HAYNES International

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SAFETY DATA SHEET

HAYNES INTERNATIONAL, INC. Corrosion-Resistant Alloys and High-Temperature Alloys

SDS IDENTIFICATION NUMBER
H2071-9
This replaces H2071-8

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August 11, 2009

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January 30, 2013

EMERGENCY PHONE NUMBERS
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This Safety Data Sheet (SDS) provides information on a specific group of manufactured metal products. Since these metal products share a common physical nature and constituents, the data presented are applicable to all alloys identified. This document was prepared to meet the requirements of the Globally Harmonized System (GHS) of Classification and Labeling of Chemicals, the Canadian Workplace Hazardous Materials Information System (WHMIS), and the Superfund Amendments and Reauthorization Act of 1986.

EMERGENCY OVERVIEW

Under normal handling and use of the solid form of this material there are few health hazards. Cutting, welding, melting, grinding, etc., of these materials will produce dust, fume, or particulate containing the component elements of these materials. Exposure to the dust, fume, or particulate may present significant health hazards which are referable to the elemental constituents in Section 3. Exposure to dust or fume may cause irritation of the eyes, skin, and respiratory tract. Fine particulates dispersed in air may present an explosion hazard.

1. PRODUCT IDENTIFICATION

CHEMICAL NAME: See Section 3 for Alloy Designations	CHEMICAL FAMILY: Alloy
TRADE NAME: See Alloys listed in this Section	FORMULA: Alloys composed of varying concentrations of elements listed in Section 3

HASTELLOY® B alloy	HASTELLOY® S alloy	HAYNES® 214® alloy
HASTELLOY® B-2 alloy	HASTELLOY® X alloy	HAYNES® 230® alloy
HASTELLOY® B-3® alloy	HASTELLOY® W alloy	HAYNES® 242® alloy
HASTELLOY® C-22® alloy	HAYNES® GTD 222 alloy	HAYNES® 244™ alloy
HASTELLOY® C-22HS® alloy	HAYNES® HR-120® alloy	HAYNES® 263 alloy
HASTELLOY® C-86 alloy	HAYNES® HR-160® alloy	HAYNES® 282® alloy
HASTELLOY® C-276 alloy	HAYNES® HR-224® alloy	HAYNES® 556® alloy
HASTELLOY® C-4 alloy	HAYNES® HR-235™ alloy	HAYNES® 600 alloy
HASTELLOY® C-2000® alloy	HAYNES® NS-163® alloy	HAYNES® 601 alloy
HASTELLOY® D-205® alloy	HAYNES® R-41 alloy	HAYNES® 617 alloy
HASTELLOY® G-3 alloy	HAYNES® Waspaloy alloy	HAYNES® 625 alloy
HASTELLOY® G-30® alloy	HAYNES® X-750 alloy	HAYNES® 625 (Low Iron) alloy
HASTELLOY® G-35® alloy	HAYNES® 6-B alloy	HAYNES® 625SQ® alloy
HASTELLOY® G-50® alloy	HAYNES® 25 alloy	HAYNES® 690 alloy
HASTELLOY® HYBRID-BC1® alloy	HAYNES® 75 alloy	HAYNES® 718 alloy
HASTELLOY® N alloy	HAYNES® 80A alloy	MULTIMET® alloy
	HAYNES® 188 alloy	ULTIMET® alloy

This SDS is also available in the English, French, German, Spanish, Italian, Czech, Chinese, Japanese, Mandarin, and Korean languages.

Product Hazard Rating
Hazardous Materials Identification System (HMIS)
H = Health Rating F = Flammability Rating R = Reactivity Rating

Alloy	Solid Article			Metal Dust			Metal Oxide Fume		
	H	F	R	H	F	R	H	F	R
HASTELLOY® B-2 alloy	0	0	0	2*	1	3	2*	0	0
HASTELLOY® B-3® alloy	0	0	0	2*	1	3	3*	0	1
HASTELLOY® C-22® alloy	0	0	0	2*	2	2	3*	0	0
HASTELLOY® C-22HS® alloy	0	0	0	2*	2	2	3*	0	0
HASTELLOY® C-86 alloy	0	0	0	2*	2	2	3*	0	0
HASTELLOY® C-276 alloy	0	0	0	2*	2	2	3*	0	0
HASTELLOY® C-4 alloy	0	0	0	2*	2	2	3*	0	0
HASTELLOY® C-2000® alloy	0	0	0	2*	2	2	3*	0	0
HASTELLOY® HYBRID-BC1® alloy	0	0	0	2*	2	2	3*	0	0
HASTELLOY® D-205® alloy	0	0	0	2*	2	1	3*	0	0
HASTELLOY® G-30® alloy	0	0	0	2*	4	1	3*	4	3
HASTELLOY® G-50® alloy	0	0	0	2*	2	1	3*	0	1
HASTELLOY® G-3 alloy	0	0	0	2*	2	1	3*	0	1
HASTELLOY® G-35® alloy	0	0	0	2*	4	1	3*	0	0
HASTELLOY® N alloy	0	0	0	2*	2	2	3*	0	0
ULTIMET® alloy	0	0	0	2*	4	3	2*	4	3
HAYNES® 600 alloy	0	0	0	2*	1	1	2*	0	0
HAYNES® 601 alloy	0	0	0	2*	2	1	3*	0	0
HAYNES® 690 alloy	0	0	0	2*	2	1	3*	0	0
HASTELLOY® S alloy	0	0	0	2*	2	2	3*	0	0
HASTELLOY® X alloy	0	0	0	2*	2	1	3*	0	0
HASTELLOY® W alloy	0	0	0	2*	2	3	3*	0	0
HAYNES® HR-120® alloy	0	0	0	2*	2	1	3*	0	0
HAYNES® HR-160® alloy	0	0	0	2*	4	3	3*	4	3
HAYNES® 214® alloy	0	0	0	2*	2	1	3*	0	0
HAYNES® HR-224® alloy	0	0	0	2*	3	1	3*	0	0
HAYNES® HR-235™ alloy	0	0	0	2*	2	1	3*	0	0
HAYNES® 230® alloy	0	0	0	2*	2	1	3*	0	1
HAYNES® 242® alloy	0	0	0	2*	2	3	3*	0	0
HAYNES® 244™ alloy	0	0	0	2*	2	3	3*	0	0
HAYNES® 556® alloy	0	0	0	2*	3	1	3*	2	2
HAYNES® 25 alloy	0	0	0	2*	4	3	2*	4	3
HAYNES® 75 alloy	0	0	0	2*	2	1	3*	0	1

Product Hazard Rating (continued)
Hazardous Materials Identification System (HMIS)
H = Health Rating F = Flammability Rating R = Reactivity Rating

Alloy	Solid Article			Metal Dust			Metal Oxide Fume		
	H	F	R	H	F	R	H	F	R
HAYNES® 188 alloy	0	0	0	2*	4	3	3*	4	3
HAYNES® NS-163® alloy	0	0	0	2*	4	3	3*	4	3
HAYNES® 263 alloy	0	0	0	2*	4	3	3*	4	3
HAYNES® 625 alloy	0	0	0	2*	2	1	3*	0	0
HAYNES® 718 alloy	0	0	0	2*	2	1	3*	0	0
HAYNES® R-41 alloy	0	0	0	2*	4	3	3*	4	3
HAYNES® X-750 alloy	0	0	0	2*	1	1	3*	0	0
HAYNES® 6-B alloy	0	0	0	2	4	3	2*	4	3
HAYNES® 80A alloy	0	0	0	2*	2	1	3*	0	0
HASTELLOY® B alloy	0	0	0	2*	2	3	2*	0	0
HAYNES® Waspaloy alloy	0	0	0	2*	4	3	3*	4	3
MULTIMET® alloy	0	0	0	2*	3	1	3*	2	2
HAYNES® 625SQ® alloy	0	0	0	2*	2	1	3*	0	0
HAYNES® 617 alloy	0	0	0	2*	3	3	3*	2	2
HAYNES® GTD 222 alloy	0	0	0	2*	4	3	3*	4	3
HAYNES® 625 (Low Iron) alloy	0	0	0	2*	2	1	3*	0	0
HAYNES® 282® alloy	0	0	0	2*	4	3	3*	4	3
HAYNES® 242® alloy	0	0	0	2*	3	1	3*	0	0

As a solid article, all Haynes alloys are rated 0 for health, flammability, and reactivity. Metal dust may be created by grinding operations. Metal oxide fume may be created during welding, thermal cutting, or melting operations.

