

This is an edited version of a briefing sent on 30th November 2006 to the Health Protection Agency – Radiation Protection Department (HPARP). The cuts are intended to avoid putting a weapon in the hands of terrorists who don't have the knowledge we are discussing here. It is, however, not arcane and the Litvinenko episode shows that someone has probably already used it. The main points are that the materials are readily available, that the quantity of Polonium-210 needed to kill people is far smaller than the authorities are saying, and that the health risks are far greater.

Polonium-210: availability, risks and precautions

The HPA and DoH are making misleading statements to the press and public about the Po-210 isotope and its potential health effects. They are

- deliberately playing down the risks
- overstating the quantities of Po-210 that would represent a hazard
- overstating the difficulty of isolating Po-210.

It must be inferred that their intention is to prevent potential terrorists conceiving the idea of copying the technique.

Trawling the internet has revealed no sign that anyone has yet published anything like the analysis we present below, though some have come close to it. Clearly there is merit in not publishing but we are concerned that efforts to trace passengers from the affected aircraft may have more to do with security than with the health of exposed people. This would be deplorable, yet it could be replicated for other exposure scenarios as this situation unfolds.

We are requesting

- a response to this analysis in terms of its accuracy
- a meeting with officials of HPA-RP and DoH to discuss the implications and the way forward.

We are contacting a small number of Members of Parliament confidentially about this as we feel it is appropriate to do so.

1. It is inaccurate to categorise Polonium-210 as principally a substance that is made in large amounts in a nuclear reactor, and therefore only available to groups who have access to nuclear reactors. It is a natural substance, a daughter of the Uranium decay chain, and alpha emitter with a half life of 138 days (1). It decays to Lead-206 which is stable.
2. It has a weak branching decay to Thallium-206 which is a beta emitter (1) (only 0.0001% decays by this route) which is probably why early measurements detected Thallium but not in sufficient quantities to have caused the effect of the parent.
3. If we assume that the absorbed dose required to kill is 2Sv (2) and that this is the dose suffered by Mr Litvinenko we can calculate the quantity of Po-210 inhaled or ingested by him. The ICRP dose coefficient for inhalation of Po-210 is 2.54×10^{-6} Sv/Bq (1) and so 2Sv represents 787 KBq. The number of atoms per Bq is obtained by multiplying the half life of any isotope in seconds by 1.44 (3). Thus there are 17.16×10^6 atoms per Becquerel of Po-210. This represents 6×10^{-15} grammes of Po-210. Multiply by 787×10^3 gives the fatal dose of 2Sv which is 4.7×10^{-9} or 4.7 nanogrammes. This is the fatal dose. The fatal ingestion (swallowing) dose would be about twenty times higher at about 100ng (because of a different absorption coefficient for ingestion). Such amounts would be equivalent to a speck of dust, invisible to the naked eye.
4. Being an alpha emitter Po-210 cannot be detected with any Geiger Counter, no matter how close to the substance the Geiger Counter is placed. The alpha particle

decay has a range of about 2cm in air, but will not penetrate the Geiger Counter window and will not register. It is necessary to use a thin window alpha discriminating scintillation counter and even then the detector has to be closer than 2cm to detect anything. Alternatively, strips of allyl diglycol carbonate CR39 plastic may be used but they have to be placed over the suspect material and left for an hour and then developed and read elsewhere. Alternatively, surfaces may be transferred to a CR39 sheet using sticky tape.

5. If as now seems likely, there is significant contamination of aircraft, then passengers are at risk of cancer from having inhaled Po-210 particles. There is a deterministic risk (due to heavy contamination) which results in radiation sickness and death. But at low doses there is significant stochastic (long term) risk leading to cancer of all types, particularly leukaemia, lymphoma and lung cancer. It is recommended that all passengers have urine tests for Po-210, and at least passengers are located and their medical cards are flagged for later epidemiological analysis.
6. Polonium-210 can be made by any terrorist [...cut...] Much has been made of the requirement to have a nuclear reactor, and this has pointed to the Russians. In fact the substance is a natural radioactive material [...cut...] Only small quantities are necessary to kill or cause a long term cancer hazard. It is impossible to detect without specialist equipment.
7. The material could be administered as a spray [...cut...] When a solution of Po-210 (as a spray) evaporates, it leaves the solid material behind. This will become resuspended and will float about in the air where it may be inhaled. This is the main risk, not ingestion. Once in the lung it passes rapidly into the lymphatic system and then has access to the whole body.
8. The calculations above are conservative and do not assume any internal enhancement. We note, however, that the DoH Radiation Research Strategy priorities published in July appear to be informed by the matters which CERRIE left unresolved; they amount to an official admission of deep ignorance concerning the health impact of internal radiation.

References

1. Eisenbud M, Gesell T (1997) *Environmental Radioactivity* San Diego Academic Press: p138
2. Sumner D Wheldon T and Watson W (1991) *Radiation Risks* Glasgow: Tarragon Press
3. Busby C (1995) *Wings of Death: Nuclear pollution and Human Health* Aberystwyth: Green Audit

Note: A standard textbook is Partington JR, *General and Inorganic Chemistry* 3rd Edn. 1957. p 737: "Since Po is almost a pure alpha emitter shielding is not necessary in working with it, but great care is necessary on account of its highly poisonous properties. Some of its compounds are volatile. An amount of 4.5×10^{-12} grams is dangerous when ingested." ibid. p 195 "Po may be purified from the active deposit in old radium tubes ... The properties of Po are known in some detail ..." citing Bagnall Quarterly review 1957 Vol. 11 p 30. See also KW Bagnall, *The Chemistry of Selenium, Tellurium and Polonium*, 1967.