Technical Note

CLIENT:	**Nyobolt Limited**
PROJECT:	**Production of Niobium Tungsten Oxide – Environmental Permit Application**
SUBJECT:	**H1 Screening Tool – Emissions to Air** **Technical Summary Note**
JOB NO.:	**BM12404**
DATE:	**October 2024**
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1 CONTEXT

1.1.1 This note has been prepared to provide a summary of the H1 Screening Tool Assessment of emissions to air from Nyobolt's pilot facility which will produce Product A to supply the battery manufacturing sector.

1.1.2 The process of producing Product A involves the processing of two metal oxides; niobium pentoxide and tungsten trioxide. The two metal oxides are subjected to a series of processes including heating, mixing, size reduction, drying, formation, deagglomeration.

1.1.3 It is the furnace emissions that this H1 assessment pertains to.

1.1.4 The furnace stack monitoring was carried out by Socotec UK Limited under trial operating conditions to determine the release of pollutants. This report is provided as **Appendix 1** of this Note.

1.1.5 Emissions testing included the following parameters:

- Tungsten;
- Niobium;
- Moisture content;
- Stack gas temperature;
- Stack gas velocity.

1.1.6 Monitoring ran continuously for 36 hours during a trial production cycle. The findings from this monitoring are summarised in Table 1.1 below.

Table 1.1: Summary of Emissions Testing	
Parameter	**Results**
Tungsten	0.0496 mg/m³
Niobium	0.00044mg/m³
Moisture	1.94%
Temperature	37°C

2 STAGE 1 SCREENING ASSESSMENT

2.1.1 In order to assess the potential impacts of the emission to air, the Version 8 H1 Screening Tool has been completed, to assess the impact of emissions, alongside following the Environment Agency's guidance on 'Air Emissions Risk Assessment for your Environmental Permit.'

2.1.2 The process contributions of emissions to air have been calculated by using the following methodology:

$$PC_{air} = DF \times RR$$

Where PC is the Process Contribution

Where DF is the Dispersion Factor

Where RR is the Release Rate of the substance

2.2 Substances to be Released

2.2.1 The H1 Screening Tool does not include tungsten nor niobium, so for the purposes of the screening, molybdenum has been used. Molybdenum has a similar atomic structure to tungsten and is also a refractory metal as is niobium and tungsten. Tungsten has an atomic weight of 183.84u, and niobium has an atomic weight of 92.91u. Molybdenum has an atomic weight of 95.94u.

2.2.2 Table 1.1 below provides the substances which may be released as part of each phase, and the long- and short-term worst-case concentrations and the long- and short-term PC calculated by the H1 tool.

2.2.3 Within the Environment Agency's consultation document '*Derivation of Environmental Assessment Levels Hierarchy*', tungsten is removed from the Future EALs for EPR substances, and there is no entry for niobium, niobium pentoxide or diniobium pentaoxide. For this reason, the AEL has been based on the no observed adverse effect level (NOAEL) or derived no effect level (DNEL).

2.2.4 Both niobium pentoxide (diniobium pentaoxide) and tungsten trioxide are registered under the European Chemicals Agency (ECHA)[1]. For the purposes of setting an AEL, NOAEL outcomes following repeated dose toxicity (inhalation) have been used, and these are provided in Table 1.1 below.

2.2.5 A review of ECHA's database has been carried out and the DNELS for tungsten and niobium are provided in Table 2.1 below.

Table 2.1: DNELS for Niobium and Tungsten

Substance	ECHA DNELS	Maximum DNEL
Niobium	• DNEL for workers via inhalation (repeated dose toxicity) is 23.5mg/m^3 [2]. • Acute toxicity via inhalation route effect level is >5mg/L[3]	>5mg/L[4]
Tungsten	• Effect level NOAEC >0.65 mg/L[5]	>0.65 mg/L[6]

2.3 Emission Points and Effective Height of Release

2.3.1 There will initially be one stack from the facility, and this may expand to up to four stacks (see Operating Techniques Report). The stacks will be 10m in height and located at the eastern side of the building. The building is approximately 8m in height.