The flammability and reactivity hazard ratings are appropriate for large, concentrated quantities of welding fume, such as those found in a dust collector.

Summary of Hazardous Material Information System (HMIS) rating numbers:
H = Health Hazard rating; 0 = minimal hazard; 1 = slight hazard; 2 = moderate hazard; 3 = serious hazard; 4 = severe hazard
F = Flammability hazard rating: 0 = minimal hazard; 1 = slight hazard; 2 = moderate hazard; 3 = serious hazard; 4 = severe hazard
R = Reactivity hazard rating: 0 = minimal hazard; 1 = slight hazard; 2 = moderate hazard; 3 = serious hazard; 4 = severe hazard

2. HAZARDS IDENTIFICATION THE HEALTH HAZARDS INFORMATION GIVEN IN SDS HW-7031 FOR WELDING PRODUCTS AND THERMAL SPRAY WIRE ALSO APPLY.

 **WARNING** ACUTE HEALTH EFFECTS AND ROUTE(S) OF EXPOSURE	INHALATION: Inhalation of metal dust, fume, or powder may result from melting, dross handling, casting, welding, thermal cutting, grinding, crushing, or similar operations which generate airborne metal particulate during use of these materials. Inhaled particulate may irritate the respiratory tract. Excessive inhalation of aluminum, cobalt, copper, manganese, nickel, and zinc can cause respiratory irritation, cough, bronchitis, chills, "metal fume fever," and asthma-like symptoms. Welding, melting, thermal cutting all products in Section 1; Warning: causes skin irritation, Category 2.
	INGESTION: Hand, clothing, food, and drink contact with metal dust, fume, or powder can cause ingestion of particulate during hand to mouth activities such as drinking, smoking, nail biting, etc. Ingestion of large doses may cause nausea, vomiting, and diarrhea. All products in Section 1 except: HYBRID-BC1, C-86, D-205-, G-35-, N-, 601-, 690-, 242-, 75-, 625-, 718-, X-750-, 625SQ-, and 625(Low Iron)-alloy: Warning, Harmful if swallowed, acute toxicity Category 4.
	SKIN: Skin contact with the dust or fume form of these materials may cause irritation and in some sensitive individuals an allergic dermatitis when elements such as chromium, cobalt, copper, and nickel are present. All products in Section 1: Warning, May cause allergic skin reaction, Category 1.
	EYES: Contact with particulate metal (dust, fume, or powder) may inflame the conjunctiva. Airborne particulate (chips, dust, or powder) is always a potential problem as well as inserting fingers into the eye socket if the hand or clothing is contaminated with metal particulate.
 **DANGER** CHRONIC HEALTH EFFECTS OF OVEREXPOSURE	Respiratory disease with symptoms ranging from shortness of breath and cough to permanent disability due to loss of lung function; sensitization or hypersensitivity and fibrosis or subsequent effects on the heart may be caused by excessive exposure to dust or fumes containing cobalt, nickel, titanium, and tungsten. Central nervous system depression has been identified with excessive manganese exposure. Insoluble nickel compounds and hexavalent chromium compounds have been linked to nasal, bronchial, and lung cancers. Aluminum and iron have been indicated to cause gastro-intestinal disorders and non-significant changes in the lung. Chronic health effects specific to an element(s) may be difficult to detect due to the numerous elemental constituents in these alloys. Melting, welding, thermal cutting all products in Section1: Danger, May cause cancer, Category 1A, Grinding, sawing, all products in Section 1: Danger: May cause allergy or asthma symptoms or breathing difficulties if inhaled, Category 1.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE	Individuals who may have had an allergic reaction or sensitivity to metals such as chromium, copper, cobalt, and nickel may encounter skin rash or dermatitis if skin contact with this product occurs. Persons with impaired pulmonary function, airway diseases and conditions such as asthma, emphysema, chronic bronchitis, etc., may incur further disability if excessive concentrations of dust or fume are inhaled. If prior damage or disease to the Neurologic (nervous), Circulatory, Hematologic (blood) or Renal (kidney) systems has occurred, proper screening or examinations should be conducted on individuals who may be exposed to further risk if handling and use of these materials cause excessive exposure.

3. COMPOSITION/INFORMATION ON INGREDIENTS

NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES METAL NUMBER, IF APPLICABLE, SHOWN IN PARENTHESIS) CAS NUMBER
NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES MEAL NUMBER; IF APPLICABLE.

