**VX** ([IUPAC](https://en.wikipedia.org/wiki/IUPAC) name *O*-ethyl *S*-[2-(diisopropylamino)ethyl] methylphosphonothioate) is an extremely toxic substance that has no known uses except in [chemical warfare](https://en.wikipedia.org/wiki/Chemical_warfare) as a [nerve agent](https://en.wikipedia.org/wiki/Nerve_agent). It is a tasteless and odorless liquid. As a [chemical weapon](https://en.wikipedia.org/wiki/Chemical_weapons), it is classified as a[weapon of mass destruction](https://en.wikipedia.org/wiki/Weapon_of_mass_destruction) by the [United Nations](https://en.wikipedia.org/wiki/United_Nations) in [UN Resolution 687](https://en.wikipedia.org/wiki/UN_Resolution_687). The production and stockpiling of VX was outlawed by the[Chemical Weapons Convention](https://en.wikipedia.org/wiki/Chemical_Weapons_Convention) of 1993.

The VX [nerve agent](https://en.wikipedia.org/wiki/Nerve_agent) is the best-known of the [V-series of nerve agents](https://en.wikipedia.org/wiki/Nerve_agent#V-series) and is considered an [area denial weapon](https://en.wikipedia.org/wiki/Area_denial_weapon) due to its physical properties.

**Contents**

  [[hide](https://en.wikipedia.org/wiki/VX_(nerve_agent))]

* [1 Discovery](https://en.wikipedia.org/wiki/VX_(nerve_agent)#Discovery)
* [2 Chemical characteristics](https://en.wikipedia.org/wiki/VX_(nerve_agent)#Chemical_characteristics)
* [3 Synthesis](https://en.wikipedia.org/wiki/VX_(nerve_agent)#Synthesis)
* [4 Solvolysis](https://en.wikipedia.org/wiki/VX_(nerve_agent)#Solvolysis)
* [5 Biological effects](https://en.wikipedia.org/wiki/VX_(nerve_agent)#Biological_effects)
* [6 Treatment](https://en.wikipedia.org/wiki/VX_(nerve_agent)#Treatment)
* [7 Diagnostic tests](https://en.wikipedia.org/wiki/VX_(nerve_agent)#Diagnostic_tests)
* [8 History](https://en.wikipedia.org/wiki/VX_(nerve_agent)#History)
* [9 US VX stockpile elimination](https://en.wikipedia.org/wiki/VX_(nerve_agent)#US_VX_stockpile_elimination)
* [10 Worldwide VX stockpile elimination](https://en.wikipedia.org/wiki/VX_(nerve_agent)#Worldwide_VX_stockpile_elimination)
* [11 In popular culture](https://en.wikipedia.org/wiki/VX_(nerve_agent)#In_popular_culture)
* [12 See also](https://en.wikipedia.org/wiki/VX_(nerve_agent)#See_also)
* [13 References](https://en.wikipedia.org/wiki/VX_(nerve_agent)#References)
* [14 External links](https://en.wikipedia.org/wiki/VX_(nerve_agent)#External_links)

Discovery[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=1)]

Ranajit Ghosh, a chemist at the Plant Protection Laboratories of the British firm [Imperial Chemical Industries](https://en.wikipedia.org/wiki/Imperial_Chemical_Industries) (ICI), was investigating a class of [organophosphate](https://en.wikipedia.org/wiki/Organophosphate) compounds (organophosphate [esters](https://en.wikipedia.org/wiki/Esters) of substituted aminoethanethiols).[[3]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-3) Like [Gerhard Schrader](https://en.wikipedia.org/wiki/Gerhard_Schrader), an earlier investigator of organophosphates, Ghosh found that they were quite effective [pesticides](https://en.wikipedia.org/wiki/Pesticide). In 1954, ICI put one of them on the market under the trade name [Amiton](https://en.wikipedia.org/wiki/Amiton). It was subsequently withdrawn, as it was too toxic for safe use. The toxicity did not go unnoticed, and samples of it had been sent to the British Armed Forces research facility at [Porton Down](https://en.wikipedia.org/wiki/Porton_Down) for evaluation. After the evaluation was complete, several members of this class of compounds became a new group of nerve agents, the V agents. The best-known of these is probably VX, assigned the UK [Rainbow Code](https://en.wikipedia.org/wiki/List_of_Rainbow_Codes#Purple) Purple Possum, with the [Russian V-Agent](https://en.wikipedia.org/wiki/VR_(nerve_agent)) coming a close second (Amiton is largely forgotten as VG). This class of compounds is also sometimes known as Tammelin's esters, after [Lars-Erik Tammelin](https://en.wikipedia.org/wiki/Lars-Erik_Tammelin) of the [Swedish Defence Research Agency](https://en.wikipedia.org/wiki/Swedish_Defence_Research_Agency). Tammelin was also conducting research on this class of compounds in 1952, but did not widely publicize his work.

