Doses in Industrial Radiography in Europe

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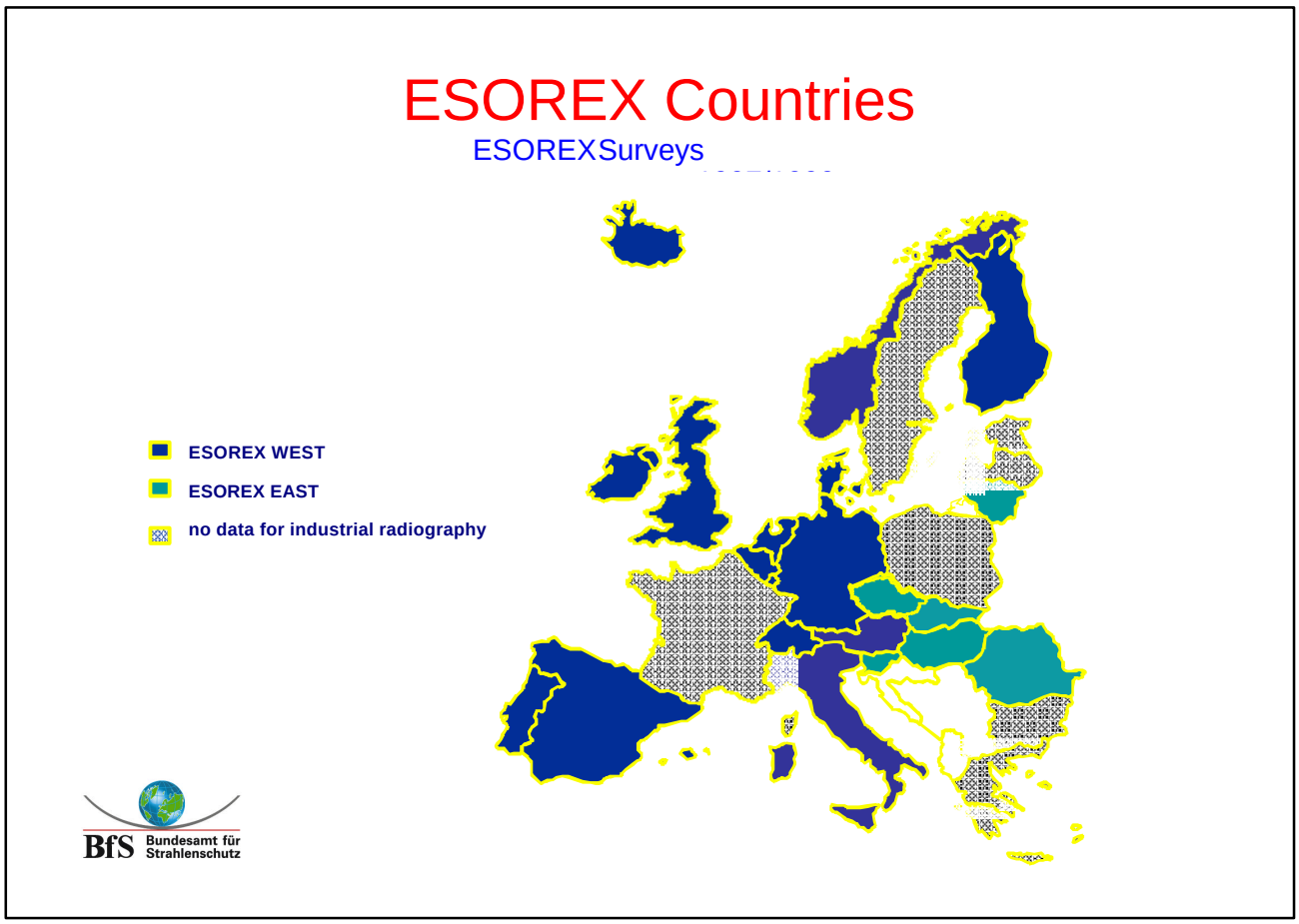
The ESOREX project was initiated by the EC DG XI and is executed by the BfS/Germany. The acronym stands for "European Studies of Occupational Radiation Exposure". One intention of the ESOREX surveys[1] is to assemble national dose statistics of radiation workers in 28 Eastern and Western European States in order to give a comparable, descriptive overview. In this paper, dose statistics for industrial radiography are presented.

