

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

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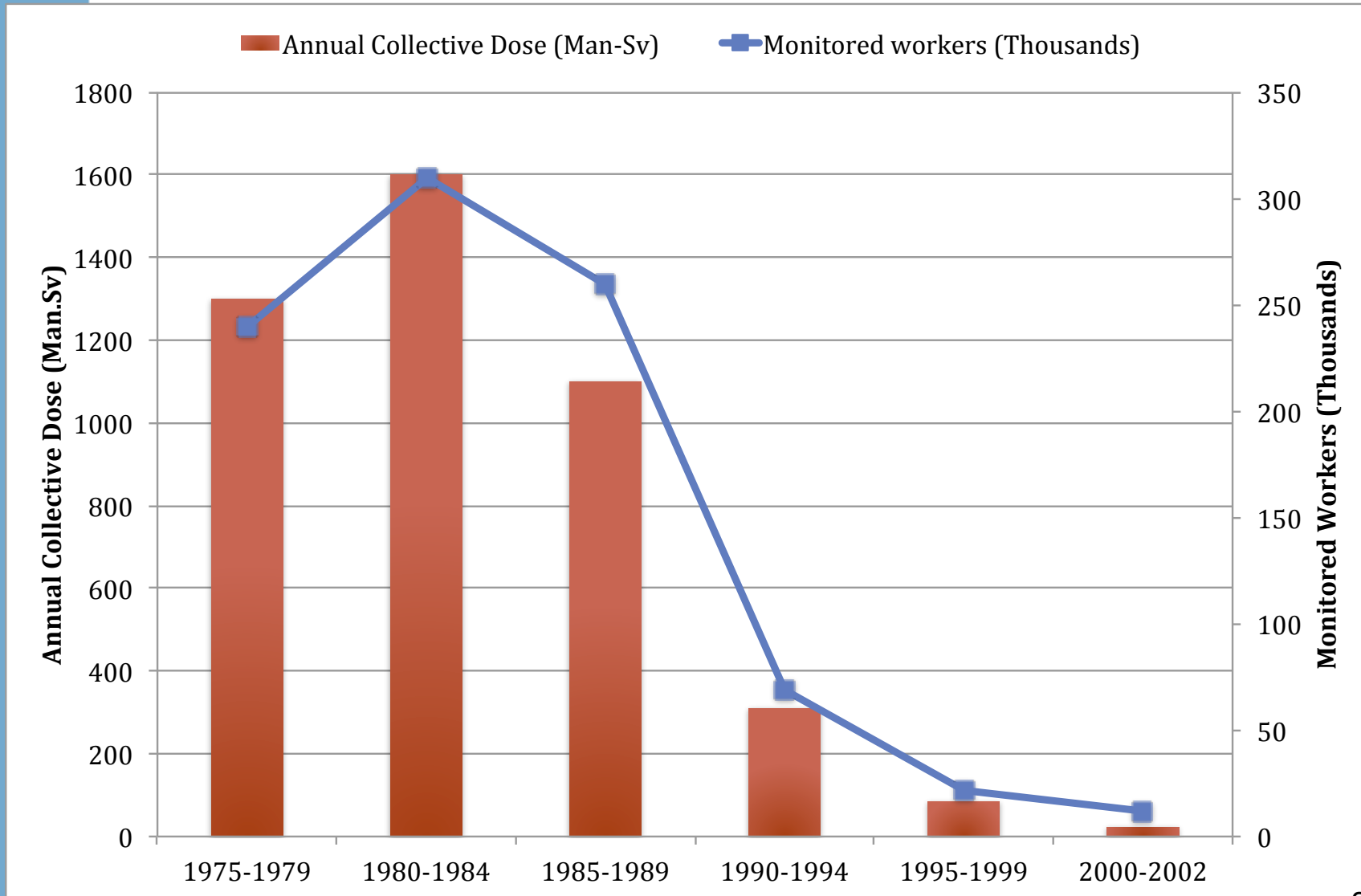
- Global overview of occupational exposures trends in nuclear facilities based on UNSCEAR latest data.
- Focus on Nuclear Power Plants based on data from the International System on Occupational Exposure (ISOE).
- Discussion.
- Perspectives & future challenges.

- 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.

