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PROJECT ANTHRACITE

The DPRK's Chemical Facilities:

Aoji-ri Area: Site Profile 6

Sean Corbett, Hailey Wingo, Grant Christopher, David Crouch and Lennie Phillips

Executive Summary

This report on the 7th July Chemical Complex and 21st July Explosives Plant at Aoji-ri in North Korea is the sixth Project Anthracite profile exploring different chemical production facilities in the country. The project uses open source information to map out North Korea's chemical industry and its potential links to the chemical weapons (CW) programme.

This report identifies that within the 7th July Chemical Complex are probable areas of coal gasification and methanol production, an area for low-temperature carbonisation of coal and production of its derivatives, an ammonia and nitric acid production area, an ammonium bicarbonate plant and an ammonium nitrate fertiliser plant. Some parts of the complex are no longer in use for production of chemicals, including a redeveloped site that is now a probable agricultural area. Other areas of the complex also have degraded and appear to no longer be in use.

This report assesses that the 7th July Chemical Complex is not currently linked to a CW programme. The absence of chorine chemistry precludes direct production of adamsite and tabun, and an absence of phosphorous chemistry precludes the direct production of G-series and V-series nerve agents (sarin, soman and VX). The site does conduct all the chemistry to provide precursors for the blood agent hydrogen cyanide. If ethylene or acetylene are produced from coal gasification byproducts, then the site could also produce the blister agent sulfur mustard, although the ethylene route produces a more impure and crude form of sulfur mustard than routes involving chlorination.

The 21st July Explosives Factory has two distinct areas, a main site and an area in a valley to the north that extends to the northwest. The main site is observably degraded and there is no evidence that it is operational. However, in the valley to the northwest there is evidence for active explosives production and storage.

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Project Background

North Korea has long been assessed by many countries as having a chemical weapons (CW) programme. In 2006 a South Korean defence ministry white paper estimated that between 2,500 and 5,000 tons of chemical warfare agents (CWAs) were stored in facilities across the country. This amount was reiterated in a 2022 white paper.[1] The types of agents alleged to be in North Korea in historical reporting include sarin, soman, tabun, V-series nerve agents, chlorine, phosgene, adamsite, lewisite, mustard agents, cyanogen chloride, hydrogen cyanide and tear gas.[2]

The 2017 assassination of Kim Jong Un's half-brother Kim Jong Nam with the nerve agent VX,[3] in an attack that was widely accepted as being orchestrated by North Korea,[4] served as a reminder of the longstanding North Korean CW programme and to highlight that very little is known about it, in contrast to the international attention paid to North Korea's missile and nuclear programmes.[5]

In an attempt to identify means to bridge that gap, RUSI published a feasibility study in partnership with the Defence Science and Technology Laboratory (Dstl) in March 2022, which concluded that open source tools could help aid understanding of North Korea's chemical industry, allowing hypotheses about CW production to be developed and refined.[6] The study formed part of a multi-year project on North Korean WMD in cooperation with VERTIC and the James Martin Center for Nonproliferation Studies.[7]

1. Ministry of National Defence, The Republic of Korea, 2022 *Defense White Paper* (Seoul: Republic of Korea, Ministry of Defense, 2022)..
2. Nuclear Threat Initiative (NTI), 'North Korea Chemical Chronology', last updated October 2012, <https://www.nti.org/wp-content/uploads/2021/09/north_korea_chemical_chron.pdf>, accessed 4 April 2026; Joseph S Bermudez Jr, 'North Korea's Chemical Warfare Capabilities', 38 North, 10 October 2013, <https://www.38north.org/2013/10/jbermudez101013/>, accessed 4 April 2026.
3. Organisation for the Prohibition of Chemical Weapons (OPCW), 'Statement by H.E. Ambassador Ahmad Nazri Yusof, Permanent Representative of Malaysia to the OPCW at the Eighty-Seventh Session of the Executive Council', EC-87/NAT.14, 14 March 2018, <http://opcw.org/sites/default/files/documents/EC/87/en/ec87nat14_e_.pdf>, accessed 4 January 2024.
4. Hannah Ellis-Petersen and Benjamin Haas, 'How North Korea Got Away with the Assassination of Kim Jong-nam,' *The Guardian*, 1 April 2019.
5. See, for example, NTI, 'The CNS North Korea Missile Test Database', 12 November 2024, <https://www.nti.org/analysis/articles/cns-north-korea-missile-test-database/>, accessed 5 February 2026; Hans M Kristensen et al., 'North Korean Nuclear Weapons 2024', *Bulletin of the Atomic Scientists* (Vol. 80, No. 4, 2024), pp. 251–71.
6. Cristina Varriale and Sarah Clapham, 'Remote Assessment of North Korea's Chemical Weapons: Feasible or Not?', *RUSI Occasional Papers* (March 2022), <https://www.rusi.org/explore-our-research/publications/occasional-papers/remote-assessment-north-koreas-chemical-weapons-feasible-or-not>, accessed 1 March 2026.
7. VERTIC, 'North Korean Weapons of Mass Destruction Capabilities', <https://www.vertic.org/programmes/vm/dprk/>, accessed 16 July 2025.

One of the conclusions of the feasibility study was that:

> Future work will need to consider industrial capability as a network; looking at single sites in isolation will leave knowledge gaps. Although this approach as applied to a single site will help inform assessments of activity taking place there, it will not support a holistic understanding of a CW capability. This is because it is unlikely that an individual facility is responsible for start-to-finish production of CW.[8]

Based on the feasibility study and with the support of Global Affairs Canada, RUSI initiated Project Anthracite, a three-year project to use open source tools and remote-sensing technologies to provide a networked overview of North Korea's chemical industry, by profiling sites and seeking to understand their role in North Korea's chemical industry as well as any links they might have to CW production.[9]

Large-scale military CW production and stockpiling have always had roots in the chemical industry, from research into new pesticides to the supply of raw materials and intermediates. Many chemicals which have formed part of historic worldwide CW programmes have been included in the Annex on Chemicals, which forms part of the Chemical Weapons Convention (CWC).[10] This annex defines the basis for allocating one of three schedules to some chemicals. The basis of the three schedules depends on aspects such as toxicity, quantity of use for purposes not prohibited by the CWC, whether it has been used as a chemical weapon or identified as a precursor. For completeness, it should be noted that a chemical can be classed as a CW without being in any of the schedules if it is intentionally used to harm humans and animals through its toxic properties.

8. Varriale and Clapham, 'Remote Assessment of North Korea's Chemical Weapons', pp. 31–32.
9. RUSI, 'Project Anthracite: Assessing the Chemical Weapons Capability of the DPRK', <https://www.rusi.org/explore-our-research/projects/project-anthracite-assessing-chemical-weapons-capability-dprk>, accessed 5 February 2026.
10. OPCW, 'Annex on Chemicals', <https://www.opcw.org/chemical-weapons-convention/annexes/annex-chemicals/annex-chemicals>, accessed 5 February 2026.

Site Selection

The 7th July Chemical Complex, originally named Aoji-ri[11] Chemical Complex, has long been reported in Western and Republic of Korea media as one of the potential sites for chemical production linked to the development and production of WMDs.[12] The 7th July Chemical Complex at Aoji-ri is also located near and connected to the 21st July Explosives Plant – both are included in this report.

Methodology

The Project Anthracite team reviewed open source information, including North Korean patent applications, state television broadcasts, scientific literature, technical reporting and academic texts. This report features satellite imagery and ground-level imagery released by North Korean media outlets as primary sources. Declassified government intelligence and think tank analysis served as secondary sources.

RUSI used the formalised, well-established satellite imagery analytical approach as trained and adopted by the military imagery analysis community. This approach considers eight factors: location, size, shape, shadow, tone/colour, texture, pattern and associated features. The information was analysed by an expert consultant. The analysis was subsequently reviewed within the team (which includes satellite imagery experts).

This report outlines the most likely process descriptions and associated chemistry used at the sites, as assessed by chemists and chemical engineers, based on research into potential processes and information on the sites found in open source information.

The report was also externally peer reviewed, with inputs included as appropriate. The satellite imagery analysis was joined to the analysis of all the other information to provide an overall analysis of the sites.

11. See, for example, CIA, 'Basic Imagery Interpretation Report: Aoji Ri Synthetic Petroleum Plant Chosen: Kyonghung-up, North Korea', June 1969, <https://www.cia.gov/readingroom/docs/CIA-RDP79T00909A000500010021-8.pdf>, accessed 9 December 2024.,
12. See, for example, Jende Huang, 'Documenting Chemical Weapons Facilities Along the DPRK's Northern Frontier', *Sino NK*, 1 January 2012, <https://sinonk.com/2012/01/01/chem-facilities-dprk-northern-frontier/>, accessed 9 December 2024.

Introduction

A facility in Aoji-ri was reportedly established in 1937 during the Japanese colonial period to produce synthetic oil from locally mined coal.[13] Comprising a sprawling industrial site located in Kyŏnghŭng county, South Hamgyong province in the far northeast of the country, approximately 6 km from the Chinese border, the complex has been afforded several alternative names. This is further complicated by the sprawling nature of the site and the proximity of other industrial sites, some of which may be associated with the primary complex (Figure 1).

Figure 1: Overview of the Aoji-ri Area

Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

7th July Chemical Complex

According to several reports,[14] the name Aoji-ri was changed to 7th July Chemical Plant under the direction of Kim Il Sung, as part of the 'Juche' drive to erase names with historically negative connotations. Alternative names are listed below, but they are not exhaustive. This report refers to the facility as the 7th July Chemical Complex.

- Aoji-ri Chemical Factory[15]
- Aoji-ri Chemical Complex[16]

13. Eiji Munekata, 'Liquefaction of Aoji Coal' (1976), *Journal of the Fuel Society of Japan*, doi10.3775/JIE.55.10_820, <https://www.semanticscholar.org/paper/Liquidification-of-Aoji-Coal-Munekata/0d6ce1d42a2d051fee317b5fa3df84aa313f8b52>, accessed 21 April 2026.
14. See, for example, Chon Hyok Song, 'With Respect Even to the Names of Places in Our Country', 24 August 2021, <http://www.ryongnamsan.edu.kp/univ/en/research/articles/02a3c7fb3f489288ae6942498498db20>, accessed 20 December 2024.
15. ijun_33, 'Aoji-ri Chemical Factory 1964', Cronobook, <https://cronobook.com/pic/3ae3a55e-2d72-4b13-920c-3937a299cb33>, accessed 20 December 2024.
16. Joseph S Bermudez Jr, Michael Elleman and Curtis Melvin, 'UDMH Production in North Korea: Additional Facilities Likely', 38 North, 25 October 2017, <https://www.38north.org/2017/10/udmh102517/>, accessed 20 December 2024.