Constituent(s)	B-2 Alloy N10665	B-3® Alloy N10675	C-22® Alloy N06022	C-22HS® Alloy N07022	C-86 Alloy N06686	C-276 Alloy N10276	C-4 Alloy N06455	C-2000® Alloy N06200	HYBRID-BC1® Alloy (2362)	CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m³) [2] OSHA PEL [3]	EXPOSURE LIMITS (as Mg/m³) [2] ACGIH TLV®-TWA [4]
Aluminum (Al)*	-	0.5 Max	-	0.5 Max	0.5 max	-	-	0.5 Max	0.5 Max	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [5]	Oxide Fume, as Al: 10
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	-	-	-	see Al & Ti	See Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	-	-	-	0.005 Max	-	-	-	-	-	7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10
Columbium (Cb) Niobium (Nb)	-	0.2 Max	-	-	-	-	-	-	-	7440-03-1	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	-		-	-	-	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	1 Max	3 Max	2.5 Max	1 Max	-	2.5 Max	2 Max	2 Max	-	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02
Chromium (Cr)*	<1	1.5	22	21	21	16	16	23	15	7440-47-3	GB4200000	Metal and Insoluble Salts, as Cr: 1 (II & III) Compounds, as Cr: 0.5 Cr, VI compounds, as Cr: 0.005	Metal and Cr: III compounds, as Cr: 0.5 Water-Soluble Cr VI compounds as Cr: 0.05 Insoluble Cr VI compounds, as Cr: 0.01
Copper (Cu)*	0.5 Max	0.2 Max	0.5 Max	0.5 Max	-	0.5 Max	0.5 Max	1.6	-	7440-50-8	GL5325000	Dust & Mists, as Cu: 1 Fume, as Cu: 0.1	Dust & Mists, as Cu: 1 Fume: 0.2
Iron (Fe)	2 Max	1.5	3	2 Max	2 max	5	3 Max	3 Max	2 Max	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5
Lanthanum (La)	-	-	-	-	-	-	-	-	-	7439-91-0	None	None	None
Manganese (Mn)*	<1	3 Max	0.5 Max	0.8 Max	0.75 max	1 Max	1 Max	0.5 Max	0.25	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.2
Molybdenum (Mo)	28	28.5	13	17	16	16	16	16	22	7439-98-7	QA4680000	Soluble Compounds and Total Dusts, as Mo: 5	Metal and Insoluble Compounds, as Mo: 10 [3, 6] Soluble Compounds, as Mo: 0.5 [6]
Nickel (Ni)*	69	65 Min	56	61	55	57	65	59	62	7440-02-0	QR5950000	Metal, Soluble & Insoluble Compounds, as Ni: 1	Metal, Inhalable: 1.5 [5] Insoluble Compounds: as Ni 0.2 [5] Soluble Compounds: as Ni 0.1 [5]
Silicon (Si)	0.1 Max	0.1 Max	0.08 Max	0.08 Max	0.09 max	0.08 Max	0.08 Max	0.08 Max	0.08 Max	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [5]	None
Tantalum (Ta)	-	0.2 Max	-	-	-	-	-	-	-	7440-25-7		Metal & Oxide Dust: 5	Metal & Oxide Dust, as Ta: 5
Titanium (Ti)	-	0.2 Max	-	-	0.14	-	0.7 Max	-	-	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10
Tungsten (W)	0.5 Max	3 Max	3	1 Max	-	4	-	-	-	7440-33-7	Y07175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]
Vanadium (V)	-	0.2 Max	0.35 Max	-	-	0.35 Max	-	-	-	7440-62-2	YW1355000	Respirable [5] Dust, as V_2O_5: 0.5 Ceiling Fume, as V_2O_5: 0.1 Ceiling	Respirable Dust & Fume, as V_2O_5: 0.05 [5]
Yttrium (Y)	-	-	-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1
Zirconium (Zr)	-	0.01 Max	-	-	-	-	-	-	-	7440-67-7	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]
Density (lb/cu in)	0.333	0.333	0.314	0.311	0.315	0.321	0.312	0.307	0.319			See Section 16 for Footnotes	
Melting Point (° F)	~2425	~2500	~2480	~2450	~2478	~2375	~2445	~2400	~2450				

3. COMPOSITION/INFORMATION ON INGREDIENTS

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NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES MEAL NUMBER, IF APPLICABLE

Constituent(s)	D-205® Alloy (2916)	G-30® Alloy N06030	G-50® Alloy N06950	G-3 Alloy N06985	G-35® Alloy N06035	N Alloy N10003	ULTIMET® Alloy R31233	600 Alloy N06600	601 Alloy N06601	CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m³) [2] OSHA PEL [3]	EXPOSURE LIMITS (as Mg/m³) [2] ACGIH TLV®-TWA [4]
Aluminum (Al)*	-	-	0.4 Max	-	0.4 Max	-	-	0.35 Max	1.4	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 10
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	0.5 Max	-	-	-	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	-	-	-	-	-	-	-	-	-	7440-42-8	ED7350000	Metal: None Oxide Dust Total: 15	Metal: None Oxide Dust Total: 10
Columbium (Cb) Niobium (Nb)	-	0.8	0.5 Max	0.5 Max	-	-	-	-	-	7440-03-1	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	0.5 Max	-	-	-	-	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	-	5 Max	2.5 Max	5 Max	<1	0.2 Max	54	2 Max	-	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02
Chromium (Cr)*	20	30	20	22	33.2	7	26	15.5	23	7440-47-3	GB4200000	Metal and Insoluble Salts, as Cr: 1 (II & III) Compounds, as Cr: 0.5 Cr. VI Compounds, as Cr: 0.005	Metal and Cr III Compounds, as Cr: 0.5 Water-Soluble Cr VI Compounds as Cr: 0.05 Insoluble Cr VI Compounds, as Cr: 0.01
Copper (Cu)*	2	2 Max	0.5 Max	2	0.3 Max	0.35 Max	-	0.5 Max	1 Max	7440-50-8	GL5325000	Dust & Mists, as Cu: 1; Fume, as Cu: 0.1	Dust & Mists, as Cu: 1; Fume: 0.2
Iron (Fe)	8	15	17	19.5	2 Max	4 Max	3	8	12	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5
Lanthanum (La)	-	-	-	-	-	-	-	-	-	7439-91-0	None	None	None
Manganese (Mn)*	-	1.5 Max	<1	<1	0.5 Max	0.8 Max	0.8	<1	1 Max	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.2
Molybdenum (Mo)	2.5	5.5	9	7	8.1	16	5	-	-	7439-98-7	QA4680000	Soluble Compounds and Total Dusts, as Mo: 5	Metal and Insoluble Compounds, as Mo: 10 [5], 3 [6] Soluble Compounds, as Mo: 0.5 [6]
Nickel (Ni)*	55	43	50 min	44	58	71	9	72 Min	61	7440-02-0	QR5950000	Metal, Soluble & Insoluble Compounds, as Ni: 1	Metal, Inhalable: 1.5 [5] Insoluble Compounds: as Ni 0.2 [5] Soluble Compounds: as Ni 0.1 [5]
Silicon (Si)	5	0.8 Max	<1	<1	0.6 Max	<1	0.3	0.5 Max	0.5 Max	7440-21-3	VW0400000	Total Dust: 15 Respirable Dust: 5 [6]	None
Tantalum (Ta)	-	-	-	-	-	-	-	0.3 Max	-	7440-25-7		Metal & Oxide Dust: 5	Metal & Oxide Dust, as Ta: 5
Titanium (Ti)	-	-	-	-	-	0.5	-	-	-	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10
Tungsten (W)	-	2.5	<1	1.5 Max	0.6 Max	0.5 Max	2	-	-	7440-33-7	Y07175000	None	Insoluble Compounds, as W: 5 (STEL: 10) Soluble Compounds, as W: 1 (STEL: 3)
Vanadium (V)	-	-	-	-	0.5 Max	0.5 Max	-	-	-	7440-62-2		Respirable [6] Dust, as V_2O_5: 0.5 Ceiling Fume, as V_2O_5: 0.1 Ceiling	Respirable Dust & Fume, as V_2O_5: 0.05 [6]
Ytrium (Y)	-	-	-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1
Zirconium (Zr)	-	-	-	-	-	-	-	-	-	7440-67-7	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]
Density (lb/cu in)	0.288	0.297	0.301	0.300	0.297	0.320	0.306	0.304	0.291			See Section 16 for Footnotes.	
Melting Point (° F)	~2100	~2370	~2325	~2375	~2400	~2375	~2430	~2470	~2370				

3. COMPOSITION/INFORMATION ON INGREDIENTS

NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES METAL NUMBER, IF APPLICABLE, SHOWN IN PARENTHESIS) CAS NUMBER
NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES MEAL NUMBER, IF APPLICABLE