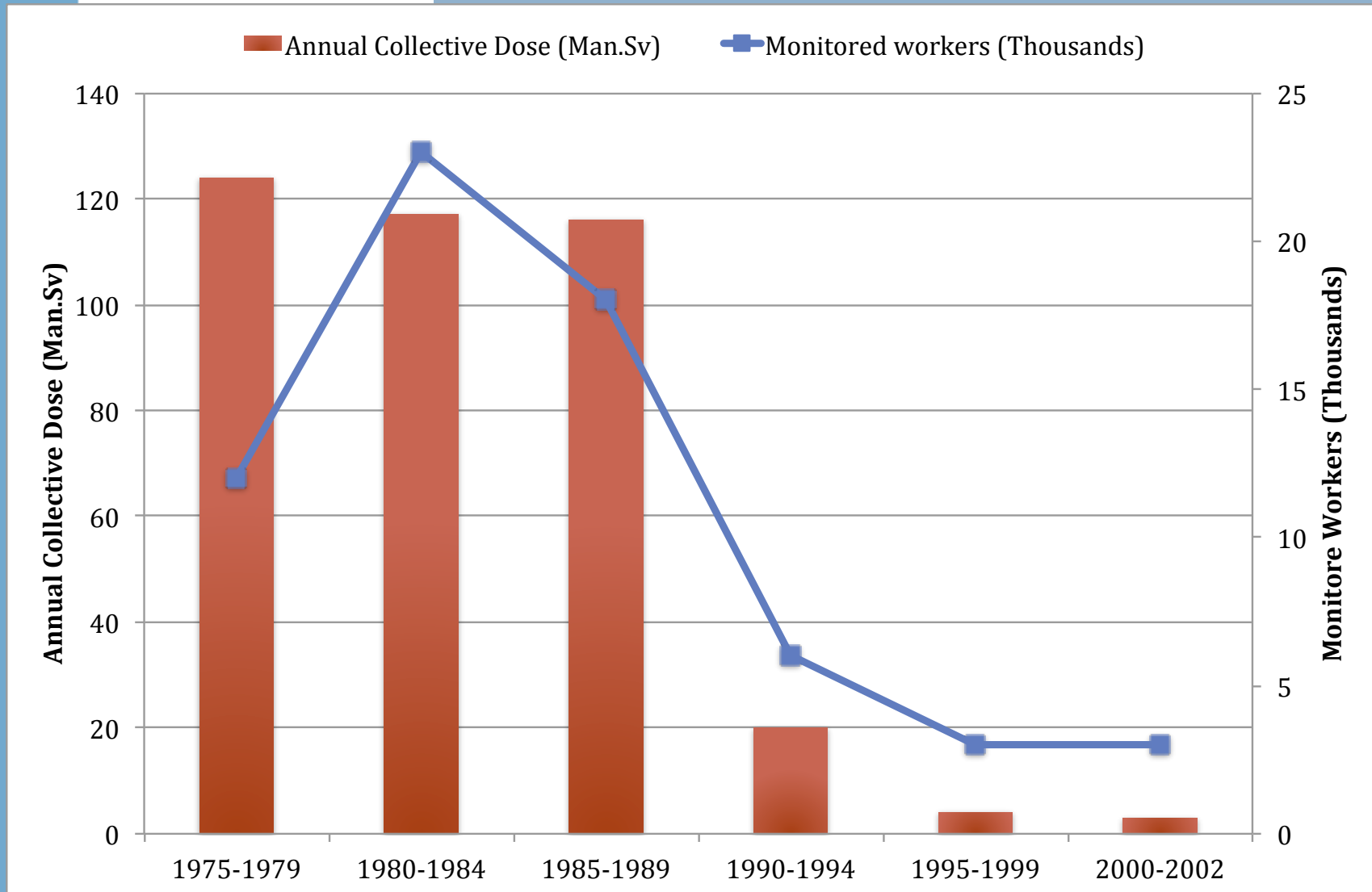
- Data on:
 - Uranium mining,
 - Uranium milling,
 - Enrichment,
 - Fuel fabrication,
 - Electricity generation,
 - Reprocessing.

- Including:
 - Collective exposure,
 - Number of monitored workers.

