

# Industrial Radiography in Denmark

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This paper presents an overview of industrial radiography (IR) in Denmark: A brief history of IR, legislation and recorded doses to individually monitored industrial radiographers from 1970 to 2000.

## **HISTORY**

On 15 April 1930 Law no. 147 concerning the use of X-rays etc. was passed, and on 31 March 1953 came Law no. 94 on the use etc. of radioactive substances. Industrial radiography using X-rays was performed already before World War II, and the first authorisation for gamma radiography was given in 1953, covering the use of a 13 GBq Ir-192 source. In pursuance of these laws two orders concerning industrial radiography were issued, both on 24 May 1984, Order no. 307 on industrial X-ray installations etc. and Order no. 308 on industrial gamma ray installations. These orders are still in force. At present 22 companies hold authorisation to perform IR, and they have at their disposal a total of 418 approved and registered equipments, see Table 1.

## **LEGISLATION**

Companies working with IR, hereunder companies, which are servicing radiographic equipment and replacing radiographic sources, must assign a supervisor in charge of each X-ray and gamma radiography installation. The qualifications of the assigned supervisor must be given to NIRH for approval. The necessary training must include a course in radiation safety with special attention on IR. NIRH offers relevant courses and follow-ups. In regard to staff involved in IR, it is common practice that they also attend these courses, but it is the sole responsibility of the supervisor that they receive sufficient training and instructions. It is the responsibility of the supervisor to ensure that the radiography installation and equipment is properly maintained, and checked at least once a year by an authorized company. Apparatus for gamma radiography must be approved before purchase and radioactive sources and X-ray equipment have to be registered. The registration and licensing are accomplished at NIRH.

Inspections are made by NIRH on a regular basis to ensure that working procedures fulfils the regulations, and that the condition of all the registered equipment is properly maintained.

## **DOSES**

All staff working with radiography equipment shall always wear a personal dosimeter and carry instruments giving acoustic warning signals. Since 1968 individually doses evaluated with film badges have been recorded by NIRH. Figure 1 shows the annual collective effective doses and the number of radiographers monitored per year. The average effective doses to radiographers are shown in figure 2. It is seen that since 1987 these doses have been nearly constant. The apparent drop in average doses in the late sixties is assumed to be due to the introduction of acoustic instruments.

Film badges have to be replaced and evaluated once a month. Furthermore in case of doses above 5 mSv the supervisor is requested to make a report explaining the high dose and

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improve the working procedures leading to it. NIRH has since 1970 recorded those doses, see figure 3.

The annual collective dose distribution ratio  $SR^*$ , given by:

$$SR_E = \frac{S(>E)}{S}$$

where  $S(>E)$  is the annual collective effective dose delivered at annual individual doses exceeding  $E$  mSv, and  $S$  is the total annual collective effective dose. In Figure 4  $SR$  is shown with the thresholds ( $>E$ ) 1, 5, 10 and 15 mSv.

### **INCIDENTS AND THE 24-HOUR DUTY AT NIRH**

Should during work a hazardous situation arise e.g. a radiography source not being under full control the radiographers shall ensure that:

1. All persons are evacuated from the area.
2. The area is cordoned off in such a way that the dose rate outside does not exceed 0.06 mSv/h, and kept under constant surveillance.
3. NIRH is informed of the incident without delay. The 24-hour duty at the Institute will then immediately send personnel to secure the source; radiographers are not allowed to do this.

The 24-hour duty was established in 1965 with the purpose of providing assistance to all areas dealing with ionising radiation when called for. At present NIRH has an agreement with the Danish Emergency Management Agency that support can be given when needed. Since 1985 there have been 29 reported incidents involving IR of which most were related to gamma radiography, see Figure 5. The observed tendency towards fewer incidents is assumed to be due to improved equipment quality. No incidents resulted in the dose limit being exceeded.

### **CONCLUSION**

The work by NIRH to maintain safe radiation practices is achieved with the inspections, training of radiographic personnel, registration and approval of equipment and a generally close

co-operation with IR companies, which this year resulted in an investigation aiming to identify the procedures, in which the highest doses are received.

