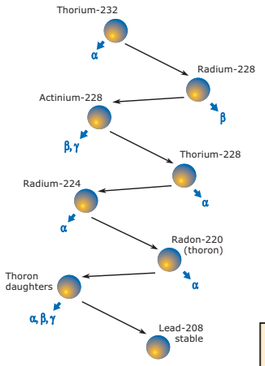
RADIATION AT WORK

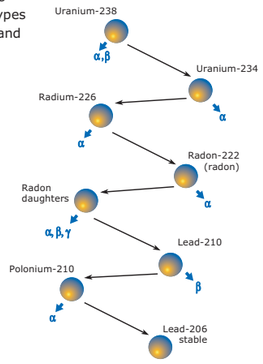
# Minerals containing Natural Radioactivity

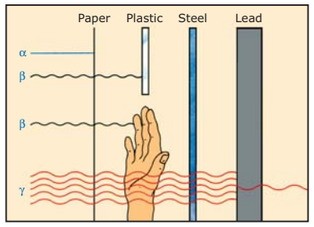
## Radioactivity, Radiations and NORM

Radioactive uranium and thorium occur naturally in all rocks.

Decay of these radioactive elements produces series of other radioactive materials. Three types of radiation are emitted: alpha (α), beta (β) and gamma (γ) rays.




Alpha particles travel only a few centimetres in air and are incapable of penetrating the skin. Beta particles have a range of more than one metre in air and up to one centimetre or so in tissue. Gamma rays can be very penetrating. They can pass through the walls of plant and equipment.

**NORM is the term used to describe *Naturally Occurring Radioactive Materials*. All geological materials contain natural radioactivity, although NORM is mostly used for minerals and other materials with above-average uranium and thorium concentrations.**

## Radiation from Minerals

### *External radiation*

Gamma radiation may be detectable close to bulk quantities of NORM. The level depends on the concentration of NORM but is usually quite low (typically no more than a few microsieverts per hour).

### *Internal radiation*

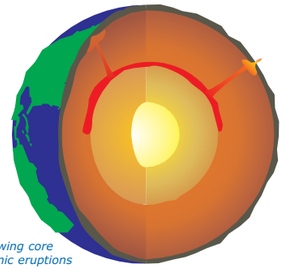
In dusty work conditions, internal radiation exposures can occur if small particles of NORM dust are inhaled. These exposures can be significant where people work for a long time in very dusty workplaces. In comparison, the exposure from ingesting such particles is very low.

*Dust generated during unloading from a ship*

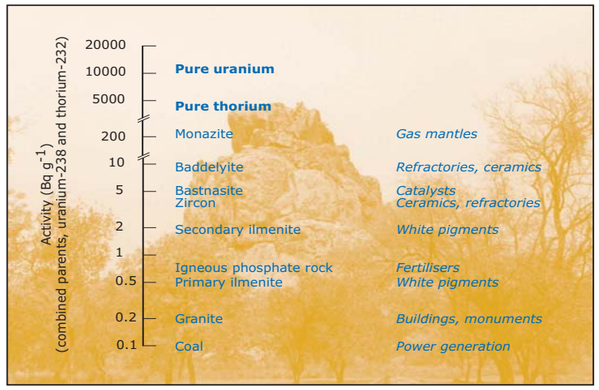
NORM may also produce the radioactive gas radon. Usually this is only a significant problem where there are high NORM concentrations in workplaces with poor ventilation, such as in reaction vessels or other confined spaces.

## Radioactivity in Minerals

Uranium and thorium were present with the other components of the Earth when it was originally formed. As molten rock cooled to form the Earth's crust, these radioactive materials became trapped within the crystal structure. The distribution is uneven – like of other trace elements, the concentration of NORM varies according to local geology.



*Earth showing core and volcanic eruptions*




*Activities and uses of some minerals (one becquerel (Bq) = one disintegration per second)*

## Detection and Measurement of NORM

To properly assess the potential radiation hazards from working with NORM it is necessary to know the concentration of radionuclides in both the uranium and thorium decay chains. This normally requires a laboratory analysis of a sample of the material. Suppliers of such materials should be asked to provide this information.

To determine if there is a risk to individuals it is also necessary to make measurements in the workplace.

### *External dose rate measurement*

Although external dose rates are often below those where control measures are required, they should be measured periodically where quantities of material are stored in bulk.

### *Dust measurement*

Measurement of airborne dust concentrations is necessary in milling and other operations which produce small particles.

Personal air samplers should be worn to assess the quantity of dust inhaled where airborne dust levels are capable of producing significant radiation exposures.

### *Radon measurement*

Measurements over a three-month period can be made using passive radon gas monitors to provide an estimate of the average radon levels.

However, care is needed to ensure that the 'background' radon from underlying rocks and building materials is considered separately. Where this is difficult, or where the average radon level does not represent that during working hours, equipment that measures the short-term radon level may be more suitable.

*Measuring radon levels in mines*

## Precautions and Procedures

### *External radiation*

Dose rates from bulk quantities of minerals are low enough for simple precautions to be generally sufficient to protect against external radiation, such as not storing such material in occupied areas.

### *Internal radiation*

Dust control systems should be considered, especially where the material is dry and fine particles are present. Where practical, engineering controls designed to prevent dust from entering the workplace should be used. In general, a factory with effective dust control will also be effectively controlling the hazards from inhaling NORM.

*Dust extraction system in a mineral processing plant*

*Radon gas emitted from minerals may accumulate in closed storage areas. This can be prevented by storage in well-ventilated sheds*

Respiratory protective equipment may be necessary where engineering controls are not practical. Normally this should be limited to short-term, well-defined tasks such as vessel entry or maintenance operations. Training in the selection, maintenance and wearing of such protective equipment is necessary for it to be effective.

## Radiation Doses

In the UK, the average annual dose to a member of the public is 2.6 mSv. Most of this is due to natural radiation. People working with NORM may receive an additional occupational dose, mostly from a combination of external gamma radiation and inhalation of dust.

**Graphic to follow**

*Average annual radiation dose received by various groups of workers*

## Regulation of Work and Waste Disposal

The protection of people and the environment may require legal controls to be enforced through a system of regulations. As NORM is present throughout the natural environment, some situations will require control and some will not. So the use and disposal of some materials may be subject to regulation – for example, where there is a significant radiation risk.

### *Worker protection*

In the European Union, regulation of work with NORM depends on the radiation risk to individuals, rather than the radioactive content of the material. Specifically, regulations apply where annual radiation doses are likely to exceed 1 mSv. Elsewhere, a different regulatory system will often apply, and the application to NORM should be checked with the relevant national authorities.

### *Environmental protection (waste disposal)*

In the UK, certain materials containing natural radioactivity are exempted from the controls normally applied to the use and disposal of radioactive materials. For example, minerals such as zircon and ilmenite are usually exempt. However, to claim exemption, various conditions need to be met and expert advice should always be sought.

The European Union has recommended that the disposal of solid NORM waste may be exempt from regulatory control if annual doses to individuals are below 0.3 mSv and general exempt concentration levels have been recommended. Studies carried out in the UK and other countries on the disposal of typical solid NORM waste to well-managed landfill facilities have indicated that the dose criterion can readily be met. Again, national regulations for NORM waste disposal will vary, and the relevant national authorities should always be consulted. If the waste is not exempt then regulatory control is required.


RADIATION AT WORK

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## Further Information

NRPB, **www.nrpb.org**

second source

third source

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