North Korea's Chemical and Biological Weapons (CBW) Programmes

Overview

Deciphering the chemical and biological weapons capabilities of any country is a challenge. Chemical weapons (CW) programmes are difficult to trace because many of the facilities potentially involved in military activities are dual-use, with legitimate peaceful purposes, and are relatively easy to conceal. With biological weapons (BW), this is even more the case. With regard to North Korea, assessments are especially difficult due to the fact that – in comparison to other countries suspected of pursuing chemical and biological weapons – the country has remained less accessible in terms of economic and political contacts. Since North Korea is not a party to the Chemical Weapons Convention (CWC), there have never been any official declarations and international inspections of its chemical infrastructure, much less suspect facilities that might be associated with a chemical weapons programme. Also, although North Korea is officially a party to the Biological Weapons Convention (BWC), the Convention lacks a strong verification and inspection mechanism. Another major hindrance to comprehensive insight on North Korea's presumed chemical and biological weapons programmes is that its research and industrial facilities in these areas are relatively isolated from the outside world, so much so that even basic questions of science and infrastructure are uncertain.

In these circumstances, an analysis of North Korea's possible chemical and biological weapons programmes has to rely on public information provided by governments, defectors, and secondary source publications.[1] Such an analysis, made using sources that by their very nature are not comprehensive, will contain many gaps and uncertainties. There are very few details on these suspect programmes that can be specified with confidence. Nonetheless, an analysis based on a variety of sources, particularly official US, Russian and South Korean statements and reports, concludes that North Korea probably has developed chemical weapons to be part of its deployed military capabilities (although there is little authoritative information on the type and amount of agent or delivery means). It is also probable that North Korea has a biological weapons programme at least at the research and development stage. North Korea has dual-use facilities that could be used to produce biological agents as well as a munitions industry that could be used to weaponise such agents. However, there is not enough information to determine whether Pyongyang has progressed beyond the research and development stage for a biological weapons programme and actually possesses stocks of biological weapons.

Chemical weapons programme

Since the early 1990s, official US, Russian and South Korean government publications have all described North Korea as having an active chemical weapons (CW) programme that has gone beyond research and development and includes the actual production and stockpiling of chemical weapons.[2] There is considerable uncertainty, however, over the composition of that stockpile. Given its large – though ageing – chemical industry, North Korea is generally thought to be capable of producing all of the traditional chemical warfare agents (nerve, blister, blood and choking), although it may require imports of some specific precursors to produce nerve agents which are relatively more difficult to fabricate than the first generation blister, blood and choking agents. However, the exact size of the North Korean chemical weapons stockpile remains unknown. Recent South Korean government reports estimate a range of between 2,500–5,000 tonnes, but it is unclear whether these estimates concern the weight of chemical agent or the overall munitions stockpile and even whether they include biological agents. In any event, these figures are highly speculative. There is little authoritative information on the types of chemical munitions that have been stockpiled, but North Korea is capable of using a variety of delivery systems to disseminate chemical agents, including artillery, multiple rocket launchers, mortars, aerial bombs, and missiles, as well as Special Forces. The role of chemical weapons in North Korea's military planning is unknown, but it may be based partially on old Soviet doctrine. US and South Korean forces operate on the assumption that North Korea would use chemical weapons against both military and civilian targets as part of either offensive operations or in retaliation for an attack on North Korea.

Origins and development

In 1954, the North Korean army reportedly established regular chemical and biological defence units, which were most likely modelled on Soviet nuclear, biological, and chemical (NBC) units.[3] According to some press accounts, North Korea's offensive chemical weapons programme also began at this time, relying primarily on assistance from the Soviet Union, but the reliability of these reports cannot be determined.[4] In any event, in the late 1950s, North Korea began to develop an extensive chemical industry.[5] The First Five Year Plan (1957–61)

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Major North Korean civilian chemical production facilities	
1. Aoji-ri Chemical Complex	Production of methanol, ammonia, ammonium bicarbonate, coal tar derivatives, liquid fuel products. About 3,500 employees. Annual lignite coal processing capacity of 600,000 tonnes per year. Ammonium bicarbonate production capacity of 100,000 tonnes per year, methane production of 35,000 tonnes per year.
2. April 25th Vinalon Factory	Annual production capacity of 540,000 tonnes of fertiliser, herbicides, and pesticides. Produces civilian products including ammonia, as well as chlorine-based pesticides – probably DDT and chlordane, among others.
3. Chongjin Chemical Fibre Complex	Employs some 3,000 people and has an annual production capacity of 300 tonnes of pesticides, 10,000 tonnes of other chemical products, and 30,000 tonnes of synthetic fibre. Also produces various chemical products, including carbonic acid, formalin and phenol.
4. Chongsu Chemical Complex	Production of large quantities of calcium carbide and smaller amounts of phosphate fertiliser and calcium cyanamide.
5. February 8th Vinalon Complex	One of the largest chemical facilities in North Korea. Employs some 10,000 people, comprises about 50 large buildings, and has an annual production capacity of 50,000 tonnes of vinalon and 10,000 tonnes of movilon. Also produces carbide, methanol, sodium hydroxide, livestock feed, sodium carbonate, vinyl chloride and agricultural insecticide.
6. Hamhung Chemical Factory	Produces civilian chemicals such as sulphuric acid, nitric acid, ammonia and fertiliser products.
7. Hungnam Chemical Fertiliser Complex	Produces civilian chemicals such as ammonium sulphate, ammonium nitrate, phosphate, and urea. Employs more than 10,000 staff and has a production capacity of 1.4 million tonnes (unclear whether annual capacity or other time period).
8. Hwasong Chemical Factory	Produces agricultural chemicals. Annual production capacity of some 2,500 tonnes of phenol. Unknown Iodine capacity.
9. Hyesan Chemical Factory	Produces chemical intermediates such as benzol, phenol and hydrochloric acid.
10. Institute of Chemistry, Hamhung Branch	Research, development, education and training in applied chemistry. Established in 1960 and includes the Revolutionary Historical Relics Preservation Institute, the Institute of Inorganic Chemistry, the Institute of Organic Chemistry, the Institute of Polymer Chemistry, and the Vinalon Institute
11. Manpo Chemical Factory	Produces civilian-related products including ammonia, sodium hydroxide and sulphuric acid.
12. Namhung Youth Chemical Complex	Produces major civilian chemical products including ammonia, ethylene, fertilisers, fibres and paper. Annual chemical production capacity of approximately 550,000 tonnes.
13. Sariwon Potash Fertiliser Complex	Produces fertilisers – planned production target of 510,000 tonnes of potash fertiliser (unclear whether annual production or other time period).

