

# Natural and Man Made Radiation Sources

## Introduction

All living creatures, from the beginning of time, have been, and are still being, exposed to radiation. This chapter will discuss the sources of this radiation, which are:

1. Natural Background Radiation
2. Man Made Sources of Radiation

There are three sources of Natural background radiation:

1. Cosmic Radiation
2. Terrestrial Radiation
3. Internal Radiation

## Cosmic Radiation

The each and all living things on it are constantly bombarded by radiation from space, similar to a steady drizzle or rain. Charged particles from the sun and stars interact with the earth's atmosphere and magnetic field to produce a shower of radiation. The dose from cosmic radiation varies in different parts of the world due to differences in elevation and to the effects of the earth's magnetic field.

Radioactive material is also found throughout nature, in soil, water, and vegetation. Low levels of uranium, thorium, and their decay products are found everywhere. Some of these materials are ingested with food and water, while others, such as radon, are inhaled. The dose from terrestrial sources also varies in different parts of the world. Locations with higher concentrations of uranium and thorium have higher dose levels.

In addition to cosmic and terrestrial sources, people also have radioactive potassium-40, carbon-14, lead-210, and other isotopes inside their bodies from birth until death. The variation in dose from one person to another is not as great as the variation in dose from cosmic and terrestrial sources, and the average annual dose is about 39 millirems/year.

## Exposures Resulting From Man made radiation sources

Although all people are exposed to natural sources of radiation, two distinct groups are exposed to man made radiation sources:

1. Members of the public
2. Occupationally exposed individuals

## **Man made radiation sources resulting in exposure to the public include –**

- ❖ Tobacco
- ❖ Televisions
- ❖ Medical x-rays
- ❖ Smoke detectors
- ❖ Lantern mantles
- ❖ Nuclear medicine
- ❖ Building materials

By far, the most significant source of man made radiation exposure to the public is from medical procedures, such as diagnostic x-rays, nuclear medicine, and radiation therapy. In addition, members of the public are exposed to radiation from consumer products, such as tobacco, building materials, combustible fuels (gas and coal), ophthalmic glass, televisions, luminous watches and dials, airport x-ray systems, smoke detectors, road construction materials, electron tubes, fluorescent lamps starters, lantern mantles, etc. Of lesser magnitude, the public is exposed to radiation from the nuclear fuel cycle, which includes the entire sequence from mining and milling of uranium to the actual production of power at a nuclear plant. The final sources to the public would be the shipment of radioactive materials and residual fallout from nuclear weapons testing and accidents, such as Chernobyl.

## **Exposures Resulting from Occupational Sources:**

- ❖ Fuel cycle
- ❖ Radiography
- ❖ X-ray technicians
- ❖ Nuclear power plant
- ❖ U.S. NRC inspectors
- ❖ Nuclear medicine technicians

Occupationally exposed individuals, on the other hand, are exposed according to their occupations, and to the sources with which they work. Occupationally exposed individuals, however, are monitored for radiation exposure with dosimeters so that their exposures are well documented in comparison to the doses received by members of the public.

The Ionizing Radiation Exposure to the Public chart is taken from the National Council on Radiation and Protection and Measurements (NCRP) Report No. 93, "Ionizing Radiation Exposure of the Population of the United States," 1987. This chart shows that of the total dose of about 360 millirems/year, natural sources of radiation account for about 82% of all public exposure, while man made sources account for the remaining 18%.

## RADIATION EXPOSURE TO THE U.S. POPULATION

The following table is extracted from material contained in NCRP Report No. 93. "Ionizing Radiation Exposure of the Population of the United States," 1987.

The first column shows the sources of radiation exposure, and the second column shows an estimate of the number of people exposed to that source. For natural sources, the entire United States population is assumed to be exposed. The third column provides the average dose (in units of millirems) to those exposed (number in column 2). The last column averages the total dose from the specific source over the entire U.S. population. For natural sources, the third and fourth columns are identical.

