Material Safety Data Sheet

Issue No.: SMC-08.04 Date: August 12, 2004

1.1 PRODUCT INFORMATION:

This MSDS covers the following Special Metals Corporation alloy families and individual products identified as:

INCONEL®, INCOLOY®, INCOCLAD®, MONEL®, UDIMET®, UDIMAR®, NILO®, NILOMAG®, NIMONIC®, NIMOLOY®, NI-SPAN-C®, BRIGHTRAY®, KOTHERM® & NIOTHERM® alloys; FERRY® alloy, Nitinol, Nickel, DEPOLARIZED® & DURVANIC® nickel, Electroformed nickel foil, Cupro 107; Miscellaneous designations, Mixed nickel alloy revert.

These are corrosion or heat resisting alloys, or alloys with special physical properties, which are primarily used in process, industrial, aerospace, automotive, marine, electrical or electronic equipment. Alloys not described in this document may be proprietary; contact one of the SMC locations below for more information.

1.2 COMPANY INFORMATION

The products are supplied by the main manufacturing companies in the Special Metals Corporation Group and/or their subsidiaries*:

USA
Special Metals Corporation
3200 Riverside Drive
Huntington, WV, USA 25705
EMERGENCY TELEPHONE NUMBER: +1(304) 526-5780
GENERAL INFORMATION: +1 (304) 526-5100

Special Metals Corporation
4317 Middle Settlement Road
New Hartford, NY, USA 13413-5392
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GENERAL INFORMATION: +1 (315) 798-2900

EUROPE
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Holmer Road
Hereford, HR4 9SL, UK
EMERGENCY TELEPHONE NUMBER: +44 (0)1432 382200
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This document does not cover Welding Products.
For Welding Products MSDS, contact:
Special Metals Welding Products Company
1401 Burris Road
Newton, NC, USA 28658
Tel: +1 (828) 465-0352
www.specialmetalswelding.com

To obtain Powder Products MSDS:

Special Metals Powder Division
100 Industry Lane
Princeton, KY, USA 42445
Tel: +1 (270) 365-9551

*For a full list of subsidiary companies, please refer to our website www.specialmetals.com or call +1 (304) 526-5100 or toll-free in the USA +1 (800) 334-4626.

2. COMPONENT INFORMATION:

The compositions of individual products in the alloy families or categories listed under 1.1 are given in the product composition tables in APPENDIX 1. Please refer to the appropriate alloy name or designation.

3. HAZARDS IDENTIFICATION:

Nickel and Cobalt are classified as suspect carcinogens (Category 3) and alloys that contain more than 1% of these elements are classified in the same way as nickel and cobalt. These elements are also classified as skin sensitizers. Additionally, individual products in the above alloy families may contain one or more of the following ingredients, which may be considered hazardous under the legislation indicated:

USA: SARA SECTION 313 SUPPLIER NOTIFICATION: Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372.

Aluminum	CAS No. 7429-90-5
Chromium	CAS No. 7440-47-3
Cobalt	CAS No. 7440-48-4
Copper	CAS No. 7440-50-8
Iron	CAS No. 7439-89-6
Manganese	CAS No. 7439-96-5
Molybdenum	CAS No. 7439-98-7
Nickel	CAS No. 7440-02-0

Niobium	CAS No. 7440-03-1
Tantalum	CAS No. 7440-25-7
Titanium	CAS No. 7440-32-6
Tungsten	CAS No. 7440-33-7
Yttrium Oxide	CAS No. 1314-36-9

EUROPE

Nickel EC Label No. 231-111-4
Index No. 028-002-00-7
Designation: Xn Harmful
Risk Phrases: R40 Possible risk of irreversible effects.
R43 May cause sensitization by skin contact.

Cobalt EC Label No. 231-158-0
Index No. 027-001-00-9
Designation: Xn Harmful.
Risk Phrases: R42/43 May cause sensitization by inhalation and skin contact.
R53 May cause long-term adverse effects in the aquatic environment.

Refer to APPENDIX 1 of this MSDS for the individual alloy name and the percent by weight of the various ingredients in each alloy.
Refer to APPENDIX 2 for detailed information on the toxicological properties of these ingredients.
Description of hazards:
There are no hazards to man or the environment from these alloys in the forms supplied. Hazardous products may be evolved during remelting, grinding, cutting, and welding. If airborne concentrations are excessive, inhalation may affect workers health. Further information is given in Section 8 - Exposure Controls / Personal Protection.