- Aoji Chemical Plant[17]
- July 7 Chemical Factory[18]
- July 7 Chemical Works[19]
- July 7 Chemical Complex[20]
- July 7 Chemical Plant[21]
- July 7 Union Enterprise[22]
- No. 77 Factory[23]
- Undok / Eundok Chemical Factory[24]
- July 27 Chemical Factory[25]
- Saebyŏl Chemical Factory[26]
- Aoji-ri Synthetic Petroleum Plant[27]
- Aoji-ri Synthetic Petroleum Refinery[28]
- 7.7 Joint Enterprise.[29]

The complex was constructed during Japanese occupation and, according to a 1969 CIA analysis, originally produced synthetic oil and refined petroleum products.[30] By 1962, it was producing ammonia and possibly methanol and urea.[31] Other reported products have included ammonium nitrate, ammonia, ammonium bicarbonate sulfuric acid, nitric acid, formalin, methanol, hexogen / RDX[32] and UDMH (Unsymmetrical dimethylhydrazine).[33]

17. ijun_33, 'Aoji Chemical Plant Methanol Rectification Tower Aoji Chemical Plant. Methanol Refining Tower 1960's', Cronobook, <https://cronobook.com/pic/t0g62z6r6o>, accessed 20 December 2024; National Photographic Interpretation Center, 'POL Storage Capacity, North Korea 1982 Estimate (S)', Imagery Analysis Report, September 1982, <https://www.cia.gov/readingroom/docs/CIA-RDP83T00574R000102600001-7.pdf>, accessed 9 February 2026.
18. Jo Hyon, 'N. Korea's Path Out of Economic Hardship is Clear', *Daily NK*, 19 June 2024, <https://www.dailynk.com/english/north-korea-path-out-economic-hardship-clear/>, accessed 19 December 2024.
19. Kim Il Sung, 'Kim Il Sung: Works, No. 37 January 1982–May 1983', p. 24, <https://www.marxists.org/archive/kim-il-sung/cw/37.pdf>, accessed 19 December 2024.
20. Food and Agriculture Organization of the United Nations, 'Fertiliser Use by Crop in the Democratic People's Republic of Korea', 2003, Chapter 2, <https://www.fao.org/4/y4756e/y4756e06.htm>, accessed 19 December 2024.
21. Chon, 'With Respect Even to the Names of Places in our Country'.
22. Hyon, 'N. Korea's Path Out of Economic Hardship is Clear'.
23. Joseph S Bermudez Jr, 'Overview of North Korea's NBC Infrastructure', North Korea Instability Project, US-Korea Institute at Johns Hopkins SAIS, June 2017, <https://www.38north.org/wp-content/uploads/pdf/NKIP-Bermudez-Overview-of-NBC-061417.pdf>, accessed 5 February 2025.
24. Hyon, 'N. Korea's Path Out of Economic Hardship is Clear'; Naver blog, 'North Korean Military Chemical Weapons Combat Power – Analysis of the Nuclear and Chemical Defense Bureau of the General Staff of the North Korean People's Army', 12 July 2015, [Reposted. Original source provided as 'North Korean Military strengthens nuclear and chemical warfare training', Yonhap, 1994], <https://blog.naver.com/citrain64/220417022692>, accessed 5 February 2025.
25. Bermudez Jr, Elleman and Melvin, 'UDMH Production in North Korea'.
26. *Ibid*.
27. CIA, 'Basic Imagery Interpretation Report: Aoji Ri Synthetic Petroleum Plant Chosen'.
28. National Photographic Interpretation Center, 'POL Storage Capacity, North Korea 1982 Estimate (S)'.
29. Kim Gyeong-won et al., *North Korea's Industry 2020 Vol. 2* (London: Korea Development Bank, 2020), pp. 281–83.
30. CIA, 'Basic Imagery Interpretation Report: Aoji Ri Synthetic Petroleum Plant Chosen'.
31. *Ibid*.
32. Kim et al., *North Korea's Industry 2020 Vol. 2*.
33. Bermudez Jr, Elleman and Melvin, 'UDMH Production in North Korea'.

The 7th July Chemical Complex is served by rail, with branch lines that connect it to the 21st July Explosives Plant, and is linked by a multilane metalled road to the main north–south G302 highway. There are two air defence sites in the immediate vicinity, although it is likely that one of those is unoccupied, and two explosives storage areas that are almost certainly related to the 21st July Explosives Plant.

There are two primary sites that make up the facility, located either side of a tributary of the Tumen River. Each of these is further subdivided into functional areas (Figure 2). These areas have been labelled arbitrarily for ease of reference.

Figure 2: Overview of Areas Within the 7th July Chemical Complex

Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

Area 1: Probable Methanol Production Area

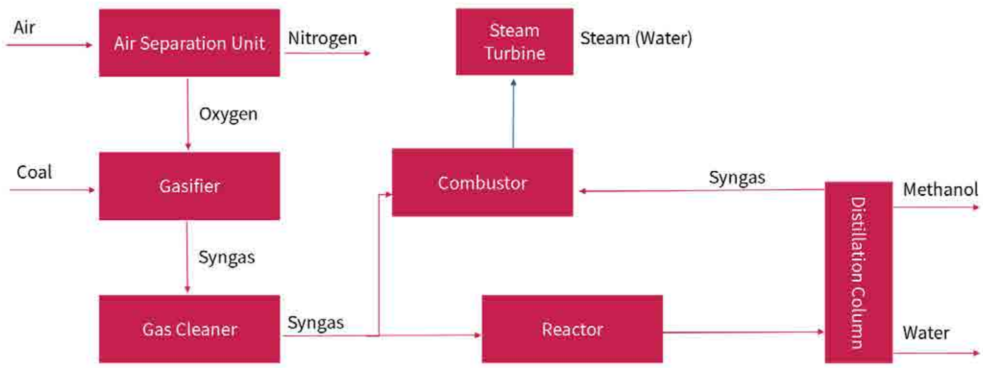
The probable methanol production area is located in the central part of the complex, adjacent to the coal storage yard, an electricity transformer station and a probable steam generation plant (Figure 3). It comprises a gas storage tank, probable gasifier, possible air separation plant, possible gas cleaners and probable distillation columns, all of which are components associated with methanol production. Taken together, this results in a high-confidence assessment of a methanol production area. However, the removal of a second gas storage tank towards the end of 2020 and the rundown nature of the facility suggests that methanol production may have ceased and the site may now be derelict.

Figure 3: Area 1: Probable Methanol Production Area

Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

Methanol could be produced at the complex through two distinct routes. The probable process in Area 1 was through direct coal gasification to syngas. This is shown in the process flow diagram in Figure 4 and is supported by the identification of a probable gasifier and possible air separation plant near the building (Figure 3). The steam generation plant to the east in Figure 3 is also possibly fed by the syngas waste from the methanol production process shown in Figure 4.

Figure 4: Process Flow for Production of Methanol Via Coal Gasification

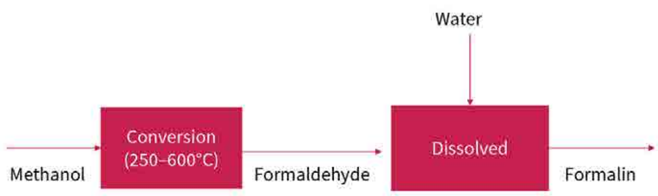


Source: Science Direct, 'Production of Methanol', <https://www.sciencedirect.com/topics/chemical-engineering/production-of-methanol>, accessed 12 February 2026. Diagram created by the authors.

In addition, methanol can be produced from the separation of syngas from coal gas produced during low temperature carbonisation of coal (see Area 3: Probable Low Temperature Coal Carbonisation and Derivatives Area).

There is very little information relating to the production of formaldehyde and formalin onsite. If they are produced onsite, this area is also a possible location for these processes due to the ready availability of methanol feedstock and potential absorption towers. Formaldehyde is a key feedstock in production routes for both RDX and UDMH.

Figure 5: Process for Production of Formaldehyde and Formalin from Methanol



Source: Joachim Thrane et al., 'A Review and Experimental Revisit of Alternative Catalysts for Selective Oxidation of Methanol to Formaldehyde', Catalysts (Vol. 11, No. 11), 2021), p. 1329. Diagram created by the authors.

Area 2: Regenerated Area

Area 2 comprises two adjacent compounds that were historically probably linked but may now have separate purposes, although due to the proximity of the two areas it cannot be ruled out that a connection remains. One appears to have been repurposed from a tank farm to an agricultural production facility and the other to a possible fabrication facility with a limited amount of processing.

Probable Agricultural Production Area

Immediately to the north of the probable methanol production area is an area that has seen significant repurposing and reconstruction since 2009. Prior to this, the area contained liquid storage tank farms, with a collocated processing building and two probable distillation columns (Figure 6). These distillation columns could have supported a manufacturing process, while the proximity of this area to the methanol production plant suggests that these tanks may have stored derivatives from and/or feed materials for the methanol production process, such as methane, carbon monoxide and hydrogen, ammonia, ammonium bicarbonate and coal tar. Between mid-2009 and mid-2011, the tank farms were dismantled and removed, with the exception of eight storage tanks in a separate compound. Of these, three were also removed somewhere between 2018 and 2019 and the rest appear to be in poor condition and may be derelict. The storage tank farm has now been replaced by rows of probable agricultural buildings, which were constructed in 2018.

Figure 6: Changes to Area 2 Between 2009 and 2024

Source: Maxar Technologies, 4 October 2024 (left) and Google (Maxar Technologies) 8 May 2009 (right). Annotated by the authors.

Possible Manufacturing / Warehouse Building

Adjacent to the agricultural production area is a possible manufacturing / warehouse building that has been in existence since at least 2005. Connected to this is a lattice tower structure and two horizontal storage tanks that have been in place since 2015. The role of the former is unidentifiable on imagery. Between 21 November 2020 and 8 October 2024, a significant amount of new construction occurred, much of which appeared to be externally complete by October 2024 (Figure 7). One of these new buildings constructed against the western edge of the compound has the appearance of a manufacturing / workshop building and was in the latter stages of construction in June 2023. The function of this area cannot be determined on imagery. Its adjacency to the agricultural area may indicate an association.

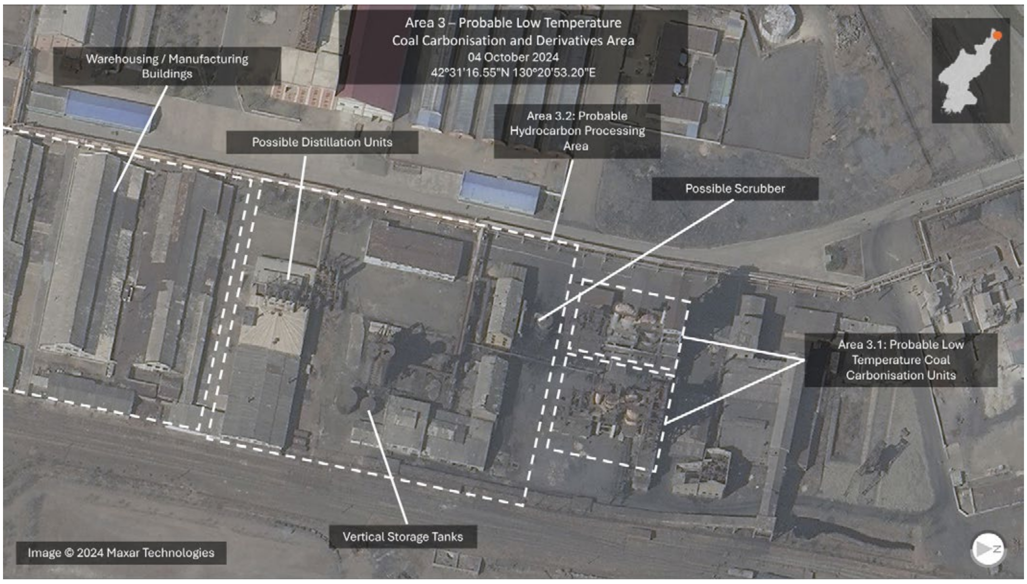
Figure 7: Redevelopment at Area 2

Source: Maxar Technologies, 4 October 2024. Annotated by the authors.