Constituent(s)	690 Alloy N06690	S Alloy N06635	X Alloy N06002	W Alloy N10004	HR-120® Alloy N08120	HR-160® Alloy N12160	214® Alloy N07214	230® Alloy N06230	242® Alloy (8422)	CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m³) [2] OSHA PEL [3]	EXPOSURE LIMITS (as Mg/m³) [2] ACGIH TLV®-TWA [4]
Aluminum (Al)*	-	0.25	0.5 Max	-	0.1	0.4 Max	4.5	0.3	0.5 Max	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [5]	OXIDE Fume, as Al: 10
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	-	-	-	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	-	0.015 Max	0.008 Max	-	0.004	-	0.01 Max	0.015 Max	0.005 Max	7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10
Columbium (Cb) Niobium (Nb)	-	-	0.5 Max	-	0.7	<1	0.15 Max	0.5 Max	-	7440-03-1	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	-	-	-	-	-	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	-	2 Max	1.5	2.5 Max	3 Max	29	2 Max	5 Max	<1	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02
Chromium (Cr)*	29	16	22	5	25	28	16	22	8	7440-47-3	GB4200000	Metal and Insoluble Salts, as Cr: 1 (II & III) Compounds, as Cr: 0.5 Cr VI Compounds, as Cr: 0.005	Metal and Cr: III Compounds, as Cr: 0.5 Water-Soluble Cr VI Compounds as Cr: 0.05 Insoluble Cr VI Compounds, as Cr: 0.01
Copper (Cu)*	0.5 Max	0.35 Max	0.5 Max	0.5 Max	0.5 Max	0.5 Max	-	0.5 Max	0.5 Max	7440-50-8	GL5325000	Dust & Mists, as Cu: 1 Fume, as Cu: 0.1	Dust & Mists, as Cu: 1 Fume: 0.2
Iron (Fe)	9	3 Max	18	6	33	2 Max	3	3 Max	2 Max	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5
Lanthanum (La)	-	0.02	-	-	-	-	-	0.02	-	7439-91-0	None	None	None
Manganese (Mn)*	0.5 Max	0.5	<1	<1	0.7	0.5	0.5 Max	0.5	0.8 Max	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.2
Molybdenum (Mo)	-	15	9	24	<1	<1	0.5 Max	2	25	7439-98-7	QA4680000	Soluble Compounds and Total Dusts, as Mo: 5	Metal and Insoluble Compounds, as Mo: 3 [6], 10 [5] Soluble Compounds, as Mo: 0.5 [6]
Nickel (Ni)*	58 Min	67	47	63	37	37	75	57	65	7440-02-0	QR5950000	Metal, Soluble & Insoluble Compounds, as Ni: 1	Metal, Inhalable: 1.5 [5] Insoluble Compounds: as Ni 0.2[6] Soluble Compounds: as Ni 0.1[5]
Silicon (Si)	0.5 Max	0.4	<1	<1	0.6	2.75	0.2 Max	0.4	0.6 Max	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [5]	None
Tantalum (Ta)	-	-	-	-	-	-	-	-	-	7440-25-7		Metal & Oxide Dust: 5	Metal & Oxide Dust, as Ta: 5
Titanium (Ti)	-	-	0.15 Max	-	0.2 Max	0.5	0.5 Max	0.1 Max	-	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10
Tungsten (W)	-	<1	0.6	<1	0.5 Max	<1	0.5 Max	14	-	7440-33-7	Y07175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]
Vanadium (V)	-	-	-	0.6 Max	-	-	-	-	-	7440-62-2	YW1355000	Respirable [5] Dust, as V_2O_5: 0.5 Ceiling Fume, as V_2O_5: 0.1 Ceiling	Respirable Dust & Fume, as V_2O_5: 0.05 [6]
Yttrium (Y)	-	-	-	-	-	-	0.01	-	-	7440-65-5		1	Metal and Compounds, as Y: 1
Zirconium (Zr)	-	-	-	-	-	-	0.1 Max	-	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]
Density (lb/cu in)	0.296	0.316	0.297	0.325	0.291	0.292	0.291	0.324	0.327			See Section 16 for Footnotes.	
Melting Point (°F)	~2450	~2435	~2300	~2350	~2375	~2360	~2475	~2375	~2350				

3. COMPOSITION/INFORMATION ON INGREDIENTS

NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES METAL NUMBER, IF APPLICABLE, SHOWN IN PARENTHESIS) CAS NUMBER

Constituent(s)	244® Alloy (2444)	556® Alloy R30556	25 Alloy R30605	75 Alloy (2076)	188 Alloy R30188	NS-163® Alloy (1630)	263 Alloy N07263	625 Alloy N06625	CAS NUMBER	NIOSH RTECS NUMBER	EXPOSURE LIMITS (as Mg/m³) [2] OSHA PEL [3]	EXPOSURE LIMITS (as Mg/m³) [2] ACGIH TLV®-TWA [4]
Aluminum (Al)*	0.5 Max	0.2	-	0.4 Max	-	0.5 Max	0.6 Max	0.4 Max	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 10
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	2.6	-	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	0.005 Max	0.02	-	-	0.015	0.015 Max	0.005 Max	-	7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10
Columbium (Cb) Niobium (Nb)	-	0.3 Max	-	-	-	1	-		7440-03-1	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	-	-	-	-	3.7	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	1 Max	18	51	-	39	40	20	<1	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02
Chromium (Cr)*	8	22	20	20	22	28	20	21	7440-47-3	GB4200000	Metal and Insoluble Salts, as Cr: 1 (II & III) Compounds, as Cr: 0.5 Cr VI Compounds, as Cr, 0.005	Metal and Cr III Compounds, as Cr: 0.5 Water-Soluble Cr VI Compounds as Cr: 0.05 Insoluble Cr VI Compounds, as Cr: 0.01
Copper (Cu)*	0.5 Max	-	-	0.5 Max	-	-	0.2 Max	0.5 Max	7440-50-8	GL5325000	Dust & Mists, as Cu: 1 Fume, as Cu: 0.1	Dust & Mists, as Cu: 1 Fume: 0.2
Iron (Fe)	2 Max	31	3 Max	5 Max	3 Max	21	0.7 Max	5 Max	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5
Lanthanum (La)	-	0.02	-	-	0.03	-	-	-	7439-91-0	None	None	None
Manganese (Mn)*	0.8 Max	<1	1.5	<1	1.25 Max	0.5 Max	0.4	0.5 Max	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.2
Molybdenum (Mo)	22.5	3	<1	-	-	-	6	9	7439-98-7	QA4680000	Soluble Compounds and Total Dusts, as Mo: 5	Insoluble Compounds, as Mo: 3 [5], 10 [6] Soluble Compounds, as Mo: 0.5 [6]
Nickel (Ni)*	60	20	10	76	22	8	52	62	7440-02-0	QR5850000	Metal, Soluble & Insoluble Compounds, as Ni: 1	Metal, Inhalable: 1.5 [5] Insoluble Compounds: as Ni 0.2 [6] Soluble Compounds: as Ni 0.1 [6]
Silicon (Si)	0.1 Max	0.4	0.4 Max	<1	0.35	0.5 Max	0.2	0.5 Max	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None
Tantalum (Ta)	-	0.6	-	-	-	-	-		7440-25-7		Metal & Oxide Dust: 5	Metal & Oxide Dust, as Ta: 5
Titanium (Ti)	-	-	-	0.4	-	1.3	2.4 Max	0.4 Max	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10
Tungsten (W)	6	2.5	15	-	14	-	-	-	7440-33-7	Y0715000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]
Vanadium (V)	-	-	-	-	-	-	-	-	7440-62-2	YW1355000	Respirable Dust as V_2O_5: 0.5 [6] Ceiling Fume, as V_2O_5: 0.1 Ceiling	Respirable Dust & Fume, as V_2O_5: 0.05 [6]
Yttrium (Y)		-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1
Zirconium (Zr)	-	0.02	-	-	-	-	0.04 Max	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]
Density (lb/cu in)	0.337	0.297	0.330	0.302	0.324	0.305?	0.302	0.305			See Section 16 for Footnotes.	
Melting Point (° F)	~2480	~2425	~2425	~2445	~2400	~2350	~2370	~2350				

3. COMPOSITION/INFORMATION ON INGREDIENTS

NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES METAL NUMBER, IF APPLICABLE, SHOWN IN PAREN-THESIS) CAS NUMBER NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES MEAL NUMBER, IF APPLICABLE.