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4. FIRST AID MEASURES:

Eye contact: Flush particles from the eyes with clean water for at least 15 minutes. If irritation persists, seek medical help.
Skin contact: Wash skin with soap and water to remove any metallic particles. If a rash develops, seek medical attention.
Inhalation: Remove from exposure. If respiratory irritation persists, seek medical help.
Ingestion: If symptoms of ingestion arise, seek medical help.

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5. FIRE or EXPLOSION HAZARD: Nonflammable, however sparks from welding or grinding in user operations could ignite flammable or combustible liquids, vapors and solids.

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6. ACCIDENTAL RELEASE MEASURES:

Vacuum or shovel any spilled material into a suitable container. Alloy wastes are normally collected to recover metal values.

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7. HANDLING AND STORAGE:

Under normal circumstances the materials do not produce any hazardous products and as such do not require any special precautions. However, see Section 10, "STABILITY AND REACTIVITY". The transient handling of the materials would not be expected to produce any sensitization but it is good practice to use gloves for handling. The normal precautions for handling heavy objects with possible sharp edges should also be observed.

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8. EXPOSURE CONTROLS / PERSONAL PROTECTION:

Respiratory Protection: Respiratory protection is necessary when exposure limits for airborne contaminants are exceeded during cutting, grinding or welding on these alloys. Use air-supplied respirator in confined spaces. In the USA, use only NIOSH-approved respirators in accordance with 29 CFR 1910.134, or other nationally approved respirators. In the EU if required use protection to EN136 (full face respirators), EN140 (half mask respirators), EN149 (filtered half masks (disposable)) or other appropriate EN standard. In the rest of the world use respiratoty protection to the appropriate national standard.

Ventilation: Use local exhaust ventilation when cutting, grinding or welding. Maintain exposures below published exposure limits. Confined spaces require special attention to provision of adequate ventilation and/or air-supplied respirators.

Eye Protection and Protective Clothing: Eye protection is recommended when cutting, grinding and welding. Wear gloves, face protection and flame retardant clothing. Do not expose skin or eyes to the heat and radiation from welding operations.

IMPORTANT

Maintain exposures below the published exposure levels. Use industrial hygiene air monitoring to ensure that your use of this material does not create exposures that exceed the recommended exposure limits. Always use exhaust ventilation in user operations such as high temperature cutting, welding and grinding. Refer to the following sources for important additional information:

In U.S.A.:	29 CFR 1910, ANSI Z49.1 , American Welding Society, OSHA, U.S. Dept of Labor
In Canada:	Canadian Standards Association, CAN/CSA - W17.2-M87
In UK:	Current exposure limits under Health & Safety Executive EH40 are given in Appendix 2.

9. PHYSICAL AND CHEMICAL PROPERTIES:

Physical State: Solid Specific Gravity: 8-9 gm/cc Melting Point: >1260 °C Odor: Odorless
Appearance: Silver-colored metal shaped as plate, bar, wire, tube, rod, strip, sheet or some intermediate form.

Other physical and chemical properties, e.g. as described in 91/155/EEC and in the Approved Code of Practice, ref. 11 (viscosity, flash point, autoflammability, vapor pressure, solubility and partition coefficient), have no safety implications in relation to these materials.

10. STABILITY AND REACTIVITY:

These alloys are very stable and no hazardous decomposition products are formed upon exposure to water or the atmosphere. Nickel can react with carbon monoxide in reducing atmospheres to form nickel carbonyl, an extremely toxic gas.

11. TOXICOLOGICAL PROPERTIES:

Nickel and cobalt are classified as Category 3 carcinogens. The exposure route of concern is inhalation.

As shipped, these complex alloys in massive form have no known toxicological properties other than causing allergic reactions in individuals sensitive to the metal(s) contained in the alloys. However, user-generated dusts and fumes may on contact with the skin or eyes produce mechanical irritation. Chronic exposures coupled with sweat could cause dermatitis (skin) or conjunctivitis (eyes). Excessive inhalation of user-generated fumes from high temperature cutting or welding of these alloys may, depending on the specific features of the process used, pose a long-term health hazard. The International Agency for Research on Cancer (IARC) has concluded that welding fumes are possibly carcinogenic to humans.

The ingredients of fumes and gases generated in user welding, grinding and high temperature cutting operations will depend on the base metal, electrode, flux and the specific process being used. Ingredients may include metals, metal oxides, chromates, fluorides, carbon monoxide, ozone, and oxides of nitrogen. Phosgene can be produced if chlorinated solvent vapors are present in user operations.

More detailed toxicological information is given in APPENDIX 2.

12. ECOLOGICAL EFFECTS:

These alloys are not soluble in water and react only very slowly with natural environments. No special precautions are necessary.

