US NUCLEAR CORP

INTRODUCTION
AIRBORNE
TRITIUM
TRITIDES

US Nuclear Corp

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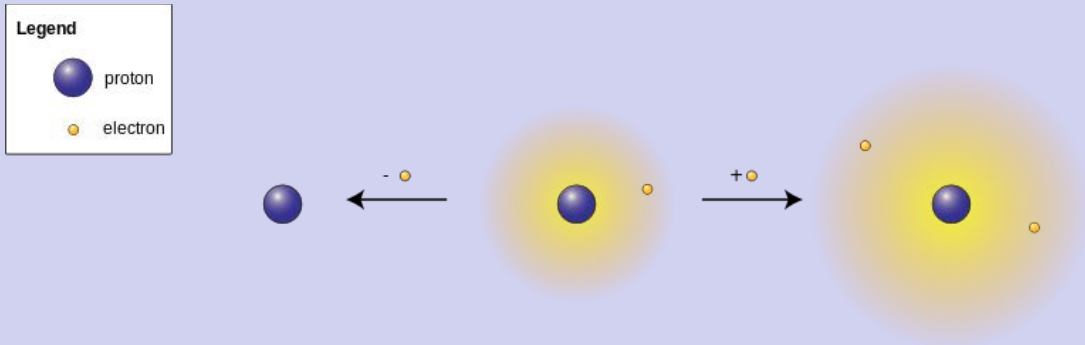
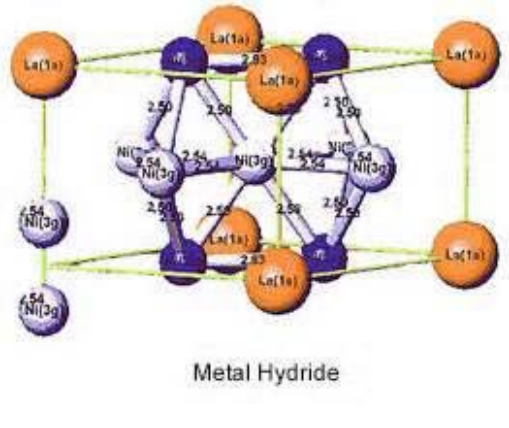
OVER 65 YEARS OF RADIATION DETECTION & MEASURMENT SOLUTIONS

HYDRIDES – An Anion of Hydrogen

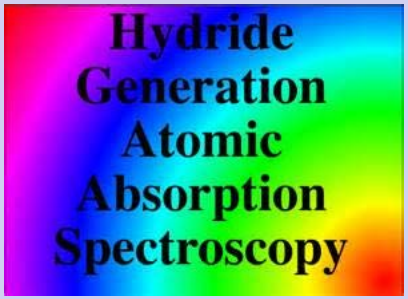


No. of protons	1	1	1
No. of electrons	0	1	2
Charge	+1	0	-1
Notation	H^+	H	H^-
Classification	cation	neutral (not an ion)	anion

Compounds containing hydrogen bonded to metals or metalloid may be referred to as hydrides



A hydride is a compound formed by hydrogen and another, usually more electropositive, element or group.

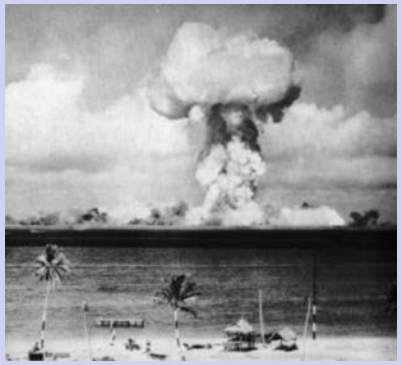


Almost all of the elements form binary compounds with hydrogen (exceptions being He, Ne, Ar, Kr, Pm, Os, Ir, Rn, Fr, and Ra). There are three main types of hydrides, based on the nature of their bonding:

1. *Ionic hydrides*, which have significant **ionic bonding** character.
2. *Covalent hydrides*, which include the hydrocarbons and many other compounds which **covalently bond** to hydrogen atoms.
3. *Interstitial hydrides*, which may be described as having **metallic bonding.**

Deuterides
Hydrides containing Deuterium are known as *Deuterides*. Some Deuterides, such as LiD, are important fusion fuels in thermonuclear weapons.