Area 3: Probable Low Temperature Coal Carbonisation and Derivatives Area

Area 3 is a substantial chemical manufacturing compound that is a probable coal and derivatives processing area, using coal derivatives from low temperature coal carbonisation process, located at the eastern edge of the 7th July Chemical Complex (Figure 8).

Figure 8: Area 3: Probable Low Temperature Coal Carbonisation and Derivatives Area



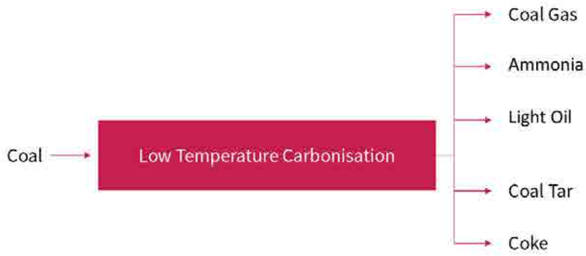
Source: Maxar Technologies, 4 October 2024. Annotated by the authors.

This area comprises, from north to south, the following areas.

Area 3.1: Probable Low Temperature Coal Carbonisation Units

Area 3.1 is a primary sub-area with two parallel units. They are fed by a raised conveyor that leads from a rail yard that has historically been used to store coal. It is likely therefore that coal is/was used as a raw material for the distillation process. This indicates destructive distillation of coal and is consistent with a partially declassified CIA imagery analysis of the complex from 1969,[34] which details the use of low temperature carbonisation of coal (Bergius process) to produce tar. Based on this assessment, the probable other products would include ammonia, coal gas, light oil and coke (Figure 9).

Figure 9: Products from Low Temperature Carbonisation of Bituminous Coal



Sources: A C Fieldner, 'Low-Temperature Carbonization of Coal,' US Department of Commerce Technical Paper 396, 1926, <https://digital.library.unt.edu/ark:/67531/metadc66430/>, accessed 6 February 2026; E O Rhodes, 'German Low-Temperature Coal-Tar Industry,' US Department of the Interior Report I C 7490, February 1949, <https://digital.library.unt.edu/ark:/67531/metadc67040/m1/1/?q=low%20temperature%20carbonization>, accessed 6 February 2026. Diagram created by the authors.

Area 3.2: Probable Hydrocarbon Processing Area

The products from low temperature coal carbonisation of coal in area 3.1 are processed in two sub-areas to the south.

The first sub-area, linked to Area 3.1 by a pipeline, comprises possible liquid storage tanks and several unidentified support buildings. The function of these have not been identified by the Project Anthracite team. However, they are likely to be involved in the processing of the primary products shown in Figure 9. For example, coal gas can be turned into syngas by separating the carbon monoxide and hydrogen from methane and other impurities, including hydrogen sulfide, which could be used in reported production of sulfuric acid at the complex.[35] Light oil and coal tar can be separated further into many compounds depending on the composition of the coal fed to the process and the reaction conditions. Possible products include benzene, toluene and

34. CIA, 'Basic Imagery Interpretation Report: Aoji Ri Synthetic Petroleum Plant Chosen'.
35. Kim et al., *North Korea's Industry 2020 Vol. 2.*

xylene (aromatic compounds which are useful for pharmaceuticals manufacture), gasoline, diesel oil, activated carbon (which can be used as catalysts in other chemical processes) and carbon fibres.[36]

A second sub-area with possible feedstocks into a large processing / manufacturing building has no obvious direct connectivity to the first and second sub-areas, other than the pipework that connects all of the complex. This pipework is connected to a probable boiler house and it is likely that it is used to provide steam throughout the installation, including the separate processing facility on the opposite side of the river (see Area 4: Probable Nitrogen Fertiliser Manufacturing Area). There appear to be possible distillation units and tanks for either treatment or storage, which would make this area consistent with further distillation of oil and tar fractions from low temperature carbonisation.

At the southern end of Area 3, there is a warehousing / manufacturing area, with three combination roofed buildings. The unique layout of this area, combined with a lack of available high-resolution imagery, precludes a positive identification of this site. However, the derelict nature of the site and the lack of observed activity indicate that this area is probably non-operational.

Possible Ammonium Bicarbonate Production Area

Between Area 3 and the river is a self-contained compound (Figure 10). This area is a possible ammonium bicarbonate production plant. It is connected via pipeline to the possible ammonia production area, contains equipment consistent with ammonium bicarbonate production, including a possible centrifuge and reaction tower, and is the only area of the complex where residue consistent with the light colour of ammonium bicarbonate is visible.

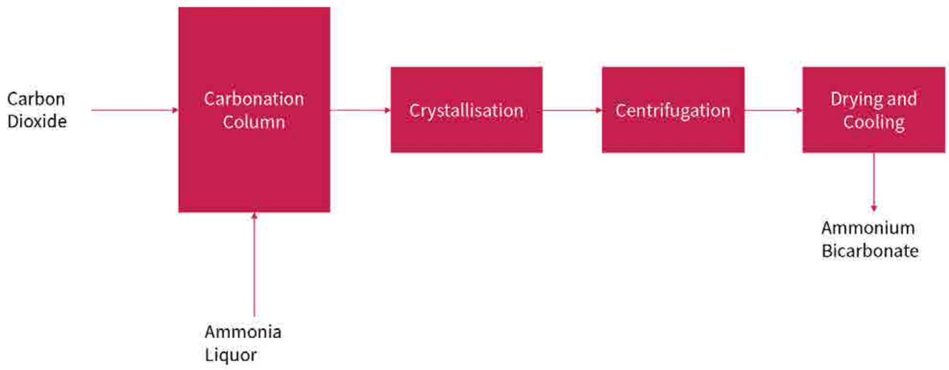
36. Carbon fibre has applications in a nuclear programme for gas centrifuges production and missile casings, but high-grade materials are extremely difficult to manufacture. See University of Kentucky Geological Survey, 'Chemicals from Coking Metallurgical Coal', <https://www.uky.edu/KGS/coal/coal-for-chemical-coke.php>, accessed 20 December 2024.

Figure 10: Possible Ammonium Bicarbonate Production Plant

Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

Ammonium bicarbonate is produced by adding carbon dioxide to ammonia liquor under pressure at low temperatures, then precipitating, centrifuging and drying the resulting ammonium bicarbonate (Figure 11).[37] It is commonly used as a leavening agent as well as an agricultural fertiliser.[38]

Figure 11: Production Process for Ammonium Bicarbonate



Source: Michelle Maddox, 'Re: Church & Dwight Co., Inc. Arm & Hammer Ammonium Bicarbonate Manufacturing Process', 22 August 2024, <https://www.ahperformance.com/products/media/ammonium-bicarbonate-manufacturing-process/>, accessed 20 December 2024. Diagram created by the authors.

37. Michelle Maddox, 'Re: Church & Dwight Co., Inc. Arm & Hammer Ammonium Bicarbonate Manufacturing Process', 22 August 2024, <https://www.ahperformance.com/products/media/ammonium-bicarbonate-manufacturing-process/>, accessed 20 December 2024.
38. Valudor Products, 'Ammonium Bicarbonate: A Key Ingredient for Agriculture and Food Processing', <https://www.valudor.com/ammonium-bicarbonate-agriculture-food-processing-benefits/>, accessed 20 February 2025.

Area 4: Probable Nitrogen Fertiliser Manufacturing Facility

Across a major road bridge over the river is another substantial chemical manufacturing facility that is a probable production area for ammonium nitrate, comprising four main areas, Areas 4.1 to 4.4 (Figure 12). In imagery via Google Earth and Vantor from 2026, there is no observed activity in this area, which suggests it is non-operational.

Figure 12: Area 4: Probable Nitrogen Fertiliser Manufacturing Facility

Source: Google Earth (CNES/Airbus), 1 June 2023. Annotated by the authors.

Area 4.1: Possible Nitric Acid or Urea Production Area

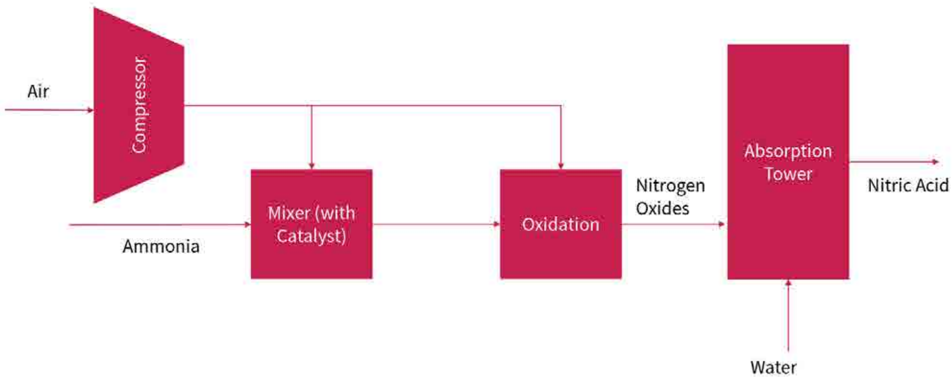
Area 4.1 comprises a possible nitric acid production area (Figure 13). There is at least one probable distillation tower integrated into the main area, and a separate probable prilling tower that does not appear to be connected to the rest of the plant. The facility is interconnected with a significant network of piping, some of which is apparently supported by an open framework. This pipework is connected to a vent stack, to a probable manufacturing building and to two adjacent compounds whose function is indeterminable, although one may be a possible transformer yard. The pipework is also connected to four substantial, probable cooling buildings, each with probably two cooling towers within, indicating a highly exothermic process.

Figure 13: Area 4.1: Possible Nitric Acid Production Area

Source: Google Earth (CNES/Airbus), 1 June 2023. Annotated by the authors.

The nitric acid production process from ammonia (Figure 14) is consistent with production in this area. The oxidation of ammonia for nitric acid production is highly exothermic, which would necessitate the cooling capacity visible on imagery.

Figure 14: Production of 50–60% Nitric Acid



Source: Royal Society of Chemistry, 'Nitric Acid', 12 November 2012, YouTube, 0:25–1:05, <https://www.youtube.com/watch?v=FIxz7biiIG0>, accessed 20 December 2024. Diagram created by the authors.