13. DISPOSAL:

Alloy wastes are normally collected to recover metal values. However, if disposal is necessary, dispose of in accordance with national, federal, state or local regulations. In the UK, most alloy material would be classified as special waste.

14. TRANSPORTATION:

No special precautions are necessary for the transport of these materials.

15. REGULATORY INFORMATION:

Classification and labelling requirements

Alloys containing less than 1% of nickel or cobalt are not classified as "dangerous for supply". Alloys containing more than 1% of either metal are classified as the metals themselves (see Section 3). However, in recognition of their essentially non-hazardous nature, these alloys in the massive form are not required to be labeled as hazardous.

16: OTHER INFORMATION:

Bibliography:

1. U.S. National Toxicology Program - 10th Report On Carcinogens
2. Health and Safety Executive UK - EH40 - Occupational exposure limits; EH42 - Monitoring Strategies for toxic substances; EH44 - Dust the Workplace - general principles of protection; EH54 - Assessment of Exposure to Fume from Welding and Allied Processes; EH55 - The Control of Exposure to Fume from Welding, Brazing and Similar Processes; EH60 - Nickel and its inorganic compounds.
3. EH Health and Safety Executive's publications (www.hse.gov.uk)

4. HSC. Information approved for the classification, packaging and labeling of dangerous substances for supply and conveyance by road
5. European Commission Directive 5/3/91 - 91/155/EEC
6. European Commission Directive 10/12/93 - 93/112/EEC
7. Twelfth adaptation of Council Directive 67/548/EEC - 91/325/EEC
8. Sixth amendment of Council Directive 67/548/EEC - 79/831/EEC
9. The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 No. 1689
10. International Agency for Research on Cancer. Monographs on the evaluation of carcinogenic risks to humans. Vol.49 Chromium Nickel and Welding, 1990.
11. Approved Code of Practice. ISBN 0 7176 0859X
12. European Norm - EN 1811

17. PREPARATION INFORMATION:

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APPENDIX 1 - HAZARDOUS INGREDIENTS

The nominal compositions of individual alloys are given in the tables below. The MSDS covers all products thus identified.

Table 1. INCONEL® alloys
Tradename and Nominal Composition (% weight)

Alloy Designation	Alum-inum	Chromium	Cobalt	Copper	Iron	Manga-nese	Molyb-denum	Nickel	Niobium	Silicon	Tantalum	Titanium	Tungsten	Yttrium Oxide
INCONEL® alloy 050		20	3		18		9	50	1					
INCONEL® alloy 22	0.2	22			2.5		14	58					3	
INCONEL® alloy 230	0.3	22	1		1	0.5	2	60					14	
INCONEL® alloy 600 & 600T		16			8			76						
INCONEL® alloy 600SP		15			8			77						
INCONEL® alloy 601	1	24			14			61						
INCONEL® alloy 601GC	1	24			14			61						
INCONEL® alloy 603XL		22					3	73		2				
INCONEL® alloy 604		16			8			72	2					
INCONEL® alloy 606		20			1	3		73	3					
INCONEL® alloy 613	1	16			6	1		76						
INCONEL® alloy 617	1	22	13		1		10	53						
INCONEL® alloy 622	0.2	22			2.5		14	58					3	
INCONEL® alloy 625		22			4		9	61	4					
INCONEL® alloy 625LCF		22			4		9	61	4					
INCONEL® alloy 672		45						54			1			
INCONEL® alloy 686		21			1		16	58					4	
INCONEL® alloy 690 & 690T		29			9			62						
INCONEL® alloy 691	1	30			9			59			1			
INCONEL® alloy 693	3	30			5			60	2					
INCONEL® alloy 702	3	16			1			79				1		
INCONEL® alloy 706		16			37			42	3			2		
INCONEL® alloy 718	1	18			18		3	54	5			1		
INCONEL® alloy 718SPF	1	18			18		3	54	5			1		
INCONEL® alloy 721		16			7	2		71				3		
INCONEL® alloy 722	1	16			7			74				3		
INCONEL® alloy 725		21			9		8	58	3			1		
INCONEL® alloy 725HS		21			9		8	58	3			1		
INCONEL® alloy 740	1	25	20		1			49	2			2		
INCONEL® alloy X-750	1	16			7			72	1			3		
INCONEL® alloy 751	1	15			7			73	1			3		
INCONEL® alloy 783	6	3	35		25			28	3					
INCONEL® alloy C-276		16			6	1	16	57					4	
INCONEL® alloy G		22	1	2	20	1	7	44	2					
INCONEL® alloy G-3		22	3	2	20	1	7	44					1	
INCONEL® alloy HX		22	2		18		9	48					1	
INCONEL® alloy MA754		20						78				1		1
INCONEL® alloy MA758		30						68				1		1
INCONEL® alloy MA6000	5	15					2	69			2	3	4	1
INCOTHERM® alloy TD		22					3	73			2			