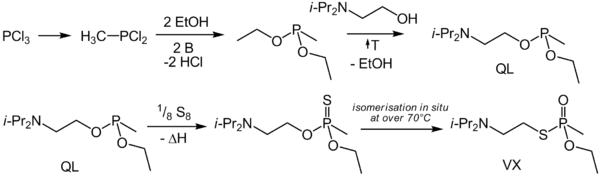
Chemical characteristics[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=2)]

With its high [viscosity](https://en.wikipedia.org/wiki/Viscosity) and low [volatility](https://en.wikipedia.org/wiki/Volatility_(chemistry)), VX has the texture and feel of motor oil. This makes it especially dangerous, as it has a high persistence in the environment. It is odorless and tasteless, and can be distributed as a liquid, either pure or as a mixture with a polymer in the form of thickened agent, or as an aerosol.

VX is an [acetylcholinesterase inhibitor](https://en.wikipedia.org/wiki/Acetylcholinesterase_inhibitor), *i.e.*, it works by blocking the function of the [enzyme](https://en.wikipedia.org/wiki/Enzyme) [acetylcholinesterase](https://en.wikipedia.org/wiki/Acetylcholinesterase). Normally, an electric nerve pulse would cause the release of [acetylcholine](https://en.wikipedia.org/wiki/Acetylcholine) over a [synapse](https://en.wikipedia.org/wiki/Synapse) that would stimulate muscle contraction. The acetylcholine is then broken down to non-reactive substances ([acetic acid](https://en.wikipedia.org/wiki/Acetic_acid) and [choline](https://en.wikipedia.org/wiki/Choline)) by the acetylcholinesterase enzyme. If more muscle tension is needed the nerve must release more acetylcholine. VX blocks the action of acetylcholinesterase, thus resulting in initial violent contractions, followed by sustained supercontraction restricted to the subjunctional [endplate](https://en.wikipedia.org/wiki/Neuromuscular_junction) [sarcoplasm](https://en.wikipedia.org/wiki/Sarcoplasm) and prolonged depolarizing neuromuscular blockade, the latter resulting in flaccid paralysis of all the muscles in the body. Sustained paralysis of the[diaphragm muscle](https://en.wikipedia.org/wiki/Diaphragm_muscle) causes death by [asphyxiation](https://en.wikipedia.org/wiki/Asphyxiation).

Synthesis[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=3)]

VX is produced via the "transester process". This entails a series of steps whereby [phosphorus trichloride](https://en.wikipedia.org/wiki/Phosphorus_trichloride) is [methylated](https://en.wikipedia.org/wiki/Methylated) to produce methyl phosphonous dichloride. The resulting material is reacted with [ethanol](https://en.wikipedia.org/wiki/Ethanol) to form a [diester](https://en.wikipedia.org/wiki/Diester). This is then [transesterified](https://en.wikipedia.org/wiki/Transesterification) with [*N*,*N*-diisopropylaminoethanol](https://en.wikipedia.org/wiki/N,N-Diisopropylaminoethanol) to produce the mixed [phosphonite](https://en.wikipedia.org/wiki/Phosphonite). Finally, this immediate precursor is reacted with sulfur to form VX.

[](https://en.wikipedia.org/wiki/File:VX_TransesterProcess.png)

VX can also be delivered in binary chemical weapons which mix in-flight to form the agent prior to release. Binary VX is referred to as VX2,[[4]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-ellison-4) and is created by mixing *O*-(2-diisopropylaminoethyl) *O′*-ethyl methylphosphonite ([Agent QL](https://en.wikipedia.org/wiki/QL_(chemical))) with elemental sulfur (Agent NE) as is done in the [Bigeye aerial chemical bomb](https://en.wikipedia.org/wiki/Bigeye_bomb). It may also be produced by mixing with sulfur compounds, as with the liquid dimethyl polysulfide mixture (Agent NM) in the canceled XM-768 8-inch binary projectile program.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

Solvolysis[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=4)]