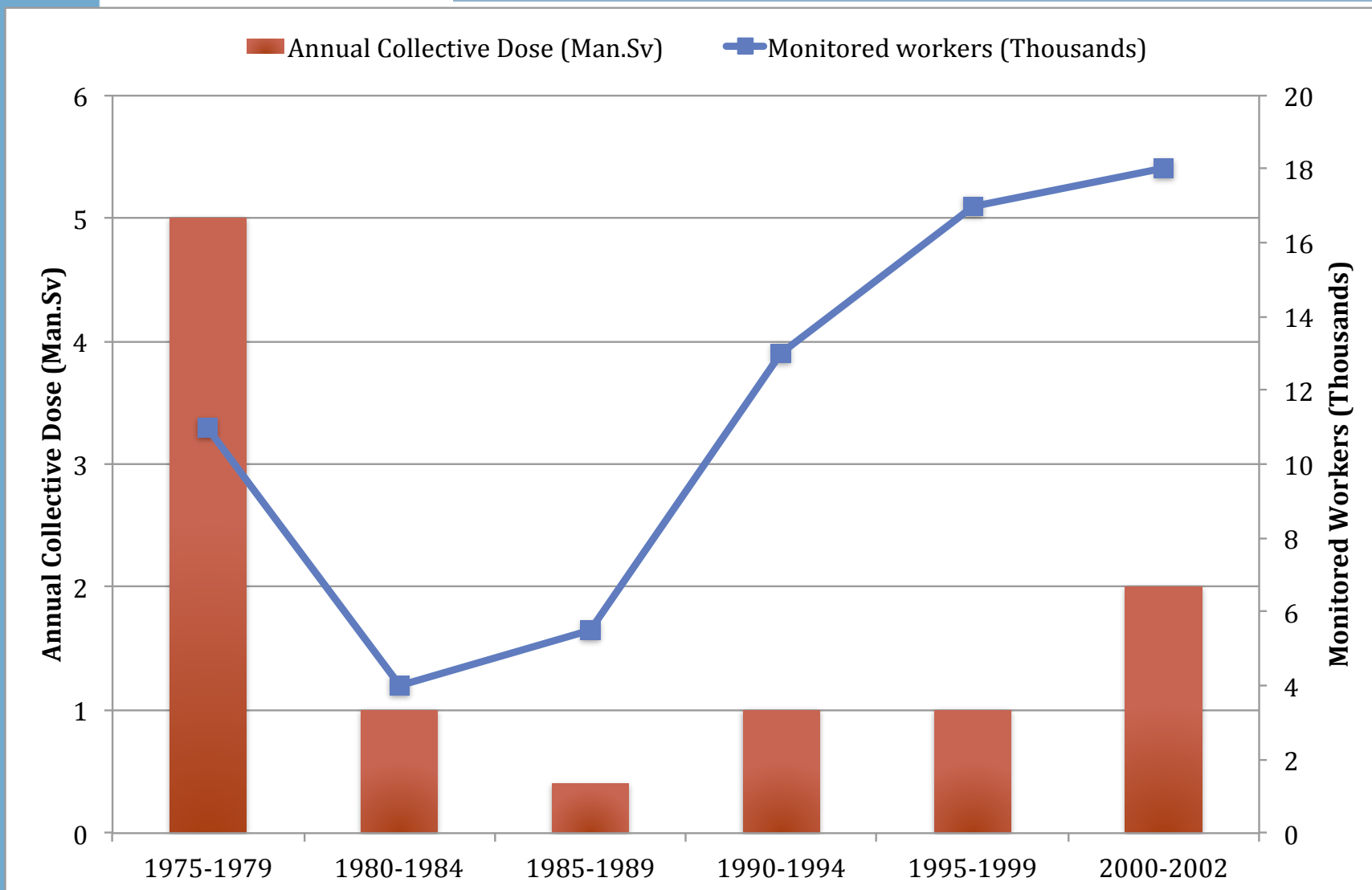
Uranium mining UNSCEAR 2008



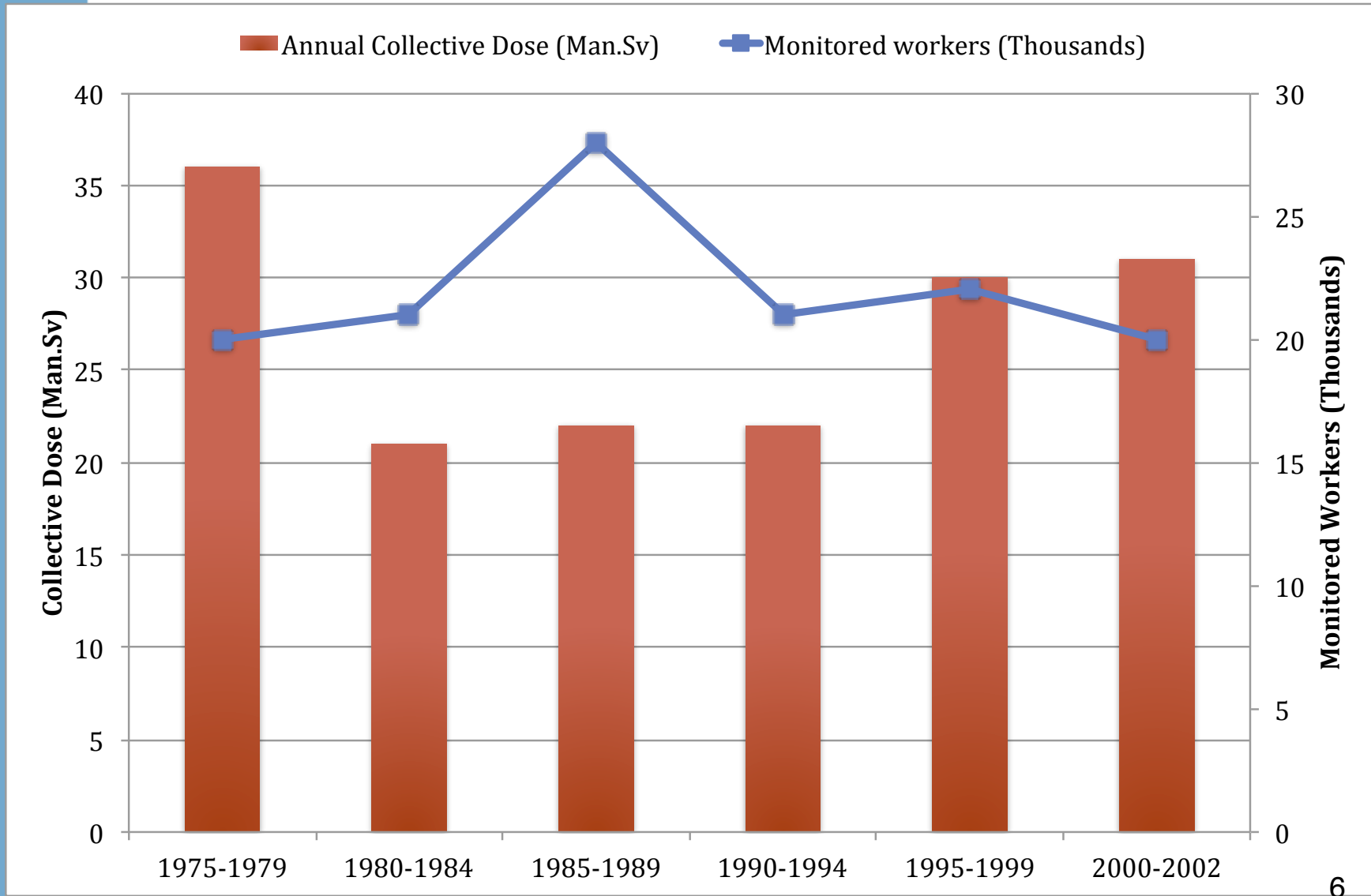
Uranium milling UNSCEAR 2008