Constituent(s)	718 Alloy N07718	R-41 Alloy N07041	X-750 Alloy N07750	6-B Alloy R30006	80A Alloy N07080	B Alloy N10001	Waspaloy Alloy N07001	MULTIMET® Alloy R30155	282® Alloy (2082)	CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m³) [2] OSHA PEL [3]	EXPOSURE LIMITS (as Mg/m³) [2] ACGIH TLV®-TWA [4]
Aluminum (Al)*	0.5	1.5	0.8	-	1.5	-	1.5	-	1.5	7429-90-5	BD0330000	Total Dust, as Al: 15,; Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 10
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	-	-	-	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	0.004	0.006	-	-	0.008 Max	-	0.006	-	0.005	7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10
Columbium (Cb) Niobium (Nb)		-		-	-	-	-	-	0.2 Max	7440-03-1	None	None	None
Columbium (Cb) +Tantalum (Ta)	5	-	<1	-	-	-	-	<1	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	<1	11	<1	58	2 Max	2.5 Max	13.5	20	10	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02
Chromium (Cr)*	18	19	16	30	19.5	<1	19	21	19	7440-47-3	GB4200000	Metal and Insoluble Salts, as Cr: 1 (II & III) Compounds, as Cr: 0.5 Cr VI Compounds, as Cr, 0.005	Metal and Cr: III Compounds, as Cr: 0.5 Water-Soluble Cr VI Compounds as Cr: 0.05 Insoluble Cr VI Compounds, as Cr: 0.01
Copper (Cu)*	0.1 Max	-	0.5 Max	-	0.2 Max	0.15 Max	0.1 Max	0.5 Max	0.1 Max	7440-50-8	GL5325000	Dust & Mists, as Cu: 1; Fume, as Cu: 0.1	Dust & Mists, as Cu: 1; Fume: 0.2
Iron (Fe)	19	5 Max	8	3 Max	1.5 Max	5	2 Max	30	1.5 Max	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5
Lanthanum (La)	-	-	-	-	-	-	-	-	-	7439-91-0	None	None	None
Manganese (Mn)*	0.35 Max	0.1 Max	0.35 Max	1.4	0.4 Max	<1	0.1 Max	1.5	0.3 Max	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.2
Molybdenum (Mo)	3	10	-	1.5 Max	-	28	4.3	3	8.5	7439-98-7	QA4680000	Soluble Compounds and Total Dusts, as Mo: 5	Metal and Insoluble Compounds, as Mo:3 [5]; 10 [5] Soluble Compounds, as Mo: 0.5 [5]
Nickel (Ni)*	52	52	70 Min	2.5	74	67	58	20	58	7440-02-0	QR5950000	Metal, Soluble & Insoluble Compounds, as Ni: 1	Metal, Inhalable: 1.5 [5] Insoluble Compounds: as Ni 0.2 [5] Soluble Compounds: as Ni 0.1[5]
Silicon (Si)	0.35 Max	0.5 Max	0.35 Max	0.7	0.8 Max	<1	0.15 Max	<1	0.15 Max	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None
Tantalum (Ta)		-		-	-	-	-	-	0.1 Max	7440-25-7		Metal & Oxide Dust: 5	Metal & Oxide Dust, as Ta: 5
Titanium (Ti)	0.9	3.1	2.5	-	2.4	-	3	-	2.1	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10
Tungsten (W)	-	-	-	4	-	-	-	2.5	0.5 Max	7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]
Vanadium (V)	-	-	-	-	-	0.3	-	-	-	7440-62-2	YW1355000	Respirable Dust, as V_2O_5: 0.5 [6] Ceiling Fume, as V_2O_5: 0.1 Ceiling	Respirable Dust & Fume, as V_2O_5: 0.05 [6]
Yttrium (Y)	-	-	-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1
Zirconium (Zr)	-	0.07 Max	-	-	-	-	0.05	-	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]
Density (lb/cu in)	0.297	0.298	0.298	0.303	0.295	0.334	0.296	0.296	0.299			See Section 16 for Footnotes.	
Melting Point (° F)	~2300	~2385	~2540	~2310	~2480	~2375	~2425	~2350	~2370				

3. COMPOSITION/INFORMATION ON INGREDIENTS

NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES METAL NUMBER, IF APPLICABLE, SHOWN IN PARENTHESIS) CAS NUMBER NOMINAL PERCENT OF ELEMENTAL CONSTITUENTS FOR THE ALLOYS SHOWN (HAYNES MEAL NUMBER, IF APPLICABLE,

Constituent(s)	617 Alloy N06617	625SQ® Alloy N06626	GTD 222 Alloy (2220)	625 (Low Iron) Alloy (2653)	HR-224® Alloy (2224)	HR-235™ Alloy (2431)			CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m³) [2] OSHA PEL [3]	EXPOSURE LIMITS (as Mg/m³) [2] ACGIH TLV®-TWA [4]
Aluminum (Al)*	1.2	0.4 Max	1.3	0.4 Max.	3.8	0.3			7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 10
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-			see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	0.006 Max	-	0.004	-	0.004 Max	-			7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10
Columbium (Cb) Niobium (Nb)	0.08	3.6	0.8	-	0.15 Max	-			7440-03-1	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	3.7		-			see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	12.5	<1	19	<1	2 Max	1.1 Max			7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02
Chromium (Cr)*	22	21.5	22.5	21	20	31			7440-47-3	GB4200000	Metal and Insoluble Salts, as Cr: 1 (II & III) Compounds, as Cr: 0.5 Cr VI Compounds, as Cr: 0.005	Metal and Cr III Compounds, as Cr: 0.5 Water-Soluble Cr VI Compounds as Cr: 0.05 Insoluble Cr VI Compounds, as Cr: 0.01
Copper (Cu)*	0.5 Max	0.5 Max	0.1 Max	0.5 Max.		3.6			7440-50-8	GL5325000	Dust & Mists, as Cu: 1; Fume, as Cu: 0.1	Dust & Mists, as Cu: 1; Fume: 0.2
Iron (Fe)	2 Max	5 Max	<1	0.75 Max.	27.5	1.5 Max			7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5
Lanthanum (La)	-	-	-	-	0.01 Max	-			7439-91-0	None	None	None
Manganese (Mn)*	0.5 Max	0.5 Max	0.1 Max	0.5 Max.	0.5 Max	0.5			7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.2
Molybdenum (Mo)	9	9	<1	9	0.5 Max	5.6			7439-98-7	QA4680000	Soluble Compounds and Total Dusts, as Mo: 5	Metal and Insoluble Compounds, as Mo: 3 [5]; 10 [5] Soluble Compounds, as Mo: 0.5 [5]
Nickel (Ni)*	52	62	50	62	47	57			7440-02-0	QR5950000	Metal, Soluble & Insoluble Compounds, as Ni: 1	Metal, Inhalable: 1.5 [5] Insoluble Compounds: as Ni 0.2 [5] Soluble Compounds: as Ni 0.1 [5]
Silicon (Si)	1.2 Max	0.15 Max	0.25 Max	0.5 Max.	0.3	0.4			7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None
Tantalum (Ta)	-	0.05 Max	1	-		-			7440-25-7		Metal & Oxide Dust: 5	Metal & Oxide Dust, as Ta: 5
Titanium (Ti)	0.3	0.4 Max	2.3	0.4 Max.	0.3	-			7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10
Tungsten (W)	-	-	2	-	0.5 Max	-			7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]
Vanadium (V)	-	-	-	-		-			7440-62-2	YW1355000	Respirable Dust, as V_2O_5: 0.5 [5] Ceiling Fume, as V_2O_5: 0.1 Ceiling	Respirable Dust & Fume, as V_2O_5: 0.05
Yttrium (Y)	-	-	-	-		-			7440-65-5		1	Metal and Compounds, as Y: 1
Zirconium (Zr)	-	-	-	-	0.025 Max	-			7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]
Density (lb/cu in)	0.302	0.305	0.298	0.305	0.280	0.298					See Section 16 for Footnotes.	
Melting Point (° F)	~2430	~2350	~2430	~2350	~2480	~2370						