Like other [organophosphorus](https://en.wikipedia.org/wiki/Organophosphorus) nerve agents, VX may be destroyed by reaction with strong nucleophiles. The reaction of VX with concentrated aqueous sodium hydroxide results in competing cleavage of the P-O and P-S esters, with P-S cleavage dominating. This is somewhat problematic, as the product of P-O bond cleavage (named EA 2192) remains toxic. In contrast, reaction with the [hydroperoxide](https://en.wikipedia.org/wiki/Hydroperoxide) anion (hydroperoxidolysis) leads to exclusive cleavage of the P-S bond.[[5]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-5)[[6]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-6)

|  |  |
| --- | --- |
| [VX-solvolysis-P-S-2D-skeletal.png](https://en.wikipedia.org/wiki/File:VX-solvolysis-P-S-2D-skeletal.png) | **P-S cleavage** NaOH(aq) reacts with VX in two ways. It can cleave VX's P-S bond, yielding two relatively nontoxic products... |
| [VX-solvolysis-P-O-2D-skeletal.png](https://en.wikipedia.org/wiki/File:VX-solvolysis-P-O-2D-skeletal.png) | **P-O cleavage** ...or it can cleave VX's P-O bond, forming ethanol and EA 2192 (shown in red), which has similar toxicity to VX itself |

Biological effects[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=5)]

*Further information:*[*Nerve agent biological effects and treatment*](https://en.wikipedia.org/wiki/Nerve_agent#Biological_effects)

VX is the most toxic nerve agent ever synthesized for which activity has been independently confirmed.[[7]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-cfr-7) The [median lethal dose](https://en.wikipedia.org/wiki/Median_lethal_dose) (LD50) for humans is estimated to be about 10 milligrams[[8]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-FoAS-8) through skin contact and the LCt50 for inhalation is estimated to be 30–50 mg·min/m3.[[8]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-FoAS-8)

Early symptoms of percutaneous exposure (skin contact) may be local muscular twitching or sweating at the area of exposure followed by nausea or vomiting. Some of the early symptoms of a VX vapor exposure to nerve agent may be [rhinorrhea](https://en.wikipedia.org/wiki/Rhinorrhea) (runny nose) and/or tightness in the chest with shortness of breath (bronchial constriction). [Miosis](https://en.wikipedia.org/wiki/Miosis)(pinpointing of the pupils) may be an early sign of agent exposure but is not usually used as the only indicator of exposure.[[9]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-DAPAM385-61-9)

Treatment[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=6)]

Primary consideration should be given to removal of the liquid agent from the skin before removal of the individual to an uncontaminated area or atmosphere. After removal from the contaminated area, the casualty will be decontaminated by washing the contaminated areas with household bleach and flushing with clean water. After decontamination, the contaminated clothing is removed and skin contamination washed away. If possible, decontamination is completed before the casualty is taken for further medical treatment.

An individual who has received a known nerve-agent exposure or who exhibits definite signs or symptoms of nerve-agent exposure should immediately have the nerve agent antidote drugs [atropine](https://en.wikipedia.org/wiki/Atropine) and [pralidoxime](https://en.wikipedia.org/wiki/Pralidoxime) (2-PAM), and a sedative/antiepileptic such as [diazepam](https://en.wikipedia.org/wiki/Diazepam) injected. In several nations the nerve agent antidotes are issued for military personnel in the form of an [autoinjector](https://en.wikipedia.org/wiki/Autoinjector) such as the United States military [Mark I NAAK](https://en.wikipedia.org/wiki/Mark_I_NAAK).[[9]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-DAPAM385-61-9)

Atropine works by binding and blocking a subset of acetylcholine receptors (known as [muscarinic acetylcholine receptor](https://en.wikipedia.org/wiki/Muscarinic_acetylcholine_receptor), mAchR), so that the buildup of acetylcholine produced by loss of the acetylcholinesterase function can no longer affect their target.

VX (and other organophosphates) block the enzymatic activity of acetylcholinesterase (AChE) by binding to the active site of the enzyme. The phosphate group on VX is then transferred from VX to AChE, inactivating the enzyme and producing an inactive metabolite of VX. The injection of pralidoxime (2-PAM) removes the phosphate group from AChE, reactivating it, thereby reversing the effects of VX. If pralidoxime is not given soon enough, the inactivated enzyme will "age", resulting in a much stronger AChEW-phosphate that pralidoxime cannot reverse.[[10]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-10)[[11]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-11)

Diagnostic tests[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=7)]

Controlled studies in humans have shown that minimally toxic doses cause 70–75% depression of [erythrocyte](https://en.wikipedia.org/wiki/Red_blood_cell) [cholinesterase](https://en.wikipedia.org/wiki/Cholinesterase) within several hours of exposure. The serum level of [ethyl](https://en.wikipedia.org/wiki/Ethyl_group) [methyl](https://en.wikipedia.org/wiki/Methyl_group)[phosphonic acid](https://en.wikipedia.org/wiki/Phosphonate) (EMPA), a VX hydrolysis product, was measured to confirm exposure in one poisoning victim.[[12]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-12)

History[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=8)]

*For an in-depth discussion, see main article on*[*nerve agent history*](https://en.wikipedia.org/wiki/Nerve_agent#History)

The chemists [Ranajit Ghosh](https://en.wikipedia.org/w/index.php?title=Ranajit_Ghosh&action=edit&redlink=1) and J.F. Newman discovered the V-series nerve agents at [ICI](https://en.wikipedia.org/wiki/Imperial_Chemical_Industries) in 1952, patenting diethyl S-2-diethylaminoethyl phosphono- thioate ([agent VG](https://en.wikipedia.org/wiki/VG_(nerve_agent))) in November 1952. Further commercial research on similar compounds ceased in 1955 when its lethality to humans was discovered. The US went into production of large amounts of VX in 1961 at [Newport Chemical Depot](https://en.wikipedia.org/wiki/Newport_Chemical_Depot).

