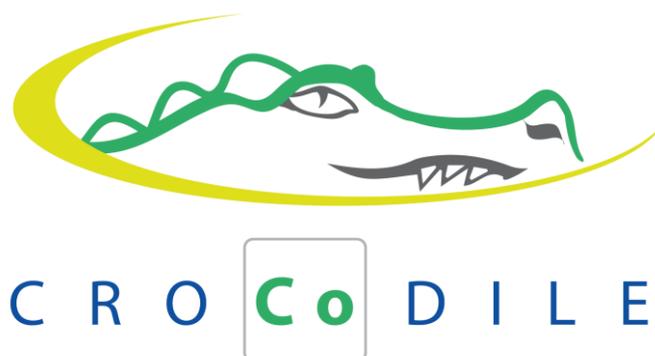


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CROCODILE PROJECT

First of a kind commercial Compact system for the efficient Recovery Of CObalt Designed with novel Integrated LEading technologies



D7.8 Standardisation of stationary plant

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List of abbreviations and definitions

Abbreviation	Definition
CLP	Classification, Labelling and Packaging
ISO	International Standards Organization
LME	London Metal Exchange
NGO	Non-Governmental Organisations
PDPS	Product Data and Packaging Sheet
PPE	Personal Protection Equipment
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SDS	Safety Data Sheet
SOP	Standard Operational Procedures



Executive summary

Metal companies, like other businesses, need a social license to operate. All plants have as a minimum to follow local law and regulations and they need permits from local or national authorities at each facility or treatment area. However, the license to operate is not only a local topic, but it includes the voice of the customers and the international society as well. ISO certificates are well recognised globally and all the main European Cobalt producing plants have their certificates for ISO 9001, ISO 14001 and ISO45001/OHSAS 18001. Most also have the ISO 50001.

It is important to note that LME require ISO 9001 today, and will most likely also require, ISO 14001 and ISO45001/OHSAS 18001 in near future.

In addition to the requirements given by the ISO standards there is a need for a good compliance systems to follow many other standards and expectation on topics like ethical and responsible sourcing, human rights, transparency, environment and social impact and Product responsibility



Standardisation of plants

General

The main European cobalt plants all have their certificates for ISO 9001, ISO 14001 and ISO 45001/OHSAS18001. In addition most also have the ISO 50001. The table below shows the certificates for European cobalt plants, based on the company webpages.

Table 1 WP 7.8 ISO standards of European Cobalt Producers, based on company webpages.

	ISO 9001	ISO 14001	OHSAS 18001 (future ISO45001)	ISO 50001	Products
Freeport Cobalt	x	x	x	x	Cobalt chemical, Cobalt powder
Glencore Nikkelverk	x	x	x	x	Cobalt cathodes
Norilsk Nickel	x	x	x		Cobalt chemicals
Umicore	x	x	x	x	Cobalt chemicals
Nickelhütte	x	x	x	x	Co intermediates / Co chemicals
Eramet (Sandouville)	x	x	x	x	Cobalt chemicals
Boliden	x	x	x	x	Co- intermediates
Terrafame	x	x	x		Co- intermediates

The main European Cobalt producing plants all have their certificates for ISO 9001, ISO 14001 and ISO45001/OHSAS 18001. Most also have the ISO 50001. Table is based on the companies webpages, and might not be 100% updated

LME require ISO 9001 today, and will most likely also require, ISO 14001 and ISO45001/OHSAS 18001 in near future.

All European cobalt plants have different historical feed sources, locations and their final product may vary. It is therefore not feasible to write one standard for all these plant. However, it is possible to give some high level guidelines on what topics that should covered by the SOPs for all plant.

Plants need good compliance system for all critical issues. All plants have as a minimum to follow local law and regulations and they need permits from local or national authorities at each facility or treatment area.

It is true that the industry improve year by year on safety, consumption of energy and chemical and reduced pollution. However, metal production, including recycling of metals is to day not a zero footprint business. Metal companies, like other businesses, needs a social license to operate. The license to operate is not only a local topic, but it includes the voice of the customers and the international society as well. Plants and companies must therefore follow many standards. The list below illustrate many of them. The list below is a guideline, not a complete and final list.

