HAYNES International

SAFETY DATA SHEET

HAYNES INTERNATIONAL, INC.
Corrosion-resistant Alloys and High-temperature Alloys

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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 those jurisdictions that have adopted the Globally Harmonized System (GHS) of Classification and Labeling of Chemicals, and the Superfund Amendments and Reauthorization Act of 1986.

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 8

HASTELLOY® B alloy	HASTELLOY® W alloy	HAYNES® 230® alloy
HASTELLOY® B-2 alloy	HAYNES® GTD 222 alloy	HAYNES® 233® alloy
HASTELLOY® B-3® alloy	HAYNES® HMA-879® alloy	HAYNES® 242® alloy
HASTELLOY® C-22® alloy	HAYNES® HR-120® alloy	HAYNES® 244® alloy
HASTELLOY® C-22HS® alloy	HAYNES® HR-160® alloy	HAYNES® 263 alloy
HASTELLOY® C-86 alloy	HAYNES® HR-224® alloy	HAYNES® 282® alloy
HASTELLOY® C-276 alloy	HAYNES® HR-235® alloy	HAYNES® 556® alloy
HASTELLOY® C-4 alloy	HAYNES® NS-163® alloy	HAYNES® 600 alloy
HASTELLOY® C-2000® alloy	HAYNES® N-86 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	STELLITE® alloy 6B	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
HASTELLOY® S alloy	HAYNES® 188 alloy	ULTIMET® alloy
HASTELLOY® X alloy	HAYNES® 214® alloy	ELGILOY® alloy

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

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

The health hazards described in this section do not apply under normal handling and use of these products in solid form. Cutting, grinding, etc., of these products may produce dust, or particulate containing the component elements of these materials with associated health hazards described in this section. If these products are involved in welding, thermal cutting, or melting, the health hazards described in the Haynes Wire Company SDS for Welding Products and Thermal Spray Wire also apply.

2.1 GHS Hazard Classification – Signal Word, Classification, and Category (separate classifications are provided for each Haynes product or product groups)	**Hazard Codes and Hazard Statements**
All products in Section 1: **Danger:** Carcinogenicity (Category 1A)	H350 May cause cancer
All products in Section 1: **Warning:** Skin sensitization, (Category 1)	H317 May cause an allergic skin reaction
All products in Section 1: **Danger:** Respiratory sensitization, (Category 1)	H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled
All products in Section 1: **Warning,** Skin irritation (Category 2)	H315 Causes skin irritation
All products in Section 1: **Warning**: Acute toxicity, inhalation (Category 4)	H 332 Harmful if inhaled
All products except those listed below: **Warning,** Acute toxicity, oral (Category 4)	H 302 Harmful if swallowed
HASTELLOY® HYBRID®BC1, C-86, D205, G-35, N, 601, 690, 242, 75, 625, 718, X-750, 625SQ, and HAYNES® 625(Low Iron) alloy.	

2.2 Label Elements and Hazards (applies to dust and metal fume only)

Precautionary Statements and Symptoms; All products in Section 1:

P201 Obtain special instructions before use.
P202 Do not handle until all safety precautions have been read and understood.
P261 + P270 Do not eat, drink or smoke when using this product. Avoid breathing dust or fume.
P264 Wash hands thoroughly after touching dust created by these products.
P271 Use only outdoors or in a well-ventilated area.
P272 Contaminated work clothing should not be allowed out of the workplace.
P280 Wear protective gloves, clothing, eye and/or face protection.
P284 In case of inadequate ventilation, wear respiratory protection

Hazards not otherwise classified or not covered by GHS

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.

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.

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.

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.

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.

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

HEALTH HAZARD TABLES: TABLE 1 shows the Hazardous Materials Information system (HMIS) hazard rating for each product. Complete chemical names, abbreviations, and Chemical Abstracts Service (CAS) numbers and exposure limits are provided in Section 8.1. The exposure limits listed in Section 8.1 include U.S. OSHA Permissible Exposure Limits (PELs), ACGIH Threshold Limit Value® (TLV)® and United Kingdom (UK) Workplace Exposure Limits (WEL) as a time-weighted average (TWA) values The American Conference of Governmental Industrial Hygienists (ACGIH) cautions “These limits are not fine lines between safe and dangerous concentration and should not be used by anyone untrained in the discipline of industrial hygiene.”

Table 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
HASTELLOY® B-2 alloy	0	0	0	2*	1	0	2*	0	0
HASTELLOY® B-3® alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® C-22® alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® C-22HS® alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® C-86 alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® C-276 alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® C-4 alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® C-2000® alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® HYBRID-BC1® alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® D-205® alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® G-30® alloy	0	0	0	2*	2	0	3*	2	0
HASTELLOY® G-50® alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® G-3 alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® G-35® alloy	0	0	0	2*	2	0	3*	0	0
HASTELLOY® N alloy	0	0	0	2*	1	0	3*	0	0
ULTIMET® alloy	0	0	0	2*	2	0	2*	2	0
ELGILOY® alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® 600 alloy	0	0	0	2*	1	0	2*	0	0
HAYNES® 601 alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 690 alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® S alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® X alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® W alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® HR-120® alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® HR-160® alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® 214® alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® HR-224® alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® HR-235® alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 230® alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 233™ alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® 242® alloy	0	0	0	2*	1	0	3*	0	0