There was evidence of a combination of chemical agents having been used by [Iraq](https://en.wikipedia.org/wiki/Iraq) against the Kurds at [Halabja](https://en.wikipedia.org/wiki/Halabja) in 1988 under [Saddam Hussein](https://en.wikipedia.org/wiki/Saddam_Hussein).[[13]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-13) Hussein later testified to[UNSCOM](https://en.wikipedia.org/wiki/UNSCOM) that Iraq had researched VX, but had failed to weaponize the agent due to production failure. After U.S. and allied forces had invaded Iraq, no VX agent or production facilities were found. However, UNSCOM laboratories detected traces of VX on warhead remnants.[[14]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-vol1_rsi-06-14)[[15]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-15)

In December 1994 and January 1995, [Masami Tsuchiya](https://en.wikipedia.org/w/index.php?title=Masami_Tsuchiya_(Aum_Shinrikyo)&action=edit&redlink=1) of [Aum Shinrikyo](https://en.wikipedia.org/wiki/Aum_Shinrikyo) synthesized 100 to 200 grams of VX which was used to attack three persons. Two persons were injured and one 28-year-old man died, who is believed to be the only fully documented victim of VX ever in the world.[[16]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-16) The VX victim, whom [Shoko Asahara](https://en.wikipedia.org/wiki/Shoko_Asahara) had suspected as a spy, was attacked at 7:00 am on December 12, 1994 on the street in Osaka by [Tomomitsu Niimi](https://en.wikipedia.org/wiki/Tomomitsu_Niimi) and another AUM member, who sprinkled the nerve agent on his neck. He chased them for about 100 yards (90 metres) before collapsing, dying 10 days later without ever coming out of a deep coma. Doctors in the hospital suspected at the time he had been poisoned with an organophosphate pesticide. But the cause of death was pinned down only after cult members arrested for the [subway attack](https://en.wikipedia.org/wiki/Sarin_gas_attack_on_the_Tokyo_subway) confessed to the killing. Ethyl methylphosphonate, methylphosphonic acid and diisopropyl-2-(methylthio) ethylamine were later found in the body of the victim. Unlike the cases for [sarin](https://en.wikipedia.org/wiki/Sarin) gas (the[Matsumoto incident](https://en.wikipedia.org/wiki/Matsumoto_incident) and the attack on the Tokyo subway), VX was not used for mass murder.

Some countries known to possess VX are the United States, Russia,[[17]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-autogenerated1-17) and Syria.[[18]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-18) A [Sudanese](https://en.wikipedia.org/wiki/Sudan) pharmaceutical facility, the [Al-Shifa pharmaceutical factory](https://en.wikipedia.org/wiki/Al-Shifa_pharmaceutical_factory), was bombed by the U.S. in 1998 acting on information that it produced VX and that the origin of the agent was associated with both Iraq and [Al Qaeda](https://en.wikipedia.org/wiki/Al_Qaeda).[[14]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-vol1_rsi-06-14) The US had obtained soil samples identified as containing [*O*-ethyl hydrogen methylphosphonothioate](https://en.wikipedia.org/wiki/O-Ethyl_methylphosphonothioic_acid) (EMPTA), a chemical used in the production of VX which may also have commercial applications. Chemical weapons experts later suggested that the widely used [Fonophos](https://en.wikipedia.org/wiki/Fonophos) organophosphate insecticide could have been mistaken for EMPTA.[[19]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-19)

US VX stockpile elimination[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=9)]

In 1969, the US government canceled its chemical weapons programs, banned the production of VX in the US, and began the destruction of its stockpiles of agents by a variety of methods. Early disposal included the US Army's [CHASE](https://en.wikipedia.org/wiki/Operation_CHASE) (Cut Holes And Sink 'Em) program, in which old ships were filled with chemical weapons stockpiles and then [scuttled](https://en.wikipedia.org/wiki/Scuttling). CHASE 8 was conducted on June 15, 1967, in which the S.S. *Cpl. Eric G. Gibson* was filled with 7,380 VX rockets and scuttled in 7,200 feet (2,200 m) of water, off the coast of[Atlantic City, New Jersey](https://en.wikipedia.org/wiki/Atlantic_City,_New_Jersey).

