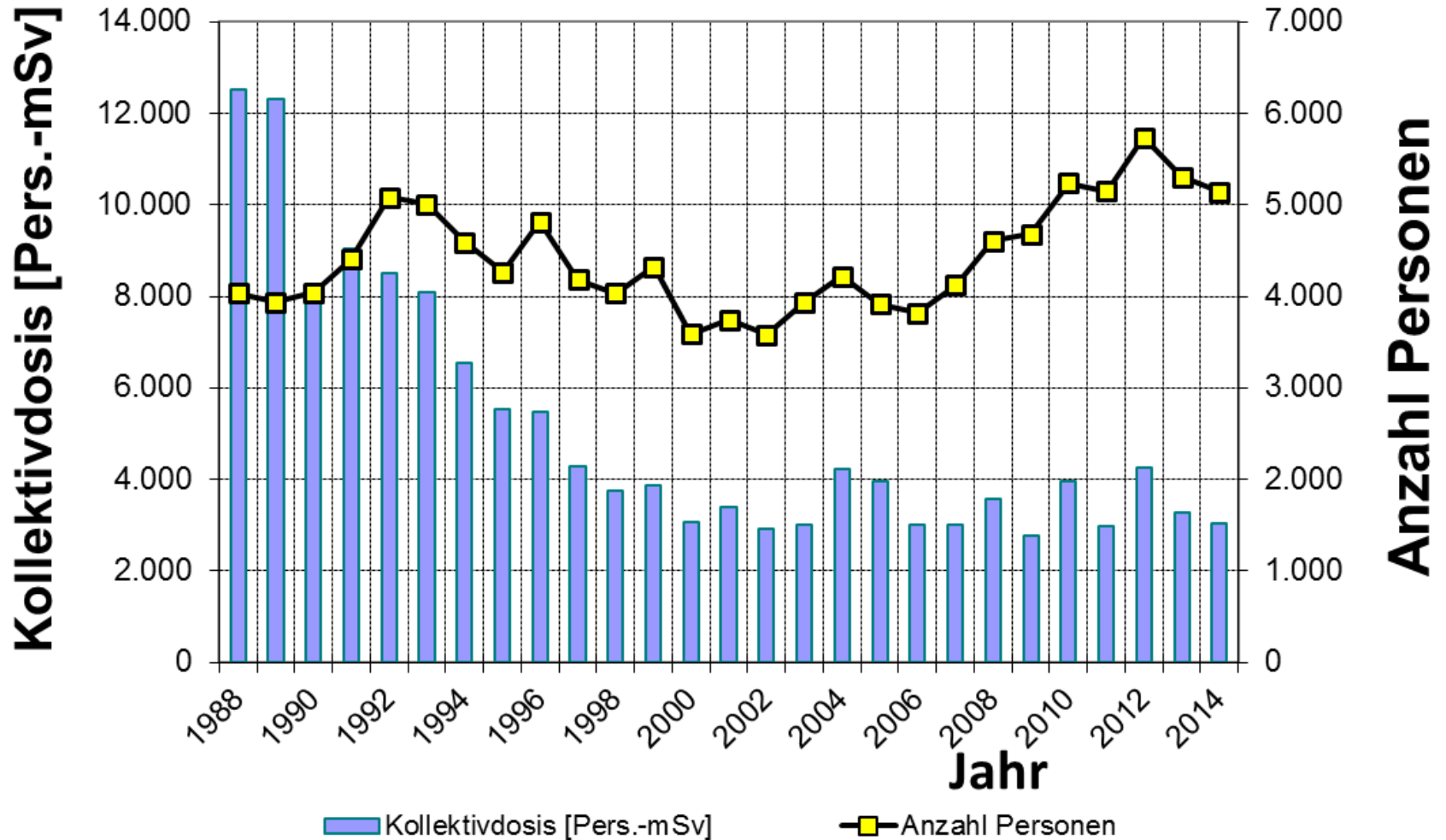
average exposure of the Swiss population by Radon is around 3,4 mSv/a (340 mrem/a)

average exposure of workers in Swiss nuclear power plants is below 1 mSv/a (100 mrem/a)



Basis for the Average Individual Dose

all Swiss nuclear power plants





Radiation Exposure per kWh

The justification for radiation exposure in nuclear power plants is primarily the generation of electrical power as a benefit for the society.

An assessment of the relation between exposure and generated electricity is useful but tricky.

We count only the exposure of workers, then all other exposures are in the first order negligible.