- Human rights
 - United Nations Universal Declaration of Human Rights
 - International Labour Organisation Declaration on Fundamental Principles and Rights at Work
 - United Nations Guiding Principles on Business and Human Rights



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- Voluntary Principles on Security and Human Rights
- Responsible sourcing
 - Use a recognised global guideline
 - All time apply to the most stringent standard of the company standards or the local regulation
 - The Equator Principles
 - Avoid conflict minerals example: US Dodd-Frank Act or EU Conflict minerals regulations 3TG, coming into effect in 2021.
 - A cobalt producer must follow the new initiatives that comes into the cobalt space at LME
 - Traceable sourcing
- Transparency is a key word to show and prove that the plant follows the rules, human rights and all the other good standards.
 - Extractive Industries Transparency Initiative
 - EU Transparency Directive
 - Global Reporting Initiative
- Environment and social impact
 - International Council for Mining and Metals Principles
 - United Nations Global Compact Principles
 - For metal and mining is important focus on following environmental challenges
 - Air quality/ pollution
 - Effluents and waste water
 - Use of water and energy
 - Climate effects
 - Land rehabilitation at mine end
 - United Nations sustainable development goals is also good guideline for operation and new projects.
 - Permits from
 - Environmental protection agent
 - Tax authorities
 - Directorate for civil protection
 - Labour authorities
- Product responsibility
 - The European Chemicals Agency's REACH Directive
 - London Bullion Market Association's Responsible Gold Standard
 - UN Globally harmonized system for classification and labelling of chemicals
 - CLP- European regulations on classification, labelling and packaging of substances and mixtures

High level check-list for standardisation of cobalt plants

In order to achieve all the good goals listed above each plant/company needs write their code of conduct and to establish good SOPs for “almost everything”. The list below is not complete, but it highlight several important issues.

- ✓ Stakeholder communication – how and who communicate with
 - Customers
 - Authorities



- NGOs
- Unions
- Press
- Neighbor
- Shareholders
- Other stakeholders
- ✓ Quality systems in general
 - This should cover all relevant topics
 - It should also cover SOPs on how the organisation will meet the requirements listed in the section above - ISO management
 - Detailed description of the organisation
 - Overall safety systems
 - Non confirmative systems
 - SOPs for handling of all kinds of deviations from the procedures
- ✓ Raw material handling
 - Procedures for raw material evaluation
 - Sampling and measurement system
 - Raw material storage
 - Raw material feeding to plant
- ✓ Production
 - Safety and environmental procedures
 - Safety for workers
 - PPE
 - SOPs
 - Process safety
 - Hygiene
 - External environmental
 - Emission to air
 - Emission to sea
 - Waste handling
 - Noise
 - Land management
 - Production procedures
 - How to operate each unit
 - How control each unit
 - Waste treatment, transport or disposal
 - Intermediate storage – if applicable.
 - Analytical lab
 - Online measurements



- Sampling of raw material (and other samples)
- Quality of raw material
- Quality of intermediates
- Quality of final product (a more detailed description is given in a separate chapter)
- Analytical procedures
- Packing of product
 - How to pack product safe with respect route of transport (IATA, ADR, IMO)
 - REACH / SDS
- Maintenance
 - Preventive
 - Reliability
 - Redundancy and maintenance during production
 - Major shutdown
- Finished goods:
 - Storage of finished good
 - Certificates for product and by product
- ✓ Staff function
 - HR
 - Payment
 - New employment
 - Pension
 - Training programs
 - Finance
 - Tax
 - Accounting system
 - Accounting audits
 - Budget
 - Insurance
 - Procurement equipment, energy and chemicals
 - Procurement of raw material and sale of finished goods
 - Raw materials
 - Products
 - Import/export
 - Logistics
 - Security strategies and procedures
 - Entrance to production area
 - IT- security
 - Product shipment
 - Energy management systems



- Document handling procedures
- R&D procedure – if applicable

A mobile plant like the crocodile, must get similar certificates and SOPs as the normal stationary – not only for the process itself, but also for the location it will connect to (eg for waste water treatment). If the plant should operate in different countries, there will be a need for getting applicable approval and permits from multiple stakeholders.