In fiscal year 2008, the US Department of Defense released a study finding that the U.S. had dumped at least 124 tons of VX into the Atlantic Ocean off the coasts of New York/New Jersey and Florida, between 1919 and 1970. This material consisted of nearly 22,000 [M55 rockets](https://en.wikipedia.org/wiki/M55_rocket), 19 bulk containers holding 1,400 pounds (640 kg) each, and one[M23 chemical landmine](https://en.wikipedia.org/wiki/M23_chemical_mine).[[20]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-20)

[Incineration](https://en.wikipedia.org/wiki/Incineration) was used for VX stockpile destruction starting in 1990 with [Johnston Atoll Chemical Agent Disposal System](https://en.wikipedia.org/wiki/Johnston_Atoll_Chemical_Agent_Disposal_System) in the North Pacific with other incineration plants following at [Deseret Chemical Depot](https://en.wikipedia.org/wiki/Deseret_Chemical_Depot), [Pine Bluff Arsenal](https://en.wikipedia.org/wiki/Pine_Bluff_Arsenal), [Umatilla Chemical Depot](https://en.wikipedia.org/wiki/Umatilla_Chemical_Depot) and [Anniston Army Depot](https://en.wikipedia.org/wiki/Anniston_Army_Depot) with the last of the VX inventory destroyed on December 24, 2008.[[21]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-21)

|  |  |
| --- | --- |
| https://upload.wikimedia.org/wikipedia/commons/thumb/2/24/Wikinews-logo.svg/40px-Wikinews-logo.svg.png | [*Wikinews*](https://en.wikipedia.org/wiki/Wikinews) has related news: |
| * [United States begins testing equipment for demolition of a major VX nerve gas stockpile](https://en.wikinews.org/wiki/United_States_begins_testing_equipment_for_demolition_of_a_major_VX_nerve_gas_stockpile) * [US VX nerve gas disposal test a success](https://en.wikinews.org/wiki/US_VX_nerve_gas_disposal_test_a_success) | |

The [Newport Chemical Depot](https://en.wikipedia.org/wiki/Newport_Chemical_Depot) began VX stockpile elimination using chemical neutralization in 2005. VX was hydrolyzed to much less toxic byproducts by using concentrated caustic solution, and the resulting waste was then shipped off-site for further processing. Technical and political issues regarding this secondary byproduct resulted in delays, but the depot completed their VX stockpile destruction in August, 2008.[[22]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-22)

The remaining VX stockpile in the US will be treated by the [Blue Grass Chemical Agent-Destruction Pilot Plant](https://en.wikipedia.org/wiki/Blue_Grass_Chemical_Agent-Destruction_Pilot_Plant), part of the [Program Executive Office, Assembled Chemical Weapons Alternatives](https://en.wikipedia.org/wiki/Program_Executive_Office,_Assembled_Chemical_Weapons_Alternatives) program. The program was established as an alternative to the incineration process successfully used by the Army Chemical Materials Agency, which completed its stockpile destruction activities in March 2012. The Blue Grass Pilot Plant has been plagued by repeated cost over-runs and schedule slippages since its inception.[[23]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-23)

Worldwide VX stockpile elimination[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=10)]

Worldwide, VX disposal has continued since 1997 under the mandate of the [Chemical Weapons Convention](https://en.wikipedia.org/wiki/Chemical_Weapons_Convention).

In Russia, the US is providing support for these destruction activities with the [Nunn-Lugar Global Cooperation Initiative](https://en.wikipedia.org/wiki/Cooperative_Threat_Reduction).[[24]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-24)  The Initiative has been able to convert a former chemical weapons depot at [Shchuchye](https://en.wikipedia.org/wiki/Shchuchye,_Kurgan_Oblast), [Kurgan Oblast](https://en.wikipedia.org/wiki/Kurgan_Oblast), into a facility to destroy those chemical weapons. The new facility, which opened in May 2009, has been working on eliminating the nearly 5,950 tons of nerve agents held at the former storage complex. However, this facility only holds about 14% of Russian chemical weapons that are stored throughout[[*vague*](https://en.wikipedia.org/wiki/Wikipedia:Vagueness)] seven sites.[[25]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-25)

In popular culture[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=11)]

One of the best-known references to VX in popular culture is its use in the 1996 film [*The Rock*](https://en.wikipedia.org/wiki/The_Rock_(film)),[[26]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-26)[[27]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-27) which centers on a threatened VX attack on [San Francisco](https://en.wikipedia.org/wiki/San_Francisco) from the island of[Alcatraz](https://en.wikipedia.org/wiki/Alcatraz). The film uses a certain [artistic license](https://en.wikipedia.org/wiki/Artistic_license), notably with VX being ascribed corrosive powers it does not possess, permitting an early scene in which a VX victim is shown with his face melting, rather than dying through asphyxiation. It also shows the hero applying an [intracardiac injection](https://en.wikipedia.org/wiki/Intracardiac_injection) of atropine as a defense against VX contamination, rather than the more usual [intramuscular injection](https://en.wikipedia.org/wiki/Intramuscular_injection) (e.g. into the thigh) of a combination of atropine and pralidoxime.

