

**Potential toxic effects of contaminants DOD is seeking to exempt from the hazardous waste management law (RCRA) and the Superfund cleanup law (CERCLA):**

Perchlorates

Salts of perchlorate are used as an oxidizer and are the primary ingredient in solid propellant for rockets, missiles, fireworks, munitions. Perchlorate has been found in groundwater at numerous facilities around the country where, for example, rocket propellants and explosives have been handled. Perchlorate interferes with iodide uptake into the thyroid gland. Because iodide is an essential component of thyroid hormones, perchlorate disrupts how the thyroid functions. Impairment of thyroid function in expectant mothers impacts the fetus and newborn and results in effects including changes in behavior, delayed development, and decreased learning capability. Anti-thyroid effects can also result in thyroid gland tumors.

Trinitrotoluene (TNT)

EPA and the Agency for Toxic Substances and Disease Registry (ATSDR) have identified TNT as a possible human carcinogen. TNT is soluble and mobile in surface water and ground water. The ecological impacts of TNT include blood, liver, and immune system effects in wildlife. In addition, in laboratory tests, male test animals treated with high doses of TNT developed serious reproductive effects.

Royal Demolition Explosive (RDX)

EPA and ATSDR have identified RDX as a possible human carcinogen. RDX dissolves in and evaporates from water very slowly. Human exposure to RDX results from breathing dust with RDX particles in it, drinking contaminated water, or coming into contact with contaminated soils. RDX inhalation or ingestion can create nervous system problems, nausea, vomiting, and possibly organ damage.

The ecological effects of RDX suggested by laboratory studies include neurological damage including seizures and behavioral changes in wildlife that ingest or inhale RDX. Wildlife exposure to RDX may also cause damage to the liver and the reproductive system.

White Phosphorus

Reproductive effects. Liver, heart, or kidney damage, death. Skin burns, irritation of throat and lungs, vomiting, stomach cramps, drowsiness.

NOTE: There are more than 20 other explosive chemicals and toxic components of munitions with possible health effects that would also be exempted.

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**Table 3-3. Potential Toxic Effects of Exposure to Explosive Chemicals and Components**  
**Contaminant 2 Chemical Composition Potential Toxicity/Effects**

TNT 3	2,4,6-Trinitrotoluene	Possible human carcinogen, targets liver, skin irritations, cataracts.
	$C_7H_5N_3O_6$	
RDX 4	Hexahydro-1,3,5-trinitro-1,3,5-triazine	Possible human carcinogen, prostate problems, nervous system problems, nausea, vomiting. Laboratory exposure to animals indicates potential organ damage
	$C_3H_6N_6O_6$	
HMX 5	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	Animal studies suggest potential liver and central nervous system damage.
	$C_4H_8N_8O_8$	
PETN 6	Pentaerythritol tetranitrate	Irritation to eyes and skin; inhalation causes headaches, weakness, and drop in blood pressure.
	$C_5H_8N_4O_{12}$	
Tetryl 7	2,4,6-Trinitrophenyl-Nmethylnitramine	Coughing, fatigue, headaches, eye irritation, lack of appetite, nosebleeds, nausea, and vomiting. The carcinogenicity of tetryl in humans and animals has not been studied
	$C_7H_5N_5O_8$	
Picric acid 8	2,4,6-Trinitrophenol	Headache, vertigo, blood cell damage, gastroenteritis, acute hepatitis, nausea, vomiting, diarrhea, abdominal pain, skin eruptions, and serious dysfunction of the central nervous system.
	$C_6H_3N_3O_7$	
Explosive D 9	Ammonium picrate	Moderately irritating to the skin, eyes, and mucous membranes; can produce nausea, vomiting, diarrhea skin staining, dermatitis, coma, and seizures.
	$C_6H_6N_4O_7$	
Tetrazene 10	$C_2H_6N_{10}$	Associated with occupational asthma; irritant and convulsants, hepatotoxin, eye irritation and damage, cardiac depression and low blood pressure, bronchial mucous membrane destruction and pulmonary edema; death.
DEGDN 11	Diethylene glycol dinitrate	Targets the kidneys; nausea, dizziness, and pain in the kidney area. Causes acute renal failure
	$(C_2H_4NO_3)_2O$	
2,4-Dinitrotoluene 12	$C_7H_7N_2O_4$	Exposure can cause methemoglobinemia, anemia, leukopenia, liver necrosis, vertigo, fatigue, dizziness, weakness, nausea, vomiting, dyspnea, arthralgia, insomnia, tremor, paralysis, unconsciousness, chest pain, shortness of breath, palpitation, anorexia, and loss of weight.
2,6-Dinitrotoluene 13	$C_7H_7N_2O_4$	Exposure can cause methemoglobinemia, anemia, leukopenia, and liver necrosis.
Diphenylamine 14	N,N-Diphenylamine	Irritation to mucous membranes and eyes; pure substance toxicity low, but impure material may contain
	$C_{12}H_{11}N$	