Tritides
Hydrides containing Tritium are known as *Tritides*.



Uranium hydride slugs were used in the "tickling the dragon's tail" series of experiments to determine the critical mass of uranium.

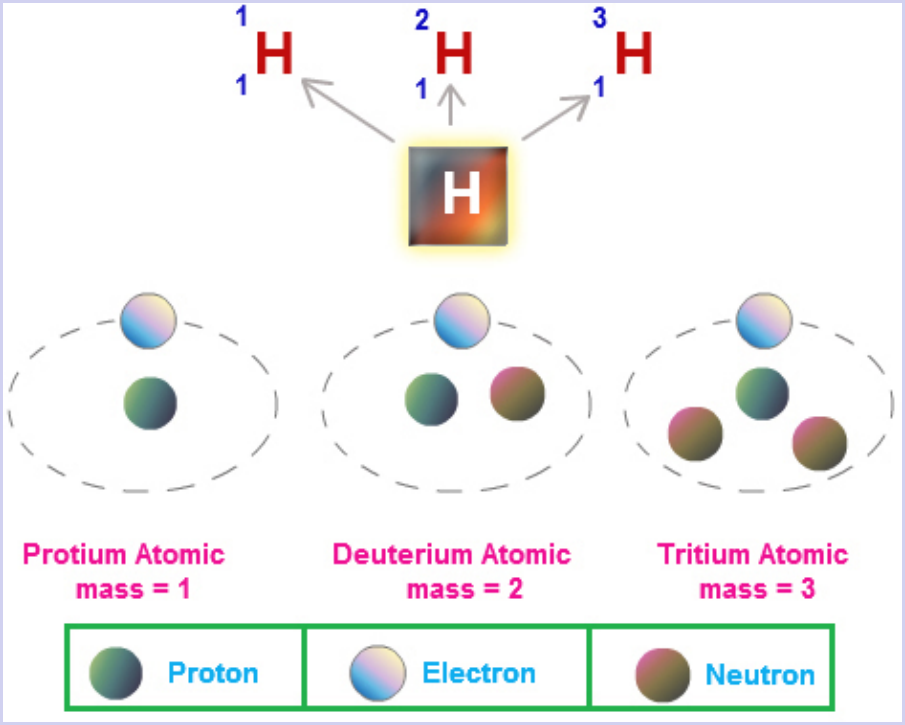
Uranium hydride and uranium deuteride were suggested as a fissile material for an uranium hydride bomb. The tests with uranium hydride and uranium deuteride during Operation Upshot-Knothole were disappointing.

During the early phases of the Manhattan Project, in 1943, uranium hydride was investigated as a promising bomb material; however, it was abandoned by the spring of 1944 as it turned out that such a design would be inefficient.

DEFINITION:

TRITIUM TRITIDES ARE SIMPLY MICROSCOPIC SIZE DUST PARTICLES OR FLAKES OF A SOLID, USUALLY FROM A METAL CONTAINING TRITIUM.

TRITIUM IS ONE OF THREE TYPES OF HYDROGEN



HOW DO TRITIUM TRITIDES OCCUR?

1. Elemental hydrogen can and will invade many substances.

2. Hydrogen substitution allows Tritium to replace the hydrogen in the solid, gas, or liquid that it comes in contact with, including organic compounds such as methane.

3. Hydrogen can invade metals – particularly iron and steel. The individual hydrogen nucleus is so small it will migrate into the body of the metal and some will eventually pass through and out the other side. This allows hydrogen to leak out of a metal bottle or tank into the environment.

4. Tritium will also leak out of metal tanks through this same mechanism. A process for estimating the quantity of Tritium inside the tank involves:

   - Swipe the outside of the tank ~ measure results of leakage
   - Clean outside of tank thoroughly ~ wait a period of time
   - Swipe the outside of the tank a second time ~ measure results of leakage rate

A SIMPLE EXAMPLE

Steel will contain Tritium temporarily.

A steel tank or bottle will eventually fail as a containment vessel if Elemental hydrogen or Tritium is contained within.