Major North Korean civilian chemical production facilities	
14. Shinhung Chemical Complex	Produces agricultural chemicals and numerous other chemicals such as calcium hypochlorite, caustic soda, dyes, hydrochloric acid, paints, vinyl chloride, polyvinyl chloride, potassium carbonate, sodium carbonate, sodium bicarbonate, barium chloride, ammonium sulphate fertiliser, magnetised fertiliser, slag fertiliser and sulphuric acid fertiliser.
15. Sinuiju Chemical Fibre Complex	Produces calcium cyanamide, chlorine, sodium hydroxide, sulphuric acid, synthetic fibre, paper products and other chemicals. Annual chemical production capacity of 107,000 tonnes.
16. Sunchon Calcium Cyanamide Fertiliser Factory	Produces fertilisers and industrial chemicals such as calcium cyanamide and calcium carbide. Annual chemical production capacity of 100,000–150,000 tonnes. One of North Korea's four major fertiliser plants and is most likely a part of the Sunchon Vinalon Complex.
17. Sunchon Vinalon Complex	North Korea's largest chemical production facility with about 50 affiliated factories. Produces vinalon and other synthetic fabrics, fertilisers, sodium carbonate, vinyl chloride, caustic soda, carbonic acid, livestock feed and methanol. First stage or construction completed in 1989, resulting in an annual production capacity of 50,000 tonnes of vinalon. Final construction reportedly still not completed as of 2000. If the complex is ever finished, its estimated annual capacity will be 100,000 tonnes of vinalon, one million tonnes of carbide, 750,000 tonnes of methanol, and 900,000 tonnes of vinyl chloride.

Based on information from The Nuclear Threat Initiative's website: www.nti.org/e_research/profiles/NK
This draws on information from documents such as 'DPRK Factories Suspected of Producing Chemical Agents', FBIS: KPP20010216000106; 'Alleged Locations of DPRK Nuclear, Biological, Chemical Warfare Facilities Mapped', 6 June 2001, FBIS: KPP20010606000075; 'North Korean Chemical Industry', FBIS: FTS19981230001322; and 'Chemical Engineering, Experts Described', 23 December 1999, FBIS: FTS19991223001168.

placed great emphasis on developing a robust organic and inorganic chemical industry, building on facilities constructed during the Japanese occupation. At the end of 1961, Kim Il Sung issued a 'Declaration of Chemicalisation'. This called for greater efforts to develop various chemical production facilities to support different sectors of the North Korean economy. According to the South Korean Ministry of National Defense, the 1961 declaration reflected North Korean recognition of the importance of chemical warfare.[6] As a result of its large chemical infrastructure, North Korea can produce a number of dual-use chemicals, such as compounds of phosphate, ammonium, fluoride, chloride and sulphur, that could be diverted from civilian chemical uses to support a chemical weapons programme.

By the late 1960s, according to the US Department of Defense, North Korea was believed to have begun experiments with the production of offensive chemical agents.[7] In May 1979, the US Defense Intelligence Agency reported that North Korea possessed only a defensive chemical weapons capability, although it noted that development of offensive chemical weapons would be the next logical step.[8] Several press reports from the 1980s continued this speculation. The first publicly available official report, to the effect that North Korea had produced chemical weapons agents, was published in January 1987. This publication, by the South Korean Ministry of National Defense, reported that North Korea possessed up to 250 tonnes of chemical weapons – including mustard and nerve agents – designed for delivery by artillery shells.[9]

According to official and secondary reporting, North Korea's chemical weapons arsenal expanded in the early 1990s. However, it is difficult to determine the extent to which such statements reflected actual developments on the ground, or whether they resulted from outside factors affecting public reports of North Korea's programme. Political factors have had an impact. For instance, in 1992, as negotiations for the Chemical Weapons Convention (CWC) were drawing to a close, Seoul sought to publicise the extent of North Korea's chemical weapons programme in a bid to pressure Pyongyang to sign the CWC. In October 1992,

North Korea's Chemical and Biological Weapons (CBW) Programmes

for example, Seoul reported that North Korea had 1,000 tonnes of chemical agent held in six storage facilities, a four-fold increase over the 1987 assessment of 250 tonnes of agent.[10] Pyongyang denied these claims, and countered that the US was storing chemical weapons in South Korea. On 14 January 1993, South Korea signed the CWC when it was opened for signature, and later declared a small stock of chemical weapons, which are being destroyed in accordance with the Convention. North Korea, on the other hand, issued a formal statement on 13 January 1993 denying that it possessed a chemical weapons programme, but it refused to join the CWC.