Table 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® 244® alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 556® alloy	0	0	0	2*	1	0	3*	1	0
HAYNES® 25 alloy	0	0	0	2*	2	0	2*	2	0
HAYNES® 75 alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 188 alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® NS-163® alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® N-86 alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 263 alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® 625 alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 718 alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® R-41 alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® X-750 alloy	0	0	0	2*	1	0	3*	0	0
STELLITE® alloy 6B	0	0	0	2	2	0	2*	2	0
HAYNES® 80A alloy	0	0	0	2*	1	0	3*	0	0
HASTELLOY® B alloy	0	0	0	2*	1	0	2*	0	0
HAYNES® Waspaloy alloy	0	0	0	2*	2	0	3*	2	0
MULTIMET® alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 625SQ® alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 617 alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® GTD 222 alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® HMA-879® alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® 625 (Low Iron) alloy	0	0	0	2*	1	0	3*	0	0
HAYNES® 282® alloy	0	0	0	2*	2	0	3*	2	0
HAYNES® 242® alloy	0	0	0	2*	1	0	3*	0	0

* = Chronic health effects, see Table 2
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

4. FIRST AID MEASURES

INHALATION	Breathing difficulty caused by inhalation of dust or fume requires removal to fresh air and keep the victim comfortable. If breathing has stopped, perform artificial respiration. Obtain medical assistance if exposed or concerned. If experiencing respiratory symptoms, call a poison center or doctor.
INGESTION	If swallowed, rinse mouth, but never give anything by mouth to an unconscious person. Contact a poison 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 if you feel unwell.
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. If irritation persists, obtain medical assistance.

5. FIRE FIGHTING MEASURES

FLASH POINT (WITH TEST METHOD): None FLAMMABLE (EXPLOSIVE) LIMITS V/V%: LEL: None; UEL: N

5.1 EXTINGUISHING MEDIA	The solid wrought forms of these alloys are noncombustible, therefore; use extinguishing media appropriate to the surrounding fire.
5.2 SPECIFIC 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.
5.3 ADVICE FOR FIREFIGHTERS	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.
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.

6.1 Personal precautions, protective equipment and emergency procedures: Remove non-emergency personnel to safety. Emergency responders should wear respiratory protection and protective clothing if exposed to metal dust. Cleanup personnel should protect against dust inhalation and skin or eye contact.

6.2 Environmental precautions: Caution should be taken to minimize airborne generation of powder or dust and avoid contamination of air and water.

6.3 Methods for cleaning up: 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. Use non-sparking tools. Properly label all materials collected in waste container.

6.4 References: 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

7.1 PRECAUTIONS FOR SAFE HANDLING	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.
7.2 CONDITIONS FOR SAFE STORAGE INCLUDING INCOMPATABILITIES	In solid form this material poses no special problems. Store containers of metal powder locked up in a dry area away from heat, ignition sources, and incompatibles (Section 10).

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 OCCUPATOINAL EXPOSURE LIMITS

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.								CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m^3) [2]		
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			OSHA PEL [3]	ACGIH TLV®-TWA [4]	United Kingdom HSE Workplace Exposure Limit (WEL) [5]
Aluminum (Al)*	-	0.5 Max	-	0.5 Max	0.5 max	-	-	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 1[6]	1.5 Resp, 4 Inh
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	-	see Al & 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	None
Columbium (Cb) Niobium (Nb)	-	0.2 Max	-	-	-	-	-	7440-03-1	None	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	-		-	-	see Cb & 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	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02	0.1 (as Co)
Chromium (Cr)*	<1	1.5	22	21	21	16	16	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 Cr VI compounds as Cr: 0.0002	Metal, Cr II, Cr: III compounds, as Cr: 0.5 Cr VI compounds as Cr: 0.025
Copper (Cu)*	0.5 Max	0.2 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	1 (as Cu)
Iron (Fe)	2 Max	1.5	3	2 Max	2 max	5	3 Max	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5 [6]	5 (as Fe)
Lanthanum (La)	-	-	-	-	-	-	-	7439-91-0	None	None	None	None
Manganese (Mn)*	<1	3 Max	0.5 Max	0.8 Max	0.75 max	1 Max	1 Max	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.02[6]	0.05 Resp
Molybdenum (Mo)	28	28.5	13	17	16	16	16	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]	Soluble Compounds as Mo 5
Nickel (Ni)*	69	65 Min	56	61	55	57	65	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]	0.5 insoluble compounds as Ni
Silicon (Si)	0.1 Max	0.1 Max	0.08 Max	0.08 Max	0.08 max	0.08 Max	0.08 Max	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None	4 Resp, 10 Inh
Tantalum (Ta)	-	0.2 Max	-	-	-	-	-	7440-25-7		Metal & Oxide Dust: 5	None	5, 10 STEL
Titanium (Ti)	-	0.2 Max	-	-	0.14	-	0.7 Max	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10	4 resp [(5)], 10 Inh [(6)]
Tungsten (W)	0.5 Max	3 Max	3	1 Max	-	4	-	7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]	Insoluble compounds as W: 5; 10 (STEL) Soluble compounds as W: 1; 3 (STEL)
Vanadium (V)	-	0.2 Max	0.35 Max	-	-	0.35 Max	-	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 [5]	0.05
Yttrium (Y)	-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1	1, 3 (STEL)
Zirconium (Zr)	-	0.01 Max	-	-	-	-	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]	5, 10 (STEL)
Density (lb/cu in)	0.333	0.333	0.314	0.311	0.315	0.321	0.312			See Section 16 for Footnotes.		
Melting Point (° F)	~2425	~2500	~2480	~2450	~2478	~2375	~2445					

