

## **Trends in occupational radiation exposure in nuclear fuel cycle facilities. An overview.**

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International Conference on Occupational Radiation Protection:  
Enhancing the Protection of Workers

1-5 December 2014

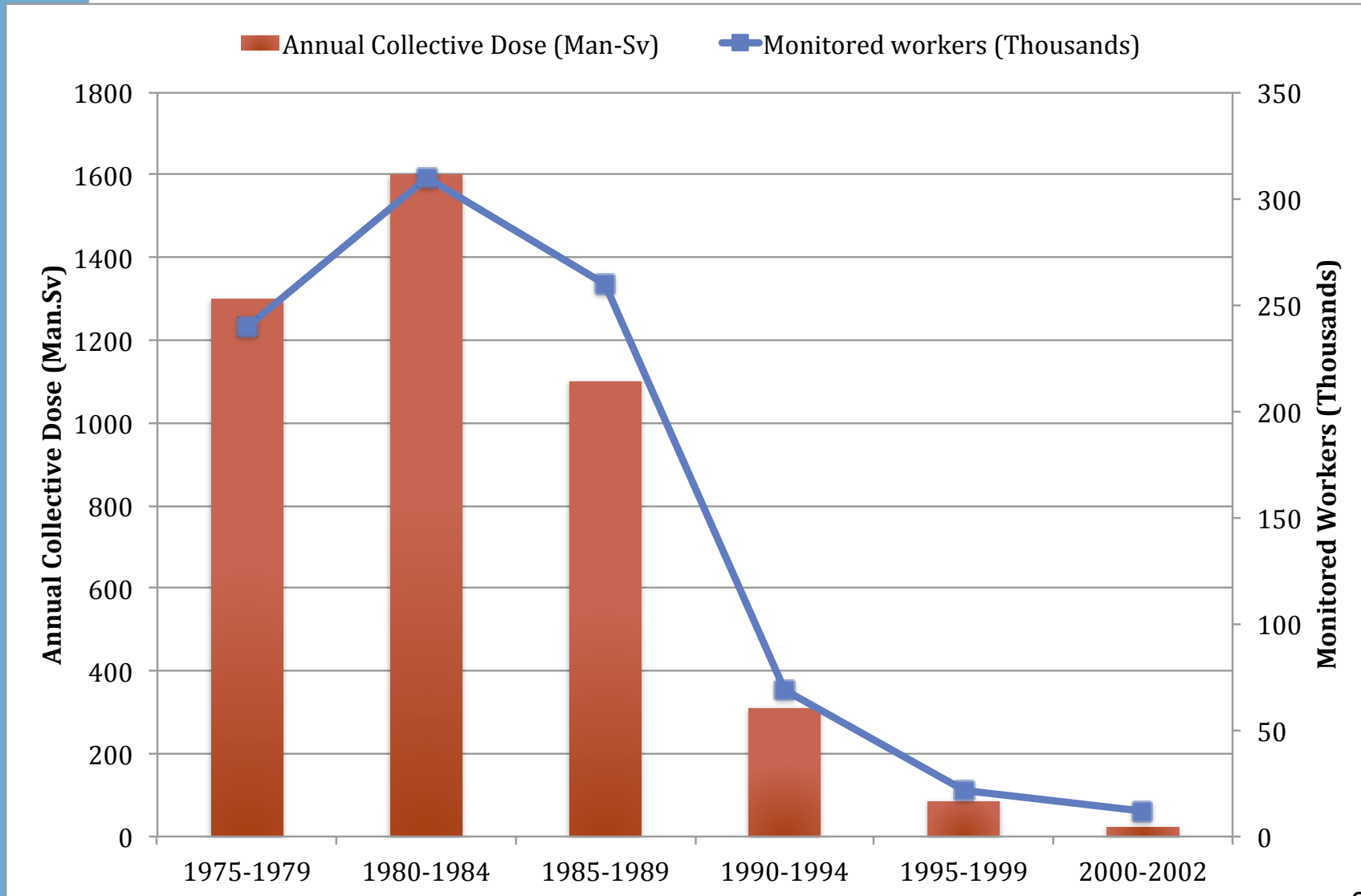
Vienna

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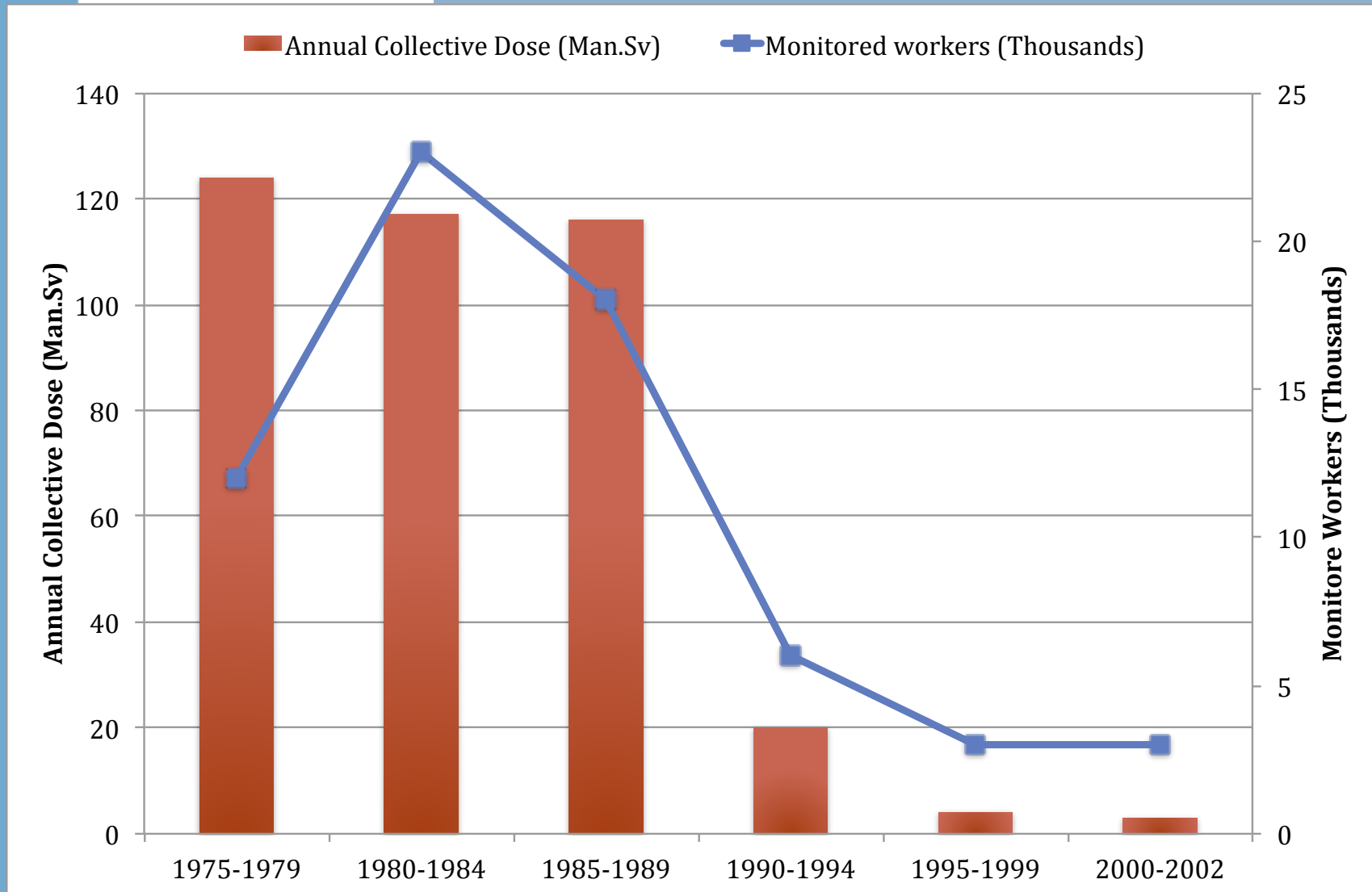
- Global overview of occupational exposures trends in nuclear facilities based on UNSCEAR latest data.
- Focus on Nuclear Power Plants based on data from the International System on Occupational Exposure (ISOE).
- Discussion.
- Perspectives & future challenges.

- UNSCEAR 2008 Vol. 1 report provides estimates on workers' occupational exposures in various field of activities, including the use of atomic energy for electricity generation.
  
- Data on:
  - Uranium mining,
  - Uranium milling,
  - Enrichment,
  - Fuel fabrication,
  - Electricity generation,
  - Reprocessing.
  
- Including:
  - Collective exposure,
  - Number of monitored workers.