In the [BBC One](https://en.wikipedia.org/wiki/BBC_One) spy drama [*Spooks*](https://en.wikipedia.org/wiki/Spooks), an episode named "I Spy Apocalypse" (Series 2, Episode 5) features an EERE (Extreme Emergency Response Exercise) turned real life emergency. A [dirty bomb](https://en.wikipedia.org/wiki/Dirty_bomb) was reported to have exploded in [Parliament Square](https://en.wikipedia.org/wiki/Parliament_Square) and later the [Morningside](https://en.wikipedia.org/wiki/Morningside) area of [Edinburgh](https://en.wikipedia.org/wiki/Edinburgh). The bomb was confirmed to have dispersed VX in quantities that exceeded the lethal dose across much of the southeast of England. It is later found that the emergency is a well constructed and believable exercise designed to test the [MI5](https://en.wikipedia.org/wiki/MI5) officers to their limits.

Another reference to VX is found in the 2012 [art-house](https://en.wikipedia.org/wiki/Art_film) [dark comedy](https://en.wikipedia.org/wiki/Dark_comedy) film [*It's a Disaster*](https://en.wikipedia.org/wiki/It%27s_a_Disaster). The film centers around four couples that gather for a regular couples brunch and later learn about a multi-city VX attack on the United States that may threaten their lives.[[28]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-28)[[29]](https://en.wikipedia.org/wiki/VX_(nerve_agent)#cite_note-29)

The [Patriot](https://en.wikipedia.org/wiki/Patriots_Novels_Series) novel series describes the use of VX by rebel forces against government officers.

See also[[edit](https://en.wikipedia.org/w/index.php?title=VX_(nerve_agent)&action=edit&section=12)]

* [Dugway sheep incident](https://en.wikipedia.org/wiki/Dugway_sheep_incident)

# Dugway sheep incident

From Wikipedia, the free encyclopedia

[](https://en.wikipedia.org/wiki/File:A0112shee.jpg)

Dead sheep owned by Ray Peck in Skull Valley, 1968[[1]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-1)

The **Dugway sheep incident**, also known as the **Skull Valley sheep kill**, was a 1968 sheep kill that has been connected to [United States Army](https://en.wikipedia.org/wiki/United_States_Army) chemical and biological warfare programs at [Dugway Proving Ground](https://en.wikipedia.org/wiki/Dugway_Proving_Ground) in [Utah](https://en.wikipedia.org/wiki/Utah). Six thousand [sheep](https://en.wikipedia.org/wiki/Sheep) were killed on ranches near the base, and the popular explanation blamed Army testing of [chemical weapons](https://en.wikipedia.org/wiki/Chemical_weapon) for the incident, though alternative explanations have been offered. A report, commissioned by Air Force Press Officer Jesse Stay and first made public in 1998, was called the "first documented admission" from the Army that a [nerve agent](https://en.wikipedia.org/wiki/Nerve_agent) killed the sheep at [Skull Valley](https://en.wikipedia.org/wiki/Skull_Valley_Indian_Reservation).

## Contents

  [[hide](https://en.wikipedia.org/wiki/Dugway_sheep_incident)]

* [1 Background](https://en.wikipedia.org/wiki/Dugway_sheep_incident#Background)
* [2 Incident](https://en.wikipedia.org/wiki/Dugway_sheep_incident#Incident)
* [3 Possible causes](https://en.wikipedia.org/wiki/Dugway_sheep_incident#Possible_causes)
* [4 Aftermath](https://en.wikipedia.org/wiki/Dugway_sheep_incident#Aftermath)
* [5 See also](https://en.wikipedia.org/wiki/Dugway_sheep_incident#See_also)
* [6 References](https://en.wikipedia.org/wiki/Dugway_sheep_incident#References)
* [7 Further reading](https://en.wikipedia.org/wiki/Dugway_sheep_incident#Further_reading)
* [8 External links](https://en.wikipedia.org/wiki/Dugway_sheep_incident#External_links)