### **REFERENCES:**

\* UNSCEAR 2000 report to the general assembly. Volume 1, sources.

<b>X-ray</b>	
X-ray apparatus for use in enclosures only	40
X-ray apparatus for use in the open	304
<b>Gamma</b>	
Radiographic container with Se-75	17
Radiographic container with Ir-192	51
Radiographic container with Co-60	6

Table 1. The number and type of registered radiographic equipment.

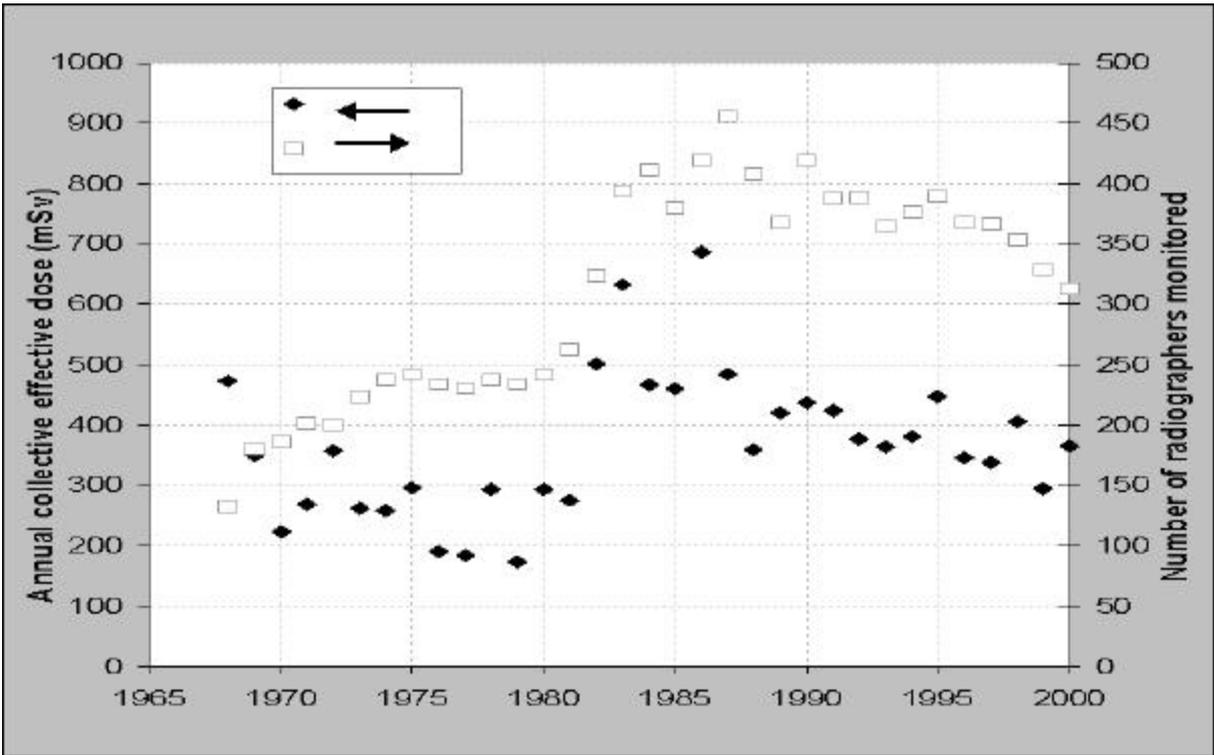


Figure 1. The annual collective effective dose and the number of monitored radiographers.