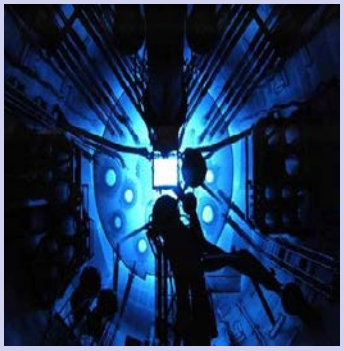
Of the Tritium atoms that invade the steel some will decay and become Helium. As it decays, the Helium gas expands and migrates… finding any flaws or fissures within the metal.

Hydrogen and Tritium at high temperatures will also combine with the carbon in steel to form methane gas, which expands, causing hydrogen (Tritium) and the Helium-3 stress cracking and embrittlement.

Industries at Risk for Tritium Tritides

Tritium is produced in four ways:

1. By cosmic rays striking the earth's atmosphere.
2. By nuclear fission – the primary source.
3. Accelerator produced Tritium
4. Neutron activation and subsequent splitting of Lithium-6



Nuclear fission occurs naturally in Uranium and in some other mineral deposits.

Over time, a large amount of Tritium is produced in every nuclear reactor.

Production industries for Tritium based products (Includes self-illuminating devices such as exit signs, gun sights, etc.)

HOW DO TRITIUM TRITIDES ENTER THE ENVIRONMENT?

Any item that has Tritium in it can produce Tritium Tritides.

Particles from rust or other corrosion, grinding, drilling, cutting, or welding can release Tritium Tritides into the environment.

DANGEROUS TO HEALTH?

10CFR835 lists STCs (Special Tritium Compounds) with DAC factors that the are 2 to 5 times more restrictive than HTO.

Microscopic Metal Dust

<u>Tritium Tritides in airborne dust particles can be inhaled.</u>

- Particle sizes from 0-3 micron diameter (depending upon the density of the Tritide molecule) are the biggest health issue with risk of inhalation.
- Particles larger than this will fall out of the air to the ground.

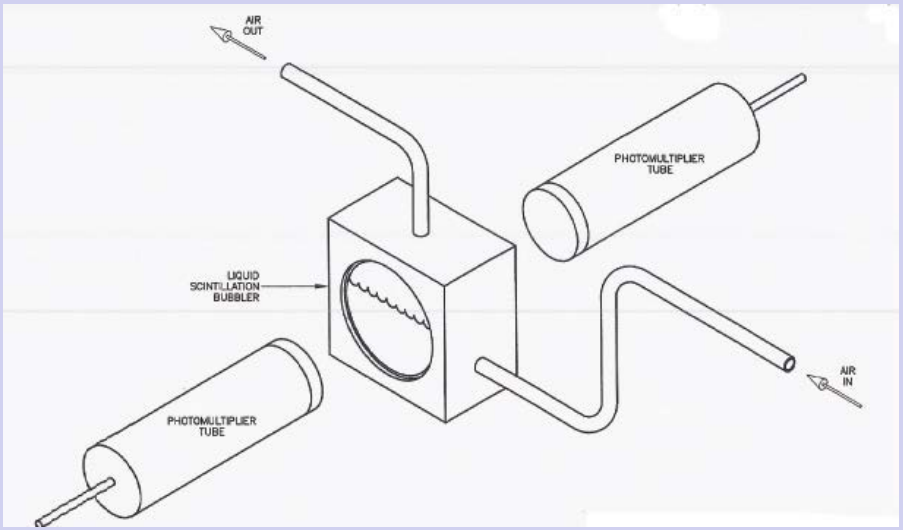
NOTE: Tritide particles are more dense than other dust. A 3 micron Tritide may have the momentum and therefore the flight path of a low density 10 micron particle.

Welding or other maintenance can put metalic particulates into the air. This is especially hazardous if Tritium is present. The risk goes up in a closed environment such as a subway tunnel.

ARE TRITIUM TRITIDES PRESENT?

Only Through Measurement Can This Be Determined.

