



COBALT,
ANTIMONY COMPOUNDS,
AND WEAPONS-GRADE
TUNGSTEN ALLOY

VOLUME 131

This publication represents the views and expert
opinions of an IARC Working Group on the
Identification of Carcinogenic Hazards to Humans,
which met remotely, 2–18 March 2022

LYON, FRANCE - 2023

IARC MONOGRAPHS
ON THE IDENTIFICATION
OF CARCINOGENIC HAZARDS
TO HUMANS

Table S1.4 Global production of cobalt in refineries, by country^a

Country	Product	Cobalt content (tonnes)					Rate of increase, 2015–2019
		2015	2016	2017	2018	2019	
Australia	Metal powder, oxide, and hydroxide	5 150	3 350	3 000	3 200	3 700	-28.2%
Belgium	Metal powder, oxide, and hydroxide	1 500	1 500	1 600	1 650	1 500	0.0%
Brazil	Metal	1 300	400	46	8	-	NC
Canada	Metal, metal powder, oxide	6 126	6 302	6 355	6 349	6 075	-0.8%
China	Metal, metal powder, oxide, salts	53 500	49 900	75 000	83 100	90 000	68.2%
Democratic Republic of the Congo	Metal	3 141	50	120	60	-	NC
Finland	Metal powder and salts	9 615	12 393	12 222	12 874	12 526	30.3%
France	Chloride	133	119	277	48	90	-32.3%
India	Metal and salts	150	100	100	100	100	-33.3%
Japan	Metal	4 259	4 305	4 159	3 669	3 800	-10.8%
Madagascar	Metal powder	3 464	3 273	3 053	2 852	2 900	-16.3%
Mexico	Metal	-	419	420	226	215	NC
Morocco	Metal	1 982	2 081	1 924	1 806	2 397	20.9%
Norway	Metal	3 117	3 541	3 473	4 166	4 354	39.7%
Russian Federation	Metal	2 040	3 092	2 077	1 800	2 000	-2.0%
South Africa	Metal powder and sulfate	1 362	1 101	1 062	1 089	1 000	-26.6%
Zambia	Metal	2 997	4 725	2 520	1 613	1 500	-49.9%
Total		99 800	96 700	117 000	125 000	132 000	32.3%

-, zero; NC, not calculated.

^a Figures represent cobalt refined from ores, concentrates, or intermediate products and do not include production of downstream products from refined cobalt.Data from [USGS \(2021\)](#).

References

- ACGIH (2019). Cobalt and inorganic compounds. TLVs and BEIs based on the documentation of the threshold limit values for chemical substances and physical agents & biological exposure indices. Cincinnati (OH), USA: American Conference of Governmental Industrial Hygienists. Available from: <https://www.acgih.org>.
- Baskett DA, Angelini G, Ingber A, Kern PS, Menné T (2003). Nickel, chromium and cobalt in consumer products: revisiting safe levels in the new millennium. *Contact Dermatitis.* 49(1):1–7. doi:[10.1111/j.0105-1873.2003.00149.x](https://doi.org/10.1111/j.0105-1873.2003.00149.x) PMID:[14641113](https://pubmed.ncbi.nlm.nih.gov/14641113/)
- EFSA (2009) EFSA Panel on Additives and Products or Substances used in Animal Feed (FEEDAP); Scientific Opinion on the use of cobalt compounds as additives in animal nutrition. *EFSA Journal.* 7(12):1383. [45 pp.]. doi:[10.2903/j.efsa.2009.1383](https://doi.org/10.2903/j.efsa.2009.1383)
- Environment Agency (2022). Derivation and use of soil screening values for assessing ecological risks. Report – ShARE id26 (revised). Bristol, UK: Environment Agency. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047897/Soil_screening_values_for_assessing_ecological_risk_-_report.pdf, accessed 2 March 2022.
- European Commission (2009a). Annex 3 to the Commission Staff Working Document accompanying the Report from the Commission in accordance with Article 3.7 of the Groundwater Directive 2006/118/EC on the establishment of groundwater threshold values. Information on the groundwater threshold values of the Member States. Brussels, Belgium: European Commission. Available from: https://ec.europa.eu/environment/water/water-framework/groundwater/pdf/com_swd_annex_iii.pdf, accessed 1 February 2022.
- European Commission (2009b). Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys. Brussels, Belgium: European Commission. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02009L0048-20210521&from=EN>, accessed 14 March 2022.
- European Commission (2010). Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). Recast. Brussels, Belgium: European Commission. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02010L0075-20110106&from=DE>, accessed 15 March 2022.
- Fréry N, Saoudi A, Garnier R, Zeghnoun A, Falq G (2011). Exposition de la population française aux substances chimiques de l'environnement. Tome 1: Présentation générale de l'étude. Métaux et métalloïdes. Saint-Maurice, France: Institut de Veille Sanitaire. Available from: <https://www.santepubliquefrance.fr/determinants-de-sante/exposition-a-des-substances-chimiques/pesticides/documents/rapport-synthese/exposition-de-la-population-francaise-aux-substances-chimiques-de-l-environnement.-tome-1.-presentation-generale-de-l-etude.-metaux-et-metalloides>, accessed 1 February 2022. [French]
- FSA (2003). Safe upper levels for vitamins and minerals. Expert Group on Vitamins and Minerals, May 2003. London, UK: Food Standards Agency. <https://webarchive.nationalarchives.gov.uk/ukgwa/20121105225356/http://www.food.gov.uk/multimedia/pdfs/vitmin2003.pdf>, accessed 30 September 2022.
- Government of British Columbia (2019). Environmental management act, contaminated sites regulation B.C. Reg. 375/96. Victoria (BC), Canada: Government of British Columbia. Available from: https://www.bclaws.gov.bc.ca/civix/document/id/crcbc/375_96_multi, accessed 30 September 2022.
- IFA (2021). Cobalt and its compounds. GESTIS International Limit Values database. Germany: Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (Institute for Occupational Safety and Health of the German Social Accident Insurance). Available from: <https://www.dguv.de/ifa/gestis/gestis-internationale-grenzwerte-fuer-chemische-substanzen-limit-values-for-chemical-agents/index-2.jsp>, accessed 30 September 2022.
- JSOH (2020). Recommendation of occupational exposure limits (2020–2021). *Environ Occup Health Practice.* 2(1): 1–34. doi:[10.1539/eohp.roel2020](https://doi.org/10.1539/eohp.roel2020)
- Klasson M, Bryngelsson IL, Pettersson C, Husby B, Arvidsson H, Westberg H (2016). Occupational exposure to cobalt and tungsten in the Swedish hard metal industry: air concentrations of particle mass, number and surface area. *Ann Occup Hyg.* 60(6):684–99. PMID:[27143598](https://pubmed.ncbi.nlm.nih.gov/27143598/)
- Norwegian Scientific Committee for Food and Environment (2007). Risk assessment of health hazards from nickel, cobalt, zinc, iron, copper and manganese migrated from ceramic articles. Opinion of the Panel on Food Additives, Flavourings, Processing Aids, Materials in Contact with Food and Cosmetics of the Norwegian Scientific Committee for Food Safety, Adopted 2 May 2007. Oslo, Norway: Norwegian Scientific Committee for Food and Environment (Vitenskapskomiteen for mat og miljø). Available from: https://vkm.no/download/18_d44969415d027c43cf13da6/1501076192110/ebc8d55983.pdf, accessed 14 March 2022.