A second factor, in the mid-1990s, that influenced the public reporting of North Korea's chemical weapons capabilities was the appearance of several prominent defectors, who publicised purported details about North Korea's chemical weapons arsenal, along with related research, production and storage facilities. The most influential of these was Sergeant Yi Chung Kuk, who worked in the Nuclear-Chemical Defence Bureau of the Korean People's Army (KPA) and defected in March 1994. He did so, he said, in order to warn South Korea about the dangers posed by North Korea's chemical weapons programme.[11] Sergeant Yi provided first-hand information on the organisation and equipment of North Korea's chemical defence units, which he was directly involved in, but he also reported secondhand information on offensive chemical weapons activities and facilities. Another key defector was Colonel Choi Ju Hwal, who also worked in the KPA and defected in 1995. Colonel Choi said that he did not have direct knowledge of North Korea's chemical weapons programme, though he claimed to have obtained information from other officials in the Ministry of Defence.[12] Much of Colonel Choi's testimony is identical to information from other defectors, press accounts, and official South Korean government documents, and it is difficult to determine how much is original and how much is derivative. Finally, Hwang Chang Yop, the Secretary of North Korea's Workers Party, defected in August 1996 and said that he had heard from other senior North Korean officials that North Korea had an arsenal of high-grade chemical weapons capable of 'scorching' South Korea and Japan. Mr Hwang did not claim any direct knowledge of chemical weapons production or deployment. Most of the information provided by these North Korean defectors cannot be independently verified, and the usual caveats about information from defectors applies. Nonetheless, their accounts were widely reported in the South Korean media and may have influenced official assessments by Seoul.

Arguably, Pyongyang had a strong incentive to enhance its chemical weapons programme in the mid-1990s, to compensate for the limits on its nuclear capabilities imposed by the October 1994 Agreed Framework. In addition, the financial limits on modernising its conventional forces may have given Pyongyang more reason to build up its CW capabilities. This speculation cannot be confirmed by direct evidence, but Seoul began to report a greater North Korean chemical weapons capability in the mid-1990s. In 1995, for example, the South Korean Foreign Ministry, the National Unification Board and South Korean military sources reported that North Korea had a stockpile of 1,000–5,000 tonnes of chemical and biological agents, including blister agents, nerve agents, choking agent, blood agent, and tear gas, which could be delivered by artillery, multiple rocket launchers, FROG rockets, and *Scud* missiles.[18] The most recent South Korean Ministry of National Defense report on North Korea's CBW capabilities, from 2001, lists but does not identify by name four research, eight production, and seven storage sites for chemical weapons, and estimates the size of the Pyongyang's stockpile at between 2,500–5,000 tonnes.[19] There is some uncertainty as to whether the various South Korean estimates are for agent or munitions tonnes, and whether they include biological as well as chemical agents.

Official US sources agree on the existence of a North Korean chemical weapons programme, including the stockpiling of agents that could be delivered by a variety of weapons, but Washington has tended to report fewer details than Seoul. In general, US analysts tend to be cautious about the reliability of human information on North Korea's CW programme, and it is extremely difficult to quantify issues concerning potential production rates and possible stockpiles because North Korean chemical facilities are not subject to international inspections, and satellite intelligence has little value in distinguishing between chemical production for military or civilian purposes. A 2001 US Department of Defense report identifies nerve, blister, blood, choking and tear gases as among the agents the North Koreans can produce and assesses that North Korea possesses a 'sizeable stockpile' of these agents, without estimating a specific quantity of agent.[20] According to the US, there may be limits on the North's production capacity. For example, the senior US military official in Seoul, General Schwartz, has testified that the North is capable of independently producing

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Defector reporting on North Korea's chemical weapons programme

NAME	BACKGROUND	DEFECTOR COMMENT
Yi Chung Kuk	Sergeant in the 18th Nuclear and Chemical Defence Battalion in the early 1990s. Defected in March 1994.	Warned that North Korea was capable of killing all people in South Korea with the chemical and bacterial weapons it possessed; identified various institutes and facilities associated with research, production, storage, and testing of biochemical weapons.[13] He provided detailed information on the 18th Nuclear and Chemical Defence Battalion, which is divided into 6 separate companies, responsible for nuclear/chemical detection, reconnaissance, and decontamination. He also provided information on Factory No. 279 and the No. 398 Research Institute in Sokam-ri, said to be responsible for development and production of chemical defence equipment. He also linked the Sunchon Vinalon Complex to North Korea's chemical weapons programme.
Choi Ju Hwal	Served in the Ministry of the Defence from 1968 to 1995. Defected from a post of Colonel and Chief of joint venture section of Yung-Seong Trading Company in 1995. (Choi acknowledged that he did not have direct knowledge of CBW programmes, but says he obtained second-hand information from other officials.)	In 1997, Choi said that North Korea has stored over 5,000 tonnes of toxic gases, including nerve gases (sarin, soman, tabun, and V agents), first-generation blister gases (lewisite and mustard gas) and blood agents (hydrogen cyanide and cyanogen chloride).[14] Choi identified numerous facilities associated with CW research and production, including several civilian chemical factories involved in vinalon production. He also said that Major Kim Jong Chan, who was an assistant military attaché at the North Korean Embassy in East Germany in the late 1970s, obtained technical knowledge on manufacturing 'extremely poisonous gases' and that North Korea started to manufacture new types of 'poisonous gases' in the mid–1980s.
Yi Sun Ok	Inmate at a North Korean prison. Defected in 1995.	Ms Yi said that some 150 fellow inmates died due to a chemical weapons test in 1990.[15]
Hwang Chang Yop	Secretary of North Korea's Workers Party. Defected in August 1996.	In August 1996, Hwang claimed that North Korea had both nuclear and chemical armed missiles capable of 'scorching' South Korea and Japan.[16] He quoted the North Korean leadership as saying that North Korea ranked third or fourth in the world in chemical weapons.
Yi Chun Son	Served as a commander at a 'missile station'. Defected in 1999 from the North Korean Ministry of People's Armed Forces.	Yi said that chemical agents are produced in Factory 102 in a process involving nitrogen dioxide mixed with sulphur dioxide which is then heated and combusted with mercury. The product is inserted into glass bottles, which are taken by helicopter to the No.108 Factory in Kanggye (which produces artillery shells). The chemical process described by Yi does not correspond to any known production process for a chemical weapon agent.
Yi Mi (pseudonym)	Worked at the Yongbyon nuclear complex. Defected in September 2000.	Yi said that the 304 Lab mainly worked on nuclear weapons development but also conducted research and development in chemical weapons.[17]