National data bases

In 21 of the 28 ESOREX countries doses from occupational radiation exposure are recorded in central registers or dosimetric services. France and Sweden run central registers only for their nuclear power workers. The remaining countries have plans or are about to develop central registration systems. The statistics calculated in ESOREX are based on the aggregated national dose data of workers who are officially classified as occupationally radiation exposed.

Fig 2: European countries with data on industrial radiography



By producing comparable European statistics with aggregated data from the various national data bases several difficulties occur:

- different semantic characterisations of the radiation work,
- different minimum recording levels
- different dose bands,
- different dose reporting and recording cultures.

The difficulties can partly be overcome by looking for the "best common denominator" among the various national workers classification systems, minimum recording levels and dose bands. But compromises had to be made and when interpreting the statistical results one should be aware of this.

Workers characterisation of radiation work

For the ESOREX statistics it was necessary to construct a common system of workers characterisations based on the existing national classification systems. This approach lead to five work sectors with various sub-categories in each sector. It shows many similarities to the classification scheme suggested by UNSCEAR[2] and is also quite alike to that one used in a previous survey executed by NRPB[3]:

- Nuclear Industry,
- Medicine,
- General Industry,
- Education, Research, Safety Inspection,
- Natural Radioactivity.

Tab 1: Radiation Workers and Doses in Europe - All Occupations

	Workers monitored	Workers (H > MRL) [%] 1)	Coll. Dose [man-Sv]	Median (H > MRL) [mSv/a]	Mean ± SD (H > MRL) [mSv/a]
ESOREX WEST 18 countries 2)	870.758	28%	367	1,3	1,5 ± 1,2
ESOREX EAST 9 countries 3)	109.110	67%	115	1,6	1,6 ± 0,8
ESOREX EUROPE	979.868	32%	482	1,5	1,5 ± 1,1

1) MRL = Minimum recording level, mainly 0.1 mSv, in some countries between 0.2 and 0.5 mSv 2) Data mainly form 1995 3) Data mainly form 1997

In Europe, about 1 Mio. workers are classified as occupationally radiation exposed and regularly monitored. 1/3 of them receive doses above the minimum recorded level. These doses add up to a collective dose of nearly 500 man-Sv/a. 90 % of the labour force work in the European Union, Iceland Norway and Switzerland.. The others live in the Central and Eastern European countries Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia.

The big difference between East (67%) and West (28%) in the fraction of people who receive doses above MRL does not reflect a major difference in radiation protection levels. In some Western Countries (and especially in Germany) many employers get their category B-workers monitored just for proving evidence that there was no exposure during the monitoring period. The average doses are only about 20% higher in East than in West.

Work sector General Industry

The sub-categories that represent the work sector „General Industry“ include:

- Accelerator operation (except medical use or university research),
- Chemical industry,
- Industrial radiation,
- Industrial radiography
- Luminizing,
- Radiochemical manufacture (production of radioactive isotopes, pharmaceuticals, labelled compounds and tracers for industrial, medical and research purposes),
- Transport (radioactive material (off-site work), security checks at airports, boards etc.)
- Other uses.

The production and transport of nuclear reactor fuel is not included in this work sector but in the sector “Nuclear Industry”.

