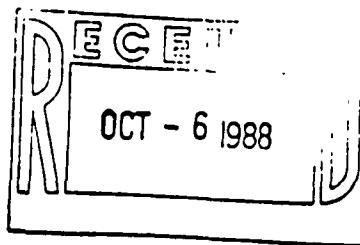


HAYNES

International

MATERIAL SAFETY DATA SHEET

Safety Department
1020 West Park Avenue
Post Office Box 9013
Kokomo, Indiana 46904-9013



August 15, 1988

FOR ALL HAYNES INTERNATIONAL, INC. WELDING CONSUMABLES

This document was prepared to meet the requirements of OSHA's Hazard Communication Standard, 29 CFR 1910.1200.

Users of the products covered by this MSDS should (1) pass this safety information on to their employees as well as customers, contractors and agents, and (2) request customers, contractors and agents to pass this same safety information on to their employees, customers, contractors and agents for the same products.

SECTION 1 - MANUFACTURER/SUPPLIER

Haynes International, Inc.
P. O. Box 9013
1020 West Park Avenue
Kokomo, Indiana 46904-9013
USA

Emergency Telephone
317-456-6894

Information Telephone
317-456-6625

SECTION 2 - PRODUCT IDENTIFICATION AND INGREDIENTS, INCLUDING HAZARDOUS INGREDIENTS

This section covers the ingredients of these welding products as manufactured. The fumes and gases (decomposition products) produced during welding, with the normal use of these products, are covered in SECTIONS 5 and 6. The composition and form of the decomposition products are different from the ingredients listed in this section. The term "hazardous" in "hazardous ingredients" should be interpreted as a term defined in the OSHA Hazard Communication Standard and does not necessarily imply the existence of a welding hazard.

The chemical ingredients of these MSDS products are shown in TABLE 1: Bare Wire Welding Products for Gas Metal Arc Welding (GMAW), Gas Tungsten Arc Welding (GTAW), Plasma Arc Welding (PAW), Submerged Arc Welding (SAW) and other similar welding processes; and TABLE 2: Shielded Metal Arc Welding (SMAW) Electrode Products. Standard chemical abbreviations and terminology are used in the tables relating to this section. Complete chemical names, abbreviations, and Chemical Abstracts Service (CAS) numbers and exposure limits are described in TABLE 6 and TABLE 7.

WARNING: Welding with these products produces chemicals which are known to the State of California to cause cancer.

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SECTION 3 - PHYSICAL/CHEMICAL CHARACTERISTICS

The bare wire welding products are produced as straight lengths and coiled wires. The SMAW electrodes are produced as metal core rods coated with a flux. As shipped these products are nonreactive, and are not chemically hazardous.

Boiling Point	N/A	Specific Gravity Range (H ₂ O = 1)
Vapor Pressure (mm Hg.)	N/A	7 - 9
Vapor Density (Air = 1)	N/A	Percent Volatile by Volume (%) N/A
Solubility in Water	INSOLUBLE	Evaporation Rate N/A

SECTION 4 - FIRE and EXPLOSION HAZARD DATA

As shipped, these products are nonflammable and non-explosive. However, welding arcs and sparks can ignite combustibles, and can initiate fires and explosions. Be sure you read and understand American National Standard Institute standard ANSI Z49.1 "Safety in Welding and Cutting" and National Fire Protection Association standard 51B for fire prevention in "Cutting and Welding Processes" before using these products.

SEC

Extinguishing Media	Flash Point (Method Used)	Flammable Limit
N/A	N/A	N/A
Unusual Fire and Explosive Hazards	Special Fire Fighting Procedures	
N/A	N/A	

SECTION 5 - REACTIVITY DATA and HAZARDOUS DECOMPOSITION PRODUCTS

Welding fumes and gases cannot be easily classified. The composition and quantity of the fumes and gases are dependent upon

- (1) the base metal being welded
- (2) the welding process and procedure being employed
- (3) the welding products being used.

Other conditions which also influence the composition and quantity of the fume and gases to which employees may be exposed include

- (1) coatings on the metal being welded (such as paint, plating, galvanizing)
- (2) the number of welders and volume of the work space
- (3) the quality and amount of ventilation
- (4) position of the welder's head relative to the fume plume, and
- (5) presence of contamination in the atmosphere (such as chlorinated hydrocarbon vapors from cleaning and degreasing).