NOTE: No effort has been made to verify the claimed backgrounds and information provided by these individuals. The chart is intended to illustrate the range and type of raw information provided by defectors.

Common chemical weapons agents

AGENT	AGENT IDENTIFICATION	PERSISTENCY	MAJOR PROMPT EFFECTS
Blister agents			
Mustard	H	Very High	Skin blistering, conjunctivitis, damage to airways, death.
Lewisite	L	Moderate	Cutaneous (skin): Pain and irritation of eyes and skin followed by blisters and lesions on the skin. Pulmonary (inhalation): runny nose, hoarseness, bloody nose, sinus pain, cough. Intenstinal: diarrhoea, nausea, vomiting.
Choking agents			
Phosgene	CG	Low	Coughing, blurred vision, shortness of breath, nausea, pulmonary oedema, heart failure, death.
Diphosgene	DP	Low	Coughing, blurred vision, shortness of breath, nausea, pulmonary oedema, heart failure, death.
Vomiting agents			
Adamsite	DM	Low	Coughing, severe headache, muscle spasms, chest pains, shortness of breath, nausea, vomiting.
Blood agents			
Cyanide (hydrogen cyanide and cyanogen chloride)	ANCK	Low	Rapid breathing, dizziness, weakness, headache, nausea, vomiting.
Nerve agents			
VX	VX	Very High	Salivation, runny nose, sweating, shortness of breath, leading to muscle spasms, unconsciousness, death.
Sarin	GB	Low	Salivation, runny nose, sweating, shortness of breath, leading to muscle spasms, unconsciousness, death.
Tabun	GA	Moderate	Salivation, runny nose, sweating, shortness of breath, leading to muscle spasms, unconsciousness, death.
Soman	GD	Moderate	Runny nose, watery eyes, rapid breathing, nausea, leading to unconsciousness, paralysis, respiratory failure, death.

For further information see:

- Organization for the Prohibition of Chemical Weapons (OPCW): www.opcw.org/resp/html/cwagents.html
- World Health Organisation (WHO): www.who.int/csr/delibepidemics/biochem_threats.pdf
- Carnegie Endowment for International Peace: www.ceip.org/files/publications/RegimeAppendix7.asp?p=
- NATO Handbook on the Medical Aspects of NBC Defensive Operations AmedP-6(B): www.fas.org/nuke/guide/usa/doctrine/dod/fm8-9/toc.htm
- US Government, the Chemical & Biological Warfare Threat; US Army Medical Research Institute of Chemical Defence, Chemical Casualty Care Division, http://ccc.apgea.army.mil

components only for first generation (i.e. World War I-type) chemical agents (e.g. phosgene and mustard).[21] Imports of some precursors may be necessary for the production of more advanced nerve agents. Official US sources agree with South Korean reports that North Korea has weaponised chemical weapons agents for deliver by artillery, missiles, and aircraft, as well as unconventional means, but US public reports generally do not discuss suspect or possible research, production, and storage sites associated with chemical weapons.

North Korean defectors and various secondary sources have provided detailed information about facilities purportedly involved in research, production, and storage of chemical precursors, agents and munitions.[22] According to these sources, North Korea's chemical weapons stockpile includes first generation blister agents (lewisite and mustard), various nerve agents (sarin, soman, tabun, and V-agents), and blood agents (hydrogen cyanide and cyanogen chloride). Chemical weapons research is said to take place at various universities and at a number of institutes under the aegis of the Second Natural Science Academy. Chemical weapons production facilities are reported to include the Kanggye Chemical Factory and Factory No. 108 in Chagang Province, the Sakchu Chemical Factory in North Pyongan Province, the Ilyong Branch of the Sunchon Vinalon Factory in South Pyongan Province and Factory No. 297 in Pyongwon, South Pyongan Province.

In addition, a number of civilian chemical facilities have been implicated in chemical weapons production, such as the Manpo Chemical Factory and Aoji-ri Chemical Complex. Defectors and press stories also report that chemical agent storage sites are located in the cities of Masan-dong, Samsan-dong, and Sariwon, and in the greater Pyongyang area. These facilities are reportedly comprised of storage tanks housed in warehouses and buildings above ground, partially buried structures, and underground tunnels. It is alleged that chemical weapons agents are transferred to facilities at Sakchu or Kanggye for loading into munitions, which include 80mm artillery shells, 240mm rockets, aerial bombs, and aerial spray tanks. Following final assembly and filling, chemical munitions are reportedly stored at the Maram Materials Corporation and the Chiha-ri Chemical Corporation, located in Masan-dong, Pyongyang, and Anbyon, Kangwon Province, respectively. Most of this information cannot be independently confirmed.