8.1 OCCUPATOINAL EXPOSURE LIMITS

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.								CAS NUMBER	NIOSH[1]	EXPOSURE LIMITS (as Mg/m^3) [2]		
Constituent(s)	C-2000® alloy N06200	HYBRID-BC1® alloy (2362)	D-205® alloy (2916)	G-30® alloy N06030	G-50®alloy N06950	G-3 alloy N06985	G-35® alloy N06035			OSHA PEL [3]	ACGIH TLV®-TWA [4]	United Kingdom HSE Workplace Exposure Limit (WEL) [5]
Aluminum (Al)*	0.5 Max	0.5 Max	-	-	0.4 Max	-	0.4 Max	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 1[6]	1.5 Resp, 4 Inh
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	-	see Al & Ti	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	None
Columbium (Cb) Niobium (Nb)	-	-	-	0.8	0.5 Max	0.5 Max	-	7440-03-1	None	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	-	-	0.5 Max	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	2 Max	-	-	5 Max	2.5 Max	5 Max	<1	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02	0.1 (as Co)
Chromium (Cr)*	23	15	20	30	20	22	33.2	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 Cr VI compounds as Cr: 0.0002	Metal, Cr II, Cr: III compounds, as Cr: 0.5 Cr VI compounds as Cr: 0.025
Copper (Cu)*	1.6	-	2	2 Max	0.5 Max	2	0.3 Max	7440-50-8	GL5325000	Dust & Mists, as Cu: 1; Fume, as Cu: 0.1	Dust & Mists, as Cu: 1; Fume: 0.2	1 (as Cu)
Iron (Fe)	3 Max	2 Max	6	15	17	19.5	2 Max	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5 [6]	5 (as Fe)
Lanthanum (La)	-	-	-	-	-	-	-	7439-91-0	None	None	None	None
Manganese (Mn)*	0.5 Max	0.25	-	1.5 Max	<1	<1	0.5 Max	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.02[6]	0.05 Resp
Molybdenum (Mo)	16	22	2.5	5.5	9	7	8.1	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]	Soluble Compounds as Mo 5
Nickel (Ni)*	59	62	65	43	50 min	44	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]	0.5 insoluble compounds as Ni
Silicon (Si)	0.08 Max	0.08 Max	5	0.8 Max	<1	<1	0.6 Max	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None	4 Resp, 10 Inh
Tantalum (Ta)	-	-	-	-	-	-	-	7440-25-7		Metal & Oxide Dust: 5	None	5, 10 STEL
Titanium (Ti)	-	-	-	-	-	-	-	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10	4 resp [(5)], 10 Inh [(6)]
Tungsten (W)	-	-	-	2.5	<1	1.5 Max	0.6 Max	7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]	Insoluble compounds as W: 5; 10 (STEL) Soluble compounds as W: 1; 3 (STEL)
Vanadium (V)	-	-	-	-	-	-	0.5 Max	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 [5]	0.05
Yttrium (Y)	-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1	1, 3 (STEL)
Zirconium (Zr)	-	-	-	-	-	-	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]	5, 10 (STEL)
Density (lb/cu in)	0.307	0.319	0.288	0.297	0.301	0.300	0.297			See Section 16 for Footnotes.		
Melting Point (° F)	~2400	~2450	~2100	~2370	~2325	~2375	~2400					