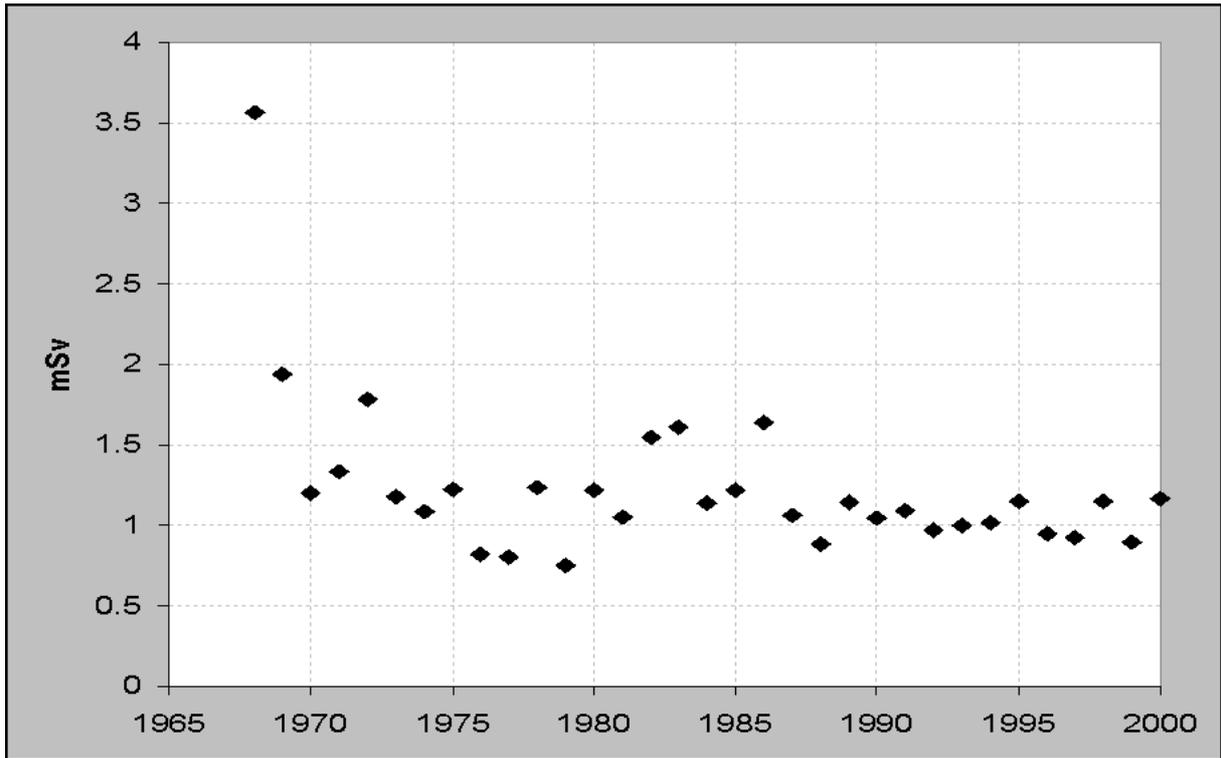


Figure 2. The average annual effective dose to the radiographers.