4-biphenylamine, a potent carcinogen.

**Contaminant Chemical Composition Potential Toxicity/Effects**

Nitrosodiphenylamine 2  
 $C_{12}H_{10}N_2O$

Probable human carcinogen based on an increased incidence of bladder tumors in male and female rats and reticulum cell sarcomas in mice, and structural relationship to carcinogenic nitrosamines.

Phthalates 3 Various

An increase in toxic polyneuritis has been reported in workers exposed primarily to dibutyl phthalates; otherwise very low acute oral toxicity with possible eye, skin, or mucous membrane irritation from exposure to phthalic anhydride during phthalate synthesis.

Ammonium nitrate 4  $NH_4NO_3$

Prompt fall in blood pressure; roaring sound in the ears with headache and associated vertigo; nausea and vomiting; collapse and coma.

Nitroglycerine 5  
(Glycerol trinitrate) 6  
 $C_3H_5N_3O_9$

Eye irritation, potential cardiovascular system effects including blood pressure drop and circulatory collapse

Lead azide 7  $N_6Pb$

Headache, irritability, reduced memory, sleep disturbance, potential kidney and brain damage, anemia.

Lead styphnate 8  $PbC_6HN_3O_8 \cdot H_2O$

Widespread organ and systemic effects including central nervous system, immune system, and kidneys. Muscle and joint pains, weakness, risk of high blood pressure, poor appetite, colic, upset stomach, and nausea.

Mercury fulminate 9  $Hg(OCN)_2$

Inadequate evidence in humans for carcinogenicity; causes conjunctival irritation and itching; mercury poisoning including chills, swelling of hands, feet, cheeks, and nose followed by loss of hair and ulceration; severe abdominal cramps, bloody diarrhea, corrosive ulceration, bleeding, and necrosis of the gastrointestinal tract; shock and circulatory collapse, and renal failure.

White phosphorus 10  $P_4$

Reproductive effects. Liver, heart, or kidney damage; death; skin burns, irritation of throat and lungs, vomiting, stomach cramps, drowsiness.

Perchlorates 11  $ClO_4$

-Exposure causes itching, tearing, and pain; ingestion may cause gastroenteritis with abdominal pain, nausea vomiting, and diarrhea; systemic effects may follow and may include ringing of ears, dizziness, elevated blood pressure, blurred vision, and tremors. Chronic effects may include metabolic disorders of the thyroid.

Hydrazine 12  $N_2H_4$

Possible human carcinogen; liver, pulmonary, CNS, and respiratory damage; death.

Nitroguanidine 13  $CH_4N_4O_2$

No human or animal carcinogenicity data available.

Specific toxic effects are not documented.