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The welding fume of most of these welding products contain certain ingredients which either may, or will, reach their PEL or TLV before reaching the TLV-TWA of 5 mg/m³ defined by ACGIH for general welding fumes. The ingredients of special concern are noted in TABLES 3, 4 and 5, as well as being listed on the product labels. Monitoring the welding fume for these ingredients is recommended. Monitoring for the ACGIH Welding fumes (NOC) is also recommended for all products.

INGREDIENTS OF SPECIAL CONCERN - CHROMIUM AND NICKEL: The National Toxicology program (NTP) lists chromium and certain chromium compounds as substances known to be carcinogenic and lists nickel and certain nickel compounds as substances that may reasonably be anticipated to be carcinogens. The International Agency for Research on Cancer (IARC) monogram series designates them as Group 1 and Group 2A, respectively.

Many of the welding products covered by this MSDS and the fumes produced during welding contain compounds of chromium and nickel. While certain chromium and nickel compounds have been clearly shown to be animal and human carcinogens, these same compounds have not been found in welding fumes. It is understood that there are no reliable scientific studies which show that stainless steel welders or any welders or workers exposed to alloys containing significant chromium and/or nickel run increased risks of lung cancer because of exposure to the forms of chromium and nickel found in welding fumes.

ROUTES OF ENTRY: The major route of entry of the fumes and gases is inhalation. Skin contact may be the cause of dermatitis or allergies. Ingestion of material is possible via dirty hand contact with food and mouth. Aggravation of preexisting respiratory allergic conditions may occur in some workers. Some studies have shown a higher level of lung related problems among older workers who smoked than those who did not smoke. Where exposure data are available, they show overexposure to welding fumes.

WELDING GASES: Shielding gases are used with GMA welding and GTA welding, and other gases are produced by the welding action itself. The GASES EXPECTED are listed in TABLE 5, and TABLE 7 lists the HEALTH EFFECTS RESULTING FROM EXCESSIVE EXPOSURE.

HEALTH HAZARD TABLES: TABLE 6 and TABLE 7 show the compounds which have been discussed in other parts of this MSDS, and the compounds which may be encountered during the normal use of Haynes International, Inc. welding products. The compound names and formulas, CAS numbers, and exposure limits are given. Table 7 presents brief descriptions of possible known short term and long term health hazards which may result from overexposure. Detailed health hazards information is not included for the chemicals listed in Table 6 because 1) they are present only as complex combinations with other

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ingredients, and 2) their presence in the welding fumes is expected to be below their PEL or TLV-TWA when the total welding fume reaches its TLV-TWA of 5mg/m³. Among the sources for this information are TSCA list for CAS numbers, NIOSH/OSHA Pocket Guide to Chemical Hazards and ACGIH Documentation of the Threshold Limit Values.

SECTION 7 - PRECAUTIONS FOR SAFE HANDLING, and

SECTION 8 - CONTROL MEASURES

WELDING HAZARDS: Welding hazards are complex. Available accident and health records show that the great majority of the problems result from physical accidents; such as from electric shock or restricted visibility/mobility, physical strains, radiation burns (such as "eye flash") heat burns due to hot metal or spatter, or metal fume fever.

Read and understand the manufacturer's instructions and precautionary labels on the products. See American National Standard Institute standard Z49.1 "SAFETY IN WELDING AND CUTTING" published by the American Welding Society, PO Box 351040, Miami, FL 33135, and the OSHA publication 2206 (29 CFR 1910) available from the US Government Printing Office, Washington DC 20402. The National Electrical Manufacturers Association publication EW 5-1982 states:

Electric arc welding may create one or more of the following health hazards:

Fumes and gases can be dangerous to your health. Short-term overexposure to welding fumes may result in discomfort such as dizziness, nausea, or dryness or irritation of nose, throat, or eyes. Arc Rays can injure eyes and burn skin. Electric shock can kill.

EXPOSURES: Maintain all exposures below the limits shown in this MSDS, and the precautionary statements on the package and on the product label. Use industrial hygiene air monitoring to ensure compliance with the recommended exposure limits. ALWAYS USE EXHAUST VENTILATION.