8.1 OCCUPATOINAL EXPOSURE LIMITS

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.								CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m^3) [2]		
Constituent(s)	N alloy N10003	ULTIMET® alloy R31233	600 alloy N06600	601 alloy N06601	690 alloy N06690	S alloy N06635	X alloy N06002			OSHA PEL [3]	ACGIH TLV®-TWA [4]	United Kingdom HSE Workplace Exposure Limit (WEL) [5]
Aluminum (Al)*	-	-	0.35 Max	1.4	-	0.25	0.5 Max	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 1[6]	1.5 Resp, 4 Inh
Aluminum (Al)+ Titanium (Ti)	0.5 Max	-	-	-	-	-	-	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	-	-	-	-	-	0.015 Max	0.008 Max	7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10	None
Columbium (Cb) Niobium (Nb)	-	-	-	-	-	-	0.5 Max	7440-03-1	None	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	-	-	-	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	0.2 Max	54	2 Max	-	-	2 Max	1.5	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02	0.1 (as Co)
Chromium (Cr)*	7	26	15.5	23	29	16	22	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 Cr VI compounds as Cr: 0.0002	Metal, Cr II, Cr: III compounds, as Cr: 0.5 Cr VI compounds as Cr: 0.025
Copper (Cu)*	0.35 Max	-	0.5 Max	1 Max	0.5 Max	0.35 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	1 (as Cu)
Iron (Fe)	4 Max	3	8	12	9	3 Max	18	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5 [6]	5 (as Fe)
Lanthanum (La)	-	-	-	-	-	0.02	-	7439-91-0	None	None	None	None
Manganese (Mn)*	0.8 Max	0.8	<1	1 Max	0.5 Max	0.5	<1	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.02[6]	0.05 Resp
Molybdenum (Mo)	16	5	-	-	-	15	9	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]	Soluble Compounds as Mo 5
Nickel (Ni)*	71	9	72 Min	61	58 Min	67	47	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]	0.5 insoluble compounds as Ni
Silicon (Si)	<1	0.3	0.5 Max	0.5 Max	0.5 Max	0.4	<1	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None	4 Resp, 10 Inh
Tantalum (Ta)	-	-	0.3 Max	-	-	-	-	7440-25-7		Metal & Oxide Dust: 5	None	5, 10 STEL
Titanium (Ti)	0.5	-	-	-	-	-	0.15 Max	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10	4 resp [(5)], 10 Inh [(6)]
Tungsten (W)	0.5 Max	2	-	-	-	<1	0.6	7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]	Insoluble compounds as W: 5; 10 (STEL) Soluble compounds as W: 1; 3 (STEL)
Vanadium (V)	0.5 Max	-	-	-	-	-	-	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 [5]	0.05
Yttrium (Y)	-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1	1, 3 (STEL)
Zirconium (Zr)	-	-	-	-	-	-	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]	5, 10 (STEL)
Density (lb/cu in)	0.320	0.306	0.304	0.291	0.296	0.316	0.297			See Section 16 for Footnotes.		
Melting Point (° F)	~2375	~2430	~2470	~2370	~2450	~2435	~2300					

8.1 OCCUPATOINAL EXPOSURE LIMITS

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								CAS NUMBER	NIOSH[1]	EXPOSURE LIMITS (as Mg/m^3) [2]		
Constituent(s)	W alloy N10004	HR-120® alloy N08120	HR-160® alloy N12160	214® alloy N07214	230® alloy N06230	233® alloy	242® alloy (8422)			OSHA PEL [3]	ACGIH TLV®-TWA [4]	United Kingdom HSE Workplace Exposure Limit (WEL) [5]
Aluminum (Al)*	-	0.1	0.4 Max	4.5	0.3	3.25	0.5 Max	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 1[6]	1.5 Resp, 4 Inh
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	-	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	-	0.004	-	0.01 Max	0.015 Max	0.004	0.006 Max	7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10	None
Columbium (Cb) Niobium (Nb)	-	0.7	<1	0.15 Max	0.5 Max	-	-	7440-03-1	None	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	-	-	-	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	2.5 Max	3 Max	29	2 Max	5 Max	19	<1	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02	0.1 (as Co)
Chromium (Cr)*	5	25	28	16	22	19	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 Cr VI compounds as Cr: 0.0002	Metal, Cr II, Cr: III compounds, as Cr: 0.5 Cr VI compounds as Cr: 0.025
Copper (Cu)*	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	1 (as Cu)
Iron (Fe)	6	33	2 Max	3	3 Max	1.5	2 Max	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5 [6]	5 (as Fe)
Lanthanum (La)	-	-	-	-	0.02	-	-	7439-91-0	None	None	None	None
Manganese (Mn)*	<1	0.7	0.5	0.5 Max	0.5	0.4 Max	0.8 Max	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.02[6]	0.05 Resp
Molybdenum (Mo)	24	<1	<1	0.5 Max	2	7.5	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]	Soluble Compounds as Mo 5
Nickel (Ni)*	63	37	37	75	57	52	65	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]	0.5 insoluble compounds as Ni
Silicon (Si)	<1	0.6	2.75	0.2 Max	0.4	0.2 Max	0.8 Max	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None	4 Resp, 10 Inh
Tantalum (Ta)	-	-	-	-	-	0.6	-	7440-25-7		Metal & Oxide Dust: 5	None	5, 10 STEL
Titanium (Ti)	-	0.2 Max	0.5	0.5 Max	0.1 Max	0.5	-	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10	4 resp [(5)], 10 Inh [(6)]
Tungsten (W)	<1	0.5 Max	<1	0.5 Max	14	0.3 Max	-	7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]	Insoluble compounds as W: 5; 10 (STEL) Soluble compounds as W: 1; 3 (STEL)
Vanadium (V)	0.6 Max	-	-	-	-	-	-	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 [5]	0.05
Yttrium (Y)	-	-	-	0.01	-	0.025 Max	-	7440-65-5		1	Metal and Compounds, as Y: 1	1, 3 (STEL)
Zirconium (Zr)	-	-	-	0.1 Max	-	0.03	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]	5, 10 (STEL)
Density (lb/cu in)	0.325	0.291	0.292	0.291	0.324	0.298	0.327			See Section 16 for Footnotes.		
Melting Point (° F)	~2350	~2375	~2360	~2475	~2375	~1358	~2350					