Until March 2018 there was a large storage tank, approximately 32 m in diameter, adjacent to the processing facility that may have contained a feedstock for this part of the facility, possibly oxygen or ammonia, but by November 2018 that had been demolished (Figure 15). Other parts of this site have also fallen into disrepair since the end of 2018. These factors, together with the lack of any observed activity (such as exhaust stack emissions, vehicle movement or new building) indicate that this part of the facility may now be non-operational, and the processing area looks obsolete in imagery.[39]

39. Construction of the Sunchon Phosphatic Fertiliser Complex began around this period. It is possible that ammonia production capacity lost at the 7th July Chemical Complex may have been established in Sunchon, although this report does not attempt to identify a link between the two production lines.

Figure 15: Support Facilities for Areas 4.1 and 4.2

Source: Google Earth (CNES/Airbus), 1 June 2023. Annotated by the authors.

Area 4.2: Possible Ammonia Production

Area 4.2 (Figure 16) comprises a series of connected flat roof multistorey buildings, in total measuring approximately 180 m long and 30 m wide. This building complex is heavily vented, indicating the need for substantial ventilation for whatever activity is contained within. The complex is fed by a discrete cluster of four probable distillation towers, supported by at least two probable pressurised gas storage tanks.

Within the context of the site chemistry, this would be a feasible location for ammonia production. There is a pipeline running directly from Area 3, which could carry methane derived from coal carbonisation to the large building visible in Area 4.2. This is supported by the building's central location to two processes identifiable with moderate confidence and which require large amounts of ammonia feedstock: nitric acid and ammonium nitrate production.

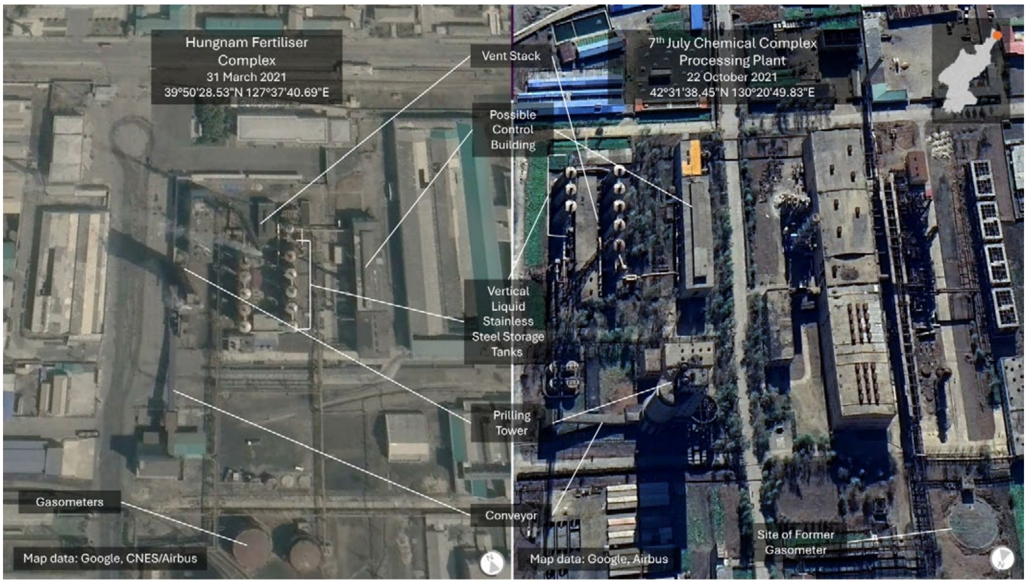
Figure 16: Area 4.2: Possible Ammonia Production Area

Source: Google Earth (CNES/Airbus), 1 June 2023. Annotated by the authors.

Area 4.3: Probable Liquid Fertiliser Production Plant

Area 4.3 comprises two rows of probable stainless-steel towers linked by pipework, on either side of a single storey T-shaped building (Figure 17). The towers are also connected to a separate stepped, multistorey flat roof production / processing building. The pipework is further connected on one side to a tall exhaust stack constructed within a girder framework. This layout is very similar to that at the Hungnam Fertiliser Complex (Figure 17), which has been previously identified by Project Anthracite as Unknown Facility 1.

Figure 17: Probable Liquid Fertiliser Production Plant at the 7th July Chemical Complex, Compared with Hungnam Fertiliser Complex



Sources: Hungnam Fertiliser Complex (left) Google Earth (CNES/Airbus), 31 March 2021; 7th July Chemical Complex (right) Google Earth (Airbus), 22 October 2021. Annotated by the authors.

Area 4.4: Probable Production Area for Pelletised Fertiliser

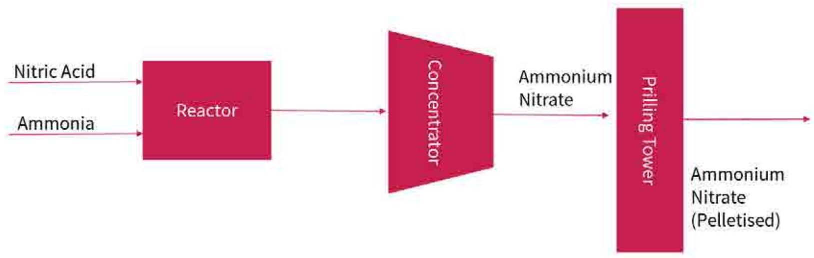
Area 4.4 comprises a prilling tower, fed by a conveyor adjacent to a rail spur (Figure 18). Directly adjacent to the prilling tower are the remains of a probable gas storage tank and in a low walled compound are four low, probably derelict, gas / liquid storage tanks. It is likely that this area comprised the finishing area for a pelletised fertiliser, possibly ammonium nitrate or urea, and associated liquid and gas by-products. However, its rundown nature indicates this site is potentially now non-operational.

Figure 18: Area 4.4: Probable Production Area for Pelletised Fertiliser

Source: Google Earth (CNES/Airbus), 1 June 2023. Annotated by the authors.

Ammonium nitrate is not listed as a product of the complex in North Korean sources, but it is both quite a common fertiliser and a possible component of explosives. Although ammonium nitrate is not a common military-grade explosive, its dual-use nature and relatively low cost of production may have made it an attractive option for North Korea, which also uses explosives extensively for underground excavation. All the materials and equipment necessary to produce the fertiliser were available at the complex at some point in time, including a prilling tower. There are partially buried storage tanks, which could be a safety measure for the storage of liquid ammonium nitrate. Further, there seems to have been immediate shipment of the product from the prilling tower offsite via the rail spur. This would also be consistent with a highly combustible material such as ammonium nitrate, as it should be stored at a safe distance from processing areas.[40] The ammonium nitrate production process is detailed in Figure 19.

Figure 19: Production of Ammonium Nitrate from Nitric Acid and Ammonia



Source: A K H Sabry, 'Synthetic Fertilizer: Role and Hazards', in S Sinha, et al. (eds), Fertilizer Technology I: Synthesis (India: Studium Press), pp. 176–199.

The alternative is that Area 4 is used for urea production. The exothermic reaction in Area 4.1 would be for production of ammonium carbamate, which decomposes to urea and water.[41] Urea was cited as a possible product in the 1969 CIA report for the facility. Both urea and ammonium nitrate could be produced in pelletised form in this production area.

Discrete Probable Processing Compound

About 150 m to the northeast of Area 4 is a discrete compound comprising a probable administrative / support area and a separately secured probable processing area. The walled nature of the processing area and its location associated with but separated from the main site make it particularly interesting. The compound has been in existence since at least 2005 (Figure 20). At that time, it was collocated with two gas storage tanks (approximately 23 m in diameter) and connected via a raised pipeline to a rail reception area and probable raw material sorting building. This in turn was connected to the conveyors feeding the facility at Area 4. It is likely, therefore, that whatever was stored in the gas tanks was either a product of, or a feed to, the process at Area 4.4. However,

40. Agricultural Industries Confederation, 'AIC Guide for the Storage, Handling and Transportation of Ammonium Nitrate-Based Fertilisers 2015', <https://www.agindustries.org.uk/resource/the-storage-handling-and-transportation-of-ammonium-nitrate-based-fertilisers-2015-25-may-2016-3-pdf-1.html>, accessed 6 February 2026.
41. Risso Chemical, 'How Are Urea Fertiliser Granules Manufactured?', 20 March 2025, <https://risso-chemical.com/how-is-urea-made/>, accessed 11 March 2026.

the discrete compound has undergone substantial change over subsequent years. The two gas tanks had been demolished by 2011, and the small processing building had become derelict.

Figure 20: Discrete Processing Compound in 2005

Source: Maxar Technologies, 5 March 2005. Annotated by the authors.

Between March 2005 and May 2009, seven smaller liquid storage tanks were constructed in the secure compound area (five approximately 3.5 m in diameter and two approximately 2.5 m in diameter). They have been there ever since. In Figure 20, a mound of earth can be seen around what appears to be an entrance to a possible underground structure next to the compound, dug into a slope. This entrance appears to have been reinforced by an arc of concrete and remains there on the latest available imagery (see Figure 21). The location of this feature next to the compound indicates a possible link, but there is no obvious road or track to this entrance and no activity has been identified on imagery, either at the entrance or in the immediate vicinity. It is therefore possible that it is unrelated. Within the secure compound itself, a new building was constructed and a second extended between 4 August and 12 October 2022. The role of these cannot be determined on imagery.

Figure 21: Discrete Processing Compound in 2024

Source: Maxar Technologies, 4 October 2024. Annotated by the authors.

Summary of Chemical Production at the 7th July Chemical Complex

The methanol, coal derivatives, ammonia and nitrate fertiliser production areas (Areas 1, 3 and 4) at the 7th July Chemical Complex may no longer be operating. It is likely that two large, recently constructed sites in the Sunchon area produce many of the same chemicals, and possibly were established as replacement facilities in a more central location.[42] The C1 Complex in Sunchon uses goal gasification, but unlike the 7th July Chemical Complex does not appear to have a low temperature coal carbonisation process.

A summary of the chemicals produced at the 7th July Chemical Complex and their current status is shown in Table 1.

Table 1: Summary of Areas Within the 7th July Chemical Complex and 21st July Explosives Plant

Complex	Area	Most Likely Products	Current Status
7th July Chemical Complex	Area 1	Methanol	Possibly non-operational
	Area 2	Agricultural	Probably operational
	Area 3	Coal-processing derivatives	Probably non-operational
	Area 4	Ammonia, nitric acid, ammonium nitrate	Possibly non-operational
	Possible Ammonium Bicarbonate Production Area	Ammonium bicarbonate	Possibly operational
21st July Explosives Plant	Main Processing and Production Area	Military high explosives, ammonium nitrate-fuel oil, emulsion explosives	Possibly non-operational
	Additional Areas	UDMH, RDX	Possibly operational

Source: The authors

42. Project Anthracite Team, Site Profile 7: 'Sunchon Chemical Facilities: DPRK's Chemical Facilities: Site Profile 7', VERTIC, 2026 (forthcoming).

21st July Explosives Plant

The 21st July Explosives Plant is a site 0.8 km northeast of Area 4 of the 7th July Chemical Complex (Figure 22), and it is linked by rail and road. This site has also been referred to as the Kyonghung Explosives Plant, Aoji-ri.[43] The plant is divided into two general functional areas: a main area reported as constructed in 1978 and a second area probably for mixing and finishing and subsequent controlled storage.