Tab 2: Radiation Workers and Doses in Europe - General Industry

	Workers monitored	Workers (H > MRL) [%] 1)	Coll. Dose [man-Sv]	Median (H > MRL) [mSv/a]	Mean ± SD (H > MRL) [mSv/a]
ESOREX WEST 18 countries 2)	181.939	17%	56	1,4	1,8 ± 2,3
ESOREX EAST 9 countries 3)	7.483	60%	6	1,9	1,3 ± 1,2
ESOREX EUROPE	189.422	19%	62	1,4	1,6 ± 2,0

1) MRL = Minimum recording level, mainly 0.1 mSv, in some counties between 0.2 and 0.5 mSv 2) Data mainly form 1995 3) Data mainly form 1997

With 96%, Western Europe dominates the number of monitored workers in the general industry. There is a clear difference between the Eastern and Western European countries in the distribution of their average annual doses. In Western Europe the mean value is higher (1,8 mSv/a) than the median (1,4 mSv/a). This is because of an outlayer (which also extends the standard deviation to 2,3). In Eastern Europe the situation is the other way round. Here, the median values serve better to describe the differences in the average annual exposures between East (1,9 mSv/a) and West (1,4 mSv/a).

Industrial radiography

Industrial radiography plays a dominant role not only within the work sector "General Industry" but also among all radiation work. The reason lies in its unique set of work characteristics and risks:

- strong sources are handled in industrial gamma-radiography,
- mobile radiography is carried out on the site and often under difficult local conditions,
- the surveillance by radiation protection officers is often poor,
- the same accounts often for the maintenance of the equipment,
- safety culture is less developed than in other occupational branches,
- accidents with sources may affect also other people and public domain.

In spite of this peculiar risk situation, there is no public risk perception and attention compared to that related to nuclear work. But within the international community of radiation protectors, industrial radiography is a topic throughout all the years. Do the dose statistics reflect this specific risk characteristic?

In Western Europe, we cannot see differences if we look only at the central tendency (median and mean) of dose distributions. The values do not differ very much from those in general industry or in all occupations. It is different in Central and Eastern Europe. Here, the average annual doses are with 2,3 mSv clearly increased. Enhanced average doses in industrial radiography are not characteristic for all states, but high values can be found in single States in East (e.g. 3,8 mSv, Lithuania) as in West (e.g. 3.0 mSv, Germany).

Tab 3: Radiation Workers and Doses in Europe – Industrial Radiography

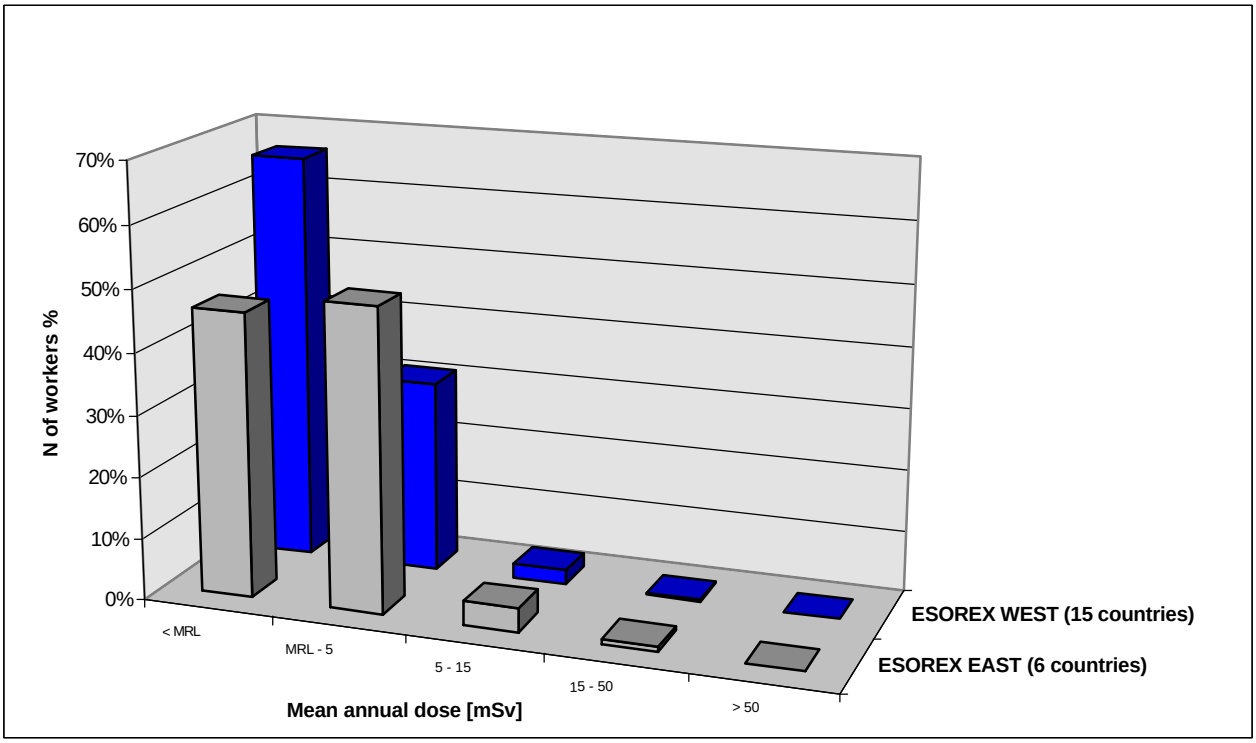
	Workers monitored	Workers (H > MRL) [%] 1)	Coll. Dose [man-Sv]	Median (H > MRL)	Mean ± SD (H > MRL) [mSv/a]	Highest mean of a country (H > MRL) [mSv/a]
ESOREX WEST 15 countries 2)	15.324	34%	7	1,4	1,3 ± 0,7	3,0
ESOREX EAST 6 countries 3)	2.748	54%	3	2,2	2,3 ± 0,9	3,8