Potential military uses for chemical weapons

Assuming that North Korea maintains a stockpile, chemical weapons agents and munitions could play a role in complementing Pyongyang's conventional military power in offensive or defensive operations. In theory, North Korean forces could use chemical weapons against US and South Korean forces to reduce these forces' combat effectiveness, deny the use of mobilisation centres, storage areas, and military bases, and hinder the arrival of reinforcements from overseas. Non-persistent chemical agents could be used to help break through defensive lines or to hinder an allied counterattack. Persistent chemical agents could be used against fixed targets, including command and control centres, logistics hubs, and airbases. North Korean forces appear to be prepared for operations in a contaminated environment. Chemical defence battalions are reportedly integrated into larger ground force units, and many troops are reportedly equipped with chemical protection equipment, including masks, suits, detectors and decontamination systems. North Korean troops are also said to participate in chemical exercises in an attempt to develop mission capability under chemical warfare conditions.

Of course, these defensive measures could reflect North Korean expectations that their forces may be subjected to a chemical attacks. Nonetheless, US and South Korean military commanders assume that North Korean offensive military plans include the use of chemical agents delivered by a variety of traditional means, such as ballistic missiles, artillery rockets and shells, mortars, and aerial bombs and sprays, against both military and civilian targets. Delivery by Special Forces is also a possibility. Aside from their potential role in offensive operations, chemical weapons presumably contribute to North Korea's deterrent posture, especially since North Korea's conventional capabilities have eroded relative to US and South Korean forces. Although Pyongyang officially denies that it possesses chemical weapons, the widespread belief that North Korea has a substantial chemical weapons arsenal – noted in official US and South Korean government reports – only serves to reinforce the view in the US, South Korea and Japan that a conflict on the Korean Peninsula would result in the use of chemical weapons against civilian and military targets.

Biological weapons programme

There is less public information on North Korea's

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Common biological weapons agents