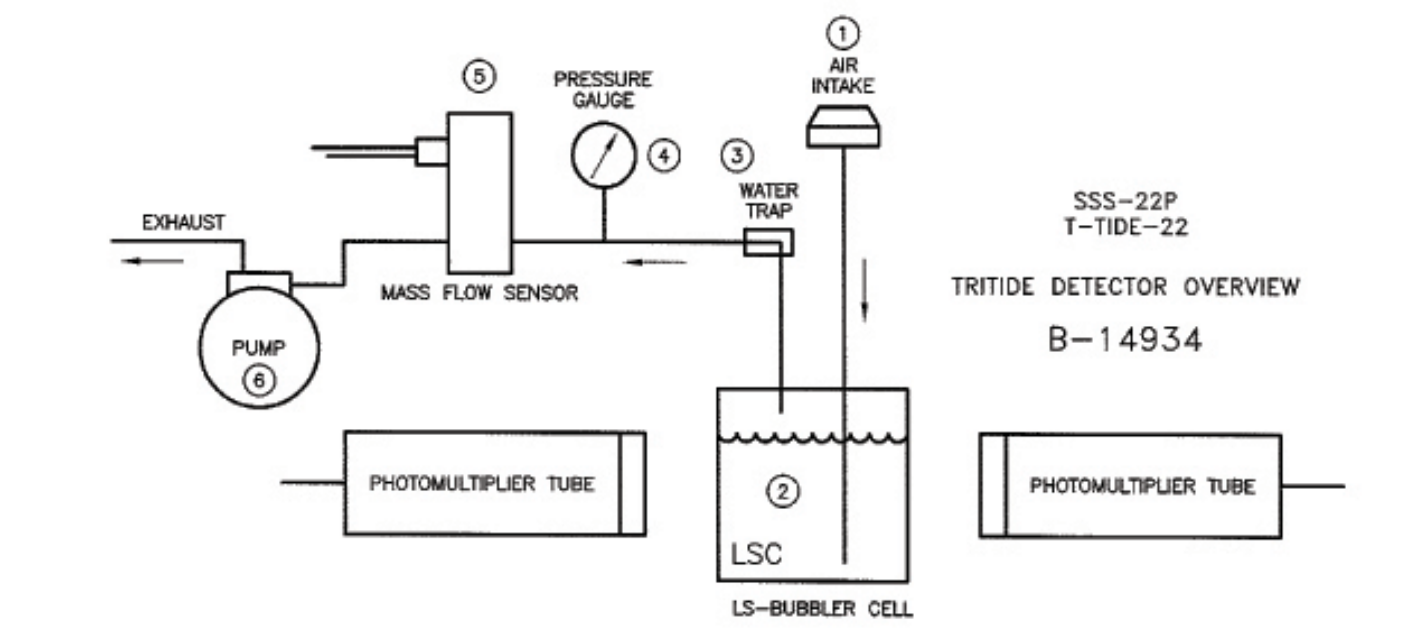
Measuring room air with a portable flow-through bubbler cell with Liquid Scintillation Fluor is an excellent fast method.



The core of the system is the flow-through bubbler cell as shown above.

An Example of a Portable Flow-Through Tritium Tritide Measurement Instrument

TA MODEL T-TIDE-22 FLOW PATH



The incoming air sample:

- Sample air bubbles through the Liquid Scintillation Fluid in the bubbler cell
- Tritium Tritide particles are left behind in the LSC fluid
- Dual photomultiplier tubes detect the particles
- Sample passes through the pressure gauge & the mass flow sensor
- Sample air leaving the pump is cleaner and is returned to the atmosphere or gas collection system

Model T-Tide-22

Pulses from the Dual Photomultiplier Tubes go to the T-Tide-22 Electronics

ELECTRONICS FEATURES:

- •Signal Enhancement
- •Quiet, High Gain Preamps
- •Noise Elimination
- •Coincidence Counter
- •Pulse Energy Selection
- •AC/DC Power

Electronics and Flow-Through Detector are Contained Together in a Carrying Case.

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PROTECTION FROM TRITIUM TRITIDES

The minimal protection is a combination HEPA/charcoal filter gas mask. Full mask is best, some facilities allow a half mask.

Full protection is a hazmat suit with self-contained breathing apparatus (SCBA).

Additional Industrial Hygiene & Environmental Precautions Include:

Metal Dust Collection System

Downdraft Grinding Table

Room Air Filtration System