VENTILATION: Use enough ventilation, local exhaust at the arc, or both to keep fumes and gases from the worker's breathing zone and the general area. Train welders to keep their heads out of the welding plume. If the fumes are removed by filtration or some other means and the air/gas stream is put back into the room, gases may build up to toxic or asphyxiation levels. Gas build-up should be monitored and if excessive should be removed or reduced to safe levels by some supplementary system and/or reduced by general ventilation.

Remember - the shielding gases used with the GMAW and GTAW processes can displace breathing air and cause asphyxiation in confined work spaces or unventilated areas.

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RESPIRATORY PROTECTION: Be sure to use a fume respirator or air supplied respirator when welding in confined spaces or where local exhaust or ventilation does not keep exposure below the PEL and TLV limits.

EYE PROTECTION: Arcs produce ultraviolet and infrared radiation. Wear a welder's helmet or use a face shield with protective lenses. As a rule start with a lens shade that is too dark to see the weld zone. Then go to a lighter shade (a lower number shade) which gives sufficient view of the weld zone. Do not go below the minimum recommended in ANSI standard Z49.1 mentioned in this MSDS.

PROTECTIVE CLOTHING: Wear hand, head and body protection which help to prevent injury from radiation, sparks and electric shock. Refer to ANSI Z49.1 for more information. At a minimum this includes dry welder's gloves and a protective face shield and may include arm protectors, aprons, hats, shoulder protectors as well as dark, substantial clothing.

ELECTRIC SHOCK: Welders should be trained to avoid electric shock by maintaining a dry work area, insulating themselves from the workpiece and ground, and not touching live electrical parts.

WASTE DISPOSAL: Dispose of fume, flux and weld grinding residues from the work area, or from filters, in accordance with local, state and federal regulations. Refer to this MSDS for information on the possible contents of the collected fumes and other materials.

* * * * *

Haynes International, Inc. believes this information to be accurate and to reflect the information available at the publication date of this MSDS. However, Haynes International, Inc. cannot make any express or implied warranty as to the accuracy of this information.

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Table 1
Bare Wire Welding Products

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ALLOY	AWS/UNS Alloy No.	Normal Composition, Weight Percent												
		Ni	Co	Cr	Mo	W	Fe	Si	Mn	Al	Ti	Cu	B	Other
HASTELLOY alloy B	Ni0001	67	2.5*	1.0*	28	1.0*	5.0	1.0*	1.0*	--	--	0.5*	--	V-0.3*
HASTELLOY alloy B-2	Ni0665	69	1.0*	1.0*	28	--	2.0*	0.10*	1.0*	--	--	0.5*	--	--
HASTELLOY alloy C-4	N06455	65	2.0*	16	15.5	--	3.0*	0.08*	1.0*	0.7	0.5*	--	--	--
HASTELLOY alloy C-22	N06022	56	2.5*	22	13	3.0	3.0	0.08*	0.5	--	--	--	--	V-0.35*
HASTELLOY alloy C-276	Ni0276	57	2.5*	15.5	16	4.0	5.5	0.08*	1.0*	--	0.5*	--	--	V-0.35*
HASTELLOY alloy G-3	N06985	44	5.0*	22	7.0	1.5*	19.5	1.0*	1.0*	--	--	2.0	--	Cb+Ta-0.50*
HASTELLOY alloy G-30	N06030	43	2.0*	29.5	5.5	2.5	15	1.0*	1.0*	--	--	2.0	--	Cb-0.80
HASTELLOY alloy H-9M	--	45	5.0*	22	9.0	2.0	18.5	0.6*	1.0*	--	--	1.0	--	Cb-0.5*
HASTELLOY alloy N	Ni0003	71	0.2	7.0	16.5	0.5*	5.0*	1.0*	0.8*	0.5*	--	0.35*	0.01*	Al+Ti-0.50*
HASTELLOY alloy S	N06635	67	2.0*	15.5	14.5	1.0*	3.0*	0.4	0.5	0.25	--	--	0.015*	La-0.05
HASTELLOY alloy W	Ni0004	63	2.5*	5.0	24	--	6.0	1.0*	1.0*	--	--	0.5*	--	V-0.60*
HASTELLOY alloy X	N06002	47	1.5	22	9.0	0.60	18.5	1.0*	1.0*	--	--	0.5*	0.008*	--
WASPALOY alloy	N07001	58	13.5	19	4.3	--	2.0*	0.15*	0.1	1.5	3.0	0.16	0.006	Zr-0.05
HAYNES alloy No R-41	N07041	52	11	19	10	--	5.0*	0.5*	0.1*	1.5	3.1	--	0.006	--
HAYNES alloy No 214	--	75	2.0*	16	0.5*	0.5*	2.5	0.2*	0.5*	4.5	--	--	0.01*	Cb-0.15*, La-0.05
HAYNES alloy No 230	N06230	57	5.0*	22	2.0	14	3.0	0.4*	0.5	0.3	--	--	0.005	La-0.03
HAYNES alloy No 263	N07263	50	20	20	6	--	0.7*	0.4*	0.6*	--	--	0.2*	--	Al+Ti-2.6
HAYNES alloy No 625	N06625	62	1.0*	21.5	9.0	--	5.0*	0.5*	0.5*	0.4*	0.4*	0.5*	--	Cb+Ta-3.7
HAYNES alloy No 718	N07718	53	1.0*	18	3.0	--	19	0.35*	0.35*	0.5	0.9	0.1*	0.004	Cb+Ta-5.0
HAYNES alloy No X-750	N07750	70	1.0	15.5	--	--	7.0	0.35	0.35	0.8	2.5	0.5*	--	Cb+Ta-1.0
HAYNES alloy No 556	R30556	20	20	22	3.0	2.5	29	0.35	1.0	0.2	--	--	--	Zr-0.02, La-0.02
MULTIMET alloy	R30155	20	20	21	3.0	2.5	30	1.0*	1.5	--	--	0.5*	--	Cb+Ta-1.0
HAYNES alloy No 25	R30506	10	51	20	--	15	3.0	0.4	1.5	--	--	--	--	--
HAYNES alloy No 31	R30031	11	54	25.5	--	7.5	2.0	1.0	1.0	--	--	--	--	--
HAYNES alloy No 188	R30188	22	39	22	--	14	3.0	0.35	1.25	--	--	--	--	La-0.07
FERRALIUM alloy 255	S32550	6	--	26	3.3	--	62	1.0*	1.5*	--	--	1.7	--	--
FM-259 alloy		9	--	25	3.1	--	Bal	0.4	1.0	--	--	1.9	--	--

