MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

INTEROFFICE COMMUNICATION

September 17, 2019

TO: File for
Nickel (CAS No. 7440-02-0)
Nickel Sulfate (CAS No. 7786-81-4)
Nickel Oxide (CAS No. 1313-99-1)
Nickel Chloride (CAS No. 7718-54-9)

FROM: Mike Depa, Air Quality Division, Toxics Unit

SUBJECT: Nickel Screening Level Update

The Initial Risk Screening Level (IRSL) and Secondary Risk Screening Level (SRSL) for nickel and nickel compounds (excluding nickel subsulfide; CAS No. 12035-72-2) are 0.006 and 0.06 µg/m³ based on an annual averaging time, respectively. These screening levels are derived from an inhalation unit risk (IUR) of 1.7E-4 per µg/m³ (as nickel). The screening levels apply to nickel and nickel compounds (as nickel):

Nickel:	7440-02-0
Nickel Sulfate:	7786-81-4
Nickel Oxide:	1313-99-1
Nickel Chloride:	7718-54-9

The screening levels above apply to the respirable portion (less than 10 µm in aerodynamic diameter; PM10) of nickel, and replace the previous IRSL and SRSL for nickel refinery dust of 0.0042 µg/m³ and 0.042 µg/m³ (based on an IUR of 2.4E-4 per µg/m³).

Background

The Air Quality Division received several public comments on the screening levels for nickel. Multiple commenters stated that it is inappropriate to base the IRSL and SRSL on the U.S. Environmental Protection Agency's (EPA's) Inhalation Unit Risk (IUR, sometimes called a Unit Risk Estimate or URE) for nickel, because EPA (1987) derived the IUR for "nickel refinery dust," and not specifically for nickel. EPA's IUR was based on studies where the exposures were to nickel refinery dust containing high concentrations of nickel subsulfide (CAS No. 12035-72-2). There are no nickel refineries in Michigan, and the foundries and ferroalloy operations that emit nickel are expected to contain very small amounts of sulfidic nickel, if any. The commenters suggested that the Texas Commission on Environmental Quality's (TCEQ's) IUR of 1.7E-4 per µg/m³ for nickel and nickel compounds is a more appropriate basis for screening levels protective of carcinogenic effects.

AQD agreed that nickel subsulfide occurs in relatively smaller quantities in the air emissions from foundries and ferroalloy industrial processes in Michigan. The AQD agreed that sulfidic nickel is the most potent carcinogenic species of nickel compounds and that some of the epidemiology studies that EPA (1987) used to derive the IUR for nickel have high exposure concentrations to sulfidic nickel. Comparing EPA's published IURs for nickel subsulfide and nickel refinery dust indicates that nickel subsulfide has a cancer potency that is two times higher than that for nickel refinery dust: 4.8E-4 vs 2.4E-4 per µg/m³ for nickel subsulfide and nickel refinery dust, respectively. TCEQ (2017) derived an IUR of 1.7E-4 per µg/m³ for nickel from studies that have lower exposure concentrations of nickel subsulfide, and which more closely represent exposures to nickel from industrial processes in Michigan.

After reviewing the derivation of TCEQ's IUR for nickel compounds it was determined that the IUR for nickel and nickel compounds (as nickel) is more appropriate than the EPA (1987) IUR for nickel refinery dust. Detailed calculations made by TCEQ to determine the IUR can be found in Haney et al (2012) and TCEQ (2017). An external peer review of the TCEQ derivation of the IUR for nickel was also done (TERA, 2009). A brief summary is provided below.

TCEQ derived an IUR for nickel based on excess lung cancer observed during occupational settings at nickel refineries. Two studies had adequate dose-response data (exposure and medical data) (see Table 1) that had low nickel subsulfide concentrations.

Table 1. Nickel Refinery Studies Used By TCEQ to Derive Inhalation Unit Risk

Study	Investigated	Worker Exposure	Citation
Kristiansand Nickel Refinery (Norway)	lung cancer incidence by cumulative nickel exposure level	1916-1983 with follow-up to 1993	Grimsrud et al. (2003)
Huntington Alloys (WV, USA)	respiratory cancer mortality by cumulative nickel exposure level	1922-1984	Enterline and Marsh (1982)

One of the studies (Enterline and Marsh, 1982) was used in the EPA (1987) assessment, while the other (Grimsrud et al., 2003) is an update to an earlier study (Magnus et al., 1982) used by EPA. A linear multiplicative relative risk model with Poisson regression modeling was used to obtain maximum likelihood estimates for cancer potency factors using cumulative nickel exposure levels versus observed and expected lung cancer mortality (Enterline and Marsh, 1982) or lung cancer incidence cases (Grimsrud et al., 2003). TCEQ (2017) applied life-table analyses to develop IURs from these two studies, which they then combined using weighting factors relevant to confidence to derive the final IUR for nickel of 1.7E-04 per µg/m^3.

The IUR for nickel compounds (as nickel; excluding nickel subsulfide) of 1.7E-04 per µg/m^3 (TCEQ, 2017) was used to derive the IRSL:

IRSL = 1E-6/IUR
IRSL = 1E-6/1.7E-04 per µg/m3
IRSL = 0.0057 µg/m^3, rounded to 1 significant figure is 0.006 µg/m^3

The SRSL is derived as follows:

SRSL = 1E-5/IUR
SRSL = 1E-5/1.7E-04 per µg/m^3
SRSL = 0.057 µg/m^3, rounded to 1 significant figure is 0.06 µg/m^3

The averaging time is annual.

References:

Enterline, P. E., and G. M. Marsh. 1982. Mortality among workers in a nickel refinery and alloy manufacturing plant in West Virginia. J Natl Cancer Inst 68 (6):925-33.

EPA. 1987. Nickel refinery dust; no CASRN. Integrated Risk Information System (IRIS), Chemical Assessment Summary. National Center for Environmental Assessment. U.S. Environmental Protection Agency. 10 pgs. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0272_summary.pdf

Grimsrud, T. K., S. R. Berge, J. I. Martinsen, and A. Andersen. 2003. Lung cancer incidence among Norwegian nickel-refinery workers 1953-2000. J Environ Monit 5 (2):190-7.

Magnus, K., A. Andersen, and A. C. Hogetveit. 1982. Cancer of respiratory organs among workers at a nickel refinery in Norway. Int J Cancer 30 (6):681-5.

TCEQ. 2017. Nickel and Inorganic Nickel Compounds. Development Support Document. Final, June 01, 2011. Accessible 2013. Revised, July 26, 2017. Prepared by: Darrell D. McCant, B.S.; Joseph T. Haney, Jr., M.S.; Roberta L. Grant, Ph.D.; Toxicology Division. Chief Engineer's Office. Texas Commission on Environmental Quality. 109 pgs. http://www.tceq.texas.gov/assets/public/implementation/tox/dsd/final/june11/nickel_&_compounds.pdf

TERA (Toxicology Excellence for Risk Assessment). 2009. Final Nickel Peer Review Meeting Report. Independent Peer Review of the Nickel Toxicity Assessment for the Texas Commission on Environmental Quality, State of Texas. 2300 Montana Avenue, Suite 409, Cincinnati, OH 45211. phone: 513.542.7475 fax: 513.542.7487. tera@tera.org. Accessed 9/9/19: https://www.tera.org/Peer/Nickel/nickel.html