8.1 OCCUPATOINAL EXPOSURE LIMITS

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)	244® alloy (2444)	556® alloy R30556	25 alloy R30605	75 alloy (2076)	188 alloy R30188	NS-163® alloy (1630)	263 alloy N07263	CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m^3) [2]		
										OSHA PEL [3]	ACGIH TLV®-TWA [4]	United Kingdom HSE Workplace Exposure Limit (WEL) [5]
Aluminum (Al)*	0.5 Max	0.2	-	0.4 Max	-	0.5 Max	0.6 Max	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 1[6]	1.5 Resp, 4 Inh
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	2.6	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	0.006 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	None
Columbium (Cb) Niobium (Nb)	-	0.3 Max	-	-	-	1	-	7440-03-1	None	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	-	-	-	-	-	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	1 Max	18	51	-	39	40	20	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02	0.1 (as Co)
Chromium (Cr)*	8	22	20	20	22	28	20	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 Cr VI compounds as Cr: 0.0002	Metal, Cr II, Cr: III compounds, as Cr: 0.5 Cr VI compounds as Cr: 0.025
Copper (Cu)*	0.5 Max	-	-	0.5 Max	-	-	0.2 Max	7440-50-8	GL5325000	Dust & Mists, as Cu: 1; Fume, as Cu: 0.1	Dust & Mists, as Cu: 1; Fume: 0.2	1 (as Cu)
Iron (Fe)	2 Max	31	3 Max	5 Max	3 Max	21	0.7 Max	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5 [6]	5 (as Fe)
Lanthanum (La)	-	0.02	-	-	0.03	-	-	7439-91-0	None	None	None	None
Manganese (Mn)*	0.8 Max	<1	1.5	<1	1.25 Max	0.5 Max	0.4	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.02[6]	0.05 Resp
Molybdenum (Mo)	22.5	3	<1	-	-	-	6	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]	Soluble Compounds as Mo 5
Nickel (Ni)*	60	20	10	76	22	8	52	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]	0.5 insoluble compounds as Ni
Silicon (Si)	0.1 Max	0.4	0.4 Max	<1	0.35	0.5 Max	0.2	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None	4 Resp, 10 Inh
Tantalum (Ta)	-	0.6	-	-	-	-	-	7440-25-7		Metal & Oxide Dust: 5	None	5, 10 STEL
Titanium (Ti)	-	-	-	0.4	-	1.3	2.4 Max	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10	4 resp [(5)], 10 Inh [(6)]
Tungsten (W)	6	2.5	15	-	14	-	-	7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]	Insoluble compounds as W: 5; 10 (STEL) Soluble compounds as W: 1; 3 (STEL)
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 [5]	0.05
Yttrium (Y)		-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1	1, 3 (STEL)
Zirconium (Zr)	-	0.02	-	-	-	-	0.04 Max	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]	5, 10 (STEL)
Density (lb/cu in)	0.337	0.297	0.330	0.302	0.324	0.305?	0.302			See Section 16 for Footnotes.		
Melting Point (° F)	~2480	~2425	~2425	~2445	~2400	~2350	~2370					

8.1 OCCUPATOINAL EXPOSURE LIMITS

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.								CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m^3) [2]		
Constituent(s)	625 alloy N06625	718 alloy N07718	R-41 alloy N07041	X-750 alloy N07750	STELLITE6-B alloy R30006	80A alloy N07080	B alloy N10001			OSHA PEL [3]	ACGIH TLV®-TWA [4]	United Kingdom HSE Workplace Exposure Limit (WEL) [5]
Aluminum (Al)*	0.4 Max	0.5	1.5	0.8	-	1.5	-	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 1[6]	1.5 Resp, 4 Inh
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	-	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	-	0.004	0.006	-	-	0.008 Max	-	7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10	None
Columbium (Cb) Niobium (Nb)			-		-	-	-	7440-03-1	None	None	None	None
Columbium (Cb) +Tantalum (Ta)	3.7	5	-	<1	-	-	-	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	<1	<1	11	<1	58	2 Max	2.5 Max	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02	0.1 (as Co)
Chromium (Cr)*	21	18	19	16	30	19.5	<1	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 Cr VI compounds as Cr: 0.0002	Metal, Cr II, Cr: III compounds, as Cr: 0.5 Cr VI compounds as Cr: 0.025
Copper (Cu)*	0.5 Max	0.1 Max	-	0.5 Max	-	0.2 Max	0.15 Max	7440-50-8	GL5325000	Dust & Mists, as Cu: 1; Fume, as Cu: 0.1	Dust & Mists, as Cu: 1; Fume: 0.2	1 (as Cu)
Iron (Fe)	5 Max	19	5 Max	8	3 Max	1.5 Max	5	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5 [6]	5 (as Fe)
Lanthanum (La)	-	-	-	-	-	-	-	7439-91-0	None	None	None	None
Manganese (Mn)*	0.5 Max	0.35 Max	0.1 Max	0.35 Max	1.4	0.4 Max	<1	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.02[6]	0.05 Resp
Molybdenum (Mo)	9	3	10	-	1.5 Max	-	28	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]	Soluble Compounds as Mo 5
Nickel (Ni)*	62	52	52	70 Min	2.5	74	67	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]	0.5 insoluble compounds as Ni
Silicon (Si)	0.5 Max	0.35 Max	0.5 Max	0.35 Max	0.7	0.8 Max	<1	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None	4 Resp, 10 Inh
Tantalum (Ta)			-		-	-	-	7440-25-7		Metal & Oxide Dust: 5	None	5, 10 STEL
Titanium (Ti)	0.4 Max	0.9	3.1	2.5	-	2.4	-	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10	4 resp [(5)], 10 Inh [(6)]
Tungsten (W)	-	-	-	-	4	-	-	7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]	Insoluble compounds as W: 5; 10 (STEL) Soluble compounds as W: 1; 3 (STEL)
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 [5]	0.05
Yttrium (Y)	-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1	1, 3 (STEL)
Zirconium (Zr)	-	-	0.07 Max	-	-	-	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]	5, 10 (STEL)
Density (lb/cu in)	0.305	0.297	0.298	0.298	0.303	0.295`	0.334			See Section 16 for Footnotes.		
Melting Point (° F)	~2350	~2300	~2385	~2540	~2310	~2480	~2375					