XX* - Indicates maximum value

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WASPALOY is a trademark of United Technologies Corp.

FERRALIUM is a registered trademark of Langley Alloys, Ltd.

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Table 2

Shielded Metal Arc Welding (SMAW) Electrode Products			
Alloy	AWS/UNS Alloy No.	Core Wire Composition ⁽¹⁾ (R 80% by Wt)	Other Coating Ingredients ⁽²⁾ (R 20% by Wt)
HASTELLOY alloy B-2	W80665	N10665	Oxides and/or Fluorides of Aluminum (Al) Barium (Ba) Calcium (Ca) Magnesium (Mg) Potassium (K) Sodium (Na) Strontium (Sr) and Titanium (Ti)
HASTELLOY alloy C-4	W86022	N106022	
HASTELLOY alloy C-22	W86022	N06022	
HASTELLOY alloy C-276	W80276	N10276	
HASTELLOY alloy G-3	W86985	N06985	
HASTELLOY alloy G-30	W86030	N06030	
HASTELLOY alloy H-9M	-	-	
HASTELLOY alloy W	W80004	N10004	
HASTELLOY alloy X	W86002	N06002	
HAYNES alloy No. 230	-	N06230	
HAYNES alloy No. 25	-	R30605	
MULTIMET alloy	-	R30155	
FERRALUM alloy 255	-	S32550	
FM-259 alloy	-	-	

(1) Corresponding core wire composition of grade is given in Table 1 as identified by UNS Number or alloy.

(2) Chemical Abstracts Service (CAS) numbers, PEL and TLV-TWA information are given in Table 6.