Table 2. INCOLOY®, NILO® and NI-SPAN-C® alloys
Tradename and Nominal Composition (% weight)

Alloy Designation	Alum-num	Chromium	Cobalt	Copper	Iron	Manga-nese	Molyb-denum	Nickel	Niobium	Silicon	Titanium	Yttrium Oxide	Nitrogen
INCOLOY® alloy 020		20		4	38		3	34	1				
INCOLOY® alloy 028		27			37		4	32					
INCOLOY® alloy 25-6MO		20		1	45	1	7	25		1			
INCOLOY® alloy 27-7MO		22		1	41	2	7	27					0.35
INCOLOY® alloy 330		19			44			36		1			
INCOLOY® alloy 330HC		19			48			34		1			
INCOLOY® alloy 800		20			45	1		33		1			
INCOLOY® alloy 800H		20			45			33			1		
INCOLOY® alloy 800HT		20			45			33			1		
INCOLOY® alloy 801		20			46	1		32			1		
INCOLOY® alloy 802		21			44	1		33			1		
INCOLOY® alloy 803		27			36	1		35			1		
INCOLOY® alloy 805		8			55	1	1	36			1		
INCOLOY® alloy 825		22		2	29	1	3	42			1		
INCOLOY® alloy 832		20			65			14		1			
INCOLOY® alloy 840		20			59			20		1			
INCOLOY® alloy 864		21			40		4	34		1			
INCOLOY® alloy 890		25			27	1	2	43		2			
INCOLOY® alloy 901		13			36		6	42			3		
INCOLOY® alloy 903	1		15		42			38	3		1		
INCOLOY® alloy 904			15		51			33			2		
INCOLOY® alloy 907		13			42			38	5		2		
INCOLOY® alloy 908	1	4			41			49	3		2		
INCOLOY® alloy 909			13		42			38	5		2		
INCOLOY® alloy 925		21		2	28		3	44			2		
INCOLOY® alloy A-286		14			58		1	25			2		
INCOLOY® alloy DS		18			42	1		37		2			
INCOLOY® alloy MA956	5	20			74							1	
INCOLOY® alloy MA957		14			85						1		
NI-SPAN-C® alloy 902		5			49			43		1	2		
NILO® alloy 36					64			36					
NILO® alloy 42					58			42					
NILO® alloy 45					55			45					
NILO® alloy 475		5			48			47					
NILO® alloy 48					52			51					
NILO® alloy 51					49			51					
NILO® alloy 55					44			56					
NILO® alloy K			17		53			30					
NILOMAG® alloy 77				5	14		4	77					

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Table 3. NIMONIC® and NIMOLOY® alloys
Tradename and Nominal Composition (% weight)

Alloy Designation	Aluminum	Chromium	Cobalt	Iron	Manganese	Molybdenum	Nickel	Niobium	Titanium
NIMONIC® alloy 70	1	20		25			51	2	1
NIMONIC® alloy 75		20		4	1		75		
NIMONIC® alloy 80a	1	20					76		2
NIMONIC® alloy 81	1	30		1			66		2
NIMONIC® alloy 86		25				10	65		
NIMONIC® alloy 90	2	20	16	1			58		3
NIMONIC® alloy 91	1	29	20				48		2
NIMONIC® alloy 101	1	24	20			2	49	1	3
NIMONIC® alloy 105		15	20			5	54		1
NIMONIC® alloy 108	5	15	20			5	53		1
NIMONIC® alloy 115	5	15	13			4	59		4
NIMONIC® alloy 263	1	20	20			6	51		2
NIMONIC® alloy 901		13		35		6	43		3
NIMONIC® alloy PE11	1	18		35		5	38		2
NIMONIC® alloy PE16	1	17		34		3	44		1
NIMONIC® alloy PK31		20	14			5	53	5	2
NIMONIC® alloy PK33	2	19	14	1		7	55		2
NIMOLOY® alloy PK37	1	19	17				60		2

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Table 4. BRIGHTRAY®, KOTHERM® and NIOTHERM® alloys
Tradename and Nominal Composition (% weight)

