

World's first lead-free non-electric detonator range, Exel™ Neo

J. Eriksson and T. Lagerström

Orica Sweden AB

ABSTRACT

Orica has developed the first fully lead-free non-electric detonator range, Exel™ Neo. The Exel™ Neo range builds on Orica's unique Non-Primary Explosive Detonator technology, which has been around for over 30 years in the explosives industry and is known for its reliability, safety, and ease of use. Orica supports the EU chemical industry transition pathway and the transition to safe and sustainable chemicals by phasing out harmful substances from our products. With lead compounds eliminated from our manufacturing process¹, there are health, safety and environmental benefits in the manufacturing process and the application through the end user. The Exel™ Neo range is manufactured in Gyttorp, Sweden, close to the customer base in Europe. The chemical and environmental regulations in the EU are regularly amended to improve and better protect the people and the environment from risks posed by hazardous chemicals. Orica is determined to support the industry transition by removing Substances of Very High Concern from the products. The Exel™ Neo innovation will ensure that together with our customers and partners, we can mobilise the earth's resources in a more sustainable manner.

1 INTRODUCTION

The protection of the environment has never received as much attention as it does today and the desire to contribute to a more sustainable future has never been greater. Both the industry and the general public are looking for solutions and products that support development towards a more sustainable future. This is also noticeable in the blasting industry, where we see an increased demand for environmentally friendly detonators and explosives. To contribute to this need, Orica has developed the world's first completely lead-free non-electric detonator range, Exel™ Neo.

2 SUBSTANCES OF VERY HIGH CONCERN

Substances that may have serious effects on human health and the environment can be identified as substances of very high concern (SVHCs). These are primarily substances which are carcinogenic, mutagenic, or toxic to

reproduction as well as substances with persistent and bio-accumulative characteristics. When a substance has been identified as a SVHC, it will be added to the candidate list of substances of very high concern for authorisation, published in accordance with the REACH regulation (Regulation (EC) No 1907/2006).

Companies manufacturing or importing articles in the EU containing these substances in a concentration above 0,1% weight of the article, have legal obligations. They are required to inform recipients of the articles about the presence of the substances and provide instructions on how to use them safely. They also need to inform consumers requesting this information (Regulation (EC) No 1907/2006, Article 33). Substances placed on the Candidate List are regularly reviewed for recommendation to the authorisation list. If a substance is added to the authorisation list, it means that after a given date, companies will not be allowed to

¹Applies to our factory in Gyttorp, Sweden. Orica Sweden does not use lead in its manufacturing processes and takes steps to seek assurances from its suppliers.

place the hazardous substance on the market or to use it. The aim of the authorisation process is to ensure that the risks related to SVHCs are properly controlled throughout their life cycle and to promote the progressive replacement of SVHCs by suitable alternatives where technically and economically feasible alternatives are available (Regulation (EC) No 1907/2006, Article 55).

Lead and lead compounds have long been known for their toxic nature and consequently have been identified as SVHCs and published on the Candidate List. The use of lead substances is highly regulated in the EU and there are recent restrictions adopted which limit the use of lead in industrial and professional applications like ammunition (Commission Regulation (EU) 2021/57) and PVC articles (Commission Regulation (EU) 2023/923).

The Occupational Exposure Limit (OEL) indicates the level of exposure that is safe for a chemical substance in the workplace. For lead substances, these values are being reduced to limits which will be difficult for manufacturers and users to comply with in the near future (2023/0033 (COD)). Lead has an impact on the environment and human health both in our manufacturing operations with exposure to workers and in the end-user applications where it is released in the surrounding environment.

Until the launch of Exel™ Neo, all detonators on the market contained some form of lead, lead compounds or other substances of very high concern (SVHCs).

3 EXEL™ NEO

Committed to operating a safe and responsible business, Orica launched a lead-free initiating system in September 2023 (Orica Limited, 2024). It is called Exel™ Neo, where Neo is Orica's brand for environmentally friendly, sustainable initiation systems products.

Figure 1 shows the cross-section of a full strength Non-Primary Explosives Detonator (NPED) from the detonator manufacturing plant Gyttopp.

The main elements of a non-electric detonator are:

- a shock tube with bushing that is crimped into the shell to make it watertight.
- a rigid element with different pyrotechnic delay compositions (and length), which provide specific burn rates and determine the delay times and accuracy. The industry commonly uses lead oxides as oxidisers in the pyrotechnic delay compositions. The new Exel™ Neo range offers completely lead-free pyrotechnic compositions.
- an initiation charge, which kicks off the underlying base charge. This can either be done with an i-element, which makes use of a deflagration to detonation process without the use of a primary explosive or with a primary explosive like e.g. lead azide, which by nature is very sensitive to friction, impact, static electricity, and heat. Only the Exel™ Neo range uses the lead-free NPED technology.
- a base charge of high explosives that kicks off the surrounding explosives.