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Table 3

Potentially Hazardous Decomposition Products for
Bare Wire Welding Products

ALLOY	AWS/UNS Alloy No	Recommended Air Monitoring (1) Where Indicated by "WILL" or "MAY" (2) (Ingredient and TLV or PEL)			
		CrII/CrIII 0.5	Ni 1.0	Co 0.05	Cu 0.1
HASTELLOY alloy B	N10001		WILL	MAY	
HASTELLOY alloy B-2	N10665		WILL		
HASTELLOY alloy C-22	N06022	WILL	WILL	MAY	
HASTELLOY alloy C-276	M10276	MAY	WILL	MAY	
HASTELLOY alloy C-4	N06455	MAY	WILL		
HASTELLOY alloy N	N10003		WILL		
HASTELLOY alloy S	N06635	MAY	WILL		
HASTELLOY alloy W	N10004		WILL	MAY	
HASTELLOY alloy X	N06002	WILL	WILL	WILL	
HASTELLOY alloy G-30	N06030	WILL	WILL	WILL	MAY
HASTELLOY alloy G-3	N06985	WILL	WILL	WILL	MAY
HASTELLOY alloy H-9M	--	WILL	WILL	WILL	
HAYNES alloy No 230	N06230	WILL	WILL	MAY	
HAYNES alloy No 625	N06625	WILL	WILL		
HAYNES alloy No 718	N07718	WILL	WILL		
HAYNES alloy No 214	--	MAY	WILL	MAY	
HAYNES alloy No X-750	N07750	MAY	WILL		
HAYNES alloy No 263	N07263	WILL	WILL	WILL	
HAYNES alloy No R-41	N07041	WILL	WILL	WILL	
WASPALOY alloy	N07001	WILL	WILL	WILL	
HAYNES alloy No 188	R30188	WILL	MAY	WILL	
HAYNES alloy No 556	R30556	WILL	MAY	WILL	
MULTIMET alloy	R30155	WILL	MAY	WILL	
HAYNES alloy No 25	R30506	WILL		WILL	
HAYNES alloy No 31	R30031	WILL		WILL	
FERRALIUM alloy 255	S32550	WILL			MAY
FM-259 alloy	--	WILL			MAY

(1) See Sections 5 and 6 and the labels on the product containers

(2) WILL - The TLV or PEL of the indicated ingredient WILL BE
EXCEEDED before reaching the ACGIH 5 mg/m³ TLV-TWA
for the general welding fume (NOC)

MAY - The TLV or PEL of the indicated ingredient MAY BE
EXCEEDED before reaching the ACGIH 5 mg/m³ TLV-TWA
for the general welding fume (NOC)

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Table 4

Potentially Hazardous Decomposition Products
for

Shielded-Metal-Arc (SMAW) Electrode Products

ALLOY	AWS/UNS Alloy No	Recommended Air Monitoring (1) Where Indicated by "WILL" or "MAY" (2) (Ingredient and TLV or PEL)		
		Cr VI <u>0.05</u>	Co <u>0.05</u>	Cu <u>0.1</u>
HASTELLOY alloy B-2	W80665			
HASTELLOY alloy C-22	W86022	WILL		
HASTELLOY alloy C-276	W80276	WILL		
HASTELLOY alloy C-4	W86455	WILL		
HASTELLOY alloy W	W80004	WILL		
HASTELLOY alloy X	W80002	WILL		
HASTELLOY alloy G-3	W86985	WILL		MAY
HASTELLOY alloy G-30	W86030	WILL		MAY
HAYNES alloy No 230		WILL		
HAYNES alloy No 25		WILL	WILL	
MULTIMET alloy		WILL	WILL	
FERRALIUM alloy 255		WILL		MAY
FM-259 alloy		WILL		MAY

(1) See Sections 5 and 6 and the labels on the product containers

(2) WILL - The TLV or PEL of the indicated ingredient WILL BE EXCEEDED before reaching the ACGIH 0.05 mg/m³ TLV-TWA for the general welding fume (NOC)

MAY - The TLV or PEL of the indicated ingredient MAY BE EXCEEDED before reaching the ACGIH 0.05 mg/m³ TLV-TWA for the general welding fume (NOC)

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Table 5
Hazardous Decomposition Product Information

PRODUCTS	FUMES EXPECTED	GASES EXPECTED	TLV or PEL for POTENTIALLY HAZARDOUS DECOMPOSITION PRODUCTS
Rare Wire Products used in Gas Metal Arc Welding (all alloys listed in Table 1)	Complex oxide combinations of all elements present in the welding wire grade listed in Table 1	Normally low. Ozone and oxides of nitrogen generation possible at welding arc or well away from arc. Inert shielding gases can cause asphyxiation in confined welding spaces and unvent- ilated areas.	TLV-TWA for welding fume (NOC)-5 mg/m ³ PEL for total respiratable dust-6 mg/m ³ TLV-TWA for chromium (II and III)-0.5 mg/m ³ PEL for chromium and insoluble salts (II and III)-1 mg/m ³ TLV-TWA for cobalt - 0.05 mg/m ³ PEL for cobalt - 0.1 mg/m ³ TLV-TWA for copper fume - 0.2 mg/m ³ PEL for copper fume - 0.1 mg/m ³ TLV-TWA and PEL for nickel metal - 1 mg/m ³
Rare Wire Products used in Gas Tungsten Arc Welding, plasma arc welding and other inert processes (all alloys listed in Table 1)	Same as above, however fume volume is very small under normal GTAW conditions	Same as above	Same as above

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Table 5 (cont.)