Alloy Designation	Chromium	Iron	Nickel	Silicon	Manganese	Copper
BRIGHTRAY® alloy B	16	24	59	1		
BRIGHTRAY® alloy C	20		78	2		
BRIGHTRAY® alloy F	18	42	37	2	1	
BRIGHTRAY® alloy S	20		78	1	1	
BRIGHTRAY® alloy 35	20	42	36	2		
KOTHERM® Positive	10		90			
KOTHERM® Negative			94	3		2
NIOTHERM® Positive	14		85	1		
NIOTHERM® Negative			96	4		

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Table 5A. Miscellaneous Designations
Tradename and Nominal Composition (% weight)

Alloy Designation	Alum-num	Chromium	Cobalt	Iron	Manga-nese	Molyb-denum	Nickel	Niobium	Rhenium	Tantalum	Titanium	Tungsten	Calcium	Silicon
JBK		15		52		1	30				2			
Nickel 200							99							
Nickel 201							99							
Nickel 205							99							
Nickel 212					2		97							
Nickel 213					1		97							
Nickel 222							99							
Nickel 229							99							
Nickel 240		2			2		96							
Nickel 243		2			2		96							
Nickel 270							99							
Electroformed nickel							99							
DEPOLARIZED® nickel							99							
DURVANIC® nickel							99							
Mixed nickel alloy revert	0-3	0-20	0-5	20-40	0-1	0-5	30-60	0-1		0-0.5	1-4	0-1	1-4	

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Table 5B. Miscellaneous Designations
Tradename and Nominal Composition (% weight)

Alloy Designation	Alum-num	Chromium	Cobalt	Iron	Manga-nese	Molyb-denum	Nickel	Niobium	Tantalum	Titanium	Tungsten
13-8	1	13		76		2	8				
UDIMET alloy 188		22	40		1		23				14
713C	6	14				5	73	2		1	
B300			9	67		5	19				
C1023	4	15	10			8	60			4	
GMR235	4	15		4		5	70			3	
GTD222	1	23	19				51		1	2	2
IN738LC	4	16	8			2	62		2	3	3
UDIMET alloy L-605		20	53		2		10				15
IN738	3	16	9			2	61	1	2	4	3
M252	1	19	10			10	57			3	
MERC76	5	13	19			3	55	1		4	
NICOCRALY	13	22	23				43				
NiTiFe				2			54			45	
Rene 220		19	12			3	56	5	3		
Rene 77	4	15	15			4	58	5	3		
Waspaloy	2	19	13			4	59			3	
X40		26	54				11			8	

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Table 6. MONEL® alloys, FERRY® alloy and Cupro 107
Tradename and Nominal Composition (% weight)

Alloy Designation	Aluminum	Copper	Iron	Manganese	Nickel	Silicon	Titanium
MONEL® alloy 400		32	1	1	66		
MONEL® alloy 401		55	1	2	43		
MONEL® alloy 404		46			54		
MONEL® alloy R-405		32	1	1	66		
MONEL® alloy 413		67	1	1	31		
MONEL® alloy 416	1	30		1		2	
MONEL® alloy 418		27		4	66	1	2
MONEL® alloy 450		67	1	1	31		
MONEL® alloy K-500	3	30	1	1	65		1
FERRY® alloy		54			44		
Cupro 107		67	1	1	31		

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Table 7. UDIMET® alloys
Tradename and Nominal Composition (% weight)

Alloy Designation	Aluminum	Chromium	Cobalt	Iron	Molybdenum	Nickel	Niobium	Titanium	Tungsten
UDIMET® alloy R41	2	19	11		10	55		3	
UDIMET® alloy 500	3	19	18		4	53		3	
UDIMET® alloy 520	2	19	12		6	57		3	1
UDIMET® alloy 700	5	15	19		5	53		4	
UDIMET® alloy 713	6	14			5	73	2		
UDIMET® alloy 718		18		19	3	54	5	1	
UDIMET® alloy 720	3	18	15		3	56		5	1
UDIMET® alloy 706		16		37		42	3	2	
UDIMET® alloy D301	5					95			
UDIMET® alloy D979	1	15		28	4	45		3	4

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Table 8. Nitinol alloys
Tradename and Nominal Composition (% weight)

Alloy Designation	Chromium	Cobalt	Copper	Iron	Nickel	Niobium	Titanium
Nickel-Titanium					54-57		43-46
Ni-Ti-Fe				1-7	48-50		43-51
Ni-Ti-Cu			5-10		43-45		46-52
Ni-Ti-Cr	0.2-0.3				54-57		43-46
Ni-Ti-Nb					45-51	13-15	34-42
Ni-Ti-Co		1-2			54-57		41-45

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Table 9. INCOCLAD® products
(N.B. these are products containing more than one alloy or component. Nominal compositions are given for each component.)
Tradename and Nominal Composition (% weight)