ESOREX EUROPE	18.072	37%	10	1,7	1,6 ± 0,9	3,8

1) MRL = Minimum recording level, mainly 0.1 mSv, in some counties between 0.2 and 0.5 mSv 2) Data mainly form 1995 3) Data mainly form 1997

The Council Directive 96/29 EURATOM has lowered the annual dose limit of occupational exposure from 50 mSv/a to 20 mSv/a. This new limit is no specific challenge for radiation protection. 99 % of the industrial radiographers in the Eastern and Western ESOREX countries receive doses below 15 mSv/a. When we look at the dose distributions we see differences between East and West mainly in the dose ranges below 5 mSv, which results from the greater amount of category-B workers in the West.

Fig 2: Dose distribution in industrial radiography



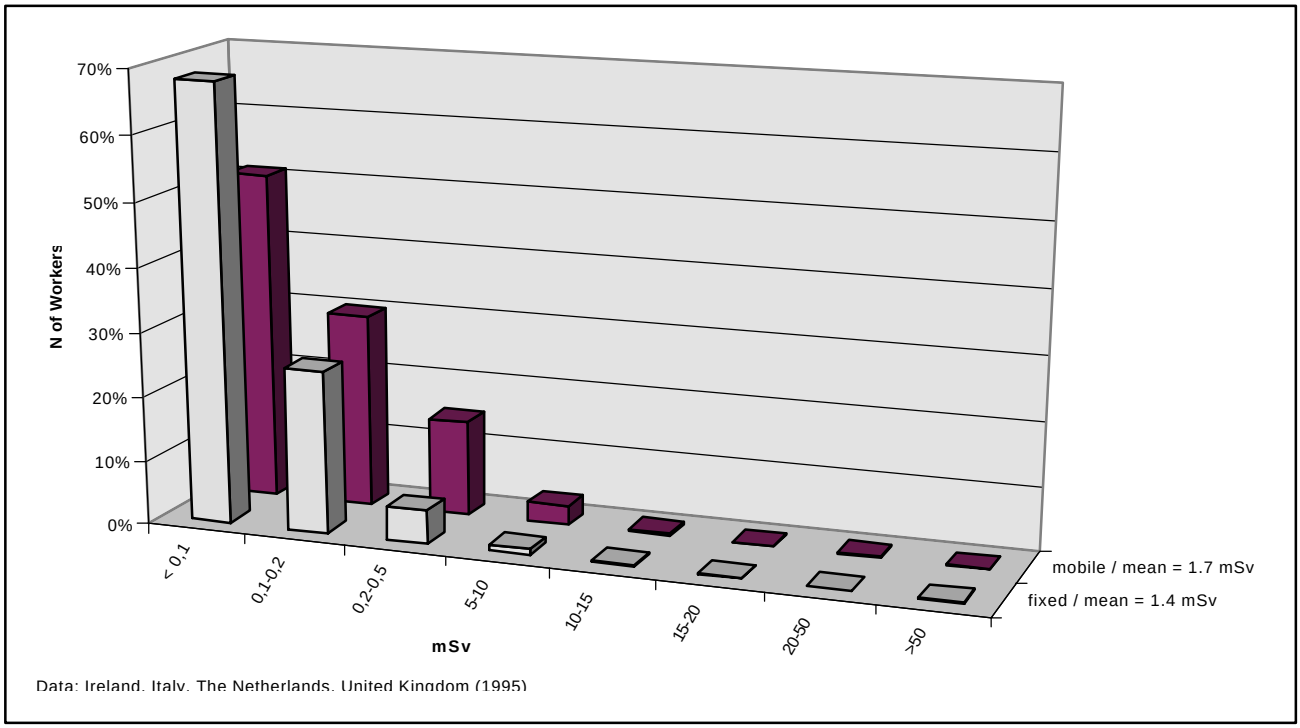
Industrial radiographers are a small group of 2 % among 1 Mio. radiation workers in Europe. Their mean annual doses are above the average.

In all radiation related occupations overexposure (i.e. high annual doses >50 mSv) is a seldom incidence. It happens only to one among 10,000 workers per year. But in industrial radiography, these overexposures occur three times more than in all other radiation work.

The statistical findings of this European comparison of doses in industrial radiation do not appear dramatic and there is no need to be generally alarmed. But there is room for optimisation and

ALARA. This applies especially to certain countries with increased average doses and to steps in order to reduce the number of incidences with high exposures and dose limit exceeds.

Fig 3: Dose distribution in fixed and mobile radiography