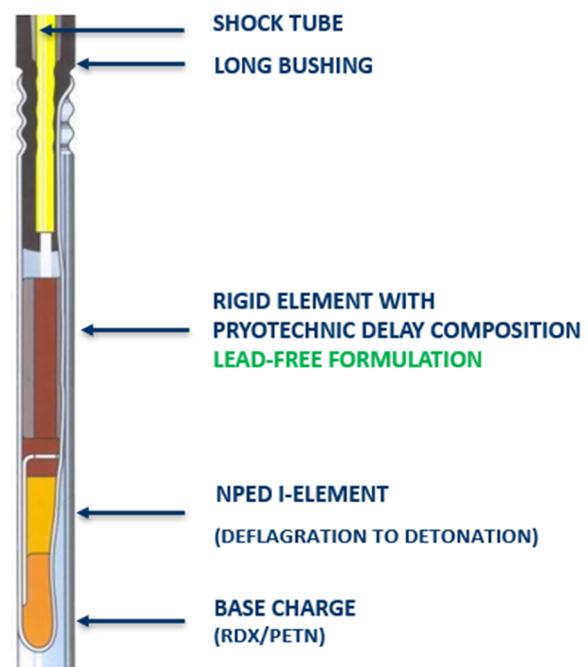


Figure 1 Cross section of Non Primary Explosives Detonator.

Based on the proven NPED technology Orica has successfully developed a range of new lead-free pyrotechnic compositions for the range of non-electric detonators produced in Gyttorp without compromising the product performance. It took significant time and work to develop lead-free alternatives that burn reliably and with comparable rates as traditional lead-based delay compositions. The compositions provide the same range of delays which meet the delay time accuracy standards for underground and surface customers in the mining, quarry and construction markets (RISE Research Institutes of Sweden AB, confidential test report).



Figure 2 Exel™ Neo LP series for tunnel and mine development.

The Exel™ Neo LP series offers 33 delay times from 25ms to 7000 ms.



Figure 3 Exel™ Neo MS and Exel™ Neo Connectadet™ SL range for surface applications in mining and quarry & construction

The Exel™ Neo MS is a full-strength downhole detonator which is used in combination with the reduced strength surface delays Exel™

Connectadet SL for a flexible initiation sequence design. Eight surface delays ranging from 9 to 175 ms are available for different blasting applications.

The NPED detonator technology also offers a very high resistance against mechanical impact which provides an extra level of safety in manufacturing, handling, transport and end-use of the product.

The manufacturing facility in Gyttorp uses modern, state of the art technology, which enables automated quality control checks for every step in the detonator manufacturing process.

With a keen focus on health, safety, and sustainability the new formulations have been developed to remove lead from the entire life cycle of the product while maintaining the performance which is driven by the reliability and accuracy of the delay compositions as well as other key features of the well-established Exel™ brand.

Some of the key benefits of the Exel™ Neo range are:

- All risks related to the use of SVHCs during the life cycle of the product in manufacture, production and application of the detonators have been eliminated.
- No accumulation of lead or lead oxides in the environment when the detonators are consumed in the blast.

Exel™ Neo have undergone extensive laboratory and field testing to ensure product specifications and performance meet the existing Exel™ in market. Tests performed externally around safety, timing accuracy and scatter patterns confirm that this invention provides the same detonator performance characteristics, such as resistance to impact, initiation output, delay time accuracy, water tightness and properties related to the shock tube (flexible shock tube with low memory effect-easy to deploy, abrasion resistance, elongation, and resistance to oil penetration) (EN 13763, 2004). The new Exel™ Neo range is CE certified by the German explosive notified body (BAM) and is fully approved for use in the European

Union (Bundesanstalt für Materialforschung und -prüfung [BAM], 2023).

4 SUMMARY

In the field of conventional initiation systems, the industry has not seen any major innovations in the last decades. It's been more than 30 years since the NPED technology was invented and more than 50 years since the shock tube was invented. Since then, we have seen the advent of the electronic detonators in the early 2000s, and more recently the development of wireless electronic blasting systems, but the development of the conventional initiations systems has stagnated. Till now. Driven by the rising global awareness and demand for more sustainable, environmentally friendly product offerings, Orica is proud to be the first in the industry that can offer a range of more environmentally friendly and sustainable detonators, that help the industry to meet their Productivity and Environmental, Social and Governance aspirations.

REFERENCES

Amendment no. 3 to the EU-type examination certificate (Module B) no. 0589.EXP.2783/18, issued 13 July 2023 by the German explosive notified body [Bundesanstalt für Materialforschung und -prüfung (BAM)]

Commission Regulation (EU) 2021/57 of 25 January 2021 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards lead in gunshot in or around wetlands

Commission Regulation (EU) 2023/923 of 3 May 2023 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards lead and its compounds in PVC.

Complete EN testing according to standard EN 13763, Explosives for civil uses - Detonators and relays has been performed for the detonator.

Confidential test report, RISE Research Institutes of Sweden AB, Report - Non-electric lead-free (examination according to EN 13763-2), Reference: P118061.DP01.A05:B.

Orica Limited. (2024). Orica launches Exel-Neo: The world's first lead-free non-electric detonator range. Retrieved May 30, 2024, from [https://www.orica.com/news-media/2023/orica-](https://www.orica.com/news-media/2023/orica-launches-exel-neo-the-worlds-first-lead-free-non-electric-detonator-range)

[launches-exel-neo-the-worlds-first-lead-free-non-electric-detonator-range](#)

Regulation (EC) No 1907/2006 - Registration, Evaluation, Authorisation and Restriction of Chemicals.

Regulation (EC) No 1907/2006. Registration, Evaluation, Authorisation and Restriction of Chemicals.. Article 33.

Regulation (EC) No 1907/2006. Registration, Evaluation, Authorisation and Restriction of Chemicals.. Article 55.

2023/0033 (COD) Proposal for amending Council Directive 98/24/EC and Directive 2004/37/EC of the European Parliament and of the Council as regards the limit values for lead and its inorganic compounds and diisocyanates.