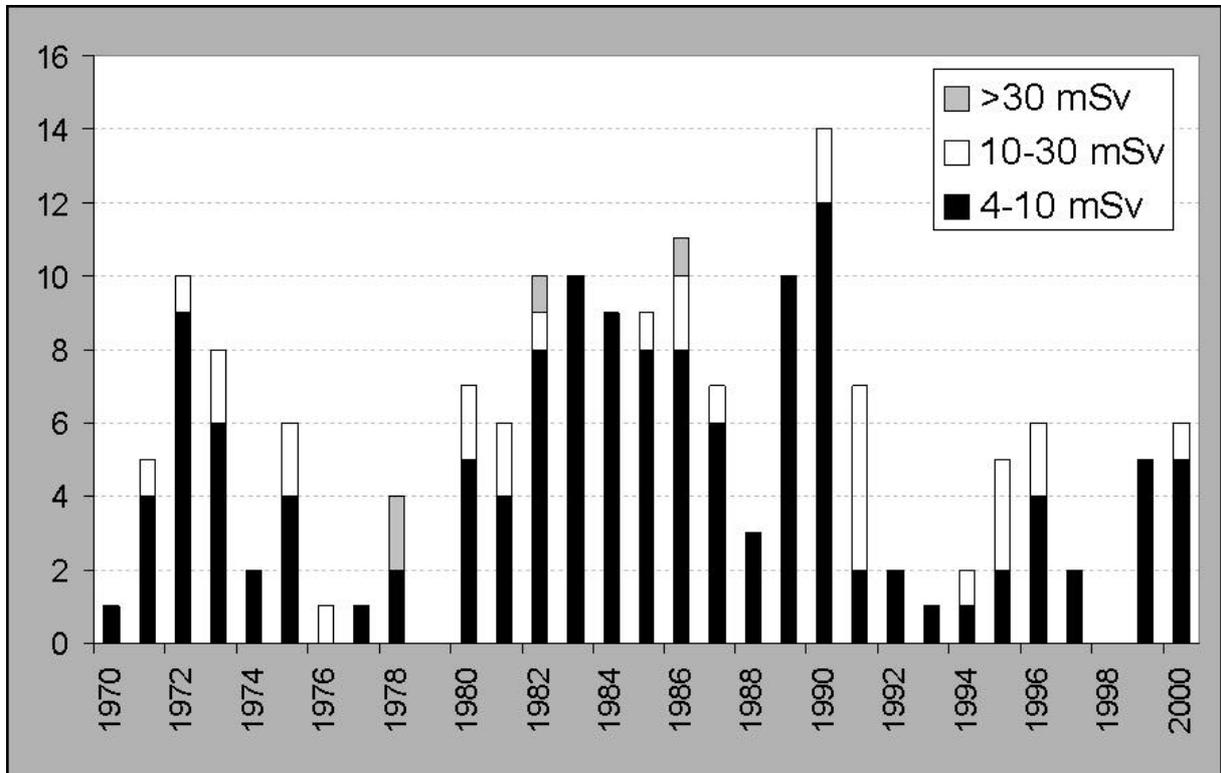


Figure 3. The number of high individual effective doses above 4 mSv in a single period (1 month), divided into 3 categories.