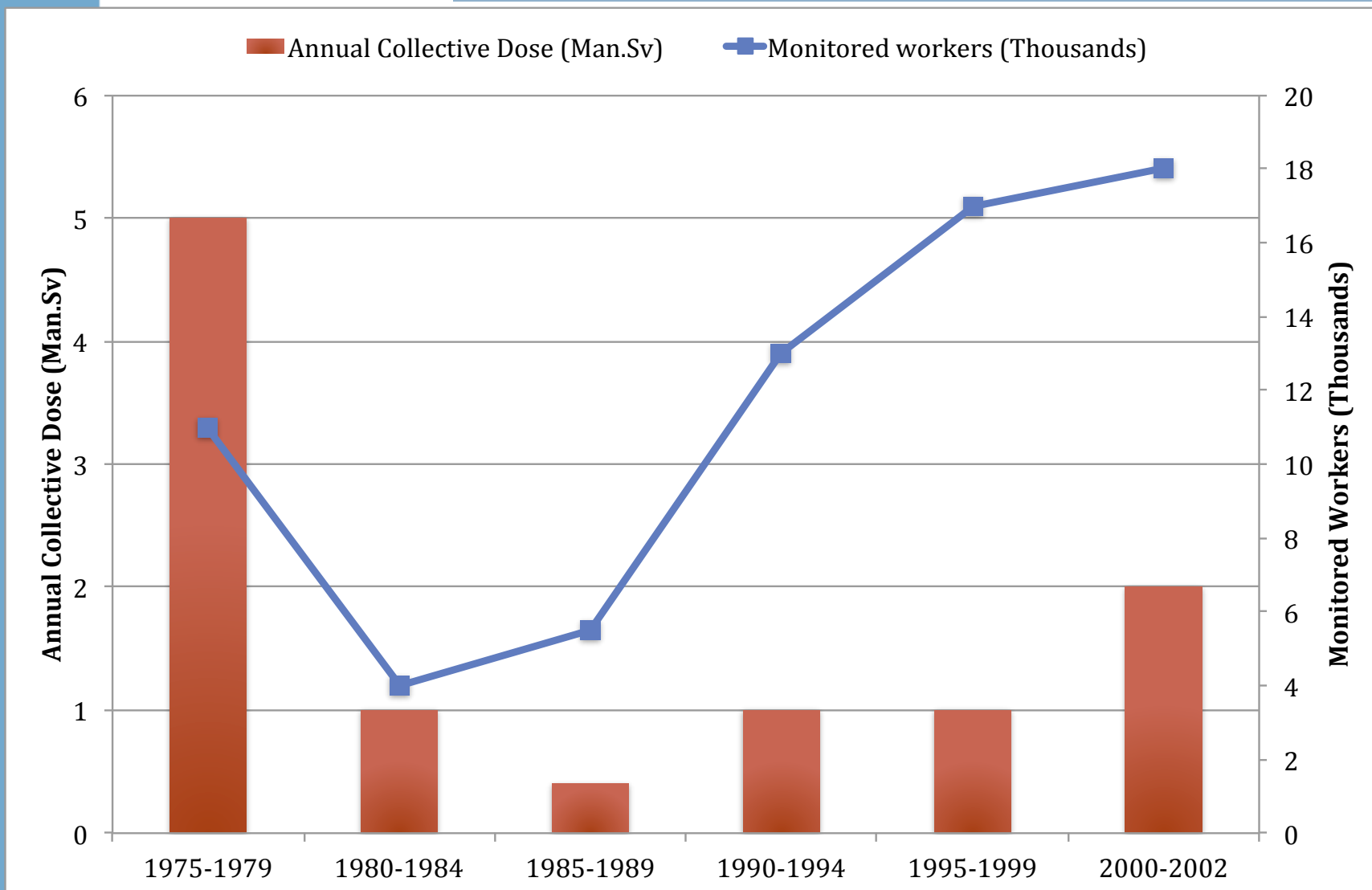
# Uranium mining UNSCEAR 2008



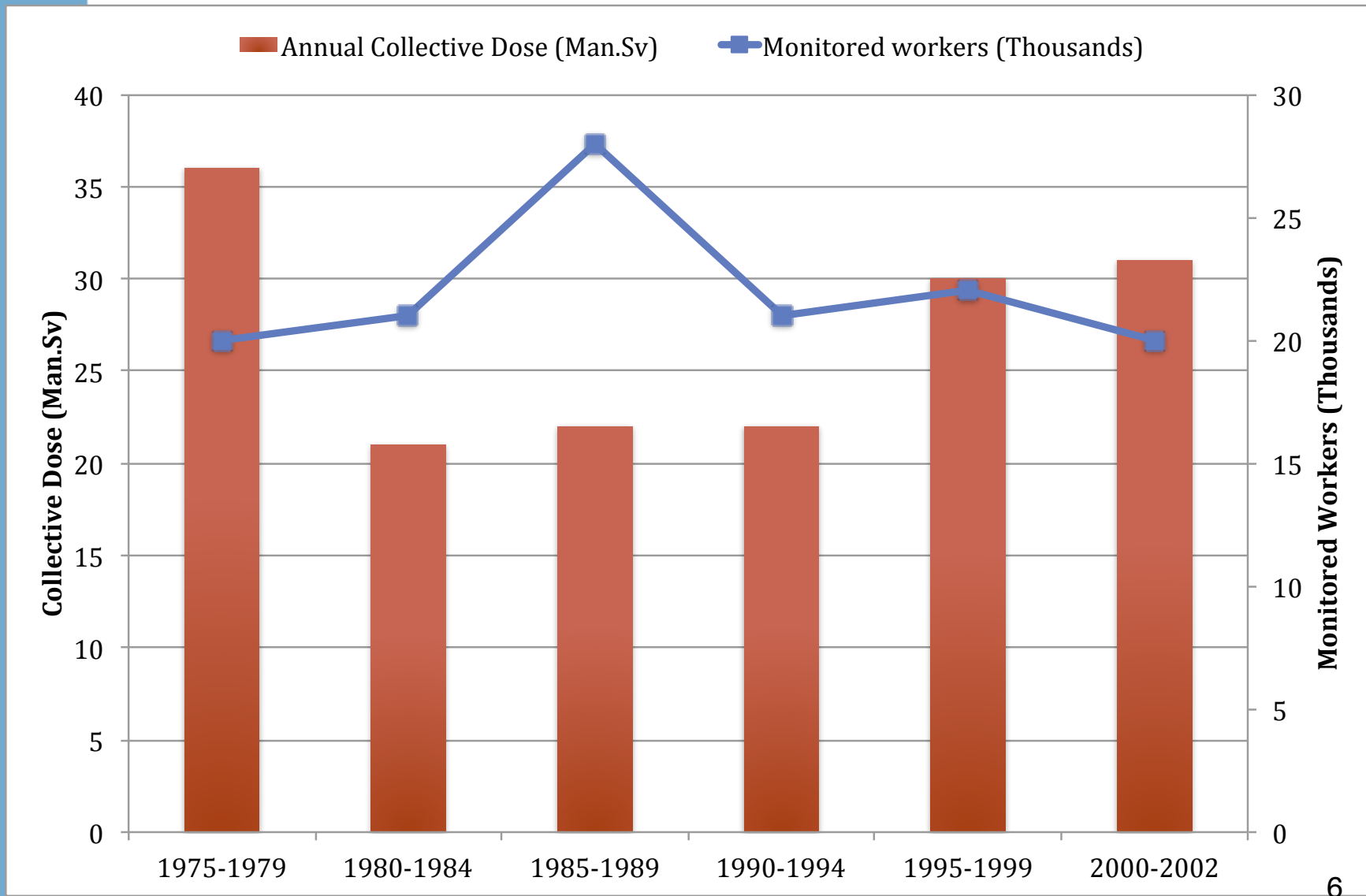
# Uranium milling UNSCEAR 2008



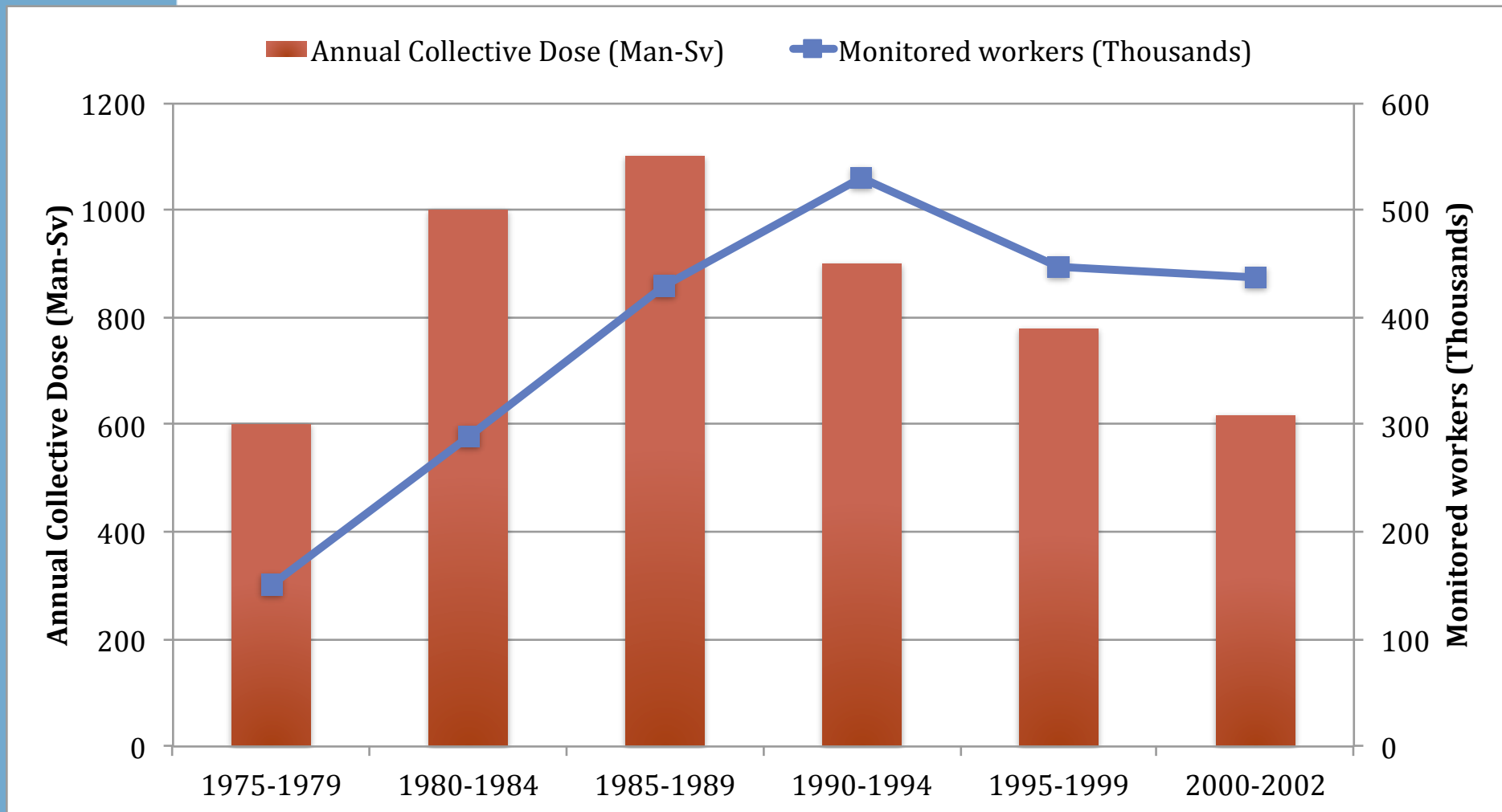
# Enrichment UNSCEAR 2008



# Fuel fabrication UNSCEAR 2008

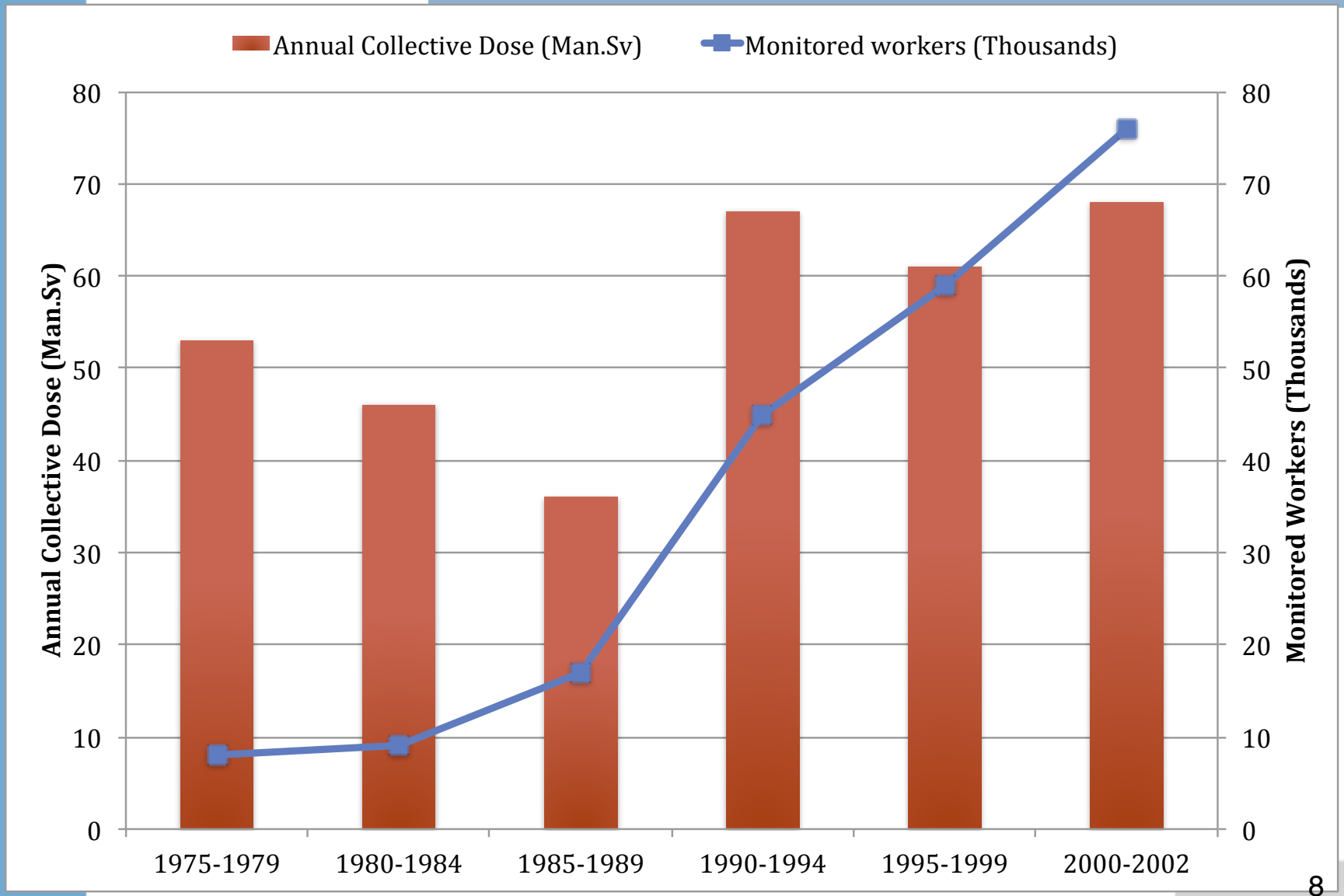