Figure 22: Overview of the 21st July Explosives Plant

Source: Google Earth (CNES/Airbus), 1 June 2023. Annotated by the authors.

Main Processing and Production Area

The chemical manufacturing area has experienced observable degradation over a long period and there is nothing on imagery to suggest that it is still operational. However, for completeness, its constituent elements are described below, arbitrarily labelled A–E for the purposes of this report (Figure 23).

43. National Photographic Interpretation Centre, 'New Probable Explosives Plant Under Construction: Kyonghung Prob. Expl. Plt. N. Aoji-ri Ucon, North Korea', 27 September 1982, <https://www.cia.gov/readingroom/docs/CIA-RDP90T00784R000200360013-1.pdf>, accessed 6 February 2026, accessed 6 February 2026.

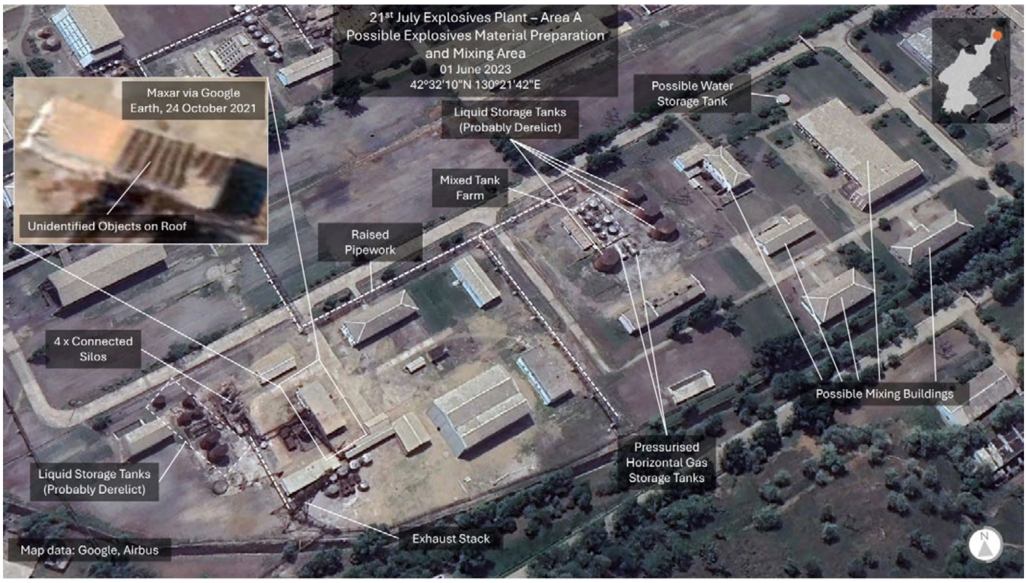
Figure 23: 21st July Explosives Plant Main Processing and Production Area

Source: Google Earth (CNES/Airbus), 1 June 2023. Annotated by the authors.

Area A: Possible Explosives Material Preparation and Mixing Area

Area A (Figure 24) is a possible explosives material preparation and mixing area, based on the presence of several tank farms of diverse shapes and sizes, (indicating different constituent raw materials), isolated buildings, many of which have no or a limited number of windows and which may be for mixing, and a comprehensive network of raised pipework, linking much of the site. The easternmost compound, notable for its three storage / processing tank clusters, has a central building that periodically has unidentified objects placed on part of its roof or just behind the building. These were observed on available imagery of October 2022, October 2021 and October 2017, indicating a potential seasonal link. The proximity of nearby cultivated land makes it possible that these objects may be agriculturally related.

Figure 24: Area A: Possible Explosives Material Preparation and Mixing Area



Source: Google Earth (CNES/Airbus), 1 June 2023. Inset: Google Earth (Maxar Technologies), 24 October 2021. Annotated by the authors.

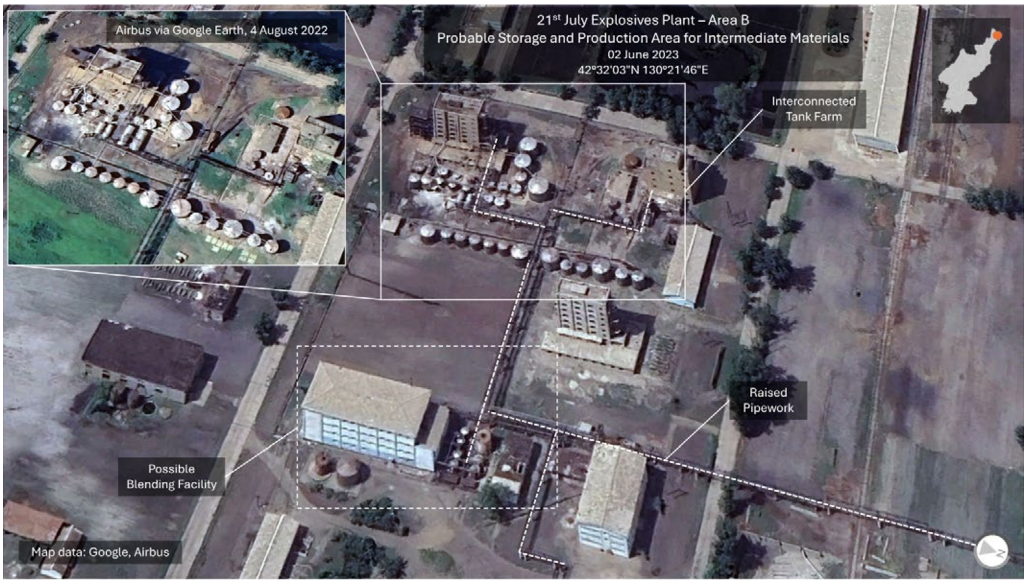
Area B: Probable Storage and Production Area for Intermediate Materials

Area B (Figure 25) is a second major processing area with a substantial interconnected tank farm. It is not possible on imagery to determine the contents of the various tanks. Intermediate materials associated with explosives production depend on the type of explosive being produced, but include the following:

- For ammonium nitrate-fuel oil: ammonium nitrate, diesel fuel or kerosene and anti-caking agents.
- For emulsion explosives: ammonium nitrate solution, emulsifiers and sensitisers such as sodium nitrate.
- For military high explosives (TNT, RDX): toluene, hexamine, nitric acid, acetic anhydride, sulfuric acid, solvents such as acetone and ethanol and stabilisers such as calcium carbonate and phlegmatisers.

The sheer number and variety of the tanks is consistent with this area being used for explosives production. There are three multistorey buildings associated with this area, all of which have large vents on the roof, indicating a possible production / manufacturing role.

Figure 25: Area B: Probable Storage and Production Area for Intermediate Materials



Source: Google Earth (CNES/Airbus), 1 June 2023. Inset: Google Earth (Maxar Technologies), 24 October 2021. Inset: Airbus via Google Earth, 4 August 2022. Annotated by the authors.

Area C: Probable Derelict Power Station

Area C is a now probably derelict power station (Figure 26) that was probably coal powered, which would be an expected feature of an explosives production facility, required for temperature-controlled reactions and process heating. Exactly when this power station ceased to operate is unknown, but there is no evidence of it functioning on all available imagery since early 2005.

Figure 26: Area C: Probable Derelict Power Station

Source: Google Earth (CNES/Airbus), 1 June 2023. Annotated by the authors.

Area D: Derelict Processing Facility

Area D is also now derelict, but its layout indicates an unidentified processing facility for raw materials (Figure 27). Unidentified raw materials were delivered by rail into a reception shed and fed into a multistorey probable processing building before potentially being stored and further processed in vertical tanks. Imagery from 5 March 2005 shows an area of red/brown discharge in addition to ice adjacent to this area, although it is unclear as to whether this is associated with the processes or just contamination from elsewhere. Exactly when this area became derelict is unclear from available imagery, but the site appears to have started to deteriorate between 2005 and 2009, as evidenced by the degradation to the roof of the reception shed.

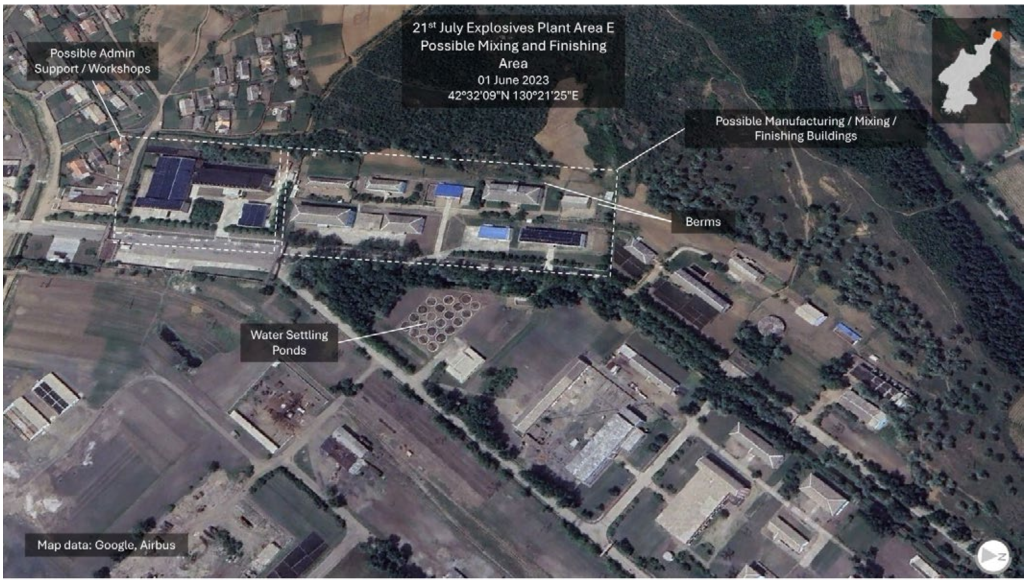
Figure 27: Area D: Comparison Between 2005 and 2024

Source: Google Earth (Maxar Technologies), 5 March 2005 (left) and Maxar Technologies, 4 October 2024 (right).

Area E: Possible Mixing and Finishing Area

Area E (Figure 28) is characterised by well-spaced buildings, some of which are semi-bermed and/or separately secured. This is likely to be a mixing / finishing area. The westernmost compound contains three very large multistorey buildings that are potentially a combination of machine shops and administration, although there is nothing on imagery to confirm this. Between October 2017 and March 2018, a group of 21 circular footings had been dug into the ground immediately outside this area. By the end of 2018 each appears to have a low wall marking its perimeter. By 2022, at least 10 of these appear to have horizontal booms within them. Over the same period, other areas of the complex had been given over to agricultural production and it is highly likely that these circular areas have been created for agricultural production.