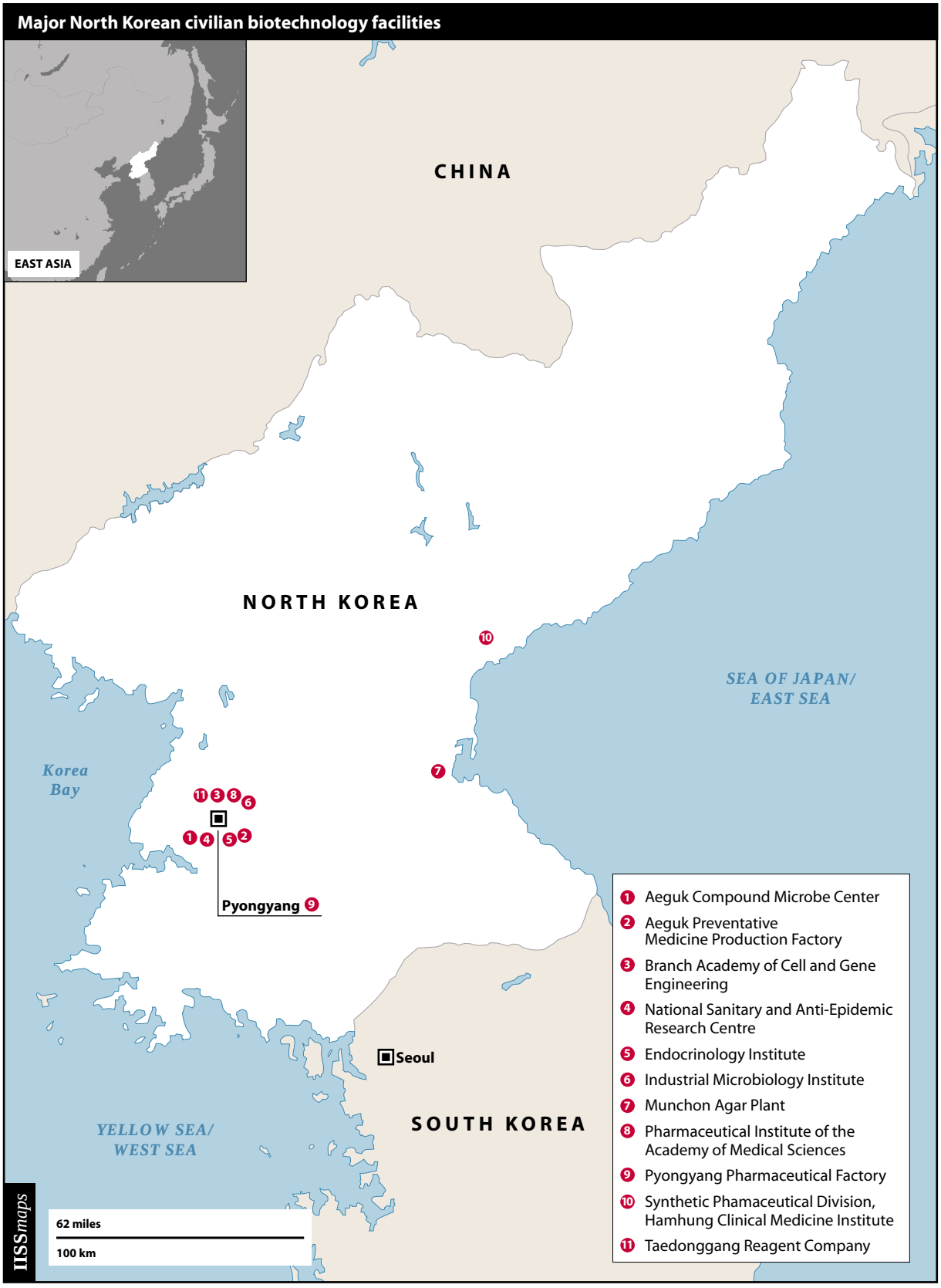
TYPE	SYMPTOMS	CHARACTERISTICS
Bacteria		
Bacillus anthracis (anthrax)	Pulmonary (inhalation): difficulty breathing, exhaustion, toxemia, terminal shock. Cutaneous (skin): itching, small lesions and possible blood poisoning. Intestinal: nausea, fever, diarrhoea.	Mortality (if untreated): Pulmonary 80–95%. Cutaneous 5–20%. Intestinal 25–60%. Incubation period: Symptoms usually occur within 7 days. Not contagious.
Vibrio cholerae (cholera)	Diarrhoea, vomiting and leg cramps. Rapid loss of body fluids, dehydration and shock.	Mortality (if untreated): 5–10%. Death in 1–3 hours. Not contagious.
Yersinia pestis (plague)	Fever, headache, extreme exhaustion, development of painful, swollen lymph nodes – called buboes. Leads to blood infection and pneumonia.	Mortality (if untreated): 50–60%. Incubation period: 1–3 days. Death in 2–6 days. Contagious through respiratory droplets from pneumonia patients.
Salmonella Typhi (typhoid fever)	Sustained fever, malaise, chills, stomach pains, headache, loss of appetite, occasional rash of flat, rose-coloured spots.	Mortality (if untreated): 12–30%.
Typhus	Fever, headache, chills, and general pains caused by a whole body rash.	Mortality (if untreated): 30–50%. Incubation period: 6–12 days. Not contagious.
Mycobacterium tuberculosis (tuberculosis)	Coughing, pain in the chest, fatigue, weight loss, loss of appetite, chills, fever, sweating at night, coughing up blood or sputum.	Mortality (if untreated): 30–50%. Incubation period: 14 days–1 year. Contagious.
Virus		
Haemorrhagic fever (Korean Strain)	Fever, fatigue, dizziness, muscle aches, exhaustion. Can cause bleeding under the skin, in internal organs, or from body orifices; coma, delirium, and seizures.	Mortality (if untreated): 5–15%. Incubation period 2–21 days. Contagious.
Variola (smallpox)	First symptoms include fever, malaise, aches, leading to high fever, rash, and crusting scabs.	Mortality (if untreated): 30–40%. Incubation period: 7 to 17 days. Contagious.
Yellow Fever	High fever, chills, headache, muscle aches, vomiting. Can lead to shock, kidney and liver failure (causing jaundice).	Mortality (if untreated): 5–40%. Incubation period: 3–6 days. Not Contagious.
Toxin		
Clostridium Botulinum (Botulinum toxin; botulism)	Nausea, weakness, vomiting, respiratory paralysis.	Mortality (if untreated): 60–90%. Incubation period: 12–36 hours after inhalation. Death in 24–72 hours, illness for months if not lethal. Not contagious.

For further information see:

- World Health Organisation (WHO): www.who.int/csr/delibepidemics/en/annex3May03.pdf
- NATO Handbook on the Medical Aspects of NBC Defensive Operations AmedP-6(B): www.fas.org/nuke/guide/usa/doctrine/dod/fm8-9/2toc.htm
- US Army Medical Research Institute of Infectious Diseases, USAMRIID's Medical Management of Biological Casualties Handbook: www.usamriid.army.mil/education/bluebook.html
- Centres for Disease Control: www.cdc.gov

Major North Korean civilian biotechnology facilities	
1. Aeguk Compound Microbe Center	Research, development and production of microbial-based fertiliser supplements. Supplies microbial stock to branch compound microbial fertiliser factories, of which there are reportedly over 120 in North Korea.
2. Aeguk Preventative Medicine Production Factory	Comprises 10 laboratories and various workshops devoted to research, development, and production of vaccines and medicines. The main product has been hepatitis B vaccine produced through the use of recombinant yeast.
3. Branch Academy of Cell and Gene Engineering	One of nine research branches of the Academy of Sciences. Conducts research on cellular biology and genetic engineering. Reportedly involved in the manufacture of human growth hormone, restriction endonucleases (enzymes used in genetic recombination techniques), snake-venom derived anticoagulant, genetically modified crops, and vaccine research.
4. National Sanitary and Anti-Epidemic Research Centre	The Haemorrhagic Fever Laboratory is established under this facility. The Institute's main duties include support for national sanitation, providing inoculations against various diseases, and administering quarantines.
5. Endocrinology Institute	Mainly diagnoses and treats diabetes and various diseases. Reportedly has three laboratories: the Biochemistry Laboratory; the Experimental Treatment Laboratory; and the Generic Engineering Laboratory.
6. Industrial Microbiology Institute	Research, development and production of microbial cultures with applications in areas such as feed supplements, medicines and vaccines, fermentative industries, and food and beverages.
7. Munchon Agar Plant	Agar (growth media) production. As of 1992, the annual agar production capacity of the factory was 200 tonnes.
8. Pharmaceutical Institute of the Academy of Medical Sciences	Research and development of medicaments. Reported work includes the development of nutritive supplements, including production of amino acids derived from industrial by-products. Described as being located at or near the logistical chain of medical supply organisations, it is likely that the Institute is in Pyongyang.
9. Pyongyang Pharmaceutical Factory	The United Nations Children's Fund (UNICEF), in collaboration with Diakonie Emergency Aid (DEA) of Germany, has provided support to upgrade North Korea's main pharmaceutical factory. As of August 2000, the factory produced seven drugs, including antibiotics and multivitamins, with raw materials provided by DEA, according to UNICEF. Support for capacity development in Good Manufacturing Practices (GMP) has been provided through in-country training.
10. Synthetic Pharmaceutical Division, Hamhung Clinical Medicine Institute	Research and development of medicaments and clinical diagnostics. Work includes improving diagnostics testing for antibiotic susceptibility by bacteria. Researchers also surveyed folk remedies and medicinal herbs for inclusion in pharmaceutical development.
11. Taedonggang Reagent Company	Research and Development of vaccines (e.g. hepatitis B), development and production of diagnostic equipment, electron microscopes, and reagents. Developed electron microscopes, which have been advertised for sale abroad. Previously known as the November 19 Institute.