* Reportable ingredients per Section 313 of SARA. (See Section 15 of this SDS)

4. FIRST AID MEASURES	
INHALATION	Breathing difficulty caused by inhalation of dust or fume requires removal to fresh air. If breathing has stopped, perform artificial respiration and obtain medical assistance at once.
INGESTION	Never give anything by mouth to an unconscious person. Contact a poison control center. Unless the poison control center advises otherwise, have that conscious person drink 1 to 2 glasses of water to dilute. Inducement of vomiting is not necessary unless large amounts are ingested. Obtain medical assistance at once.
SKIN	Skin cuts and abrasions can be treated by standard first aid. Quickly remove contaminated clothing but do not shake clothing. Skin contamination with dust or powder can be removed by washing with soap and water. If irritation or reddened, blistered skin occurs, obtain medical assistance. Launder clothing before re-use.
EYES	Do not allow victim to rub or keep eyes tightly shut. Dust or powder should be flushed from the eyes with copious amounts of clean water for at least 15 minutes. If irritation persists, obtain medical assistance.

5. FIRE FIGHTING MEASURES		
FLASH POINT (WITH TEST METHOD) None	FLAMMABLE (EXPLOSIVE) LIMITS V/V% LEL: None	UEL: None
EXTINGUISHING MEDIA	The solid wrought forms of these alloys are noncombustible, therefore; use extinguishing media appropriate to the surrounding fire.	
SPECIAL FIREFIGHTING PROCEDURES	To extinguish a metal powder fire, use dry sand, dry graphite or other class "D" fire extinguishing powder. Do NOT use water, carbon dioxide, or halogenated fire extinguishing agents.	
UNUSUAL FIRE AND EXPLOSION HAZARDS	No unusual fire or explosion hazards from alloys in solid wrought form. Dust created by grinding or similar processes can ignite only if a substantial number of small particles are dispersed in an enclosed space, such as a dust collector.	
HAZARDOUS COMBUSTION PRODUCTS	Various metal oxides, carbon dioxide, carbon monoxide.	

6. ACCIDENTAL MATERIAL RELEASE OR SPILL CONTROL MEASURES
In solid form this material poses no special clean-up problems. If this material is in powder or dust form, do not dry sweep. Notify safety personnel. Clean-up should be conducted with a vacuum system utilizing a high efficiency particulate air (HEPA) filtration system. Caution should be taken to minimize airborne generation of powder or dust and avoid contamination of air and water. Cleanup personnel should protect against dust inhalation and skin or eye contact. Use non-sparking tools. Properly label all materials collected in waste container. Follow applicable OSHA regulations (29 CFR 1910.120). (Emergency Response), Canadian Workplace Hazardous Materials Information System (HMIS) Regulations, or other regulatory requirements.

7. HANDLING AND STORAGE	
HANDLING PRECAUTIONS	This product must be handled according to the size, shape and quantity of material involved. Dust or powder forms of these products should be moved or transported to minimize spill or release potential. Avoid dust inhalation and eye or skin contact. Wear personal protective equipment to prevent contact with skin and eyes (Section 8). Practice good housekeeping techniques that minimize accumulation of dust. Practice good personal hygiene after handling dust or powder forms of this material, especially before eating, drinking, smoking, or applying cosmetics.
STORAGE PRECAUTIONS	In solid form this material poses no special problems. Store metal powder in a dry area away from heat, ignition sources, and incompatibles (Section 10).

8. EXPOSURE CONTROLS/PERSONAL PROTECTION	THE INDUSTRIAL HYGIENE CONTROL MEASURES GIVEN IN SDS HW-7031 FOR WELDING PRODUCTS AND THERMAL SPRAY WIRE ALSO APPLY
VENTILATION	Local exhaust ventilation should be used to control exposure to airborne dust and fume emissions near the source (during crushing, grinding, welding, etc.) below the exposure limits cited in Section 3.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION (continued)	
RESPIRATORY PROTECTION	Use NIOSH approved respirators as specified by an Industrial Hygienist or qualified Safety Professional. Lung function tests are recommended for users of negative pressure devices. Use a fume respirator or an air supplied respirator where local exhaust or ventilation does not keep exposure below the exposure limits for air contamination.
EYE PROTECTION	Wear safety glasses when risk of eye injury is present particularly during machining, grinding, welding, powder handling, etc. Contact lenses should not be worn if working with metal dusts and powders.
SKIN PROTECTION	Wear gloves to prevent metal cuts and skin abrasions particularly during handling of wrought forms, solid metal sheet, strip, or tube. Protective clothing such as uniforms, disposable coveralls, safety shoes, etc., may be required during metal handling operations as appropriate to the circumstances of exposure.
RECOMMENDED MONITORING PROCEDURES	ENVIRONMENTAL SURVEILLANCE: Exposure to the elements identified in Section 3 can be best determined by having air samples taken in the employee breathing zone, work area, or department. MEDICAL SURVEILLANCE: Lung function tests, identified in Section 2 can be determined by chest x-rays and routine physical examinations may be useful to determine effects of dust or fume exposure. Specific medical tests to be performed should be determined by a consulting physician.

9. PHYSICAL AND CHEMICAL PROPERTIES	
MELTING POINT: See Section 3	VAPOR PRESSURE (mmHg): Not Applicable
SUBLUMES @: Not Applicable	VAPOR DENSITY (AIR=1): Not Applicable
pH = Not Applicable	SPECIFIC GRAVITY (H2O=1): See Section 3
BOILING POINT: Not Applicable	SOLUBILITY IN WATER = None
EVAPORATION RATE: Not Applicable	% VOLATILES BY VOLUME: None
APPEARANCE AND COLOR: Solid - Silver Gray Color or No Color	

10. STABILITY AND REACTIVITY	
GENERAL REACTIVITY	These alloys are stable materials.
INCOMPATIBILITY (MATERIALS TO AVOID)	The corrosion-resistant alloys were designed for use in, and possess outstanding resistance to, mineral acids. To a lesser extent, the high temperature alloys also withstand these acids. Be aware, however, that if corrosion does occur, hydrogen might be evolved, causing a potentially explosive environment in confined, closed systems.
HAZARDOUS DECOMPOSITION PRODUCTS	Various elemental metals and metal oxides may be generated from welding, cutting, grinding, melting, or dross handling operations. Refer to Section 3 for permissible exposure limits. The permissible exposure limits given in SDS HW-7031 for Welding Products and Thermal Spray Wire also apply.
POSSIBILITY OF HAZARDOUS REACTIONS	Does not occur.