**Table 3-4. Primary Uses of Explosive Materials 1**  
Compound 2 Propellant Primary or Initiator Booster Burster  
Charge Pyrotechnics Incendiary

TNT  
RDX  
HMX  
PETN  
Tetryl  
Picric acid  
Explosive D  
Tetrazene  
DEGDN  
Nitrocellulose  
2,4-  
Dinitrotoluene  
2,6  
Dinitrotoluene  
Ammonium Nitrate\  
Nitroglycerine  
Lead azide  
Lead styphnate  
Mercury fulminate  
White phosphorus  
Perchlorates  
Hydrazine  
Nitroguanidine

<sup>54</sup>Agency for Toxic Substances and Disease Registry, *Toxicological Profile for White Phosphorous*, U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA, 1970.

<sup>55</sup>*Carcinogenicity Assessment for Lifetime Exposure of Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), and Carcinogenicity Assessment for 2,4,6-trinitrotoluene (TNT) for Lifetime Exposure*, EPA Integrated Risk Information System, 1993.

<sup>56</sup>Agency for Toxic Substances and Disease Registry, *Toxicological Profile for 2,4,6-trinitrotoluene (update), and Toxicological Profile for RDX*, U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA, 1995.

***White Phosphorus 1***

One of the most frequently used pyrotechnics is white phosphorus, which is used for “spotting” or marking an area. White phosphorus burns rapidly when exposed to oxygen. In soils with low oxygen, unreacted white phosphorus can lie dormant for years, but as soon as it is exposed to oxygen, it may react. If ingested, white phosphorus can cause reproductive, liver, heart, or kidney damage, or death. Skin contact can burn the skin or cause organ damage.<sup>54</sup>

***Trinitrotoluene (TNT)***

TNT is soluble and mobile in surface water and groundwater. It is rapidly broken down into

other chemical compounds by sunlight, and is broken down more slowly by microorganisms in water and sediments. TNT is not expected to bioaccumulate under normal environmental conditions. Human exposure to TNT may result from breathing air contaminated with TNT and TNT-contaminated soil particles stirred up by wind or construction activities. Workers in explosive manufacturing who are exposed to high concentrations of TNT in workplace air experience a variety of organ and immune system problems, as well as skin irritations and cataracts. Both EPA and ATSDR have identified TNT as a possible human carcinogen.

#### **Toxicological Profiles of RDX and TNT**

The EPA's IRIS uses a weight-of-evidence classification for carcinogenicity that characterizes the extent to which the available data support the hypothesis that an agent causes cancer in humans. IRIS classifies carcinogenicity alphabetically from A through E, with Group A being known human carcinogens and Group E being agents with evidence of noncarcinogenicity. IRIS classifies both TNT and RDX as Group C, possible human carcinogens, and provides a narrative explanation of the basis for these classifications.<sup>55</sup>

The ATSDR is tasked with preventing exposure and adverse human health effects and diminished quality of life associated with exposure to hazardous substances from waste sites, unplanned releases, and other sources of pollution present in the environment.

The ATSDR has developed toxicological profiles for RDX and TNT to document the health effects of exposure to these substances. The ATSDR has identified both TNT and RDX as possible human carcinogens.<sup>56</sup>

The ecological impacts of TNT include blood, liver, and immune system effects in wildlife. In addition, in laboratory tests, male test animals treated with high doses of TNT developed serious reproductive system effects.

#### ***Royal Demolition Explosive (RDX)***

RDX, also known as Royal Demolition Explosive, is another frequently found synthetic explosive chemical. RDX dissolves in and evaporates from water very slowly. RDX does not bind well to soil particles and can migrate to groundwater, but the rate of migration depends on the soil composition. If released to water, RDX is degraded mainly by direct photochemical degradation that takes place over several weeks. RDX does not biologically degrade in the presence of oxygen, but anaerobic degradation is a possible fate process under certain conditions. RDX's potential for bioaccumulation is low. Human exposure to RDX results from breathing dust with RDX particles in it, drinking contaminated water, or coming into contact with contaminated soils. RDX inhalation or ingestion can create nervous system problems and possibly organ damage. As discussed previously, RDX has been identified as a possible human carcinogen.

The ecological effects of RDX suggested by laboratory studies include neurological damage including seizures and behavioral changes in wildlife that ingest or inhale RDX. Wildlife exposure to RDX may also cause damage to the liver and the reproductive system.