8.1 OCCUPATOINAL EXPOSURE LIMITS

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.								CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m^3) [2]		
Constituent(s)	Waspaloy alloy N07001	MULTIMET® alloy R30155	282® alloy (2082)	617 alloy N06617	625SQ® alloy N06626	GTD 222 alloy (2220)	625 (Low Iron) alloy (2653)			OSHA PEL [3]	ACGIH TLV®-TWA [4]	United Kingdom HSE Workplace Exposure Limit (WEL) [5]
Aluminum (Al)*	1.5	-	1.5	1.2	0.4 Max	1.3	0.4 Max.	7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 1[6]	1.5 Resp, 4 Inh
Aluminum (Al)+ Titanium (Ti)	-	-	-	-	-	-	-	see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	0.006	-	0.005	0.006 Max	-	0.004	-	7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10	None
Columbium (Cb) Niobium (Nb)	-	-	0.2 Max	0.08	3.6	0.8	-	7440-03-1	None	None	None	None
Columbium (Cb) +Tantalum (Ta)	-	<1	-	-	-	-	3.7	see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	13.5	20	10	12.5	<1	19	<1	7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02	0.1 (as Co)
Chromium (Cr)*	19	21	19	22	21.5	22.5	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 Cr VI compounds as Cr: 0.0002	Metal, Cr II, Cr: III compounds, as Cr: 0.5 Cr VI compounds as Cr: 0.025
Copper (Cu)*	0.1 Max	0.5 Max	0.1 Max	0.5 Max	0.5 Max	0.1 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	1 (as Cu)
Iron (Fe)	2 Max	30	1.5 Max	2 Max	5 Max	<1	0.75 Max.	7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5 [6]	5 (as Fe)
Lanthanum (La)	-	-	-	-	-	-	-	7439-91-0	None	None	None	None
Manganese (Mn)*	0.1 Max	1.5	0.3 Max	0.5 Max	0.5 Max	0.1 Max	0.5 Max.	7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.02[6]	0.05 Resp
Molybdenum (Mo)	4.3	3	8.5	9	9	<1	9	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]	Soluble Compounds as Mo 5
Nickel (Ni)*	58	20	58	52	62	50	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]	0.5 insoluble compounds as Ni
Silicon (Si)	0.15 Max	<1	0.15 Max	1.2 Max	0.15 Max	0.25 Max	0.5 Max.	7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None	4 Resp, 10 Inh
Tantalum (Ta)	-	-	0.1 Max	-	0.05 Max	1	-	7440-25-7		Metal & Oxide Dust: 5	None	5, 10 STEL
Titanium (Ti)	3	-	2.1	0.3	0.4 Max	2.3	0.4 Max.	7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10	4 resp [(5)], 10 Inh [(6)]
Tungsten (W)	-	2.5	0.5 Max	-	-	2	-	7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]	Insoluble compounds as W: 5; 10 (STEL) Soluble compounds as W: 1; 3 (STEL)
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 [5]	0.05
Yttrium (Y)	-	-	-	-	-	-	-	7440-65-5		1	Metal and Compounds, as Y: 1	1, 3 (STEL)
Zirconium (Zr)	0.05	-	-	-	-	-	-	7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]	5, 10 (STEL)
Density (lb/cu in)	0.296	0.296	0.299	0.302	0.305	0.298	0.305			See Section 16 for Footnotes.		
Melting Point (° F)	~2425	~2350	~2370	~2430	~2350	~2430	~2350					

