

A LIST OF  
CHEMICAL, BIOLOGICAL, AND SMOKE COMPOUNDS  
RELEASED IN THE OPEN ATMOSPHERE AT DUGWAY  
(1942-1995)

APRIL 1995

U.S. ARMY DUGWAY PROVING GROUND  
DUGWAY, UTAH 84022-5000

CHEMICALS RELEASED IN THE OPEN ATMOSPHERE AT DUGWAY

AC	Hydrogen cyanide
AC-CK	Hydrogen cyanide-cyanogen chloride mixture
CK	Cyanogen chloride
Agent BLUE	Cacodylic acid or dimethylarsenic acid (Phytar 560G)
Butane	Butane bomb and gasoline bomb
BZ	2-quinuclidinyl benzilate
CA	Bromobenzylcyanide
CN	Tear gas (Chloroacetophenone)
CNB	Chloroacetophenone in benzene and carbon tetrachloride
CNC	Chloroacetophenone in chloroform
CNS	Chloroacetophenone, chloropicrin and chloroform mixture
CS	Super tear gas (O-chlorobenzylidene malononitrile)
CG	Phosgene (Carbonyl chloride)
DP	Diphosgene (Trichloromethyl chloroformate)
CX	Phosgene oxime
DA	Diphenylchloroarsine
DC	Diphenylcyanoarsine
DF	Methyl phosphonyl difluoride (GB precursor)
DM	Adamsite (Diphenylaminochloroarsine)
ED	Ethylidichloroarsine
MD	Methylidichloroarsine
PD	Phenylidichloroarsine
GA	Tabun (Ethyl N, N-dimethyl phosphoramidocyanidate)
GB	Sarin (Isopropyl methyl phosphonofluoridate)
GD*	Soman (Pinacolyl methyl phosphonofluoridate)
H	Levinstein mustard
Thickend H	Levinstein mustard thickend with asbestos
HC	Mixture of grained aluminum, zinc oxide, hexachloroethane
ED	Distilled mustard [Bis-(2-chloroethyl) sulfide]
HL	Distilled mustard-Lewisite mixture
EN-1	Nitrogen mustard (2,2-Dichlorotriethylamine)
EN-2	Nitrogen mustard (2,2'-Dichloro-N-methyldiethylamine)
EN-3	Nitrogen mustard (2,2',2"-trichlorotriethylamine)
HS	Sulfur mustard
HT	Mustard-T mixture (Levinstein mustard and oxygen mustard)
L	Lewisite [Dichloro (2-chlorovinyl) arsine]
LNA	2,4-Dichlorophenoxyacetic acid (2,4-D)
LNB	2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)
LNX (Agent ORANGE)	50% 2,4-Dichlorophenoxyacetic acid (2,4-D) 50% 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)

\*GD only tested indoors at DPG.

CHEMICALS RELEASED IN THE OPEN ATMOSPHERE AT DUGWAY (Cont'd)

Napalm	50%	acid from coconut oil
	25%	naphthenic acid
	25%	oleic acid
Napalm B	46%	polystyrene
	21%	benzene
	33%	gasoline
NC	33%	rhombic sulfur (NE) in carbon disulfide
NE		Rhombic sulfur (precursor of VX)
OPA		Isopropyl alcohol-Isopropyl amine (GB precursor)
OL		O-Ethyl 2-diisopropylaminoethyl methylphosphonite (precursor of VX)
RP		Red phosphorus
SA		Arsine (Arsenic trihydride)
TEA		Triethyl aluminum
TE		Thermit (Thermite)
Thermite	73%	Ferric oxide
	27%	Fine granular aluminum
VX		O-Ethyl-S(2-diisopropylaminoethyl) methylphosphonothiolate
WP		White phosphorus ( $P_4$ )
EWP		Eutectic white phosphorus ( $P_2S_5$ in white phosphorus)
PWP		Plasticized white phosphorus <sup>2</sup> (mixed with synthetic rubber)