11. TOXICOLOGICAL INFORMATION		
TOXICITY DATA	Eye: Rabbit (cobalt) unknown amount produced severe reaction with abscess involving lens, ciliary body, vitreous humor and retina.	
	Skin: No data.	
	Ingestion:	Guinea Pig (nickel): LD_{Lo}: 5 mg/kg Mouse (boron): LD_{50}: 560 mg/kg Rat (cobalt): LD_{50}: 6,171 mg/kg Rabbit (cobalt)): LD_{50}: 750 mg/kg Human (copper): TD_{Lo}: 120 µg/kg, affects the gastrointestinal tract (nausea or vomiting). Human (chromium): LD_{Lo}: 71 mg/kg

11. TOXICOLOGICAL INFORMATION (continued)

TOXICITY DATA	Ingestion (cont.):	Rat (Iron): LD_{50}: 30,000 mg/kg Rat (manganese) LD_{50}: 9,000 mg/kg Rabbit (Silicon Dioxide): LD_{50}: >5,000 mg/kg Rat (Titanium): LD_{50}: >5,000 mg/kg
	Inhalation:	Rabbit (nickel): TC_{Lo}: 130 µg/m^3 35 weeks (intermittent) - 6 hours Human (chromium VI): TC_{Lo}: 110 µg/m^3 3 years (continuous) tumorigenic (carcinogenic per RTECS) Pig (cobalt): TC_{LO}: 100 µg/m^3/6 hours for 13 weeks (intermittent) Human (manganese): TC_{Lo}: 2300 µg/m^3 Rat (titanium): LC_{50}: >6,820 mg/ m^3
	Subchronic:	Rat (molybdenum) inhalation: 12-16 g/m^3/1 hour/30 days, resulted in slight growth depression, and thickening of the intra-alveolar septa, which contained connective tissue fibers.
	Other:	Dog (nickel) Intravenous: LD_{Lo}: 10 mg/kg Rat (chromium), Implant: TD_{Lo}: 1200 µg/kg intermittent over 6 weeks. Rat (cobalt) intramuscular: 126 mg/kg, tumorigenic at site of application. Rabbit (molybdenum) intra-tracheal: LD_{Lo}: 70 mg/kg produced focal fibrosis (pneumoconiosis).
	Nickel alloys and hexavalent chromium compounds are listed as carcinogens by IARC. Detailed information from these sources may be obtained from the following: IARC Monographs on the evaluation of carcinogenic risk of Chemicals to Man; and the NTP annual report on carcinogens, NTP Public Information Office, MD B204 Box 12233, Research Triangle Park, North Carolina 27709.	
	Welding Fumes - OSHA requires that welding fumes be considered as carcinogens because they are so classified by NIOSH.	
	Teratology:	Rat (nickel) oral: TDLo: 158 mg/kg Rat (molybdenum) oral: 5800 µg/kg given to female 30 weeks prior to mating and during days 1-20 of pregnancy caused specific musculoskeletal system development abnormalities.
	Reproduction:	Rat (molybdenum) oral: 6050 µg/kg given to female 35 weeks prior to mating produced pre-, and post-implantation mortality. Rat (cobalt) unspecified exposure route, 0.05 mg/kg continuous, administered throughout gestation to female was embryotoxic.
	Mutagenicity:	Hamster (chromium III) lung cell: 34 mg/L caused sister chromatid exchange. Human (cobalt) DNA damage: Human Leukocyte 3mg/L. Human (Chromium VI) DNA damage: Human Leukocyte 50µmol/L.

12. ECOLOGICAL INFORMATION

In solid form these alloys pose no special environmental problems. Metal powders or dusts may have significant impact on air and water quality. Airborne emissions, spills, and releases to the environment (discharge to streams, sewer systems, surface soil, etc.) should be controlled immediately.

Ecotoxicity: Few plants accumulate cobalt at greater than 100 ppm, the level at which severe phytoxicity would occur. The potential for bioaccumulation of Cobalt by both aquatic and terrestrial organisms is low with trophic transfer factors less than 1. There is little tendency for chromium III bioaccumulation along the food chain. Terrestrial plants can contain enough molybdenum to be toxic to animals but still grow normally.

Molybdenum; (fathead minnow), LC_{50}: 370 mg/L/96 hours. Terrestrial plants can contain enough molybdenum to be toxic to animals but still grow normally.

Environmental Fate: In water, cobalt is adsorbed greatly to hydrolysate or oxidate sediments. It may be taken into solution in small amounts through bacteriological activity. In water, molybdenum will precipitate out with natural calcium. In water, chromium III oxide is expected to eventually precipitate to sediments. In air, chromium III oxide is primarily removed by fallout and precipitation. Soils with a high chromium content (>0.2%) are expected to be infertile. The half-life of chromium in soils may be several years. Manganese undergoes complex geochemical cycling, and can accumulate in the top layer of sediment in lakes. In water, molybdenum will precipitate out with natural calcium. Soil levels should not exceed 50 ppm to avoid problems with livestock.

13. DISPOSAL CONSIDERATIONS

Whenever possible, recover alloys for reuse or recycling. If necessary, dispose of waste material in accordance with local, state, or federal regulations. For specific labeling, packing, storage, transportation, and disposal procedures, contact an Environmental Engineer or consultant familiar with waste disposal regulations.

14. TRANSPORT INFORMATION

As a wrought product, these alloys are not regulated by the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA).

The following information should be used by individuals with "Function-specific Training" required by U.S. Department of Transportation 49 CFR 172.704, and Dangerous Goods Regulations published by the International Air Transport Association (IATA).

SHIPPING NAME	If alloy dust or powder is created, it may be a flammable solid or spontaneously combustible material (DOT hazard class 4.1 and 4.2, respectively). A sample of metal powder should be tested according to the U.N. manual of tests and criteria. See 49 CFR 173.124 (a) and (b).
IDENTIFICATION NUMBER	Not Available (Determine by test results)
HAZARD CLASS	Not Available (Determine by test results)
LABEL(S) REQUIRED	Not Available (Determine by test results)

15. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS

OSHA: Listed as air contaminants (29 CFR 1910.1000). Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

TSCA (Toxic Substance Control Act): Components of this material are listed on the TSCA inventory.

CERCLA: Hazardous Substance (40 CFR 302.4): Chromium, Copper, Nickel
Extremely Hazardous Substance (40 CFR 355): Not Listed

SARA HAZARD CATEGORY: Listed below are the hazard categories for Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III):

Immediate Hazard:	X
Delayed Hazard:	X
Fire Hazard:	-
Pressure Hazard:	-
Reactivity Hazard:	-

Chemicals subject to the reporting requirements of Section 313 or Title III of SARA and 40 CFR Part 372: Aluminum (as a fume or dust), chromium, cobalt, copper, manganese, nickel.

STATE REGULATIONS

California's "Safe Drinking Water and Toxic Enforcement Act of 1986" (Proposition 65)

During welding, thermal cutting and melting these products may produce cobalt oxide, nickel compounds, and hexavalent chromium compounds which are known to the State of California to cause cancer. State of California, Health and Welfare Agency, 1600 Ninth Street, Room 450, Sacramento, CA 95914, Telephone (961) 455-6955.

Pennsylvania Worker and Community Right to Know: Aluminum, Chromium, and Vanadium (fume or dust) are designated environmental hazards on the Hazardous Substance List. Title 34, Part XIII, Chapter 323.