## Background[[edit](https://en.wikipedia.org/w/index.php?title=Dugway_sheep_incident&action=edit&section=1)]

Since its founding in 1941, much of the activity at [Dugway Proving Ground](https://en.wikipedia.org/wiki/Dugway_Proving_Ground) is a closely guarded secret. Activities at Dugway included aerial [nerve agent](https://en.wikipedia.org/wiki/Nerve_agent) testing.[[2]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-norrell-2) According to reports from [*New Scientist*](https://en.wikipedia.org/wiki/New_Scientist), Dugway was still producing small quantities of [anthrax](https://en.wikipedia.org/wiki/Anthrax) as late as 1998, 30 years after the United States renounced biological weapons.[[3]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-hambling-3) There were at least 1,100 other chemical tests at Dugway during the time period of the Dugway sheep incident. In total, almost 500,000 lb (230,000 kg) of nerve agent were dispersed during open-air tests.[[2]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-norrell-2) There were also tests at Dugway with other [weapons of mass destruction](https://en.wikipedia.org/wiki/Weapons_of_mass_destruction), including 328 open-air tests of biological weapons, 74 [dirty bomb](https://en.wikipedia.org/wiki/Dirty_bomb) tests, and eight furnace heatings of nuclear material under open air conditions to simulate the dispersal of fallout in the case of [meltdown](https://en.wikipedia.org/wiki/Nuclear_meltdown) of aeronautic [nuclear reactors](https://en.wikipedia.org/wiki/Nuclear_reactor).[[2]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-norrell-2)

## Incident[[edit](https://en.wikipedia.org/w/index.php?title=Dugway_sheep_incident&action=edit&section=2)]

In the days preceding the Dugway sheep incident the [United States Army](https://en.wikipedia.org/wiki/United_States_Army) at [Dugway Proving Ground](https://en.wikipedia.org/wiki/Dugway_Proving_Ground) conducted at least three separate operations involving nerve agents.[[4]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-woolf-4) All three operations occurred on March 13, 1968. One involved the test firing of a chemical [artillery shell](https://en.wikipedia.org/wiki/Artillery_shell), another the burning of 160 U.S. [gallons](https://en.wikipedia.org/wiki/Gallon) (600 L) of nerve agent in an open air pit and in the third a jet aircraft sprayed nerve agent in a target area about 27 mi (43 km) west of Skull Valley. It is the third event that is usually connected to the Skull Valley sheep kill.[[4]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-woolf-4)

The incident log at Dugway Proving Ground indicated that the sheep incident began with a phone call on March 17, 1968 at 12:30 a.m. The director of the [University of Utah's](https://en.wikipedia.org/wiki/University_of_Utah)ecological and epidemiological contract with Dugway, a Dr. Bode, phoned Keith Smart, the chief of the [ecology](https://en.wikipedia.org/wiki/Ecology) and [epidemiology](https://en.wikipedia.org/wiki/Epidemiology) branch at Dugway to report that 3,000 [sheep](https://en.wikipedia.org/wiki/Sheep)were dead in the [Skull Valley](https://en.wikipedia.org/wiki/Skull_Valley_(Utah)) area. The initial report of the incident came to Bode from the manager of a Skull Valley livestock company.[[5]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-regis-5) The sheep were grazing in an area about 27 mi (43 km) from the proving ground; total sheep deaths of 6,000-6,400 were reported over the next several days as a result of the incident.[[6]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-hoeber-6) The Dugway Safety Office's attempt to count the dead sheep compiled a total of 3,843.[[7]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-mauroni-7)

## Possible causes[[edit](https://en.wikipedia.org/w/index.php?title=Dugway_sheep_incident&action=edit&section=3)]

Previously obtained documents said one such demonstration also occurred the day before the mysterious sheep deaths in 1968.[[8]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-8) On 13 March 1968, an [F-4 Phantom](https://en.wikipedia.org/wiki/McDonnell_Douglas_F-4_Phantom_II) strike aircraft flew a test mission over the Dugway Proving Ground with chemical dispensers containing VX. One of the dispensers was not completely emptied during the test, and as the F-4 gained altitude after its bombing run, VX trickled out in a trail behind the aircraft, drifted into Skull Valley, north of the proving ground, and settled over a huge flock of sheep.[[9]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-9)

One explanation in the aftermath of the incident was that a [chemical](https://en.wikipedia.org/wiki/Chemical_weapon) or [biological agent](https://en.wikipedia.org/wiki/Biological_weapon) had escaped from the Dugway Proving Ground. Circumstantial evidence seemed to support this assertion, the [United States Army](https://en.wikipedia.org/wiki/United_States_Army) admitted to conducting open-air tests with the [nerve agent](https://en.wikipedia.org/wiki/Nerve_agent) [VX](https://en.wikipedia.org/wiki/VX_(nerve_agent)) in the days preceding the sheep kill.[[5]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-regis-5) The Army intimated that a spray nozzle had malfunctioned during the test causing an aircraft to continue spraying VX as it climbed to higher altitudes.[[5]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-regis-5)[[6]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-hoeber-6) It was reported that a small amount of VX was found in the tissue of the dead sheep.[[6]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-hoeber-6)

