

Appendix F –KS21™ Environmental Assessment Level Supporting Information.

Methodology for deriving an indicative Environmental Assessment Level (EAL) for MHI CCS

This document sets out a methodology to derive indicative EALs for the amines emitted from the carbon capture plant. Amines and nitrosamines/nitramines (N-aminers) are considered separately.

Amine Emissions

The Environment Agency (EA) have set an EAL for monoethanol amine (MEA):

1 hour: 400µg/m³

24 hour: 100 µg/m³

This is based upon a No Observed Adverse Effect Concentration (NOAEC) value of 10mg/m³ 1. To derive the EAL, a safety factor of 25 has been applied to derive the 1 hour EAL, and a safety factor of 100 has been applied to derive the 24 hour EAL.

There is also a NOAEL for monoethanol amine of 300mg/kg 2.

[REDACTED]

The amines emitted to air from the MHI Carbon Capture plant are:

- Ethylamine (EA)
- 2-(Ethylamine) ethanol (EAE)

[REDACTED]

With regards to EA and EAE, a literature review did not identify a NOAEC for these substances. However, the literature review did identify NOAELs. These are:

- EAE 40 mg/kg bw/day 3
- EA 15ppm (28mg/m³) 4

¹ Environment Agency (2020) Using our 2012 methodology to derive new Environmental Assessment Levels for emissions to air Revision of 10 existing EALs and derivation of two new EALs Date: October 2020

² Sasol (accessed July 2022) EC Safety Data Sheet: Monoethanolamine
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEWjd8La0no5AhVqSUEAHbnwBeQQFnoECAgQAQ&url=https%3A%2F%2Fsasoldcproducts.blob.core.windows.net%2Fdocuments%2FSafety%2520Datashets%2Fd3b3178e-74e5_EU_MEA_EN-GB.pdf&usg=AOvVaw2jKJ-K0TyDwDZHDirc9JnZ

³ Mitsubishi Heavy Industries (undated) Chemical safety report: 2-(Ethylamine) ethanol

⁴ Safe Work Australia (accessed July 2022) Material Safety Data Sheet for Ethylamine (https://ehq-production-australia.s3.ap-southeast-2.amazonaws.com/55799ac852b5fb0aa1f7877b2ad4c27ecc74c544/documents/attachments/000/123/275/original/draft-evaluation-report-wes-ethylamine-pdf.pdf?X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIBJCUKKD4ZO4WUUA%2F20220721%2Fap-southeast-2%2Fs3%2Faws4_request&X-Amz-)

Combining the above data it is possible to derive indicative EALs for EA and EAE by factoring from the MEA EAL using the toxicology profiles for all three amines, noting the following:

- The toxicology of MEA, EA and EAE is assumed to behave in a similar manner, this is supported by the toxicology data identified that all three are acute irritants
- NOAEL and NOAEC are understood to be equivalent
- The literature review identified that MEA, EA and EAE are all non-carcinogenic, or expected to have low potential for carcinogenicity and therefore cancer outcomes do not need to be considered

The table below illustrates the derivation of indicative EALs for EA and EAE, based upon the data cited and factoring from the MEA EAL. The EALs in italics are the derived EALs for EA and EAE.

Amine	NOEAL (mg/kg bw/day)	NOEAL/NOAEC (mg/m3)	1 hour EAL (µg/m3)	24 hour EAL (µg/m3)
MEA	300	10	400	100
EA		28	<i>1120</i>	<i>280</i>
EAE	40		<i>53</i>	<i>13</i>

The methodology is considered to be a reasonable approach for deriving EALs for EA and EAE:

- The EALs are based on direct toxicity for EA and EAE
- The toxicity data for EAE and EA is directly comparable to MEA, given that there are NOAELs for all three substances
- All three amines are understood to have a similar toxicity profile, being acute irritants
- All three amines are understood to not be carcinogenic, and therefore no specific consideration of carcinogenic outcomes for long term exposures are required

N-amine emissions

The EA have set an EAL for N-nitrosodimethylamine (NDMA):

Annual mean: 0.0002µg/m³

This is based on a Dose Level (BMDL10) of 0.023 mg/m³ 6. The EA also state: “NDMA is one of the most potent nitrosamines [in terms of carcinogenic potential]” and also state that NDMA is one of the most widely studied of the N-amines, recognising that toxicology data for other N-amines is scarce, particularly for carcinogenic potential.

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⁵ Gupta P (2018) General Toxicology in: Illustrated Toxicology 2018

<https://www.sciencedirect.com/topics/nursing-and-health-professions/no-observed-adverse-effect-concentration>

⁶ Environment Agency (2020) Using our 2012 methodology to derive new Environmental Assessment Levels for emissions to air Revision of 10 existing EALs and derivation of two new EALs Date: October 2020

Drax Bioenergy with Carbon Capture and Storage

The carbon capture process will emit N-Ethyl-N(2Hydroxyethyl)nitrosamine (EHEN). EHEN is a known carcinogen ⁷. However, a literature review (including a search on the International Agency for Research on Cancer (IARC) website) did not identify a BMDL10, or other carcinogenic potential proxy that could be used to compare EHEN with NDMA to assess relative carcinogenic potential.

On this basis, the assessment will rely on the use of the NDMA EAL of 0.0002µg/m³, as a proxy for EHEN. This is considered to be a reasonable approach:

- NDMA is recognised as one of the most potent carcinogens, and as such EHEN is unlikely to be substantially more carcinogenic
- The worst case assumptions built into the impact assessment are likely to overestimate exposure, including:
 - The EAL is based upon lifetime exposure to NDMA, and in practice exposure will be lower as a receptor will not be in the same location for an entire lifetime
 - The assessment is based upon the worst case meteorological year, however overall exposure will be lower as in some years the annual mean would be lower
 - The EA significance criteria of PEC <70% inherently includes a degree of conservatism, including uncertainty in the EAL

⁷ ChemSrc (accessed July 2022) N-ETHYL-N-(2-HYDROXYETHYL)NITROSAMINE
https://www.chemsrc.com/en/cas/13147-25-6_908009.html#ebiemingDiv