Report 12164:

Selection of AN Source for the Nitro Sibir BlackBear Plant

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1. BACKGROUND

1.1. Overview

Nitro Sibir Australia (NSA) manufactures and supplies ammonium nitrate emulsion (ANE) explosives to the mining industry in addition to a range of related explosive goods and technical services. NSA produces ANE in bulk at its BlackBear plant, located within the Kalgoorlie Explosives Reserve in Western Australia. The ANE is then transported in tankers to the customer mine site where final mixing with additives to produce the explosive product occurs. The BlackBear plant has been operating since at least 2016.

Detonics managing director Jennifer Bloomer has provided consultancy services to NSA on production quality matters, attending the NSA facilities several times between March 2016 and April 2017 including inspection of all areas within the BlackBear plant. During these visits a detailed understanding of the raw materials, manufacture processes and product range of NSA was gained.

1.1. Scope of Work

Detonics was requested to prepare a witness report in response to the following question:

Why only HDAN, and not LDAN or ANSOL, is suitable for use by NSA in the manufacture of emulsion explosives at the BlackBear plant.

This report details why HDAN is used at the BlackBear plant in lieu of other forms of ammonium nitrate, including an explanation of the terms and relevant production processes to support this response.

1.2. Credentials

Jennifer Bloomer is the owner and operator of Detonics, established in 2012 to provide independent technical support to the explosives industry. Detonics operates an open-air blasting range and performs testing, research and disposal of explosives in addition to consulting services. Jennifer holds a Bachelor of Science with Honours in Chemistry and has been active in the Australian explosives industry for over 12 years. Previous employment roles include Product Development/Research Chemist for Orica Mining Services, which involved laboratory and pilot-plant trials for the manufacture of ammonium nitrate emulsion explosives as well as assessment of raw materials including ammonium nitrate. With Detonics, Jennifer routinely handles and performs testing of mining explosives including ANE, HDAN and LDAN. Her role also includes attendance at ANE manufacture plants for quality and other research support projects.

2. RELEVANT TERMS AND PROCESSES

2.1. AN

Ammonium Nitrate (AN) is the predominant raw material used in mining explosives around the world. It is available for large scale industrial use in three distinct forms:

i. HDAN, High Density Ammonium Nitrate (solid)
ii. LDAN, Low Density Ammonium Nitrate (solid)
iii. ANSOL, Ammonium Nitrate Solution (liquid).

These materials are mixed and blended with other ingredients to form mining explosives predominantly in two forms:

i. Ammonium Nitrate and Fuel Oil (ANFO): a mixture of LDAN and fuel such as diesel.
ii. Ammonium Nitrate Emulsion (ANE): a gel-like viscous liquid which is blended with ANFO or LDAN to form an explosive with higher energy and greater water-resistance than ANFO.

2.2. HDAN

High Density AN (HDAN) is a raw material designed for the production of ANE. It consists of high-purity AN in a dense granular form which is dissolved in water (with minor additives as required), forming the water phase of the emulsion.

2.3. ANSOL

Ammonium Nitrate Solution (ANSOL) is a raw material designed for the production of ANE as an alternative to HDAN. ANSOL is a super-saturated solution of pure ammonium nitrate in water which is used by diluting to the required concentration (with minor additives as required) to form the water phase of the emulsion. Due to its high concentration, ANSOL must remain hot during transport, storage and use to ensure the ammonium nitrate remains dissolved.

2.4. LDAN

Low Density AN (LDAN) is a raw material designed for the production of ANFO. LDAN consists of free-flowing prills (grains) which each contain over 6% air voids to allow diesel or other fuel oils to soak into the crystal structure, forming an explosive. The LDAN prills contain internal additives to assist air void formation, and external organic coatings to reduce the hydroscopic properties of AN and prevent prills from clumping together.

3. AN RAW MATERIAL SOURCE AT NSA BLACKBEAR PLANT

LDAN is not suitable for the production of ANE as the additives and external coating present within the prills can seriously degrade the final ANE product, causing rapid crystallisation and failure of the explosive. Further, the organic coating residue generated by dissolving LDAN can build up within batch tanks and pipework causing blockages and equipment damage. In order to be used as a substitute for HDAN, LDAN would require flocculation and other liquid cleaning processes in order to produce an ANE of acceptable quality for mining use.

ANSOL is suitable for the production of ANE however requires infrastructure for receiving, storage and transfer to production batch tanks as required. As a 90% solution, ANSOL must be maintained at 100^{o}C or more during transport, storage and handling to prevent the ammonium nitrate from crystallising out of solution. Appropriate infrastructure for this includes one or more heated bulk storage tanks within a bunded area, insulated pipes and pumps to enable the transfer of ANSOL according to production schedules. This infrastructure is not available at the BlackBear plant and therefore it is not possible to use ANSOL within the ANE manufacture processes currently in effect. In order to install the infrastructure necessary for ANSOL handling and use, NSA would require specific approvals and licenses to comply with planning, environment, safety and explosives legislation.

HDAN is suitable for the production of ANE and requires infrastructure for bulk receival, handling and use according to production schedules. The BlackBear plant has a storage shed which is purpose-built and licenced for the storage of up to 500 tonnes of ammonium nitrate in prilled (LDAN) or granular (HDAN) form. These raw materials are transported in 1 tonne bulka bags, with forklifts used for unloading and handling onsite. The LDAN is used within ANFO and similar production streams, while HDAN is used within the ANE production stream as described above. These activities are licenced and authorized under relevant legislation and as required by the government-operated Kalgoorlie Explosives Reserve.

4. SUMMARY & CONCLUSION

Nitro Sibir manufactures the semi-finished product ammonium nitrate emulsion in bulk at its BlackBear plant at Kalgoorlie, WA, for supply to mines within its blasting explosive product range. The water phase of the emulsion is produced using High Density Ammonium Nitrate (HDAN), a granular solid which is dissolved in water as required. Infrastructure specific to this process is present at the BlackBear site including a 500 tonne bulk storage shed and handling equipment for 1 tonne bulk bags of granular HDAN.

Ammonium nitrate emulsion may be manufactured using Ammonium Nitrate Solution (ANSOL) instead of HDAN. ANSOL is super-saturated solution of pure ammonium nitrate in water and requires specific infrastructure for liquid handling, including bunded bulk storage tanks, transfer pipes and pumps. As

ANSOL must be maintained at a temperature of 100°C or above to prevent the ammonium nitrate crystallising out of solution, all associated infrastructure must be temperature-controlled.

Detonics managing director Jennifer Bloomer has attended the NSA BlackBear plant several times during 2016-2017 and can confirm that this plant does not have the infrastructure required to accommodate the use of ANSOL within its ANE production stream.

Signature:

Jennifer Bloomer
Managing Director
Detonics Australia Pty Ltd

5. GLOSSARY

AN	Ammonium nitrate
ANE	Ammonium nitrate emulsion
ANFO	Ammonium nitrate and fuel oil
ANSOL	Ammonium nitrate solution
HDAN	High density ammonium nitrate
LDAN	Low density ammonium nitrate
NSA	Nitro Sibir Australia Pty Ltd