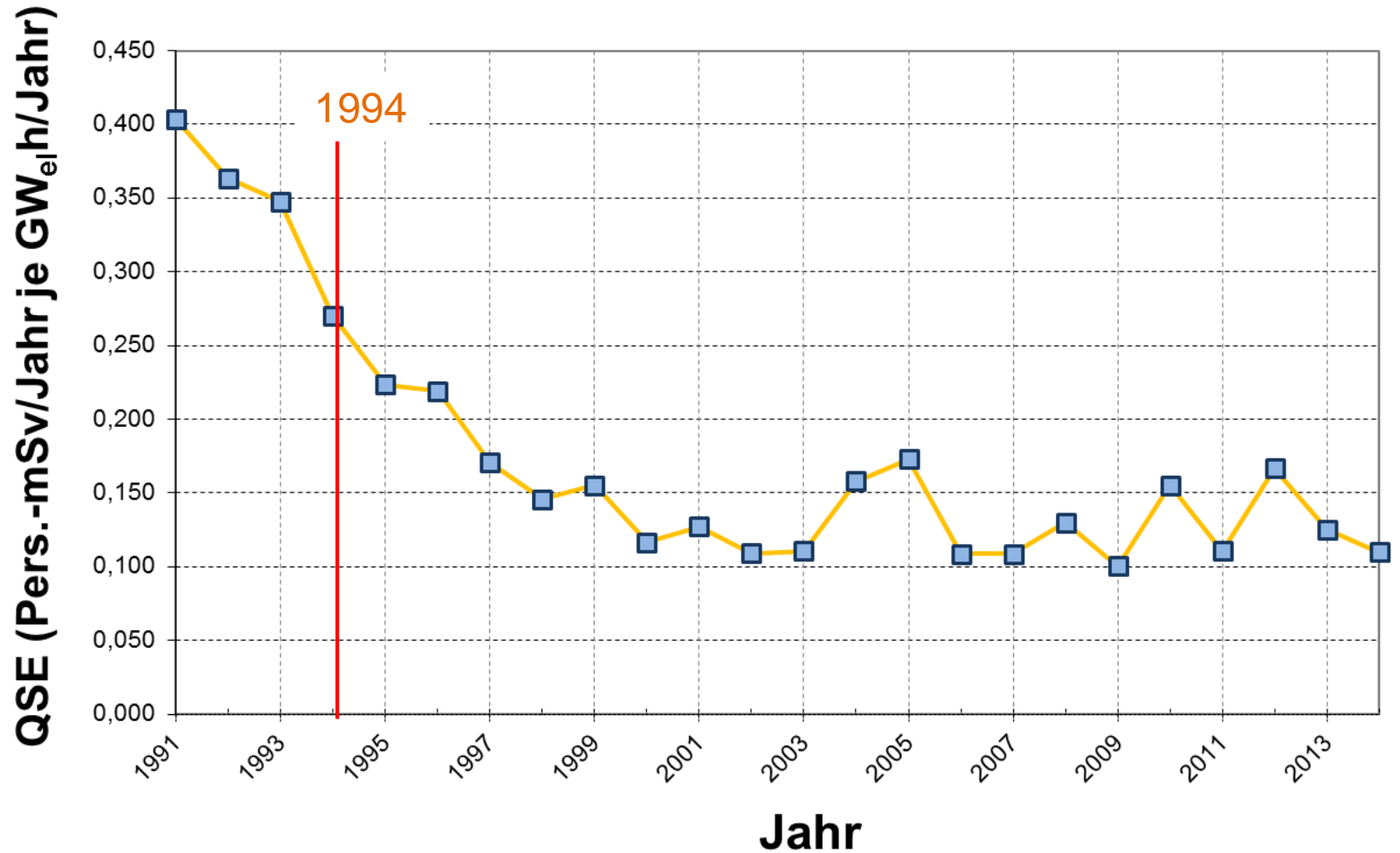
The parameter is called

QSE in Pers.-mSv/a per GWh/a or short mSv/GWh



QSE [Pers.-mSv/GWh]