# Reactor Operation UNSCEAR 2008



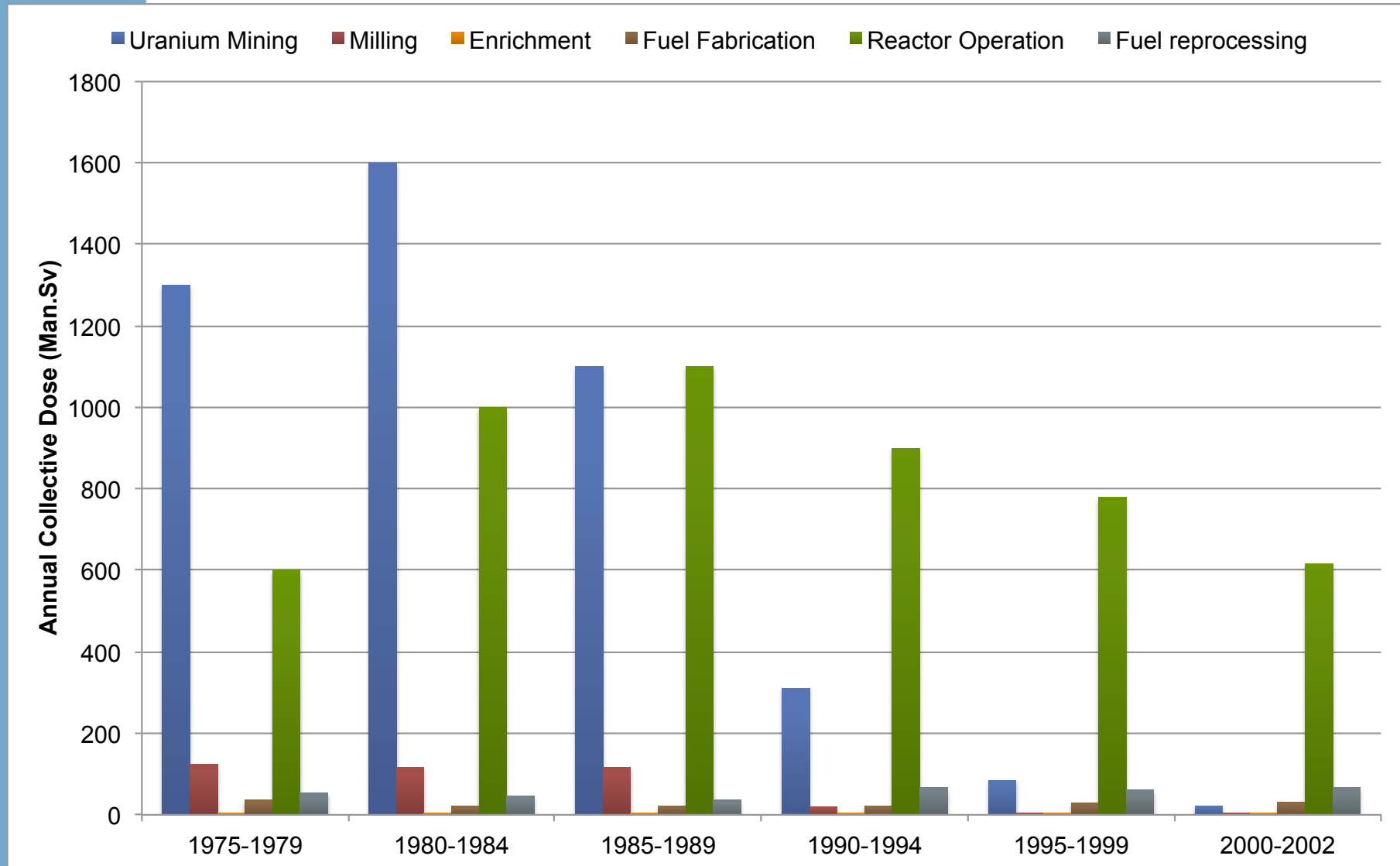


# Reprocessing UNSCEAR 2008

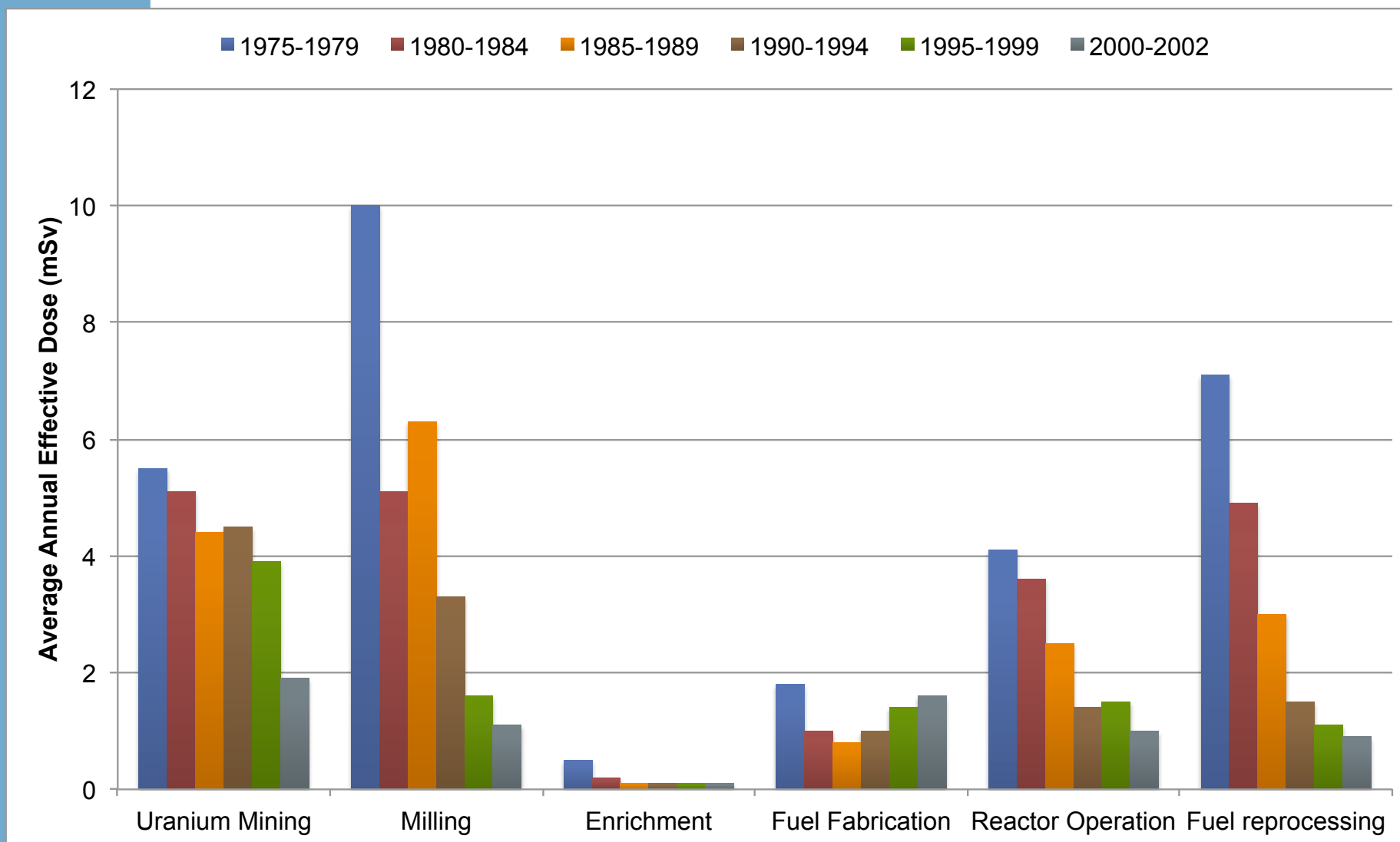


# Overview - Collective exposures

## UNSCEAR 2008



# Overview – Average individual