INTERNATIONAL REGULATIONS

Labeling in Accordance with the GHS

The following hazard classification and risk phrases required by the GHS apply only to welding fumes and particulate created by these products.

All products in Section 1 in the form of welding fume: Danger, May cause cancer by inhalation, Category 1A.

All products in the form of dust: Danger: May cause allergy or asthma symptoms or breathing difficulties if inhaled, Category 1.

All products in Section 1 in the form of welding fume: Warning, May cause an allergic skin reaction, Category 1.

All products in Section 1 except: HYBRID-BC1, D-205-, G-35-, N-, 601-, 690-, 242-, 75-, 625-, 718-, X-750-, 625SQ-, and 625(Low Iron)-alloy: Warning, Harmful if swallowed, acute toxicity Category 4.
All products in Section 1 created by melting, welding, thermal cutting; Warning: causes skin irritation, Category 2.

Canada WHIMS These products have been classified in accordance with the hazard criteria of the CPR, and the SDS contains all of the information required by the CPR.

WHIMS Classification: D2B "Toxic Material"

16. OTHER INFORMATION

SDS STATUS

This SDS replaces the August 11, 2009 revision. Several sections were renamed to be consistent with the Globally Harmonized System (GHS) of Classification and Labeling of Chemicals, and Sections 2, 4, 5, 6, 7, 11, 14, 15, and 16 were revised.

The above information has been prepared by Shaw Environmental, Inc., under contract with Haynes International and is a compilation of information from various sources believed to be accurate. As the conditions or methods of use are beyond our control, we do not assume any responsibility and expressly disclaim any liability for any material described herein. Information contained herein is believed to be true and accurate, but all statements or suggestions are made without warranty, expressed or implied, regarding accuracy of the information, the hazards connected with the use of the material, or the results to be obtained from the use thereof. Compliance with all applicable Federal, State, and local laws and regulations remain the responsibility of the user.

1 NIOSH RTECS Number: The National Institute for Occupational Safety & Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS) Access number for a specific element or compound's toxicological data.

2 Mg/m^3 = milligrams per cubic meter. Many substances do not have a unique exposure limit. The absence of an exposure limit does not lessen consideration for exposure risk. In the absence of specific information, professional judgment may be required.

3 OSHA PEL: the Occupational Safety & Health Administration (OSHA) Permissible Exposure Limit (PEL) unless noted otherwise is an 8-hour time weighted average (TWA). Ceiling limits are listed for some materials that should not be exceeded at any time.

4 ACGIH TLV®: The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV®) - ACGIH also recommends a short term exposure limit (STEL) for certain substances (which are a 15-minute TWA) during the shift.

5 Inhalable fraction of particulate - see the ACGIH-TLV® booklet for a definition.

6 Respirable fraction of particulate - see the ACGIH-TLV® booklet for a definition.

LABEL INFORMATION

Corrosion-Resistant Alloys and High-Temperature Alloys

HASTELLOY® B-2-, HASTELLOY® B-3®-, HASTELLOY® HYBRID®-BC1-, HASTELLOY® C-4-, HASTELLOY® C-22®-, HASTELLOY® C-22®HS-, HASTELLOY® C-86-, HASTELLOY® C-276-, HASTELLOY® C-2000®-, HASTELLOY® D-205®-, HASTELLOY® G-3-, HASTELLOY® G-30®-, HASTELLOY® G-35®-, HASTELLOY® G-50®-, HASTELLOY® B-, HASTELLOY® N-, HASTELLOY® S-, HASTELLOY® W-, and HASTELLOY® X-alloy.

HAYNES® GTD222-, HAYNES® HR-120®-, HAYNES® HR-160®-, HAYNES® HR-224®-, HAYNES® NS-163®-, HAYNES® HR-235™-, HAYNES® Waspaloy-, HAYNES® X-750-, HAYNES® 6-B-, HAYNES® 25-, HAYNES® R-41-, HAYNES® 75-, HAYNES® 80A-, HAYNES® 188-, HAYNES® 214®, HAYNES® 230®-, HAYNES® 242®-, HAYNES® 244™-, HAYNES® 263-, HAYNES® 282®-, HAYNES® 556®-, HAYNES® 617-, HAYNES® 625-, HAYNES® 625(Low Iron)-alloy, and HAYNES® 600-, HAYNES® 601-, HAYNES® 625SQ®-, HAYNES® 690-, HAYNES® 718 alloy, MULTIMET® alloy, and ULTIMET® alloy.

The following hazard classification and risk phrases required by the Globally Harmonized System (GHS) apply **only** when these products create fume and particulate when subjected to melting, dross handling, casting, welding, thermal cutting, grinding, hot milling, crushing, or similar operations.

Danger, May cause cancer by inhalation, Category 1A;

Danger, May cause allergy or asthma symptoms or breathing difficulties if inhaled, Category 1.

Warning, May cause an allergic skin reaction, Category 1.

Warning, Causes skin irritation, Category 2.

Warning, Harmful if swallowed, acute toxicity Category 4. All products except: HAYNES® HYBRID-BC1 Alloy, D-205 Alloy, G-35 Alloy, N Alloy, 601 Alloy, 690 Alloy, 242 Alloy, 75 Alloy, 625 Alloy, 718 Alloy, X Alloy, 750 Alloy, 625SQ Alloy, and 625(Low Iron) Alloy.

DANGER

WARNING

First Aid: (The following instructions apply only to dust and fume forms of the product)

Inhalation: Breathing difficulty caused by inhalation of dust or fume requires removal to fresh air. If breathing has stopped, perform artificial respiration and obtain medical assistance at once.

Ingestion: Never give anything by mouth to an unconscious person. Contact a poison control center. Unless the poison control center advises otherwise, have that conscious person drink 1 to 2 glasses of water to dilute. Inducement of vomiting is not necessary unless large amounts are ingested. Obtain medical assistance at once.

Skin: Skin cuts and abrasions can be treated by standard first aid. Quickly remove contaminated clothing but do not shake clothing. Skin contamination with dust or powder can be removed by washing with soap and water. If irritation or reddened, blistered skin occurs, obtain medical assistance. Launder clothing before re-use.

Eyes: Do not allow victim to rub or keep eyes tightly shut. Dust or powder should be flushed from the eyes with copious amounts of clean water for at least 15 minutes. If irritation persists, obtain medical assistance.

Notice: INHALATION OF DUST OR FUME MAY CAUSE SERIOUS LUNG INJURY. SKIN, EYE, AND MUCOUS MEMBRANE IRRITATION MAY OCCUR.

- These products may contain, in varying concentrations, the following elemental constituents: aluminum, cobalt, chromium, copper, iron, manganese, molybdenum, nickel, and tungsten. For specific concentrations of these and other elements present, refer to the Haynes® International Safety Data Sheet (SDS) H-2071 for these products.
- Inhalation of metal dust or fume generated from welding, cutting, grinding, melting, or dross handling of these alloys may cause adverse health effects such as reduced lung function, nasal, and mucous membrane irritation. Exposure to dust or fume generated by the use of these alloys may also cause eye irritation, skin rash, and effects on other organ systems.
- Chromium and its compounds, cobalt and its compounds, and nickel and its compounds are classified as carcinogens by NTP and/or IARC.
- Avoid breathing dust of fume. If this material produces dust or fume, use appropriate ventilation controls, personal protective equipment, or both. For additional information refer to the Safety Data Sheets (SDS H2071 and H1072) for these products.

HAYNES International

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