Hazardous Decomposition Product Information

PRODUCTS	FUMES EXPECTED	GASES EXPECTED	TLV or PEL for POTENTIALLY HAZARDOUS DECOMPOSITION PRODUCTS
1/1 Shielded Metal Arc Welding electrode alloys listed in Table 2	Complex oxide and fluoride combinations of all electrode ingredients listed in Table 2	Normally low, if any symptoms indicate the need, check for gaseous fluorides and/or oxides of nitrogen See Health Hazard Data given in Table 6 for symptoms.	TLV-TWA for welding fume (MOC) - 5 mg/m ³ PEL for total respirable dust - 5 mg/m ³ TLV-TWA for chromium (VI) - 0.05 mg/m ³ PEL for chromium soluble salts 0.5 mg/m ³ TLV-TWA for cobalt - 0.05 mg/m ³ PEL for cobalt - 0.1 mg/m ³ TLV-TWA for copper fume - 0.2 mg/m ³ PEL for copper fume - 0.1 mg/m ³ TLV-TWA and PEL for nickel metal - 1 mg/m ³
Bare Wire Products used in Submerged Arc Welding (some alloys listed in Table 1)	Same as above, however fume volume is very small under normal SAW conditions	Same as above	Same as above

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Table 6
Component Materials Identification

MSDS Welding Products
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Metal or Chemical	Symbol	CAS Number	Exposure Limits (as Mg/m ³)*	
			OSHA PEL	ACGIH TLV
Aluminum	Al/Al ₂ O ₃	7429-90-5/1344-28-1	None	5.0 (as welding fume)
Barium (compounds)	Ba (X)	7440-39-3	0.5(soluble compounds as Ba)	0.5 (soluble compounds as Ba)
Boron	B	7440-42-8	None	None
Boron Oxide	B ₂ O ₃	1303-86-2	15.0	10.0
Calcium	Ca	7440-70-2	None	None
Calcium oxide	CaO	1305-78-8	5.0	2.0
Columbium (Niobium)	Cb/Cb ₂ O ₈ (Nb/Nb ₂ O ₈)	7440-03-1/1313-96-8	None	None
Lanthanum	La	7439-91-0	None	None
Lithium	Li/Li ₂ O	7439-92-2/12057-24-8	None	None
Magnesium	Mg	7439-95-4	None	None
Magnesium oxide	MgO	1309-48-4	15.0 (as fume)	10.0
Molybdenum (compounds)	(Mo)(X)	7439-98-7	15.0 (insoluble compounds as Mo)	10.0 (insoluble compounds as Mo)

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Table 6 (cont.)
Component Materials Identification

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Metal or Chemical	Symbol	CAS Number	Exposure Limits (as Mg/m^3)*	
			OSHA PEL	ACGIH TLV
Potassium	K/K ₂ O	7440-09-7/12136-47-7	None	None
Silicon	Si	7440-21-3	None	None
Silicon oxide (amorp)	SiO ₂	7631-86-9	20 mppcf	10.0
Sodium	Na/Na ₂ O	7440-23-5/1313-59-3	None	None
Strontium	Sr/SrO	7440-24-6/1314-11-0	None	None
Titanium	Ti	7440-32-6	None	None
Titanium oxide	TiO ₂	13463-67-7	15.0	10.0
Tungsten compounds	(W) (X)	7440-33-7	None	5.0 (10.0 STEL) (insoluble compounds as W)
Zirconium compounds	(Zr) (X)	7440-67-7	5.0 (compounds as Zr)	5.0 (10.0 STEL) (compounds as Zr)

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Table 7
HEALTH HAZARD TABLE

MSDS Welding Product,
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The following table shows the compounds and gases which have been discussed previously, and which may be encountered, their names and formulas, their CAS number, the maximum allowable exposure limits per OSHA (PELs) and ACGIH (TLVs), and briefly describes possible known short term and long term health effects which may result from excessive exposure.