Only a few countries distinguish between fixed and mobile radiography when registering doses. Differences in the dose distribution as well as in the average doses are visible. But with mean values of 1.7 mSv in mobile radiography and 1.4 mSv in the category “fixed”, the differences are not so intensively as one would expect.

Tab 3: Occupational Radiation Exposure in Europe

	Monitored Workers	Workers with Doses > MRL	Mean Dose [mSv/a]	Exceeds [> 50 mSv/a]
All Occupations	≈ 1 Mio.	32 %	1.5	1 / 10,000
General Industry	≈ 200,000	19 %	1.4	1 / 10,000

Industrial Radiography	≈ 20,000	37 %	1.7	3 / 10,000

Apart from the statistical evidence of the recorded data, we should take into account that maybe not all exposures have been measured, reported or recorded. Furthermore, the given data refer solely to person doses. Common European data about partial body exposure are currently not yet available.

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References

[1] ESOREX - European Study of Occupational Radiation Exposure - initiated by the EC DG XI and executed by the BfS/Germany. The ESOREX project consists of surveys executed in the 28 European states. The study provides comparable descriptions of the national administrative structures used to monitor and register individual occupational radiation exposure and the national dose statistics. It shall lay the basis to identify the differences between the states and to analyse the possibilities for a European harmonisation.

[2] UNSCEAR 2000 Report to the General Assembly with Scientific Annexes: Sources and Effects of Ionizing Radiation; Vol 1; Annex E: Occupational Radiation Exposures; United Nations New York, 2000

[3] C.E. McDonnel, J.R. Croft, R.H. Atkinson, M.L. Hyde: Assessment of occupational exposures to ionising radiation of workers in the Member States of the European Communities, NRPB, Chilton 1993.