Figure 28: Area E: Possible Mixing and Finishing Area



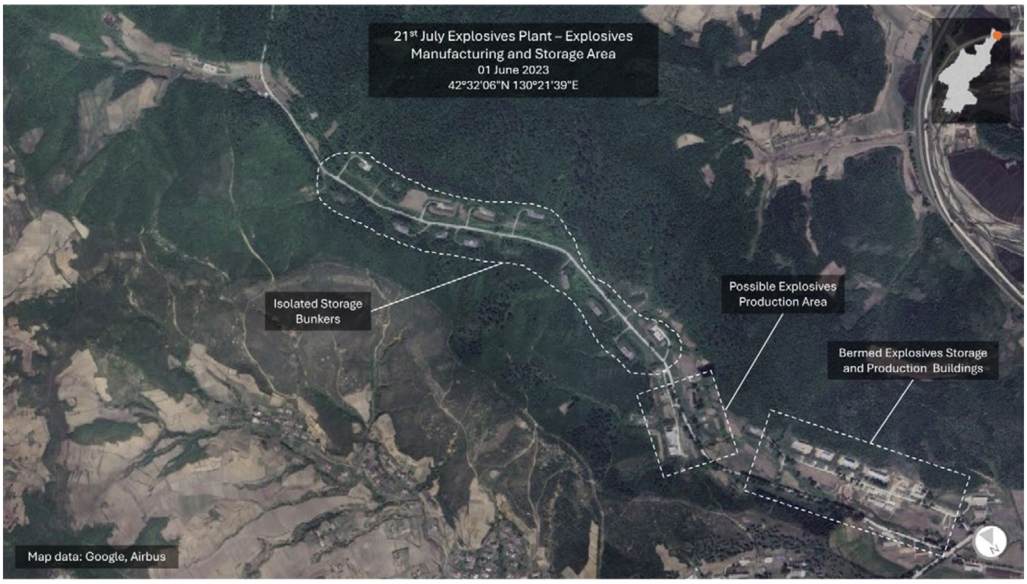
Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

Additional Areas

Explosives Production and Storage Area

Figure 29 shows a significant explosives manufacturing and storage area bounded by a valley within a mountainous area north of the main facility. This is characterised by individual, bermed explosives storage buildings, but notably also a probable production capability. There are broadly three distinct areas, characterised below.

Figure 29: Probable Explosives Manufacturing and Storage Area

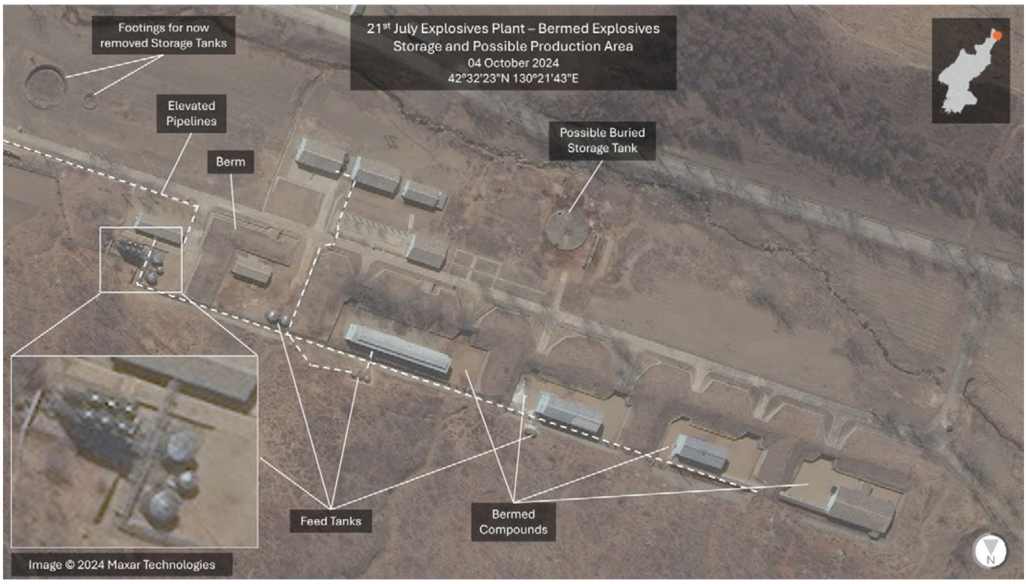


Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

Explosives Storage and Production Area

At the entrance to the valley is an area with four distinctive fully bermed compounds, each with what appear to be possibly reinforced concrete buildings (Figure 30). There are two further adjacent compounds, one of which is semi-bermed with two possible fuel / liquid storage tanks and one with six integrated possible processing silos and three probable feed tanks. There are footings for storage tanks that have been removed, and the compounds are all linked with an elevated pipeline, which extends the main complex. The layout indicates that the buildings within these compounds may be involved in mixing or other volatile processes. The well-kempt nature of these compounds also indicates that they may be operational.

Figure 30: Bermed Explosives Storage and Possible Production Area



Source: Maxar Technologies, 4 October 2024. Annotated by the authors.

Manufacturing Area

Adjacent to this area is a second area comprising a multilevel manufacturing building approximately 65 m long by 15 m wide (Figure 31). This is connected via a dual pipeline to a separate chemical processing plant comprising six identical towers, two smaller possible feed tanks and a vent stack.

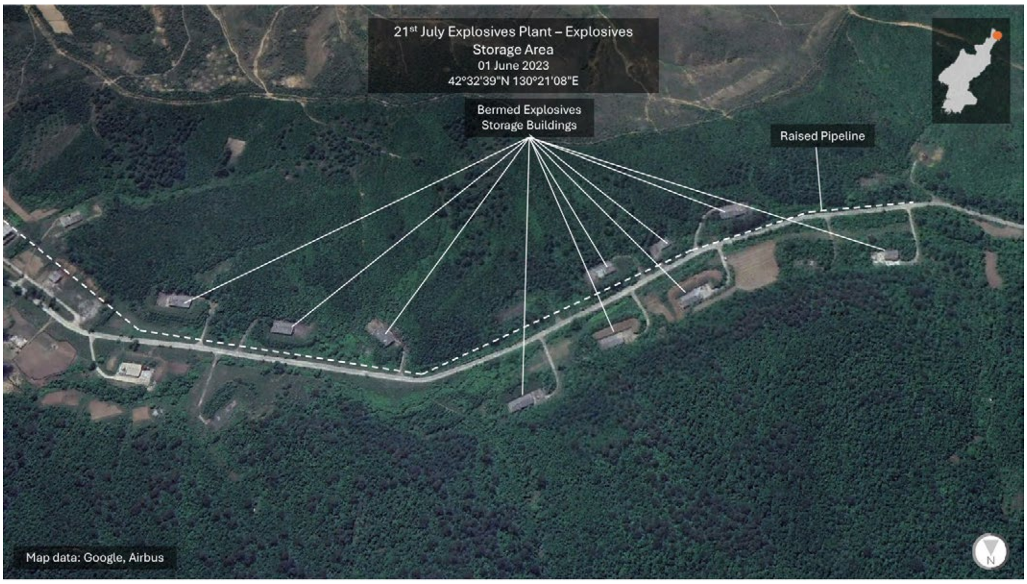
Figure 31: Probable Explosives Storage and Production Area

Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

Additional Storage Area

The pipeline from the possible mixing / finishing building in the above manufacturing area is connected to a series of remote, bermed probable explosives storage buildings higher up the valley (Figure 32).

Figure 32: Explosives Storage Area



Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

RDX is one of the reported products from this area, and it is feasible that North Korea could still be producing it in these bermed buildings.[44] However, some of the precursors may no longer be produced nearby at the 7th July Chemical Complex and may be shipped in from elsewhere (for example, the status of the identified methanol production area is uncertain).

There has also been reporting, which this report has not been able to corroborate, of possible production of UDMH at the 7th July Chemical Complex[45] but this area of the 21st July Explosives Plant has components that would be consistent with this assessment.

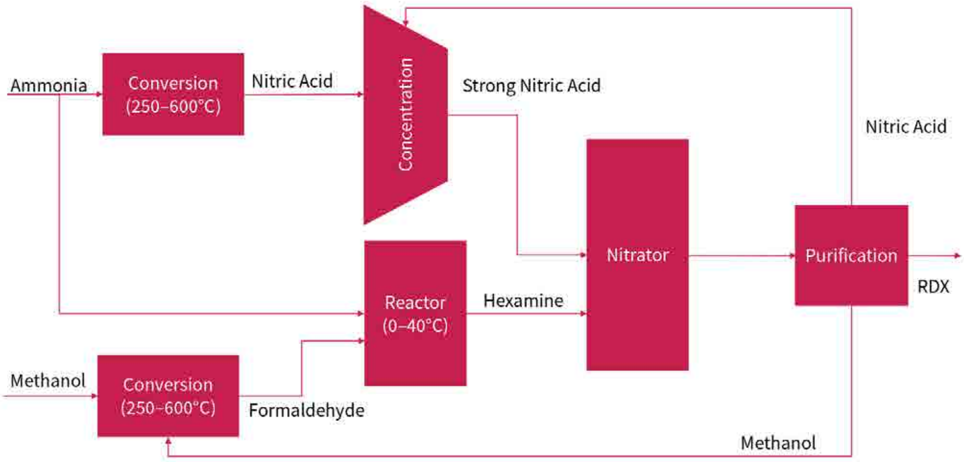
The Olin-Raschig process has been assessed as likely based on publications related to UDMH production at the 8th February Vinalon Complex.[46] The 8th February Vinalon Complex is assumed to produce chlorine and chlorine-containing compounds, and there is an absence of indications of chlorine chemistry at the 7th July Chemical Complex. However, this does not preclude the possibility of chlorine shipments to the complex from elsewhere in North Korea.

Chlorine in most of the world is typically transported by rail in specialised horizontal cylindrical railcars for hazardous substances, and tanks possibly consistent with these characteristics have been seen at the northern rail end of the 21st July Explosives Plant.[47] Other analyses have identified the use of flatcars for the transport of chemicals in North Korea, and open-top flatcars can be seen on imagery at both the 7th July Chemical Complex and the 21st July Explosives Plant.[48] Although none of the flatcars seen at Aoji-ri have been identified with tanks visible inside, this does not preclude the possibility that they may have carried similar tanks which were not captured on satellite imagery.

UDMH production in this area could potentially occur via another, more complicated yet chlorine-free route: the reaction of acetylhydrazine with formaldehyde and hydrogen. A schematic of this possible route to UDMH is shown in Figure 33. However, this report still assesses that production of UDMH in North Korea is more likely via the Olin-Raschig process, as it is likely that shipping precursors between facilities is less complicated than developing two routes to UDMH. If the Olin-Raschig process is used to manufacture UDMH at the 21st July Explosives Plant, it would indicate the production of dimethylamine at either the Explosives Plant or the 7th July Chemical Complex.