[1] Homepage - ECHA (europa.eu)
[2] Niobium 100.028.284 | 7e2b7b6d-7fc0-4f6e-803f-e42759fe1387 - ECHA CHEM (europa.eu)
[3] Niobium 100.028.284 | 7e2b7b6d-7fc0-4f6e-803f-e42759fe1387 - ECHA CHEM (europa.eu)
[4] Niobium 100.028.284 | 7e2b7b6d-7fc0-4f6e-803f-e42759fe1387 - ECHA CHEM (europa.eu)
[5] Tungsten 100.028.312 | 6a39dfb1-3c25-4adb-a0f4-402c8f9c516d - ECHA CHEM (europa.eu)
[6] Tungsten 100.028.312 | 6a39dfb1-3c25-4adb-a0f4-402c8f9c516d - ECHA CHEM (europa.eu)

2.3.2 In accordance with Environment Agency guidance[7], where the emission release is less than 3m above the building on which the stack is located, the effective height of release should be regarded as 0m.

2.3.3 This effective stack height gives a long-term dispersion factor of 148, short term dispersion factor of 3,900, and a monthly dispersion factor of 529.

2.4 Release Rate

2.4.1 The gas volumetric flow rate from the stack is 6,600m³/hour, and the velocity 7.4m/s.

2.5 Operating Mode

2.5.1 The operating mode has been inputted at 100% to ensure the H1 assessment has been carried out as worst-case scenario with regard to emissions.

2.6 Stage One Screening Results

2.6.1 Emission testing concluded that 0.0496mg/m³ of tungsten and 0.00044mg/m³ of niobium would be released.

2.6.2 Molybdenum has been used for both tungsten and niobium for the purposes of the model, which calculates the long-term PC to be **0.0136ug/m³**, and short term PC to be **0.3676ug/m³**.

2.6.3 Whilst there is no specific BAT-AEL for molybdenum, tungsten or niobium, Annex 1 of the Environment Agency Guidance Note for the Inorganic Chemicals Sector (EPR 4.03)[8] provides benchmark emission values for emissions to air associated with the use of BAT. The substances which are most applicable and relevant to activities involving metals, in lieu of specific substance limits, are provided in Table 2.1 below.

Table 2.1: Emissions to Air Benchmark Values Associated with BAT

Released Substance	Benchmark value (mg/Nm³)	Basis of Benchmark[1]
Heavy metals (other than Hg and Cd)	1.5	Waste Incineration Directive

[7] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit
[8] How to comply (publishing.service.gov.uk)

Table 2.1: Emissions to Air Benchmark Values Associated with BAT		
Released Substance	**Benchmark value (mg/Nm³)**	**Basis of Benchmark[1]**
Lead and compounds (inorganic)	2	
Nickel and compounds	2 – 10	2mg/Nm³ for soluble Ni compounds

2.6.4 Nyobolt's emissions of tungsten and niobium (substituted with molybdenum for the purposes of the H1 Assessment) are well within the benchmark values for heavy metals, lead and nickel, which pose a greater risk with regard to environmental harm/toxicity than niobium or tungsten which are unreactive and stable.

2.6.5 The H1 Screening passes at stage 1 and no further assessment is required.

3 DEPOSITION ASSESSMENT

3.1.1 This assessment has been carried out using molybdenum, as described above. Molybdenum is listed as a substance where a substance deposition assessment is required.

3.1.2 The deposition calculation is as follows:

- Calculate the 'PC to air' by multiplying the long term dispersion factor (148) by the release rate and multiplying by the 'operating mode (100%)'.
- Do this calculation: PC to air × 0.01 × 3 × 86,400.
- Divide the number you get by 1,000.

3.1.3 The result is 0.00002 mg/m² per day for niobium and 0.00023 mg/m² per day for tungsten.

3.1.4 Note that H1 calculates the release rate as zero. This is probably down to the number of decimal places set in the tool (which cannot be changed be users). This gives further reassurance that the release rate is likely to be so low that the deposition is negligible.

3.1.5 The PC to ground limit for molybdenum is 0.016mg/m². 1% of 0.016 is 0.00016. The H1 assessment suggests that the PC to ground is below this limit for niobium. Tungsten would be at 1.4% of the limit.

3.1.6 It is considered that at this low level the result should screen out as insignificant and no further modelling is required. Although tungsten is marginally above the screening limit of 1% of the actual limit, we note that it is likely to be of less concern than molybdenum, because no specific limit for tungsten has been set. In addition, the H1 assessment has been based on the plant operating 100% of the time to provide an absolute worst case. This is unrealistic and it is likely that there will be several days a year when the plant is not used due to maintenance and so on.