all Swiss nuclear power plants





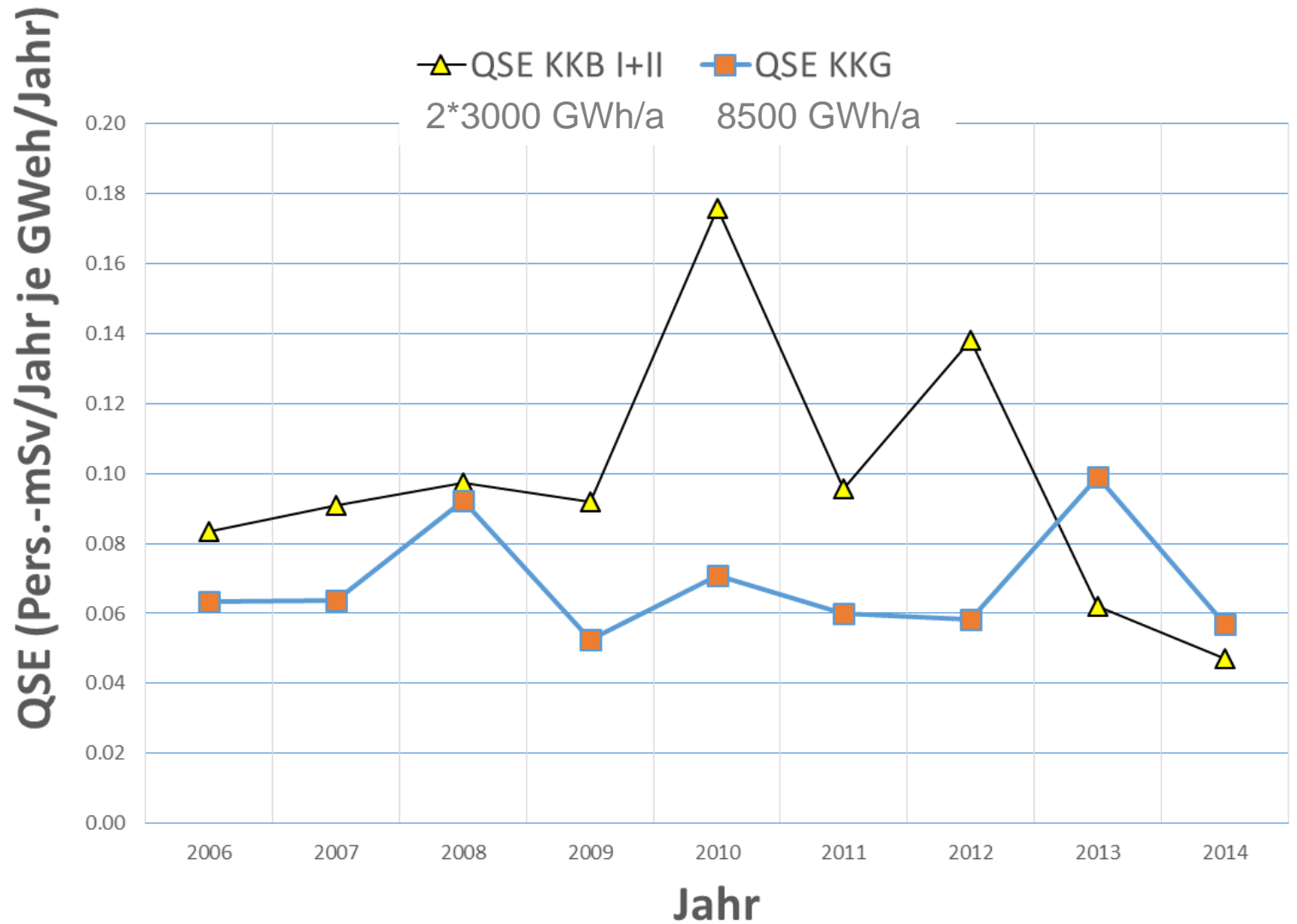
QSE is a complex value

The QSE shows all deficits:

- Design, nominal power, efficiency
- breakdown of turbine or generator
- planned or unplanned outages
- need for frequent repairs
- extensive shut downs
- inspections or repairs in radiation fields
- high exposure of personnel



Druckwasserreaktoren





Summary

The exposition of worker in Switzerland is on a low level constant.

The number of workers with a yearly exposure over 10 mSv (1 rem) is low.

no incorporations with significant effective dose

only easy removable contaminations on personnel

but: three violations of limits within 20 years

good developed safety and radiation protection

culture

Future for Nuclear Installations

Phase out determines the future; the build of new nuclear power plants has been cancelled; *social, ethical and political aspects*

The Mühleberg nuclear power plant KKM will stop operations in 2019 and starts afterwards decommission.

Two of three research reactors finished operations and will soon start decommission.

Both reactors of Beznau nuclear power plant KKB have been renewed and therefore, produced in 2015 not as expected. Block 1 suffers at the time on defects in the pressure vessel material.

Decommission of Swiss Nuclear Installations

The nuclear power plant Lucens is decommissioned.

The research reactors DIORIT and SAPHIR are de facto finished.

The decommission of an incineration facility and of two small research reactors will start this days.

Sufficient capacity is available for the storage of radioactive material.

ENSI is now prepared for the big decommission processes starting with Mühleberg nuclear power plant in 2020. **Radiation protection personnel will stay up to the end of the decommission process.**



more actual information:



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Thank you for your attention