44. Kim et al., *North Korea's Industry 2020 Vol. 2.*
45. Bermudez Jr, Elleman and Melvin, 'UDMH Production in North Korea'.
46. Jeffrey Lewis, 'Domestic UDMH Production in the DPRK,' *Arms Control Wonk*, 27 September 2017, <http://www.armscontrolwonk.com/archive/1204170/domestic-udmh-production-in-the-dprk/>, accessed 19 February 2025.
47. See Maxar via Google Earth, 14 January 2019, 42°32'6.11'N, 130°21'37.01'E; Airbus via Google Earth, 12 February 2019, 42°32'6.27'N, 130°21'33.52'E.
48. Joseph S Bermudez Jr and Jennifer Jun, 'Manpo Unha Factory Part 1: A Missing Piece in North Korea's Nuclear Puzzle,' *Beyond Parallel,* 27 March 2023, <https://beyondparallel.csis.org/manpo-unha-factory-part-1-a-missing-piece-in-north-koreas-nuclear-puzzle/>, accessed 2 April 2026. Imagery via Google Earth and Vantor.

Figure 33: Alternative Route to Olin-Raschig Chlorine-Based Process for UDMH



Sources: American Chemical Society, '1,1-Dimethylhydrazine', 21 March 2023, <https://www.acs.org/molecule-of-the-week/archive/d/dimethylhydrazine.html>, accessed 25 July 2025; Niir Project Consultancy Services, 'How to Start an Acetyl Hydrazine Manufacturing Business?', 19 February 2025, <https://www.niir.org/blog/how-to-start-an-acetyl-hydrazine-manufacturing-business/>, accessed 25 July 2025; International Agency for Research on Cancer, 'Some Industrial Chemicals', Volume 115, 2018, <https://monographs.iarc.who.int/news-events/volume-115/>, accessed 25 July 2025. Diagram created by the authors.

Additional Explosives Plant

There is a further area of remote probable explosives storage buildings further north from the 21st July Explosives Plant, comprising 18 similar bermed buildings (Figure 34). These are closely located to and connected by road to two similarly configured separately secured compounds, both with large possible manufacturing buildings and support / storage buildings. This valley system comprises another probable explosives production plant. This assessment, which was made independently by the Project Anthracite team, was later corroborated by a historical declassified CIA report.[49]

49. National Photographic Interpretation Centre, 'New Probable Explosives Plant Under Construction: Kyonghung Prob. Expl. Plt. N. Aoji-ri Ucon, North Korea'.

Figure 34: Remote Explosives Storage Area

Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

Associated Facilities

There are several other potentially related facilities in the vicinity of the 7th July Chemical Complex and 21st July Explosives Plant.[50] There is some question as to the limits of the 7th July Chemical Complex and other collocated facilities and it is likely that there is, or has been in the past, a degree of association. For example, according to one defector, the 'Aoji Chemical Factory' was built on and around a mountain and comprised a series of production lines for munitions[51] which is consistent with the 21st July Explosives Plant.

Aoji Coal Mine

The Aoji coal mine (also known as the 10th June or 13th June Coal Mine or the Eundok District Coal Mine[52]) is located approximately 500 m from the complex and directly linked to an unloading and storage area by a rail spur that includes a tunnel under the adjacent air defence site (Figure 35). Historical reporting indicates that bituminous coal was used to extract methanol[53] and the proximity of the coal handling and storage

50. Joshua H Pollack et al., 'Background: North Korea's Missile Complex', James Martin Center for Nonproliferation Studies (CNS), 1 April 2019, pp. 4–9, <http://www.jstor.org/stable/resrep19700.6>, accessed 6 February 2026.
51. Jeong Gi-hae, '<아북녘동포>23.제3부2.군수산업으로 압박받는 민간경제 [출처:중앙일보]' ['North Korean Compatriots Part 3. The Private Economy Under Pressure from the Military Industry',] *JoongAng Ilbo*, 29 March 1995, <https://www.joongang.co.kr/article/3039320>, accessed 12 February 2025.
52. Citizens Alliance for North Korean Human Rights, 'Blood Coal Export From North Korea: Pyramid Scheme of Earnings Maintaining Structures of Power', 2020, <https://www.nkhrcampaign.org/copy-of-blood-coal-export-from-north>, accessed 3 February 2025; Moon Seong-hui and Park Seong-woo, '"아오지 탄광" 생산중단 위기, 왜? ['Why is the Aoji Coal Mine Facing a Production Halt?'], *RFA Korean Weekly*, 29 July 2013, <https://www.rfa.org/korean/weekly_program/nk_now/fe-ms-07292013124523.html>, accessed 3 February 2025.
53. Search for '7.7연합기업소' ['7.7 Joint Enterprise'], North Korea Information Portal, <nkinfo.unikorea.go.kr>, accessed 11 March 2026.

area supports this view. However, the relatively low stocks of coal at the handling area since 2020 and the lack of apparent activity at the coal mine indicate that the mine may currently be inactive.

Figure 35: 10th June Coal Mine

Source: Maxar Technologies, 4 October 2024. Annotated by the authors.

Electricity Sub-Station

There is an electricity sub-station located between the 7th July Chemical Complex and 21st July Explosives Plant at 42.531748 N, 130.350567 E (Figure 36). Pylons indicate that this sub-station supports both sites, but its operational status is indeterminable on imagery.

Figure 36: Electricity Sub-Station

Source: Maxar Technologies, 4 October 2024. Annotated by the authors.

Facility of Interest

One additional facility of interest was identified within 1.5 km of the 21st July Explosives Plant and connected by road to the 7th July Chemical Complex (Figure 37). The facility has been in existence since at least 2005 when the first commercial image was available. It comprises a double entrance built into a hillside with three possible support buildings. The entrances are noticeably large (both at least 5 m wide) and associated vehicular activity indicates they are vehicle capable. They have earth walls built outside the entrances that form either a protective barrier or a 'privacy' wall to prevent visibility into the entrance. There is a possible third smaller entrance at right angles to the primary two. There were unidentified vehicles and a layer of probable sand outside the complex on imagery of 23 June 2025, indicating that the facility was operational at this time. The role of the site is undetermined from satellite imagery. While there is no obvious external physical security associated with the facility, its isolated location and configuration suggest it may have a sensitive function.

Figure 37: Probable Buried Facility

Source: Google Earth (Airbus), 1 June 2023. Annotated by the authors.

CWA Inferences

Project Anthracite recently released a report, 'Raw Materials for Potential Chemical Warfare Agents', which provides a basic background and reference document for the chemistry outlined in this section of this report.[54]

The 7th July Chemical Complex possesses several industrial features and chemical processes that, while primarily aligned with civilian production, could plausibly support CWA synthesis. The historical and probably still existing production of key industrial chemicals such as ammonia, methanol, sulfuric acid, formaldehyde and ammonium bicarbonate[55] provides a foundation for producing CWA precursors.

The 7th July Chemical Complex was thought by historical CIA reports to employ the Bergius process for liquefaction of bituminous coal to hydrocarbons.[56] Given this capacity, it is possible that operators could exploit these facilities to generate ethylene or acetylene from a range of hydrocarbon sources; however, no candidate areas for this have been identified at the 7th July Chemical Complex. Ammonia liquors derived from the low-temperature carbonisation of bituminous coal are rich in nitrogenous compounds, including ammonia and amines, making them valuable feedstocks for CWA synthesis. Methanol's widespread industrial use and dual-use nature make it a strategically important chemical in both legitimate and clandestine chemical synthesis pathways. All these intermediates could, in turn, support the synthesis of hydrogen cyanide, G-series nerve agents, mustard agents, Adamsite and VX.

Hydrogen Cyanide

Project Anthracite has identified shipments of significant quantities of exports of sodium cyanide from North Korea between 2015 and 2024,[57] which indicates a production capacity for similarly large quantities of sodium cyanide's precursor, hydrogen cyanide (CWC Schedule 3A(3) toxic chemical). The 7th July Chemical Complex has been associated with blood agent production,[58] and the potential availability of methanol and ammonia onsite indicate hydrogen cyanide as the most likely CWA to be produced at this site, if it does in fact produce CWAs.

54. Project Anthracite Team, 'Raw Materials for Potential Chemical Warfare Agents: Technical Assessment 1', RUSI, 16 July 2025, <https://www.rusi.org/explore-our-research/publications/special-resources/raw-materials-potential-chemical-warfare-agents-technical-assessment-1>, accessed 23 July 2025.
55. While not a direct precursor to chemical warfare agents (CWAs), ammonium bicarbonate can serve a supporting role in their synthesis by acting as a source of ammonia for the production of key intermediates such as methylamine, dimethylamine or di-isopropylamine. Ammonium bicarbonate's ability to release ammonia under thermal decomposition, along with its wide availability and innocuous uses, makes it a useful dual-use chemical in resource-limited or clandestine production environments.
56. Takao Kaneko et al., 'Coal Liquefaction', in Wiley-VCH, *Ullmann's Encyclopedia of Industrial Chemistry* (Weinheim: Wiley-VCH, 2012).
57. Hailey Wingo and Jack Crawford, 'North Korean Trade Data: The Case of the Chemical Industry' in Yonho Kim (ed), *Discerning North Korean Economic Strategies*, Institute for Korean Studies, The George Washington University, 2026.
58. Bermudez Jr, 'Overview of North Korea's NBC Infrastructure'.

Tabun

The availability of ammonia and methanol indicates the possibility for the production of methylamine and ethylamine intermediates at the 7th July Chemical Complex. However, there is currently no observable evidence of chlorine chemistry at the complex, which would limit the site's capability to produce tabun (GA), in contrast to facilities such as the 8th February Vinalon Complex,[59] where the combined presence of chlorine and an ammonia production infrastructure would make it far more suitable for dimethylamine synthesis and tabun production.[60]

Sarin and Soman

Methanol is also a recognised precursor in the synthesis of methylphosphonic dichloride[61] from phosphorus trichloride, an intermediate in the production of G-series agents such as sarin (GB) and soman (GD). However, no phosphorus-based precursors have been identified at Aoji-ri, indicating it is unlikely to be directly engaged in such production. Instead, reports of phosphorus chemistry at other North Korea facilities – such as the 8th February Vinalon Complex[62] – raise the possibility of a dispersed or multisite CWA programme, in which the 7th July Chemical Complex provides bulk intermediates such as methanol, while specialised precursor production occurs elsewhere.

Mustard Agents

Methanol and ammonia can also be used to synthesise methylamine[63] and dimethylamine[64] feedstocks for nitrogen mustards. Additionally, methanol can be used to synthesise alcohols and diethanolamines,[15] further supporting vesicant production. Isolation of sulfur compounds from coal processing may be used to produce sulfuric and sulfurous acids at the complex but may also enable sulfur mustard (HD) synthesis, which has been more commonly stockpiled in CW programmes than nitrogen mustards.

VX

Ammonia, ethylene and acetylene are also relevant to the synthesis of VX via its precursor, di-isopropylamine. However, Project Anthracite has not identified phosphorus chemistry at scale at the 7th July Chemical Complex; thus, if this site is involved in VX production it is likely to be indirectly.