dose UNSCEAR 2008



## General comment on UNSCEAR 2008

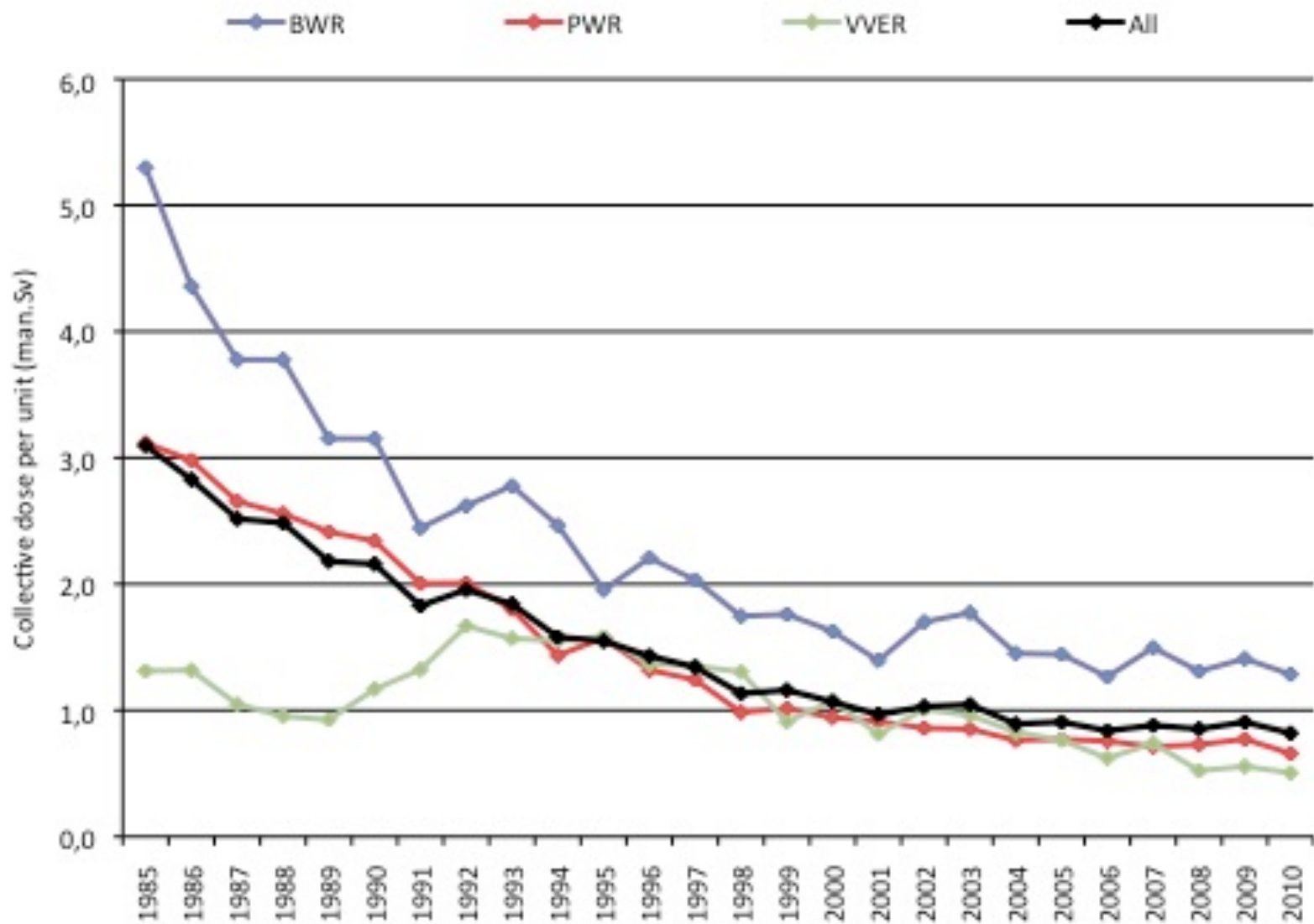
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- UNSCEAR 2008 data outline the following trends:
  - A general trend in the decrease of the average individual exposure.
  - Highest collective exposures associated with:
    - Uranium mining (a strong decrease is observed),
    - Reactor Operation.
  - Reactor Operation appears since the beginning of the 90ies to be the most important contributor to occupational collective exposure associated with the nuclear fuel cycle.

- The ISOE network - [www.isoe-network.net](http://www.isoe-network.net) - provides detailed information on occupational exposures of workers in NPP.
- These data help to analyse and detail the observed trends.

