PUBLIC AFFAIRS

Figure 11. Fact Sheet 5: Characteristics, Hazards, and Health Considerations of Tritium

FACT SHEET 5

CHARACTERISTICS, HAZARDS, AND
HEALTH CONSIDERATIONS OF TRITIUM

(For Operational Commanders)

Some nuclear weapons have small metal bottles that contain tritium, a radioactive gas. In an accident involving nuclear weapons, it is possible that these gas bottle systems may be damaged, and that some or all of the tritium gas is released into the air. Tritium gas that is released into the air is quickly diluted and dispersed, and is not likely to be a significant hazard, unless there was a fire or explosion at the accident, and then it should only be a hazard to people in the immediate area of the accident.

Tritium is a radioactive form of the element hydrogen. From a chemical standpoint, tritium atoms behave just like hydrogen atoms. Tritium is often stored and used in the form of a gas. Like stable hydrogen, tritium combines readily with many other elements. In a fire, tritium combines spontaneously with oxygen in the air and also replaces ordinary hydrogen in water, forming tritiated water, sometimes called "tritium oxide" or "HTO." It may also replace the stable hydrogen in other hydrogenous material (grease or oil), causing these materials to become radioactive. Metals can react with tritium in two ways: plating, the deposition of a thin film of tritium on the surface of the metal; or hydriding, the chemical combination with the metal. In either case, the surface of the metal becomes contaminated.

Some tritium is produced naturally, by the interaction of cosmic rays in the earth's atmosphere. These cosmic ray interactions produce about 4 million Ci of tritium every year worldwide. This tritium is incorporated into rainwater, resulting in a low, but measurable "background," level of tritium in almost all water. The concentration of tritium in surface water is typically on the order of 10 to 50 picocuries per liter.

Tritium is also produced in nuclear reactors. This manufactured tritium may be separated and purified for a variety of uses. There is no difference between manufactured tritium and tritium that is produced naturally. Tritium is used in nuclear weapons, fusion research, luminous signs and watches, and in biomedical research.

Tritium gas is relatively harmless, since very little of it is absorbed into the body, even if inhaled; however, if there were a fire or explosion at the same time as the tritium was released, some or all of the tritium gas would probably be converted to HTO, which behaves like water vapor. When people are exposed to HTO in the air, some of it is inhaled, and some of it may be absorbed through the skin.

The radiation doses that might be received from exposure to the smoke plume decrease rapidly with distance away from the accident. People who were directly exposed to the smoke plume very close to the accident site (within a few hundred yards) might -- although unlikely -- receive radiation doses greater than the occupational limit of 5 rem. Beyond a few hundred yards, doses should be well below a few rem. Beyond about 1/2 mile, the dose to a person who was directly in the smoke plume is likely to be less than the dose a person receives every year from natural background radiation. The key point to remember is that as distance from the plume increases, radiation dose decreases.

Normal RADIACs cannot detect tritium; specialized portable/laboratory instruments are required. Tritium on surfaces may be detected by rubbing a small piece of filter paper over the surface, and then "counting" the radioactivity on the paper (which is placed in a small vial) in an instrument called a "liquid scintillation counter." Tritium in water or other liquid may be counted by placing a sample of the liquid in a small vial and then counting the vial in the liquid scintillation counter. Tritium in the air may be measured by sampling the air with a "flow-through ionization chamber" instrument, which gives a real time reading of the concentration of tritium in air.

The form of tritium that is most likely to get inside the body is HTO in the form of water vapor (in the air.) Airborne tritium (as HTO vapor) may be inhaled, and may also be absorbed through the skin. When people are exposed to HTO vapor, about 2/3 of the total intake comes from inhalation of the tritium, and about 1/3 comes from absorption of the tritium through the skin. Tritium may also be incorporated into crops, which then may be ingested. Tritium release could be a significant hazard only for personnel close to the accident site.

Once tritium is inside the body, it behaves just like water and is distributed rapidly and uniformly throughout the entire volume of body water, where it may deliver a radiation dose to the soft tissues of the entire body. Tritium is eliminated from the body at the same rate and through the same pathway as water is eliminated from the body, excretion of urine and feces, sweat, and loss through exhalation.

The amount of time required for half of the tritium remaining in the body to be removed from the body is called the "biological half life." Although the physical half-life of tritium is 12.26 years, because tritium in the body behaves just like water, and since the body's water is continually eliminated and replaced, the biological half life of tritium is very short – about 10 days.