Other information contradicted the initial assumptions about the cause of the incident. One contradiction to nerve agent exposure as a cause came in the symptoms of some of the sheep following the incident.[[7]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-mauroni-7) Several sheep, still alive, sat unmoving on the ground. The sheep refused to eat, but exhibited normal breathing patterns and showed signs of[internal hemorrhaging](https://en.wikipedia.org/wiki/Internal_hemorrhage).[[7]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-mauroni-7) Regular breathing and internal hemorrhaging are inconsistent with nerve agent exposure,[[7]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-mauroni-7) "no other animals of any type, including cows, horses, dogs, rabbits, or birds, appeared to have suffered any ill effects, a circumstance that was hard to explain if VX had in fact caused the sheep deaths."[[5]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-regis-5)

## Aftermath[[edit](https://en.wikipedia.org/w/index.php?title=Dugway_sheep_incident&action=edit&section=4)]

The incident had an impact on the Army, and U.S. military policy within a year. The international infamy of the incident contributed to President Richard Nixon's decision to ban all open-air chemical weapon testing in 1969.[[2]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-norrell-2) The sheep incident was one of the events which helped contribute to a rise in public sentiment against the [U.S. Army Chemical Corps](https://en.wikipedia.org/wiki/Chemical_Corps) during and after the [Vietnam War](https://en.wikipedia.org/wiki/Vietnam_War).[[10]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-mauroni2-10) Ultimately, the Chemical Corps was almost disbanded as a result.[[10]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-mauroni2-10)

Following the incident, the Army and other state and federal agencies compiled reports, some of which were later characterized as "studies".[[4]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-woolf-4) A report which remained classified until 1978 and unreleased to the public until nearly 30 years after the incident was called the "first documented admission" by the Army that VX killed the sheep. In 1998, Jim Woolf, reporting for [*The Salt Lake Tribune*](https://en.wikipedia.org/wiki/The_Salt_Lake_Tribune), made the content of the report public for the first time.[[2]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-norrell-2) The report described the evidence that nerve agent was the cause of the sheep kill as "incontrovertible."[[4]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-woolf-4) The 1970 report, compiled by researchers at the U.S. Army's [Edgewood Arsenal](https://en.wikipedia.org/wiki/Edgewood_Arsenal) in [Maryland](https://en.wikipedia.org/wiki/Maryland), stated that VX was found in both snow and grass samples recovered from the area three weeks after the sheep incident.

The report concluded that the "quantity of VX originally present was sufficient to account for the death of the sheep."[[4]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-woolf-4) Even after the report surfaced, the Army maintained that it did not accept responsibility for the incident and did not admit negligence.[[2]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-norrell-2) As late as 1997, one year before the report went public, [U.S. Department of Defense](https://en.wikipedia.org/wiki/United_States_Department_of_Defense) officials stated that "the reason it (the report) was never published is because it wasn't particularly revealing."[[11]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-bacon-11) Lee Davidson, correspondent for Deseret News, wrote in June 1994 that Ray Peck, who owned the sheep that were killed, was outside working during the May 13, 1968, incident; members of his family developed nervous-system illnesses that were similar to those reported by people exposed to low levels of VX in lab experiments. Also, the probe showed that medical tests the Army had used to claim humans were not affected are now considered inconclusive, and the Pecks had shown other signs of low-level VX exposure.[[12]](https://en.wikipedia.org/wiki/Dugway_sheep_incident#cite_note-12)

## See also[[edit](https://en.wikipedia.org/w/index.php?title=Dugway_sheep_incident&action=edit&section=5)]

* [Deseret Chemical Depot](https://en.wikipedia.org/wiki/Deseret_Chemical_Depot)
* [Deseret Test Center](https://en.wikipedia.org/wiki/Deseret_Test_Center)
* [Dugway Proving Ground](https://en.wikipedia.org/wiki/Dugway_Proving_Ground)
* [Granite Peak Installation](https://en.wikipedia.org/wiki/Granite_Peak_Installation)
* [Operation CHASE](https://en.wikipedia.org/wiki/Operation_CHASE)
* [Project 112](https://en.wikipedia.org/wiki/Project_112)
* [Project SHAD](https://en.wikipedia.org/wiki/Project_SHAD)
* [Unethical human experimentation in the United States](https://en.wikipedia.org/wiki/Unethical_human_experimentation_in_the_United_States)
* [United States and weapons of mass destruction](https://en.wikipedia.org/wiki/United_States_and_weapons_of_mass_destruction)