HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE (RDX)

PROFILE OF DRINKING WATER CONTAMINANTS FOR EMERGENCY RESPONSE

GENERAL INFORMATION

Hexahydro-1,3,5-trinitro-1,3,5-triazine, commonly designated RDX (British code name for Research Department Explosive or Royal Demolition Explosive), is an extensively used high-impact explosive in munition formulations. It is also used as a rat poison.

RDX is chemically stable and can be stored up to 10 months at 85°C without deteriorating.

Production in the United States is mainly at one Army ammunition plant. RDX in wastewater is not expected to be appreciable because of the low solubility of RDX in water. However, the potential for aquatic pollution may exist from RDX manufacturing, loading, transportation, and storage.

In soils, RDX persists, resists aerobic bacterial degradation, and slowly leaches into ground water. RDX is rapidly degraded by light. Volatilization is not a significant environmental fate.

PHARMACOKINETICS

RDX is completely absorbed when ingested, the rate being faster in rats than in humans, and rapidly distributes to body tissues. Highest RDX levels are found in kidneys, liver, brain, and heart. RDX is metabolized by the liver, and its metabolites are excreted in urine. The metabolites have not been characterized.

HEALTH EFFECTS

Humans

In some case studies of RDX ingestion by military personnel, symptoms of central nervous system (CNS) dysfunction including convulsions and coma were observed.

Data gathered through an occupational health study at an Army ammunition plant indicated that inhalation of dust containing RDX at unknown levels causes nausea and CNS dysfunction including convulsions and unconsciousness. In another study, medical tests of workers exposed to 1.57 mg RDX/m³ or less revealed no adverse health effects.

HEALTH EFFECTS

Experimental Animals

Single oral doses of RDX in rats and mice produce convulsions, labored breathing, and other CNS effects. Oral doses of RDX for 10 days in monkeys induced vomiting and convulsions.

Tests in rabbits indicate that RDX produces dermatitis. Slight erythema was observed in guinea pigs after the first but not subsequent applications. No conclusive results were obtained in dogs given repeated topical applications of RDX.

Toxic effects seen in 13-week feeding studies with rats and mice were increased liver weights and anemia.

Lifetime feeding studies in rats and mice showed increased mortality, weight loss, anemia, liver and kidney toxicity, testicular degeneration, and prostate inflammation.

Decreased fertility was observed in a two-generation reproductive study in rats. Decreased pup weights and embryo toxicity but no teratogenic effects were seen in the F_1 litter.

RDX has not been found to be mutagenic. It induces hepatocellular carcinomas and adenomas in mice.

OTHER CRITERIA, ANALYSES, AND TREATMENT TECHNOLOGIES

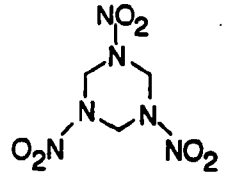
The American Conference of Governmental Industrial Hygienists (ACGIH) 8-hour time-weighted average Threshold Limit Value (TLV) for exposure to RDX is 1.5 mg/m³. The U.S. Army Medical Bioengineering Research and Development Laboratory recommends an RDX limit of 0.03 mg/L in drinking water.

Methods are available for the analysis of RDX in bulk material and in trace quantities. Volumetric methods involving reduction, hydrolysis, or acid-base titrations are used for bulk analysis. For analyzing trace quantities (below 10 parts per million), high-performance liquid chromatography appears to be the method of choice. Other methods include thin-layer chromatography, gas-liquid chromatography, and single-sweep polarography.

Treatment technologies for the removal of RDX in wastewater include ultraviolet (UV) radiation in combination with hydrogen peroxide, strongly alkaline ion exchange resins, chemical oxidation, chemical coagulation with lime, activated carbon, and aerobic and anaerobic microbial degradation.

Physical and Chemical Properties

Empirical Formula	$C_3H_6N_6O_6$
Synonyms	RDX, Cyclonite, Hexogen, Cyclotrimethylenetrinitramine, Hexahydro-1,3,5-trinitro-1,3,5-triazine, sym-Trimethylenetrinitramine, 1,3,5-Trinitrohexahydro-s-triazine, T_4
CAS Number	121-82-4
Physical State	White crystalline solid
Molecular Weight	222.26
Melting Point	204.1°C
Specific Gravity	1.816 at 20°C
Solubility (at 25°C)	In water: 7.6 mg/L. In acetone: 8.3% w/w. In nitrobenzene: 1.5% w/w.



Health Effects Data and Advisory Values

Genotoxicity

RDX did not induce genetic effects in *Salmonella typhimurium* and *Saccharomyces cerevisiae* assays, or in a rat dominant lethal assay. No unscheduled DNA synthesis was seen in *in vitro* studies with human fibroblasts.

Reproductive and Developmental Effects

Reduced rates of mating and fertility and decreased litter size and pup survival, but no teratogenic effects, were reported in a two-generation study of Fischer 344 rats. No developmental effects were found in New Zealand rabbits below maternally toxic doses.

Cancer Classification

EPA Group C, possible human carcinogen, based on hepatocellular adenomas and carcinomas in female B6C3F1 mice.

Reference Dose (RfD)

0.003 mg/kg/day

Drinking Water Equivalent Level (DWEL)

0.1 mg/L

Health Advisory Values

One-Day	0.1 mg/L
Ten-Day	0.1 mg/L
Longer-Term (child)	0.1 mg/L
Longer-Term (adult)	0.4 mg/L
Lifetime	0.002 mg/L

This summary was developed using information from the Drinking Water Health Advisory. For further information contact EPA's Office of Science and Technology at (202) 260-7571.

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