Name of Compound, Formula and CAS Number	Allowable Exposure Limit as Element Unless Otherwise Indicated PEL (OSHA) TLV (ACGIH)	On Any Carcinogens List? If So, Which Ones?	Health Effects Resulting From Excessive Exposures	
			Acute (Short Term)	Chronic (Long Term)
Welding Fumes and Components of Welding Fumes				
Welding Fumes (not otherwise classified)	PEL equivalent is 5 mg/m ³ for any respirable mineral inert or nuisance dust (Table Z-3)	No	May include metallic taste, nausea, tightness of chest, fever, dizziness, dryness or irritation of eyes, nose or throat	Excessive levels may cause bronchial asthma, lung fibrosis, pneumoconiosis or "siderosis"
CAS No. - none	TLV-TWA - 5 mg/m ³		See also gases shown later in this table - some of the above effects may come from the gases present	
Chromium VI-Cr VI Sodium Chromate Na ₂ CrO ₃ (soluble) CAS No. 7775-11-3 Potassium Chromate K ₂ CrO ₃ (soluble) CAS No. 7789-00-6	PEL-0.05 mg/m ³ as Cr VI (Table Z-2 is 1 mg/ 10 m ³ as CrO ₃) TLV-TWA 0.05 mg/m ³	Yes IARC NTP OSHA	Allergic reaction in some people irritation of mucous membranes	Compounds are dissolved, and excreted or modified to Cr II or Cr III. LISTED AS SUSPECT HUMAN CARCINOGEN. Evidence from studies of welding and metallurgical process fumes containing chromium compounds do not confirm any carcinogenic effect.
Chromium-Cr CAS No. 7440-47-3 Chromium oxide (Cr II)CrO CAS No. 12018-00-7 Chromium oxide (Cr III) Cr ₂ O ₃ CAS No. 1308-38-9	PEL-1 mg/m ³ as Cr metal TLV-TWA-0.5 mg/m ³ as Cr metal	Yes IARC NTP	Allergic reactions in some people	None known, but LISTED AS A SUSPECT HUMAN CARCINOGEN ON IARC AND NTP LISTS. Evidence from studies of welding and metallurgical process fumes containing chromium II and III compounds do not confirm any carcinogenic effect.
Nickel-Ni CAS No. 7440-02-0 Nickel oxide-NiO CAS No. 1313-99-1	PEL-1 mg/m ³ (as Ni metal) TLV-TWA-1 mg/m ³ (as Ni metal)	Yes IARC NTP	Allergic reactions in some people. Metallic taste, nausea, tightness in chest, metal fume fever.	None known, BUT LISTED AS A SUSPECT HUMAN CARCINOGEN ON IARC AND NTP LISTS. Evidence from studies of welding and metallurgical process fumes containing nickel compounds d not confirm any carcinogenic effect.

Table 7 (cont.)
HEALTH HAZARD TABLES

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Name of Compound, Formula and CAS Number	Allowable Exposure Limit as Element Unless Otherwise Indicated PEL (OSHA) TLV (ACGIH)	On Any Carcinogens List? If So, Which Ones?	Health Effects Resulting From Excessive Exposures	
			Acute (Short Term)	Chronic (Long Term)
Welding Fumes and Components of Welding Fumes				
Cobalt-Co CAS No. 7440-48-4 Cobalt Oxide-CoO CAS No. 1307-9606	PEL-0.1 mg/m ³ TLV-TWA-0.05 mg/m ³ (as Co metal for dust and fume)	No	Pulmonary irritant, cough, dermatitis	Possible lung fibrosis and respiratory hypersensitivity.
Copper-Cu CAS No. 7440-50-8 Copper oxide-CuO CAS No. 1317-38-0	PEL-0.1 mg/m ³ for fume TLV-TWA-0.2 mg/m ³ for fume	No	Metal fume fever, muscle ache, respiratory irritant	None known.
Manganese-Mn CAS No. 7439-96-5 Manganese dioxide- as Mn for fume MnO ₂ CAS No. 1313-13-9	PEL-5 mg/m ³ as ceiling (maximum at any time) TLV-TWA-1 mg/m ³	No	Can include metal fume fever, dry throat, coughing, tight chest, low back pain, vomiting, fatigue, headache	"MANGANISM". SENSITIVITY VARIES. Affects central nervous system. Muscular weakness, tremors, symptoms similar to Parkinson's disease.
Vanadium Pentoxide (V ₂ O ₅) CAS No. 1314-62-1	PEL-0.1 mg/m ³ TLV-TWA-0.05 mg/m ³ as dust and fume	No	Irritant to mucous membranes. Metallic taste, cough, throat and eye irritation, eczema.	Nasal catarrh, nose bleeds, chronic respiratory problems.
Iron-Fe CAS No. 7439-89-6 Iron Oxide-FeO CAS No. 1345-25-1 Iron Oxide-Fe ₂ O ₃ CAS No. 1309-37-1 Iron Oxide-Fe ₃ O ₄ CAS No. 1309-38-2	PEL-5 mg/m ³ (as Fe in welding fumes) TLV-TWA 5 mg/m ³ (as Fe in welding fumes)	No	Probably none, except as nuisance dust.	Possible siderosis if exposures are excessive and long term. Regarded as benign. Lungs clear gradually after exposure is ended.