<i>Exposure Source</i>		<i>Population Exposed (Millions)</i>	<i>Average Dose Equivalent to Exposed Population (mRem/year)</i>	<i>Average Dose Equivalent to U.S. Population (mRem/year)</i>
Natural:	Radon	230	200 <i>mRem</i>	200 <i>mRem</i>
	Other	230	100 <i>mRem</i>	100 <i>mRem</i>
Occupational:		0.93	230 <i>mRem</i>	0.9 <i>mRem</i>
Nuclear Fuel Cycle: <sup>1</sup>		—	—	—
Consumer Products:	Tobacco <sup>2</sup>	50	—	—
	Other	120	5 - 30 <i>mRem</i>	5 - 13 <i>mRem</i>
Environment:		25	0.6 <i>mRem</i>	0.06 <i>mRem</i>
Medical:	Diagnostic x-rays <sup>3</sup>	—	—	39 <i>mRem</i>
<b>Industrial</b>	Product Dose passing through Eagle Pack.	0	0 <i>mRem</i>	0.0 to population and 0.1 <i>mRem</i> to the product.
<b>Industrial</b>	Dose to operator.	—	—	
	Nuclear Medicine <sup>4</sup>	—	—	14
Approximate Total:	230	—	—	360

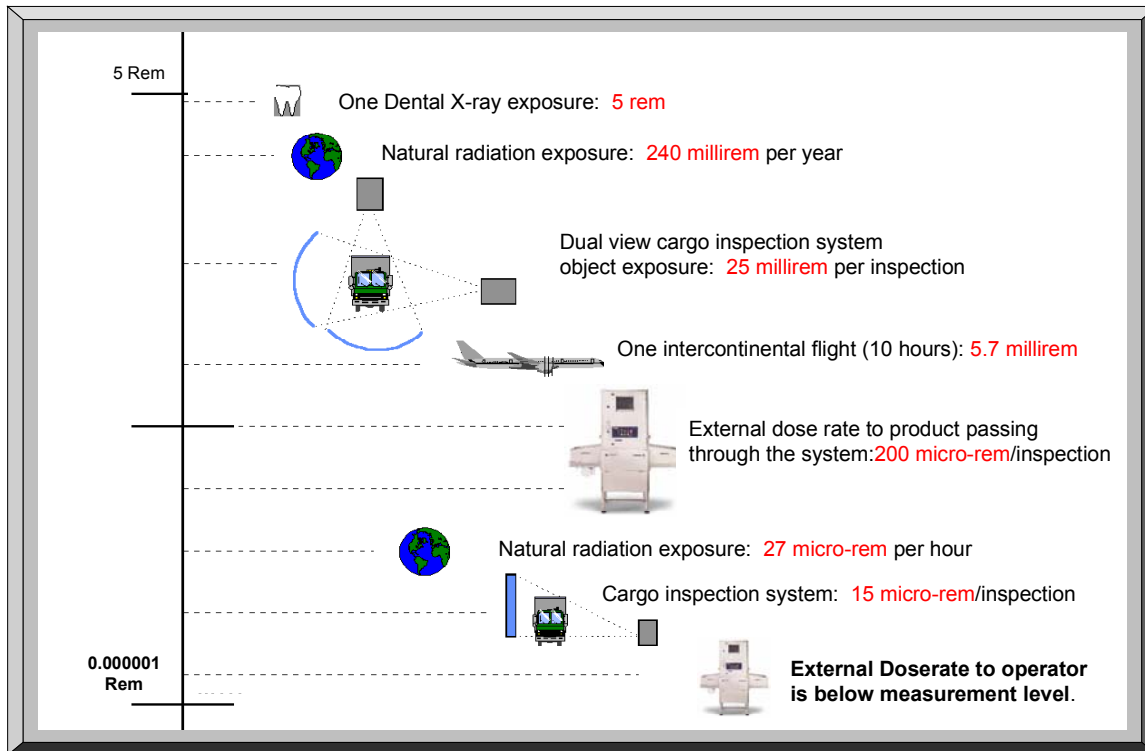
<sup>1</sup>Collective dose to regional population within 50 miles of each facility.