Alloy Designation	Chromium	Cobalt	Copper	Iron	Molybdenum	Nickel	Niobium	Titanium
INCOCLAD® 625/steel	22			4	9	61	4	
				95				
INCOCLAD® 671/800H/HT	49					51		
	20			45		33		

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APPENDIX 2

TOXICOLOGICAL AND EXPOSURE LIMIT INFORMATION

The following information is primarily directed to the ingredients of the complex alloys listed in APPENDIX 1. Although it is the user's responsibility to assess end products, intermediates or fugitive emissions arising out of the use of these alloys, information is also provided for common fume ingredients. *UK EH40 limits for the ingredients are shown in italics at the end of each section.*

Aluminum (Al)
Exposure Limits[1]: **TLV: 10 mg/m^3 (Metal dust); 5 mg/m^3 (Welding fumes)**
PEL: 15 mg/m^3 (Total metal dust); 5 mg/m^3 (Metal dust - respirable fraction)
CAS No.[2]: 7429-90-5
LD_{50}: Not Available

Aluminum is not readily absorbed through the skin or the GI tract and only poorly through the lungs. Foreign literature between 1958 and 1962 reported cases of severe and sometimes fatal pulmonary fibrosis in workers exposed to aluminum dust. In one of the fatal cases, the worker developed fibrosis and encephalopathy after 13.5 years of exposure to aluminum dust.

In rodent studies and currently in US industry, no fibrosis or encephalopathy have been reported from the inhalation of aluminum powder. Acute exposure to alumina fume may cause bronchial irritation, however reports of pulmonary fibrosis and emphysema in alumina abrasive workers are no longer seen, owing to improved environmental control.

EH40 - Aluminium metal:
Total inhalable dust OES 10 mg/m^3 (8 hours TWA) *Total respirable dust OES 4 mg/m^3 (8 hours TWA)*

Chromium (Cr)
Exposure Limits[1]: **TLV: 0.5 mg/m^3**
PEL: 1.0 mg/m^3 (Metal as Cr)
CAS No.[2]: 7440-47-3
LD_{50}: Not Available

Chromium metal is relatively nontoxic. Chromium metal and insoluble salts are said to be involved in fibrosis of the lungs. When the metal is heated to a high temperature, fumes produced may be damaging to the lungs if inhaled. The International Agency for Research on Cancer has concluded that the evidence for carcinogenicity in humans and animals is inadequate for chromium metal and trivalent chromium compounds, but sufficient for hexavalent chromium compounds. Fumes from welding chromium-containing stainless steel or certain chromium-containing rods can trigger eczematous eruptions on the palms of the hands of chromium-sensitized individuals.

EH40 - Chromium:
Chromium VI compounds (as Chrome) MEL 0.05 mg/m^3 (8 hours TWA)
Chromium II compounds (as Chrome) OES 0.5 mg/m^3 (8 hours TWA)
Chromium III compounds (as Chrome) OES 0.5 mg/m^3 (8 hours TWA)
Chromium OES 0.5 mg/m^3 (8 hours TWA)

Cobalt (Co)
Exposure Limits[1]: **TLV: 0.02 mg/m^3 (Dust & fume as Co)**
PEL: 0.1 mg/m^3 (As Co metal)
CAS No.[2]: 7440-48-4
LD_{50}: 6,170 mg/kg, rat, oral

Asthmatic symptoms and pulmonary fibrosis occurring in the tungsten carbide industry may be related to the inhalation of metallic cobalt dust. Evidence of polycythemia (an increase in the total red cell mass of the blood in the body) and altered thyroid, kidney and liver function have also been found. Excessive inhalation of metallic cobalt have produced cardiac changes in miniature swine. Eye contact may cause conjunctivitis. Symptoms of excessive ingestion may be a sensation of hotness with vomiting, diarrhea and nausea along with the potential for causing damage to blood, heart, thyroid and pancreas. Repeated skin contact can cause sensitivity and allergic skin rashes. Cobalt powders have caused tumors at the site of injection in rodents. However, studies of cobalt-containing prostheses do not suggest a significant risk for humans.