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Table 7 (cont.)
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Name of Compound, Formula and CAS Number	Allowable Exposure Limit as Element Unless Otherwise Indicated PEL (OSHA) TLV (ACGIH)	On Any Carcinogens List? If So, Which Ones?	Health Effects Resulting From Excessive Exposures	
			Acute (Short Term)	Chronic (Long Term)
Welding Fumes and Components of Welding Fumes				
Calcium Fluoride CaF_2 (Insoluble) CAS No. 14542-23-5 Sodium fluoride NaF fume.(soluble) CAS No. 7681-49-4 Potassium fluoride KF (soluble) CAS No. 7789-23-3 Aluminum Fluoride AlF_3 (Insoluble) CAS No. 7784-18-1 Lithium Fluoride LiF (slightly soluble) CAS No. 7789-24-4	PEL-2.5 mg/m^3 (as fluorine) TLV-TWA-2.5 mg/m^3 (as fluorine)	No	CaF_2 probably inert. Soluble fluorides may be irritants and corrosive to mucous membranes	Soluble portions may cause osteopor- osis and mottling of teeth, but effects seem reduced in presence of iron as in welding electrode fumes.
Gases Generated by Arc Welding Processes				
Fluorides: i.e., Silicon tetrafluoride SiF_4 CAS No. 7783-61-1 Hydrogen fluoride HF CAS No. 7664-39-3	See soluble fluorides portion under Welding Fumes			
Nitric oxide- NO CAS No. 10102-43-9	PEL-25 ppm TLV-TWA-25 ppm	No	Irritant to mucous membranes, drowsiness.	Chronic respiratory disease.
Nitrogen dioxide NO_2 CAS No. 10102-44-2	PEL-5 ppm TLV-TWA STEL 5ppm (10 mg/m^3)- 3ppm	No	Irritant to mucous membranes, coughing, chest pain, pulmonary edema.	Chronic respiratory disease.

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Table 7 (cont.)
HEALTH HAZARD TABLES

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Name of Compound, Formula and CAS Number	Allowable Exposure Limit as Element Unless Otherwise Indicated PEL (OSHA) TLV (ACGIH)	On Any Carcinogens List? If So, Which Ones?	Health Effects Resulting From Excessive Exposures	
			Acute (Short Term)	Chronic (Long Term)
Gases Generated by Arc Welding Processes				
Ozone-O ₃ CAS No. 10028-15-6	PEL-0.1 ppm (0.2 mg/m ³) TLV-TWA-same as PEL. STEL - 0.3 ppm (0.6 mg/m ³)	No	Irritant to mucous membranes, pulmonary edema.	Chronic respiratory disease
Carbon monoxide-CO CAS No. 630-08-0	PEL-50 ppm (55 mg/m ³) TLV-TWA-same as PEL STEL-400 ppm-(440 mg/m ³)	No	Headache, rapid breathing, oxygen deprivation, confusion, dizziness, weakness.	Oxygen deprivation.
Argon-A Carbon dioxide-CO ₂ Helium-He Nitrogen-N	Regarded as simple asphyxiants	No	Inert gases which may replace air and deprive the body of oxygen. (CO ₂ is not inert but effect is as above).	

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