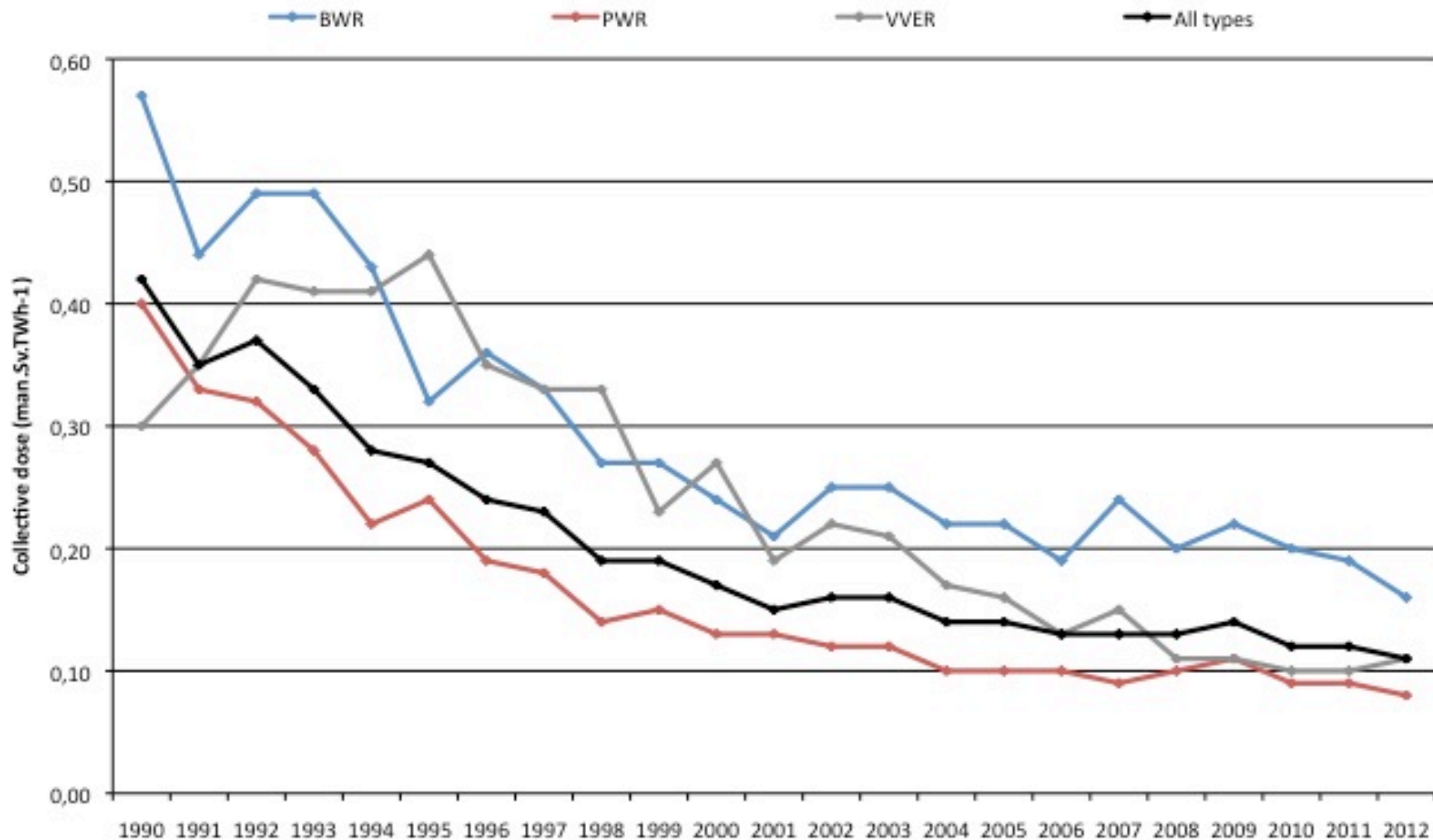
## Electricity generation – Collective dose / reactor

Data from the ISOE network



# Electricity generation – Collective dose / TWh

## Data from the ISOE network



- **A general decrease of occupational collective exposures:**
  - For various design of NPPs,
  - For normalized collective exposures (in man.Sv per TWh<sup>-1</sup>).
  
- **What is behind this trend?**
  - Evolution of the radiation protection system with ICRP Pub. 60:
    - Individual dose limit from 50 to 20 mSv.year<sup>-1</sup>, and
    - ALARA as a key requirement and driving force for the management of occupational exposures.
  - Feedback experiences,
  - NPP design improvements,
  - Etc.



- **Stakeholders involvement:**
  - Management,
  - Workers,
  - Authority.
  
- **Building capacities:**
  - Training and ALARA culture,
  - Sharing experiences.

- **Improvement of source term**, ‘If you decrease dose rate, then for the same task, you decrease dose’:
  - Monitoring program (follow trends and detect deviations - dose rate, CZT, gamma camera, etc. -),
  - Remediation (chemical decontamination),
  - Co source term reduction plan,
  - Zinc injection,
  - Steam Generator Replacement, etc.

- **New techniques:**
  - Remote Monitoring System,
  - Pool decontamination and cleaning,
  - Filters and resins for radioactive effluent treatment,
  - Etc.
  
- In addition to the management of collective exposure and in agreement with ALARA principle (and equity value),  
**focus on highest individual doses**

## Perspectives and future challenges (1)

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- Analysis of data from UNSCEAR and ISOE shows that collective and individual exposures have progressively decreased during the last decades.
- **ALARA programs** play a key role.
- **Networking** (IAEA, NEA, ISOE, IRPA, etc.) and **experience sharing** allow to 'still' improve (or at least maintain) our performances and are needed to face forthcoming challenges.

## Perspectives and future challenges (2)

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- Need to develop capabilities and skills in case of an **emergency situation** in order to reach ALARA objectives in such a context.
- Need to take into account (anticipate) evolutions of the RP system:
  - Lens of the eye,
  - New scientific evidences may lead to a review of the radiation detriment.

## Perspectives and future challenges (3)

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- Challenges for occupational exposures in NPP and other nuclear fuel cycle facilities :
  - **New ‘comers’:**
    - Feedback experiences to be taken into account, importance of networking activities,
    - Trained actors as a requirement to ensure that occupational exposures are ALARA (utility, national Authority, TSO, etc.).
  - **Operation:**
    - Massive departures of highly qualified workers may lead to a loss of experience if not sufficiently anticipated (How to maintain an effective RP culture?),
    - Increase of the operating life time of NPP and post-Fukushima related work leads to an increase of working time in controlled areas.

## Perspectives and future challenges (4)

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- Challenges for occupational exposures in NPP and other nuclear fuel cycle facilities :
  - **Dismantling:**
    - Need to develop an industrial approach of nuclear facilities dismantling taking into account:
      - Radiation protection - contamination and alpha risk management -,
      - Industrial safety,
      - Radioactive waste management.



## 2015 ISOE International ALARA Symposium

Rio de Janeiro, Brazil, 26-28 May, 2015



[www.isoe-network.net](http://www.isoe-network.net) & IAEA webpage on ORPNET





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**Thank you for your attention**