EH40 - MEL 0.1 mg/m^3 (8 hours TWA)

Copper (Cu)

Exposure Limits[1]: **TLV: 1 mg/m^3 (Dusts & mists, as Cu), 0.2 mg/m^3 (Fume)**
PEL: 1 mg/m^3 (Dusts & mists, as Cu), 0.1 mg/m^3 (Fume as Cu)
CAS No.[2]: 7440-50-8
LD_{50}: 35 mg/kg, mouse, intraperitoneal

Copper metal dust and fume may be irritating to the respiratory tract. In user operations where copper fume is generated, inhalation of the fume can result in symptoms of "Metal Fume Fever" such as chills, fever and sweating. A few instances of allergic skin rashes have been reported in workers with skin exposure to metallic copper. In the eyes, copper metal as a foreign body can provoke an inflammatory reaction resulting in pus formation in the conjunctiva, cornea or sclera. Ingestion of copper metal may cause gastrointestinal upset. Wilson's disease can occur in certain individuals with a rare, inherited metabolic disorder characterized by retention of excessive amounts of copper in the liver, brain, kidneys and corneas. These deposits eventually lead to tissue necrosis and fibrosis, causing a variety of clinical effects, especially liver disease and neurological changes. Wilson's disease is progressive and, if untreated, leads to fatal liver failure.

EH40: Fume OES 0.2 mg/m^3 (8 hours TWA)
Dusts & mists (as Cu) 1.0 mg/m^3 (8 hours TWA), 2.0 mg/m^3 (15 minute reference period)

Iron (Fe)

Exposure Limits[1]: **TLV: No limit set (For Fe_2O_3 fume the TLV is 5 mg/m^3 as Fe)**
PEL: No limit set (For Fe_2O_3 dust & fume the PEL is 10 mg/m^3 as Fe)
CAS No.[2]: 7439-89-6
LD_{50}: Not Available

Inhalation of the excessive oxide fumes or dusts can lead to irritation of the respiratory tract. Prolonged inhalation of iron oxide for periods of 6 to 10 years is known to cause siderosis which appears to be a benign pneumoconiosis. Prolonged eye contact with the metal dust could cause rust brown colored spots forming around the particles and if left for several years, permanent damage could result.

EH40 - Iron Oxide, fume (as Fe) OES 5.0 mg/m^3 (8 hours TWA), 10 mg/m^3 (15 minute reference period)

Manganese (Mn)

Exposure Limits[1]: **TLV: 0.2 mg/m^3 elemental and inorganic compounds, as Mn**
PEL: 5 mg/m^3 (Ceiling, as Mn compounds); 5 mg/m^3 (Fume, as Mn)
CAS No.[2]: 7439-96-5
LD_{50}: 9,000 mg/kg, rat, oral

Excessive inhalation or ingestion of manganese can produce manganese poisoning. Chronic exposures can lead to neurological problems such as apathy, drowsiness, weakness, spastic gait, paralysis, and other neurological problems resembling Parkinsonism. These symptoms can become progressive and permanent if not treated. Excessive inhalation of fumes may cause "Metal Fume Fever" with its flu-like symptoms, such as chills, fever, body aches, vomiting, sweating, etc.

EH40 - Fume (as Mn) OES 1.0 mg/m^3 (8 hours TWA), 3.0 mg/m^3 (15 minute reference period)
Manganese and compounds (as Mn) OES 5.0 mg/m^3 (8 hours TWA)

Molybdenum (Mo)

Exposure Limits[1]: **TLV: 10 mg/m^3 (Insoluble and metal compounds, as Mo)**
PEL: 15 mg/m^3 (Insoluble compounds, total dust as Mo)
CAS No.[2]: 7439-98-7
LD_{50}: Not Available

Molybdenum and its insoluble compounds are reported to have a low toxicity. High dietary intake may produce a gout-like disease and high blood uric acid. Inhalation of fumes has caused kidney damage, respiratory irritation and liver damage in animals. Skin and eye contact may cause irritation.

EH40 - Molybdenum compounds (as Mo):
Soluble - OES 5.0 mg/m^3 (8 hours TWA), 10 mg/m^3 (15 minute reference period)
Insoluble - OES 10 mg/m^3 (8 hours TWA), 20 mg/m^3 (15 minute reference period)

Nickel (Ni)

Exposure Limits[1]: TLV: 1.5 mg/m^3 as metal (Inhalable Fraction)
PEL: 1 mg/m^3 for metal and insoluble compounds as Ni
CAS No.[2]: 7440-02-0
LD_{50}: >9,000 mg/kg, rat, oral

The U.S. National Toxicology Program (NTP) 10th Report on Carcinogens has listed "metallic nickel" as "reasonably anticipated to be a human carcinogen" and "nickel compounds" as "known human carcinogens". "Nickel Alloys" were reviewed but not listed. The International Agency for Research on Cancer (IARC) concluded that nickel compounds were carcinogenic to humans and that metallic nickel is possibly carcinogenic to humans. Epidemiological studies of workers exposed to nickel powder and to dust and fume generated in the production of nickel alloys and of stainless steel have not indicated the presence of a significant respiratory cancer hazard.