- NTP (2021). 15th report on carcinogens. Research Triangle Park (NC), USA: United States Department of Health and Human Services, Public Health Service. Available from: <https://doi.org/10.22427/NTP-OTHER-1003>, accessed 14 March 2022. doi:[10.22427/NTP-OTHER-1003](https://doi.org/10.22427/NTP-OTHER-1003)
- Ontario Ministry of Environment and Energy (1996). Scientific criteria document for the development of a provincial water quality objective for cobalt (stable isotope). PIBS 3361E. Toronto (ON), Canada: Ontario Ministry of Environment and Energy. Available from: <https://archive.org/details/cobaltscientific00torouoft>, accessed 1 February 2022.
- Saravanabhan G, Werry K, Walker M, Haines D, Malowany M, Khoury C (2017). Human biomonitoring reference values for metals and trace elements in blood and urine derived from the Canadian Health Measures Survey 2007–2013. *Int J Hyg Environ Health*. 220(2 Pt A):189–200. doi:[10.1016/j.ijheh.2016.10.006](https://doi.org/10.1016/j.ijheh.2016.10.006) PMID:[27776932](https://pubmed.ncbi.nlm.nih.gov/27776932/)
- Scarselli A, Di Marzio D, Iavicoli S (2020). Assessment of exposure to cobalt and its compounds in Italian industrial settings. *Med Lav*. 111(1):22–31. PMID:[32096770](https://pubmed.ncbi.nlm.nih.gov/32096770/)
- Schmitz-Spanke S, Drexler H, Hartwig A, MAK Commission (2019). Addendum to cobalt and cobalt compounds [BAT value documentation, 2018]. In: The MAK-collection for occupational health and safety: annual thresholds and classifications for the workplace. Vol. 4, No. 3. Weinheim, Germany: Wiley-VCH Verlag GmbH Co. KGaA. Available from: 10.1002/3527600418. bb744048vere2319 doi:[10.1002/3527600418.bb744048vere2319](https://doi.org/10.1002/3527600418.bb744048vere2319)
- USGS (2021). US Geological Survey Minerals Yearbook 2019. Cobalt. Washington (DC), USA: United States Department of the Interior. Available from: <https://www.usgs.gov/centers/national-minerals-information-center/cobalt-statistics-and-information>, accessed 1 October 2021.
- Water Quality Australia (2018). Australian and New Zealand guidelines for fresh and marine water quality. Canberra (ACT), Australia: Department of Agriculture, Water and the Environment. Available from: <https://www.waterquality.gov.au/anz-guidelines>, accessed 1 February 2022.
- WHO (2006). Cobalt and inorganic cobalt compounds. Geneva, Switzerland: World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/43426/9241530693_eng.pdf?sequence=1&isAllowed=yhttps://apps.who.int/iris/handle/10665/43426, accessed 6 March 2022.