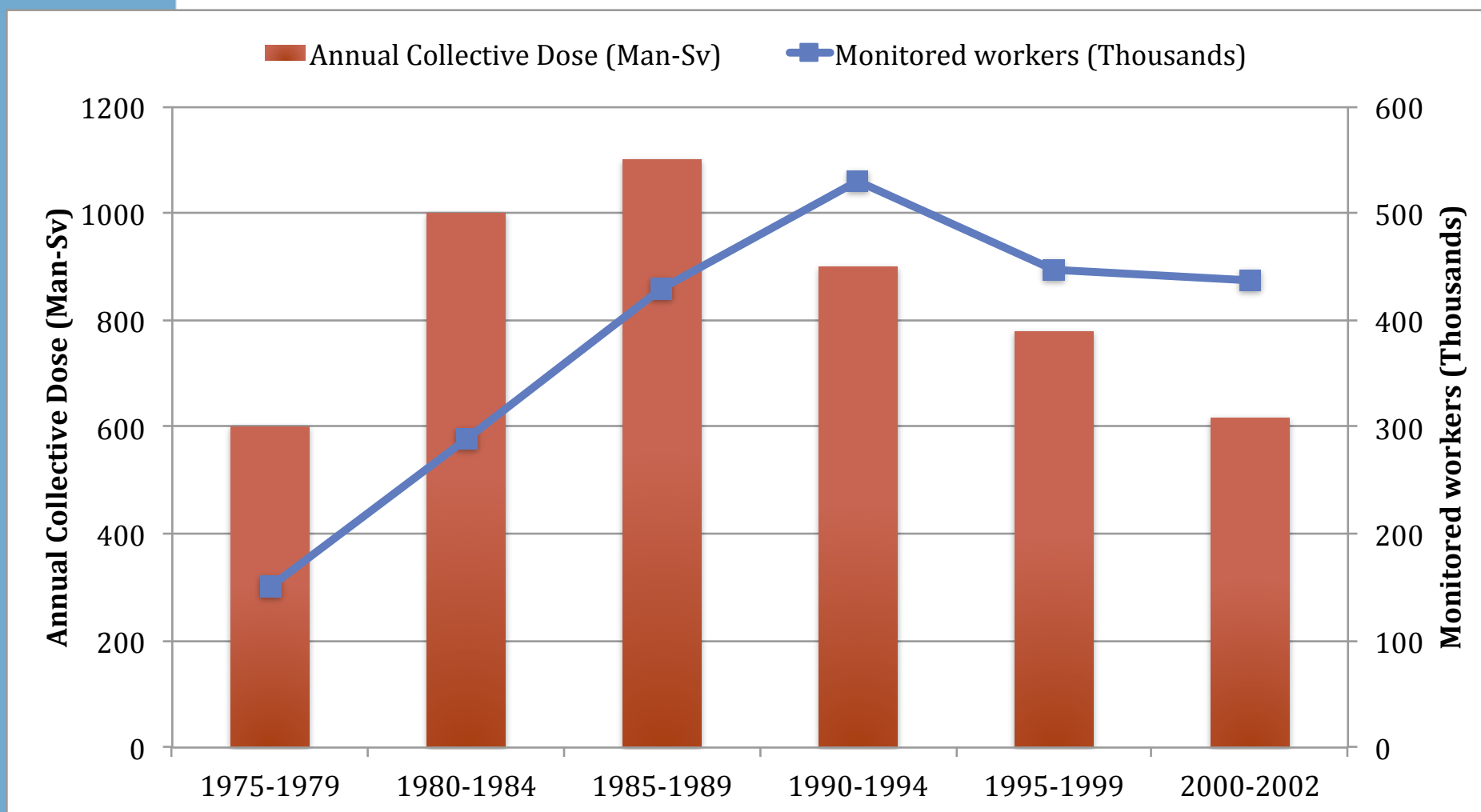
Enrichment UNSCEAR 2008



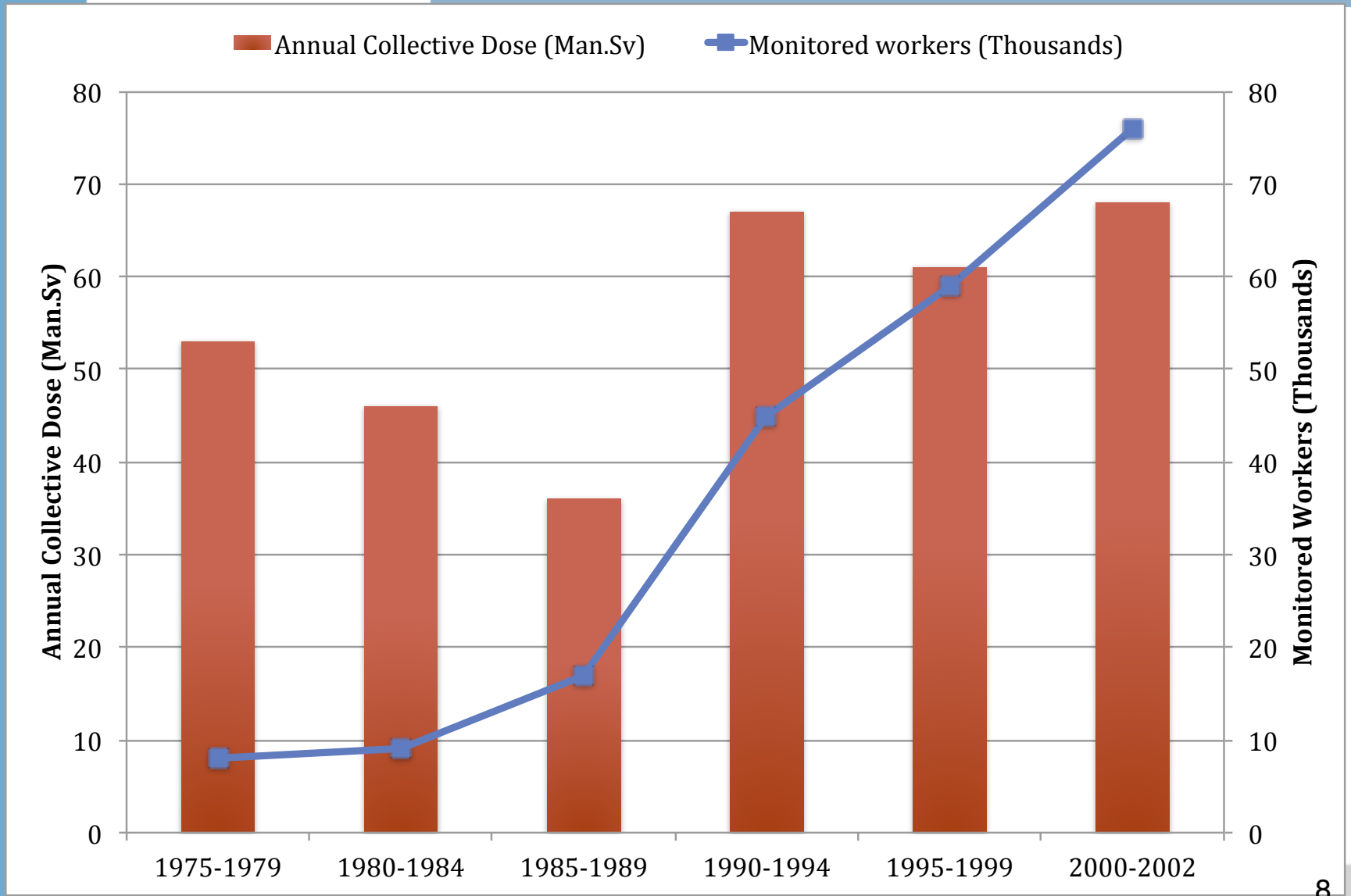
Fuel fabrication UNSCEAR 2008



Reactor Operation UNSCEAR 2008