<sup>2</sup>Difficult to determine a whole body dose equivalent. However, the dose to a portion of the lungs is estimated to be 16,000 millirems per year.

<sup>3</sup>Number of persons unknown, however, 180 million examinations performed with an average dose of 50 millirems per examination.

<sup>4</sup>Number of persons unknown, however, 7.4 million examinations performed with an average dose of 430 millirems per examination.

## Putting All The Above In Perspective With The Heimann X-ray Systems.



## Putting X-ray Doserates In Perspective

Notice in the above chart that we have started with a dental X-ray dose which is 5 Rem. This is 1/10th of the medical X-ray dose, which is the highest normal dose that would be deliberately administered to a human. This is also the permissible dose a nuclear power plant operator is allowed to have his nuclear worker employee receive. Next below this, we show the dose that a stowaway would get if he was hidden in a truck that was X-rayed at one of the Heimann truck inspection points (such as at both ends of the Eurotunnel ("Chunnel")). The next on the graph is the dose of 5.7 mRem that you would get (above a normal ground-level terrestrial daily dose) when you take an international flight. The aircraft at 30,000+ feet is above a lot of the shielding atmosphere, and thus the cosmic doserate is higher. However, there is no higher incidence of cancer in airline crew than any other occupation. The next down is the dose that the product receives when it passes through the primary beam in the tunnel. The next world symbol shows the magnitude of the normal background radiation everywhere on the earth (due to the combination of incoming cosmic and terrestrial radium/radon) and the resultant annual dose. Below this is the dose a stowaway (or the contents) of an airline cargo container gets passing through a Heimann CargoScan system. Finally, at the bottom is the doserate that an operator would get using the Heimann Eagle Series of products, and it is worthy of note that it is below any accurate level of dose measurement by any normal means such as doserate badges and/or doserate measuring instruments.

### Some points of perspective then are:

- ❖ Anyone who would have concern about being in proximity to the Heimann Eagle Series of X-ray Inspection machines would certainly have to refuse medical/dental X-rays.
- ❖ Anyone who would have concern about being in proximity to the Heimann Eagle Series of X-ray Inspection machines would certainly have to refuse to fly on aircraft that would exceed 30,000 feet for more than even one hour.
- ❖ Virtually every aspect of normal life includes some risk. Virtually nothing is risk free. When one decides to drive ones car, they accept the well documented risk of death by car crash, and they deem that the combination of their personal driving skills, the road they will take and its reputation, and the crash-worthiness of their car makes the risk acceptable. The statistics show that risk to be many thousands of time more risky than the nuclear worker employee faces, and he in turn faces many thousands of times more radiation than available as an operator of the Heimann Eagle Series of X-ray systems.
- ❖ At airports, the baggage handling systems that Heimann and others sell have security personnel in intimate contact with the machine day-in and day-out. There is no evidence of any increased risk to this very large workforce globally.

The main point of all of this is to allow a nervous user to get some feeling of what he or she is really looking at in risk terms. There is **no such thing** as totally zero risk in life. When the author of this document sits in front of his video monitor, there is a very small but finite amount of radiation emitted by the screen due to the processes necessary in a video display of the Cathode Ray Tube (a.k.a. CRT) type of system (most common in offices today). This risk, however, is so low as to be considered virtually non-existent by the author, and is in the same magnitude as that provided by the Eagle Series of X-ray inspection systems.

Hopefully, this dissertation will allow any user of the Heimann Eagle-Series of X-ray Inspection systems some degree of comfort, and do so by providing a realistic measure of understanding of what risks are involved.