8.1 OCCUPATOINAL EXPOSURE LIMITS

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.								CAS NUMBER	NIOSH[1] RTECS NUMBER	EXPOSURE LIMITS (as Mg/m^3) [2]		
Constituent(s)	HR-224® alloy (2224)	HR-235® alloy (2431)	HMA-879® alloy (8790)	N-86 alloy (9086)	ELGILOY® alloy (1299)					OSHA PEL [3]	ACGIH TLV®-TWA [4]	United Kingdom HSE Workplace Exposure Limit (WEL) [5]
Aluminum (Al)*	3.8	0.3	1.1	-	0.1 Max			7429-90-5	BD0330000	Total Dust, as Al: 15, Respirable Dust, as Al: 5 [6]	Oxide Fume, as Al: 1[6]	1.5 Resp, 4 Inh
Aluminum (Al)+ Titanium (Ti)	-	-	1.4	-	-			see Al & Ti	see Al & Ti	See Al & Ti	See Al & Ti	See Al & Ti
Boron (B)	0.004 Max	-	0..006 Max	0.002 Max	0.001 Max			7440-42-8	ED7350000	Metal: None; Oxide Dust Total: 15	Metal: None; Oxide Dust Total: 10	None
Columbium (Cb) Niobium (Nb)	0.15 Max	-	-	-	0.1 Max			7440-03-1	None	None	None	None
Columbium (Cb) +Tantalum (Ta)		-	-	-	-			see Cb & Ta	see Cb & Ta	See Cb & Ta	See Cb & Ta	See Cb & Ta
Cobalt (Co)*	2 Max	1.1 Max	7.5	2 Max	40			7440-48-4	GF8750000	Metal, Dust & Fume, as Co: 0.1	Elemental and Inorganic Compounds, as Co: 0.02	0.1 (as Co)
Chromium (Cr)*	20	31	22	2.5	20			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 Cr VI compounds as Cr: 0.0002	Metal, Cr II, Cr: III compounds, as Cr: 0.5 Cr VI compounds as Cr: 0.025
Copper (Cu)*		3.8	-	0.2 Max	-			7440-50-8	GL5325000	Dust & Mists, as Cu: 1; Fume, as Cu: 0.1	Dust & Mists, as Cu: 1; Fume: 0.2	1 (as Cu)
Iron (Fe)	27.5	1.5 Max	3 Max	5 Max	15			7439-89-6	NO4565500	Oxide Fume: 10	Oxide Dust and Fume, as Fe: 5 [6]	5 (as Fe)
Lanthanum (La)	0.01 Max	-	-	-	-			7439-91-0	None	None	None	None
Manganese (Mn)*	0.5 Max	0.5	1 Max	1 Max	2			7439-96-5	OO9275000	Compounds & Fume, as Mn: 5 Ceiling	Elemental and Inorganic Compounds, as Mn: 0.02[6]	0.05 Resp
Molybdenum (Mo)	0.5 Max	5.6	9	10	6.4			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]	Soluble Compounds as Mo 5
Nickel (Ni)*	47	57	54	60	15			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]	0.5 insoluble compounds as Ni
Silicon (Si)	0.3	0.4	0.3 Max	1 Max	1 Max			7440-21-3	VW0400000	Total Dust: 15; Respirable Dust: 5 [6]	None	4 Resp, 10 Inh
Tantalum (Ta)		-	-	-	0.02 Max			7440-25-7		Metal & Oxide Dust: 5	None	5, 10 STEL
Titanium (Ti)	0.3	-	0.3	-	0.1 Max			7440-32-6	XR1700000	Total Oxide Dust: 15	Total Oxide: 10	4 resp [(5)], 10 Inh [(6)]
Tungsten (W)	0.5 Max	-	3	-	0.1 Max			7440-33-7	YO7175000	None	Insoluble Compounds, as W: 5 (STEL: 10) [4] Soluble Compounds, as W: 1 (STEL: 3) [4]	Insoluble compounds as W: 5; 10 (STEL) Soluble compounds as W: 1; 3 (STEL)
Vanadium (V)		-	-	-	0.1 Max			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 [5]	0.05
Yttrium (Y)		-	-	-	-			7440-65-5		1	Metal and Compounds, as Y: 1	1, 3 (STEL)
Zirconium (Zr)	0.025 Max	-	-	0.1 Max	-			7440-67-6	ZH7070000	Compounds, as Zr: 5	Metal and Compounds, as Zr: 5 (STEL: 10) [4]	5, 10 (STEL)
Density (lb/cu in)	0.280	0.298	0.309	0.309	0.300					See Section 16 for Footnotes.		
Melting Point (° F)	~2480	~2370	~2,430	~2,470	~2,600							

8. EXPOSURE CONTROLS/PERSONAL PROTECTION (Continued)

8.2 Exposure Controls

ENGINEERING CONTROLS	Local exhaust ventilation should be used to control exposure to airborne dust and fume emissions near the source (during crushing, grinding, welding, etc.). THE INDUSTRIAL HYGIENE CONTROL MEASURES GIVEN IN SDS HW-7031 FOR WELDING PRODUCTS AND THERMAL SPRAY WIRE ALSO APPLY.
RESPIRATORY PROTECTION	Use respirators approved by NIOSH or equivalent organization as specified by an Industrial Hygienist or qualified Safety Professional. Lung function tests are recommended for users of negative pressure devices. Use a respirator equipped with a HEPA filter 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	BOILING POINT; Not applicable
SUBLUMES @: Not Applicable	VAPOR DENSITY (AIR=1): Not Applicable	FLAMMABILITY: Not Flammable
pH = Not Applicable (NA)	SPECIFIC GRAVITY (H2O=1): See Section 3	LOWER/UPPER EXPLOSIVE LIMIT: NA
BOILING POINT: Not Applicable (NA)	SOLUBILITY IN WATER = None	AUTO-IGNITION TEMP.: Not Applicable
EVAPORATION RATE: Not Applicable	% VOLATILES BY VOLUME: None	RELATIVE VAPOR DENSITY: NA
PHYSICAL STATE AND COLOR: Solid - Silver Gray Color or No Color	VAPOR PRESSURE: Not Applicable	PARTICLE CHARACTERISTCS: Varies by process.