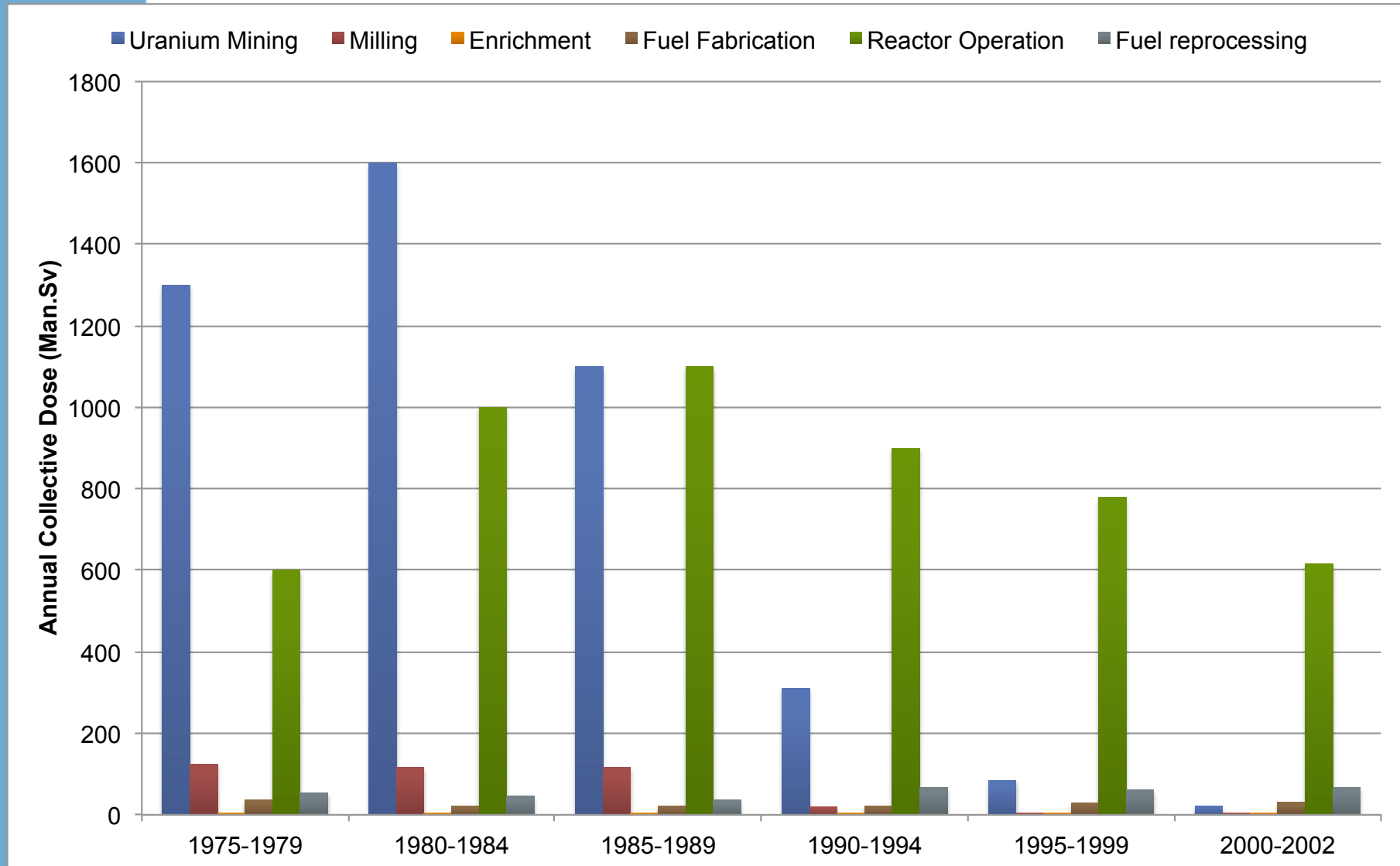


Reprocessing UNSCEAR 2008

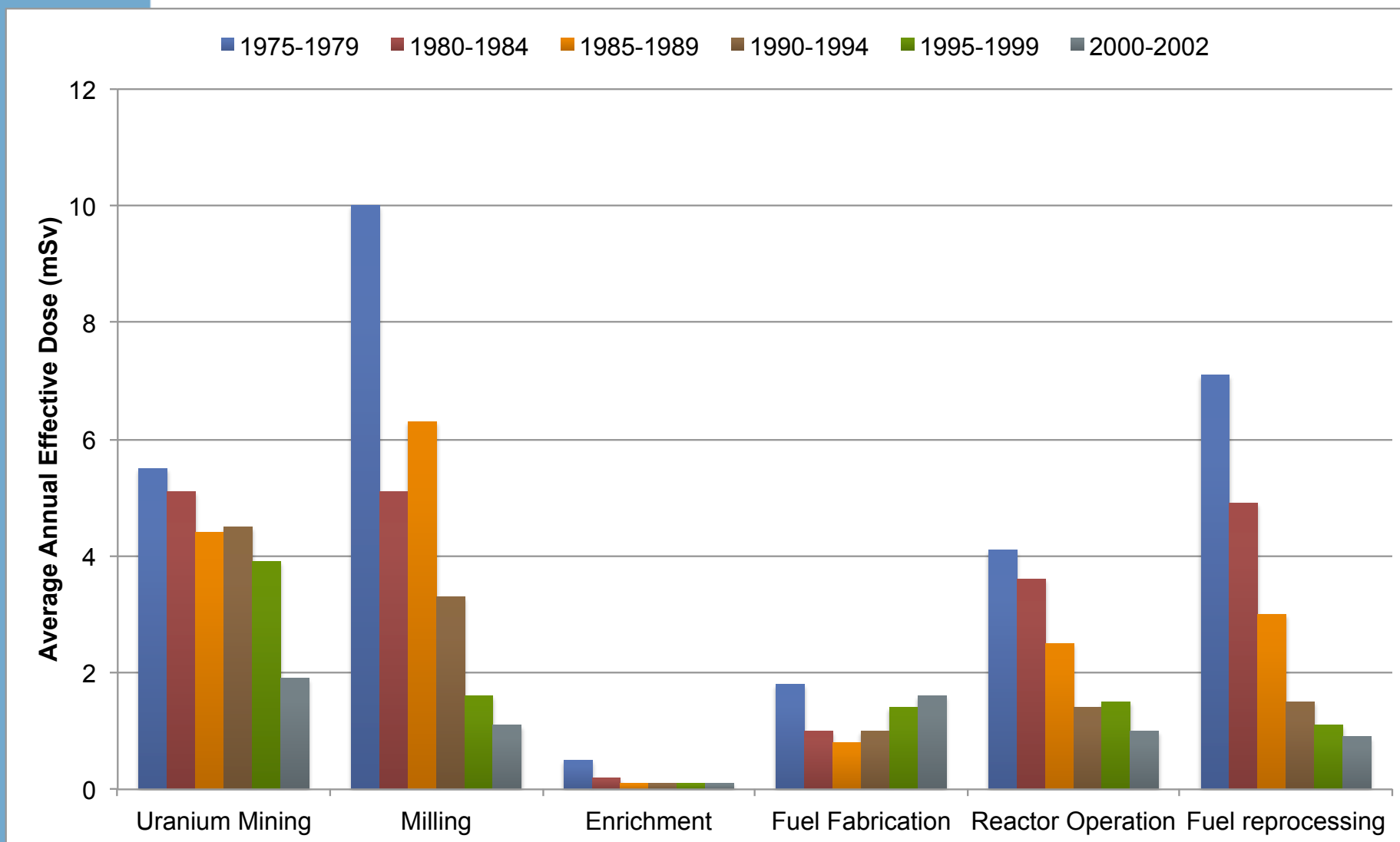


Overview - Collective exposures

UNSCEAR 2008