Sources: Nuclear Threat Initiative: www.nti.org; 'DPRK's NAS Pursues Cultivation of Stock Bacteria for Microbial Fertilizers', *Chungang Ilbo*, 17 January 2000; UNICEF Emergency Programmes: DPRK Korea Donor Update, 7 Aug 2000: www.reliefweb.int


Major North Korean civilian biotechnology facilities
EAST ASIA
CHINA
NORTH KOREA
SEA OF JAPAN/
EAST SEA
Korea
Bay
Pyongyang
Seoul
SOUTH KOREA
YELLOW SEA/
WEST SEA
1 Aeguk Compound Microbe Center
2 Aeguk Preventative Medicine Production Factory
3 Branch Academy of Cell and Gene Engineering
4 National Sanitary and Anti-Epidemic Research Centre
5 Endocrinology Institute
6 Industrial Microbiology Institute
7 Munchon Agar Plant
8 Pharmaceutical Institute of the Academy of Medical Sciences
9 Pyongyang Pharmaceutical Factory
10 Synthetic Phamaceutical Division, Hamhung Clinical Medicine Institute
11 Taedonggang Reagent Company
62 miles
100 km
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biological weapons programme than on its chemical weapons programme. Official US, Russian and South Korean reports agree that North Korea has conducted biological weapons research, but there is considerable uncertainty as to whether Pyongyang possesses biological weapons and, if so, the types of agents involved. While official South Korean sources claim that North Korea has weaponised one or two biological agents, official US and Russian sources characterise North Korea as 'capable' of producing a variety of agents, including anthrax, cholera and plague without judging that North Korea has actually produced biological weapons. Given the dearth of information, it is impossible to make a firm judgement either way. Various defectors and press reports give details of biological weapons research, testing and production, but such information cannot be confirmed. There is no authoritative information on the potential role of biological weapons in North Korean military strategy, beyond speculation that biological weapons may be relatively less significant than chemical weapons, which have more utility as a battlefield weapon, and nuclear weapons, which are a more capable mass destruction weapon.[23]

Virtually nothing is known about the history of North Korea's biological weapons programme. Official US sources state that North Korea has pursued a biological warfare capability since the 1960s.[24] During this time, according to press reports, a laboratory was established under the authority of the Academy of National Defence and 10–13 different pathogens were investigated, including anthrax, cholera, bubonic plague, smallpox and yellow fever, some of which reportedly were imported from culture collections in Japan.[25] According to another secondary source, construction of an underground biological weapons research and development facility was completed in the 1970s[26]. This facility was located in Onjong-ri, South Pyongan Province and conducted research, development, and testing of biological weapons agents on small laboratory animals.

A 1998 White Paper released by the South Korean Ministry of National Defense, reported that, 'by 1980, [North Korea] had succeeded in its experiments in bacteria and virus cultivation to produce biological weapons, and by the late 1980s had completed live experiments with such weapons.'[27] This is generally consistent with a 1993 report by the Russian intelligence service on proliferation, which stated that North Korea was performing 'applied military-biological research' with anthrax, cholera, bubonic plague and smallpox at a number of institutes and universities and testing biological weapons on North Korean islands.[28] South Korean press and other unofficial sources go even further, claiming that, in the early 1980s, North Korea began actual production of biological agents and obtained a turnkey plant for agar (growth media) from East Germany in 1984 to further the biological weapons programme.[29] In contrast, a 1997 US Department of Defense report judged that North Korea's biological weapons programme was probably still at the level of research and development.[30]

Whatever the status of its biological weapons efforts, North Korea has developed a number of dual-use biotechnology facilities that could be used to research biological weapons agents and produce militarily significant quantities of biological agents. But this infrastructure is not highly developed and there is no definitive evidence that it is being used for this purpose.[31] North Korea joined the BWC on 13 March 1987 (followed by South Korea on 25 June 1987), but the convention has no provisions for mandatory declarations or inspections of civilian or suspect military biological facilities.