10. STABILITY AND REACTIVITY

10.1 AND 10.2 REACTIVITY AND STABILITY	Stability – These alloy products are stable, non-reactive materials. For those processes that create a dust form of these products, Haynes recommends a dust sample be tested to determine if the dust is explosible according to the National Fire Protection Association (NFPA) Standard 654.
10.3 POSSIBILITY OF HAZARDOUS REACTIONS	Does not occur.
10.4 INCOMPATIBILITY AND CONDITIONS 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.
10.5 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.

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 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 IARC) 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, NTP, and NIOSH.
	Metal Fumes - Metal particulate and fume created by welding and thermal cutting , hexavalent chromium, created when welding alloys that containing chromium, and nickel are identified as carcinogens.
	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 phytotoxicity 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. P501 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	**WARNING**: This product can expose you to chemicals including chromium, cobalt nickel, and titanium, which are known to the State of California to cause cancer. For more information, go to www.P65Warnings.ca.gov. 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.

15. REGULATORY INFORMATION (continued)

UNITED KINGDOM, E.U. and Other INTERNATIONAL REGULATIONS

International Inventories

Europe (EINECS), China (IECSC), Korea (KECL), Japan (ENCS), Canada (DSL/NDSL), Australia AIIC, US EPA (TSCA) - Toxic Substances Control Act, (40 CFR Part 710).

Component	CAS No	EINECS	TSCA	IECSC	DSL	KECL	ENCS	AIIC
Aluminum (Al)	7429-90-5	231-072-3	Listed	Listed	Listed	Listed	-	Listed
Chromium (Cr)	7440-47-3	231-157-5	Listed	Listed	Listed	Listed	-	Listed
Cobalt (Co)	7440-48-4	231-158-0	Listed	Listed	Listed	Listed	Listed	Listed
Copper (Cu)	7440-50-8	231-159-0	Listed	Listed	Listed	Listed	Listed	Listed
Iron (Fe)	1309-37-1	215-168-2	Listed	Listed	Listed	Listed	-	Listed
Manganese (Mn)	7439-96-5	231-105-1	Listed	Listed	Listed	Listed	-	Listed
Molybdenum (Mo)	7439-98-7	231-107-2	Listed	Listed	Listed	Listed	-	Listed
Nickel (Ni)	7440-02-0	231-111-4	Listed	Listed	Listed	Listed	-	Listed
Palladium	7440-05-3	231-115-6	Listed	Listed	Listed	Listed	-	Listed
Silicon (Si)	7440-21-3	231-130-8	Listed	Listed	Listed	Listed	-	Listed
Tin (Sn)	7440-31-5	231-141-8	Listed	Listed	Listed	Listed	-	Listed
Titanium (Ri)	7440-32-6	241-036-9	Listed	Listed	Listed	Listed	-	Listed
Tungsten (W)	7440-33-7	231-143-9	Listed	Listed	Listed	Listed	-	Listed
Vanadium (V)	7440-62-2	231-171-1	Listed	Listed	Listed	Listed	-	Listed

Authorization/Restrictions according to EU REACH Not applicable

Seveso III Directive (2012/18/EC)

Regulation (EC) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of dangerous chemicals: Not applicable.

Contains component(s) that meet a 'definition' of per & poly fluoroalkyl substance (PFAS)? Not applicable

The contents and format of this SDS are in accordance with EEC Commission Directive 2008/1272/EC, and EEC Commission Regulation 1907/2006/EC (REACH) Annex II. This product is classified according to Regulation (EC) Number 2020/878.

Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work.

UNITED KINGDOM, E.U. and Other 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 alloy, G-35 alloy, N alloy, 601alloy, 690 alloy, 242alloy, 75alloy, 625 alloy, 718 alloy, X-750 alloy, 625SQ alloy, 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.

16. OTHER INFORMATION

SDS STATUS

This SDS replaces the January 20, 2022 revision. Sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 15, and 16 were revised.

The above information has been prepared by APTIM, LLC., 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. All limits are Total Dust unless indicated otherwise.

[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. All limits are Total Dust unless indicated otherwise.

[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.

[7] United Kingdom Health and Safety Executive (HSE), EH40/2005 (Fourth Edition 2020) Workplace Exposure Limits (WEL). All limits are Total Dust unless indicated otherwise.

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 alloys.

HAYNES® GTD 222, HAYNES® HR-120®, HAYNES® HR-160®, HAYNES® HR-224®, HAYNES® NS-163®, HAYNES® HR-235®, HAYNES® Waspaloy, HAYNES® X-750, STELLITE® alloy 6B, 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® alloys.

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

DANGER **WARNING**

Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wash hands thoroughly after touching dust created by these products. Contaminated work clothing should not be allowed out of the workplace.

Do not eat, drink, or smoke when using this product. Avoid breathing dust or fume.

Wear safety glasses. Cut-resistant gloves and respiratory protection may be required for specific jobs. Use only outdoors, or in a well-ventilated area. In case of inadequate ventilation, wear respiratory protection.

Whenever possible recover alloys for reuse or recycling. If necessary, dispose of waste material in accordance with local, state or federal regulations.

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. If exposed or concerned, get medical advice.

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. If irritation persists, obtain medical assistance.

WARNING: This product can expose you to chemicals including chromium, cobalt nickel, and titanium, which are known to the State of California to cause cancer. For more information, go to www.P65Warnings.ca.gov.

- 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.

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