Overview – Average individual dose UNSCEAR 2008



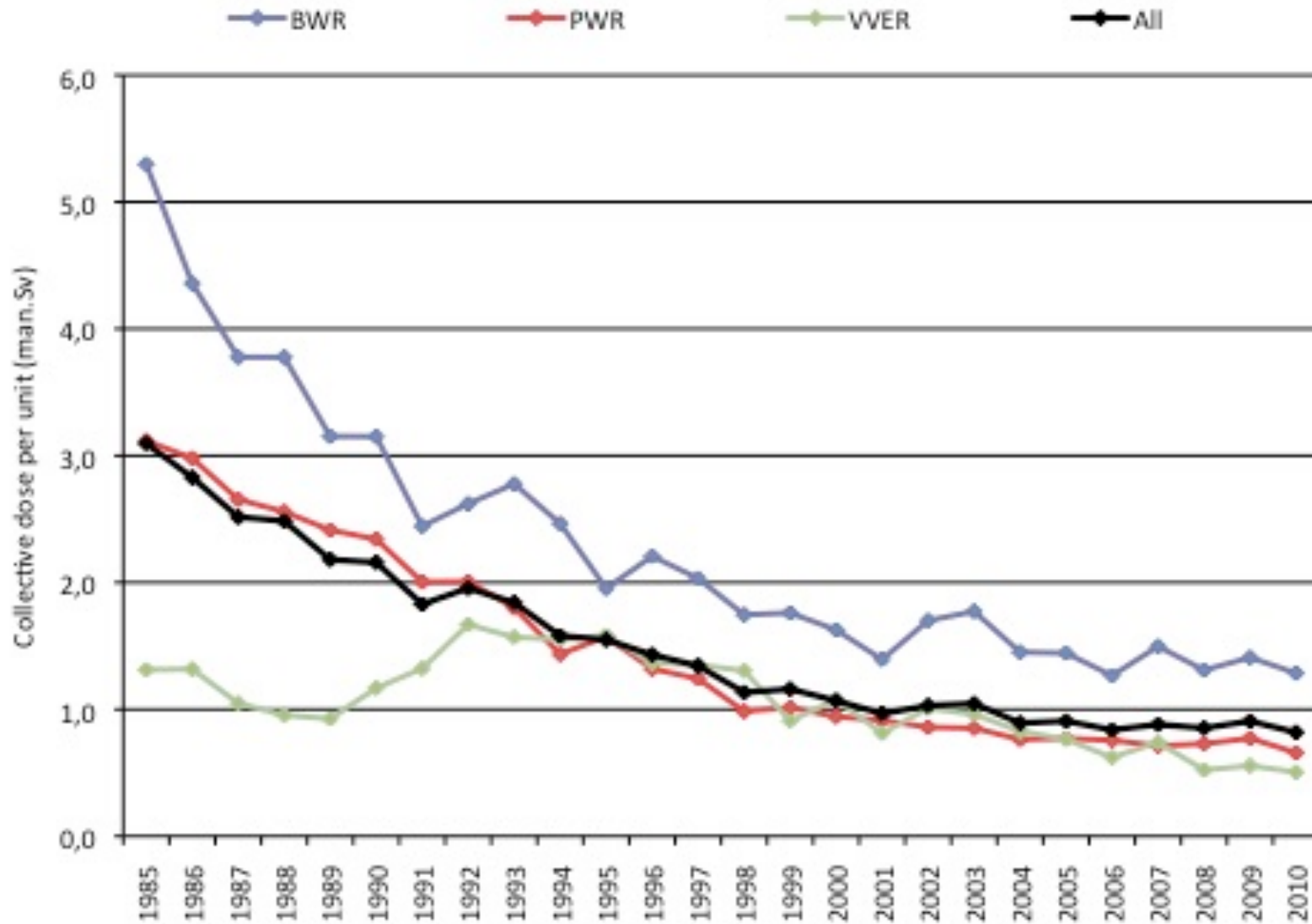
General comment on UNSCEAR 2008

- 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 - provides detailed information on occupational exposures of workers in NPP.
- These data help to analyse and detail the observed trends.