Overview of analytical methods to measure cobalt metal quality

Analytical procedure for final metals may be more common for all producers even if the processes are different. However, even on metal there might be differences due different customer demands and laboratory setup. The methodology presented here is based Nikkelverk producers.

The sample from a lot must be representative. Sampling similar to the withdrawn ISO 7156:1991 for sampling of refined Nickel are applied. It is important to remember that sampling is a practical skill – and each plant needs find practical solutions at their site. However, 3rd party audits on sampling and sample preparation is recommended to make sure that all parts of the procedure are within good industrial standards and practice.

- At Nikkelverk each lot represent 10-13 MT.
- Each lot are given a unit lot number
- Primary sample:
 - All cathodes at Nikkelverk is cut into 1' * 1' peaches before sale. The pieces are packed in 250 kg drums.
 - 2 Co-pieces are sampled for each 250 kg Co metal packed. The weight of each piece is about 60-70 g.
 - This gives about 100 pieces of metal for each lot and a primary sample of 7 kg.
- The upstream process of the Co-EW has a tight process control, and there are also metal analyses of starting sheets in the cobalt EW. This in combination of historical data justify the relatively small primary sample.
- Sample preparation:
 - One corner is cut from every piece
 - 100 grams of the corners are dissolved in (1:1) Nitric Acid for analysis.
 - In addition, 4 separate pieces are milled for Carbon and Sulphur analysis.

Basic methods for minor elements in cobalt metals

ICP-MS is used at Nikkelverk for detection of Cu, Fe, Pb, Ni, Si and Zn daily for all lots. Some customers might also demand certificates on other elements as well. In addition, more elements are tracked for a monthly quality check.

Combustion, IR-detection and thermic conductivity determination for Sulphur, Carbon, Hydrogen, Nitrogen and Oxygen.

Procedure, High level

Dissolve the metal in in HNO₃ (1:1 diluted with water). Dilute the solution down to 100 g/l of Co and at the second step dilute once more down to 5 g/l Co. Run the sample through the ICP-MS.

It is important that the ICP-MS is calibrated for each element that should be checked. It must be developed a specific method for each instrument.



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Interferences and contamination

- When developing the method for the ICP, look out for interferences and non-linear signals. The method must suit the normal standard of each product.
- Si may contaminate your standards when stored on glass bottles.
- Many elements may be contaminate over time – so change tubes, including plastic tubing regular
- New parts put into the ICP must be cleaned properly before use, they may be contaminated at arrival.

Reporting

Each concentration med should be reported and certificates made for all each lot according to company SOPs. The Product Data and Packaging Sheet for Nikkelverk cobalt is shown below.





NIKKELVERK
A GLENCORE COMPANY

Cobalt

Typical Analysis

Cobalt	99.95%	Nickel	0.03%
Carbon	0.002%	Nitrogen	0.0001%
Copper	0.0005%	Oxygen	0.005%
Hydrogen	0.0005%	Silicon	0.0003%
Iron	0.001%	Sulphur	0.0002%
Lead	0.0002%	Zinc	0.0002%



Sizing

Bulk density of 25 mm squares:
Approx. 4.6 kg/dm³

Typical sizing: 25 mm X 25 mm (±5mm)

Guaranteed sizing: 94% with <30 mm X <30 mm

Product Description

Nikkelverk COBALT has one of the lowest concentrations of total impurities of any commercially available COBALT.

Our COBALT is recommended for all high purity requirements, particularly superalloys, magnetic alloys, heat and wear resistant alloys, tool steels and other non-ferrous alloys.

The high purity of our COBALT makes it well suited for the production of catalysts, driers and other chemical uses.

Further information and assistance are available upon request and on the following webpages:

www.nikkelverk.no

www.glencore.com

Standard Packaging



25 mm squares

4 x 250 kg steel drums, net weight 1,000 kg, strapped to a skidded wooden pallet.



The Quality Management System for the production of cobalt products at Nikkelverk's refinery located in Kristiansand, Norway is ISO 9001, ISO 14001, OHSAS 18001 and ISO 50001 registered.

Safety Data Sheet available upon request

Oct. 2018

Figure 1 Product Data and Packaging Sheet (PDPS) of Cobalt cathodes from Nikkelverk