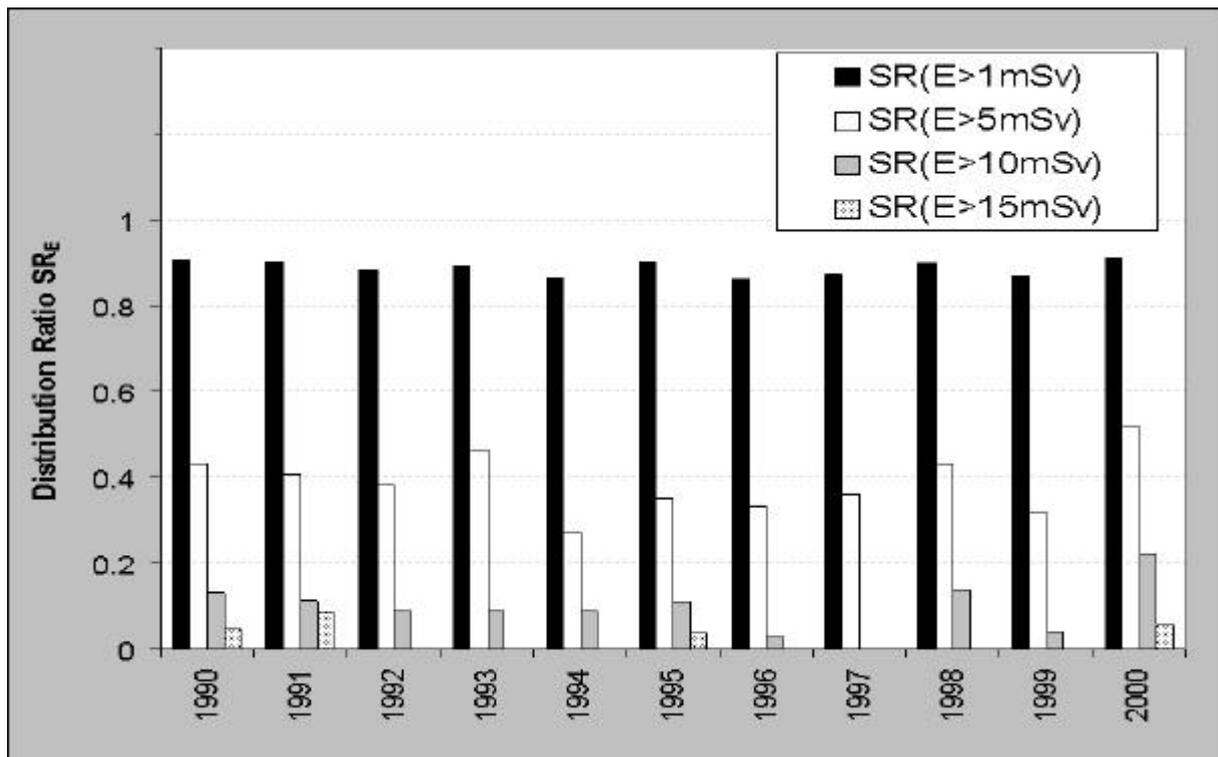


Figure 4.  $SR_E$ , with the thresholds 1, 5, 10, 15 mSv respectively.

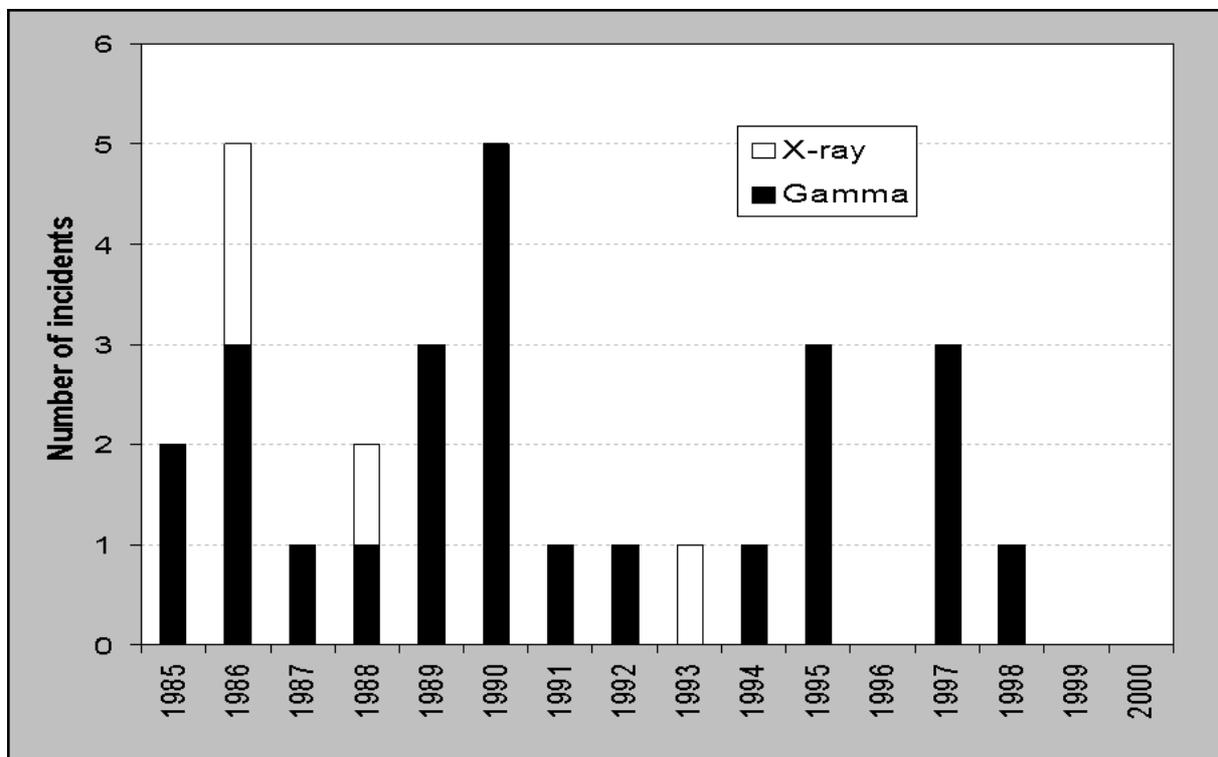


Figure 5. Reported incidents for industrial radiography since 1985.