Self-Luminous Markers

What are they?

Self-Luminous Markers basically comprise a hollow polycarbonate enclosure fitted with a Betalight gaseous tritium light source (GTLS). A GTLS is a borosilicate glass tube which contains a small amount of a radioactive gas called tritium and which is coated on its internal surfaces with a fine, phosphor powder coating. Radiation released by the tritium activates the phosphor and causes it to emit light, normally only visible in the dark. The markers are useful for highlighting assets or locations in the dark.

What is tritium?

Tritium is a form of hydrogen gas that is also radioactive. As it decays, it releases electrons, also known as beta particles. The type and energy of radiation it emits means that the radiation cannot pass through the walls of the GTLS. In fact, the energy levels are so low they cannot penetrate a sheet of paper. Nor can they penetrate human skin.

Can we avoid radiation?

No, it is not possible to avoid radiation as natural radioactive sources exist in the rock and soil. We are also exposed to cosmic radiation from outer space. These natural sources give rise to a yearly radiation dose equivalent to 2,200 microsieverts [ref 1] which is equivalent to around 110 X-rays to the chest for medical diagnosis [ref 1]. Moreover, activities that we all take for granted can slightly increase our radiation dose, such as:

- Taking a return flight from London to New York results in a higher radiation dose due to cosmic radiation from outer space.
- Eating 100 grammes of Brazil nuts delivers an increased radiation dose due to the ability of the nuts to concentrate radium out of the soil.
- Smoking results in a higher dose due to naturally radioactive elements in the tobacco.

The average dose we all receive from all sources of background radiation in the UK is 2,700 microSieverts per year [ref 1].

The maximum dose permitted in the workplace for a radiation worker is 20,000 microsieverts and for anyone else is 1,000 microsieverts [ref 2].

How is radiation harmful?

Exposure to ionising radiation has the potential to be harmful. Penetrating radiations can damage cells from outside the body, but other radiations need to be taken in to the body (by eating or breathing in) to allow them to damage cells. The ability of ionising radiation to cause cancer is well documented and the way in which this happens is clearly understood.

Is the radiation in the markers harmful?

The exposure risk from handling a Self-luminous Marker illuminated by GTLS is virtually nil. A tiny amount of X-ray radiation is produced by interaction of the beta particles with the glass tube, but this is barely measureable and presents no significant exposure risk.

What if the marker is damaged?

If the marker is accidently broken the escaped gas will disperse rapidly into the atmosphere and be quickly diluted in the air.

Example 1: A marker (containing 15 GBq, the greatest quantity of tritium gas in our markers) is broken in a room 3m x 5m x 2m (30 m^3) and all the gas is released. Assuming no air change and a person remains in the room for 1 hour, a dose of 1 microSievert would be received, a tiny fraction of the annual background exposure.

Example 2: If the same marker is broken in a small, air-sealed vehicle then the dose received would be 4 microSieverts, i.e. equivalent to eating 100 grammes of brazil nuts [ref 1].

Example 3: if a MiniGlow or Bivvy Marker (both containing less than 1 GBq of tritium gas) is broken under similar circumstances to example 1, the dose received would be just 0.07 microSieverts, equivalent to the natural gamma radiation dose we all receive in 1 hour [ref 1].

References

1. Ionising Radiation Exposure of the UK Population: 2005 Review. Health Protection Agency. HPA-RPD-001.

2. The Ionising Radiations Regulations 1999. Statutory Instrument No. 3332. UK Govnt.

Technical assessment

Tritium (^3H) is a pure beta emitter, meaning it decays by the emission of beta particle radiation only with no accompanying gamma radiation.

The energy of the radiation is maximum 18 keV, average 6 keV. These beta particles can penetrate only about 6 mm of air, and they are incapable of passing through the dead outermost layer of human skin.

Being an isotope of hydrogen the tritium molecule rapidly exchanges with body water to be assimilated in the person. The route of uptake may be either by inhalation or ingestion. Although the radioactive half-life of tritium is 12.3 years (tritium decays to stable helium), the biological half-life is just 10 days i.e. the rate with which tritium is turned over in the body is very high due to the excretion of body water.

Example 1: A marker (containing the greatest quantity of tritium gas) is broken in a room 3m x 5m x 2m (30 m^3) and all the gas is released.

The highest activity (source strength) in a single marker = 15 GBq (gigabecquerels)

Activity concentration in the room = 0.5 GBq/m^3

Breathing rate of a person engaged in light activity = 1.2 m^3/h

Activity inhaled in 1 hour = 0.6 GBq

Dose coefficient* for elemental tritium gas (inhalation) = 1.8×10^{-15} Sv/Bq

Effective (whole-body) dose delivered = 1.8×10^{-15} [Sv/Bq] x 0.6 GBq = 1.1 µSv (microSievert)

* Dose coefficients provide a direct correlation between activity ingested or inhaled and the resultant 'committed effective dose' to both workers and members of the public. Ref: Annals of the International Commission on Radiological Protection, Publication 72; Age-dependent Doses to Members of the Public from Intake of Radionuclides, Part 3, Dose Coefficients. 1996.