The most recent official US and South Korean reports agree that North Korea has a biological weapons programme, although only Seoul reports that it has advanced beyond the research and development stage. In 2001, for example, a South Korean defence White Paper described the North Korean threat as including 'chemical and biological weapons such as anthrax of which North Korea is believed to hold a stockpile of 2,500–5,000 tons.'[32] The report does not address the issue of delivery systems, other than to note that North Korean Special Forces could launch attacks with biological weapons. Another South Korean Ministry of National Defense report from 2001 claims that North Korea possesses three research and six production facilities to support its biological weapons programme and has weaponised one or two types of biological agents.[33] In contrast, the most recent public US government report, from 2001, says that 'North Korea is believed to possess a munitions-production infrastructure that would allow it to weaponize biological warfare agents, and may have biological weapons available for use'.[34] According to press accounts, the US intelligence community has assessed with 'medium' confidence that North Korea possesses stocks of smallpox virus, but the evidence is not definitive.[35]

Most of the detailed information about North Korea's biological weapons programme has come from defectors and other secondary sources of unknown

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reliability. According to Choi Ju Hwal, the Germ Research Institute in the General Logistic Bureau of the Armed Forces Ministry is responsible for developing biological weapons.[36] Yi Chung Kuk, meanwhile, claims that biological weapons research and development is carried out at the Microbiological Institute and that there are other facilities in North Korea for producing and storing biological weapons.[37] Yi Sun Ok, who was an inmate at a North Korean prison camp, claims she witnessed biological weapons experiments in mid-1980s, which resulted in the deaths of some 50 inmates.[38] However, none of these reports can be confirmed.

A number of secondary sources provide additional details on facilities and suspected agents said to be involved in North Korea's biological weapons programme. According to one report, research on anthrax, bubonic plague, smallpox, yellow fever, cholera and other pathogens is carried out at the National Defence Research Institute and Medical Academy (NDRIMA).[39] Another report says that North Korea's inventory of biological agents includes anthrax, botulism, cholera, haemorrhagic fever (Korean strain), bubonic plague, smallpox, tuberculosis, typhoid, typhus, and yellow fever.[40] Another claims that 13 types of biological weapons agents are produced at the Workers Party's Central Biology Research Institute, the Preventive Military Medical Unit, and the February 25th Plant in Chongju, North Pyongan Province.[41] But these reports also cannot be confirmed. To date there is no reliable information available to confirm whether North Korea has engaged in the development of genetically modified biological agents.[42]

In conclusion, there is not enough information to reach a firm judgement on the progress of, or possible effectiveness of, North Korea's biological weapons programme. This is understandable, given North Korean secrecy and the inherent difficulties of detecting and assessing biological weapons programmes, compared to nuclear or even chemical weapons activities. US, South Korean, and Russian official sources agree that North Korea has conducted research on a variety of biological agents, but only Seoul reports that North Korea has actually produced stocks of one or two types of biological weapons. The basis for this assessment is unspecified. Given its biotechnical infrastructure, North Korea is capable of producing significant amounts of common biological agents, such as anthrax, and delivering these agents through a variety of conventional and unconventional means, but it is not known how important Pyongyang views the development and deployment of a biological weapons capability. In any event, the possibility that North Korea may have biological weapons contributes to deterrence.

Conclusion

The available evidence suggests that North Korea probably possesses both a chemical and biological weapons programme, although they may differ in terms of scope and state of advancement. The chemical weapons programme probably involves some chemical weapons production and stockpiling, although the amount and types of agents that have been produced, the number and types of munitions that have been stockpiled, and the location of key research, production, and storage facilities cannot be assessed with high confidence. North Korea is thought to be capable of producing a variety of traditional blister, blood, choking and nerve agents, although there may be limits on what it can produce in its ageing chemical industry. Meanwhile, given its munitions industry, North Korea is thought capable of producing a variety of delivery systems for chemical weapons, including artillery, multiple rocket launchers, mortars, aerial bombs, and missiles. The extent to which Pyongyang has chosen to deploy these capabilities is unknown, but US and South Korean forces prudently assume that North Korea possesses chemical weapons and is prepared to use them against military and civilian targets in offensive operations or in retaliation for an attack on North Korea. By comparison, less is known about North Korea's presumed biological weapons programme. While there is general agreement that North Korea has conducted research and development on biological agents, there is not enough information to conclude whether it has progressed to the level of agent production and weaponisation, although North Korea is most likely technically capable of both.

Whatever the actual status of North Korea's chemical and biological capabilities, the perception that it has, or likely has, chemical and biological weapons contributes to Pyongyang's interest in creating uncertainties in Washington, Seoul and Tokyo and raises the stakes to deter or intimidate potential enemies. From Pyongyang's perspective, chemical and biological weapons could have utility both on the battlefield and at the strategic level. US and South Korean military commands have to operate on the assumption that North Korea maintains a large stockpile of chemical and possibly biological munitions integrated with its conventional forces and deployed for use on the battlefield. This complicates allied

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military planning for defence against any North Korean attack or for conducting offensive operations against the North. Some measures have been taken to strengthen allied troops' CBW defences, but it is difficult to accurately assess their effectiveness without knowing the size, composition, or delivery means of North Korea's presumed chemical weapons arsenal. At the strategic level, the potential delivery of large quantities of chemical or biological agents to nearby targets (such as Seoul) and smaller quantities to more distant targets (such as Tokyo) could cause significant civilian casualties, depending on the amount and type of agent, the delivery means, the extent of civilian defence measures, and many other factors. In any event, the plausible threat that North Korea might use chemical or biological weapons, if the survival of the regime was at stake, contributes to deterrence and discourages Seoul and Tokyo from pursuing policies that could increase the risk of conflict and drive Pyongyang to take desperate measures.