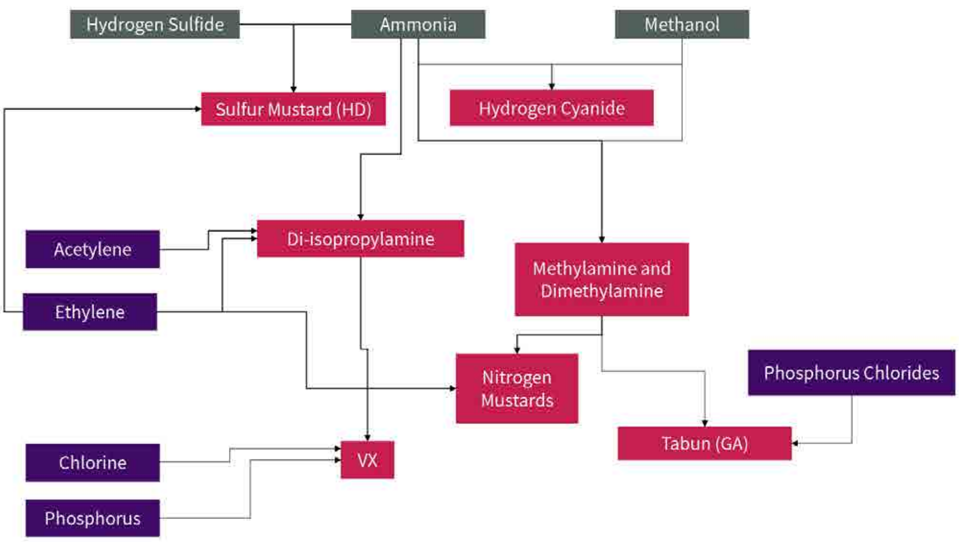
59. Based on research conducted for a forthcoming Project Anthracite site profile of the 8th February Vinalon Complex (May 2026).
60. Bermudez Jr, Elleman and Melvin, 'UDMH Production in North Korea'. See also *ibid*.
61. R M Black and J M Harrison, 'The Chemistry of Organophosphorus Chemical Warfare Agents', in S Patai, Z Rappoport and F R Hartley (eds.), *The Chemistry of Organophosphorus Compounds* (New York, New York: John Wiley & Sons, 1996) <https://doi.org/10.1002/0470034351.ch10>, accessed 13 May 2026.
62. Based on research conducted for a forthcoming Project Anthracite site profile of the 8th February Vinalon Complex (May 2026).
63. V Merz and K Gasiorowski , 'Ueber die direkte Ueberführung von Gliedern der Weingeistreihe in Amine' ['On the Direct Conversion of Members of the Spirit Series into Amines'], *Berichte der deutschen chemischen Gesellschaft* (Vol. 17, Issue 1, 1884), p. 623.
64. B August B and Willy Musin, 'Methylamines', in Wiley-VCH, *Ullmann's Encyclopedia of Industrial Chemistry* (Weinheim: Wiley-VCH, 2000).

Adamsite

Other reporting has postulated the production of Adamsite at the facility.[65] Project Anthracite has not identified the chlorine chemistry needed to support Adamsite production at the 7th July Chemical Complex. As with nitrogen mustards, this assessment does not preclude the shipment of chlorine compounds to the complex, or the shipment of products from the 7th July Chemical Complex elsewhere for later use in Adamsite production. Arsenic could be available as a byproduct of coal gasification.

Possible CWAs from the 7th July Chemical Complex are shown with links to available precursor chemicals in Figure 38. A longlist of CWAs and the potential ability to produce them from chemicals available at the complex (if the relevant processes are operational) are shown in Table 2.

Figure 38: Possible Routes to CWAs from Precursors at the 7th July Chemical Complex



Source: The authors.

Note: Grey boxes indicate precursor chemicals which could be available at the 7th July Chemical Complex; purple boxes indicate precursor chemicals which are unlikely to be produced at the 7th July Chemical Complex; red boxes indicate CWAs and their scheduled precursors.

65. NTI, 'Chemical Agents: Adamsite (DM, diphenylaminochloroarsine)', updated March 2003, archived via The Wayback Machine, 29 July 2005, <https://web.archive.org/web/20050729074635/http://www.nti.org/e_research/profiles/NK/Chemical/50_1074.html>, accessed 25 July 2025.

Table 2: Chemical Weapons Precursors and their Potential Availability at 7th July Chemical Complex and 21st July Explosives Factory at Aoji-ri

CW Agent		Immediate Precursors	Precursor Starting Materials (Where Applicable)	Potential Availability at Aoji-ri
Blood agents	Hydrogen cyanide	Methanol		✓
		Ammonia		✓
	Cyanogen chloride	Chlorine		✗
		Hydrogen cyanide	Methanol	✓
			Ammonia	✓
Blister agents	Nitrogen mustard (HN3)	Triethanolamine	Ammonia	✓
			Ethylene oxide	?
		Chlorinating agent		✗
	Nitrogen mustard (HN2)	N-methyl diethanolamine	Methanol	✓
			Ammonia	✓
			Ethylene oxide	?
		Chlorinating agent		✗
	Nitrogen mustard (HN1)	N-ethyl diethanolamine	Ethanol	?
			Ammonia	✓
			Ethylene oxide	✗
		Chlorinating agent		✗
	Sulfur mustard	Thiodiglycol	Ethanol	?
			Anthracite coal	✓
			Chlorine	✗
			Calcium hydroxide	?
			Sodium sulfide	?
		Chlorinating agent		✗
	Sulfur mustard (alternative route)	Vinyl chloride		✗
		Hydrogen sulfide		✓
Choking agents	Phosgene	Carbon monoxide		✓
		Chlorine		✗
	Chlorine gas			✗
Vomiting agents	Adamsite	Arsenic trichloride	Arsenic	?
			Chlorine	✗
		Diphenylamine	Benzene	✓
			Nitric acid	✓
			Sulfuric acid	✓
		Hydrochloric acid		✗

CW Agent		Immediate Precursors	Precursor Starting Materials (Where Applicable)	Potential Availability at Aoji-ri
Nerve agents	Soman	Methylphosphonic dichloride	Phosphorus trichloride	✗
			Phosphorus pentachloride	✗
			Dimethyl methylphosphonate (DMMP)	✗
		Pinacolyl alcohol	Propene	?
			Carbon monoxide	✓
			Hydrogen	✓
	Sarin	Methylphosphonic dichloride	Phosphorus trichloride	✗
			Phosphorus pentachloride	✗
			DMMP	✗
		Isopropanol		✗
		Sodium fluoride		✗
	Tabun	Ethanol		?
		Phosphorus oxychloride		✗
		Phosphorus trichloride	Phosphate	✗
			Chlorine	✗
		Phosphorus pentachloride	Phosphate	✗
			Chlorine	✗
		Dimethylamine	Methanol	✓
			Ammonia	✓
	VX	Di-isopropylamine	Ammonia	✓
		Ethylene oxide		✗
		Methylphosphonic dichloride	Phosphorus trichloride	✗
			Phosphorus pentachloride	✗
			DMMP	✗

Source: The authors

Key

✓ Plausible that this chemical is available,
providing the associated production plant is operational.

? No direct evidence to suggest the chemical is available,
but it is associated with a production process that may be taking place.

✗ No open source evidence found to suggest the chemical is available.

The 7th July Chemical Complex infrastructure includes gasifiers, chemical separation equipment, pipeline-linked processing zones, and potential legacy munitions links (for example, RDX and formalin production). Yet several constraints temper assessment of the site's dual-use potential: there is no observable evidence of chlorine chemistry,[66] key facilities such as methanol production and coal carbonisation may no longer be operational, and much of the site has been repurposed for agricultural or non-military industrial use. On balance, while the current evidence does not suggest that this site is actively engaged in CWA production, it cannot be excluded from consideration as part of North Korea's broader, dispersed chemical network.

Relevance to the CWC

This section outlines how the 7th July Chemical Complex and the 21st July Explosives Plant might be relevant to the provisions of the CWC, should North Korea become a ratified signatory. The analysis in this section is based on the findings from open source information and do not necessarily reflect the real situation.

While it is likely that production takes place in the 21st July Explosives Plant, it is highly likely that it exclusively produces explosives and as such would be exempted from declaration and verification requirements.

No scheduled chemicals have been identified as being produced during the manufacture of fertilisers at the 7th July Chemical Complex. On this basis, the site would not be declarable under parts VI, VII and VIII of the Verification Annex of the CWC.[67] According to paragraph 4 of Part I of the Verification Annex, methanol and formaldehyde would be classed as unscheduled Discrete Organic Chemicals (DOCs). From satellite imagery, both methanol and possibly formaldehyde might have been produced in one relatively self-contained area – Area 1 – giving one DOC plant. Among the chemicals identified as being produced on the site, there are no DOCs containing the elements phosphorus, sulfur or fluorine (PSF-chemicals), so the number of plants producing PSF-chemicals is nil.

Based on this analysis, the Project Anthracite team has identified OPCW Declarations Handbook (DH) product group code 519 ('methanol, ethanol, urea, formaldehyde, ethyl tert-butyl ether (ETBE), methyl tertbutyl ether (MTBE), surfactants based on sulfonic acids and fatty acid salts')[68] as the main activities of the 7th July Chemical Complex which would be declarable under Part IX of the Verification Annex.

In terms of production range, the size of the equipment related to methanol production is large scale, as would be expected with the production of methanol. This would certainly show production capability of methanol alone as exceeding 10,000 tonnes per year (see Appendix 7 of the DH).

66. Project Anthracite Team, 'Raw Materials for Potential Chemical Warfare Agents: Technical Assessment 1'.
67. OPCW, 'Annexes', <https://www.opcw.org/chemical-weapons-convention>, accessed 21 April 2026.
68. OPCW, 'Declarations Handbook 2013: Revised Version 3', 1 January 2022. p. 322, <https://www.opcw.org/sites/default/files/documents/2021/12/Declarations%20Handbook%202013%20Revised%20Version%203_0.pdf>, accessed 21 April 2026.

Neither the size of the equipment nor the production capacity actually defines the amount of production, as capacity does not account for shutdowns, low production rates and so on. So, while the declared production range is likely to be over 10,000 tonnes per year, the actual production range would depend on actual output in a given year.

Conclusions

The 7th July Chemical Complex and 21st July Explosives Plant are likely to be more relevant than CW capacity to North Korea's missile and explosives programmes, and the available information supports claims that the 7th July Chemical Complex provided chemical precursors needed for explosives manufacturing, although these may now be shipped in from elsewhere.

Some areas of the 7th July Chemical Complex show either potential signs of disrepair – these include Area 1 (methanol), Area 3 (coal derivatives) and Area 4 (possible ammonia, nitric acid and ammonium nitrate production) – or extensive overhauls (Area 2). The 21st July Explosives Plant and the additional explosives production and storage areas appear to remain partially active.

None of the available information suggests that the 7th July Chemical Complex is currently actively involved in CW production. However, historical information does indicate that it is likely that it once was relevant to North Korea's capacity to produce CWAs and chemical weapons precursors.

About the Authors

Sean Corbett is a Senior Associate Fellow at RUSI.

Hailey Wingo is a Researcher in VERTIC's Verification and Monitoring Programme and an Associate Fellow at RUSI.

Grant Christopher is the Co-Programme Director of VERTIC's Verification and Monitoring Programme.

David Crouch is a Senior Associate Fellow at RUSI.

Lennie Phillips is the former Senior Research Fellow on Chemical Weapons in RUSI's Proliferation and Nuclear Policy research group.

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