SIMULANTS RELEASED IN THE OPEN ATMOSPHERE AT DUGWAY

AA	2,4-Pentanedione or acetylacetone
BIS	Bis-(2-ethylhexyl) hydrogen phosphite
BUSH	n-Butyl mercaptan
Corn Oil	
CEES	Chloroethyl ethyl sulfide
CT	<u>o</u> -Chlorotoluene
DBA	di-n-butylamine
DC	Methyl phosphonyl dichloride
o-DCB	o-Dichlorobenzene
DCP	1,5-Dichloropentane
DEHP	Diethyl hydrogen phosphite
DEM	Diethyl malonate
DFP	Diisopropyl fluorophosphate
DIMP	Diisopropyl methylphosphonate
DMHP	Dimethyl hydrogen phosphite
DMMP	Dimethyl methylphosphonate
DMP	Dimethyl phosphite
DMSO	Dimethyl sulfoxide
DOP	Bis-(2-ethylhexyl) phthalate
DPM	Propyleneglycol monomethyl ether
EA	Ethyl acetate
EAA	Ethyl acetoacetate
ECA	Ethyl chloroacetate
EDA	Ethyl dichloroacetate
EtOH	Ethyl alcohol
Freon E3	
Freon 113	1,1,2-Trichloro 1,2,2-Trifluoroethane
HA	Enanthaldehyde or heptanal
HEES	2-Hydroxyethyl ethyl sulfide
IPA	Isopropyl alcohol
Lutidine	2,6-Lutidine
MA	Methyl anthranilate
MAA	Methyl acetoacetate
MeS	Methyl salicylate
MC	Cacodylic acid
ML	1,3,5-Trimethylbenzene or mesitylene
MR	Molasses residuum (mustard simulant)
MS	Methyl salicylate (MeS)

SIMULANTS RELEASED IN THE OPEN ATMOSPHERE AT DUGWAY (Cont'd)

NM	Dimethyl polysulfide
PA	Propionic acid
PEG 200	Polyethylene glycol 200
PEG 300	Polyethylene glycol 300
PERC	Perchloroethylene (tetrachloroethylene, TCE)
PG	Propylene glycol
SF <sub>6</sub>	Sulfur hexafluoride
SnCl <sub>4</sub>	Stannic chloride
TBP	Tributyl phosphate
TCE	Tetrachloroethylene (PERC)
TCP	1,2,3-Trichloropropane
TEF	Triethyl orthoformate
TEP	Triethyl phosphate
TiCl <sub>4</sub>	Titanium tetrachloride
TIP	Triisopropyl phosphite
TOF	Tri(2-ethylhexyl) phosphate
	Trans-1,4-dichloro-2-butene

COMPOSITION OF ANTICROP AGENTS (HERBICIDES OR DEFOLIANTS)

Chemical Composition	ORANGE	PURPLE	PINK	GREEN	WHITE	BLUE
2,4-D (2,4-Dichlorophenoxyacetic acid)	50%	50%			80%	
n-Butyl ester of 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	50%	30%	60%	98-100		
Isobutyl ester of 2,4,5-T		20%	40%			
4-Amino 3,5,6-trichloropicolinic acid					20%	
Cacodylic acid (Dimethyl arsenic acid)						5%
Sodium cacodylate						29%
Water						66%

# Smoke and Obscurant Testing

## Projected Materials for Smoke Week XV

Fog Oil	14,400.0	gls
JP5	4,320.0	gls
Diesel	4,320.0	gls
Graphite	72,034.9	lbs
Kaolin	43,200.0	lbs
Brass	44,697.6	lbs
Dust (Silica)	72,000.0	lbs
Aluminum	43,200.0	lbs
Crude Oil, Arab Meduim	800.0	gls
Iron Pentacarbonyl	111.0	gls
M76 flare	36.0	flare
White Phosphorous	4,620.0	lbs
Red Phosphorous	15,728.4	lbs
Carbon Fiber	4,783.2	lbs
Al Coated Glass Fiber	300.0	lbs
Flare Pellets	432.0	lbs
Primer Cord	29.7	lbs
C4	48.8	lbs
PEG 200	543.6	lbs
OGA 476	2.9	lbs
Trimethyl benzene	0.09	lbs
PBXN 5	6.1	lbs
PBXN 201	118.9	lbs