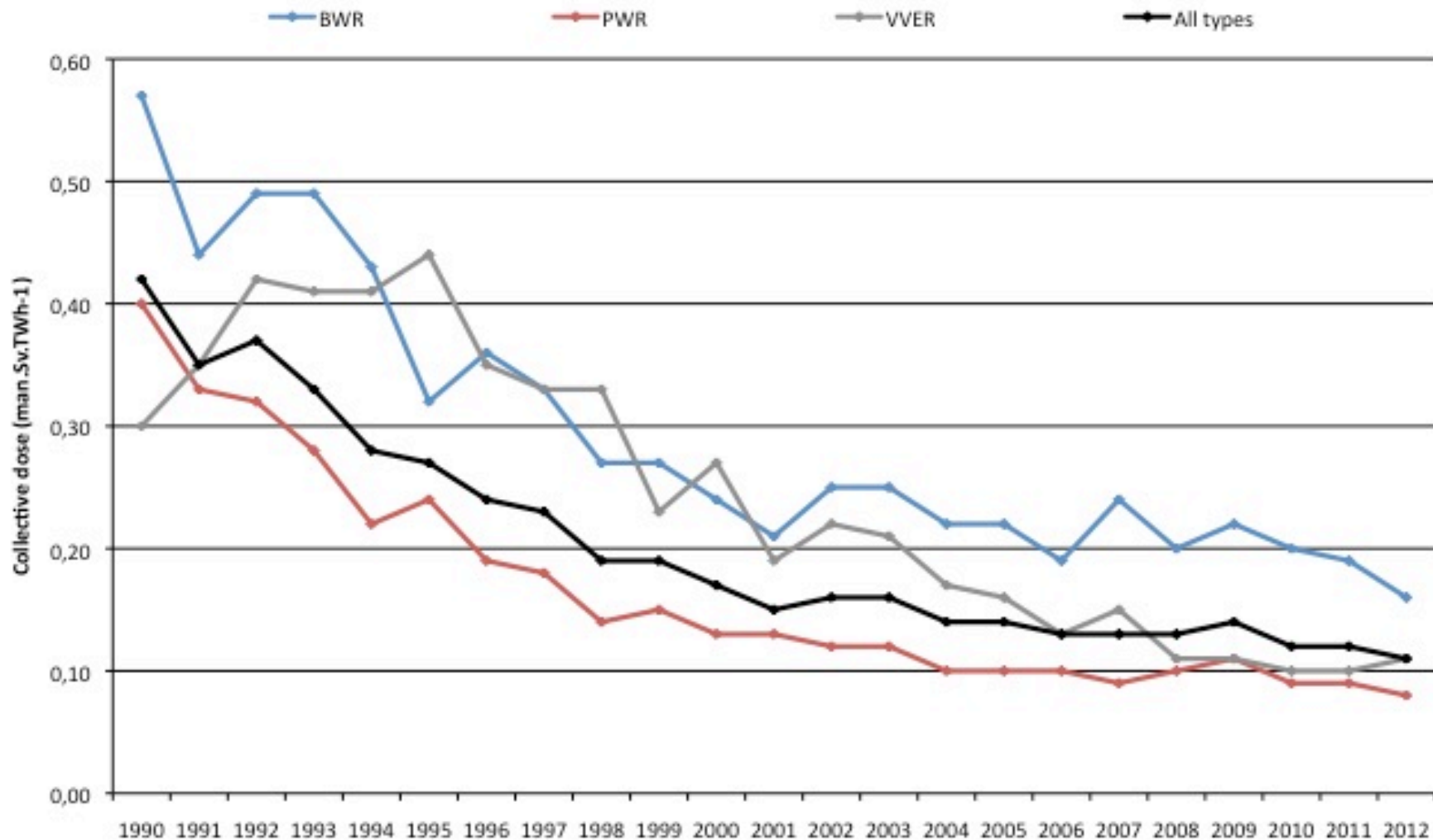
Electricity generation – Collective dose / reactor

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⁻¹).

- **What is behind this trend?**
 - Evolution of the radiation protection system with ICRP Pub. 60:
 - Individual dose limit from 50 to 20 mSv.year⁻¹, 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.

Electricity generation ALARA in NPP (2)

- **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)

- 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)

- 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)

- 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)

- 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.



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www.isoe-network.net & IAEA webpage on ORPNET



CEPN

Thank you for your attention