The inhalation of nickel powder has not resulted in an increased incidence of malignant tumors in rodents. Repeated intratracheal instillation of nickel powder produced an increased incidence of malignant lung tumors in rats, but did not produce an increased incidence in hamsters when administered at the maximum tolerated dose. However, single intratracheal instillations of nickel powder in hamsters at doses near the LD_{50} have produced an increased incidence of fibrosarcomas, mesotheliomas and rhabdomyosarcomas. Inhalation of nickel powder at concentrations 15 times the PEL irritated the respiratory tract in rodents. Nickel is a known sensitizer and may produce allergic reactions.

EH40 - Nickel and its inorganic compounds (except nickel carbonyl):

Water soluble nickel compounds (as nickel) MEL 0.1 mg/m^3 (8hours TWA)

Niobium (Nb)

Exposure Limits[1]: TLV: No limit set
PEL: No limit set
CAS No.[2]: 7440-03-1
LD_{50}: Not Available

Also known as Columbium (Cb), there is almost no information on the toxicity of this metal or its fumes. Russian medical literature has described early chest x-ray changes in welders and chemical workers handling niobium and tantalum, but no specific data has been found. It is expected that the metal dust and fumes could cause irritation to the skin, eyes and respiratory tract upon acute exposure.

EH40-40: No limit set.

Tantalum (Ta)

Exposure Limits[1]: TLV: 5 mg/m^3 (Metal & oxide dusts)
PEL: 5 mg/m^3 (Metal & oxide dusts)
CAS No.[2]: 7440-25-7
LD_{50}: Not Available

There are no reports of adverse health effects in industrially exposed workers. Massive doses of tantalum given by the intratracheal route to rats have produced respiratory tract lesions. In contact with tissue, metallic tantalum is inert. Tantalum pentoxide has an LD_{50} of >8 g/kg, orally in rats.

EH40 - OES 0.5 mg/m^3 (8 hours TWA), 10 mg/m^3 (15 minute reference period)

Titanium (Ti)

Exposure Limits[1]: TLV: No limit set
PEL: No limit set
CAS No.[2]: 7440-32-6
LD_{50}: Not Available

Inhalation of titanium could cause mild irritation to the respiratory tract. Inhalation of titanium dioxide dust or fume could produce lung fibrosis and chronic bronchitis.

EH40 - As Titanium dioxide:

Total inhalable dust OES 10 mg/m^3 (8 hours TWA), Total respirable dust OES 4 mg/m^3 (8 hours TWA)

Tungsten (W)
Exposure Limits[1]: **TLV: 5 mg/m^3 insoluble compounds, as W**
STEL: 10 mg/m^3 for insoluble compounds, as W
PEL: No limit set
CAS No.[2]: 7440-33-7
LD_{50}: 2,000 mg/kg, rat, unreported route

Inhalation of tungsten dust may cause irritation of the respiratory tract. Skin or eye contact could cause abrasion or irritation of the respective surfaces. No hazards have been identified for tungsten fume except that it may aggravate an existing chronic respiratory disease.
EH40 - No limit set.

Yttrium Oxide (Y_2O_3)
Exposure Limits[1]: **TLV: 1 mg/m^3 (as Y)**
PEL: 1 mg/m^3
CAS No.[2]: 1314-36-9
LD_{50}: 230 mg/kg, rat, intraperitoneal

Short term inhalation in large amounts could cause discomfort, coughing and nasal discharge similar to the symptoms of a bad cold. Drying of the mucous membranes might be experienced. After intratracheal administration in rats, emphysema and diffused modular fibrosis in the lungs have been reported. The oral toxicity of this material is low as it is poorly absorbed from the gastrointestinal tract. Skin and eye contact should produce no problems other than mechanical irritation.
EH40 - No limit set.

Silicon (Si)
EH40 - Total inhalable dust OES 10 mg/m^3 (8 hours TWA). Total respirable dust OES 4 mg/m^3 (8 hours TWA).

Rhenium (Rh)
EH40 - No limit set.

Calcium (Ca)
EH40 - As oxide OES 2 mg/m^3 (8 hours TWA).

Notes: (1) TLV = Threshold Limit Values - American Conference of Governmental Industrial Hygienists
PEL = Permissible Exposure Limit - OSHA 29 CFR 1910.1000
C = Ceiling value
STEL = Short Term Exposure Limit - a time-weighted 15-minute exposure limit, not to be exceeded at any time during a workday.
(2) CAS No. = Chemical Abstracts Services Number

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