Table 3-2. Colored Smoke Fillings

Type mixture	Ingredient	Percentage (approximate)
Red smoke	Dye: 1-N-Methylaminoanthraquinone	42
	85 percent; dextrin 15 percent	19
	Sodium bicarbonate	28
	Potassium chlorate	11
Green smoke	Sulfur	
	1,4-di-p-toluidinoanthraquinone	
	70 percent; Indanthrene golden yellow	40.0
	10.5 percent; Benzanthrone 19.5 percent	22.6
Yellow smoke	Sodium bicarbonate	27.0
	Potassium chlorate	10.4
	Sulfur	
	Benzanthrone 65 percent; Indanthrene	38.5
Violet smoke	Golden yellow 35 percent	33.0
	Sodium bicarbonate	20.0
	Potassium chlorate	8.5
	Sulfur	
Starter	1,4-diamino-2,3-dihydroanthraquinone	42.0
	80 percent; 1-N-Methyl aminoanthraquinone 20 percent	18.0
	Sodium bicarbonate	28.8
	Potassium chlorate	11.2
Starter	Sulfur	37.8
	Potassium nitrate	28.0
	Silicon	4.2
	Charcoal	1.2
Starter	Cellulose nitrate	28.8
	Acetone	

APPENDIX C

Test Materials Used in Open Air Tests at DPG

Test Material	Agent Simulated	Test Program	Test Description
TCP (1,2,3-trichloropropane)	GB	XM687	Explosive dissemination to determine area coverage, contamination density, and agent cloud formation for the XM687 binary GB projectile
EDA and Freon 113 (ethyl dichloroacetate and 1,1,2-trichloro-1,2,2-trifluoroethane)	GB2	XM687	Explosive dissemination to obtain area coverage, contamination density, and agent cloud formation for the XM687 binary GB projectile
1-Bromopropane	GB2	XM687	Explosive dissemination to obtain area coverage, contamination density, and agent cloud formation for the XM687 binary GB projectile
Methylcyclohexane	GB2	XM687	Explosive dissemination to determine if flashing is effected
Acetic acid, ethylene glycol, triethylamine, 2-propanol, and brom cresol purple	GB2 GB2 VX2	XM687	Simulated weight to determine a projectile ballistic match
PG (propylene glycol)	TGD	Agent Transfer Test	Pickup and transfer of thickened agent
DEM (diethyl malonate)	TGD	Agent Transfer Test	Pickup and transfer of thickened agent

APPENDIX C  
Test Materials Used in Oper Air Tests at RPG (continued)

Test Material	Agent Simulated	Test Program	Test Description
BIS [ bis(2-ethylhexyl) hydrogen phosphite ]	VX	TNU28/B	Evaluation of area coverage and downwind hazard associated with inadvertent release of the munition
	TGD	Thickened Agent Investigation	Contamination density on ground and manikins from aerielly released thickened test material
	VX	TNU28/B and Aero 148	Area coverage, contamination density, particle size distribution and aerosol travel from aerial spray systems
	VX	70-11 69-10	Aerielly released spray to determine area coverage
TOF [ tris(2-ethylhexyl) phosphate ]	TGD	DECAP CHUTE	Decontamination of vehicles contaminated with thickened test material
DMMP (dimethyl methyl- phosphonate)	TGD	74-01n	Vapor penetration of enclosure, agent pickup and decontamination of equipment contaminated with thickened test material
	TGD	049-004	Thickened simulant investigation to determine the munition characteristics of the M107 projectile
TEP/EA/DBA (triethyl phosphite, ethyl acetate, di-n-butylamine)	VX2	XM736	Explosive dissemination for area coverage, particle-size distribution and source parameters. Also in-flight mixing and hazard classification testing